Microsoft Teams
Video Capture Specification

For personal and conferencing devices

V4 April 2019

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1 Revision History

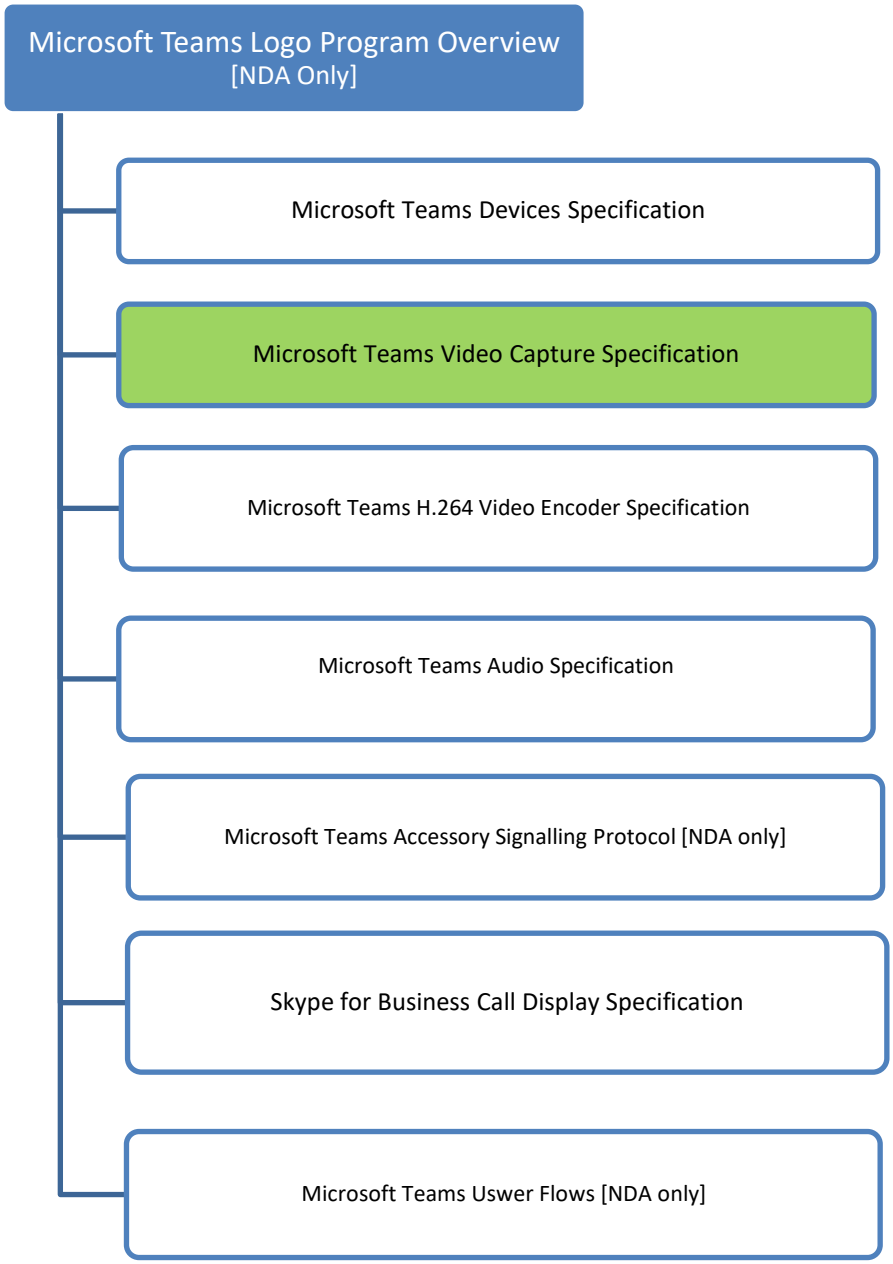
Revision	Published	Description
4.0	*4/2019*	Merged with conferencing devices specification Added greater granularity of room sizes for testing Section 5.1.1.3 is amended with the note about allowing adjusting physical zoom setting (this note remained also in section 5.1.1.2). AV sync requirement aligned with the specification for personal devices. A spreadsheet created to help conducting the video sanity tests. Respective changes made in Section 3.1.1 and note added as Section 3.1.1.5. Section 3.4.7 is revised to allow alternative solutions to LED based usage indicator. Section 6.1.4 is revised calling out that Microsoft reserves right to replace the Skype for Business client by Teams client for End to End testing. System latency and Audio/video synchronization requirements changed to account for the changes in the Remote Capture Tool. White balance error requirements are relaxed by 5 units for light conditions with color temperature up to 3000K. Premium requirement is removed. Color saturation requirement removed from secondary use case.
3.0	*11/2016*	Conferencing solutions separated into another document. This specification is valid for personal solutions only. Renamed to Skype for Business Video Capture Specification. Respective changes are made throughout the document. VGA resolution is not required. System latency requirements are relaxed by 30ms due to changes with tools. CPU requirement is clarified. Horizontal field of view consistency is relaxed to 25%. White balance error requirements are relaxed by 5 units for light conditions with color temperature up to 3000K. Premium requirement is removed. Tables 5 and 6 are amended with 4K resolution. YUY2 is no longer allowed for USB3 cameras. MJPEG stream is required for 720p and 1080p USB 2.0 cameras. MTF requirement for 80% center circle ROI is clarified. Section 5 is updated.
2.0	*10/2014*	Section 2.2 is edited to clarify the meaning of Standard and Premium levels. Section 2.3 is reviewed and fixed where incorrect. Section 2.4 is revised: • Category added for handheld devices • Camera positioning for other tests than described in Section 4.1 are described under each test target in Section 5.1.6. • Usage scenarios are split into primary and secondary ones. Limited set of requirements are added to the secondary use cases. Sections 3 and 4 are reorganized. CPU usage test description and requirement are updated. References to Windows HCK are removed. The lists of required resolutions and formats is updated. Requirement added about vertical field of view consistency.

	ST-52 test chart is replaced with ColorChecker or ITDR-36. Exposure accuracy and color saturation requirements are revised. Veiling glare test description is updated. Test conditions updated in Section 5.1.6. Latency over Skype call requirements relaxed. White balance error requirements introduced in Standard criteria. Time to change resolution requirement relaxed. Section 6.1.8 is updated by amending the lights section with additional components to control the CFL light. CFL and A-light bulbs related information is reviewed in Table 92: Light sources used in video tests. Updated the respective images in Section 5.1.5. Dot pattern charts are revised – 15 line versions are suitable but the 25 line versions are more convenient to run the distortion test. Light box related information is added. MTF50 is used instead of MTF30 when testing autofocus. Many language issues fixed. Explaining images updated for oversharpening, veiling glare, field of view, spatial SNR, temporal SNR, and field of view consistency tests.

2 Introduction

2.1 Overview

The family of documents supporting the Microsoft Teams Certification Program is shown below and contains detailed requirements that candidate devices, being submitted to the *Certification Program*, must meet.



The technical requirements listed in this document, the Microsoft Teams *Video Capture Specification*, have been derived solely for the purpose of maximizing interoperability and optimizing the quality of experience using the devices with Microsoft Teams and Skype for Business. Any use of this technical

specification for purposes other than optimizing the video quality for Microsoft Teams and Skype for Business is not authorized.

Partners who license, develop, market, and/or sell devices for Microsoft Teams or Skype for Business 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 Teams or Skype for Business platform, new device categories, as well as performance improvements in the hardware used in peripheral devices.

2.2 Performance levels

This document provides performance requirements for Microsoft Teams certified devices.

There are two levels of camera performance defined by this specification:

- Standard: Defines a good video quality level that, when achieved, makes the device eligible for Microsoft Teams Certification Program. For other entry criteria besides device AV quality, please refer to the Program Overview document mentioned in Section 2.1.
- Premium: Provided as a design target. Offered as a guidance to achieve exceptional video quality. Passing the premium requirements is not a mandatory for the logo certification.

2.3 Definitions

A-light	Incandescent light source that has similar spectral power distribution as 'illuminant A' defined by CIE.
Color accuracy	The measurement of the deviation of colors captured by a camera and the expected colors using a test chart like the ColorChecker.
Color uniformity	The measurement of the variation of color throughout an image (not just the center compared to the edges).
Color space	A color space is a mathematical model describing the way colors can be represented as tuples of numbers, typically as three or four values or color components. The standard PC color space for displays is sRGB, while cameras generally use YUV color spaces for capture.
Depth of field	Depth of field is the range of distances from the nearest to the farthest objects that a camera is able to depict in acceptably sharp manner, either at the same time or after refocusing.
DUT	Device under testing.
Dynamic range	Dynamic range is the range of unclipped gray densities the camera can capture.
Edge roughness	Edge roughness is a measurement of how rough an edge is. An edge can be rough due to demosaicing, image scaling, spatial denoising and excessive noise level.
Field of view	The field of view is the angular extent of the observable world that is seen at any given moment from a camera.
Focus	An image, or image point or region, is in focus (focused) if light from a point on the object is converged almost as much as possible in the image, and out of focus if light is not well converged. The border between these is determined by measuring the MTF.
Gamma	Gamma correction is a nonlinear operation used to code and decode luminance or tristimulus values in video or still image system to achieve best tonal reproduction and image contrast.
Geometric distortion	Geometric distortion is a deviation from rectilinear projection, a projection in which straight lines in a scene remain straight in an image.
Jitter	Jitter is the standard deviation from true periodicity of a presumed periodic signal in electronics and telecommunications, often in relation to a reference clock source.
Latency	Latency is a measure of time delay experienced in a system. For video conferencing the most important latency measurement is end-to-end latency, which is the time from photons in to a camera to photons out of a display.
MTF	Modulation Transfer Function is the magnitude of the Optical Transfer Function. MTF30 is the spatial frequency (cycles per pixel) where the MTF has dropped to 30% of its low frequency value. MTF30 is generally considered to represent the highest spatial frequency acceptably captured in an image.
Oversharpening	Oversharpening or undersharpening is a measurement that characterizes the degree that the image is sharpened relative to a standard sharpening model. If it is negative, sharpening is applied to the original response; if it is positive, de-sharpening is applied by the standard sharpening.
Relative illumination	Relative illumination, or vignetting, is a measure of the diminishing of image brightness from the center towards the corners.
ROI	Region of interest
SNR	Signal to Noise Ratio

Table 1: Definitions

2.4 Classification of the products

This document applies to all personal devices or meeting room system solutions with integrated webcam and for video peripheral devices. The described requirements are separated into requirements for personal and conferencing devices.

2.4.1 Personal solutions

The differences in usage scenarios for personal devices are considered when positioning the device under testing for tests defined in Section 4.1 Detail quality.

Category	Nominal distance	Minimum distance	Maximum distance
Handheld devices	0.30m	0.30m	1.0m
Portable devices	0.50m	0.30m	1.5m
Desktop cameras	0.70m	0.40m	1.5m

Table 2: Testing distances for personal devices to be used at Section 4.1 Detail quality.

For Section 4.1 Detail quality the conferencing cameras are to be set up at minimum supported distance. If not clearly specified in the end user documentation, then 1.0 m is the default.

Microsoft reserves the right to choose the distances for each solution separately based on the intended use cases. Vendor's recommendations provided before testing are considered.

Testing distances for other sections that are not category dependent are based on respective test targets described in Section 6.1.6 Test charts.

2.4.2 Personal solutions that fit into multiple categories

In case a product can fit into multiple categories then the use cases are prioritized based on how Microsoft Teams is used for video calling. The main use case must pass the whole specification whereas the secondary one(s) needs to pass a subset of requirements.

If the same camera can be used in a secondary use case then it must pass the tests defined in Section 4.1 at nominal distance. Namely:

- 4.1.1 MTF
- 4.1.2 Oversharpening
- 4.1.3 Edge roughness
- 4.1.5 Texture acutance

If a different camera is used for secondary use case(s) then the following requirements are applicable:

- Detail quality:
  - 4.1.4 Depth of field
- Tonal response and noise:
  - 4.2.2 Exposure accuracy
  - 4.2.3 Gamma

    - 4.2.4 Spatial SNR
    - 4.2.5 Temporal SNR
- Color quality
    - 4.3.1 Color accuracy
- Timing:
    - 4.6.5 Video frame rate during a call

General guidance for prioritizing the use cases and choosing the appropriate distances for testing:

- Mobile handsets and tablet PCs without integrated stand:
    - Main use case: handheld devices - front camera.
    - Secondary use case: portable devices - rear camera.
- Laptops and tablet PCs with integrated stand:
    - Main use case: portable devices - front camera.
    - Secondary use case: portable devices - rear camera.
- Detachable type of PC:
    - Main use case: portable devices - front camera.
    - Secondary use case: handheld devices - front camera.
    - Secondary use case: portable devices - rear camera.
- Convertible type of PC:
    - Main use case: portable devices - front camera.
    - Secondary use case: portable devices - rear camera.

Vendor's recommendations provided before testing are considered for prioritizing the use cases. Without such recommendations a tester can choose the main use case.

2.4.3 Conferencing solutions

Conferencing devices must be tested and certified according to the usage distance that the device targets. This will be represented as usage distance and/or recommended room size in certification messaging (marketing materials).

In addition to passing all of the other requirements in this specification, the recommended room size will be determined by the combination of the results from the following sections:

- 4.4.1 Field of view
- 5.1.1 Maximum recommended distance
- 5.1.2 Closest user acuity

Required distances and success criteria for these 3 tests is outlined in Table 3. If a device needs to use zoom to achieve the maximum distance for the target room size, HFOV must be measured with the same level of zoom applied and compared against the requirement for that room size.

All tests in Section 4 are to be conducted at the following distances:

- Section 4.1 Detail quality at 1m. Note that the Section 4.1.4 is not applicable to conferencing devices and is covered by Sections 5.1.1 and 5.1.2.
- Other tests in Section 4 are based on respective test targets described in Section 6.1.6 Test charts.

	Camera at the front of room	Camera on the table[1]
Phone Room (2m*2m)	**Max distance: 1.5m** **HFOV: ≥90 deg** Min distance: 0.4M	**-N/A-**
Focus room (3m*3m)	**Max distance: 2.6m** **HFOV: ≥90 deg** Min distance[2]: 1m for non-touch enabled devices; 0.4M for touch enabled devices	**Max distance: 1m** **HFOV: ≥180deg** Min distance: 0.5m
Small room (3m*4.5m or 4.5m*4.5m)	**Max distance: 3.3m** **HFOV: ≥90 deg** Min distance[2]: 1m	**Max distance: 1.2m** **HFOV: ≥270deg** Min distance: 0.5m
Medium room (4.5*6M)	**Max distance: 5m** **HFOV: ≥90 deg** Min distance[2]: 1m	**Max distance: 1.5m** **HFOV: ≥270 deg** Min distance: 0.5m
Large room (4.5m*8.5m)	**Max distance: 7.4m** **HFOV: ≥70 deg** Min distance[2]: 1.5m	**Max distance: 3.3m** **HFOV: 360 deg** Min distance: 0.5m
Extra-Large room (6m*10m)	**Max distance: 9m** **HFOV: ≥70 deg** Min distance[2]: 1.5m	**Max distance: 3.3m** **HFOV: 360 deg** Min distance: 0.5m
Collaboration: Huddle Room 2.3m radius around touch screen	**Max distance: 2.3m** **HFOV: ≥120 deg** Min distance: 0.4m	**-N/A-**
Collaboration Meeting Room 2.3m radius around touch screen	**Max distance: 2.3m** **HFOV: ≥120 deg** Min distance: 0.4m	**-N/A-**
Collaboration: Lounge 3.5m radius	**Max distance: 3.5m** **HFOV: ≥90 deg** (120° if used w/ touch screen) Min distance[2]: 1m	**-N/A-**

Table 3: Conferencing device critical parameters for defined room types

3 Entry criteria for video testing

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

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

[1] This current specification does not support certification for multi-lens cameras (e.g., RoundTable).

[2] For touch enabled devices (e.g., conferencing displays with touch screen) minimum distance is 0.4m, use test setup as per personal solution as per 2.4.2

3.1 Video prerequisite testing

All devices shall be evaluated over both Microsoft Teams and Skype for Business calls at each engineering stage (e.g. by the OEM at major internal milestones, and again by the test lab prior to beginning the quantitative testing). The goal is to identify any obvious problems before beginning the quantitative testing.

The evaluation should be performed under well-lit office conditions. Lighting conditions for these sanity tests are intentionally less controlled (and slightly more relaxed) than those for the formal quantitative tests because these are intended to be easy to execute, with a focus on highlighting obvious issues that would be apparent to an average end user. All tests below require two people. The term “near-end user” describes the person using the DUT and the term “far-end user” describes the person in a remote room who is using a reference device to communicate with the near-end user.

Well-lit office or meeting room environment:

- Moderately sized room, with overhead lights
- For personal cameras, the light should be in the FOV behind the DUT user; for conferencing cameras the light source should not be directly in FOV.
- Lighting level is at least 200 lux measured with the light meter sensor held at users face at face level of the DUT user facing the camera.

Example of a simulated living room conditions:
Reduced ambient light level is 40 lux plus or minus 20 lux using incandescent indirect lighting measured with the light meter at face level of the DUT user facing the camera. Incandescent indirect lighting example would be a floor standing Touchier lamp with a tungsten filament lamp (either ordinary or halogen) with adjustable brightness. The lamp should be approximately 1.5 meters behind the user and visible in the field of view.

Far-end system requirements:

- The far-end user is required to have a system capable of rendering the max resolution that is supported by the camera (http://technet.microsoft.com/en-us/library/jj688132.aspx).
- Good quality HD (1080p capable) monitor

Test Score definitions scale:

Test scoring will be done on a scale of 1 to 5, with a score of 1 being BAD and 5 being GOOD
5: No detectable flaws in the observed metric (Pass)
4: Some minor flaws detectable by an observant user (Pass)
3: Flaws detectable to the casual user (Possible Fail further review required)
2: Serious flaws making the call difficult to continue (Fail)
1: Very serious flaws preventing the completion of the call (Fail)

3.1.1 E2E Scenarios: Video Sanity Tests

Conferencing solutions should be tested only in the well-lit office conditions, but the personal solutions must be tested in both office and living room conditions.

3.1.1.1 Video Render

1. Begin the evaluation by opening video in both directions. Far end user needs to have the video window maximized to achieve the maximum resolution of the DUT camera (720p or 1080p). Far end should observe the video startup checking the startup time, resolution switching, and note the maximum resolution achieved.
2. The far end should observe and evaluate the image captured by DUT camera (rendered on far end) looking for any of the following problems:
    - Image orientation and position:
        i. Obstruction of the camera during normal use. Any obstruction should be considered a fail.
        ii. Poor framing of the user due to camera positioning or orientation.
    - Image clarity flaws.
        i. Watch for sharpness and texture based on natural features (e.g. ceiling tiles, textiles, and user's head).
        ii. Watch for sharpening artifacts (like exaggerated texture, halos, dark lines) on areas with high contrast.
    - Encoding related artifacts.
        i. Watch for video jerkiness – stalling or skipping video frames.
        ii. Watch for image blockiness and other encoding artifacts like blurring, color bleeding, staircase effect, ringing, false contouring, and mosquito effect.
    - Image color flaws.
        i. Watch for skin tone, walls, and light coming from light fixture.
        ii. Watch for disturbing color noise levels.
    - Exposure flaws.
        i. Watch for face exposure related problems. Try out a lamp positioned in the camera FOV on the table and behind the user.
3. Turn the lights off and on while creating as little physical movement on the scene as possible. Check if the image is restored correctly (without artifacts, correct colors, no significant noise additions).

For personal solutions only: in living room conditions add an additional desk lamp to simulate realistic glare and backlight conditions.

