RECOMMENDATION ITU-R BT.800-2*,**

User requirements for the transmission through contribution and primary distribution networks of digital television signals defined according to the 4:2:2 standard of Recommendation ITU-R BT.601 (Part A)

(Question ITU-R 44/6)

(1992-1994-1995)

The ITU Radiocommunication Assembly,

considering

a) that Recommendation ITU-R BT.601 (Part A) defines the parameters of 4:2:2 based digital luminance and colour difference signals***;

b) that signals conforming to that standard are required to be transmitted through digital contribution and primary distribution networks;

c) that coding algorithms have been devised and standards established or proposed to enable such transmission to be effected using bit rate reduction techniques;

d) that prototype codec equipment using these algorithms is being developed and needs to be assessed;

e) that general advice on methods of assessment is contained within ITU-R texts, and that subjective testing methods are defined in Recommendation ITU-R BT.500;

f) that such assessment will need to take account of basic picture quality, the failure characteristic in the presence of errors on the transmission link, and the quality achieved after downstream processing;

g) that both the design of codecs and their assessment will need to take account of user requirements;

h) that in order to be complete, the user requirements should specify the test procedures and test material that should be used to check that the requirements are being met,

recommends

that the following user requirements should govern the specification design and testing of systems for the transmission of 4:2:2 based television signals through contribution and primary distribution networks.

1 Performance requirements

All quality assessment ratings in this section are carried out using the procedures given in Recommendation ITU-R BT.500 using the subjective assessment methods indicated.

---

* This Recommendation should be brought to the attention of Telecommunication Standardization Study Group 9.

** Radiocommunication Study Group 6 made editorial amendments to this Recommendation in 2003 in accordance with Resolution ITU-R 44.

*** The main elements of this standard are reproduced in Annex 1.

Requirements relating to contribution and primary distribution codecs are given in Table 1.

TABLE 1

Contribution and primary distribution codecs

Source signals	4:2:2 with potential for full spectral occupancy
Destination signals	4:2:2
Maximum relative sound/vision delay	± 2 ms per codec
Basic quality	Number of codecs tested: 34-45 Mbit/s: single codec 140 Mbit/s: 3 codecs in tandem (1) Quality difference: ≤ 12%(2) with DSCQS method using at least 4 sequences taken from Recommendations ITU-R BT.802, ITU-R BT.1128 and ITU-R BT.1210, at least half of which must be high activity sequences. The given quality grade must be met using at least 75% of the sequences chosen; the remainder must achieve ≤ 20%
Failure characteristic/error performance(3)	BER ≤ 1×10^{-4} including error bursts ≤ 30 bits Impairment ≤ 1 grade with DSIS method using at least 2 sequences taken from Recommendations ITU-R BT.802, ITU-R BT.1128 and ITU-R BT.1210
Recovery time (4) (5)	≤ 500 ms after a break of 50 ms(3)
Change in overall delay after signal interruption	As small as possible (in ITU-T Recommendation J.81 a value of ± 20 μs is suggested, for further study)

DSCQS: double stimulus continuous quality scale.

DSIS: double stimulus impairment scale.

(1) It is appreciated that there are problems in estimating or measuring the characteristics of codecs in tandem, in particular if a number of different codecs have to be considered. These quality criteria assume that direct codec tandem connections are entirely digital. For contribution applications, downstream processing should be inserted between codecs.

(2) In reporting the results of tests, it is desirable to identify separately those relating to high activity sequences; this matter is under study.

(3) The decoder should maintain a still frame output during resynchronization.

(4) Further information relating to failure characteristics and recovery time is given in Annex 2.

(5) The recovery time can be measured as the number of fields of delay that is required between the connection of signal to the decoder, and switching the picture monitor input from a grey level signal (or a suitably delayed non-processed signal) to the decoder output signal such that no picture disturbance can be observed.

A similar procedure should be adopted to assess the recovery time associated with bit-slips, as might occur following, for example, a non-sync cut.

Additional requirements for contribution codecs are given in Table 2.

TABLE 2

Additional requirements for contribution codecs

Basic quality	Number of codecs tested: 34-45 Mbit/s: 2 codecs in tandem (1) 140 Mbit/s: 3 codecs in tandem (1) Quality difference: ≤ 12%(2) with DSCQS method using at least 4 sequences taken from Recommendations ITU-R BT.802, ITU-R BT.1128 and ITU-R BT.1210, at least half of which must be high activity sequences. The given quality grade must be met using at least 75% of the sequences chosen; the rest must achieve ≤ 20%
Quality after colour matte	Quality difference: ≤ 18% with DSCQS method using two foreground sequences and appropriate background material taken from Recommendations ITU-R BT.802, ITU-R BT.1128 and ITU-R BT.1210, between two codecs
Quality after modification to picture geometry	Quality difference: ≤ 18% with DSCQS method using an appropriate sequence from Recommendations ITU-R BT.802, ITU-R BT.1128 and ITU-R BT.1210, between two codecs
Quality after slow motion	Quality difference: ≤ 18% with DSCQS method using an appropriate sequence taken from Recommendations ITU-R BT.802, ITU-R BT.1128 and ITU-R BT.1210 with 10:1 slow motion between two codecs

DSCQS: double stimulus continuous quality scale.

