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ITU-T

TELECOMMUNICATION
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J.140

(03/98)

SERIES J: TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Measurement of the quality of service

Subjective picture quality assessment for digital cable television systems

ITU-T Recommendation J.140

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION J.140

SUBJECTIVE PICTURE QUALITY ASSESSMENT FOR DIGITAL CABLE TELEVISION SYSTEMS

Summary

This Recommendation specifies a subjective picture quality assessment method for digital cable television applications.

Source

ITU-T Recommendation J.140 was prepared by ITU-T Study Group 9 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 18th of March 1998.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation J.140

SUBJECTIVE PICTURE QUALITY ASSESSMENT FOR DIGITAL CABLE TELEVISION SYSTEMS

(Geneva, 1998)

1 Scope

This Recommendation describes a subjective method for assessment of picture quality for digital cable television systems. It concerns all of the television chain from the signal source to user's receiver. This chain may contain satellite links, terrestrial links and/or cable links. The assessment is made using consumer grade receivers assuming a home viewing environment.

2 References

The following ITU-T Recommendations, and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-R Recommendation BT.1129-1 (1995), *Subjective assessment of standard definition digital television (SDTV) systems.*

[2] ITU-R Recommendation BT.500-7 (1995), *Methodology for the subjective assessment of the quality of television pictures*.

[3] ITU-R Recommendation BT.1210-1 (1997), *Test materials to be used in subjective assessment*.

[4] ITU-T Recommendation J.84 (1995), *Distribution of digital multi-programme signals for television, sound and data services through SMATV networks*.

[5] ITU-T Recommendation J.83 (1995), *Digital multi-programme systems for television, sound and data services for cable distribution*.

[6] ITU-T Recommendation P.910 (1996), *Subjective video quality assessment methods for multimedia applications*.

[7] ITU-T Recommendation P.920 (1996), *Interactive test methods for audiovisual communications*.

[8] ITU-T Recommendation P.80 (1993), *Methods for subjective determination of transmission quality*.

[9] ITU-R Recommendation BT.814-1 (1993), *Specifications and alignment procedures for setting of brightness and contrast of displays*.

[10] ITU-R Recommendation BT.815-1 (1993), *Specification of a signal for measurement of contrast ratio and displays*.

3 Terms and definitions

This Recommendation defines the following term:

3.1 **PLUGE**: Test signal consists of a peak white level patch and several dark level patches/stripes used for the setting of brightness and contrast of the display. For details, see Recommendation ITU-R BT.814-1.

4 Abbreviations

This Recommendation uses the following abbreviations:

PS Programme Segment

PVD Preferred Viewing Distance

QP Quality Parameter

SDTV Standard Definition Television

SSCQE Single Stimulus Continuous Quality Evaluation

TP Test Presentation

TS Test Session

5 General

Subjective assessment methods are used to establish the performance of television systems using measurements that more directly anticipate the reactions of those who might view the systems tested. In this regard, it is understood that it may not be possible to fully characterize system performance by objective means; consequently, it is necessary to supplement objective measurements with subjective measurements.

In subjective method, test pictures, after passing through the measured line, are assessed by a group of assessors in specific viewing conditions and results of these tests are treated statistically.

In ITU-R Recommendation BT.500-7, two classes of subjective assessment are given, and a few methods are representative of each class.

Introduction of digital coding produces impairments to picture quality which are scene-dependent and time-varying. Methods of laboratory testing do not replicate home viewing condition of cable television.

For the evaluation of these types of picture quality, new methods are developed and tested. One of them is given in Annex A.

Other methods are still under study and need validation.

6 Test material

A number of approaches may be taken in establishing the kinds of test material required in television assessments. In practice, however, particular kinds of test materials should be used to address particular assessment problems. A survey of typical assessment problems and of test materials used to address these problems is given in Table 1.

Table 1/J.140 – Selection of test material

Assessment problem	Material used
Overall performance with average material	General, "critical but not unduly so"
Capacity, critical applications (e.g. contribution)	Range, including very critical material for the application tested
Performance of "adaptive" systems	Material very critical for "adaptive" scheme used
Identify weaknesses and possible improvements	Critical, attribute-specific material
Identify factors on which systems are seen to vary	Wide range of very rich material
Conversion among different standards	Critical for differences (e.g. field rate)

Some parameters may give rise to a similar order of impairments for most pictures or sequences. In such cases, results obtained with a very small number of pictures or sequences (e.g. two) may still provide a meaningful evaluation.