3.1.1.2 Image Motion

Begin the evaluation by opening video in both directions. Near end user to waive hand as sanity check for Jitter. Near end user to Clap hands as sanity check for A/V sync.

- Far-end user to watch for Jitter during hand wave.
- Far-end user to watch for A/V sync during hand clap.
- Far-end user to verify sufficient frame rate.

3.1.1.3 Whiteboard– for conferencing devices only

Begin the evaluation by opening video in far-end. Near end user to use a whiteboard at different realistic positions writing some text with 10cm height.

- Far-end user to try to read the text written. In case of problems the far end can instruct the near end user to zoom, pan or tilt if that functionality is enabled.

3.1.1.4 Zooming related– for conferencing devices only

Begin the evaluation by opening video in both directions. Near end user to try out zooming in and out together with pan and tilt functions if supported.

- Far-end user to assess the smoothness of pan, tilt, and zoom functions. Near end to assess the ease of getting a desired object into frame.
- Far-end user to assess the image quality at the maximum zoom setting.

3.1.1.5 Additional features related – for conferencing devices only

If the solution under testing supports additional features, then it must be verified that they work as intended. Examples:

- In case the solution provides directional audio then the audio and video directionalities must match.
- Active speaker view must not react to the speech reflections from a whiteboard, windows or walls.
- Active speaker view must handle multiple people talking simultaneously.

3.1.1.6 Note

There are Excel spreadsheets available for personal and conferencing solutions to help conducting the video sanity tests. Please contact your Microsoft partner manager to get it.

3.2 Driver

This section applies to external USB cameras.

3.2.1 Support USB Video Class (UVC) Driver

3.2.1.1 Purpose

External accessory cameras should be fully functional with Windows in built UVC drivers. Note all tests in this specification need to be run with the Windows built-in UVC drivers as well as the OEM drivers (if supplied to the end user with a product).

3.2.1.2 Requirements

If the camera uses USB bus it must support the UVC standard 1.0 or later versions and work with Windows built-in UVC drivers.

3.2.1.3 Test procedure

Run Device Manager and check if the camera is using the Windows UVC driver usbvideo.sys and that the driver provider is Microsoft. If the driver is not the Windows UVC driver, roll back the driver to the Windows UVC driver.

3.2.2 Support USB Audio Class (UAC) Driver

3.2.2.1 Purpose

USB cameras should be fully functional with default Windows drivers. If the camera has a microphone built-in then it must work with UAC driver.

3.2.2.2 Requirements

If the USB camera has built-in microphone then it must support the UAC standard 1.0 and work with Windows in built UAC drivers.

3.2.2.3 Test procedure

Run Device Manager and check if the camera 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.

3.2.3 CPU usage for personal devices

3.2.3.1 Purpose

Makes sure the custom webcam driver (not windows in built UVC/UAC drivers), which includes any video processing, does not cause excessive CPU usage. Only the CPU usage of OEM drivers are measured, not the Windows in-box UVC/UAC drivers.

This test is not applicable for conferencing devices as they are expected have dedicated PCs as room systems.

3.2.3.2 Requirements

The CPU usage requirements are given in Table 4. The test shall be conducted using the Balanced power plan.

Resolution	CPU usage for Remote Capture Tool on 64bit Windows 10 or newer
VGA 30 FPS	<8% on Core i5@1.7Ghz
720p 30 FPS	<16% on Core i5@1.7Ghz
1080p 30 FPS	<30% on Core i5@1.7Ghz

Table 4: CPU usage

Microsoft Teams test labs use Surface Pro with Intel HD Graphics 4000 in case of external webcam. This test can be skipped if camera uses the Windows in built UVC driver.

3.2.3.3 Test procedure

- Install the 3rd party webcam driver and verify the right driver is in use for the Camera from Device Manager
- Run Remote Capture Tool, configure the settings as following:
  - Camera pin to ‘Record’
  - YUV transform to ‘on’
- Run Resource Monitor (resmon.exe). Open the CPU tab and select the ‘RemoteCaptureTool.exe’ process.
- Run Remote Capture Tool and Task Manager in Split Window mode simultaneously and configure it to show video in 640x360 @ 30fps in MJPEG or YUY2 mode.

- Repeat for 720p @30fps and if available then 1080p@30fps resolutions in MJPEG or YUY2 mode.
- Snapshot minimum of 60 second CPU load result image and Average CPU statistic for each video mode and check against the requirements.

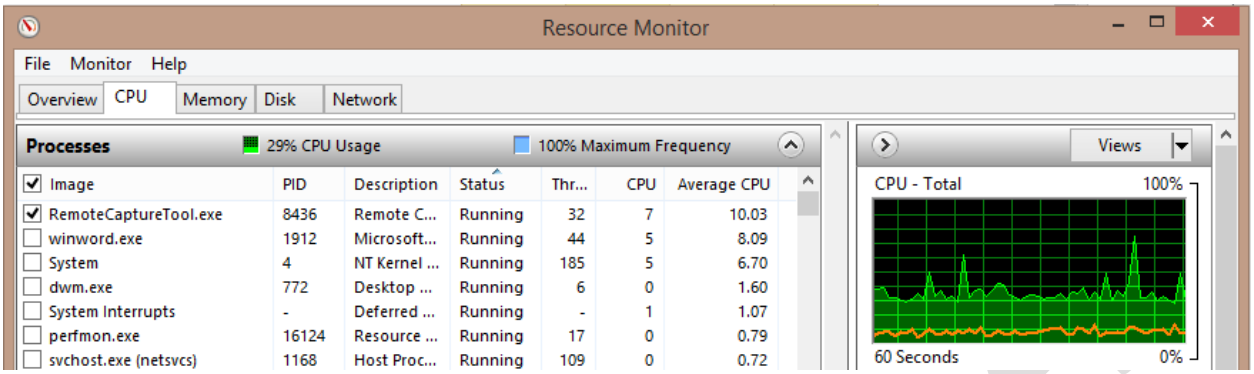


Figure 1: Resource Monitor – camera driver CPU load

3.3 Basic video attributes

3.3.1 Image resolutions, frame rates, color spaces

3.3.1.1 Purpose

This test ensures that required image resolutions, native frame rates, and color spaces are supported.

3.3.1.2 Requirements

3.3.1.2.1 Image resolutions for USB cameras

Resolution	Min frame rate in 200lux	Color space	Required for conferencing solutions	Required for personal solutions
1920x1080	30	MJPEG	Yes	Optional
1280x720	30	MJPEG	Yes	Yes
640x360	30	YUY2	Yes	Yes

Table 5: Required video formats for USB 2.0 cameras

Resolution	Min frame rate in 200lux	Color space	Required for conferencing solutions	Required for personal solutions
3840x2160	30	MJPEG	Optional	Optional
2560x1440	30	MJPEG or NV12 or YUY2	Optional	Optional
1920x1080	30	NV12 or YUY2	Yes	Optional
1280x720	30	NV12 or YUY2	Yes	Yes
640x360	30	NV12 or YUY2	Yes	Yes

Table 6: Required video formats for USB 3.0 HD cameras

3.3.1.2.2 Image resolutions for MIPI cameras

Resolution	Min frame rate in 200lux	Color space	Required for conferencing solutions	Required for personal solutions
3840x2160	30	NV12	Optional	Optional
2560x1440	30	NV12	Optional	Optional
1920x1080	30	NV12	Yes	Optional
1280x720	30	NV12	Yes	Yes
640x360	30	NV12	Yes	Yes

Table 7: Required video formats for HD MIPI cameras

3.3.1.2.3 Notes

- It is critical that cameras do not expose high resolutions supported by Microsoft Teams if 15 FPS can't be met.
- Optional resolutions are only required if webcam supports them.
  If the 2160p resolution is supported then it is mandatory to support 1440p resolution too.
  Other resolutions can be supported, but not used in a video call.
- MJPEG streams should be exposed rather than having custom drivers that decompress MJPEG.
- Expected luminance and color ranges are described in Table 15: Luminance and chrominance ranges.
- H.264 capable cameras must be fully compatible with Microsoft Teams H.264 Video Encoder Specification mentioned in Section 2.1 Overview.

3.4 Pre-conditions to enable testing the video quality requirements

The requirements in this chapter are to ensure the feasibility and reliability of automated tests described in Section 4. The automatically adjusted image parameters (such as gain and white balance) and if available autofocus must stabilize within 5 seconds for personal and within 20 seconds for conferencing solutions. It is recommended to avoid too aggressive adjustments for conferencing cameras.

3.4.1 Anti-flicker solution

3.4.1.1 Purpose

Imaging in lighting powered by 50 or 60 Hz mains frequency can result in flicker that significantly degrades SNR (> 8 dB). The camera has to be able to suppress this effect in captured video. This is especially important for notebook computers that may travel between 50 and 60 Hz countries.

3.4.1.2 Requirements

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

	Standard	Premium
Anti-flicker	Supports manually selected 50 Hz and 60 Hz AEC modes	Automatically selects 50 Hz or 60 Hz AEC mode

Table 8: Anti-flicker solution

3.4.2 Automatic white balance, exposure and gain

3.4.2.1 Purpose

Automatic white balance, exposure and gain control are needed to ensure the image has sufficient contrast and is not over-saturated or under-saturated in typical light conditions.

The image must be stabilized within 20 seconds after the target change to provide reasonable video call experience. This is also important from test automation perspective – the stabilization time between changing the test target or light conditions and capturing an image is typically set to 20 seconds in the test automation scripts.

3.4.2.2 Requirement

	Requirement
Supports automatic white balance	Enabled by default
Supports automatic gain and exposure	Enabled by default
Stabilization time	< 5s

Table 9: Video AEC and AGC requirements for personal cameras

	Requirement
Supports automatic white balance	Enabled by default
Supports automatic gain and exposure	Enabled by default
Stabilization time	< 20 s

Table 10: Video AEC and AGC requirements for conferencing cameras

3.4.3 Pixel aspect ratio

3.4.3.1 Purpose

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

If the pixel aspect ratio is incorrect then it is also likely to cause issues with automatic detection of the test charts and the Video quality requirements cannot be tested using the Video Analyzer.

3.4.3.2 Requirement

	Requirement
All resolutions	$0.98 \leq R \leq 1.02$

Table 11: Pixel aspect ratio

3.4.3.3 Test procedure

Test target	ColorChecker
ROI	Whole chart
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 12: Vertical field of view test details

3.4.4 Field of view consistency

3.4.4.1 Purpose

In addition to a minimal or target VFOV the FOV should also be consistent within different resolutions. The camera may be reopened at various resolutions due to bandwidth limitation or lighting changes, and to keep a smooth user experience, the center of FOV should not move and the height of the visible area should not change when switching between resolutions.

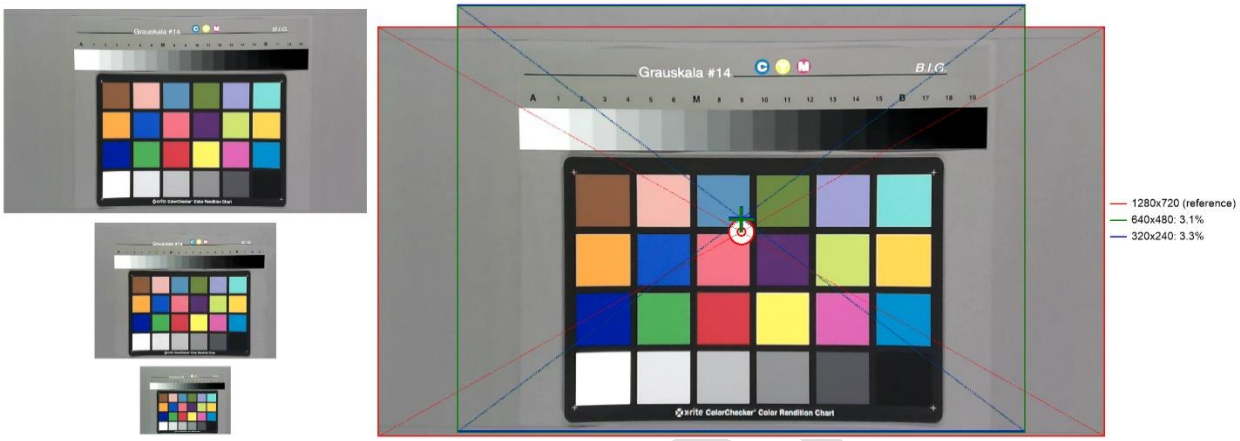


Figure 2: Sample of poor FOV consistency – movement of the center location

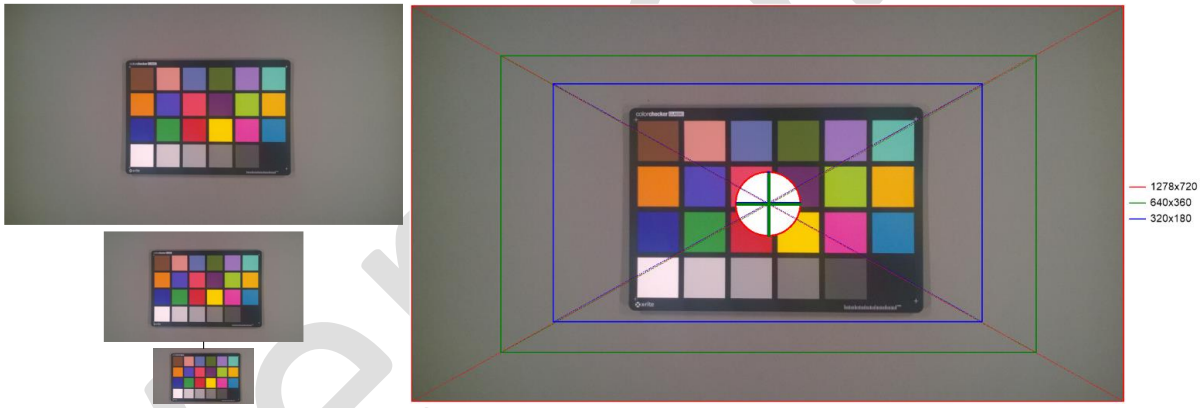


Figure 3: Sample of poor FOV consistency – changing of Vertical FOV size

3.4.4.2 Requirements

Field of view consistency	**Requirement**
FOV(center consistency)	≤ 3%
Vertical FOV consistency	≤ 25%

Table 13: Field of view consistency requirements

3.4.4.3 Test procedure

Test target	ColorChecker
ROI	Whole chart
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 14: Vertical field of view test details

3.4.5 Autofocus performance

3.4.5.1 Purpose

This requirement specifies autofocus performance and manual focus API support (for cameras with autofocus). Most cameras 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 is sufficient. To minimize focus swimming, the autofocus performance is specified in a real-world test. To allow Microsoft Teams to programmatically specify manual focus, the application must be able to switch off autofocus through API and set it to default focal distance.

3.4.5.2 Requirements

1. Autofocus performance: Images must be focused 99% of the time over 5 minutes in a typical use-case scenario.
2. Manual-focus performance: The default distance for manual focus must be equal to the nominal distance for the matching category as described in Section 2.4. 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 MTF50 must be with 15% relative error to the autofocus MTF50.
3. If the auto-focus cannot be manually disabled, it must adapt to changes of the test target or lighting within 5 seconds.

3.4.5.3 Test procedure

3.4.5.3.1 Convergence test

1. Choose the testing area the following way:
   - Only overhead lighting without any sunlight – on the desk surface in front of the tester it should be around 300 lux.
   - The background should be neutral colors. The tester should avoid wearing clothing with high frequencies (i.e. no stripes thinner than 25mm / 1 inch).
   - Use two tilted edge printouts on either side of the person's head (above shoulders). These will be used to determine if the image in respective frame is in focus. Having the edges on either side should help make sure that at least one of them is visible in each frame. The tilted edges are no farther than 30cm (1 foot) behind the tester.
2. Set up the camera at nominal distance from the tester.
3. Record a video from DUT camera for 5 minutes while tester is moving in front of camera.
4. Measure the time while autofocus was automatically being adjusted. If there was a period when the autofocus was set incorrectly then this time should be added to the measured time.
   Also, take a note in case the autofocus was not adapting within the required time in any occurrence.

3.4.5.3.2 Stability test

1. Set up the solution at nominal distance from the SFRplus chart.
2. Find manually the best focus setting for the center of the chart. Calculate the average MTF50 of the 4 edges in the center of the chart with the Video Analyzer.
3. Manually offset the focus to an extreme and enable autofocus.
4. Once the autofocus is stabilized calculate the MTF50 values again and compare the average with previously found average.

3.4.6 Verification of correct use of luminance and color spaces

3.4.6.1 Purpose

The luminance and chrominance ranges for supported color spaces are given in Table 15.

Color space	Luminance	Chrominance
YUY2	16-235	16-240
NV12	16-235	16-240
MJPEG	0-255	0-255

Table 15: Luminance and chrominance ranges

For color spaces in limited ranges the Microsoft Teams client does the stretching to full RGB range during the video rendering. Incorrectly used ranges result in false rendering.

The MF_MT_VIDEO_NOMINAL_RANGE values for the camera driver are given in Table 16

Video stream type	Media Foundation attribute	Required value
MJPEG	MF_MT_VIDEO_NOMINAL_RANGE	MFNominalRange_0_255
Uncompressed (YUY2, NV12)	MF_MT_VIDEO_NOMINAL_RANGE	MFNominalRange_16_235

Table 16: MF_MT_VIDEO_NOMINAL_RANGE for Windows 8.1 and newer

3.4.6.2 Requirements

On Windows 8.1 and newer systems the MF_MT_VIDEO_NOMINAL_RANGE property must be populated with values marked in Table 16 above.

	Requirement
Limited range: average luminance pixel value for “patch 36 (black)” when YUV transform is turned off in Remote Capture Tool	16 ≤ avg pixel value
Limited range: average luminance pixel value for “patch 1 (white)” when YUV transform in Remote Capture Tool is turned off	avg pixel value ≤ 235

Table 17: min/max luminance level requirements

3.4.6.3 Test procedure

Test target	ITDR-36 chart
ROI	Patch 1 (white reference) / patch 36 (black reference)
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value MF_MT_VIDEO_NOMINAL_RANGE property is validated using Remote Capture Tool.

Table 18: min/max luminance level test details

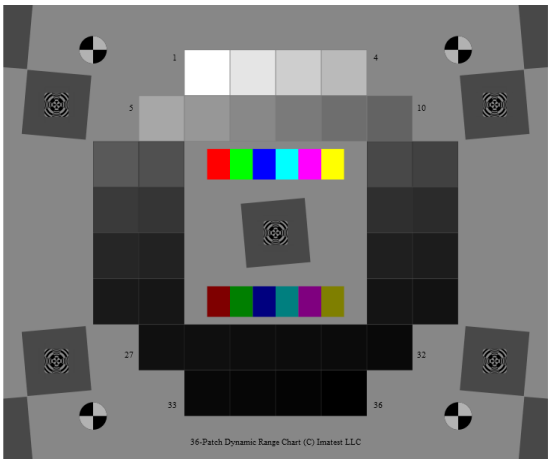


Figure 4: Transmissive dynamic range test chart

Use Remote capture tool – make snapshots for all raw video mode resolutions (YUY2, NV12, I420) of ITDR-36 chart without the YUV transform enabled.

