INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

RED BOOK

VOLUME VII – FASCICLE VII.1

TELEGRAPH TRANSMISSION

RECOMMENDATIONS OF THE R SERIES

TELEGRAPH SERVICES
TERMINAL EQUIPMENT

RECOMMENDATIONS OF THE S SERIES

VIII[TH] PLENARY ASSEMBLY
MALAGA-TORREMOLINOS, 8-19 OCTOBER 1984

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ISBN 92-61-02271-5

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APPLICABLE AFTER THE EIGHTH PLENARY ASSEMBLY (1984)

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PRELIMINARY NOTES

1 The Questions entrusted to each Study Group for the Study Period 1985-1988 can be found in Contribution No. 1 to that Study Group.

2 In this fascicle, the expression "Administration" is used for shortness to indicate both a telecommunication Administration and a recognized private operating agency.

PART I

Series R Recommendations

TELEGRAPH TRANSMISSION

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SECTION 1

TELEGRAPH DISTORTION

Recommendation R.2

ELEMENT ERROR RATE

(Geneva, 1964)

The CCITT,

considering

(a) that in practice, the error rate on transitions is not used and, with the development of data transmission, it is the notion of element error rate that has come into use,

(b) that in general, the expression *element error rate* is used with the meaning of *error rate on unit elements.* Although this equivalence of meaning is acceptable for isochronous signal trains, this is not so for start-stop signal trains. In fact, there may be elements in start-stop signal trains whose duration is different from that of the unit elements (for example, the stop element of a start-stop signal in accordance with International Telegraph Alphabet No. 2),

unanimously declares the view

(1) that the following definitions be adopted:

element error rate: the ratio of the number of incorrectly received elements to the number of emitted elements.

unit element error rate for isochronous modulation: the ratio of the number of incorrectly received elements to the number of emitted elements.

(2) that, for start-stop signal trains, the notion of character error rate be used;

(3) that, when error rates are measured to assess the quality of a communication, the original message acting as a reference for the calculation of the error rate shall be considered as being free of error;

(4) that measurement of the element error rate assumes that it has been possible to record the elements received in such a way that they can be recognized as being correctly or incorrectly recorded. As the result of an error rate measurement thus depends on the recording system at the end of the connection, this system must be specified when the results of the element error rate are given. Whenever possible the element error rate should be measured at the output of the regenerating device which normally precedes the translation device; the signals should be translated for checking purposes.

Recommendation R.4

METHODS FOR THE SEPARATE MEASUREMENTS OF THE DEGREES OF VARIOUS TYPES OF TELEGRAPH DISTORTION

(New Delhi, 1960; amended at Geneva, 1980)

For separate measurements of the degrees of characteristic distortion, bias distortion and fortuitous distortion affecting a telegraph modulation or restitution, the following is recommended where circuits and voice-frequency telegraph (VFT) channels are used to carry information employing International Telegraph Alphabet No. 2, without regeneration;

1 Measure the degree of overall distortion (at the actual mean modulation rate) on text, for instance the **QKS** text specified in Recommendation R.51 *bis*. Let Δ be the measurement obtained.

2 Measure the degree of distortion on reversals at the modulation rate used in the measurement of § (1) above. Let Δ_1 be the measurement obtained. Δ_1 is the sum of the bias and fortuitous distortions.

3 By using a compensator fitted to the distortion-measuring equipment, for example a compensating winding on the distortion meter relay, reduce the degree of distortion reading obtained to its minimum value. Let this figure be δ. For practical purposes δ is the fortuitous distortion. $\Delta_1 - \delta$ is, for practical purposes, the bias distortion.

4 Keep the distortion meter adjusted as for the measurement of δ. Measure the degree of distortion at the actual mean modulation rate on text (**QKS** text, for instance). Let Δ' be the reading. $\Delta' - \delta$ is, for practical purposes, the characteristic distortion.

Note 1 – This method gives approximate results; it is possible that the equation $\Delta_1 + \Delta' - \delta = \Delta$ may not be exactly satisfied.

Note 2 – The method can be applied by using either an isochronous distortion-measuring set or a start-stop distortion-measuring set.

Note 3 – The fact that the separate measurement of degrees of different types of distortion is said to be possible and that a method is recommended for such a measurement does not mean that separate measurements of the degrees of different types of distortion are to be recommended when international routine maintenance measurements are carried out.

Recommendation R.5

OBSERVATION CONDITIONS RECOMMENDED FOR ROUTINE DISTORTION MEASUREMENTS ON INTERNATIONAL TELEGRAPH CIRCUITS

(New Delhi, 1960; amended at Geneva, 1964, Mar del Plata, 1968, and Geneva, 1980)

The CCITT,

considering

(a) Recommendations R.51, R.51 *bis*, R.54 and R.55;

(b) that, for the measurement of the degree of distortion of signals on an international telegraph circuit, it is necessary to specify the best condition of observation in order to be sure that the measurement obtained gives a good indication of what the performance of the circuit will be during periods of normal traffic;

(c) that the observation conditions should be such that their duration or their complexity does not unduly increase the load on the maintenance services;

(d) that certain Administrations, to determine these conditions, have carried out statistical measurements of the degree of individual start-stop distortion using distortion analyzers, the results of which seem to be in agreement;

unanimously declares the view

(1) that the tests should be carried out at nominal modulation rates of 50, 75, 100 and 200 bauds, depending on the type of circuits concerned;

(2) that the text transmitted during measurements should be that of Recommendation R.51 *bis*;

(3) that the degree of transmitter distortion of text signals should not exceed 1%;

(4) that, during normal maintenance tests, the duration of the observation should correspond to the examination of at least 800 significant instants, whatever the type of distortion meter used, isochronous or start-stop. At a modulation rate of 50 bauds this results in an observation period of about 30 seconds. At other modulation rates, the observation should last about 20 seconds;

Note – The period of observation required to assess properly the performance of tandem code-independent time-division multiplexers may be much longer than for voice-frequency telegraph equipment.

(5) that, when making start-stop measurements using test equipment that does not register the peak early and peak late reading simultaneously, the observation period should be divided into two more or less equal parts: one part during which the significant instants in advance of their theoretical position could be observed and the other part during which the significant instants coming later than their theoretical position could be observed.

Recommendation R.9

HOW THE LAWS GOVERNING DISTRIBUTION OF DISTORTION SHOULD BE ARRIVED AT

(Geneva, 1964)

The CCITT,

considering

(a) that for the sake of comparative studies of degrees of distortion, it would be well if the procedures for measurement of distortion, and the layout of results, could be standardized. The distortion in question is:

– start-stop individual;
– isochronous individual;
– degree of start-stop distortion,

(b) that the degree of isochronous distortion is of no great practical interest, since it is the individual isochronous distortion that, when isochronous distortion is present, supplies all the useful information. Hence it is not proposed to include the degree of isochronous distortion in this Recommendation.

unanimously declares the following view:

1 Start-stop individual distortion

1.1 As regards start-stop individual distortion, the distribution curves will be plotted by means of a statistical distortion analyzer. The width of the measurement steps should make it possible to take measurements with steps of 1%, 2%, 4%, 8%. A measurement will cover about 20 000 transitions (measurement duration of about 15 minutes at 50 bauds: three transitions on the average per start-stop alphabetic signal).

1.2 The results will be shown on the graphs on the linear scale with distributional representation, or on the normal probability scale with cumulative representation, the ordinates being the probabilities or probability density and the abscissae the degree of distortion.

1.3 For individual distortion, the curves will give negative (early) and positive (late) distortion.

1.4 For more detailed studies, the number of transitions to be examined may be higher than 20 000, the number depending on the chosen probability that the nominal figure will be exceeded.

2 Isochronous individual distortion

2.1 There is the difficulty of synchronism between the transmitter and the distortion analyzer, when the measurements are made at two different points; moreover, the average propagation time of the signals is to be taken into consideration when loop measurements are made.

2.2 The methods of measuring and presenting the results will be the same as for the preceeding case, but the transmitter and the analyzer will have to be synchronized as accurately as possible, taking into account the distortion values to be measured.

3 Start-stop distortion

3.1 This is a matter of the (maximum) degree noted during a measurement. It is then necessary to decide on the length of the sample to be measured; the text to be measured will be composed at random. The measurement at 50 bauds will last 30 seconds, distributed as specified in § 5 of Recommendation R.5.

