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MULTIMEDIA SYSTEMS AND EQUIPMENT – QUALITY ASSESSMENT – AUDIO-VIDEO COMMUNICATION SYSTEMS

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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Technical reports do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful by the maintenance team.

IEC 62251, which is a Technical Report, has been prepared by IEC technical committee 100: Audio, Video and Multimedia Systems and Equipment.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
100/561/DTR	100/662/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

MULTIMEDIA SYSTEMS AND EQUIPMENT – QUALITY ASSESSMENT – AUDIO-VIDEO COMMUNICATION SYSTEMS

1 Scope

This Technical Report specifies items to be measured by objective methods, methods of measurement together with measuring conditions, processing of the measured data and presentation of acquired information for objective assessment of end-to-end quality of audio-video communication systems over digital networks. The measurements are supposed to be conducted in a double-ended and a full reference. The systems are assumed to have electrical interface channels at the input and at the output of audio-video signals for objective assessment.

The extension for systems that do not have such channels is left for further study.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies

IEC 60268-4, *Sound system equipment – Part 4: Microphones*

IEC 60268-5, *Sound system equipment – Part 5: Loudspeakers*

IEC 61146-1:1994, *Video cameras (PAL/SECAM/NTSC) – Methods of measurement – Part 1: Non-broadcast single-sensor cameras*

IEC 61146-2:1997, *Video cameras (PAL/SECAM/NTSC) – Methods of measurement – Part 2: Two- and three-sensor professional cameras*

IEC 61966-2-1:1999, *Multimedia systems and equipment – Colour measurement and management – Part 1: Colour management – Default RGB colour space – sRGB*

Amendment 1 (2003)

IEC 61966-2-1, *Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB*

IEC 61966-3:2000, *Multimedia systems and equipment – Colour measurement and management – Part 3: Equipment using cathode ray tubes*

IEC 61966-4:2000, *Multimedia systems and equipment – Colour measurement and management – Part 4: Equipment using liquid crystal display panels*

IEC 61966-5:2000, *Multimedia systems and equipment – Colour measurement and management – Part 5: Equipment using plasma display panels*

IEC 61966-9:2000, *Multimedia systems and equipment – Colour measurement and management – Part 9: Digital cameras*

CIE 15.2:1986, *Colorimetry*

ITU-R BS.1387-1 :2001, *Method for objective measurements of perceived audio quality*

ITU-R BT.601-5 :1995,*Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios*

ITU-T J.144 :2001, *Objective perceptual video quality measurement techniques for digital cable television in the presence of a full reference*

ITU-T P.931 :1998, *Multimedia communications delay, synchronization and frame rate measurement*

3 Terms and definitions

In order to understand this Technical Report, the following terms and definitions apply.

3.1
audio-video communication system
system that handles audio, video and optionally other data streams in a synchronized way within users' perception in order to transmit and/or exchange information, which is assumed to operate over a local- or wide-area digital network

3.2
DMOS
difference between the source and processed Mean Opinion Scores (MOS) resulting from the subjective testing experiment conducted by the Video Quality Expert Group (VQEG)

3.3
PEAQ
perceived evaluation of audio quality defined by ITU-R BS.1387-1

3.4
PSNR
objective video quality metric defined by peak-signal to noise ratio, the noise being calculated from the source and processed video frames

3.5
VQR
objective video quality rating reduced from any objective metric by being optimally correlated with the DMOS

4 Configuration for quality assessment

4.1 Input and output channels

Audio signal and video signal in audio-video streams shall be captured at the input and at the output channel, respectively, of the audio-video communication system as shown in Figure 1.

