INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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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
XX/XX/CDV	XX/XX/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 3.

This document which is purely informative is not to be regarded as an International Standard.

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 forms to report acquired information for assessment of end-to-end quality of audio-video communication systems over digital networks. The systems are assumed to have electrical interface channels at the input and at the output of audio-video signals for inspection.

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

2 References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

ITU-T Recommendation P.930, Principles of a reference impairment system for video.

ITU-T Recommendation G.113, Transmission impairments, Annex I: Provisional planning values for the equipment impairment factor *Ie*

ITU-T Recommendation P.861, Objective quality measurement of telephone-band (300-3400 Hz) speech codecs.

ITU-T Recommendation P.931, Multimedia communications delays, synchronization and frame rate measurement.

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

IEC 61966-2-3: ---[1], Multimedia systems and equipment – Colour measurement and management – Part 2-3: Colour management – Default YCC colour space – sYCC

3 Terms and definitions

To understand this Technical Report, following terms and definitions apply.

3.1
audio-video communication system
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a 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
virtual conference
meeting of a group of people who do not assemble to the same geographical place, but they exchange their views and opinions in use of multimedia logically connected each other.

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[1] Under development by TC 100/PT 61966-2-3.

3.3
latency
time required to send and receive a signal.

3.4
lineality
the number of video frames skipped at receiving end

3.5
PSNR
peak signal to noise ratio

4 Configuration for 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.

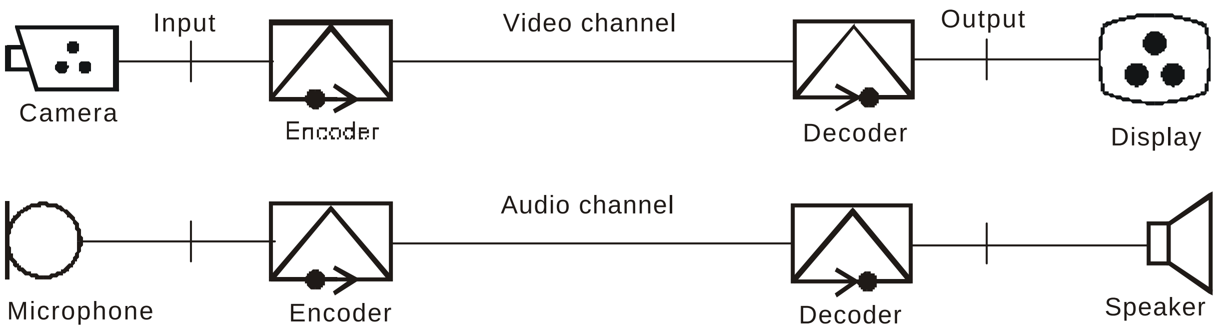


Figure 1 – Model of telecommunication system

4.2 New sub-clause should be added

5 Items to be measured

5.1 Video quality

5.1.1 Frame rate and linearity

The original analogue video is encoded at 30 frame/s and transmitted to a client by either live or on-demand over the local area network. The frame rate of received digital videos are measured.

Table – Streamed and received frame rates

Product	Small size (160×120)	Large size (320×240)
N	4,95 fps	4,97 fps
R	14,71 fps	12,51 fps
V	28,01 fps	28,55 fps

NOTE – The product N performed in real time encoding and streaming, the other products steamed encoded and archived digital videos.

The linearity is also measured. For all products, fairly good linearity is noted.

5.1.2 Latency

The delay time in second from analogue video input to encoder and received digital video.

5.1.3 PSNR

5.1.3.1 Method of measurement

The peak signal-to-noise ratio between a full reference image and a reproduced image define by the following equation shall be calculated.

$$PSNR = 10\log_{10}\left(\frac{S_{\max}^2}{MSE}\right)$$

$$MSE = \frac{1}{(P2-P1+1)(M2-M1+1)(N2-N1+1)}\sum_{p=P1}^{P2}\sum_{m=M1}^{M2}\sum_{n=N1}^{N2}(d(p,m,n)-o(p,m,n))^2$$

where $d(p,m,n)$ and $o(p,m,n)$ represent respectively degraded and original pixel value at frame p , row m and column n , and $S_{\max}$ is the maximum possible value of the pixels.

NOTE PSNR 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. The normalisation method is described in annex B.