3.2 Distribution curves of these degrees of start-stop distortion will be drawn as a function of the number of samples.

Recommendation R.11

CALCULATION OF THE DEGREE OF DISTORTION OF A TELEGRAPH CIRCUIT IN TERMS OF THE DEGREES OF DISTORTION OF THE COMPONENT LINKS

(New Delhi, 1960; amended at Geneva, 1964, and 1980)

1 In general the isochronous standardized test distortion δ (Definitions 33.07 and 33.12, Recommendation R.140 of a telegraph circuit consisting of a number *n* of links in tandem lies between the arithmetic sum and the square root of the sum of the squares of the degrees of distortion of the individual links,

$$\sum_{i=1}^{n} \delta_i > \delta > \sqrt{\sum_{i=1}^{n} \delta_i^2},$$

n being the number of links in tandem. The few exceptions to this rule that have been observed related to extremely long circuits (for example, four links, each of approximately 3500 km looped at voice-frequency at the distant end to give the equivalent of four links (each 7000 km go and return) and a total length of approximately 28 000 km on cable and open-wire carrier telephone-type channels).

2 For such purposes as the planning of networks, the degree of distortion of a telegraph circuit consisting of *n* channels or links in tandem in the telex service (where a great number of channels will be interconnected at random) is given fairly approximately by:

$$\delta_{\text{inherent}} = \sum_{n}^{1} \delta_c + \sqrt{\sum_{1}^{n} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2}.$$

Similarly, for the combination of a transmitter and a telegraph circuit consisting of n channels or links in tandem in the telex service, the degree of distortion is given fairly approximately by:

$$\delta_{\text{text}} = \sum_{1}^{n} \delta_c + \sqrt{\delta_t^2 + \delta_v^2 + \sum_{1}^{n} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2},$$

where

δ_{inherent} = the probable degree of inherent start-stop distortion on standardized text,

δ_{text} = the probable degree of gross start-stop distortion in service,

δ_c = the degree of characteristic start-stop distortion of a single channel or link,

δ_t = the degree of synchronous start-stop distortion of the transmitter,

δ_v = the degree of start-stop distortion due solely to the difference between the mean transmitter speed and the standardized speed. (The difference to be considered is equal to six times the mean difference for one element.)

δ_{bias} = the degree of asymmetrical (bias) distortion of one channel measured using 1:1 or 2:2 signals (either 1:1 or 2:2 signals should be used according to which is normally employed for adjusting the channels),

$\delta_{\text{irreg.}}$ = the degree of fortuitous distortion of one channel measured using 1:1 or 2:2 signals.

3 The values of distortion (except for δ_c) inserted in the foregoing formulae must have the same probability of being exceeded (p). The degree of characteristic distortion δ_c of a channel is fairly constant for each type of voice-frequency channel and can be determined in laboratory tests. Nevertheless, the maximum degree of characteristic distortion is reached for only about 20% of the signals of International Telegraph Alphabet No. 2. Empirical values for δ_c can be obtained with reasonable accuracy by using methods recommended by Recommendation R.4.

4 The probability of exceeding the degrees of distortion δ_{inherent} and δ_{text} calculated with the aid of the above formulae is 0.2 p.

Note – The laws governing the addition of distortion in tandem connected code-independent time-division multiplex systems, and in particular the duration of measurement to be assumed, are the subject of study.

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SECTION 2

VOICE-FREQUENCY TELEGRAPHY

Recommendation R.20

TELEGRAPH MODEM FOR SUBSCRIBER LINES

(Geneva, 1980; amended at Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that the use of high-level telegraph transmission with single or double current may cause disturbing impulse noise in adjacent cable pairs that may be eliminated by applying low-level transmission with telegraph modems;

(b) that telegraph modems would substantially reduce the power consumption in the central office;

(c) that where connection to a subscriber has to be achieved over a non-metallic pair (e.g., a voice-channel frequency-division multiplex or pulse code modulation system) a telegraph modem has to be utilized;

(d) that the frequencies given below are already standardized in Recommendation V.21 [1];

(e) that suitable inexpensive telegraph modems can be used for full duplex transmission on 2-wire circuits at modulation rates up to 300 bauds;

unanimously declares the view

that where low-level telegraph transmission is used, the following method of transmission should be recommended for all modulation rates up to 300 bauds.

1 Channel allocation

The method of transmission is based on Recommendation V.21 [1] with the following frequency designations:

Central office to subscriber (channel 1) $F_A = 1180$ Hz,
$F_Z = 980$ Hz;

Subscriber to central office (channel 2) $F_A = 1850$ Hz,
$F_Z = 1650$ Hz.

The characteristic frequencies as measured at the telegraph modem line output should not differ by more than ± 3 Hz from the nominal figures.

The modem shall continue to operate with a ± 6 Hz change in receive frequency.

It should be noted that there is equipment in use that applies alternative frequencies to those shown in this Recommendation.

2 Interface

Where the modem is a separate, self-contained unit, the following interchange circuits shall be used:

Common return (e.g. circuit 102 in Recommendation V.24 [2])

Transmitted data (e.g. circuit 103 in Recommendation V.24 [2])

Received data (e.g. circuit 104 in Recommendation V.24 [2])

Carrier detect (e.g. circuit 109 in Recommendation V.24 [2]) [1)].

3 Electrical characteristics

The electrical characteristics (for stand alone telegraph modems) of the interchange circuits, should be in accordance with CCITT Recommendation V.28.

4 Performance

4.1 The modem under test shall be connected to another modem (according to this Recommendation or to Recommendation V.21) via an attenuator having a return loss of 4 dB and an insertion loss of 30 dB. The relative group-delay characteristics of the transmit filters are subject to further study.

4.2 Uniform spectrum Gaussian noise (band limited to 10 kHz) shall be added to give a normalized signal-to-noise ratio of 32 dB.

4.3 Test signals to Recommendation R.51 *bis* (QKS) shall be sent at a -13 dBm transmit level in both directions simultaneously. (To ensure incoherence, the rate of the test signals for the direction not under test shall be slightly lower.) The test period shall be 15 seconds.

The performance shall be in accordance with Table 1/R.20.

TABLE 1/R.20

Transmit rate (bit/s)	Maximum isochronous distortion (%)		
	140 or 2600 ohms line		600 ohms line
	No frequency error	± 6 Hz recommended frequency error	No frequency error
50	5	7	3
110	7	10	5
200	11	16	8
300	15	22	11

Note – At rates above 110 bit/s these values may be incompatible with circuits planned in accordance with Recommendation R.120.

4.4 In certain configurations, it is not possible to check the modem distortion, e.g. telegraph terminals, multiplex and switching equipment with integral telegraph modems on which the d.c. signal output of the telegraph modem is inaccessible for any reason. The performance will normally be in the form of a test for distortion margin before errors are output from the equipment.

Note – The modem need only be tested at the maximum modulation rate of the equipment into which it is to be incorporated.

4.5 The design of the telegraph modem shall be such that the transmission performance is guaranteed without adjustment on installation or subsequently.

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1) This is considered optional, particularly at the subscriber's location.

5 Line signal levels and terminating impedance

The line interface of the modem shall be balanced and shall present an impedance of 600 ohms with a return loss (reference 600 ohms resistive) of not less than 14 dB (reflection coefficient no greater than 20%) over the range 300-3400 Hz.

5.1 *Output signal level*

5.1.1 When terminated in 600 ohms the output level should be set to −13 dBm.

Note 1 – In some applications an alternative level of up to 0 dBm may be required.

Note 2 – When using bearers with carrier equipment, the level at the input to the carrier equipment needs to be limited to −13 dBm0.

5.1.2 The difference in output levels between the Binary 1 (condition Z) and Binary 0 (condition A) signals shall not be greater than 1 dB for either of the channels.

5.2 *Receive signal level*

5.2.1 If the receive signal level falls below −48 dBm (with the local transmit signal still keying), the binary data output shall be clamped to Binary 0 or 1 (condition A or Z), (Clamp ON), even if the audio line is broken.

5.2.2 If the receive signal level is greater than −43 dBm, the clamp shall remain inoperative (Clamp OFF).

5.2.3 The detector used to control the condition of the clamp shall respond to the total power contained within the nominal spectrum occupied by the received line signal and shall exhibit a hysteresis action such that the level at which the OFF-ON transition occurs is at least 2 dB lower than the level at which the ON-OFF transition occurred.

5.2.4 The detector used to control the clamp shall be such that the clamp satisfies the following times:

OFF-ON – When the level of the received signal is less than the level at which the OFF-ON transition occurs for a period greater than or equal to 20 ms, the clamp shall be in the ON condition. When the level of the received signal is less than the level at which the OFF-ON transition occurs for a period less than or equal to 10 ms, the clamp shall be in the OFF condition.

