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**ITU-T**

TELECOMMUNICATION  
STANDARDIZATION SECTOR  
OF ITU

**J.86**

**(ex CMTT.658)**

**(06/90)**

**TELEVISION AND SOUND TRANSMISSION**

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**MIXED ANALOGUE-AND-DIGITAL  
TRANSMISSION OF ANALOGUE  
COMPOSITE TELEVISION SIGNALS  
OVER LONG DISTANCES**

**ITU-T Recommendation J.86**

(Formerly Recommendation ITU-R CMTT.658)

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## FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. 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, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation J.86 (formerly Recommendation ITU-R CMTT.658) was elaborated by the former ITU-R Study Group CMTT. See Note 1 below.

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## NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector (ITU-R).

Conforming to a joint decision by the World Telecommunication Standardization Conference (Helsinki, March 1993) and the Radiocommunication Assembly (Geneva, November 1993), the ITU-R Study Group CMTT was transferred to ITU-T as Study Group 9, except for the satellite news gathering (SNG) study area which was transferred to ITU-R Study Group 4.

2 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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**Recommendation J.86<sup>1)</sup>**

**MIXED ANALOGUE-AND-DIGITAL TRANSMISSION OF ANALOGUE  
COMPOSITE TELEVISION SIGNALS OVER LONG DISTANCES**

*(1986; revised 1990)*

The CCIR,

CONSIDERING

- (a)* that, although television studios may progressively adopt operation based on separate component coding (e.g. according to Recommendation 601 for digital systems), existing analogue operation using composite signals will continue for a considerable time (see Note 1);
- (b)* that a transitional period will occur during which analogue composite television signals will be transmitted through a circuit comprising analogue and digital sections in tandem;
- (c)* that to facilitate the international transmission of television programmes during the transitional period, the methods of coding should preserve the quality of the colour television signals (e.g. NTSC, SECAM, PAL) and of the ancillary and additional signals (e.g. insertion test signals, teletext, etc.);
- (d)* that, when establishing digital circuit sections, account should be taken of the different digital transmission hierarchies and the H-channel rates and interfaces for ISDN recommended by the CCITT;
- (e)* that while the use of bit-rate reduction techniques could be economically desirable, further studies are required before coding methods to comply with *(c)* above can be recommended,

UNANIMOUSLY RECOMMENDS

1. that when carrying a television signal presented in analogue composite form, preference should be given to all-analogue paths. However, in cases where mixed analogue-and-digital paths are unavoidable, the principles given in this Recommendation should be followed;
2. that the number of digital sections in a real circuit should be kept to the minimum;
3. that the hypothetical reference circuit for mixed analogue-and-digital transmission shall be equivalent to that defined in § A.1.2 of Recommendation 567, which applies to the case where the three sections all use analogue transmission. When one or more sections use digital transmission, the same structure should apply but modifications may be required for sections employing digital transmission (see Note 2). The signals at the input and output, and at the intermediate interconnection points of the hypothetical reference circuit, are in analogue form (see Note 3);
4. that the design objectives and tolerances specified for a hypothetical reference circuit in Recommendation 567 should also apply for mixed analogue-and-digital transmission (see Note 4);
5. that the overall quality of the hypothetical reference circuit, when considered against the objective and subjective criteria defined by Study Group 11, shall be no worse than the equivalent analogue system. In practice this may be achieved by using the parameter values defined in Annex I (see Note 5).

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<sup>1)</sup> Formerly Recommendation ITU-R CMTT.658.

*Note 1* – This Recommendation does not apply either to component analogue signals or to encrypted signals. These areas require further study which should lead to new Recommendations.

*Note 2* – The detailed requirements for the digital sections of the hypothetical reference circuit require further study on such issues as their lengths, the number of digital sections permitted, etc. Section 6 of Report 646 gives details of the progress achieved in defining the digital sections and of the areas where further studies are required.

*Note 3* – In real circuits, when two digital sections are interconnected, it is not necessary, apart from adjustment periods, to introduce an analogue interface.

*Note 4* – Some additions to the methods of test specified in Recommendation 567 may need to be added to this new Recommendation for application where digital sections are included (see Report 819). Moreover, additional tests and objectives may be required to deal with new types of impairment caused by digital coding. These matters are under study (see Report 646).

*Note 5* – The parameter values in Annex I have been shown to meet this criterion. Other parameter sets may meet this criterion, but their conformance would need to be demonstrated. Administrations are reminded that they have the right to make bilateral agreements on coding parameters for a single colour television system, should this be required. If, however, such a circuit is to form part of an international television connection, it should meet the requirements specified in this Recommendation.

## ANNEX I

### A SPECIFICATION FOR DIGITAL SECTIONS OF MIXED LINKS

This specification applies to one of the three equal sections of the hypothetical reference circuit specified in Recommendation 567. Since the distortion introduced by a digital section (apart from transmission errors) is due entirely to the analogue-to-digital converter (ADC) and digital-to-analogue converter (DAC), it follows that any number of digitally-connected links of any length may be considered as making up one such digital section.

