INTERNATIONAL TELECOMMUNICATION UNION

# ITU-T

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STANDARDIZATION SECTOR
OF ITU

**R.44**

## TELEGRAPHY

## TELEGRAPH TRANSMISSION

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# 6-UNIT SYNCHRONOUS TIME-DIVISION 2-3-CHANNEL MULTIPLEX TELEGRAPH SYSTEM FOR USE OVER FMVFT CHANNELS SPACED AT 120 Hz FOR CONNECTION TO STANDARDIZED TELEPRINTER NETWORKS

## ITU-T Recommendation R.44

(Extract from the *Blue Book*)

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**NOTES**

1 ITU-T Recommendation R.44 was published in Fascicle VII.1 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

**Recommendation R.44**

## 6-UNIT SYNCHRONOUS TIME-DIVISION 2-3-CHANNEL MULTIPLEX TELEGRAPH SYSTEM FOR USE OVER FMVFT CHANNELS SPACED AT 120 Hz FOR CONNECTION TO STANDARDIZED TELEPRINTER NETWORKS

*(Mar del Plata, 1968, amended at Melbourne, 1988)*

The CCITT,

*considering*

(a) that synchronous modulation enables a larger number of telegraph channels to be constituted by time-subdivision of a standardized telegraph channel (Recommendation R.35);

(b) that such an increase may be of interest in the case of long submarine cables of the telephone type in view of the resulting economies;

(c) that, in addition to the signals of International Telegraph Alphabet No. 2, transmission of the selection and supervisory signals is essential when incorporating the telegraph channels thus provided into the international switching network;

(d) that it is desirable to allow for the provision of half-rate and quarter-rate channels;

(e) that correct phase-relationship should be established and also maintained automatically;

(f) that systems using 5- and 6-unit codes have been proposed,

*unanimously declares the view*

that, where the synchronous multiplex system uses a 6-unit binary code, the equipment should be constructed to the following standards (Administrations may of course by mutual agreement use a different system with a 5-unit code such as that described in [1]).

### 1 Telegraph modulation

1.1 The character period should be 145 5/6 ms.

1.2 The multiplexing should provide for the derivation of either 2 or 3 time-division channels from each voice-frequency telegraph (VFT) channel. The aggregate modulation rate will be 82 2/7 bauds for a 2-channel multiplex and 123 3/7 bauds for a 3-channel multiplex. Generally it is found that VFT systems conforming to Recommendation R.35 will operate satisfactorily at 82 2/7 bauds, but to ensure satisfactory operation at 123 3/7 bauds, it is necessary to employ characteristic distortion compensation (CDC) at the receiving end of the VFT channel.

1.3 The time derived channels shall be element interleaved to form the aggregate signal.

### 2 Connection to start-stop circuits

2.1 The channel inputs shall be capable of accepting signals from start-stop equipment conforming to Recommendation S.3 [2] (except § 1.6 of S.3). The channel output should be start-stop with a modulation rate of 50 bauds. Standards of performance are given in § 9 below.

### 3 Alphabet

3.1 Combinations 1 to 31 of the 5-unit International Telegraph Alphabet No. 2 shall each be preceded by an A-condition element, while the continuous start and continuous stop conditions shall utilize the 6-unit combinations AAAAAA and ZZZZZZ respectively. The remaining combination No. 32 shall be preceded by a Z element.

3.2 The alphabet should be as shown in Annex A.

## 4 Grouping of multiplex systems

4.1 A common phasing control can be used for a number of multiplex systems carried by different channels of the same VFT system. A group of multiplexes shall comprise a maximum of six systems. Some time-derived channels shall be capable of being further divided to provide sub-channels. The various channels should be identified by a figure denoting the number of the multiplex system within the group of six, i.e. 1-6 followed by a letter denoting the channel within that system, i.e. A, B or C. Thus the complete channel numbering will be as follows:

*Multiplex system/channel*

1A, 2A, 3A, 4A ,5A, 6A
–, 2B, 3B, 4B, 5B, 6B } full rate
1C, 2C, 3C, 4C, 5C, 6C

(1B is not available as a full-rate channel – see § 7 below.)

4.2 Each A channel should be full character rate only.

4.3 Each B channel should be capable of full character rate and subdivision (except 1B, which is permanently subdivided).