ON-OFF – When the level of the received signal is greater than the level at which the ON-OFF transition occurs for a period greater than or equal to 20 ms, the clamp shall be in the OFF condition. When the level of the received signal is greater than the level at which the ON-OFF transition occurs for a period less than or equal to 10 ms, the clamp shall be in the ON condition.

6 Maintenance facilities

The subject is left for further study.

7 Protection against high voltages

The equipment shall withstand residual lightning surges, high voltage line faults, and high level telegraph keying. The protection required is for further study.

8 Line wetting

8.1 Line wetting, where required by the type of line plant used, will normally be sourced by the in-station equipment and looped by the subscriber's equipment.

8.2 The current has a maximum value of 15 mA with the line short-cirucited. The wetting current shall be a minimum of 5 mA on 4000-ohm lines. The open circuit voltage shall be under 80 V.

Note – In some countries, other values may apply.

Where a modem may be required to work in the presence of line wetting, then the modem performance (§ 4) and the modem line impedance (§ 5) requirements must apply with line wetting current flowing.

The noise applied to the line from the wetting power supply shall be under –80 dBm (600 ohms) over a range 300 to 3400 Hz (flat).

9 Permitted out-of-band energy

9.1 The out-of-band energy is a national matter; however the following information is provided to assist equipment manufacturers:

9.2 The transmitted signal level (with an output level at –13 dBm) at any one frequency shall not exceed the following limits (with the forward and reverse channel keyed at 300 bit/s with a QKS code):

200 Hz to 3200 Hz	–13 dBm
100 Hz to 200 Hz and 3200 Hz to 3400 Hz	–23 dBm
Below 100 Hz	–33 dBm
Above 3400 Hz	–33 dBm and decreasing by 12 dB/octave to –67 dBm

References

[1] CCITT Recommendation *300 bits per second duplex modem standardized* for use in the general switched telephone network, Rec. V.21.

[2] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment,* Rec. V.24.

Recommendation R.30

TRANSMISSION CHARACTERISTIC FOR INTERNATIONAL VFT LINKS

(Mar del Plata, 1968; amended at Geneva, 1976)

1 Standardized carrier systems with 4-kHz and 3-kHz spacing permit homogeneous voice-frequency telegraph (VFT) systems providing the capacities of telegraph channels given in Table 1/R.30.

TABLE 1/R.30

Bearer bandwidth	50-baud 120-Hz spacing	100-baud 240-Hz spacing	200-baud 360-Hz spacing	200-baud 480-Hz spacing
4 kHz	24	12	8 (not normally used)	6
3 kHz	22	11	7	5

2 Audio-frequency circuits with heavy or semi-heavy loading permit 12-channel 50-baud systems; circuits with lighter loading permit 18 channels at 50 bauds.

3 Four-wire links are to be preferred for voice-frequency telegraphy.

4 The composition of a 4-wire link for voice-frequency telegraphy differs from that of a telephone circuit in that there are no terminating sets, signalling equipment and echo suppressors.

5 With 2-wire links, a duplex arrangement would not be feasible since the links could not be balanced with the necessary precision to avoid mutual interaction. If the low frequencies are used for transmission in one direction and high frequencies for the other direction, a 2-wire link can be used for voice-frequency telegraphy.

6 The conditions of use of international VFT links are described in detail in Recommendation H.22 [1].

7 PCM (pulse code modulation) channels complying with Recommendation G.712 [2] are also suitable as bearers for FMVFT (frequency-modulated voice-frequency telegraph) links. However, the increase in telegraph distortion in relation to the transmission level and the number of tandem-connected PCM channels is the subject of further study.

References

[1] CCITT Recommendation *Transmission requirements of international voice-frequency telegraph links (at 50, 100 and 200 bauds)*, Rec. H.22.

[2] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Rec. G.712.

Recommendation R.31

STANDARDIZATION OF AMVFT SYSTEMS FOR A MODULATION RATE OF 50 BAUDS

(Mar del Plata, 1968, incorporating former Recommendations R.31, R.32 and R.34; amended at Malaga-Torremolinos, 1984)

The CCITT,

unanimously declares the following view:

1 It is advisable to adopt, for amplitude-modulated voice-frequency telegraph (AMVFT) systems and for a modulation rate not exceeding 50 bauds, the series of frequencies formed by odd multiples of 60 Hz, the lowest frequency being 420 Hz as shown in Table 1/R.31.

2 This numbering is valid whatever use is made of the channel (e.g. traffic channel, pilot channel, etc.) or the method employed to obtain the line frequencies, e.g. by group modulation. For the numbering of channels that has been adopted in the international service see Recommendation R.70 *bis.*

3 In the case of systems on telephone-type circuits with a spacing of 3-kHz operating in accordance with the standardized frequency series, channel positions 23 and 24 cannot be used.

4 The frequencies applied to the telephone-type circuit that is used as the voice-frequency telegraph bearer circuit should not deviate by more than 6 Hz from the nominal value when the telegraph channels supplied are operating over a telephone-type circuit composed exclusively of audio-frequency sections, and not more than 3 Hz in other cases.

5 The power levels of carrier waves transmitted on the line and measured successively in as short a period as possible should not differ from one another by more than 1.74 dB when they are operating on a constant impedance.

6 The power of each of the carrier waves transmitted on the line should not vary in operation by more than $\pm$ 0.87 dB when it operates on a constant impedance.

TABLE 1/R.31

Channel Position	Frequency Hz	Channel Position	Frequency Hz
1	420	13	1860
2	540	14	1980
3	660	15	2100
4	780	16	2220
5	900	17	2340
6	1020	18	2460
7	1140	19	2580
8	1260	20	2700
9	1380	21	2820
10	1500	22	2940
11	1620	23	3060
12	1740	24	3180

7 The amplitude of the signals transmitted by a channel modulator during a transition from condition A to condition Z should remain within the tolerances of Figure 1/R.31 in which the values t_0 and y_2 and y_1 are fixed as follows:

t_0 = 11 ms,

y_1 = 95%,

y_2 = 110%.

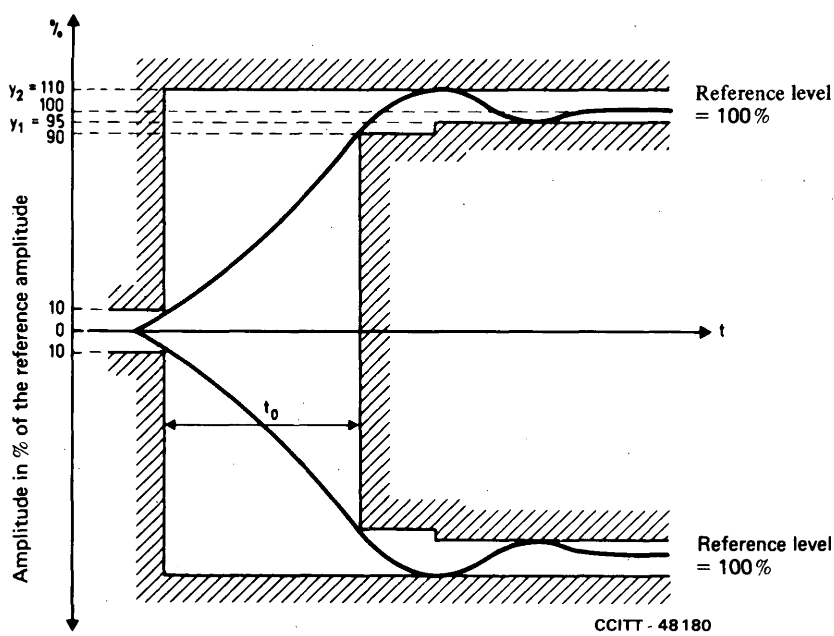


FIGURE 1/R.31

Diagram of tolerances to assess the waveform of the sent signals in AMVFT systems

8 Receivers with rapid-action level correction should not be so sensitive to secondary pulses following the signal pulse provided that the amplitude of the signal emitted does not exceed the reference level by more than 10% and that the reference level does not exceed the normal level by 10.4 dB. (This provision applies only to new systems.)

9 If 1:1 reversals at frequency f_p corresponding to the modulation rate are sent over a channel with mid-frequency F_0, the voltage at frequency $F_0 \pm 3 f_p$ must not exceed 3% of the nominal voltage at frequency F_0 and the voltage at the frequencies $F_0 \pm 5 f_p$ must not exceed 0.4% of the nominal voltage at frequency F_0.