However, digital systems frequently have an impact which depends heavily on the scene or sequence content. In such cases, there will be, for the totality of programme hours, a statistical distribution of impairment probability and picture or sequence content. Without knowing the form of distribution, which is usually the case, the selection of test material and interpretation of results must be done very carefully.

In general, it is essential to include critical sequences, because it is possible to take this into account when interpreting results, but it is not possible to extrapolate from non-critical material. In cases where scene or sequence content affects results, the material should be chosen to be "critical but not unduly so" for the system under test. The phrase "not unduly so" implies that the pictures could still conceivably form part of normal programme hours. At least four items should, in such cases, be used: for example, half of which are definitely critical, and half of which are moderately critical.

It is recommended that at least six picture sequences be used in the assessment, plus an additional one to be used for training purposes prior to the start of the trial. The sequences should range between moderately critical and definitely critical in the context of the bit-rate reduction application being considered.

In subjective assessment, still pictures and moving sequences may be selected from those listed in ITU-R Recommendation BT.1210-1, Annex 1. In this respect, it should be noted that digitally-stored pictures and sequences, being the most reproducible source signals, are the preferred sources for assessment.

Annex A

Assessment method

The methodologies applied are based on the SSCQE method developed by the ITU-R and given in ITU-R Recommendation BT.500-7, and therefore it is desirable to refer to the latest actual method when ITU-R Recommendation BT.500-7 is modified.

A.1 Single Stimulus Continuous Quality Evaluation (SSCQE) method

In this method, observers are asked to assess instantaneous picture quality continuously during a test session with subjects viewing the material once without a source reference.

A.1.1 Continuous assessment of overall quality

A.1.1.1 Recording device and set-up

An electronic recording handset connected to a computer should be used for recording the continuous quality assessment from the subjects. This device should have the following characteristics:

– slider mechanism without any sprung position;

– linear range of travel of 10 cm;

– fixed or desk-mounted position;

– samples recorded twice a second.

A.1.1.2 General form of the test protocol

Subjects should be presented with test sessions of the following format:

– Programme Segment (PS): a PS corresponds to one programme type (e.g. sport, news, drama) processed according to one of the Quality Parameters (QP) under evaluation (e.g. bit rate); each PS should be at least 5 minutes long.

– Test Session (TS): a TS is a series of one or more different combinations PS/QP without separation and arranged in a pseudo-random order. Each TS contains at least once all the PS and QP but not necessarily all the PS/QP combinations; each TS should be between 30 and 60 minutes duration.

– Test Presentation (TP): a TP represents the full performance of a test. A TP can be divided in Test Sessions to cope with maximum duration requirements and in order to assess the quality over all the PS/QP pairs. If the number of PS/QP pairs is limited, a TP can be made of a repetition of the same Test Session to perform the test on a long enough period of time.

For service quality evaluation, audio may be introduced. In this case, selection of the accompanying audio material should be considered at that same level of importance as the selection of video material, prior to the test performance.

The simplest test format would use a single Programme Segment and a single Quality Parameter.

A.1.1.3 Grading scales

Subjects should be made aware in the test instructions that the range of travel of the handset slider mechanism corresponds to the continuous quality scale, as described in subclause 5.4 of ITU-R Recommendation BT.500-7.

A.1.1.4 Observers

At least fifteen subjects, non-experts, should be employed.

At least 15 observers should be used. They should be non-expert, in the sense that they are not directly concerned with television picture quality as part of their normal work, and are not experienced assessors[1]. Prior to a session, the observers should be screened for (corrected-to-) normal visual acuity on the Snellen or Landolt chart, and for normal colour vision using specially selected charts (Ishihara, for instance). The number of assessors needed depends upon the sensitivity and reliability of the test procedure adopted and upon the anticipated size of the effect sought[1].

A.1.1.5 Instructions to the observers

In the case of services quality evaluation (with accompanying audio), observers should be instructed to consider the overall quality rather the video quality only.