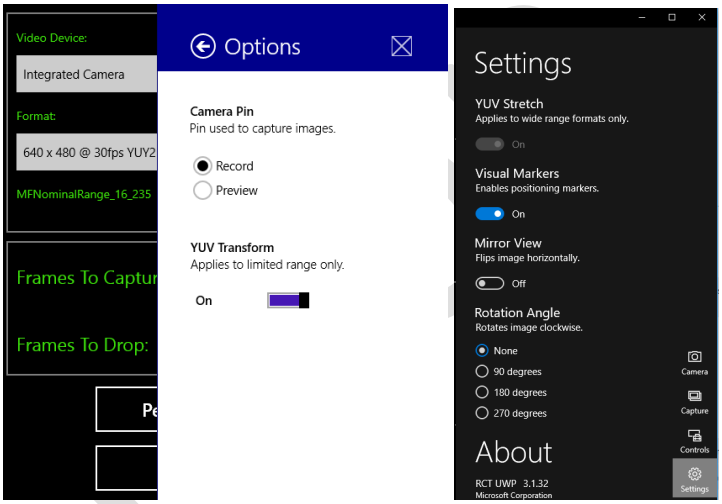


Figure 5: YUV transform setting in RCT version 3 (left) and RCT version 3.1 (right)

Below are two samples where the camera poses a correct behavior. The left picture is without the YUV transform and right picture has the YUV transform enabled during render (as Microsoft Teams client will do for the raw video camera modes on render side).

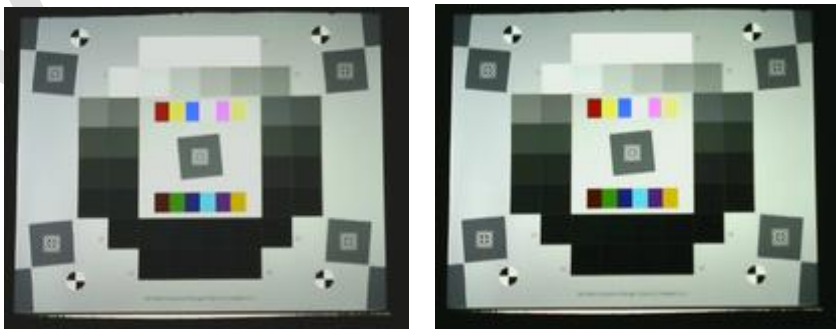


Figure 6: Sample image - YUV transform off (left) and on (right)

With correct behavior the white and black will go close to pixel values of 255 and 0 only when YUV transform is enabled. Also, the color saturation increase is visible on the image on right.

3.4.7 Usage indicator

3.4.7.1 Purpose

This requirement lets the user know when the camera is on and imaging the user or off and not imaging the user.

It is advised to either use a low power diffuse LED or add a diffusing glass/plastic in front of the LED. Too bright indicator LED could disturb the user when he or she is looking directly at the camera in a dark room.

3.4.7.2 Requirements

	Requirement
Usage indicator	Indication provided when capturing video Indicator can be on when capturing audio (optional) Indicator is off (or a clear indication about not capturing is provided) otherwise

Table 19: Usage indicator

Alternative solutions to LED usage are allowed but those need to be agreed with Microsoft partner manager.

3.4.7.3 Test procedure

For each resolution and max frame rate:
Open and render the capture source. DUT usage indicator should be on.

4 Video quality requirements in lab environment

This section defines video metrics that help ensure good-quality Windows video capture for Microsoft Teams and Skype for Business.

Cameras will be tested under all resolutions and color spaces required unless specified otherwise.

If a conferencing system contains more than one camera then both need to meet the requirements below. The behavior needs to be consistent to avoid notable degradations in case of switching between them.

In case a standalone webcam has a custom driver then it must be tested two times – with the UVC driver and with the custom driver. All requirements must be met in both cases.

4.1 Detail quality

These tests ensure that images provide a desired 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.

If autofocus is supported, then it should be on.
If optical zoom is supported, then it is recommended to zoom out as much as possible.

4.1.1 MTF

4.1.1.1 Purpose

MTF30 is a measure of the spatial frequency response of a camera system. Poor MTF30 is typically due to a poor quality lens or lens/sensor fit, or poor image signal processing. For example, Figure 8 shows a synthetic example of an image with good and poor MTF. Figure 7 shows the MTF of a typical Premium camera and the criteria for Standard and Premium.

Related standard: ISO 12233-2000.

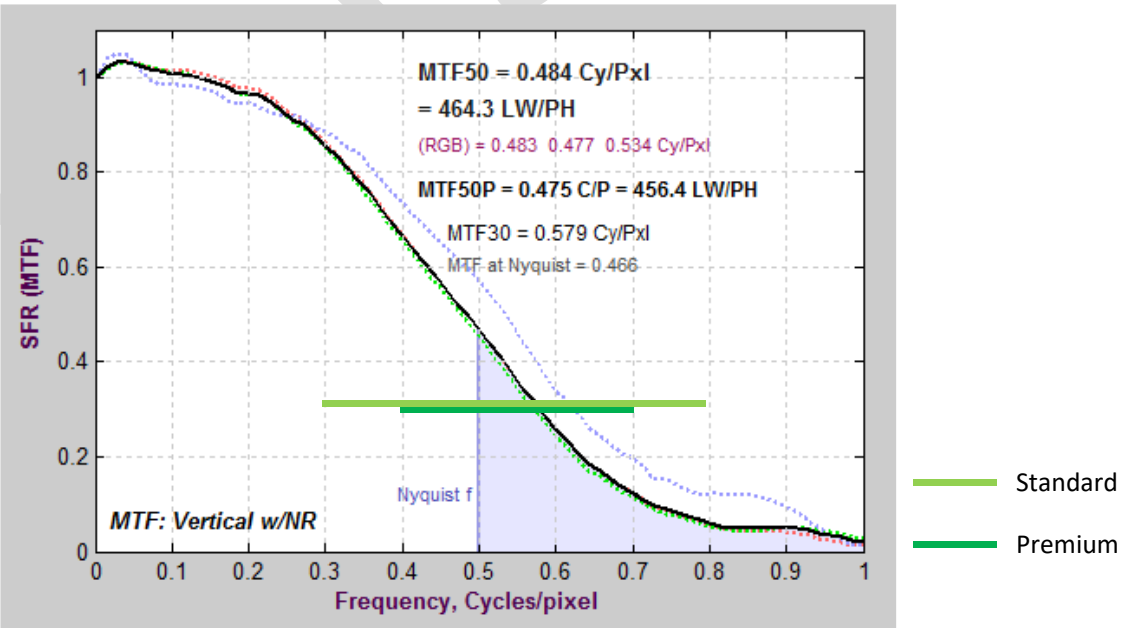


Figure 7: MTF30 criteria shown in a typical Premium camera

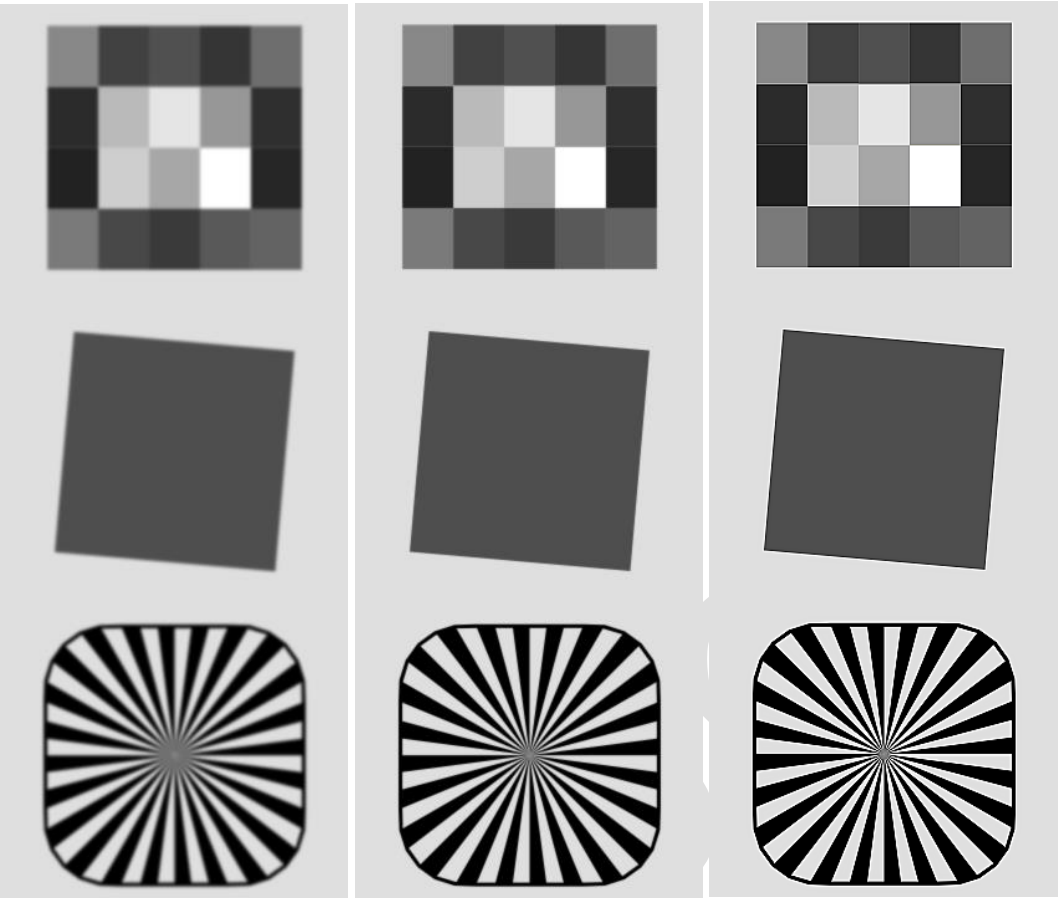


Figure 8: Left: MTF30=0.20; Middle: MTF30=0.53; Right: MTF30=0.88

4.1.1.2 Requirements

MTF30	Standard	Premium
MTF30 (20lux 3000K LED, center)	[0.3,0.8]	[0.4,0.7]
MTF30 (80lux 3000K LED, center)	[0.3,0.8]	[0.4,0.7]
MTF30 (80lux 3000K LED, 80% center circle)	N/A	[0.3,0.7]

Table 20: MTF requirements for personal solutions

MTF30	Standard	Premium
MTF30 (200lux 3000K LED, center)	[0.3,0.8]	[0.4,0.7]

Table 21: MTF requirements for conferencing solutions

4.1.1.3 Test procedure

Test target	Default: SFR Plus (small) Alternate: SFR Plus (large) in case all corners fit into the wider ROI on SFR Plus (small)
ROI	2 horizontal and 2 vertical edges in the middle of the SFR Plus chart
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value. The single value reported for the multiple edges is the worst case.
Note	It is allowed to use custom made slanted edge charts with similar contrast ratio, but those won't be automatically detected, and the analysis has to be done manually in Skype Certification Video Analyzer. The same edges should be replicated (storing the first value returned) and the worst of the stored values reported.

Table 22: MTF test details

4.1.2 Oversharpening

4.1.2.1 Purpose

Oversharpening (and undersharpening) is a measure used to ensure that cameras are not using too much sharpening (or not enough), which induces image artifacts like ringing around edges or fuzzy images. Most cameras will need a certain amount of image sharpening. It is possible to sharpen images captured with soft focus arbitrarily, enough to pass the MTF requirements. However, images obtained this way would still have significant loss of detail and high probability of artifacts appearing. This metric limits the amount of oversharpening or undersharpening allowed. Figure 9 shows an example of oversharpening and undersharpening.

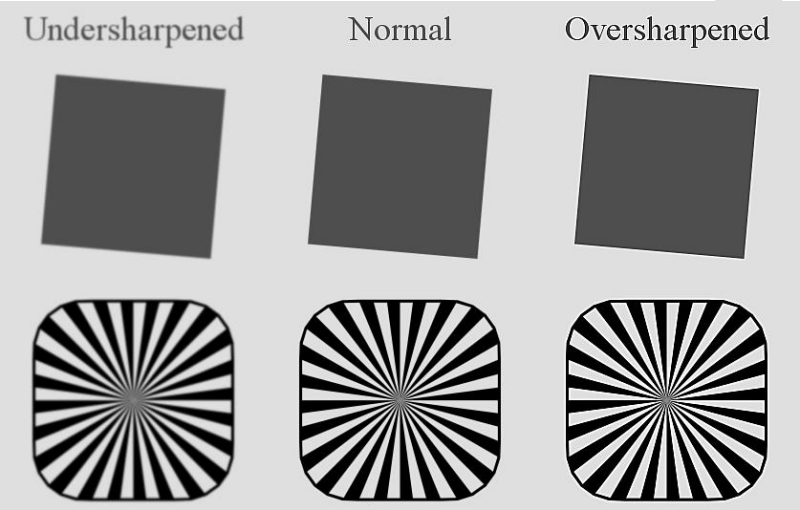


Figure 9: Left: undersharpening 32%; Middle: oversharpening=1%; Right: oversharpening=32%

4.1.2.2 Requirements

Oversharpening	Standard	Premium
Oversharpening(20lux 3000K LED, center square)	|≤ 20%|	|≤ 15%|
Oversharpening(80lux 3000K LED, center square)	|≤ 20%|	|≤ 15%|
Oversharpening(200lux 3000K LED, center square)	|≤ 20%|	|≤ 15%|

Table 23: Oversharpening requirements for personal solutions

Oversharpening	Standard	Premium
Oversharpening(200lux 3000K LED, center square)	|≤ 30%|	|≤ 20%|

Table 24: Oversharpening requirements for conferencing solutions

4.1.2.3 Test procedure

Test target	Refer to Table 22: MTF test details
ROI	2 horizontal and 2 vertical edges in the middle of the test target
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and analysis. The single value reported for the multiple edges is the worst case.
Note	It is allowed to use custom made slanted edge charts with similar contrast ratio, but those won't be automatically detected, and the analysis has to be done manually in Skype Certification Video Analyzer. The same edges should be replicated (storing the first value returned) and the worst of the stored values reported.

Table 25: Oversharpening test details

4.1.3 Edge roughness

4.1.3.1 Purpose

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

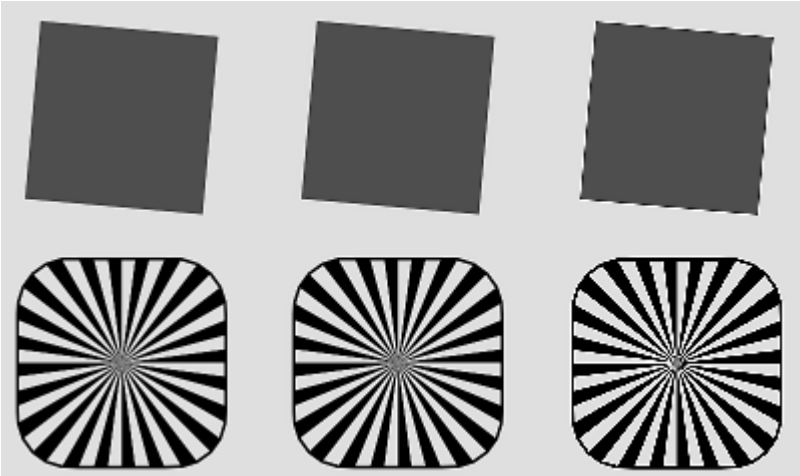


Figure 10: Left: bicubic scaling, edge roughness=0.039; Middle: bilinear scaling, edge roughness=0.052; Right: nearest neighbor scaling, edge roughness=0.309

4.1.3.2 Requirements

Edge roughness	Standard	Premium
ER(80lux 3000K LED, center square)	≤ 0.1	≤ 0.05

Table 26: Edge roughness requirements for personal solutions

Edge roughness	Standard	Premium
ER(200lux 3000K LED, center square)	≤ 0.1	≤ 0.05

Table 27: Edge roughness requirements for conferencing solutions

4.1.3.3 Test procedure

Test target	Refer to Table 22: MTF test details
ROI	2 horizontal and 2 vertical edges in the middle of the test target
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value. The single value reported for the multiple edges is the worst case.
Note	It is allowed to use custom made slanted edge charts with similar contrast ratio, but those won't be automatically detected, and the analysis has to be done manually in Skype Certification Video Analyzer. The same edges should be replicated (storing the first value returned) and the worst of the stored values reported.

Table 28: Edge roughness test details

4.1.4 Depth of field

4.1.4.1 Purpose

A camera should be able to capture a focused image over a range of working distances from the minimum to maximum distance as defined in Section 2.4.

Related standard: ISO 12233-2000.

4.1.4.2 Requirements

Depth of field	Standard	Premium
MTF30 min distance (80lux 3000K LED, center square / all edges)	[0.3,0.8]	[0.4,0.7]
MTF30 max distance (80lux 3000K LED, center square / all edges)	[0.3,0.8]	[0.4,0.7]

Table 29: Depth of field requirements for personal solutions

Note: Section 5 covers depth of field related requirements for conferencing solutions.

4.1.4.3 Test procedure

Test target	Default: SFR Plus (small) Alternate: SFR Plus (large) *Use the SFRPlus (small) test chart, capture the image. Make sure that the full chart fills at least 75% of pixel area. If the camera FOV is very wide or test distance causes the chart to appear smaller than the above recommendation, then use the alternate test chart instead.*
ROI	2 horizontal and 2 vertical edges in the middle of the test target
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value. The single value reported for the multiple edges is the worst case.
Note	It is allowed to use custom made slanted edge charts with similar contrast ratio, but those won't be automatically detected, and the analysis has to be done manually in Skype Certification Video Analyzer. The same edges should be replicated (storing the first value returned) and the worst of the stored values reported.

Table 30: Depth of field test details

Camera lenses with fixed or manual focus are not adjusted when changing working distance. If autofocus is available, it is enabled during this test, and it is allowed to take up to 5 seconds to converge.

4.1.5 Texture acutance

4.1.5.1 Purpose

Many new cameras use very small pixels that are less sensitive than larger pixels and therefore have higher noise (lower SNR). To improve the SNR, noise suppression methods can be used; however, even if it improves SNR, excessive noise suppression will often lose small details from the image, degrading the Texture acutance and MTF. For example, Figure 11 (left) shows a camera image with a low Texture acutance due to excessive noise suppression, even in >200 lux of light. In the same scene, Figure 11 (right) shows a camera image with high Texture acutance. Both cameras pass Premium levels for MTF30 and SNR, but obviously the left camera has inferior quality for video conferencing.

Standard: CPIQ Texture Acutance, Phase 3.

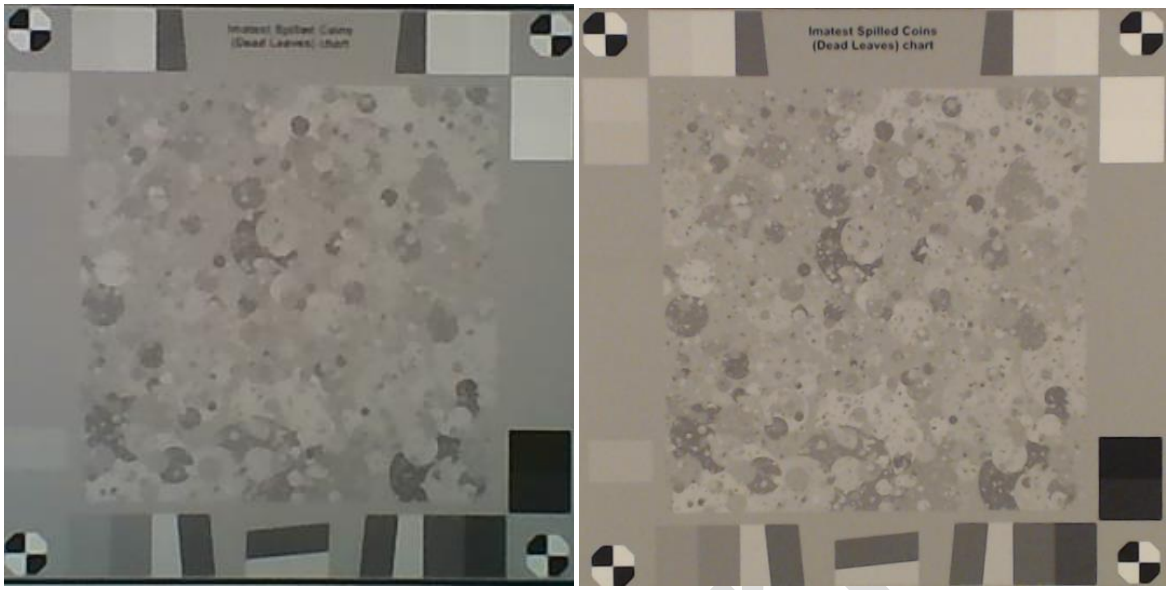


Figure 11: Left: Cropped image from a 720p camera with low Texture acutance; Right: cropped image from another 720p camera (different than the left one) with high Texture acutance

4.1.5.2 Requirements

Texture acutance	**Standard**	**Premium**
Acutance (20lux 3000K LED)	≥ 0.70	≥ 0.80
Acutance (80lux 3000K LED)	≥ 0.70	≥ 0.83

Table 31: Texture acutance requirements for personal solutions

Texture acutance	**Standard**	**Premium**
Acutance (200lux 3000K LED)	≥ 0.70	≥ 0.83

Table 32: Texture acutance requirements for conferencing solutions

Resolutions to be tested for texture acutance are the following: 1920x1080, and if supported then 2560x1440 and 3840X2160.