Note – These tolerances will be required only for future systems. Administrations should try as far as possible to use systems satisfying these tolerances on international relations.

10 The unbalance of the emitted signal should not be greater than ± 4% (methods of measuring this unbalance are described in [1] and [2]). This tolerance takes account of the limit in § 11 below for new systems.

11 For new systems, the static relay should introduce a difference of not less than 45 dB between the two signalling conditions. (For existing systems the limit is 30 dB.)

12 In the event of failure of the control current in the sending static relay, the attenuation of the residual signal relative to this nominal level should be at least 27 dB. This attenuation of the signal need not occur immediately on the failure of the control current.

13 Systems should be able to tolerate slow level variations of at least ± 6 dB. Administrations should equip systems that are unable to tolerate such variations with a common amplifier to enable them to tolerate variations of at least ± 6 dB.

14 The permissible limit for the power of the telegraph signal on each telegraph channel when a continuous tone is being transmitted is given in Table 2/R.31.

TABLE 2/R.31

Normal limits (nominal values) for the power per telegraph channel in AMVFT systems

Number of telegraph channels in the AMVFT system	Allowable power per telegraph channel at a point of zero relative level when sending a signal corresponding to continuous Z condition	
	microwatts	decibels
12 or less	35	–14.5
18	15	–18.3
24	9	–20.45

Note — These limits are such that the maximum instantaneous voltage will not exceed that of a sinusoidal voltage with a power of 5 milliwatts at a point of zero relative level. This power is the maximum permissible for voice-frequency circuits.

15 Audio-frequency is transmitted to line when stop polarity (condition Z) is sent.

16 When a signal, whose frequency is equal to the nominal frequency of the channel and whose level is 18.3 dB below the normal signal level of the channel, is applied to the detector of a 24-channel AMVFT system, the receiving relay should not respond.

17 It must be possible to subject any channel to a test without withdrawing from service a channel other than the return channel of the circuit planned.

18 In graded harmonic frequency telegraphy, it is desirable that the same frequencies be used separately for circuits established on different successive sections of a 4-wire circuit.

19 In graded harmonic frequency telegraphy, the attenuation of the filters that pass a group of frequencies must, in the suppressed frequency band, be higher by at least 35 dB than that shown in the transmission band.

20 In graded harmonic frequency telegraphy, in order to facilitate local tests, the frequencies used for communications set up between two international offices in one direction should also be used in the opposite direction, if possible.

References

[1] *Measuring method to determine the asymmetry of an amplitude-modulated telegraph signal*, Blue Book, Vol. VII, Supplement No. 11, ITU, Geneva, 1964.

[2] *The measurement of the distortion produced in the sending terminal equipment of an A.M.-V.F. telegraph system*, Blue Book, Vol. VII, Supplement No. 12, ITU, Geneva, 1964.

Recommendation R.35

STANDARDIZATION OF FMVFT SYSTEMS FOR A MODULATION RATE OF 50 BAUDS

(former CCIT Recommendation B.48, Geneva, 1956; amended at New Delhi, 1960, Geneva, 1964, Mar del Plata, 1968, Geneva, 1972, 1976, 1980 and Malaga-Torremolinos, 1984)

Note – In this Recommendation, frequency-modulated voice-frequency telegraph (FMVFT) equipment with and without crystal control are distinguished. In order to improve the quality of transmission and to minimize maintenance costs, the application of equipment with crystal control is recommended.

1 The nominal modulation rate should be standardized at 50 bauds.

2 For the nominal mean frequencies, the series formed by the odd multiples of 60 Hz should be adopted, the lowest frequency being 420 Hz in accordance with Recommendation R.31, § 1, the mean frequency F_0 being defined as half the sum of the two characteristic frequencies corresponding to the permanent start polarity F_A and stop polarity F_Z. For the numbering of channels that has been adopted in the international service, see Recommendation R.70 *bis.*

3 The mean frequencies at the sending end should not deviate from their nominal value by more than:

a) for equipment without crystal control 2 Hz;

b) for equipment with crystal control 0.5 Hz.[1)]

4 The unbalance due to the modulation process $\delta = 2 \dfrac{|F_0' - F_l|}{F_A' - F_Z'}$ should not exceed 2%,

where

F_A' and F_Z' are the two characteristic frequencies measured over a period of 10 s;

F_0' is the mean static frequency measured $= \dfrac{F_A' + F_Z'}{2}$;

F_l is the mean dynamic frequency measured with 1:1 rectangular signals during 10 s.

Measurement should be made applying to the input of the transmitter 1:1 rectangular signals with the build-up and hangover time below 1 μs and with the unbalance below 0.1%. In the event that in service the transmitter is controlled by an electro-mechanical relay (with a certain transit time), the measurement should also be made with that type of relay inserted between the 1:1 signal generator and the input to the transmitter. Both forms of measurements need not necessarily be included in the maintenance procedure but should be included in laboratory type tests.

Note – To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F_A', F_Z' and F_l and to calculate the mean frequency F_0' and the unbalance

$$\delta = 2 \frac{|F_0' - F_l|}{F_A' - F_Z'}$$

1) The tightening of this tolerance is for further study.

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

– the mean dynamic frequency F_l with 1:1 signals during 10 seconds;
– the mean dynamic frequency F_m with 2:2 signals during 10 seconds;

$$\delta = 2\,\frac{|F_0' - F_l|}{F_A' - F_Z'} = 4\frac{|F_0' - F_m|}{F_A' - F_Z'}$$

or to subtract:

$$|F_l - F_m| = \frac{1}{4}\,(F_A' - F_Z')\,\delta \approx \frac{1}{4}\,(F_A - F_Z)\,\delta \leq 0.4 \text{ Hz.}$$

The absolute value of the difference between the two frequencies measured, F_l and F_m, must be less than 0.4 Hz.

5 The difference between the two characteristic frequencies (corresponding to the start and the stop conditions) should be 60 Hz.

6 The maximum tolerance on this difference should be ± 3 Hz.

7 The total average power transmitted to the telephone-type circuit is normally dependent on the transmission characteristics of the circuit as follows:

a) For circuits with characteristics not exceeding the limits given in Annex A, the total average power transmitted by all channels of a system should preferably be limited to 50 μW at a point of zero relative level. This sets, for the average power of a telegraph channel (at a point of zero relative level), the limits given in Table 1/R.35.

b) For other circuits, the total average power transmitted by all channels of a system is limited to 135 μW at a point of zero relative level. This sets, for the average power of a telegraph channel (at a point of zero relative level), the limits given in Table 2/R.35.

TABLE 1/R.35

Normal limits (nominal values) for the power per telegraph channel in FMVFT systems for bearer circuits with characteristics not exceeding the limits given in Annex A

Number of telegraph channels in the FMVFT system	Allowable power per telegraph channel at a point of zero relative level	
	in microwatts	in absolute power level decibels
12 or less	4.0	−24.0
18	2.7	−25.7
24	2.0	−27.0

8 In service, the levels of the signals corresponding to continuous condition Z and continuous condition A should not differ by more than 1.7 dB in the same channel. Both of these levels must lie between ± 1.7 dB with reference to the level given in Table 1/R.35 or Table 2/R.35 as applicable.

9 The frequency for the transmitted condition corresponding to the condition A is the higher of the two characteristic frequencies and that corresponding to the condition Z is the lower.

10 In the absence of a channel-modulator control telegraph current, a frequency should be transmitted within ± 5 Hz of the frequency normally transmitted for the start polarity. This frequency need not be sent immediately after interruption of the control current.

11 The frequency spectrum of the emitted signal, when transmitting 1:1 signals at the modulation rate of 2 f_p (f_p = frequency of modulation), should be in accordance with the limits specified in Figure 1/R.35, which shows the levels of the spectra of different components with respect to the amplitude of the non-modulated carrier as ordinates and the frequencies as abscissae.

TABLE 2/R.35

Normal limits (nominal values) for the power per telegraph channel in FMVFT systems for other bearer circuits

Number of telegraph channels in the FMVFT system	Allowable power per telegraph channel at a point of zero relative level	
	in microwatts	in absolute power level decibels
12 or less	10.8	−19.7
18	7.2	−21.4
24	5.4	−22.7

Note — The figures in Tables 1/R.35 and 2/R.35 assume the provision of a pilot channel on the telegraph bearer at a level of −27.0 dBm0 and −22.7 dBm0 respectively.

