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ITU-T

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(ex CMTT.660)

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TELECOMMUNICATION
STANDARDIZATION SECTOR
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TELEVISION AND SOUND TRANSMISSION

TRANSMISSION OF ANALOGUE HIGH-QUALITY SOUND-PROGRAMME SIGNALS ON MIXED ANALOGUE-AND-DIGITAL CIRCUITS USING 384 kbit/s CHANNELS

ITU-T Recommendation J.54

(Formerly Recommendation ITU-R CMTT.660)

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.54 (formerly Recommendation ITU-R CMTT.660) was elaborated by the former ITU-R Study Group CMTT. See Note 1 below.

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 Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector (ITU-R).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.

Recommendation J.54[1)]

TRANSMISSION OF ANALOGUE HIGH-QUALITY SOUND-PROGRAMME SIGNALS ON MIXTED ANALOGUE-AND-DIGITAL CIRCUITS USING 384 kbit/s CHANNELS

(1986)

The CCIR,

CONSIDERING

(a) that high-quality sound-programme signals on mixed analogue-and-digital circuits must satisfy the performance requirements of Recommendation 505;

(b) that the number of analogue-to-digital and digital-to-analogue conversions as well as the number of digital coding techniques should be kept to a minimum, in order for the international sound programme connection to provide the same or higher degree of performance than possible with a homogeneous analogue connection;

(c) that the CCITT has recommended a 384 kbit/s H0 bearer channel in Recommendation I.412 which has the capacity to transport sound-programme signals on an integrated services digital network (ISDN);

(d) that digital-to-digital conversions using the same encoding law on tandem sound-programme circuits with different primary rates should not introduce any signal degradation,

UNANIMOUSLY RECOMMENDS

that the transmission of sound-programme signals on 384 kbit/s channels, with an analogue interface at the input and output of the international connection, should satisfy the analogue-and-digital requirements defined in § 1 and 2 respectively of this Recommendation.

Note 1 – Equipment characteristics for the coding of analogue high-quality sound-programme signals using 384 kbit/s channels have been defined in CCITT Recommendation J.41. Characteristics for equipment offering digital access at 384 kbit/s into 2048 kbit/s are given in CCITT Recommendations G.735 and G.737.

Note 2 – Other coding techniques are proposed and are the subject of Question 18/CMTT, for example, coding of analogue sound-programme signals at 316 kbit/s, insertion into a 320 kbit/s channel and multiplexing of six high-quality sound-programme channels within 2048 kbit/s. Techniques which may be used by bilateral agreement of the administrations concerned are listed in Table I of Report 647.

1. Analogue requirements

Transmission of high-quality sound-programme signals on mixed analogue-and-digital circuits shall satisfy the performance requirements of Recommendation 505.

1.1 *Single codec performance*

The analogue-to-analogue transmission performance of a single codec shall be equivalent to one-third the performance characteristics of the hypothetical reference circuit (see Recommendation 505). Where applicable, the laws of addition given in Recommendation 605 can be used to calculate the single codec performance with $n = 3$ analogue-to-analogue sections.

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1) Formerly Recommendation ITU-R CMTT.660.

1.2 *Tandem codec performance*

The hypothetical reference circuit (HRC) given in Recommendation 502 is divided into three sections of equal length which could be either analogue or digital. Each digital section should only contain one encoder and one decoder. Therefore, in a mixed analogue-and-digital HRC, Table I indicates the number of codecs which may be connected in tandem.

TABLE I – *Number of tandem codecs on a mixed analogue-and-digital sound programme circuit*

Analogue sections	Tandem codecs
0	3
1	2
2	1
3	0

2. Digital requirements

Digital-to-digital conversions using the same encoding law as given in Table II or Table III of this Recommendation on tandem sound-programme circuits with different primary rates should not introduce any signal degradation. Digital-to-digital conversions using different encoding laws, as given in Tables II and III, should cause minimum signal degradation.

TABLE II – *Coding table for instantaneous companding of sound-programme signals* *

Normalized analogue input ([1])	Normalized analogue output ([1])	Compressed digital code	Segment No.	Effective resolution (bits)
8160 to 8192 4096 to 4128	8176 4112	895 768	1	9
4080 to 4096 2048 to 2064	4088 2056	767 640	2	10
2040 to 2048 1024 to 1032	2044 1028	639 512	3	11
1020 to 1024 512 to 516	1022 514	511 384	4	12
510 to 512 256 to 258	511 257	383 256	5	13
255 to 256 128 to 129	255.5 128.5	255 128	6	14
127 to 128 0 to 1	127.5 0.5	127 0		

* The positive half of the coding table only is shown.

([1]) The top code word of ± 8192 corresponds to an overload level of +15 dBm0s at the 0 dB insertion loss frequency (2.1 kHz) of the CCITT Recommendation J.17 pre-emphasis circuit with 6.5 dB loss at 800 Hz.

TABLE III – *Coding table for near-instantaneous companding of sound-programme signals*

Range	Normalized analogue input ([1])	Normalized analogue output ([1])	Compressed digital code	Effective resolution (bits)
4	+8176 to +8192 0 to +16 –16 to 0 –8192 to –8176	+8184 +8 –8 –8184	+511 0 –1 –512	10
3	+4088 to +4096 0 to +8 –4096 to –4088	+4092 –8 +4o 0 –4 –4092	+511 0 –1 –512	11
2	+2044 to +2048 0 to +4 –4 to 0 –2048 to –2044	+2046 +2 –2 –2046	+511 0 –1 –512	12
1	+1022 to +1024 0 to +2 –2 to 0 –1024 to –1022	+1023 +1 –1 –1023	+511 0 –1 –512	13
0	+511 to +512 0 to +1 –1 to 0 –512 to –511	+511.5 +0.5 –0.5 –511.5	+511 0 –1 –512	14

([1]) The top code word of ±8192 corresponds to an overload level of +12 dBm0s at the 0 dB insertion loss frequency (2.1 kHz) of the CCITT Recommendation J.17 pre-emphasis circuit with 6.5 dB loss at 800 Hz.