4.1.5.3 Test procedure

Test target	Personal solutions: Default: 8”x8” Spilled coins test chart Alternate: 12”x12” Spilled coins test chart Conferencing solutions: 12”x12” Spilled coins test chart
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 33: Texture acutance test details

4.2 Tonal response and noise

4.2.1 Dynamic range

4.2.1.1 Purpose

Sufficient dynamic range is required to capture the user and background without losing significant amount of the dark or bright tones by driving the signal to its limits.

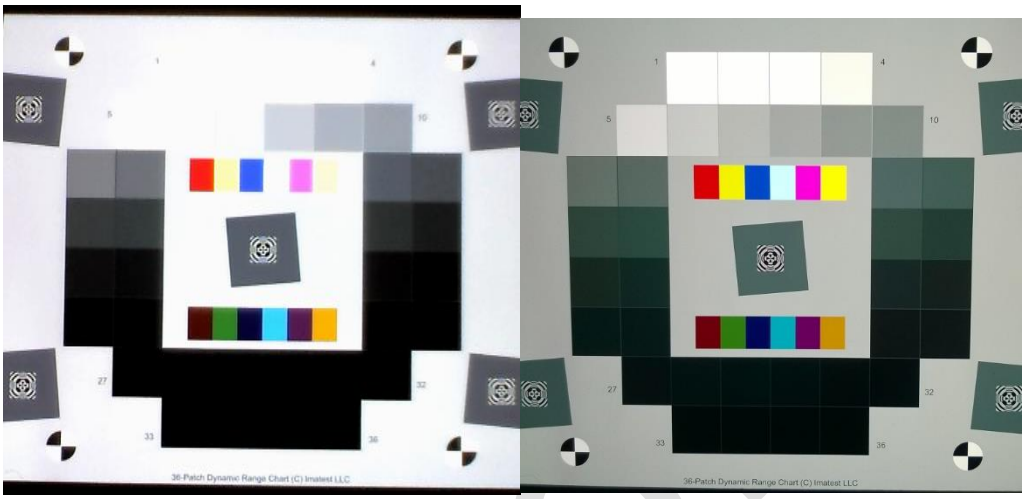


Figure 12: Left: dynamic range=30 dB, Right: dynamic range=58 dB

4.2.1.2 Requirements

Dynamic range	**Standard**	**Premium**
DR	≥ 33 dB	≥ 36 dB

Table 34: Image dynamic range requirements for personal solutions

Dynamic range	**Standard**	**Premium**
DR	≥ 36 dB	≥ 40 dB

Table 35: Image dynamic range requirements for conferencing solutions

4.2.1.3 Test procedure

Test target	ITDR-36 chart
ROI	All patches
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 36: Image dynamic range test details

4.2.2 Exposure accuracy

4.2.2.1 Purpose

Automatic exposure is needed to ensure the image has sufficient contrast and isn't oversaturated or under-saturated in typical light conditions.

4.2.2.2 Requirements

Mean value of Y channel on patch 22 on ColorChecker	**Standard**	**Premium**
Y(20lux 3000K LED)	[92,162]	[102, 142]
Y(80lux 3000K LED)	[92,162]	[102, 142]
Y(200lux 3000K LED)	[92,162]	[102, 142]
Y(1000lux 5000K LED)	[92,162]	[102, 152]

Table 37: Image exposure accuracy requirements for personal solutions

Mean value of Y channel on patch 22 on ColorChecker	**Standard**	**Premium**
Y(80lux 3000K LED)	[92,162]	[102, 142]
Y(200lux 3000K LED)	[92,162]	[102, 142]
Y(1000lux 5000K LED)	[92,162]	[102, 152]

Table 38: Image exposure accuracy requirements for conferencing solutions

4.2.2.3 Test procedure

Test target	ColorChecker
ROI	Patch 22
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 39: Image exposure accuracy test details

4.2.3 Gamma

4.2.3.1 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 response of the total capture-to-render system. Gamma >> 0.45 can give images that have excessive contrast and look unnatural due to the non-linear color mapping.

Figure 13: Upper-Left: gamma=0.3, Upper-Right: gamma=0.5, Bottom-Left: gamma=0.7, Bottom-Right: gamma=0.9

4.2.3.2 Requirements

Gamma	Standard	Premium
Gamma(20lux 3000K LED)	[0.4, 0.75]	[0.4, 0.65]
Gamma(80lux 3000K LED)	[0.4, 0.75]	[0.4, 0.65]

Table 40: Gamma requirements for personal solutions

Gamma	Standard	Premium
Gamma(200lux 3000K LED)	[0.4, 0.75]	[0.4, 0.65]

Table 41: Gamma requirements for conferencing solutions

4.2.3.3 Test procedure

Test target	ColorChecker
ROI	Patches 20-23
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 42: Gamma test details

4.2.4 Spatial SNR

4.2.4.1 Purpose

Spatial noise is the measure of image noise in a single image. Spatial noise indicates a pixel level variation of each pixel compared to neighboring pixels on single captured image. Figure 14 is an example of a high and low noise image.

Figure 14: Left: SNR=30.6 dB; Right: SNR=41.9 dB

4.2.4.2 Requirement

Spatial SNR	Standard	Premium
SNR(20lux 3000K LED)	≥ 30 dB	≥ 33 dB
SNR(80lux 3000K LED)	≥ 33 dB	≥ 36 dB
SNR(20lux 6000K LED)	≥ 30 dB	≥ 33 dB
SNR(80lux 6000K LED)	≥ 33 dB	≥ 36 dB

Table 43: Image spatial SNR requirements for personal solutions

Spatial SNR	Standard	Premium
SNR(200lux 3000K LED)	≥ 38 dB	≥ 41 dB
SNR(200lux 6000K LED)	≥ 38 dB	≥ 41 dB

Table 44: Image spatial SNR requirements for conferencing solutions

4.2.4.3 Test procedure

Test target	ColorChecker
ROI	Patch number 22
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 45: Image spatial SNR test details

4.2.5 Temporal SNR

4.2.5.1 Purpose

Temporal noise is the measure of noise as difference of pixel values in consecutive frames. As opposed to spatial noise that indicates a pixel level variation of each pixel within a single captured frame, compared to neighboring pixels, the temporal noise measurement compares the pixel value difference of the same pixel on two consecutive images. Temporal noise becomes visible to human eye when looking at a live video image instead of a single snapshot.

4.2.5.2 Requirement

Temporal SNR	**Standard**	**Premium**
TSNR(20lux 3000K LED)	≥ 30 dB	≥ 33 dB
TSNR(80lux 3000K LED)	≥ 33 dB	≥ 36 dB
TSNR(20lux 6000K LED)	≥ 30 dB	≥ 33 dB
TSNR(80lux 6000K LED)	≥ 33 dB	≥ 36 dB

Table 46: Image temporal SNR requirements for personal solutions

Temporal SNR	**Standard**	**Premium**
TSNR(200lux 3000K LED)	≥ 38 dB	≥ 41 dB
TSNR(200lux 6000K LED)	≥ 38 dB	≥ 41 dB

Table 47: Image temporal SNR requirements for conferencing solutions

4.2.5.3 Test procedure

Test target	ColorChecker
ROI	Patch number 22
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value *Select 2 captures in the Video Analyzer and run the test. The captures have to be unique frames with the same resolution and captured in minimal interval between them without moving the camera.*

Table 48: Image temporal SNR test details

4.3 Color quality

4.3.1 Color accuracy

4.3.1.1 Purpose

Accurate colors are required to make images look natural under various lighting temperatures. Note the criteria for A light is relaxed compared to 3500 K CFL and 5000K LED to allow A lighting to still have a yellow tint. Figure 15 gives an example of good and bad color accuracy.

Figure 15: Left: Image with poor color accuracy (Mean $\Delta C_{00} = 9.40$, Max $\Delta C_{00} = 15.9$); Right: good color accuracy (Mean $\Delta C_{00} = 4.1$, Max $\Delta C_{00} = 6.67$);

4.3.1.2 Requirements

Color accuracy	Standard	Premium
Max ΔC_{00} (80lux 2700K E27 Warm LED)	≤ 20	≤ 15
Mean ΔC_{00} (80lux 2700K E27 Warm LED)	≤ 15	≤ 10
Max ΔC_{00} (80lux A-light)	≤ 20	≤ 15
Mean ΔC_{00} (80lux A-light)	≤ 15	≤ 10
Max ΔC_{00} (20lux 3000K LED)	≤ 15	≤ 10
Mean ΔC_{00} (20lux 3000K LED)	≤ 10	≤ 5
Max ΔC_{00} (80lux 3000K LED)	≤ 15	≤ 10
Mean ΔC_{00} (80lux 3000K LED)	≤ 10	≤ 5
Max ΔC_{00} (80lux 6000K LED)	≤ 15	≤ 10
Mean ΔC_{00} (80lux 6000K LED)	≤ 10	≤ 5
Max ΔC_{00} (80lux 5000K E27 Cool LED)	≤ 15	≤ 10
Mean ΔC_{00} (80lux 5000K E27 Cool LED)	≤ 10	≤ 5
Max ΔC_{00} (80lux CFL 3500K)	≤ 15	≤ 10
Mean ΔC_{00} (80lux CFL 3500K)	≤ 10	≤ 5

Table 49: Color accuracy requirements for personal solutions

Color accuracy	**Standard**	**Premium**
Max ΔC_{00} (80lux 2700K E27 Warm LED)	≤ 20	≤ 15
Mean ΔC_{00} (80lux 2700K E27 Warm LED)	≤ 15	≤ 10
Max ΔC_{00} (80lux A-light)	≤ 20	≤ 15
Mean ΔC_{00} (80lux A-light)	≤ 15	≤ 10
Max ΔC_{00} (200lux 3000K LED)	≤ 15	≤ 10
Mean ΔC_{00} (200lux 3000K LED)	≤ 10	≤ 5
Max ΔC_{00} (200lux 6000K LED)	≤ 15	≤ 10
Mean ΔC_{00} (200lux 6000K LED)	≤ 10	≤ 5
Max ΔC_{00} (80lux 5000K E27 Cool LED)	≤ 15	≤ 10
Mean ΔC_{00} (80lux 5000K E27 Cool LED)	≤ 10	≤ 5
Max ΔC_{00} (80lux CFL 3500K)	≤ 15	≤ 10
Mean ΔC_{00} (80lux CFL 3500K)	≤ 10	≤ 5

Table 50: Color accuracy requirements for conferencing solution

4.3.1.3 Test procedure

Test target	ColorChecker
ROI	Patches 1-18
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 51: Color accuracy test details

4.3.2 Color saturation

4.3.2.1 Purpose

Accurate color saturation is required to make images look natural under various lighting temperatures.

4.3.2.2 Requirements

Saturation	Standard	Premium
Sat (80lux 2700K E27 Warm LED)	[85%, 135%]	[95%, 135%]
Sat (80lux A-light)	[80%, 135%]	[95%, 135%]
Sat (20lux 3000K LED)	[80%, 135%]	[95%, 135%]
Sat (80lux 3000K LED)	[85%, 135%]	[95%, 135%]
Sat (80lux 6000K LED)	[85%, 135%]	[95%, 135%]
Sat (80lux 5000K E27 Cool LED)	[85%, 135%]	[95%, 135%]
Sat (80lux CFL 3500K)	[85%, 135%]	[95%, 135%]

Table 52: Color saturation requirements for personal solutions

Saturation	Standard	Premium
Sat (80lux 2700K E27 Warm LED)	[85%, 130%]	[95%, 130%]
Sat (80lux A-light)	[80%, 130%]	[95%, 130%]
Sat (200lux 3000K LED)	[85%, 130%]	[95%, 130%]
Sat (200lux 6000K LED)	[85%, 130%]	[95%, 130%]
Sat (80lux 5000K E27 Cool LED)	[85%, 130%]	[95%, 130%]
Sat (80lux CFL 3500K)	[85%, 130%]	[95%, 130%]

Table 53: Color saturation requirements for conferencing solutions

4.3.2.3 Test procedure

Test target	ColorChecker
ROI	Patches 1-18
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 54: Color saturation test details

4.3.3 White balance error

4.3.3.1 Purpose

Accurate color representation is required to make images look natural under various types of lighting with different color temperatures. In addition to color accuracy also gray world should keep neutral gray tone instead of pink or magenta toning for example.

4.3.3.2 Requirements

White balance error	Standard
WB error P.21 (80lux 2700K E27 Warm LED)	$\Delta C_{00} \leq 15$
WB error P.21 (80lux A-light)	$\Delta C_{00} \leq 15$
WB error P.21 (20lux 3000K LED)	$\Delta C_{00} \leq 15$
WB error P.21 (80lux 3000K LED)	$\Delta C_{00} \leq 15$
WB error P.21 (80lux 6000K LED)	$\Delta C_{00} \leq 10$
WB error P.21 (80lux 5000K E27 Cool LED)	$\Delta C_{00} \leq 10$
WB error P.21 (80lux CFL 3500K)	$\Delta C_{00} \leq 10$

Table 55: White balance error requirements for personal solutions

White balance error	Standard
WB error P.21 (80lux 2700K E27 Warm LED)	$\Delta C_{00} \leq 15$
WB error P.21 (80lux A-light)	$\Delta C_{00} \leq 15$
WB error P.21 (200lux 3000K LED)	$\Delta C_{00} \leq 15$
WB error P.21 (200lux 6000K LED)	$\Delta C_{00} \leq 10$
WB error P.21 (80lux 5000K E27 Cool LED)	$\Delta C_{00} \leq 10$
WB error P.21 (80lux CFL 3500K)	$\Delta C_{00} \leq 10$

Table 56: White balance error requirements for conferencing solutions

4.3.3.3 Test procedure

Test target	ColorChecker
ROI	Patch 21
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 57: White balance error test details

4.4 Geometry

4.4.1 Field of view

4.4.1.1 Purpose

This test ensures that the camera has sufficient field of view. For personal solutions vertical field of view is the limiting factor covering speakers head and torso, whereas for conferencing devices the important aspect is horizontal field of view to capture all participants. For conferencing solutions please see Section 7.1 for meeting room examples and brought out requirements for different room sizes.

4.4.1.2 Requirements

Vertical field of view	**Standard**	**Premium**	**Recommended**
VFOV	≥ 35°	≥ 40°	60°

Table 58: Vertical field of view requirements for personal solutions

Horizontal field of view	**Standard**
HFOV	≥ 60°

Table 59: Horizontal field of view requirements for conferencing solutions

The requirement for conferencing solutions brought out is a minimum and fits only for the large rooms. The requirements and recommendations for smaller rooms is to be decided based on the intended conferencing room according to descriptions in Section 7.1.

4.4.1.3 Test procedure

Test target	ColorChecker
ROI	Whole chart
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 60: Vertical field of view test details

4.4.2 Geometric distortion

4.4.2.1 Purpose

Low geometric distortion guarantees that straight lines in a scene remain straight on the captured image. Large geometric distortion makes it difficult to accurately perceive the shape and size of objects in the captured scene.

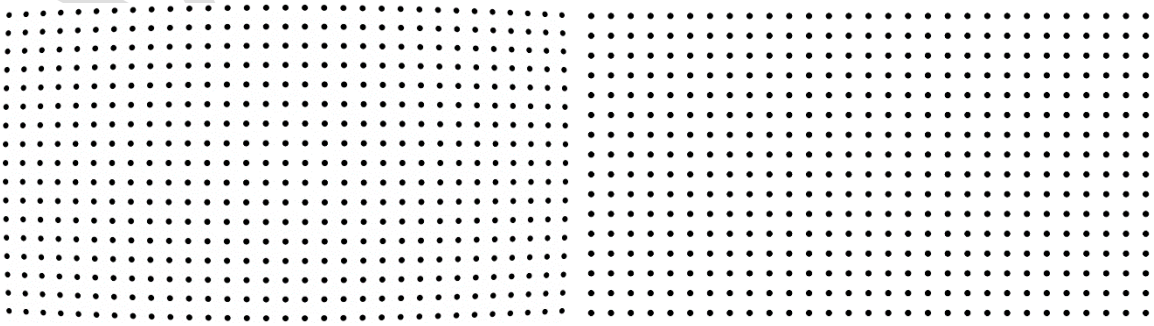


Figure 16: Left: Distortion=6.2%; Right: Distortion=0%

4.4.2.2 Requirements

Geometric distortion	Standard	Premium
Camera FOV measured in Section 4.4.1 is 35 to 45deg Distortion (80lux 3000K LED, max resolution)	|≤ 6%|	|≤ 3%|
Camera FOV measured in Section 4.4.1 is 46 to 65deg Distortion (80lux 3000K LED, max resolution)	|≤ 10%|	|≤ 6%|
Camera FOV measured in Section 4.4.1 is > 65deg Distortion (80lux 3000K LED, max resolution)	|≤ 14%|	|≤ 10%|

Table 61: Geometric distortion requirements for personal solutions

Geometric distortion	Standard	Premium
Distortion (200lux 3000K LED, max resolution)	|≤ 10%|	|≤ 6%|

Table 62: Geometric distortion requirements for conferencing solutions

4.4.2.3 Test procedure

Test target	Default: Dot Pattern test chart (small) Alternate: Dot Pattern test chart (large)
ROI	At least 15 rows of dots. *Make sure the chart fills full field of view. If needed, move the camera closer, or use a bigger test chart size. Camera must be aligned very carefully to avoid trapezoidal distortions due to camera position.*
Analysis	Skype Certification Video Analyzer: automatic detection of the ROI and calculation of value

Table 63: Geometric distortion test details

4.5 Shading

4.5.1 Relative illumination

4.5.1.1 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.