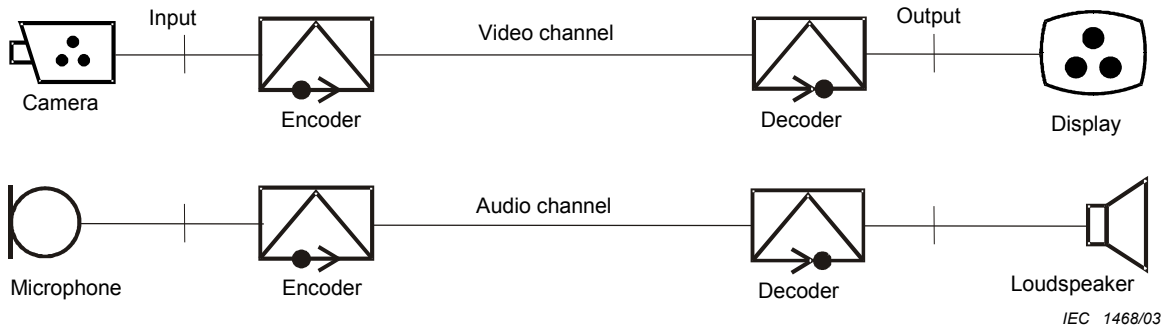
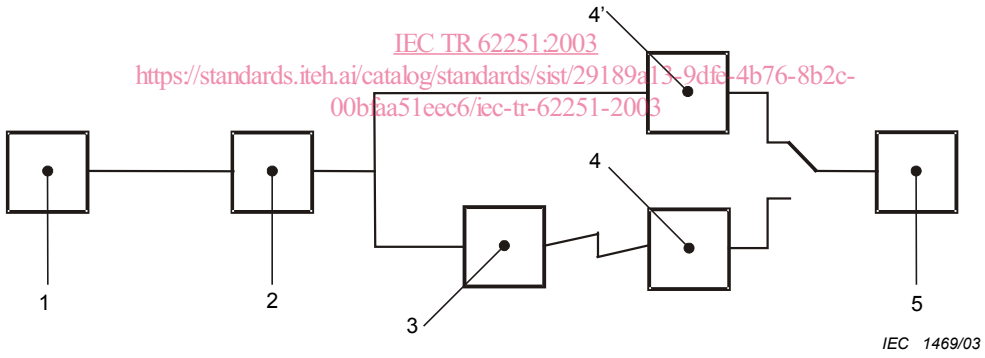


Figure 1 – Model of audio-video communication systems

4.2 Points of input and output terminals

In the spirit of the end-to-end quality assessment of audio-video communication systems, the points for acquisition of raw data should be as far as ultimate end points as possible. However, since the methods of measurement and characterization for equipment which incorporates input transducers such as video cameras and microphones have already been standardized, such as in IEC 61146-1, IEC 61146-2, IEC 61966-9 and IEC 60268-4, and the methods of measurement and characterization of equipment which incorporates output transducers such as video signal displays and loudspeakers, as in IEC 61966-3, IEC 61966-4, IEC 61966-5 and IEC 60268-5, they can be outwith the scope of the rage of the end-to-end.

Figure 2 shows a schematic diagram for quality assessment under double-ended and full reference conditions.



Key

1 Original audio or video reference.

2 Pre-conditioner: reduced dynamic range, frequency range for audio; reduced frame size and frame rate for video to fit to the quality assessment of the audio-video communication systems, if necessary.

3 Encoder for network streaming with a specified bit-rate in order to fit to the bandwidth of end-to-end network connection.

4 Decoder and rendering for the received data to make them audible and visible.

4' Rendering for the preconditioned data to make them audible and visible, optional.

5 Data acquisition and calculation for quality assessment to provide information specified in this report.

Figure 2 – Schematic diagram for quality assessment

5 Video quality

5.1 Introduction

For the purpose of end-to-end objective assessment of video quality, two aspects have been covered in this Technical Report; one is static characteristics such as tone reproduction and colour reproduction described in 5.2 and 5.3, the other dynamic characteristics based on streaming of video frames to networks described in 5.4, 5.5 and 5.6.

It is recommended to make use of a set of commonly available video sources as reference such as the test sequences in the Canadian Research Centre (CRC) as the original video reference for the item 1 in Figure 2. Because of its high bit-rate and large frame size, the reference source should be reduced in frame size and bit-rate for use as the item 2 in Figure 2, if necessary, for actual encoding as streaming video to a network with limited bandwidth.