A.1.1.6 Test session

Time duration and conditions of the test session should be those currently specified in subclause 2.7 of ITU-R Recommendation BT 500-7.

A.1.1.7 Data presentation, results processing and presentation

Data should be collated from all test sessions. A single graph of mean quality rating as a function of time, q(t), can therefore be obtained as the mean of all observers' quality gradings per programme segment, quality parameter or per entire test session (see example in Figure A.1).

This data can be converted to a histogram of probability, P(q), of the occurrence of quality level q (see example in Figure A.2).

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1 Preliminary findings suggest that non-expert observers may yield more critical results with exposure to higher quality transmission and display technologies.

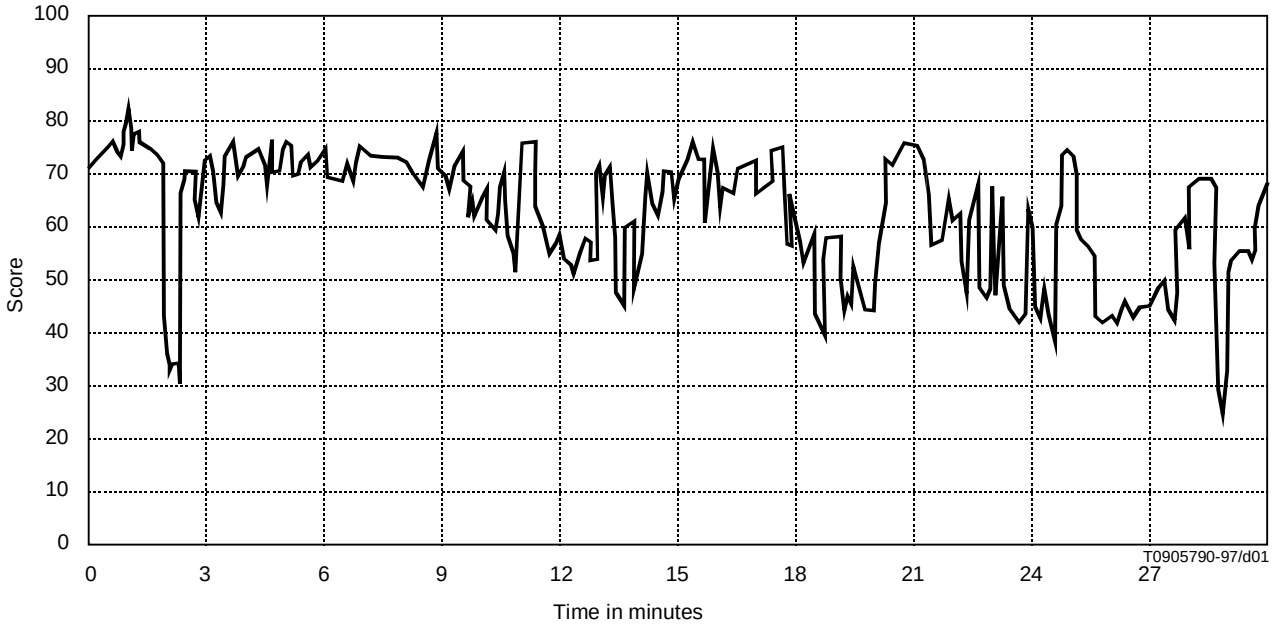

Figure A.1/J.140 – Test condition: Codec X/programme segment: Z

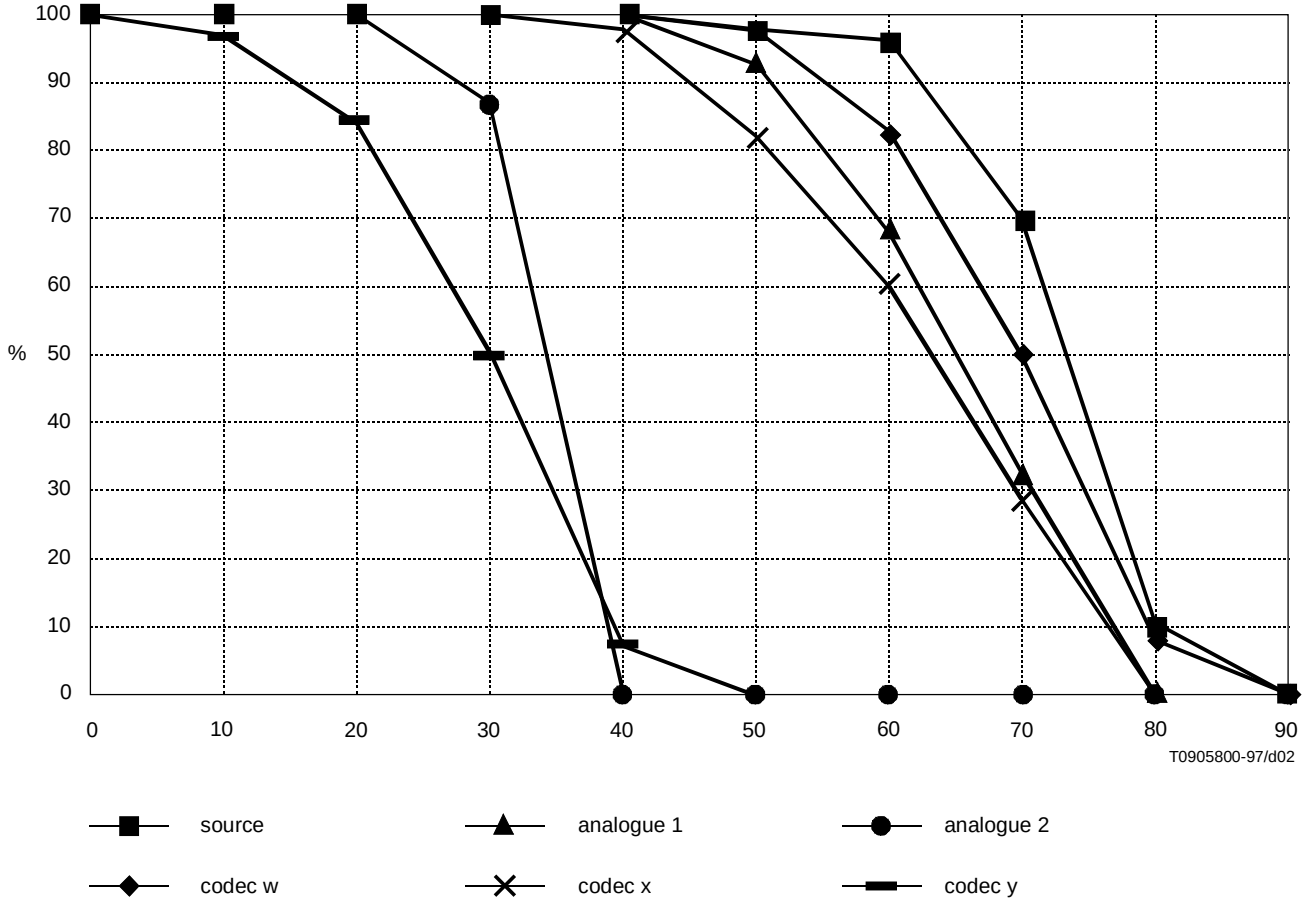

Figure A.2/J.140 – Mean of scores of voting sequences on programmes segment Z

A.1.1.8 Calibration of continuous quality results and derivation of a single quality rating

Conventional ITU-R methodologies employed in the past have been able to produce single quality ratings for television sequences. Experiments have been performed which have examined the relationship between the continuous assessment of a coded video sequence, and an overall single quality rating of the same segment. It has already been identified that the human memory effects can distort quality ratings if noticeable impairments occur in approximately the last 10-15 s of the sequence. However, it has also been found that this human memory effects could be modelled as a decaying exponential weighting function. Hence a possible third stage in the SSCQE methodology would be to process these continuous quality assessments, in order to obtain an equivalent single quality measurement. This is currently under study.