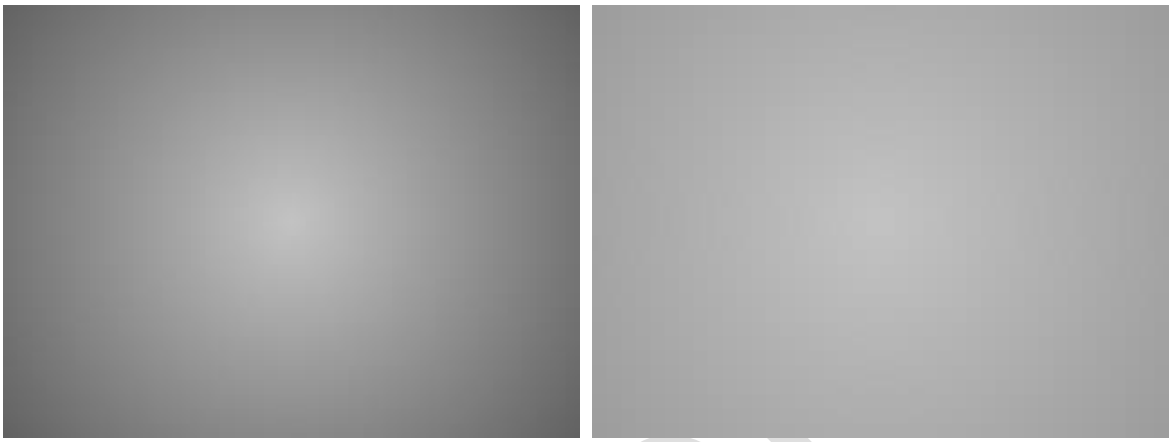


Figure 17: Left: Relative illumination=65%; Right: Relative illumination=86%

4.5.1.2 Requirements

Relative illumination	**Standard**	**Premium**
RI (80lux 3000K LED)	≥ 70%	≥80%

Table 64: Relative illumination requirements for personal solutions

Relative illumination	**Standard**	**Premium**
RI (200lux 3000K LED)	≥ 70%	≥80%

Table 65: Relative illumination requirements for conferencing solutions

4.5.1.3 Test procedure

Test target	Gray board
ROI	Whole frame
Analysis	Skype Certification Video Analyzer

Table 66: Relative illumination test details

4.5.2 Color uniformity

4.5.2.1 Purpose

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

Related standards: CPIQ Phase 2 – Color Uniformity.

Figure 18: Left: Max ΔC=12.3; Right: Max ΔC=3.2

4.5.2.2 Requirements

Color uniformity	Standard	Premium
Max ΔC (80lux 3000K LED)	≤ 10	≤ 5

Table 67: Color uniformity requirements for personal solutions

Color uniformity	Standard	Premium
Max ΔC (200lux 3000K LED)	≤ 10	≤ 5

Table 68: Color uniformity requirements for conferencing solutions

4.5.2.3 Test procedure

Test target	Gray board
ROI	Whole frame
Analysis	Skype Certification Video Analyzer

Table 69: Color uniformity test details

4.5.3 Veiling glare

4.5.3.1 Purpose

Due to internal reflections, light sources targeted to a camera may cause light scattering to extensive areas of its sensor. This stray light mostly affects the darker parts of a frame, in effect lowering the dynamic range of the camera. For cameras without anti-reflective coating and/or without lens hoods, even common overhead lighting can cause significant fidelity problems. The Veiling glare test measures the amount of stray light, to avoid its impact on image quality and the loss of dynamic range and acuity.

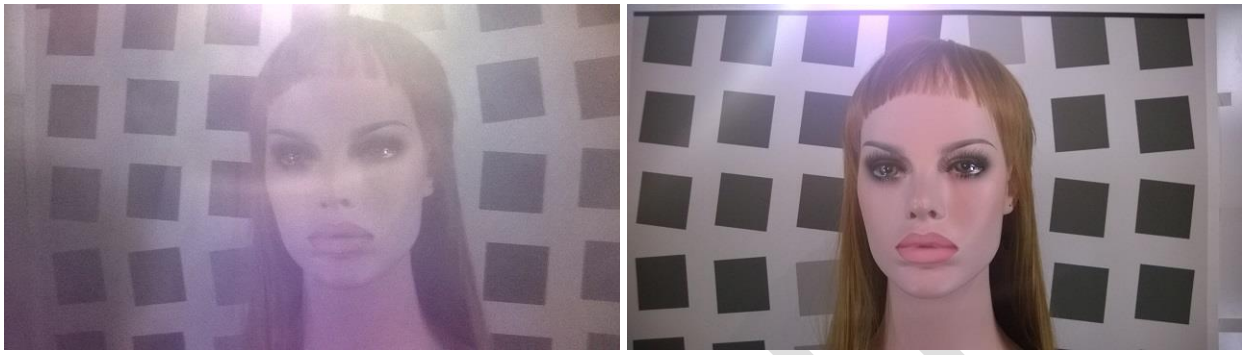


Figure 19: Image of a scene with overhead lighting from the front camera (left) and rear camera (right) of a mobile phone. The cover glass of the rear camera has anti-reflective coating, which improves the veiling glare; good lens hood can have the similar improvement

4.5.3.2 Requirements

Veiling glare	Standard	Premium
Veiling glare (avg pixel value)	≤ 10	≤ 5

Table 70: Veiling glare requirements

4.5.3.3 Test procedure

- Adjust the veiling glare light for a reading of 80lux at the camera position, as described in Section 6.1.5.
    - Make sure to use exactly the same type of light bulb for the veiling glare light as for the two auxiliary test target illumination lights.
    - Verify that the veiling glare light does not increase the illuminance of the test target by more than 5 Lux
    - Note that glare light must be 10cm higher than the upper edge of the field of view (adjusted according to resolution that gives widest vertical field of view)
- Adjust the main auxiliary lights for 80lux on the test target
- Capture an image of the uniform gray board with only the two main auxiliary lights turned on
- Capture an image of the uniform gray board with both the two main auxiliary lights turned on and the glare light also turned on
- Convert the images to grayscale and calculate the average of absolute value pixel differences between the two images.

Test target	Gray board
ROI	Whole frame
Analysis	Skype Certification Video Analyzer

Table 71: Veiling glare test details

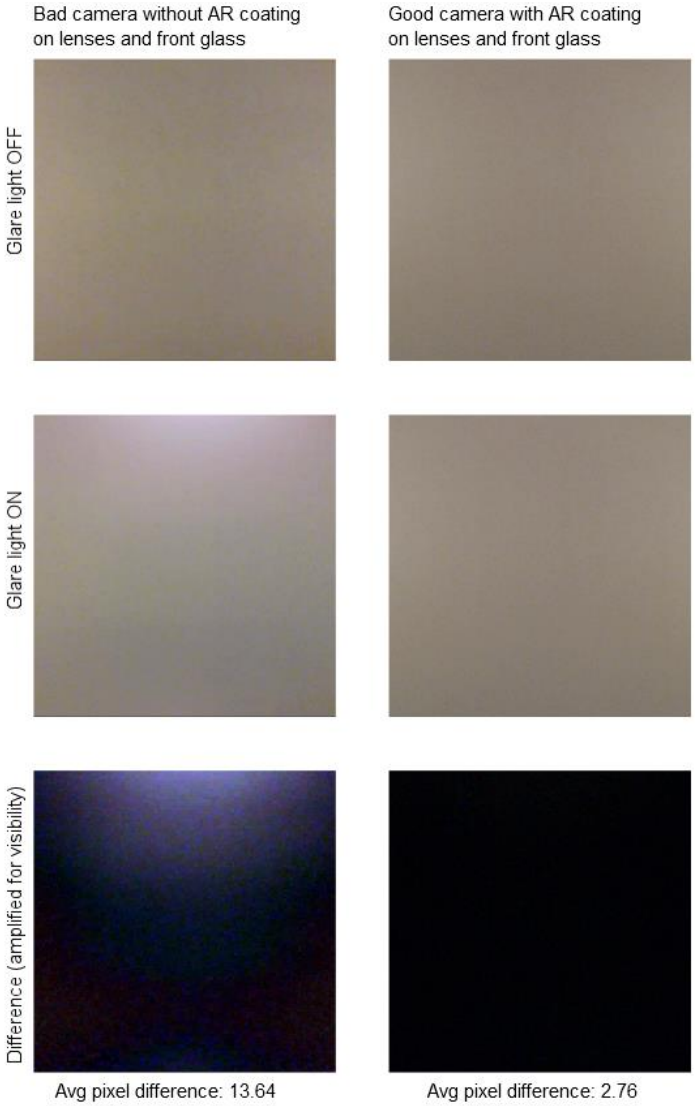


Figure 20: Veiling glare algorithm explanation

4.6 Timing

4.6.1 Jitter

4.6.1.1 Purpose

Ensure the camera and its drivers provide frames at a consistent rate without excessive jitter in frame timing.

4.6.1.2 Requirements

The jitter at all resolutions and at 30 fps must be ≤ 7 ms.

Jitter	**Standard**
Jitter(200lux 3000K LED)	≤ 7 ms

Table 72: Jitter requirement

4.6.1.3 Test procedure

Analysis	Skype Certification Video Analyzer peered with Remote Capture Tool

Table 73: Jitter test details

4.6.2 Time to capture first image, change resolutions

4.6.2.1 Purpose

The time to capture the first image is important to minimize the latency seen by the user, to facilitate dynamic changing of resolutions and to avoid excessive AV offsync from appearing right from the beginning of a video transmission.

4.6.2.2 Requirements

	Standard	**Premium**
Time to capture first image	≤ 1500 ms	≤ 500 ms
Time to change resolutions	≤ 1500 ms	≤ 750 ms

Table 74: Time to capture first image and change resolution requirements

4.6.2.3 Test procedure

Analysis	Skype Certification Video Analyzer peered with Remote Capture Tool

Table 75: Time to capture first image test details

4.6.2.4 Note

All required resolutions will be tested.

4.6.3 System latency

4.6.3.1 Purpose

This requirement makes sure the camera or its driver does not induce excessive latency, which would degrade the overall video end-to-end experience. The latency is measured over the complete system - from the photons entering the camera to the photons emitted by the display.

4.6.3.2 Requirements

In case of external webcam Microsoft Teams test labs use Surface Pro (1st generation) with Intel HD Graphics 4000 for this test.

Local video latency (VL) – measured with Remote Capture Tool **version 3.1** (from capture of photons to render on screen)	**Standard**	**Premium**
VL(200+ lux, YUY2)	≤ 130 ms	≤ 115 ms
VL(200+ lux, MJPEG, NV12)	≤ 140 ms	≤ 120 ms

Table 76: Video latency (system) requirements

4.6.3.3 Test procedure

Test target	Blinking LED
Analysis	Latency measurement kit *Can be used together with Skype Certification Video Analyzer*

Table 77: Video latency (system) test details

- Run Remote Capture Tool, configure the
  - Options -> Camera pin to 'Record'
  - Options -> YUV transform to 'off'
- Follow the instructions provided by the VideoTMT

4.6.3.4 Notes

The DUT has to be positioned so that the blinking LED is on the center row of the video frames.
The rendered video on DUT (or test PC) screen should reach the cameras maximum 30FPS.

4.6.4 Audio/video synchronization

4.6.4.1 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 camera uses excessive frame buffers for processing video with low latency audio or has significant delay with audio processing with low latency video.

4.6.4.2 Requirements

AV synchronization measured with Remote Capture Tool **version 4**	**Standard**	**Premium**
AVoffsync(200+lux)	Audio leading <75ms Audio behind <105ms	Audio leading <65ms Audio behind <95ms

Table 78: Audio/video synchronization requirements

4.6.4.3 Test procedure

Test target	Blinking LED / beeping speaker
Analysis	Latency measurement kit *Can be used together with Skype Certification Video Analyzer*

Table 79: Audio/video synchronization test details

Only to be tested in 1280x720. YUV transform to 'off'.

4.6.5 Video frame rate during a call

4.6.5.1 Purpose

To ensure that the video stream is transmitted without significant degradation.

4.6.5.2 Requirements

Video framerate during a call	**Standard**
Send video frame rate (20lux 3000K LED)	>14 fps
Send video frame rate (80lux 3000K LED)	>29 fps
Send video frame rate (160lux 3000K LED)	>29 fps
Send video frame rate (200lux 3000K LED)	>29 fps
Receive video frame rate (30fps, max resolution)[3]	>29 fps

Table 80: Video frame rate during a call requirements for personal solutions

Video framerate during a call	**Standard**
Send video frame rate (200lux 3000K LED)	>29 fps
Receive video frame rate (30fps, max resolution)[4]	>29 fps

Table 81: Video frame rate during a call requirements for conferencing solutions

[3] Applicable only for devices that have receive video capability as part of the solution.
[4] Applicable only for devices that have receive video capability as part of the solution.

4.6.5.3 Test procedure

1. Set up a Microsoft Teams video call to reference PC. The reference PC should have 1080p camera to enable sending maximum resolution the DUT can receive.
2. Capture the video from the reference PC using DVI capture card and measure the frame rate using Video Analyzer.
3. Optionally in case of questions or doubts a rotating object can be used to manually check the unique frame rate and visualize any issues (300RPM speed is recommended as it is easier to calculate the frame rate and also an exposure time)

Test target	Timing test chart
Analysis	Skype Certification Video Analyzer with Datapath DVI capture card

Table 82: Video frame rate during a call test details

4.6.6 Video latency during a call

4.6.6.1 Purpose

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

4.6.6.2 Requirements

Video delays during call	**Standard**	**Premium**
Send video latency (max resolution)	< 220ms	< 150ms
Preview video latency (max resolution)	< 180ms	< 120ms
Receive video latency (max resolution)[5]	< 220ms	< 150ms

Table 83: Video latency during call requirements

4.6.6.3 Test procedure

Test target	Blinking LED
Analysis	Latency measurement kit *Can be used together with Skype Certification Video Analyzer*

Table 84: Video latency (system) test details

[5] Applicable only for devices that have receive video capability as part of the solution

5 Video quality requirements in conference room environment

This section is applicable only to conferencing solutions and defines requirements for the respective use cases.

If the conferencing system has multiple cameras for long range usage, then all need to pass the requirements defined in this section. If it is possible that the cameras can be switching in some use case then it shall be made sure that notable quality degradation does not happen.

The image detail quality requirements are largely based on the intended usage of the camera. For room setup see the well-lit environment described in section 3.1.

5.1.1 Maximum recommended distance

5.1.1.1 Purpose

At maximum distance and whole room view the face should be recognizable and minimum requirements met for face detection based features.

5.1.1.2 Requirement

Limiting spatial resolution at maximum distance	**Standard**	**Premium**
LSR30(maximum resolution)	≥ 0.7 cy/cm	≥ 1.0 cy/cm

Table 85: Limiting spatial resolution requirements at maximum distance

At the maximum recommended distance the MTF30 has to be at least 0.7 cycles per centimeter as standard criteria and 1.0 cycles per centimeter as the premium criteria. The device shall be tested at the longest distance targeted for the device based on room size categories outlined in Table 3 (OEM must indicate in the submission checklist the room sizes that the device is seeking to be certified for).
Note that if the DUT has zoom functionality then it is allowed to apply zoom as long as the minimum recommended horizontal field of view requirement is satisfied for the target room size.

If the maximum recommended distance is clearly defined in the end user documentation then the experimentally found one should not be shorter.
If not defined then the distance is still noted but the test verdict is not to be marked as a pass or fail, but the tester should be aware if the device is to be tested against standard or premium requirements.

The numeric requirements are based on a user study that showed at 0.7 cy/cm results in less than 25% drop of recognizing emotions and above 1.0 cy/cm the improvement was not noticed.

5.1.1.3 Test procedure

1. Open the camera at maximum resolution and framerate that is to be used with Microsoft Teams .
2. Zoom out to widest available field of view setting. Note that if the DUT has zoom functionality then it is allowed to apply zoom as long as the minimum recommended horizontal field of view requirement is satisfied for the room type.
3. Set up the camera and test chart so that the test chart is positioned in the frame where the furthest user is expected to be:
   - For the cameras at the same height with users: center of the frame.

- For a device to be used on the top of a screen: on the center vertical above the center point depending on the camera and intended room specifics.
  Testing note: if the lab doesn't have a room large enough to accommodate the maximum camera distance, one mirror may be used in the test room to simulate doubling the distance. Adjustments will need to be performed due to target being mirror imaged.

4. Subjectively adjust the position so that the required spatial frequency is visible on the test chart.
5. Take a local capture with Remote Capture Tool. Open the capture with Skype Certification Video Analyzer and compute the metric.
6. If needed, then fine tune the position and calculate again.

Test target	Siemens Star
Analysis	Skype Certification Video Analyzer

Table 86: Maximum usage distance test details

5.1.2 Closest user acuity

5.1.2.1 Purpose

In case of the whole room view the closest persons to the camera need to be adequately sharp for subjective recognition and face detections based features.

5.1.2.2 Requirement

MTF30 at minimum distance	**Standard**	**Premium**
MTF30(maximum resolution)	≥ 0.17 cy/px	≥ 0.25 cy/px

Table 87: MTF30 requirement at minimum distance

The numeric requirements are based on user study that showed 75% and 95% of viewers tolerate the sharpness of the closest user at the standard and premium level respectively.

5.1.2.3 Test procedure

1. Continue using the positioning and zoom setting as found in Section 5.1.1.
2. Set the test chart to a position of the closest user. If it is not clearly described by the vendor, then choose it based on the maximum recommended distance and room descriptions Section 7.1. The chart is expected to appear at the edge of a frame.
3. Take a local capture with Remote Capture Tool. Open the capture with Skype Certification Video Analyzer and compute the metric.

Test target	Siemens Star
Analysis	Skype Certification Video Analyzer

Table 88: Closest user acuity test details

5.1.3 Video acuity with digital zoom

5.1.3.1 Purpose

If the camera enables digital zoom, then it must be limited to avoid wasting network bandwidth. The digital zoom can cause a degradation in video image quality due to the cropping of an image from a part

of the sensor and following interpolation back to the full resolution. This can cause poor acuity on users faces, increase the visible noise etc.

5.1.3.2 Requirement

Applicable only to conferencing cameras with digital zoom.

MTF30 at maximum distance	**Standard**	**Premium**
MTF30(maximum resolution)	≥ 0.17 cy/px	≥ 0.25 cy/px

Table 89: MTF30 requirement at minimum distance

5.1.3.3 Test procedure

1. Use the positioning of the test chart and DUT as found in Section 5.1.1.
2. Zoom in the test chart so that the chart fills the frame or maximum zoom setting is achieved.
3. Take a local capture with Remote Capture Tool. Open the capture with Skype Certification Video Analyzer and compute the metric.

Test target	Siemens Star
Analysis	Skype Certification Video Analyzer

Table 90: Active talker acuity test details

5.1.3.4 Requirement

5.1.3.5 Test procedure

5.1.4 Camera reorientation step size at maximum zoom setting

5.1.4.1 Purpose

When zoomed in on a user's face at the maximum distance (as found in section 5.1.1) then one step of pan or tilt must not move the field of view too much so that framing a specific person's head to the middle of the frame is not possible.

5.1.4.2 Requirement

If pan and tilt functions are provided, then their step size at maximum zoom setting has to be such that after a single step in any direction, at least 2/3 of the area visible in the previous frame still remains same.

5.1.4.3 Test procedure

1. Continue using the positioning of the test chart and camera as in section 5.1.3.
2. Move the camera 1 step up or down.
3. Verify that the step was not more than 1/3 of the frame.

Test target	Siemens Star
Analysis	Manual

Table 91: Camera reorientation step test details

6 Video test setup

6.1.1 Video test setup in lab

DUT camera is connected to a test PC unless it is an embedded camera in laptop, tablet or All In One (AIO) type of computer.

The Remote Capture Tool is used to capture the images and transport the images to the Video TMT machine for analysis.