2.1 *Sampling frequency*

The sampling frequency shall be 32 kHz. The associated tolerance shall be $\pm 5 \times 10^{-5}$ as specified in CCITT Recommendations G.732 and G.733 for primary PCM multiplex equipment. This sampling frequency conforms with that given in Recommendation 606.

2.2 *Encoding method*

The recommended encoding laws are based on a uniformly quantized 14-bit per sample PCM technique with companding and shall employ either method (a) or method (b) with the appropriate rules of precedence as defined below:

(a) eleven-segment 14-to-11 bit instantaneous A-law companding. The companding characteristic is illustrated in Fig. 1;

(b) five-range 14-to-10 bit near-instantaneous companding. The companding characteristic is illustrated in Fig. 2.

Digital paths between administrations which have adopted different systems should carry signals encoded according to method (a). Where both administrations have adopted the same method, that method should be used on digital paths between them. Any necessary transcoding will be done by administrations using method (b).

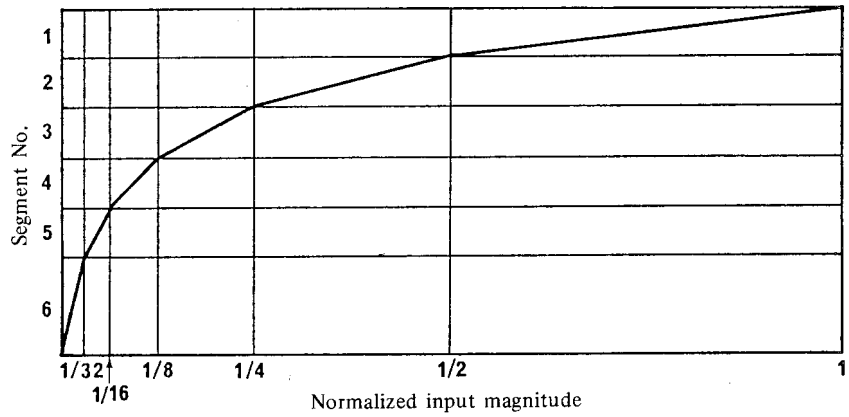

FIGURE 1 – *Instantaneous companding characteristics*

d01-sc

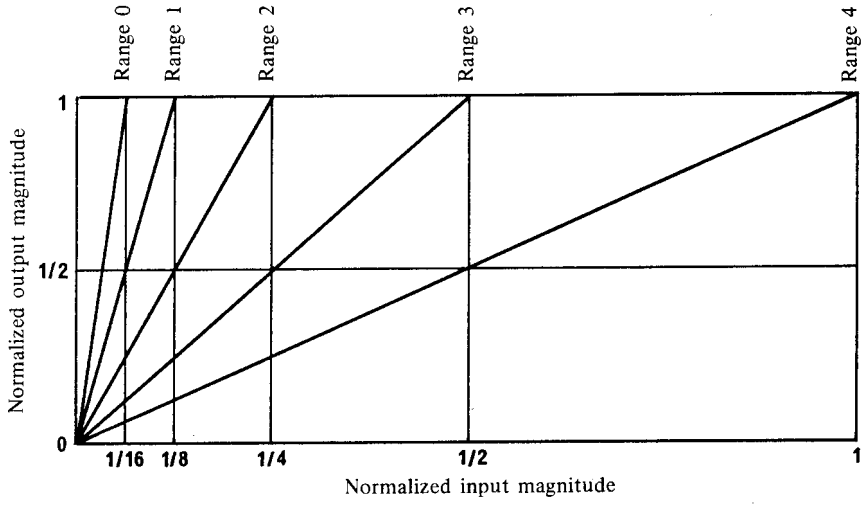

FIGURE 2 – *Near-instantaneous companding characteristics*

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2.3 *Coding table*

The coding table for the instantaneous A-law compandor is specified in Table II and the coding table for the near-instantaneous compandor is specified in Table III.

2.4 *Bit error protection*

2.4.1 *Error detection*

Error detection shall be used to detect erroneous sound programme samples which can be caused by random bit errors, burst errors, frame loss or frame slips.

2.4.2 *Error concealment and correction*

Error concealment or correction techniques shall be used to ensure that the subjective quality of the sound-programme signal is not degraded below grade 4.5 as defined in Recommendation 562. This quality shall be maintained for a random bit error ratio of 10^{-6} as defined in CCITT Recommendation G.821. Further study is necessary to define a requirement for burst errors (see Report 648).

2.4.3 *Frame loss/recovery*

Frame loss/recovery on digital channels causes interruptions to sound-programme signals. The tolerable limits for these interruptions require further study (see Reports 642 and 647).

2.5 *Jitter*

Jitter characteristics from the digital interface can produce impairments to the decoded analogue signal after passing through a digital system. This requires further study as outlined in Report 648.

2.6 *Transmission bit rate*

2.6.1 *Monophonic transmission*

The transmission bit rate for one sound-programme channel shall be 384 kbit/s, including all ancillary bits as necessary.

2.6.2 *Stereophonic transmission*

Two separate 384 kbit/s channels shall be used to form a stereophonic (stereo-pair) sound-programme circuit. Both sound-programme channels shall be routed together over the same transmission path to avoid transmission delay differences.

2.7 *Network access*

Sound-programme signals coded into 384 kbit/s digital channels should interface to the ISDN at 1544 kbit/s or 2048 kbit/s as specified in CCITT Recommendation I.412.