(1) It is appreciated that there are problems in estimating or measuring the characteristics of codecs in tandem, in particular if a number of different codecs have to be considered. These quality criteria assume that direct codec tandem connections are entirely digital. For contribution applications, downstream processing should be inserted between codecs.

(2) In reporting the results of tests, it is desirable to identify separately those relating to high activity sequences; this matter is under study.

2 Use for conveying composite signals

Although primarily designed to carry signals conforming with Recommendation ITU-R BT.601 (Part A), the system will also be required to carry signals derived from a composite signal. The latter will be decoded into components at the sending terminal and reassembled into composite form at the receiving terminal.

In such applications, it is desirable to use a complementary separation and recombining process. For such a process, separation of luminance and colour-difference may not be complete and cross components may exist, even though the overall process may be transparent. It is essential therefore that the digital codec should transmit the cross components with minimum distortion and the capability for conveying a level of cross components should be specified.

In addition, an auxiliary data capacity should be provided within the multiplex channel to signal sub-carrier phase and V-axis switch information. Investigations are proceeding to determine the data rate required for the data signal and a standardized interface may prove desirable; the ancillary data capacity specified in § 2.5 of Recommendation ITU-R BT.656 is thought adequate for the inclusion of PAL encoding data.

When used in this manner, the system will not be suitable for long distance transmission with mixed analogue/digital links, and does not have to be transparent to vertical interval test signals. Because of the presence of cross effects, however, the received signals should only be used in the reassembly of the composite signal.

3 Conditional access

Bit-rate reduction processes are based on the systematic elimination of redundancy in the signal in several dimensions. Signals that are already scrambled for conditional access will have reduced spatial and temporal correlation and hence the performance of the coding process and the resulting signal quality at the decoder may not be suitable at low bit rates for signals that have already been scrambled. Therefore, in case additional security of transmission is required, an arrangement for the additional scrambling of the transmitted data stream is desirable.

4 Upward extensibility

Consideration should be given to coding algorithms which are modular in concept and that could be applied for other applications e.g. HDTV.

5 Other applications

It would be convenient if some parts of the transmission codec could be adapted for use in other applications, e.g. digital recording.

6 System complexity

The complexity of the codec should be such that it can be implemented with available technologies at a cost reasonably related to the transmission costs for the intended application.

7 System availability

Any relevant patents should be available without discrimination worldwide on equitable terms.

8 Associated sound signals

User requirements for digital sound transmission over contribution and distribution circuits are defined elsewhere.

The figure of ±2 ms per codec allowed in Table 1 for maximum sound-vision delay was chosen in the light of the maximum discrepancy of 20 ms (sound advanced) or 40 ms (sound delayed) specified in ITU-T Recommendation CMTT.717 for the whole signal chain, taking account of the likelihood that:

– a number of codecs will be connected in tandem; and

– the major part of the overall discrepancy will occur elsewhere in the signal chain.

The partitioning of the overall tolerance is under study.

Annex 1

Principal elements of the 4:2:2 standard as given in Recommendation ITU-R BT.601 (Part A)

Parameters	525-line, 60 field/s systems	625-line, 50 field/s systems
1. Number of samples per total line:		
– luminance signal (Y)	858	864
– each colour-difference signal (C_R, C_B)	429	432
2. Number of samples per digital active line:		
– luminance signal	720	
– each colour-difference signal	360	
3. Coding format	Uniformly quantized PCM, 8 bits per sample, for the luminance signal and each colour difference signal	

Annex 2

Further information relating to failure characteristics and recovery time

– Interruptions of any part of the multiplex lasting several seconds or more are intolerable and protection modes would be required.

– With regard to the response to burst errors of short duration, the synchronizing system should have adequate protection so that the effect of the errors on the video, audio or data would not be extended due to the need for resynchronization. By maintaining synchronization through the interruption, the error management systems for the video, audio and data could be independent.

– It is likely that it will not be possible to protect against interruptions of the order of 50 ms. After such events, the decoder circuits will have to relock in a manner similar to that of the initial switch-on. It is suggested that the relocking sequence should be complete within 160 ms.

– It is important that the overall signal delay through the codec should not change markedly under the influence of transmission errors or interruptions. The degree to which the delay should be permitted to change is under study; ITU-T Recommendation J.81 suggests that ± 20 μs would be a reasonable maximum.

– Note that very short duration defects are less tolerable in the sound than in the picture.

– The degree of protection required for the data is heavily dependent on the application. For example, if the data is being used for system control it could be very critical and require powerful protection.

– Under normal operating conditions there should be no perceptible effect from channel errors in video, sound or data.

– In the design of protection systems to be used when the performance of the link in use deteriorates, the switching to the protection link should not cause a disturbance in the video, sound or data signal.