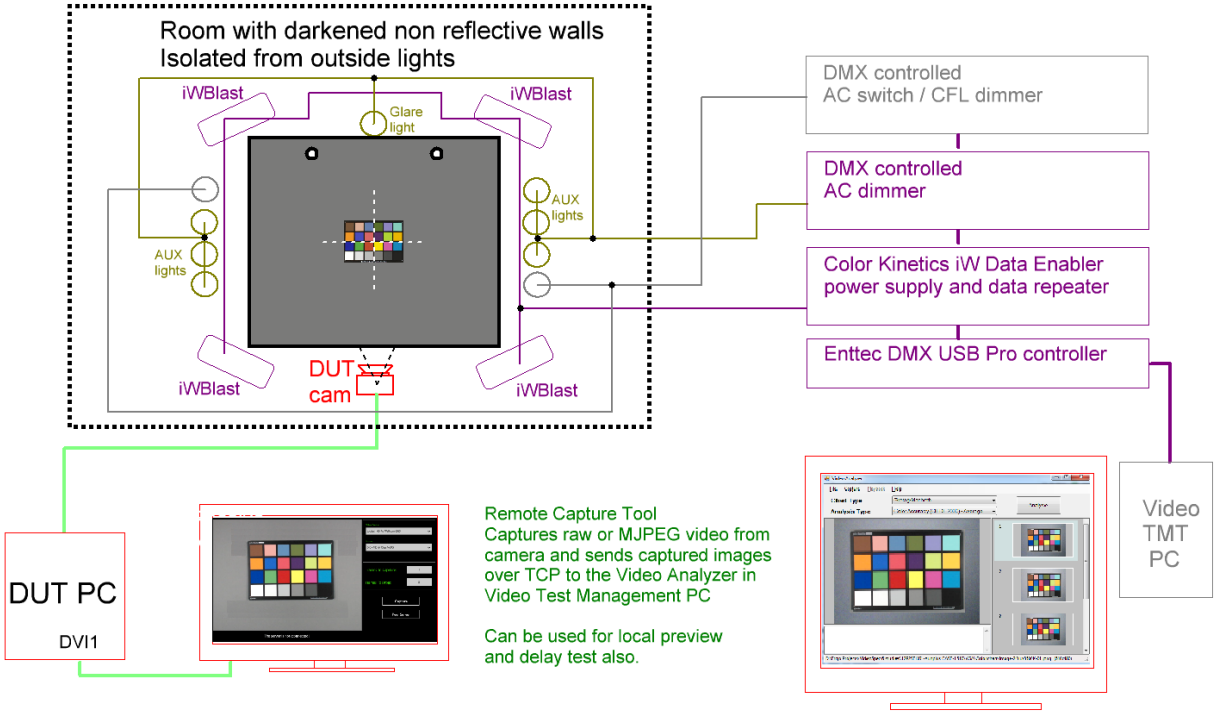


Figure 21: Main video test setup

6.1.2 Video latency test setup for system latency

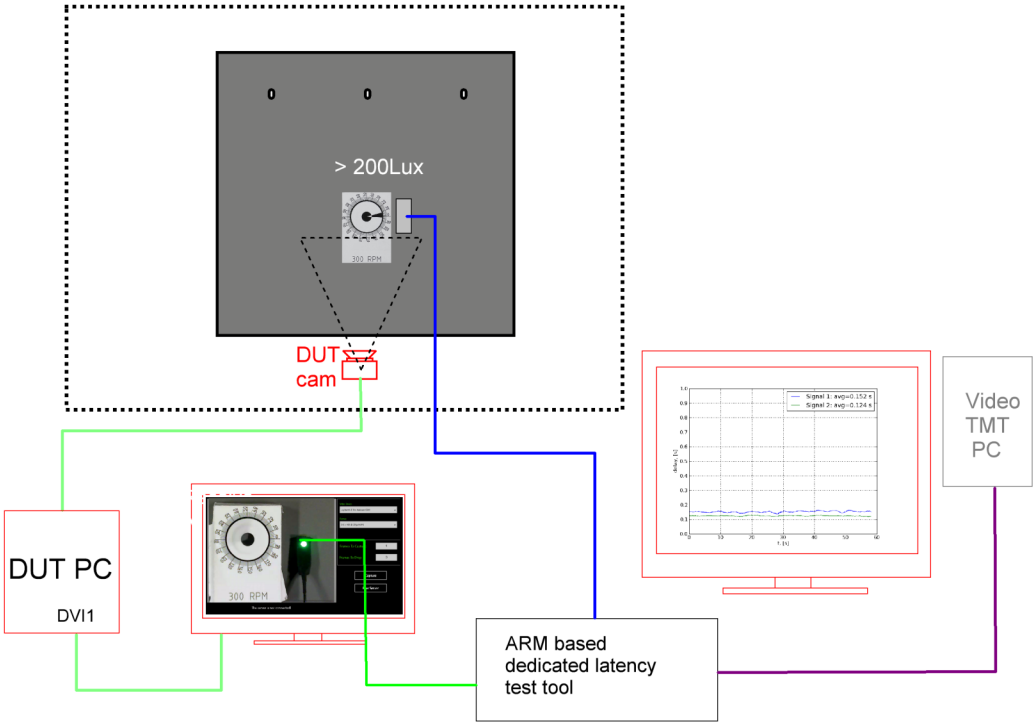


Figure 22: System latency test setup

6.1.3 Video latency test setup – End to End

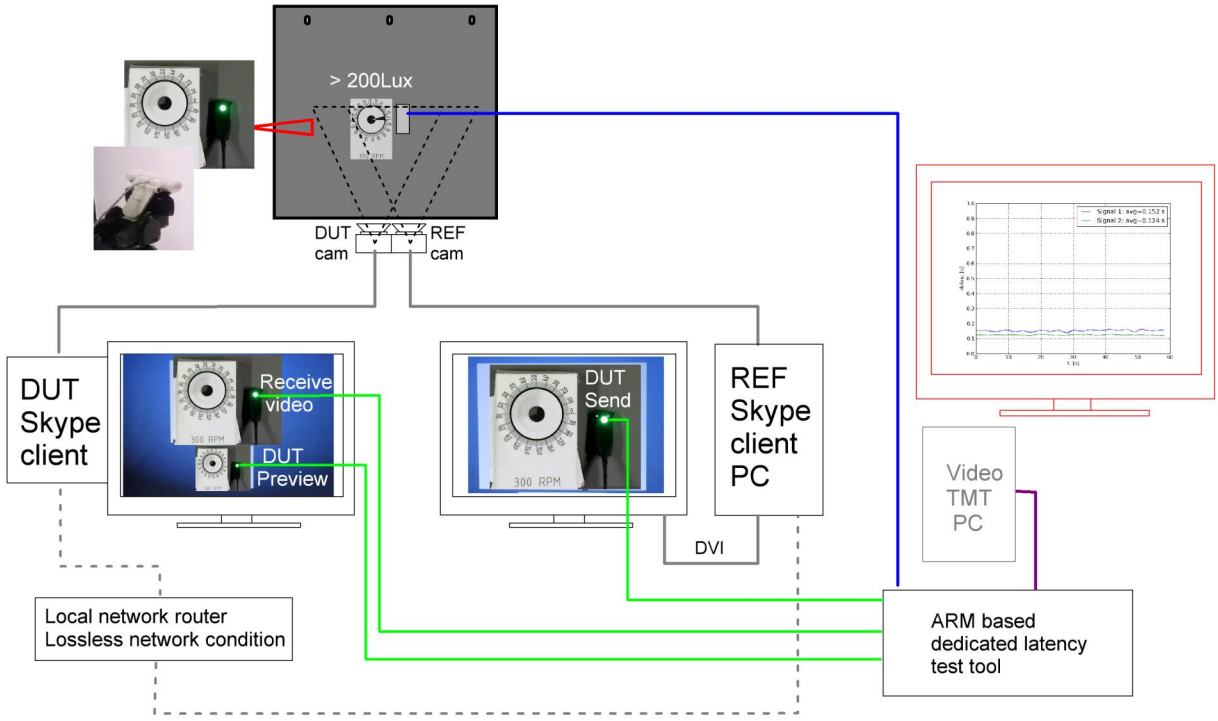


Figure 23: End to end latency measurement setup

6.1.4 End to End testing over a video call

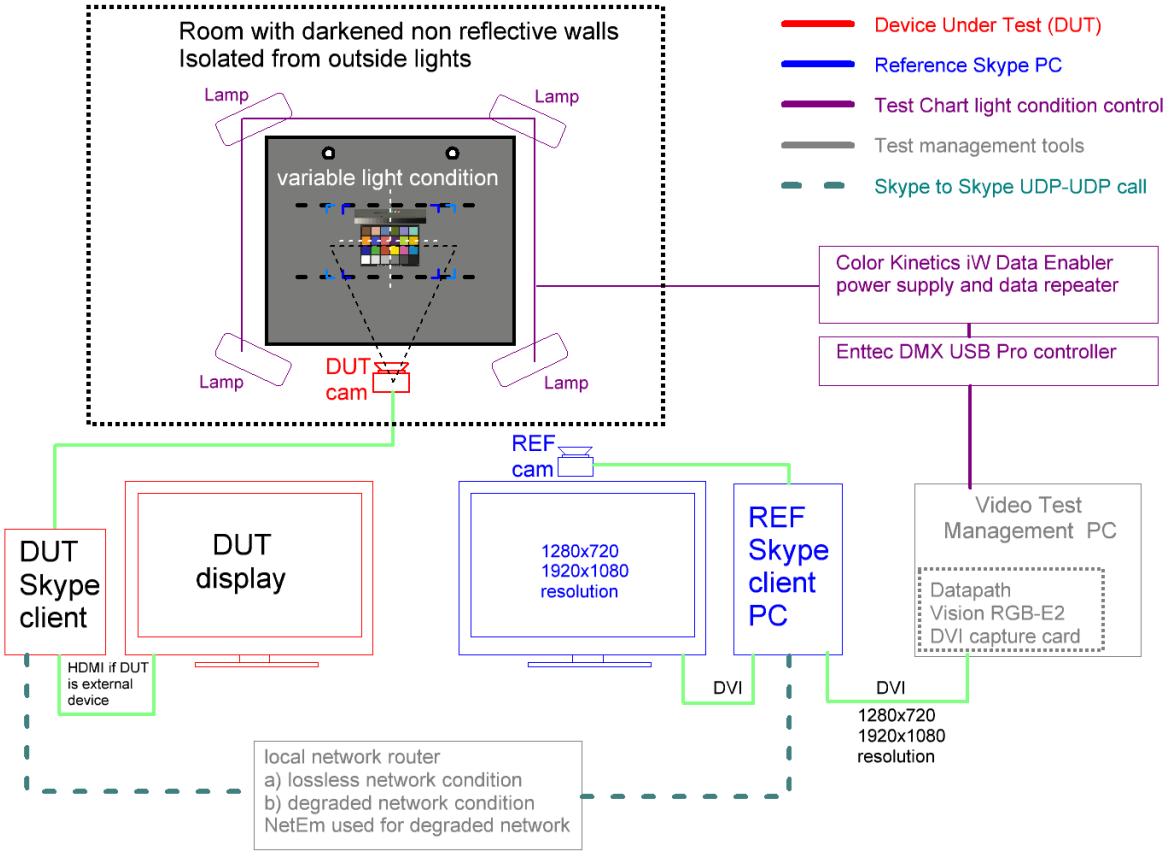


Figure 24: End to End test setup over Microsoft Teams call

End to End test is conducted over a Microsoft Teams two way video call. The call is made in the ideal network conditions. Microsoft reserves the right to replace the Skype for Business client with Microsoft Teams client at a later date.

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

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

A call is made between the DUT and the Reference PC. The Reference PC is configured for 1280x720 or 1920x1080 resolution from PC's graphics properties, and one of the two video output 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 from the reference PC video output and extracting the frames for image processing/analysis. The DVI video is captured at constant frame rate 50 or 60 frames per second.

6.1.5 Light setup and conditions

The test lab should be a dark room isolated from external light in order to control the lighting conditions. The floor, ceiling, walls and objects in the room should be matt with black or dark gray color. The wall behind the test chart could be painted mid gray. Any light fixtures, poles etc, should not produce light reflections on test target or camera.

The automated light setup enables altering of the light on test target for different color temperature and illuminance.

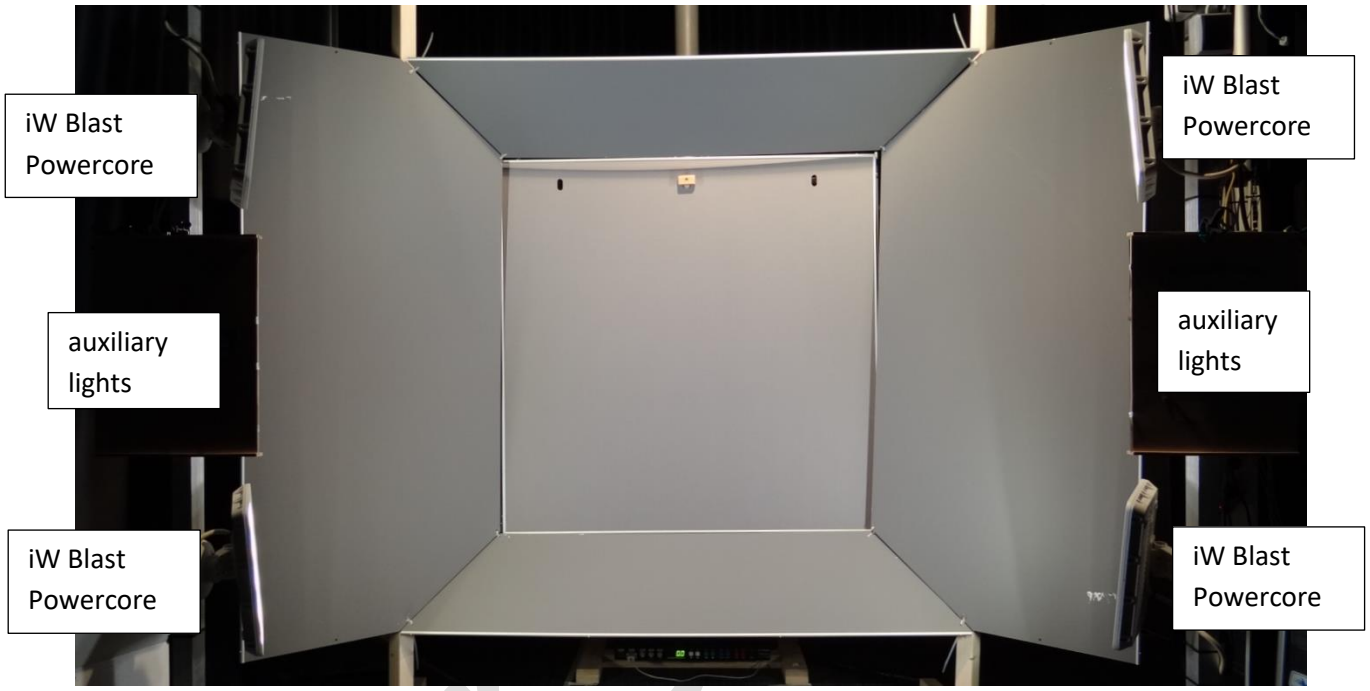


Figure 25: Light sources in video lab

Auxiliary light source light bulbs are installed in a vertical row. Left and right side bulbs are in reverse order (upper bulb on left side and lower bulb in right side are of same type).

A mirror is used to direct the light energy to test target. This helps to achieve the required Lux level on test target with 2 light bulbs and also helps to improve the light uniformity achieving the 10% tolerance over Colorcheck chart.

Figure 26: Auxiliary light fixture

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

	Light source	Lux levels on target
2700K A19 Warm LED	Philips A19 replacement LED	80Lux
A-light	Frosted 60W incandescent halogen bulb	80Lux
3000K LED	Philips iW Blast Powercore	10Lux ….. 1000Lux USB/DMX control
6000K LED	Philips iW Blast Powercore	10Lux ….. 1000Lux USB/DMX control
5000K A19 Cool LED	Philips A19 replacement LED	80Lux
CFL 3500K	Philips 268243	80Lux

Table 92: Light sources used in video tests

The USB controlled variable Lux/temperature light setup is built using 4 iWBlast Powercore lights in X shape configuration. This setup gives the best and largest area of light uniformity. The maximum 10% variation in uniformity criteria can be achieved for 90% area on the 1mx1m test chart. Thus also the SFRPlus and Dot chart can be lit uniformly.

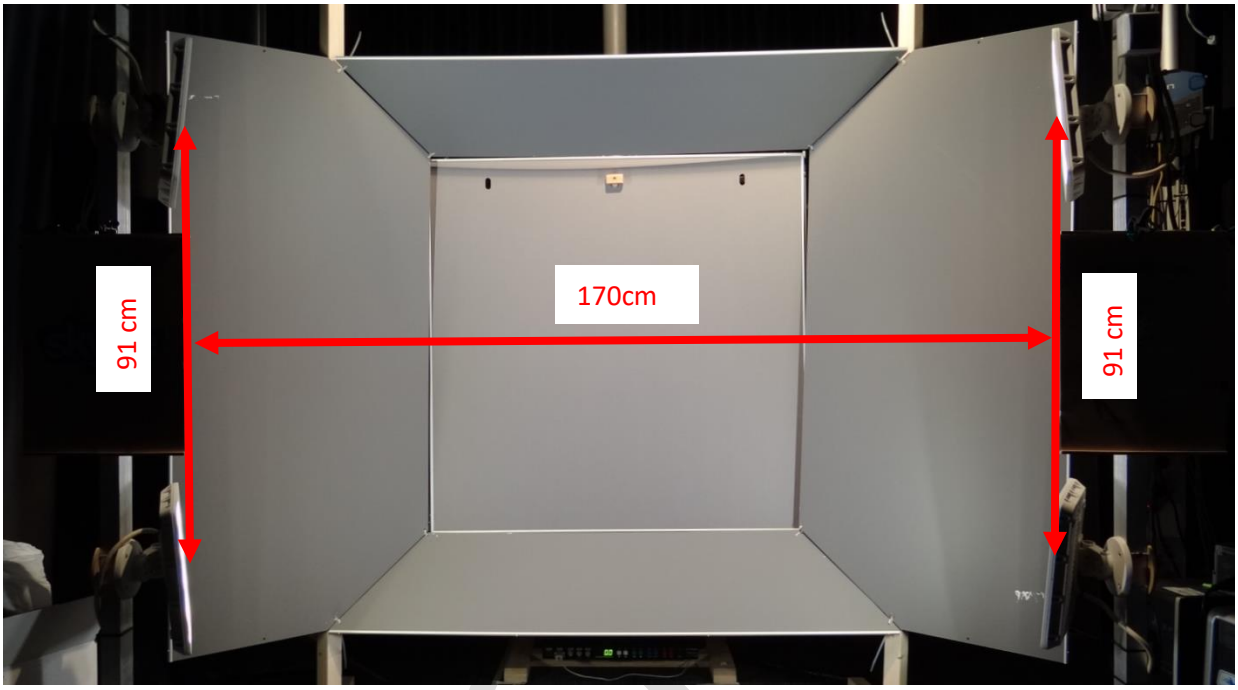


Figure 27: Distances between the centers of the lamps

The centers of iWBlast Powercore lamps are on a plane that is 90..95cm from test target surface.

The initial alignment of the 4 lamps is made experimentally by photographing the full test chart area. Then running the uniformity measurement on the chart area equal to size of smaller SFRPlus chart as shown on example below. The process is repeated until best setting is found.

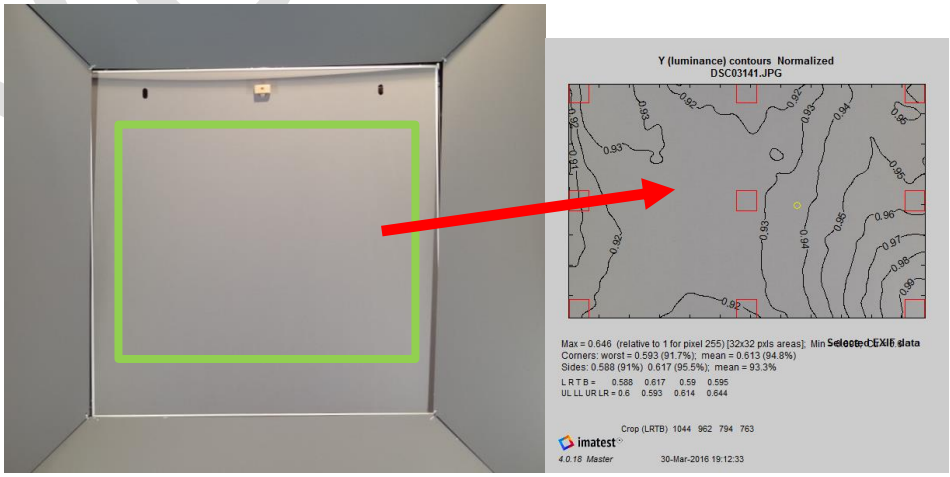


Figure 28: Uniformity of main lamps

The auxiliary lights cannot achieve equally large uniform area, thus the optimization is done to make sure the 10% uniformity is achieved at center of the test target area in equal size to the X-Rite Color Checker.