12 The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to condition A when the receiving level has fallen to 23.5 dB below the nominal level. The nominal level is the level resulting from the choice of power per channel (see Tables 1/R.35 or 2/R.35 as applicable) depending upon the number of channels (12, 18 or 24) on the circuit. The alarm-control level is left to the choice of each Administration.

13 On delivery by the manufacturer of 50-baud FMVFT equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel. These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken in accordance with Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within:

1) for equipment without crystal control ± 2 Hz;
2) for equipment with crystal control ± 0.5 Hz[1]),

of their nominal value (see § 3 above) and the difference between the two characteristic frequencies is within the permitted tolerance of less than 3 Hz (see § 6 above). Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of inter-channel interference is to be included in the measurement. These "unrelated signals" can conveniently be 1:1 signals from different generators at approximately 50 bauds but not synchronous to each other or to the signal on the channel under test.

a) The transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 5% for the degree of inherent isochronous distortion.
b) The level being maintained constant, but at a value different from the normal level, for all constant levels between 8.7 dB above the normal reception level and 17.4 dB below the normal reception level, the other conditions being the original measurement condition: 7% for the degree of inherent isochronous distortion.
c) In the presence of interference by a single sine-wave frequency equal first to one and then to the other characteristic frequency, with a level of 20 dB below the signal level, the other conditions for the start of measurements being maintained: 12% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone).
d) By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf being not more than 5 Hz and the initial condition of the test otherwise being preserved:

– for equipment without crystal control – for equipment with crystal control but without compensation for frequency drift	$(5 + 2.5\ \Delta f\ \text{Hz})$ %
– for equipment with crystal control and compensation for frequency drift	7%

for the degree of inherent isochronous distortion.

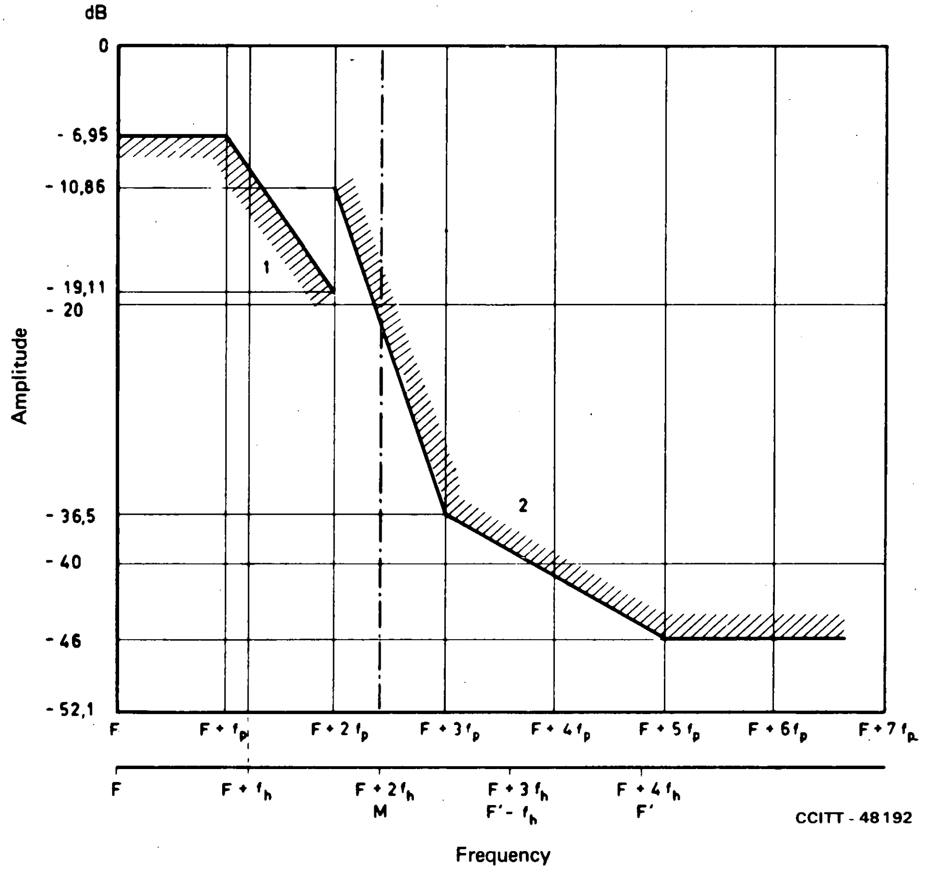
1) The tightening of this tolerance is for further study.

By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf being not more than 10 Hz, and the initial conditions of the test otherwise being preserved:

– for equipment with crystal control and compensation for frequency drift 13%

for the degree of inherent isochronous distortion. The measurements shall be made after the transient effects of changing frequency have ceased.

e) Equipment with crystal control, with any climatic conditions specified for the tested equipment, the initial condition of the test otherwise being preserved: 8% for the degree of inherent isochronous distortion. The bias distortion caused by changes of climatic conditions should not be eliminated.



F = carrier frequency of a channel
f_p = frequency of modulation = 25 Hz
f_h = frequency shift = 30 Hz
M = centre line between adjacent channels
F' = carrier frequency of the adjacent channel

Curve 1 = lower limit in the pass band
Curve 2 = upper limit in the stop band

Note — The reference level (0 dB) is the mean value of the levels of the signals corresponding to continuous stop and continuous start polarity, which are measured at the characteristic frequencies F_Z and F_A.

FIGURE 1/R.35

Frequency spectrum for 1:1 signals in 50-baud/120-Hz FMVFT systems

14 Frequency drifts on modern telephone-type circuits are generally less than 2 Hz. Hence it is not necessary to recommend frequency drift control. For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranted, and on which the distortion resulting from the frequency drift is not acceptable, compensation seems necessary. Two methods can be used:

a) compensation for each channel up to about 15 Hz;

b) compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. The frequencies 3300 Hz or, preferably, 300 Hz are recommended for this pilot, with a tolerance of:

1) for equipment without crystal control ± 1 Hz

2) for equipment with crystal control ± 0.2 Hz.

The mean power emitted at the relative zero point on this frequency should not exceed −27.0 dBm0 or −22.7 dBm0 as appropriate (see Table 2/R.35).

15 The number of significant modulation conditions is fixed at two; this number may be increased, if necessary, by agreement between the Administrations concerned.

ANNEX A

(to Recommendation R.35)

Limits required by a bearer circuit for FMVFT application if the total power transmitted by all channels is set at 50 microwatts

A.1 *Loss/frequency distortion*

The variation with frequency of the overall loss of the link with respect to the loss at 800 Hz should not exceed the limits shown in Figure A-1/R.35.

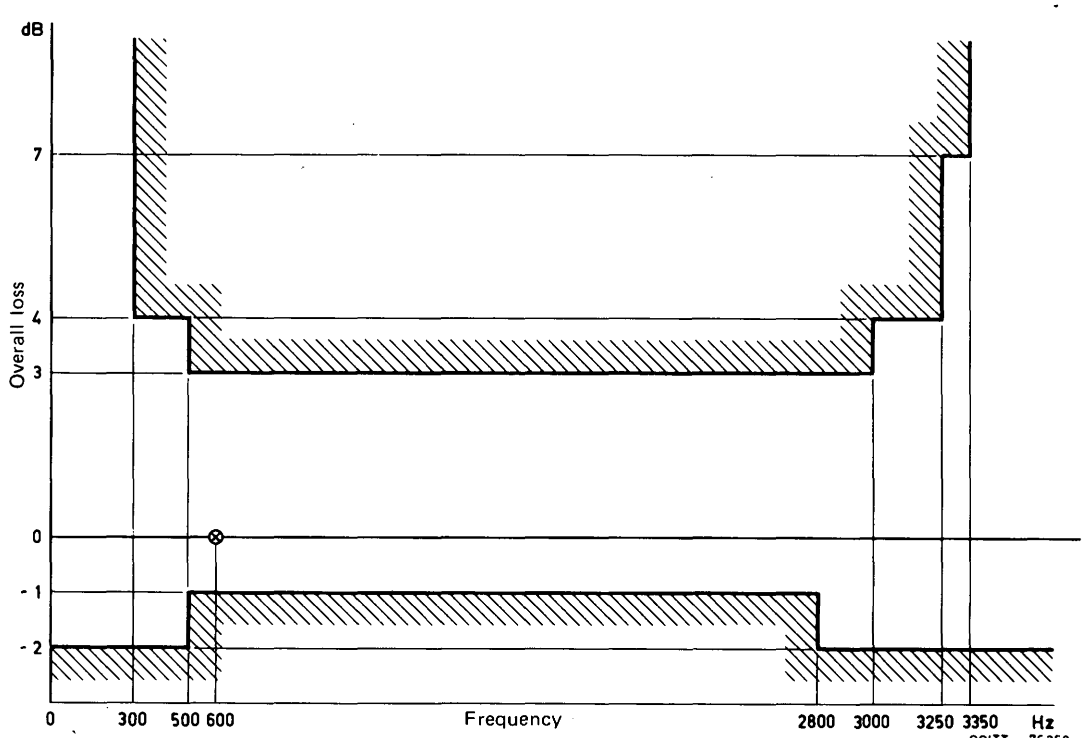


FIGURE A-1/R.35

A.2 *Random noise*

The mean psophometric noise power referred to a point of zero relative level should not exceed 32 000 pW0p (−45 dBm0p), using a psophometer in accordance with Recommendation P.53 [1].