For colour images, each picture element is normally composed of three dimensional values, red, green and blue.

$$MSE_{\mathrm{RGB}} = \frac{1}{(P_2-P_1+1)(M_2-M_1+1)(N_2-N_1+1)}\sum_{p=P_1}^{P_2}\sum_{m=M_1}^{M_2}\sum_{n=N_1}^{N_2}\left((R_d-R_o)^2+(G_d-G_o)^2+(B_d-B_o)^2\right)$$

where $S_{\max(\mathrm{RGB})} = 3\times 2^{2(N-1)}$ for the values in N -bit encoding.

It may also be evaluated in the more uniform colour space, CIELAB.

$$MSE_{\mathrm{Lab}} \frac{1}{(P_2 - P_1 + 1)(M_2 - M_1 + 1)(N_2 - N_1 + 1)} \sum_{p=P_1}^{P_2} \sum_{m=M_1}^{M_2} \sum_{n=N_1}^{N_2} \left(\left(L_d^{*} - L_o^{*}\right)^2 + \left(a_d^{*} - a_o^{*}\right)^2 + \left(b_d^{*} - b_o^{*}\right)^2 \right)$$

where $S_{\max(\mathrm{Lab})} = \left(L_{\max}^{*}\right)^2 + \left(a_{\max}^{*}\right)^2 + \left(b_{\max}^{*}\right)^2$ which depend on a colour gamut of original RGB colour space.

Editor's note – three dimensional space, Y, P_B, P_R (or YCC defined by IEC 61966-2-3) should also be taken into account.

5.1.3.2 Report of the measured result

5.1.4 Colour reproduction

5.1.4.1 Method of measurement

Under consideration. See also worked example in annex A.

5.1.4.2 Report of the measured results

The measured results shall be reported together with the conditions use in the measurements.

NOTE Table shows examples of colour shift in $\Delta u'v$ from the original NTSC colour bars directly displayed on the same equipment using cathode ray tubes.

Table – Average colour shifts of saturated colours

Condition	Small size (160×120)	Large size (320×240)
N	0,025	0,012
R	0,042	0,015
V	0,029	0,009

5.1.5 Impairment/Blockiness

5.2 Audio quality

5.2.1 Introduction

Perceived audio quality is one of the key factors when designing digital audio-video communication systems. Formal listening tests have been the relevant method for judging audio quality. However subjective quality assessments are both time consuming and expensive. The objective measurement method to produce an estimate of the audio quality, is desirable. Traditionally for objective measurement methods, Signal-to-Noise-Ratio (SNR) or Total-Harmonic-Distortion (THD) has been used. The problems of SNR and THD, become even more evident when the methods are applied on modern codecs which are both non-linear and non-stationary. ITU-R recommends an objective measurement method to estimate the perceived audio quality of a device under test, e.g. a low bit-rate codec.

5.2.2 Basic Audio Quality

The output variable from the ITU-R Recommendation BS.1387 objective measurement method is the Objective Difference Grade (ODG) and is corresponds to the SDG in the subjective domain. Either of SNR, THD or ODG variable shall be measured, according to the audio coding method and et al.

5.2.2.1 Signal-to-Noise-Ratio

Signal-to-Noise Ratio (SNR) may be calculated. SNR is the ratio of the signal power to the noise power, and relates how much stronger a signal is than the background noise. Generally, SNR indicates the quality and clarity of sound. SNR is usually measured in decibels (dB). SNR may be measured.

5.2.2.2 Total-Harmonic-Distortion (THD)

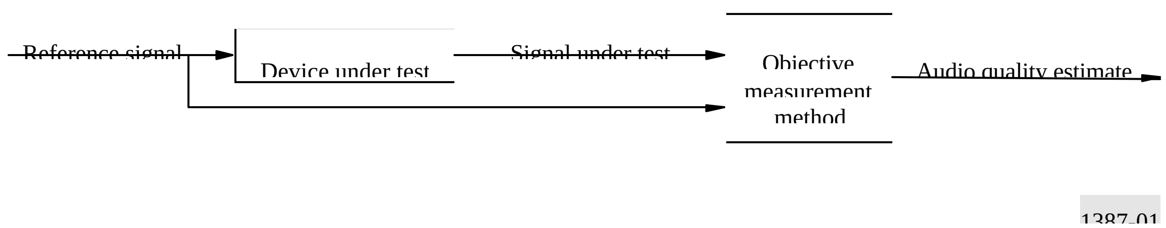
Harmonic-Distortion is the production of harmonics at the output of a circuit when period wave is applied to its input. THD is the ratio of the root-mean-square (rms.) value of the sum of the squared individual harmonic amplitudes to the rms. value of the fundamental frequency of a complex waveform. THD may be measured.