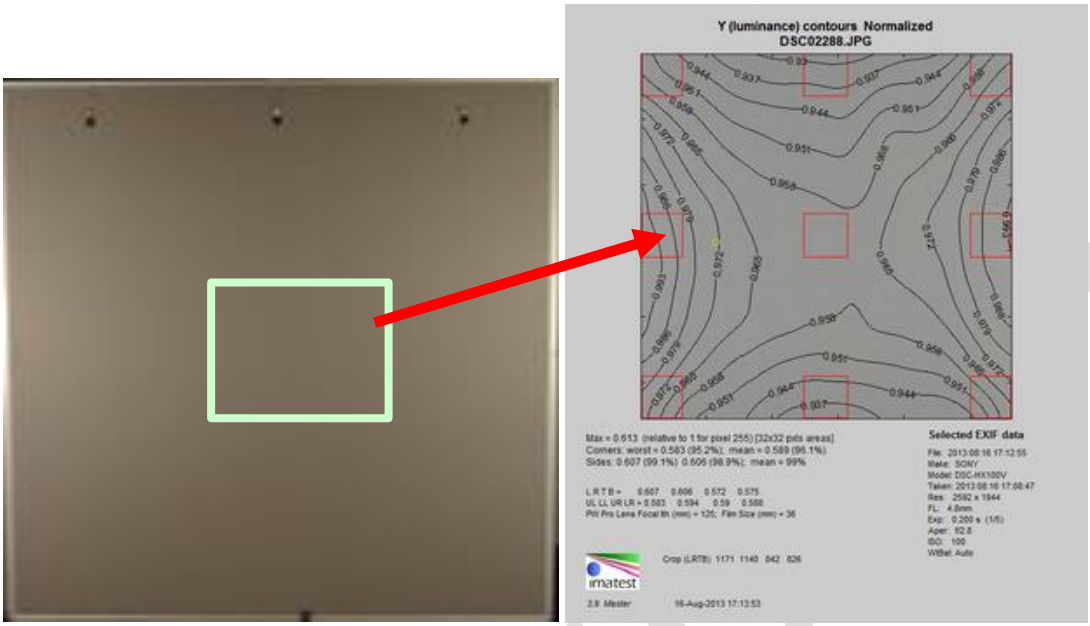


Figure 29: Uniformity of auxiliary lights

Below drawings give guidelines for veiling glare test setup. Important note here is that the main lights used for the test and the veiling glare light are of the same exact type. For example the same type of A19/E27 socket 2700K Philips Warm LED-s are used for all three.

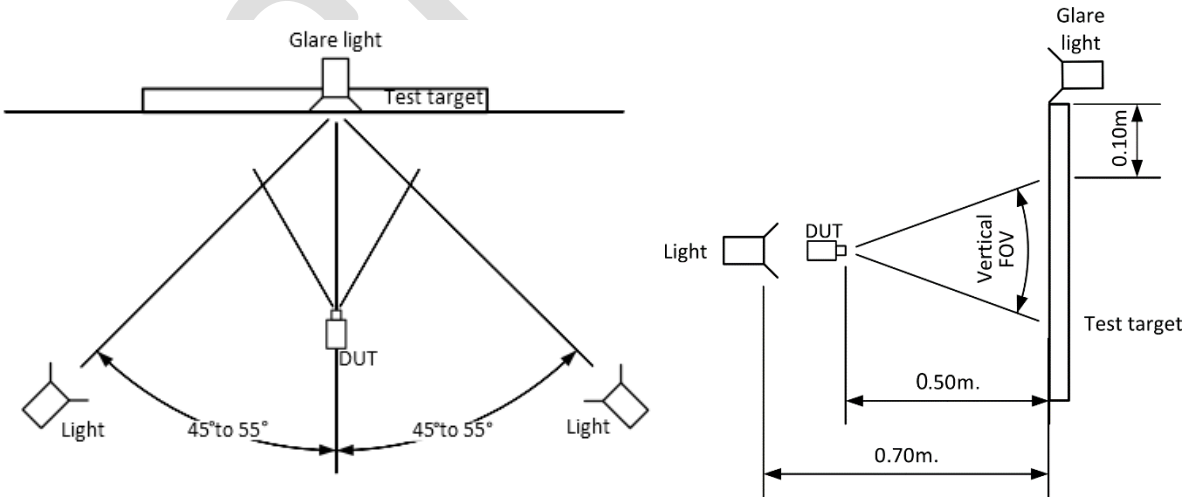


Figure 30: Veiling glare test setup

6.1.6 Test charts

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

6.1.6.1 Gray Board – for relative illumination, color uniformity and framerate tests

The distance between camera the test target has to be chosen the following way:

- DUT must not create shadows on the target within its field of view.
- Only the target surface can be in the frame.
- Note: the testing distance for veiling glare is described on Figure 30: Veiling glare test setup.

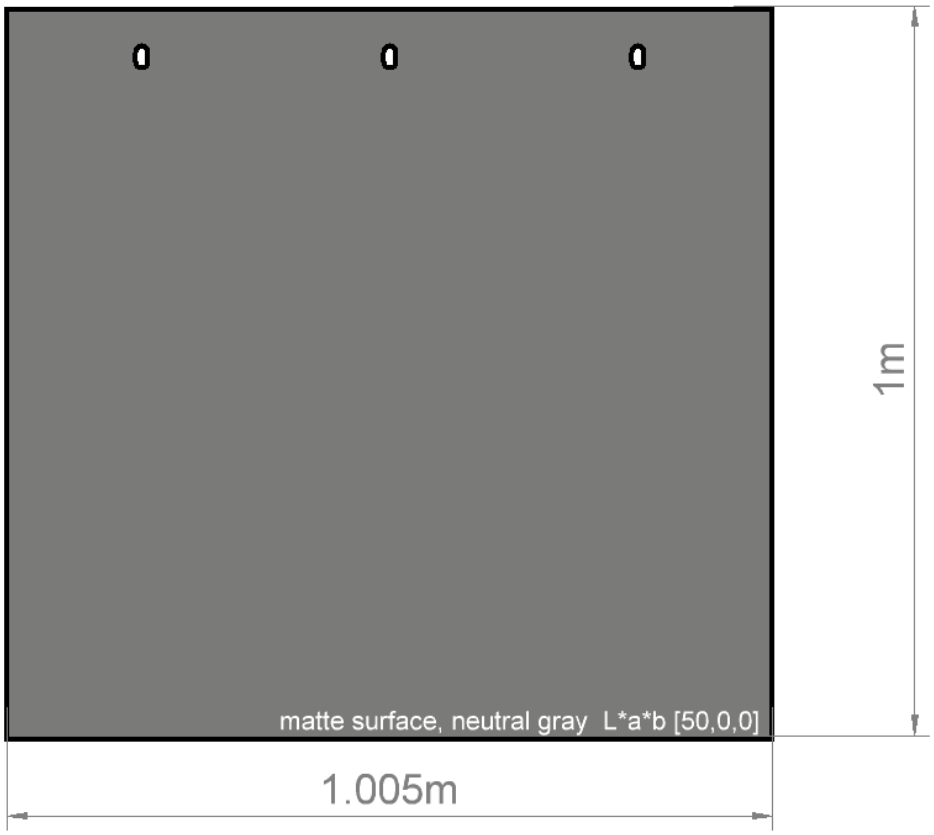


Figure 31: Gray board

The board is made of aluminum composite, surrounded with aluminum profile and covered with Hama neutral gray background paper or painted with 18% Neutral Gray (N5) Interior Wall Paint.

It is possible to order the boards from Reklaamikompanii (http://www.reklaamikompanii.ee/).

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

6.1.6.2 X-Rite ColorChecker Classic

The distance between the camera and the test target has to be chosen in the following way:

- DUT must not cast shadows on the ColorChecker chart.
- The chart should fill at least 70% of the vertical field of view in all resolutions tested.
  Note: For testing repeatability and automation purposes it is recommended to minimize the distance based on the resolution required that has the smallest field of view.

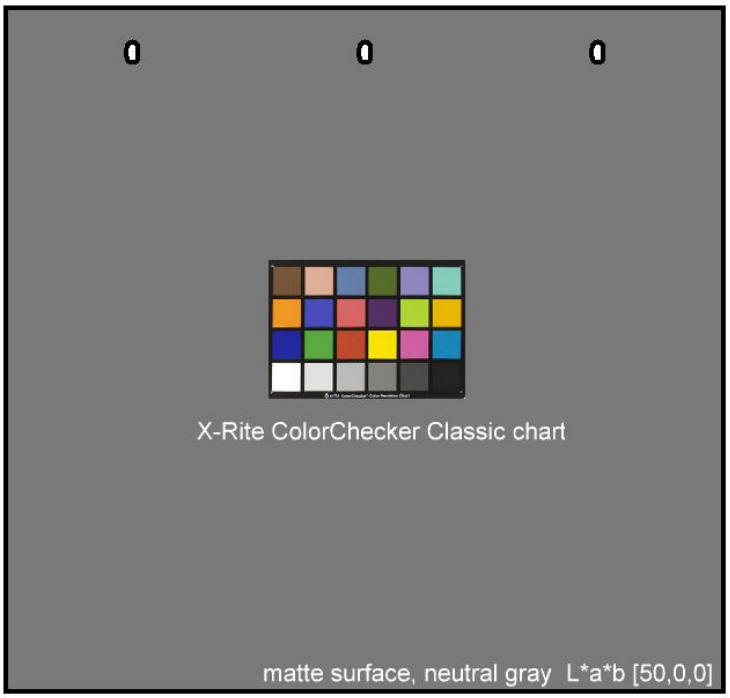
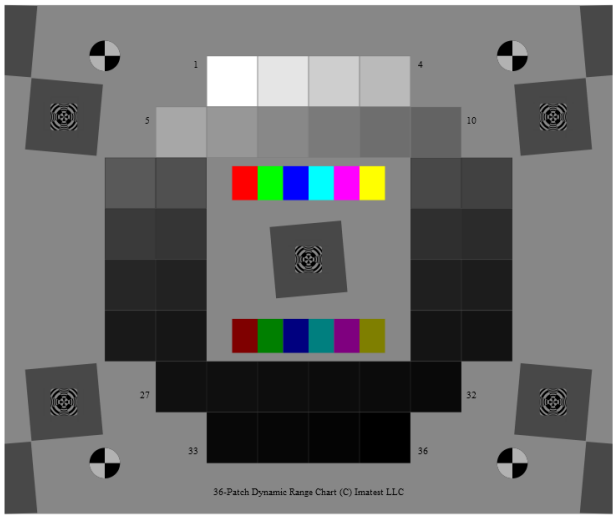


Figure 32: X-Rite ColorChecker

6.1.6.3 36-Patch Dynamic Range Test Chart (transmissive)

The distance between camera the test target has to be chosen the following way:

- There must be at least one bright and at least one dark patch clipping. If it is not achieved automatically then it is allowed to manually adjust the backlight brightness or camera exposure.
- The chart must fill at least 70% of the vertical field of view in all resolutions tested.
  Note: For testing repeatability and automation purposes it is recommended to minimize the distance based on the resolution required that has the smallest field of view.



Note !

This chart needs a uniform light emitting surface behind the chart, such as a dedicated light box. See suggestions under test equipment section.

Figure 33: Transmissive dynamic range test chart (ITDR-36 chart)

6.1.6.4 Dead Leaves / Spilled Coins - texture acuity test chart

The distance between camera the test target has to be chosen the following way:

- Refer to the category based nominal distance described in Section 2.4 Classification of the products.
  Note: if the nominal distance exceeds 1.0m then use 1.0m instead.

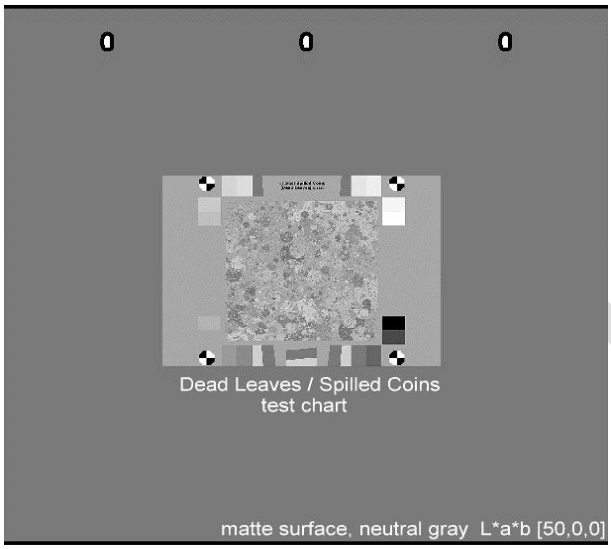


Figure 34: Spilled Coins test chart

Imatest order information - Spilled Coins (Dead Leaves) Test Chart, Size – 12''x 12'' active area, matte

6.1.6.5 SFR Plus 5x7 chart for MTF, oversharpening, edge roughness, and depth of field tests

The distance between the camera and the test target has to be chosen in the following way:

- Refer to the category based nominal distance described in Section 2.4 Classification of the products.
- For the depth of field tests, the category based minimum and maximum distance are used.

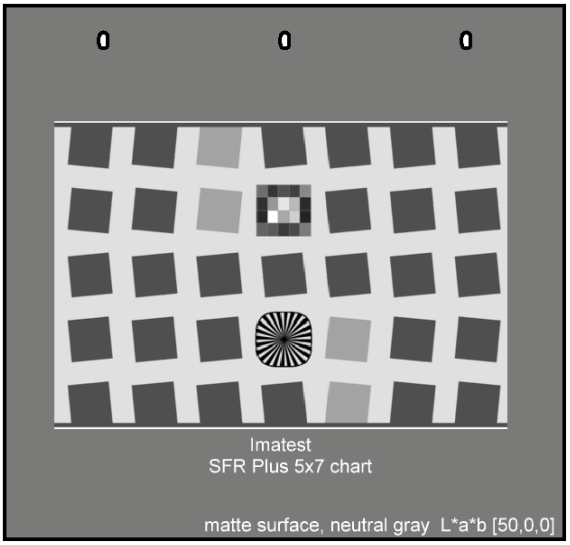


Figure 35: SFRplus test chart (small)

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

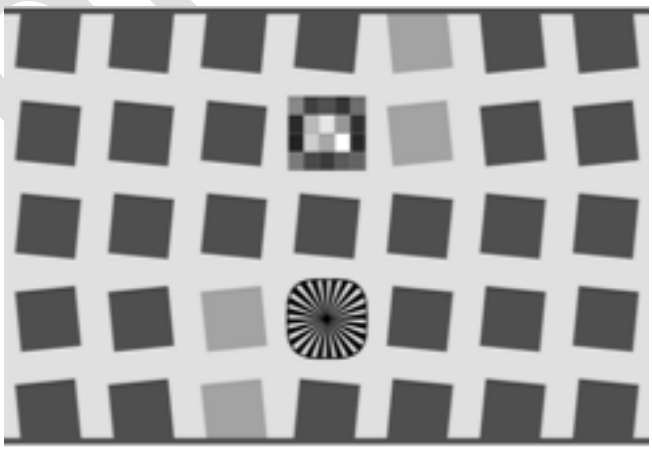


Figure 36: SFRplus test chart (large)

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

6.1.6.6 Siemens Star

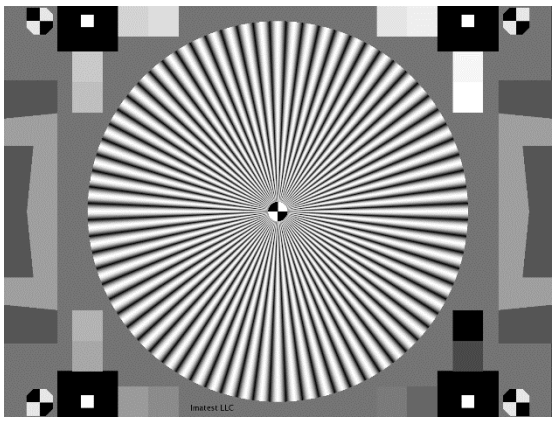


Figure 37: Siemens Star chart on a high contrast background

Details: 72 stripes, printed out 600dpi and 40cm height.

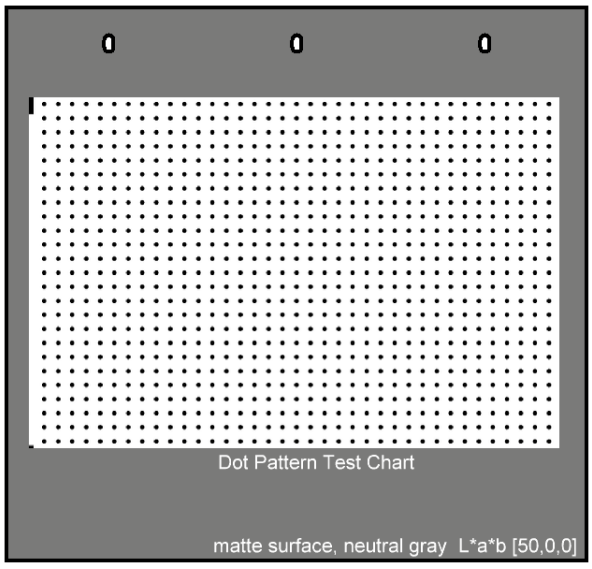
Chart background: white board (60cm height), surrounded by black frame (10cm height).

6.1.6.7 Imatest Dot Pattern Test Chart

The distance between the camera and the test target has to be chosen in the following way:

- The camera should see at least 15 rows of dots.
  Note: For testing automation purposes it is recommended to choose the distance based on the resolution required that has the smallest field of view.
- The camera should not see anything outside the dotted region

The camera should be aligned to this test target as precisely as possible to avoid any trapezoid distortion that could affect the distortion measurements.



Note!

This chart is used for distortion measurement, but in future it will be also used for chromatic aberration test.

Figure 38: Dot Pattern test chart (small)

Imatest order information - Dot Pattern Test Chart, Size - Medium, 25 dot.