A.3 *Impulsive noise*

The number of counts of impulsive noise that exceeds −28 dBm0 should not exceed 18 in 15 minutes when measured with an impulsive noise counter in accordance with Recommendation O.71 [2].

A.4 *Error rates*

The telegraph character error rate that may be caused by interruptions and noise in the bearer circuit should not exceed the limits stated in Recommendations R.54 and F.10 [3].

References

[1] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise),* Rec. P.53.

[2] CCITT Recommendation *Specification for an impulsive noise measuring instrument for telephone-type circuits,* Rec. O.71.

[3] CCITT Recommendation *Character error rate objective for telegraph communication using 5-unit start-stop equipment,* Rec. F.10.

Recommendation R.35 *bis*

50-BAUD WIDEBAND VFT SYSTEMS

(Geneva, 1964)

The CCITT,

considering

(a) that Voice-frequency telegraph (VFT) systems standardized by the CCITT for 50-baud channels are described in Recommendations R.31 (for amplitude modulation) and R.35 (for frequency modulation). Systems that comply with these Recommendations are those normally recommended by the CCITT. However, it may sometimes be advisable to use a VFT system for a speed of 50 bauds in which the channels have wider spacing than in systems complying with Recommendations R.31 and R.35,

(b) that the use of channels with a spacing of more than 120 Hz for a modulation rate of 50 bauds offers certain advantages in the following cases:

i) on links with not much traffic (which it is not intended to increase to more than 12 channels for a long time to come);

ii) on links where channels are required to have less distortion than on channels established in accordance with Recommendations R.31 and R.35;

iii) as far as maintenance is concerned, wideband equipment requires less attention,

(c) that in particular, if telephone-type circuits carrying VFT systems are unstable, the use of wideband channels together with frequency modulation is recommended,

(d) Moreover that, if systems are standardized so that only one modulation method is used, the cost of equipment should be lower.

unanimously declares the view

that when Administrations agree to set up a 50-baud VFT system with spacing of more than 120 Hz, the VFT equipment should have the following characteristics:

1) VFT systems for wideband 50-baud channels should be homogeneous systems using frequency modulation only;

2) equipment in conformity with Recommendation R.37 is recommended for this purpose.

REPORT ON VOICE-FREQUENCY TELEGRAPH CHANNELS FOR USE ABOVE 50 BAUDS

(Common introductory report on Recommendations R.36, R.37, R.38 A and R.38 B)
(Geneva, 1964; amended at Mar del Plata, 1968, and Geneva, 1980)

1 The CCITT has examined the characteristics of telegraph circuits for use above 50 bauds. It has been noted that modulation rates of 75, 100, 150, 200 and 300 bauds are envisaged. The CCITT considers that the number of different types of VFT channels to be provided should not fully correspond to such a detailed list, for two basic reasons:

a) With the exception of 300 bauds, a particular rate circuit can be provided over a higher rate channel. In some cases a lower rate channel might also be considered, this being the situation where a 300-baud circuit may sometimes be supported on a nominally 200-baud channel.

b) The lease charges envisaged are generally such that a marginal tariff difference may exist between circuits operated at the next higher rate.

2 The CCITT has therefore established VFT standards for nominal 100- and 200-baud channels in addition to the earlier standards for channels for operation at nominally 50 bauds.

Note – The performance of a circuit operated at a modulation rate of 75 bauds via one VFT channel conforming to Recommendation R.35 should be quite satisfactory. Similarly, the performance of a circuit operated at a modulation rate of 300 bauds via one VFT channel conforming to Recommendation R.38 A may be satisfactory. However when a circuit consists of two or more channels in tandem, the use of a regenerative repeater may be required. To judge this, it is advisable to conduct distortion measurements on the end-to-end circuit concerned and also on the individual VFT channels employed. In general, it is recommended that circuits operated at a particular modulation rate should not be routed over nominally lower rate VFT channels, whenever this can be avoided.

3 Very different possibilities for using these channels may be envisaged:

- start-stop transmission or synchronous transmission;
- tandem operation of several channels;
- use of point-to-point circuits, circuits with broadcast or switched circuits;
- integration into the world network;
- data transmission.

4 Signal regeneration devices do not normally form an integral part of a VFT channel, as their presence reduces the flexibility to assign a channel for a different use.

5 With regard to channels for 200 bauds, it has been agreed that the spacing for such channels should normally be 480 Hz because of the advantages of 480 Hz spacing compared with 360-Hz spacing with regard to distortion and the cost of equipment. But when the advantage of having a greater number of telegraph channels on the same bearer circuit is considered essential by the Administration (e.g. on long submarine cables employing narrow band 3-kHz telephone channeling equipment), the use of 360-Hz spacing between 200-baud telegraph channels may be justified.

6 For the above reasons, Recommendations R.36, R.37, R.38 A and R.38 B have been adopted.

7 Recommendation R.36 applies to heterogeneous systems and Recommendations R.37, R.38 A and R.38 B apply to homogeneous systems.

8 For the homogeneous systems referred to by Recommendations R.37, R.38 A and R.38 B, only frequency modulation is recommended.

Comparative table of values for the degree of tolerable distorsion on telegraph channels with various modulation rates

Reception condition	Inherent isochronous distorsion (%) for different types of VFT channels				
	Recommendation				
	R.35 (50 bauds 120 Hz)	R.35 *bis* (50 bauds 240 Hz)	R.37 (100 bauds 240 Hz)	R.38A (200 bauds 480 Hz)	R.38B (200 bauds 360 Hz)
With the normal reception level	5		5	5	6
In the case of slow level variation of + 8.7 dB to − 17.4 dB with respect to the normal reception level	7		7	7	8
In the presence of interference by a single sinewave frequency equal to either of two characteristic frequencies with a level of 20 dB below the signal level of the test channel	12		12	10	15
With introduction of a frequency drift (Δf Hz) of the signals:					
a) for a drift $\leqslant$ 5 Hz: Equipment without crystal control; Equipment with crystal control but without compensation for frequency drift	$(5 + 2.5\ \Delta f)$		$(5 + 1.3\ \Delta f)$	$(5 + 0.7\ \Delta f)$	$(6 + 1.2\ \Delta f)$
Equipment with crystal control and compensation for frequency drift	7		7		
b) for a drift $\leqslant$ 10 Hz: Equipment with crystal control and compensation for frequency drift	13		10		

Recommendation R.36

COEXISTENCE OF 50-BAUD/120-Hz CHANNELS, 100-BAUD/240-Hz CHANNELS, 200-BAUD/360-Hz OR 480-Hz CHANNELS ON THE SAME VOICE-FREQUENCY TELEGRAPH SYSTEM

(New Delhi, 1960; amended at Geneva, 1964 and 1980)

1 Common views

1.1 Channels with higher modulation rates (100 or 200 bauds) must be capable of being inserted in systems of amplitude-modulated 50-baud/120-Hz channels conforming to Recommendations concerning them respectively as well as in systems of frequency-modulated 50-baud/120-Hz channels (conforming to Recommendation R.35). However, it is preferable that these high-speed channels should, as far as possible, be placed in a frequency-modulated system (conforming to Recommendation R.35). However, 200-baud/360-Hz channels can be set up only on systems established on bearer circuits having a spacing of 3 kHz.