5.2.2.3 Perceived Audio Quality with Full-Reference signals

ITU-R recommends an objective measurement method of perceived audio quality, ITU-R Rec. BS-1387. The basic concept for objective measurements with the recommended method is illustrated in Figure 1 below.

FIGURE 1

Basic concept for making objective measurements



The measurement method in this Recommendation is applicable to most types of audio signal processing equipment, both digital and analogue. It is, however, expected that many applications will focus on audio codecs.

The output variable from the objective measurement method, is the Objective Difference Grade (ODG) and corresponds to the SDG in the subjective domain. The resolution of the ODG is limited to one decimal. One should however be cautious and not generally expect that a difference between any pair of ODGs of a tenth of a grade is significant.The ODG variable may be measured.

5.2.3 Sampling rate and qantization

Sampling rate is relevant to the bandwidth of audio signals. For high-quality audio signals, the sampling rates 48kHz, 44.1kHz are used. The sampling rate and bandwidth of received audio signals shall be measured.

Resolution of quantization relates to the dynamic range of audio signals or quantization noise. For high-quality audio signals, the linear (or uniform) quantization method, which have 16-bit quantization resolution, are used. The resolution and quantization method of received audio signals should be measured.

5.2.4 Loudness

Loudness is the measure of the auditory sensation produced by a sound. It is a subjective quality related to the physical quantity intensity. It is chiefly a function of the sound pressure, but it is also dependent upon frequency and waveform.

Loss of loudness between input audio to encoder and received digital audio, shall be measured.

(Under consideration)

5.2.5 Echo

(Under consideration)

5.2.6 Delay

The delay time in seconds from analogue audio inputs to encoder and received digital audio, shall be measured.

5.3 Overall quality

5.3.1 Synchronisation of audio and video (lip sync)

Received and recorded videos are analized to acquire delay between synchronised audio and video.

Table – Synchronisation

Product	Small size (160×120)	Large size (320×240)
N	0,699 (s)	0,818 (s)
R	0,494 (s)	0,469 (s)
V	0,448 (s)	0,446 (s)

5.3.2 Scalability

Autonomous function to tune frame rate dynamically depending on time variant available bandwidth between the server and the client logical link.

Annex A
(Informative)

Video quality assessment (trial)

A.1 Introduction

This annex is prepared just for information to report some of the preliminary results of measurement made in The Laboratory of Multimedia Systems, Faculty of Engineering, Chiba University, Japan. Three different target products for application to desk-top personal computers are tested. They are getting popular and are publicly available for evaluation.

A.2 Configuration for measurement

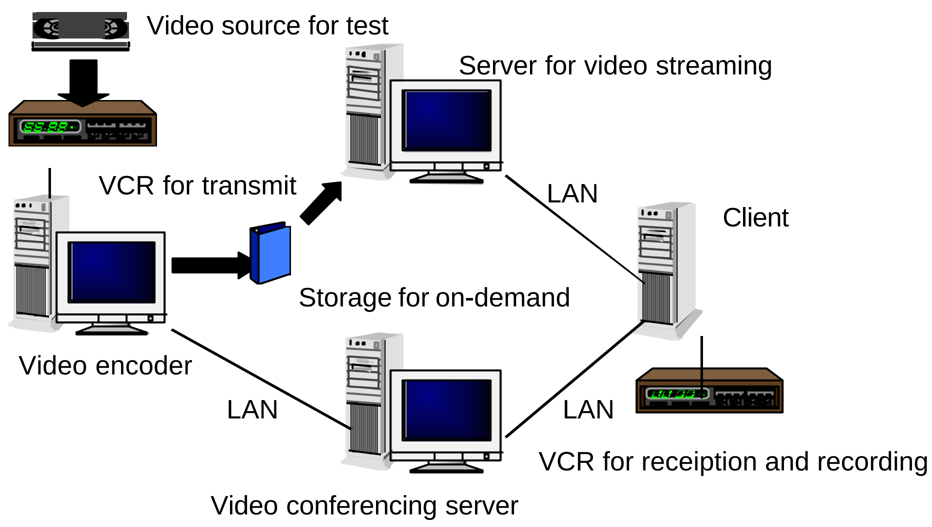


Figure A.1 – General configuration for measurement

Annex B
(normative)

Normalization for calculation of PSNR

B.1

Under drafting by Ikeda.

B.2

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