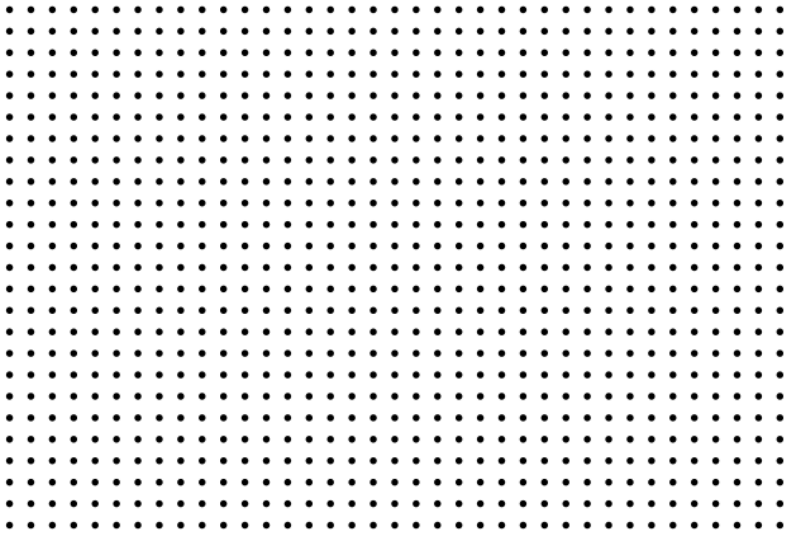
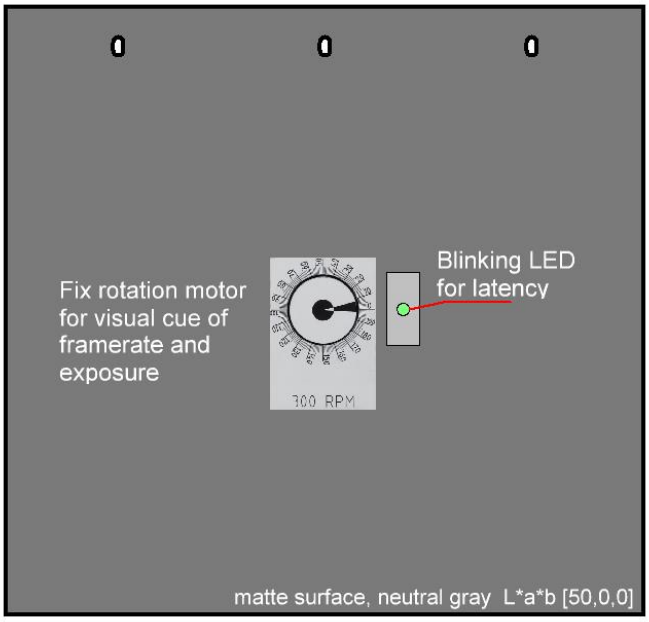


Figure 39: Dot Pattern test chart (large)

Imatest order information - Dot Pattern Test Chart, Size – X-Large, 25 dot.

6.1.6.8 Timing test chart

The distance between the camera and the test target is not relevant. Blinking LED must be in the middle of vertical field of view. Positioning it to the center point of the frame would allow to test multiple resolutions without the need to reposition the measurement equipment.
It is recommended to move the camera closer if there are problems with detecting the blinking LED on a small screen.



Note!

Blinking LED is part of the latency measurement kit.

Rotating wheel is optional. Frame rate test can be also conducted using an empty gray board

Figure 40: Timing test chart

Blinking LED is part of the Latency measurement kit described in Section 6.1.7.

Fix rotation motor is optional – it is not needed for any automated tests.

6.1.7 Latency measurement kit

ScienceMosaic™ (http://sciencemosaic.com/) video and audio latency measurement system is intended to provide an accurate way to measure latencies between different video and audio signals. It is designed as an on-the-field tool for video and audio equipment designers and QA specialists to get a fast understanding of what are the latency parameters in the audio/video system they are working with.

Latency measurement system generates visible (LED with different blinking patterns) and audible (speaker with different beeping patterns) reference signal and it has 3 optical inputs (with TOSLINK connectors) for different video signals and 2 RCA audio inputs for different audio signals.

Figure 41: Latency measurement kit

6.1.8 Other inventory

Besides the charts, Microsoft labs use the following equipment when performing the certification tests:

- Lights with power supply and controller
  - AC -> DC -> AC 50/60Hz conversion for lights
    - RSP-1000-48 – AC to 48V/21A DC
    - TS-700-248 - DC to 50/60Hz 110/230V AC converter
  - USB to DMX controller - Enttec DMX USB Pro controller
  - Two / four Color Kinetics iW Blast 12 Powercore lights (83° Beam Angle)
    - four lights achieve a better uniformity over the full 0.9 x 1m test chart area
    - color temperature adjustable in the region of $-2900K$ $-6500K$
    - luminous intensity controllable
    - average power consumption is 200W
    - AC/DC converter built into the lights (accepts 110V … 230V AC)
    - light controlling data path: PC → DMX USB Pro → Data Enabler → Lights
  - Color Kinetics iW Data Enabler- power supply and data repeater (DMX version)
  - DMX controlled AC dimmer.
  - DMX4ALL 90-5243 and two units of Philips Advance Mark 7 IZT-2S26-M5-BS
  - Lightbox – Image Quality Labs IQL-LE002 D65

- Camera holder mechanism
- Laser distance meter
  - Bosch DLE 50 Professional
  - minimum measuring distance: 5 cm
- Video test management PC
  - CPU Type: 4 Core or more, ≥3GHz
  - system memory: ≥6Gb
  - SSD hard drive with sequential transfer read/write speed of 360Mb/s
  - Must be able to fit full size PCI Express x4 plug in capture card
  - ≥ 6 USB sockets, including USB 3.0 support
- Datapath VisionRGB-E2 / VisionRGB-E2s Dual DVI capture card
- Reference Skype PC / DUT PC for USB cameras
  - CPU Type: Core 2 Duo or more, ≥3GHz
  - System memory: ≥6Gb
- 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)

7 Appendix

7.1 Room type definitions

Room types are defined based on industry standards. Testers can target a room type (focus room, small meeting room, medium meeting room or large meeting room) that the solution is intended for.

The tester should consider the room specifics and mark down in which rooms the solutions can be used. These rooms can also be used to select maximum distance for video testing if the end user documentation provided with the solution is not clear.

7.1.1 Reference focus room design

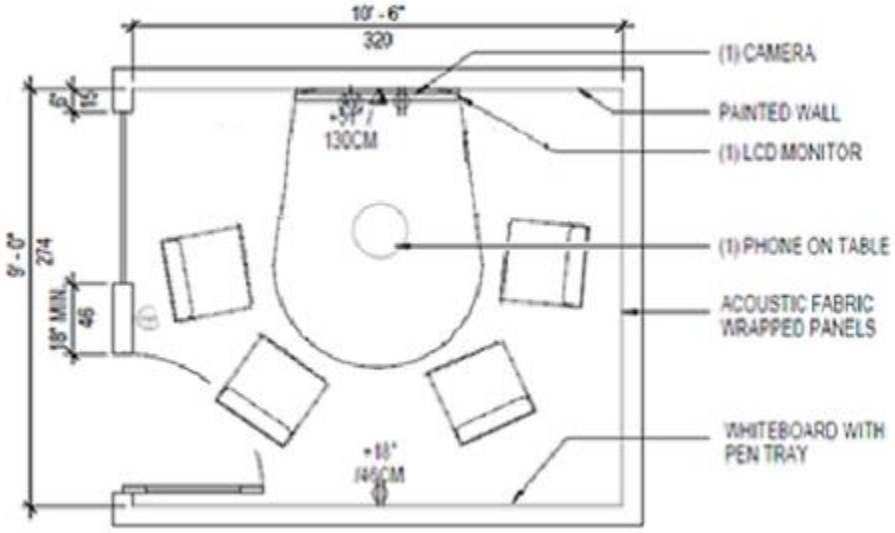


Figure 42: Focus room layout

If the microphone is intended to be positioned at the center of the table meaning that the distance to a user is about 1m. Microphone at the camera would mean that distances up to 2.5m need to be supported.

For video conferencing purposes the chairs can be collocated slightly towards the end of the table. This still means that at least 90 degrees horizontal field of view has to be supported. The preferred horizontal field of view is 120 degrees.

7.1.2 Reference small meeting room

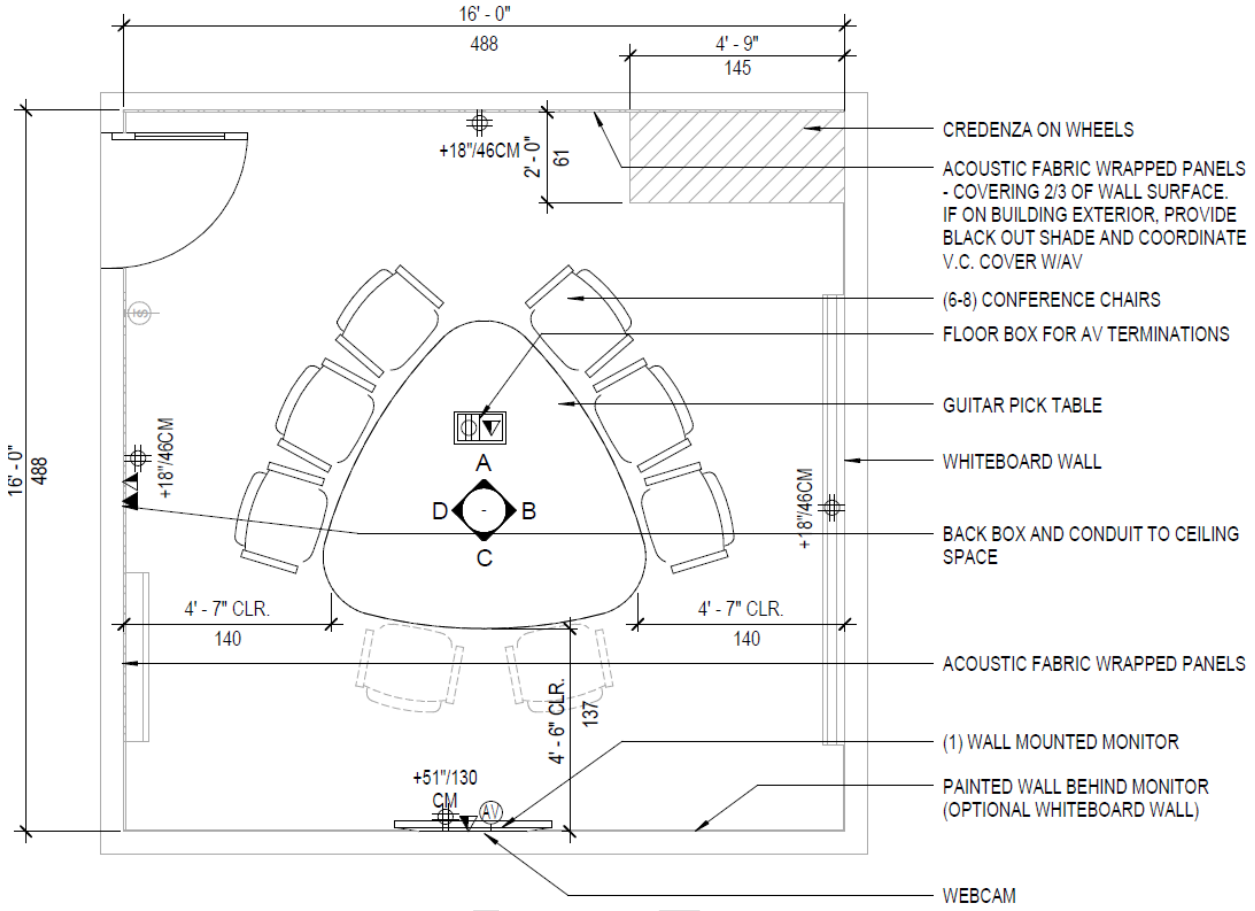


Figure 43: Small meeting room layout

If the microphone is intended to be positioned at the center of the table meaning that the distance to a user is about 1.2m. In case of 2 microphones can be positioned flexibly then the distance to consider is 0.85m to user.
Microphone at the camera would mean that distances up to 3.5m need to be supported.

The camera position is intended to be on the top of the TV. The horizontal field of view has to be at least 70 degrees (preferably 80).

7.1.3 Reference medium meeting room

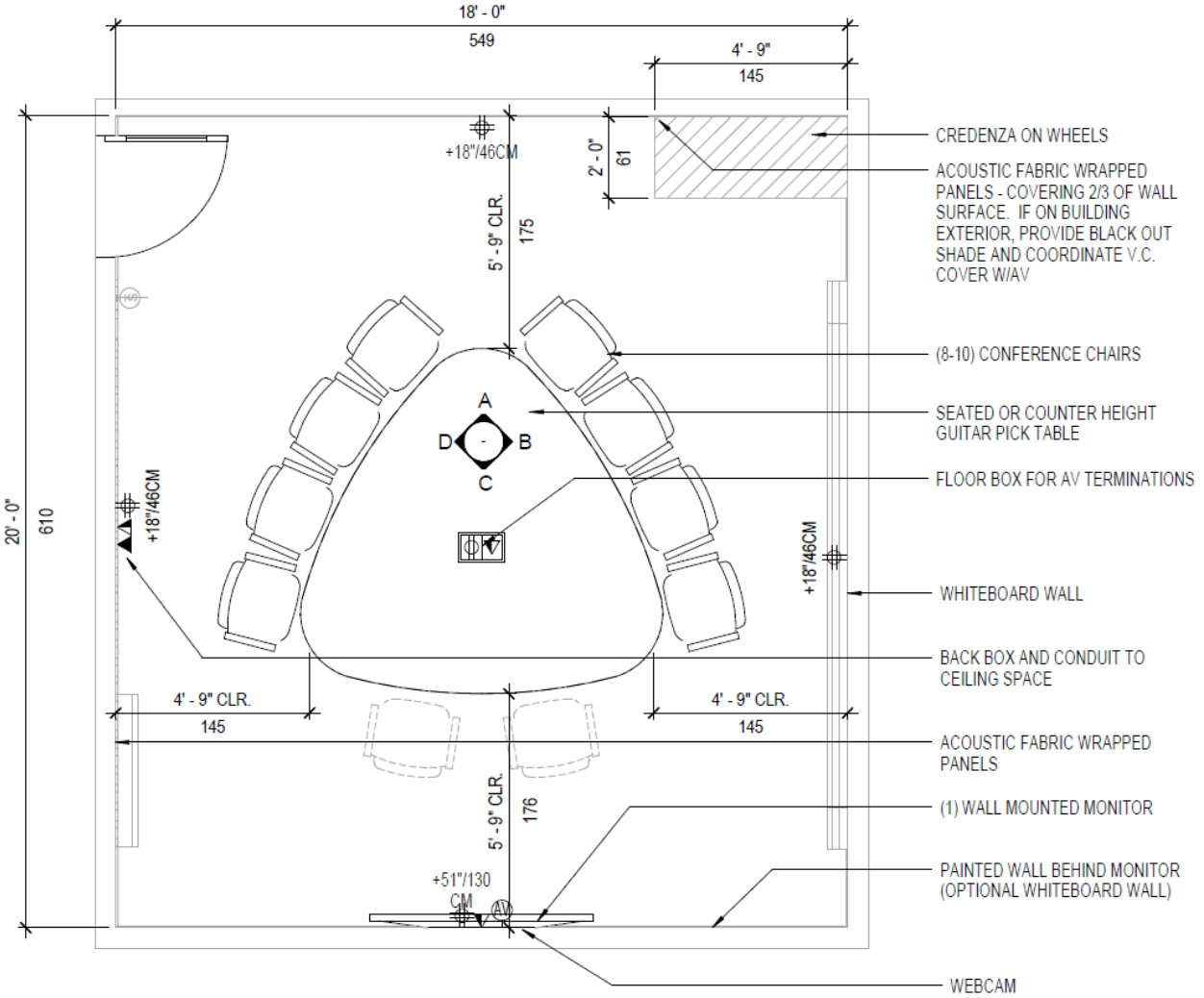


Figure 44: Medium size meeting room layout

If the microphone is intended to be positioned at the center of the table meaning that the distance to a user is about 1.5m. In case of 2 microphones can be positioned flexibly then the distance to consider is 1.0m to user.
Microphone at the camera would mean that distances up to 4.1m need to be supported.

The camera position is intended to be on the top of the TV. The horizontal field of view has to be at least 70 degrees (preferably 80).

7.1.4 Reference large meeting room

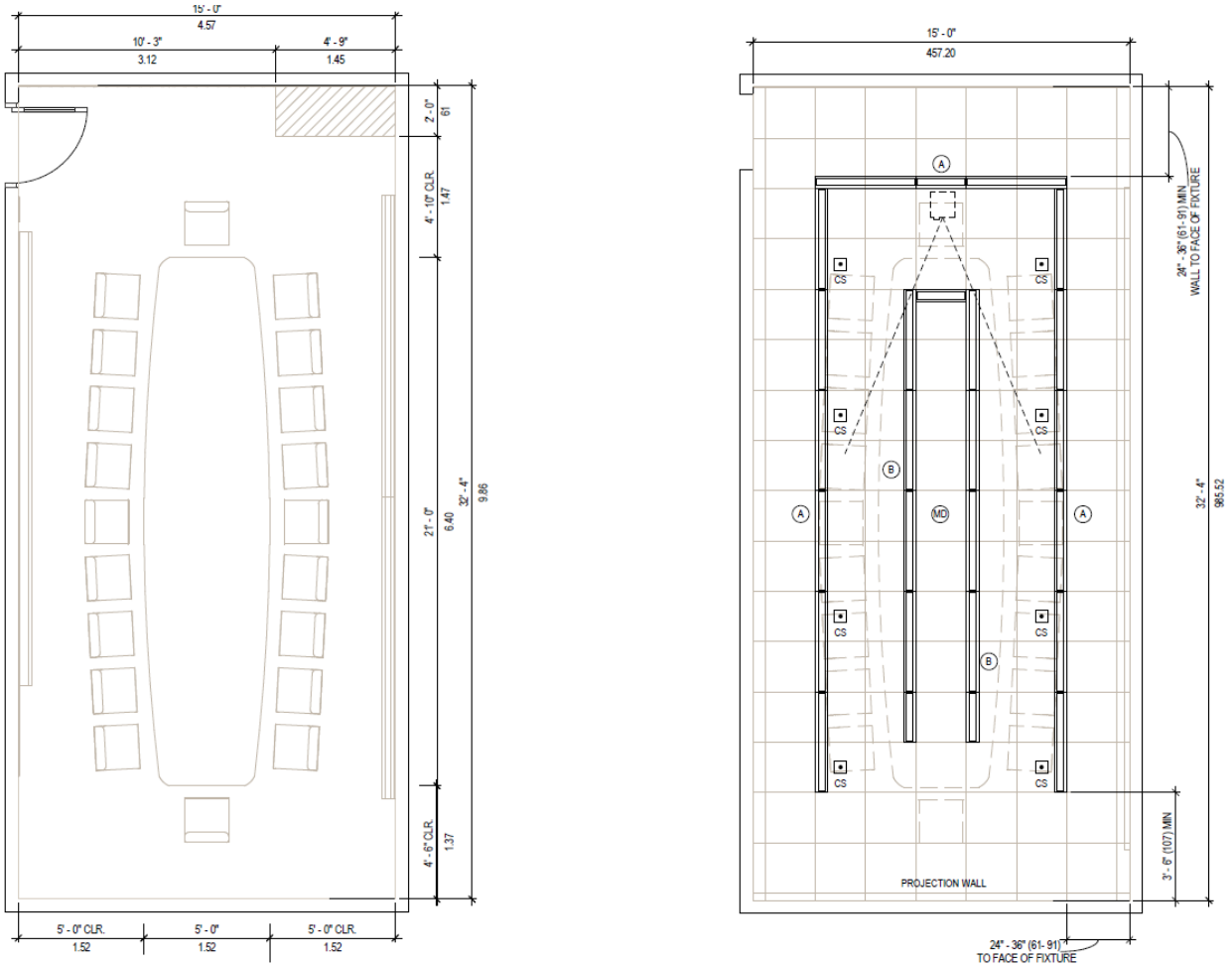


Figure 45: Large meeting room layout

If the microphone is intended to be positioned at the center of the table meaning that the distance to a user is about 3.3m. In case of 2 microphones can be positioned flexibly then the distance to consider is 2.2m to user, 3 microphones about 1.2m, and less than 1m for 4.
Microphone only at the camera would mean that distances up to 8m need to be supported.

The camera position is intended to be on the projection wall. The horizontal field of view has to be at least 60 degrees. Pan, tilt, and zooming functionality is strongly recommended when planning a camera for this room. (The tester should point it out if any of these functions is not supported).