1.2 If there are 50-baud channels on a mixed system, the distortion limits for the 50-baud channels on homogeneous 50-baud channel systems will have to be respected; hence, 100-baud and 200-baud channel equipment will have to be designed to this end. If this is not possible, the power levels on the 100-baud and 200-baud channels will have to be reduced.

1.3 The 100- and 200-baud channels should have performances comparable to those that could be obtained in a homogeneous system, as specified in Recommendations R.37, R.38 A, R.38 B, provided that the condition indicated under § 1.2 above is respected. They should, in particular, satisfy § 13a) of Recommendations R.37, R.38 A, or R.38 B respectively.

1.4 The mean power transmitted to line at a point of zero relative level is normally dependent on the transmission characteristics of the bearer circuit as follows:

a) 50 μW total for FMVFT aggregates carried on circuits complying with the limits specified in Annex A to Recommendation R.35;

b) 135 μW total for other circuits and for AMVFT.

The mean normal power for each channel should not exceed the values specified in Table 1/R.36, for cases a) and b) above.

TABLE 1/R.36

VFT channel power levels

VFT channel power level (μW)		Relevant Recommendation	VFT channel characteristics		
Bearer case a)	Bearer case b)		Modulation rate (bauds)	Bandwidth (Hz)	Type of modulation
—	9	R.31	50	120	AM
2.0	5.6	R.35	50	120	FM
4.0[a]	10.8[a]	R.37	100	240	FM
—	19.2[a]	R.38B	200	360	FM
8.0[a]	21.6[a]	R.38A	200	480	FM

[a] Provided that the condition mentioned under § 1.2 is respected.

2 Combined use of channels with 240-Hz spacing and channels with 120-Hz spacing

2.1 Channels with 240-Hz spacing should be installed in the following preferred order: 12 (if possible), 11, 10, 9, 8, 7, . . . The channel numbers[1)] are in accordance with Recommendation R.37 (100-baud channels with 240-Hz spacing).

3 Combined use of 200-baud channels with 360-Hz spacing and channels with 120-Hz or 240-Hz spacing

3.1 The characteristics of these channels with high modulation rates are defined in Recommendations R.37 on 100-baud channels with 240-Hz spacing and R.38 B on 200-baud channels with 360-Hz spacing.

3.2 The 200-baud/360-Hz channels should be installed in the following preferred order: 5, 4, 6, 3, 2, 1 instead of the corresponding 50-baud channels. The channel numbers[1)] are in accordance with Recommendation R.38 B.

3.3 In combined systems using channels with three different modulation rates, the order indicated in § 3.2 above should be used in preference to that indicated in § 2.1 above.

4 Combined use of 200-baud channels with 480-Hz spacing and channels with 120-Hz or 240-Hz spacing

4.1 For a combination of channels with 240-Hz spacing and channels with 480-Hz spacing, the channels with 480-Hz spacing should be installed in the following preferential order: 4, 3, 5, 2, 6[1)].

4.2 For a combination of channels with 120-Hz spacing and channels with 480-Hz spacing, the order indicated in § 4.1 above is applicable.

Note – In cooperation with a system using 6-channel group modulation, the preferred order would be: 4, 3, 6 (if possible), 1[1)].

4.3 In combined systems using channels with three different modulation rates, the order indicated in § 4.1 above should be used in preference to that indicated in § 2.1 above.

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1) For the numbering of channels that has been adopted in the international services see Recommendation R.70 *bis*.

STANDARDIZATION OF FMVFT SYSTEMS FOR A MODULATION RATE OF 100 BAUDS

(Geneva, 1964; amended at Mar del Plata, 1968, Geneva, 1972, 1976, 1980 and Malaga-Torremolinos, 1984)

Note – In this Recommendation frequency-modulated voice-frequency telegraph (FMVFT) equipment with and without crystal control are distinguished. In order to improve the quality of transmission and to minimize maintenance costs, the application of equipment with crystal control is recommended.

1 The nominal modulation rate is standardized at 100 bauds.

2 The nominal mean frequencies are 480 + (n – 1) 240 Hz, n being the channel position number. The mean frequency is defined as half the sum of the characteristic frequencies corresponding to the start polarity and stop polarity. For the numbering of channels that has been adopted in the international service see Recommendation R.70 *bis*.

3 The mean frequencies at the sending end should not deviate from their nominal value by more than:

a) for equipment without crystal control 3 Hz;

b) for equipment with crystal control 0.5 Hz[1].

4 The difference between the two characteristic frequencies in the same channel is fixed at 120 Hz.

5 The maximum tolerance on this difference should be ± 4 Hz.

6 The unbalance due to the modulation process $\delta = 2 \dfrac{|F'_0 - F_l|}{F'_A - F'_Z}$, should not exceed 2%,

where

F'_A and F'_Z are the two characteristic frequencies measured over a period of 10 s;

F'_0 is the mean static frequency measured $\dfrac{F'_A + F'_Z}{2}$;

F_l is the mean dynamic frequency measured with 1:1 rectangular signals during 10 s.

Measurement should be made applying to the input of the transmitter 1:1 rectangular signals with the build-up and hangover time below 1 µs and with the unbalance below 0.1%. In the event that in service the transmitter is controlled by an electro-mechanical relay (with a certain transit time), the measurement should also be made with that type of relay inserted between the 1:1 signal generator and the input to the transmitter. Both forms of measurement need not necessarily be included in the maintenance procedure but should be included in laboratory type tests.

Note – To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F'_A, F'_Z and F_l and to calculate the mean frequency F'_0 and the unbalance

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z}$$

[1] The tightening of this tolerance is for further study.

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

- the mean dynamic frequency F_l with 1:1 signals during 10 s;
- the mean dynamic frequency F_m with 2:2 signals during 10 s;

$$\delta = 2\,\frac{|F'_0 - F_l|}{F'_A - F'_Z} = 4\,\frac{|F'_0 - F_m|}{F'_A - F'_Z}$$

or to subtract:

$$|F_l - F_m| = \frac{1}{4}\,(F'_A - F'_Z)\,\delta \approx \frac{1}{4}\,(F_A - F_Z)\,\delta \leqslant 0.9\ \text{Hz}.$$

The absolute value of the difference between the two frequencies measured, F_l and F_m, must be less than 0.9 Hz.

7 The total average power transmitted to the telephone-type circuit is normally dependent on the transmission characteristics of the circuit as follows:

a) For circuits with characteristics not exceeding the limits (nominal values) given in Annex A to Recommendation R.35, the mean power per channel at a point of relative zero level should not be more than 4.0 μW (−24.0 dBm0). The pilot channel, where employed, should have a level of not more than 2.0 μW (−27.0 dBm0);

b) for other circuits, the mean power per channel at a point of relative zero level should not bé more than 10.8 μW (−19.7 dBm0). The pilot channel, where employed, should have a level of not more than 5.4 μW (−22.7 dBm0).

8 In service, the levels of signals corresponding to continuous condition Z and continuous condition A should not differ by more than 1.7 dB in the same channel. Both of these levels must lie between ± 1.7 dB with reference to the level in § 7 above.

9 The frequency for the transmitted condition corresponding to the condition A is the higher of the two characteristic frequencies and that corresponding to the condition Z is the lower.

10 In the absence of a channel-modulator control telegraph current, a frequency shall be transmitted that shall be within ± 10 Hz of the frequency normally transmitted for the condition A. It is not necessary for this transmission to take place immediately after the control current has been cut.