4.4 The full-rate channels A and B in the case of 2-channel multiplexing, or A, B and C in the case of 3-channel, should be multiplexed on an element-interleaved basis in the following sequence:

Al, B1, A2, B2, etc. for 2-channel operation (where Al is the first element of channel A etc.);

Al, B1, C1, A2, B2, C2, etc. for 3-channel operation.

## 5 Subdivision of channels

5.1 All full character-rate channels B (except B1) and C should be capable of subdivision into quarter character-rate channels, and into multiples of quarter-rate, i.e. one half-rate, using two quarter-rate channels. (Although theoretically three-quarter rate channels could be provided, controlled by means of pulses from the multiplex equipment, provision of this facility is not recommended.)

5.2 The sub-channels should be identified basically in the same manner as the full-rate channels with the addition of a numeral denoting the quarter-rate channel, i.e. 1-4. In the case of half-rate channels, the numbers of the two quarter-rate channels used for it should be shown, i.e. 1/3 or 2/4. Thus the complete sub-channel numbering will be as follows:

*Multiplex system/channel/sub-channel*

1B1, 2B1, 3B1, 4B1, 5B1, 6B1. 1C1, 2C1, 3C1, 4C1, 5C1, 6C1
1B2, 2B2, 3B2, 4B2, 5B2, 6B2. 1C2, 2C2, 3C2, 4C2, 5C2, 6C2
1B3, 2B3, 3B3, 4B3, 5B3, 6B3. 1C3, 2C3, 3C3, 4C3, 5C3, 6C3 } quarter rate
- , 2B4, 3B4, 4B4, 5B4, 6B4. 1C4, 2C4, 3C4, 4C4, 5C4, 6C4

(1B4, phasing control only)

1B1 / 3, 2B1 / 3, 3B1 / 3, 4B1 / 3, 5B1 / 3, 6B1 / 3
- , 2B2 / 4, 3B2 / 4, 4B2 / 4, 5B2 / 4, 6B2 / 4
(1B2 / 4 not available)
1C1 / 3, 2C1 / 3, 3C1 / 3, 4C1 / 3, 5C1 / 3, 6C1 / 3 } half rate
1C2 / 4, 2C2 / 4, 3C2 / 4, 4C2 / 4, 5C2 / 4, 6C2 / 4

5.3 The sub-channels 1, 2, 3 and 4 shall be operated in the following character sequence:

A B1 A B2 A B3 A B4 A B1, etc. for 2-channel operation,

A B1 C1 A B2 C2 A B3 C3 A B4 C4 A B1 C1, etc. for a 3-channel operation.

5.4 All the sub-channels shall be transmitted with the same polarity except those of channel 1B, which should be inverted.

## 6 Transposition pattern

6.1 To avoid inadvertent cross-connections between channels when the system is out of phase, element transpositions should be allocated to the channels and sub-channels as follows:

| | | |
|---|---|---|
| Channel A | 1 2 3 4 5 6 | sub-channel 1 |
| Channel B | 1 3 2 4 5 6 | |
| Channel C | 1 2 4 3 5 6 | |
| Channel A | 1 2 3 5 4 6 | sub-channel 2 |
| Channel B | 1 2 3 4 6 5 | |
| Channel C | 1 4 3 2 5 6 | |
| Channel A | 1 2 5 4 3 6 | sub-channel 3 |
| Channel B | 1 2 3 6 5 4 | |
| Channel C | 1 5 3 4 2 6 | |
| Channel A | 1 2 6 4 5 3 | sub-channel 4 |
| Channel B | 1 6 3 4 5 2 | |
| Channel C | 1 6 5 4 3 2 | |

6.2 Full character-rate and half character-rate channels should take that sequence which is allocated to their lowest-numbered sub-channel, i.e. a full character-rate channel should take the sequence for its sub-channel 1, a half character-rate sub-channel using sub-channels 1 and 3 should take the sequence for its sub-channel 1, and a half character-rate sub-channel using sub-channels 2 and 4 should take the sequence for its sub-channel 2.

6.3 The element transpositions shall be carried out in the permanent wiring to the start-stop input and output units so that each of these units may be used in any position without alteration.

## 7 Phasing

7.1 Provision should be made for:

a) automatic phasing, automatically initiated (normal working condition);

b) automatic phasing, manually initiated;

c) manual phasing.