- (a) Composite television signals must not be decoded into components.
- (b) The lowpass filters in ADCs and DACs must be such that six filters in tandem would satisfy the requirements for short-time waveform distortion given in § D.3.5.1.4 of Recommendation 567. In practice the luminance filter specified in Annex III to Recommendation 601 would meet this requirement.
- (c) Sampling frequency must be 13.0 MHz or higher.
- (d) Uniform quantization coding must be used.
- (e) ADC and DAC must be monotonic.
- (f) The conversion range of the ADC must be  $1.75 \text{ V} \pm 10 \text{ mV}$  (see Note 1, below).
- (g) The signal-to-quantizing-noise ratio of the ADC/DAC combination must be better than 58 dB. The signal-to-quantizing-noise ratio should be measured in the presence of a line sawtooth signal or a 0.7 V p-p low frequency sine wave both with and without a superimposed 0.35 V p-p sine wave at a high frequency (> 4 MHz); with the superimposed high frequency sine wave an extra implementation margin of up to 6 dB may be allowed. (Unified weighted r.m.s. noise in 5.0 MHz bandwidth relative to 0.7 V, see Note 2 below.)
- (h) Signals containing synchronising pulses and blanking intervals must be clamped at the input to the ADC so that black level is at one-quarter of the conversion range (level 128 in a 9-bit system). The coder must clamp both 625/50 signals and 525/60 signals correctly.
- (i) The clamp time constant must be at least 2 ms (see Note 3 below).
- (j) Any waveform not containing synchronising pulses and blanking intervals must not be clamped but must be coupled to the ADC input in such a way that its mean level is close to the centre of the conversion range.
- (k) All parts of the signal must be transmitted without modification.

- (l) No bit rate reduction coding may be used.
- (m) If no error correction is used, the long-term mean bit error ratio (BER) must be better than  $10^{-8}$ . Bursts of errors with BER worse than  $10^{-6}$  should not be longer than 5 s and there should not be more than one such burst in any hour (see Note 4 below).
- (n) If error correction is used, residual BER after correction in the two most significant bits must be no worse than that specified in (m) (see Note 4 below).
- (o) Jitter on the regenerated samples at the DAC must be less than 0.3 ns r.m.s. (see Note 5 below).

*Note 1* – This conversion range allows the transmission of 100% colour bars at 3 dB overload without crushing. However, modern equipment might allow the specification of a lower overload margin; further work is required. The use of a lower conversion range will improve the signal-to-quantizing noise ratio.

*Note 2* – This requirement ensures that the quantizing noise contributed by a digital section is no more than one third of the total allowance for the three-section HRC specified in Recommendation 567. It is shown in [CCIR, 1986-90a] that this requirement may be met by the use of nine bits per sample at a sampling frequency of 13 MHz. The frequency of the high-frequency sinewave may depend on the television standard and measuring equipment in use. Further work is needed to standardize this parameter.

If the frequency used lies within the passband of the 5 MHz noise measuring filter, it will be necessary to remove the high-frequency sinewave with a supplementary filter and to correct the result for the noise bandwidth of the supplementary filter as described in [Devereux, 1982].

*Note 3* – A shorter time constant gives clamp streaking from noise. A time constant of 2 ms gives 6 dB suppression of mains hum; if mains hum is not a problem, the time constant could be longer. Devereux [1982] gives more details.

*Note 4* – Experiments reported in [Ratliff, 1974] showed that random errors were “imperceptible” at a BER better than  $10^{-8}$  and “definitely perceptible but not disturbing at a BER of  $10^{-6}$ ” and that, for linear PCM, protecting the two MSB’s is as effective as protecting all bits of the video sample word.

*Note 5* – Devereux [1971]; Devereux and Wilkinson [1973] show that 0.3 ns r.m.s. is the threshold of perception for timing jitter on PAL signals.

It is recognized that due to jitter produced by practical multiplexers and demultiplexers – for example, multiplexing from 140 Mbit/s to 565 Mbit/s and back to 140 Mbit/s – (waiting time jitter) this specification may be difficult to meet in practice. Further work is needed.

## REFERENCES

- DEVEREUX, V. G. [1971] Pulse code modulation for video signals: subjective tests on acceptable limits for timing jitter in the decoded analogue samples. BBC Research Department Report 1971/42.
- DEVEREUX, V. G. and WILKINSON, G. C. [1973] Digital video: effect of PAL decoder alignment on the acceptable limits for timing jitter. BBC Research Department Report 1973/1.
- DEVEREUX, V. G. [1982] Tests on eight video p.c.m. codecs in tandem handling composite PAL and monochrome video signals. BBC Research Department Report 1982/19. Information in this Reference is also contained in EBU Rev. (*Tech.*) 199, June 1983, 114-131.
- RATLIFF, P. A. [1974] Digital video: Subjective assessment of an experimental Wyner – Ash error corrector. BBC Research Department Report 1974/41.

### *CCIR Documents*

[1986-90]: a. CMTT/176 (United Kingdom).