For the dynamic characteristics, reference video sequences currently available are listed in Table A.1. All reference video sources in Table A.1 have been adopted in this Technical Report with the permission of the owner, the Canadian Research Council (CRC), which were used by the Video Quality Expert Group (VQEG) for subject video quality tests to obtain the Difference of Mean Opinion Score (DMOS) and also object Video Quality Metric (VQR) as reported in ITU-R 10-11Q/56-E.

The format of each of the reference video sources is composed of 10 frames (for leader) + video frames for 8 s + 10 frames (for trailer). There are two video formats 525/60Hz and 625/50Hz, but only the 525/60Hz format shown in Table A.1 is adopted in this Technical Report for evaluation.

Each line is in pixel multiplexed 4:2:2 component video format as Cb Y Cr Y … and so on, encoded in line with ITU-R BT.601-5, where 720 bytes/line for Y, 360 B/line for Cb and 360 B/line for Cr. The lines are concatenated into frames and frames are concatenated to form the sequence files.

The format contains 720 pixels (1 440 bytes) per horizontal line and has 486 active lines per frame. The frame sizes are 1 440 x 486 = 699 840 B/frame and the sequence sizes are 240 frames file size for 8 s + 20 frames. Thus, file size is 699 840 bytes/frame x 260 frames = 181 958 400 bytes. 30 frame/s will result a bit-rate of 699 840 bytes/frame x 30 frame/s x 8 bits = 167 961 600 bit/s. Since it is a too high bit-rate to be handled by ordinary personal computers and to be streamed to the Internet, the original test sequences have been reduced in frame size to be 320 x 240 pixels, and in format to be RGB (instead of YCC) 24-bit/pixel to fit to a typical video format (AVI) where IEC 61966-2-1 is taken into account.

NOTE 1 Pixel-by-pixel error assessment requires a very high degree of normalisation to be used with confidence. The normalisation requires both spatial and temporal alignment as well as corrections for gain and offset. For this purpose, Clause A2 of ITU-R 6Q/39-E should be referred to.

NOTE 2 Since the values of objective quality metrics largely depend on video contents, varieties of commonly available video sources should be used as far as possible.

NOTE 3 Video quality metrics obtained by objective assessment in Clause 5 should be converted to be VQR by optimum correlation with DMOS, which is under consideration within ITU-R WP 6Q.

5.2 End-to-end tone reproduction

5.2.1 Items to be assessed

End-to-end non-linearity in term of tone reproduction.

5.2.2 Method of assessment

An image of the grey steps chart defined in IEC 61146-1, as shown in Figure 3, should be used as the reference source for item 1 of Figure 2. The still neutral image should be prepared as a file for item 2 of Figure 2 and repeatedly encoded to be a streaming video transmitted to a network.

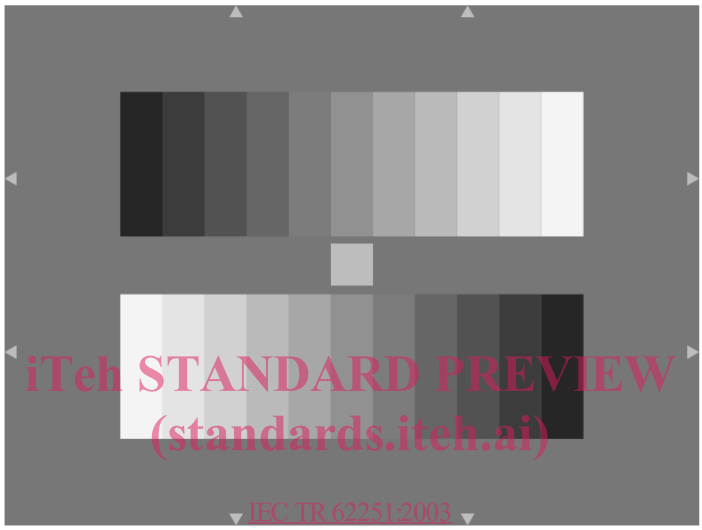


Figure 3 – The image of the grey steps defined in IEC 61146-1

The received streaming video should be decoded and rendered by a viewer for the incoming streaming videos. The image data to be displayed should be captured at an output terminal.