7.2 One quarter-rate channel of the group (1 B4) should be permanently allocated for phasing control purposes, and should continuously send the character ZZAAZZ (the phasing signal).

7.3 Automatic initiation of phasing should occur when three successive phasing signals have not been recognized.

7.4 Automatic phasing may be in steps of one element per expected reception of the phasing signal, i.e. every four transmission cycles (583 ms), or alternatively a method that will carry out rephasing in one operation thus reducing the time spent on phasing. Phasing shall automatically cease when the phasing signal is recognized on the phasing sub-channel receiving unit.

7.5 Visual indication of the correct reception of the phasing signal should be given.

## 8 Telex and gentex signalling

8.1 The multiplex equipment should be capable of accepting CCITT types A, B and C signals and shall sensibly reproduce them with minimum delay or change.

8.2 It is especially desirable to transmit the signals used for calling and call confirmation with the minimum delay in order to minimize the probability of simultaneous seizure from both ends where circuits are used for both-way working.

8.3 To meet this requirement of minimum delay it is necessary that both the normal character storage inherent in a random arrival system should be bypassed during the free-line condition and the incoming signal from telex should be inspected at the most frequent intervals possible, with element interleaving between channels. Thus effectively the line input circuit is connected directly to the multiplex aggregate, and is inspected at intervals of 24 11/36 ms causing an element of this length and input polarity to be transmitted over the aggregate signal path. At the receiving end this element would be distributed to the appropriate channel and produce an element of like polarity at the output. The result of this is to transmit elements of 24 11/36 ms of a polarity determined by the channel input.

8.4 With the character store bypassed in this way the transmission of pulse signals, which may be signalling or dialling, during the setting up of a telex call is also permitted. The character store must, however, be switched into use prior to the transmission of teleprinter characters whether these are signalling or traffic.

8.5 The method of switching start-stop stores into the connection depends on the type of signalling and it may vary with the direction of calling. Normally each direction of signalling may be considered separately and the stores can be switched into the connection within a period less than one character length of the inversion to stop polarity's being recognized, but with calls to type B dial selection systems switching must be deferred until such conversion has occurred on both signalling paths.

8.6 It seems desirable to guard against reproduction of short spurious pulses on the input line as full elements. Pulses of up to 8-10 ms should therefore be rejected. Thus pulses would result as follows:

| *Input to system* | *Multiplex aggregate* | *Output from system* |
|---|---|---|
| 0-9 (± 1) ms of either polarity | No pulse | No pulse |
| 9 (± 1)-33 11/36 ms | 1 element (24 11/36 ms) | For A polarity 45 ms<br>For Z polarity 33 ms |
| 33 11/36-57 11/18 ms | 2 elements (48 11/18 ms) | Both polarities 48 11/18 ms |

8.7 An alternative method of producing pulses, as follows, would be acceptable:

| | | |
|---|---|---|
| 0-9 (± 1) ms | No pulse | |
| 9 (± 1)-24 11/36 ms | 1 element (24 11/36 ms) | For A polarity, 45 ms |
| 24 11/36-48 11/18 ms | 1 element (24 11/36 ms) | For Z polarity, 33 ms |
| | or 2 elements (48 11/18 ms) | Both polarities 48 11/18 ms |
| 48 11/18-72 11/12 ms | 2 elements (48 11/18 ms) | |
| | or 3 elements (72 11/12 ms) | Both polarities 72 11/12 ms |

8.8 Dial pulse trains when received within the speed and ratio limits specified in Recommendation U.2 should be regenerated within the bypass unit, to be retransmitted by the multiplex equipment when the store is bypassed with a minimum duration of Z polarity of 32-34 ms and that of A polarity of 44-46 ms. Two or more elements of either A or Z polarity should be transmitted as multiples of 24 11/36 ms and within the ratio limits specified should not exceed 73 ms for Z polarity and 98 ms for A polarity.

8.9 The type B call confirmation or proceed-to-select signal when received by the multiplex equipment within the limits specified by Recommendation U.1 should, on retransmission by the multiplex equipment, fall within the limits of 32-50 ms. The interval of A polarity between call-confirmation and proceed-to-select signals should be not less than 60 ms.

8.10 In order to discriminate between the various type B backward path signals and to preserve their duration within acceptable limits it may be necessary to delay their transmission. This delay should be kept to a minimum in all cases.