A.2 Viewing parameters

Viewing conditions should be those currently specified in ITU-R Recommendations BT.500-7 and BT.1129-1 for subjective assessment in home viewing environment:

a)	ratio of Luminance of inactive screen to peak Luminance:	≤ 0.02
b)	display brightness and contrast:	set up via PLUGE
c)	maximum observation angle relative to the normal:	30°
d)	monitor input:	baseband component input without digital processing
e)	monitor resolution:	to be checked and reported
f)	ratio of viewing distance to picture height:	6 H
g)	screen size for a 4/3 format ratio:	From 25″ to 29″ (Note 1)
h)	screen size for a 16/9 format ratio:	From 32″ to 36″ (Note 1)
i)	monitor standard:	SDTV
j)	peak luminance:	200 Cd/m (Note 2)
k)	environmental Illuminance on the screen:	200 Lux (Note 2)

NOTE 1 – This screen size satisfies rules of the "Preferred Viewing Distance" (PVD) for PVD = 6 H.

NOTE 2 – Incident from the environment falling on the screen should be measured perpendicularly on the screen.

The viewing distance and the screen sizes are to be selected in order to satisfy the "Preferred Viewing Distance" (PVD). The PVD (in function of the screen sizes) is shown in the following table and graph. See Figure A.3.

This table and this graph are intended to give information on the Preferred Viewing Distance and related screen sizes to be adopted in the Recommendations for specific applications.

Screen diagonal (inch)		**Screen height (H)**	**PVD**
4/3 ratio	16/9 ratio	(m)	(H)
12	15	0.18	9
15	18	0.23	8
20	24	0.30	7
29	36	0.45	6
60	73	0.91	5
> 100	> 120	> 1.53	3-4

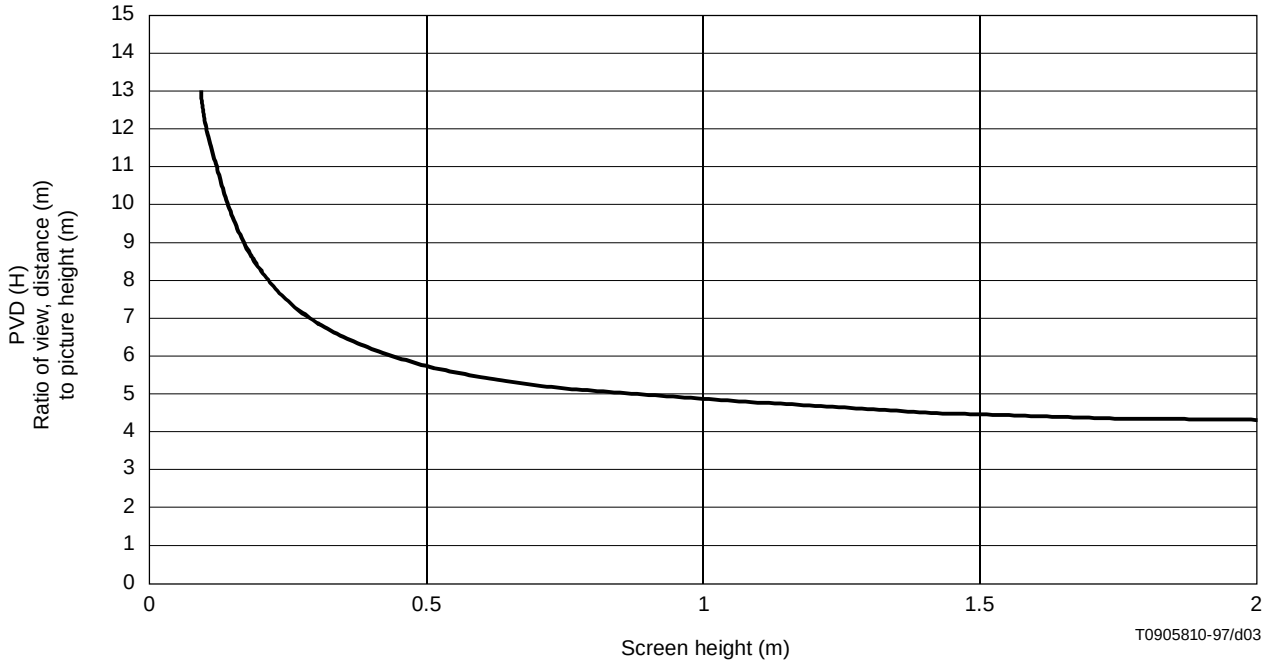

Figure A.3/J.140 – PVD for moving images

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