The image data should be compared in terms of three component data, R, G, and B, averaged in each of the corresponding areas.

5.2.3 Presentation of assessment result

The data for display versus the input image data should be reported as a table and a plot as shown in Table 1 and Figure 4, respectively, as examples, together with the audio-video communication system under assessment and the specification of the input-output point.

Table 1 – An example of tone reproduction

	Specification			Input			Output		
	R %	G %	B %	R	G	B	R	G	B
0	2,0	2,0	2,0	44	43	44	34	39	28
1	4,5	4,5	4,5	63	63	62	55	60	53
2	8,1	8,1	8,1	82	81	82	73	78	69
3	13,0	13,0	13,0	102	102	101	93	98	87
4	19,8	19,8	19,8	123	122	123	115	120	110
5	27,9	27,9	27,9	144	144	144	136	140	128
6	37,8	37,8	37,8	165	164	165	158	163	152
7	48,6	48,6	48,6	184	184	186	174	180	171
8	63,0	63,0	63,0	207	206	208	198	203	195
9	77,3	77,3	77,3	226	227	228	216	219	213
10	89,9	89,9	89,9	243	243	235	217	218	211

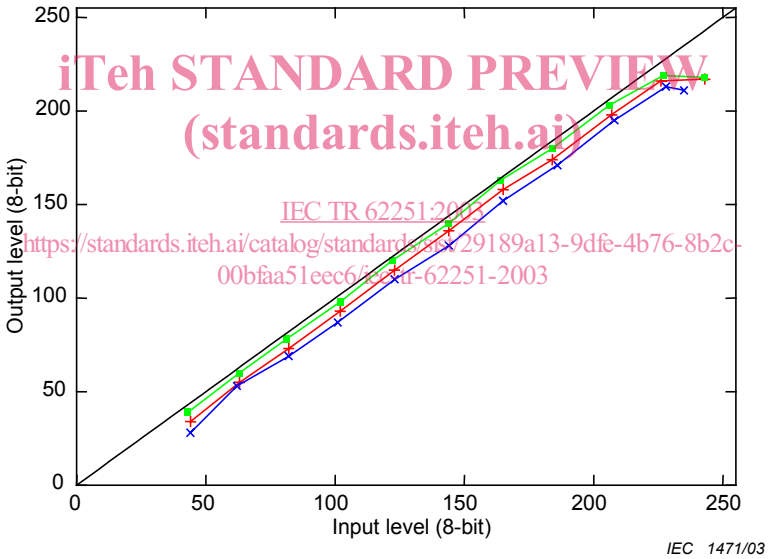


Figure 4 – An example plot of tone reproduction

5.3 End-to-end colour reproduction

5.3.1 Item to be assessed

End-to-end colour shifts in the CIELAB colour space for a still colour image.

5.3.2 Method of assessment

An image of the colour reproduction chart defined in IEC 61146-1, as shown in Figure 5, should be used as the reference source for item 1 of Figure 2. The still colour image should be prepared as a file for item 2 of Figure 2 and repeatedly encoded to be a streaming video transmitted to a network.

IEC 1472/03

Figure 5 – The image of the colour reproduction chart defined in IEC 61146-1

The received streaming video should be decoded and rendered by a viewer for streaming videos. The colour image data to be displayed should be captured at an output terminal.

The image data should be acquired in terms of three component data, R, G and B, averaged in each of the corresponding areas.

5.3.3 Presentation of assessment result

Input colours and output colours in R, G and B data should be regarded to be in sRGB defined in IEC 61966-2-1. They should be converted to CIE 1976 L*a*b* uniform colour space. Colour differences ΔE^*_{ab} between the reference data and the received data should be calculated and reported as shown in Table 2.