## 9 Standards of performance

9.1 The stability of the master oscillator controlling the timing of each group should not be worse than ± 1 part in $10^6$.

9.2 The degree of isochronous distortion of the aggregate output should not exceed 3%. The degree of synchronous start-stop distortion of the channel output should not exceed 3%.

9.3 The receiving input margin for both the aggregate and start-stop channel input should not be less than ± 45%.

9.4 The maximum speed error for the start-stop output signals should not be greater than ± 0.5%.

## 10 Miscellaneous facilities

10.1 It should be arranged that when phase is lost the output of the multiplex channels becomes a continuous condition. When a channel is used for telex, the continuous condition should be A. When a channel is used for other services the condition may be Z if required.

10.2 With the exception of combination No. 32, the 6-unit equivalents to the combinations of International Telegraph Alphabet No. 2 have the first element of condition A. If the first element is received erroneously as condition Z, the character need not be rejected but may be passed to the channel output.

*Note* – The requirements to be met by synchronous multiplex equipment for telex and gentex operation are defined in Recommendation U.24.

ANNEX A

(to Recommendation R.44)

| Combination No. in International Telegraph Alphabet No. 2 | Letter case | Figure case | Code in International Telegraph Alphabet No. 2 (see Note 1) | Code in International Telegraph Alphabet No. 4 (see Note 1) |
|---|---|---|---|---|
| 1 | A | – | ZZAAA | AZZAAA |
| 2 | B | ? | ZAAZZ | AZAAZZ |
| 3 | C | : | AZZZA | AAZZZA |
| 4 | D | Note 2 | ZAAZA | AZAAZA |
| 5 | E | 3 | ZAAAA | AZAAAA |
| 6 | F | | ZAZZA | AZAZZA |
| 7 | G | Note 2 | AZAZZ | AAZAZZ |
| 8 | H | | AAZAZ | AAAZAZ |
| 9 | I | 8 | AZZAA | AAZZAA |
| 10 | J | Note 2 | ZZAZA | AZZAZA |
| 11 | K | ( | ZZZZA | AZZZZA |
| 12 | L | ) | AZAAZ | AAZAAZ |
| 13 | M | . | AAZZZ | AAAZZZ |
| 14 | N | , | AAZZA | AAAZZA |
| 15 | O | 9 | AAAZZ | AAAAZZ |
| 16 | P | 0 | AZZAZ | AAZZAZ |
| 17 | Q | 1 | ZZZAZ | AZZZAZ |
| 18 | R | 4 | AZAZA | AAZAZA |
| 19 | S | ’ | ZAZAA | AZAZAA |
| 20 | T | 5 | AAAAZ | AAAAAZ |
| 21 | U | 7 | ZZZAA | AZZZAA |
| 22 | V | = | AZZZZ | AAZZZZ |
| 23 | W | 2 | ZZAAZ | AZZAAZ |
| 24 | X | / | ZAZZZ | AZAZZZ |
| 25 | Y | 6 | ZAZAZ | AZAZAZ |
| 26 | Z | + | ZAAAZ | AZAAAZ |
| 27 | carriage return | | AAAZA | AAAAZA |
| 28 | line-feed | | AZAAA | AAZAAA |
| 29 | letter-shift | | ZZZZZ | AZZZZZ |
| 30 | figure-shift | | ZZAZZ | AZZAZZ |
| 31 | space | | AAZAA | AAAZAA |
| 32 | not normally used | | AAAAA | ZAAAAA |
| - | phasing signal | | – | ZZAAZZ |
| - | signal $\alpha$ | | permanent A polarity | AAAAAA |
| - | signal $\beta$ | | permanent Z polarity | ZZZZZZ |

*Note 1* – Symbols A and Z have the meanings defined in Definition 31.38 of Recommendation R.140.

*Note 2* – See Recommendation S.4 [3].

**References**

[1] *Report on synchronous telegraphy over standardized telegraph channels*, White Book, Vol. VII, Supplement No. 8, ITU, Geneva, 1969.

[2] CCITT Recommendation *Transmission characteristics of the local end with its termination (ITA No. 2)*, Rec. S.3.

[3] CCITT Recommendation *Use of International Telegraph Alphabet No. 2*, Rec. S.4.