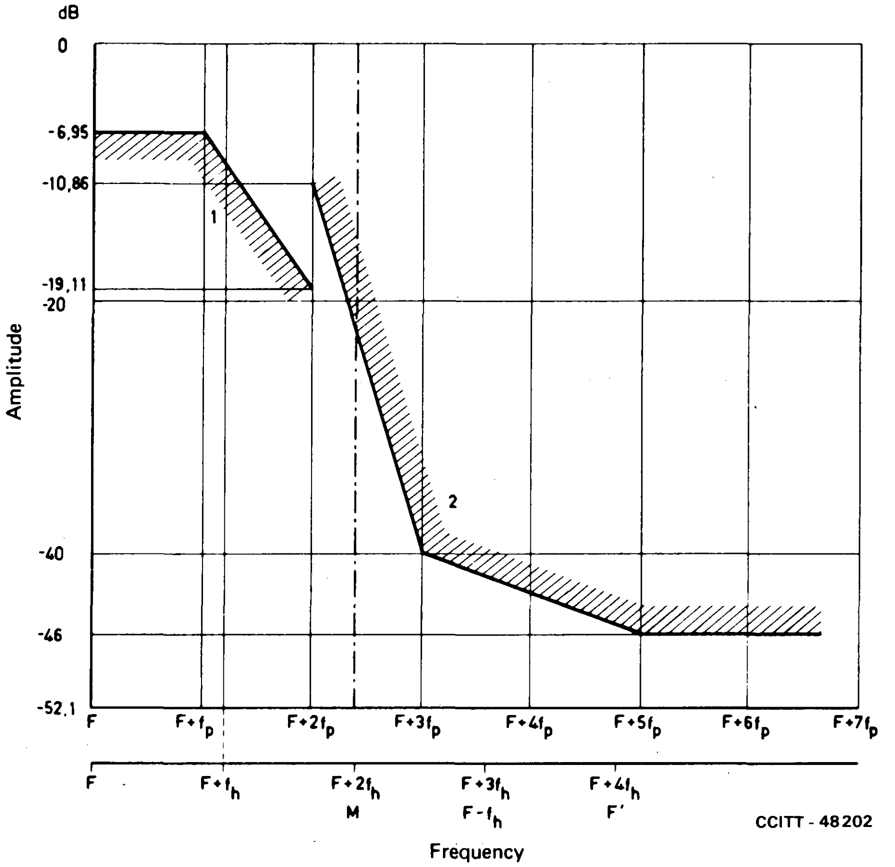
11 The frequency spectrum of the emitted signal, when transmitting 1:1 signals (periodical signals in which every significant interval is equal to the unit interval) at the modulation rate of $2f_p$ (f_p = frequency of modulation), should be in accordance with the limits specified in Figure 1/R.37, which shows the levels of the spectra of different components with respect to the amplitude of the non-modulated carrier as ordinates and the frequencies as abscissae.

12 The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to condition A when the receiving level has fallen to 23.5 dB below the nominal level. The alarm-control level is left to the choice of each Administration.

13 On delivery by the manufacturer of 100-baud FMVFT equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel. These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken in accordance with Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within:

1) for equipment without crystal control ± 3 Hz;
2) for equipment with crystal control ± 0.1 Hz[1],

[1] The tightening of this tolerance is for further study.



F = carrier frequency of a channel
f_p = frequency of modulation = 100 Hz
f_h = frequency shift = 120 Hz

M = centre line between adjacent channels
F' = carrier frequency of the adjacent channel

Curve 1 = lower limit in the pass band
Curve 2 = upper limit in the stop band

Note – The reference level (0 dB) is the mean value of the levels of the signals corresponding to continuous condition Z and continuous condition A polarity, which are measured at the characteristic frequencies F_Z and F_A.

FIGURE 1/R.37

Frequency spectrum for 1:1 signals in 100-baud/240-Hz and 200-baud/480-Hz frequency-modulated voice-frequency telegraph (FMVFT) systems

of their nominal value (see § 3 above) and the difference between the two characteristic frequencies is within the permitted tolerance of less than 4 Hz (see § 5 above). Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of interchannel interference is to be included in the measurement. These "unrelated signals" can conveniently be 1:1 signals from different generators at approximately 100 bauds but not synchronous to each other or to the signal on the channel under test.

a) The transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 5% for the degree of inherent isochronous distortion.

b) The level being maintained constant, but at a value different from the normal level, for all constant levels between 8.7 dB above the normal reception level and 17.4 dB below the normal reception level, the other conditions being the original measurement conditions: 7% for the degree of inherent isochronous distortion.

c) In the presence of interference by a single sine-wave frequency equal first to one and then to the other characteristic frequency, with a level of 20 dB below the signal level, the other conditions for the start of measurements being maintained: 12% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone).

d) By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf being not more than 5 Hz and the initial condition of the test otherwise being preserved:

– for equipment without crystal control – for equipment with crystal control but without compensation for frequency drift	(5 + 1.3 Δf Hz) %
– for equipment with crystal control and compensation for frequency drift	7%

for the degree of inherent isochronous distortion.

By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf being not more than 10 Hz, and the initial conditions of the test otherwise being preserved:

– for equipment with crystal control and compensation for frequency drift	10%

for the degree of inherent isochronous distortion. The measurements shall be made after the transient effects of changing frequency have ceased.

e) Equipment with crystal control, with any climatic conditions specified for the tested equipment, the initial condition of the test otherwise being preserved: 8% for the degree of inherent isochronous distortion. The bias distortion caused by changes of climatic conditions should not be eliminated.

14 Frequency drifts on modern telephone-type circuits are generally less than 2 Hz. Hence it is not necessary to recommend frequency drift control. For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranteed, and on which the distortion resulting from the frequency drift is not acceptable, compensation seems necessary. Two methods can be used:

a) compensation for each channel up to about 15 Hz;

b) compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. The frequencies 3300 Hz or, preferably, 300 Hz are recommended for this pilot, with a tolerance of:

   1) for equipment without crystal control ± 1 Hz

   2) for equipment with crystal control ± 0.2 Hz.

   The mean power emitted at the relative zero point on this frequency should not exceed −27.0 dBm0 or −22.7 dBm0 as appropriate (see § 7 and Tables 1/R.35 and 2/R.35 in Recommendation R.35, which are also applicable to equipment to this Recommendation).

15 The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the Administrations concerned.

Recommendation R.38 A

STANDARDIZATION OF FMVFT SYSTEM FOR A MODULATION RATE OF 200 BAUDS WITH CHANNELS SPACED AT 480 Hz

(Geneva, 1964; amended at Mar del Plata, 1968, Geneva, 1972, 1976, 1980 and Malaga-Torremolinos, 1984)

Note 1 – This is the standardized system for operation at 200 bauds.

Note 2 – In this Recommendation frequency-modulated voice-frequency telegraph (FMVFT) equipment with and without crystal control are distinguished. In order to improve the quality of transmission and to minimize maintenance costs, the application of equipment with crystal control is recommended.

1 The nominal modulation rate is fixed at 200 bauds.

2 The nominal mean frequencies are $600 + (n - 1)\ 480$ Hz, n being the channel position number. The mean frequency is defined as half the sum of the characteristic frequencies corresponding to conditions A and Z. For the numbering of channels that has been adopted in the international service see Recommendation R.70 *bis*.

3 The mean frequencies at the sending end should not deviate from their nominal value by more than:

a) for equipment without crystal control 4 Hz;

b) for equipment with crystal control 0.8 Hz [1)].

4 The difference between the two characteristic frequencies in the same channel is fixed at 240 Hz.

5 The maximum tolerance on this difference should be ± 6 Hz.

6 The unbalance due to the modulation process $\delta = 2 \dfrac{|F'_0 - F_l|}{F'_A - F'_Z}$ should not exceed 2%,

where

F'_A and F'_Z are the two characteristic frequencies measured over a period of 10 s;

F'_0 is the mean static frequency measured $\dfrac{F'_A + F'_Z}{2}$;

F_l is the mean dynamic frequency measured with 1:1 rectangular signals during 10 signals.

Measurement should be made applying to the input of the transmitter 1:1 rectangular signals with the build-up and hangover time below 1 μs and with the unbalance below 0.1%. In the event that in service the transmitter is controlled by an electro-mechanical relay (with a certain transit time), the measurement should also be made with that type of relay inserted between the 1:1 signal generator and the input to the transmitter. Both forms of measurements need not necessarily be included in the maintenance procedure but should be included in laboratory type tests.

Note – To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F'_A, F'_Z and F_l and to calculate the mean frequency F'_0 and the unbalance

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z}$$

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

– the mean dynamic frequency F_l with 1:1 signals during 10 s;

– the mean dynamic frequency F_m with 2:2 signals during 10 s;

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z} = 4 \frac{|F'_0 - F_m|}{F'_A - F'_Z}$$

or to subtract:

$$|F_l - F_m| = \frac{1}{4} (F'_A - F'_Z)\,\delta \approx \frac{1}{4} (F_A - F_Z)\,\delta \leqslant 1.8 \text{ Hz.}$$

The absolute value of the difference between the two frequencies measured, F_l and F_m, must be less than 1.8 Hz.

7 The total average power transmitted to the telephone-type circuit is normally dependent on the transmission characteristics of the circuit as follows:

a) For circuits with characteristics not exceeding the limits given in Annex A to Recommendation R.35, the mean power per channel at a point of relative zero level should not be more than 8.0 μW (−21.0 dBm0). The pilot channel, where employed, should have a level of not more than 2.0 μW (−27.0 dBm0).

1) The tightening of this tolerance is for further study.

b) For other circuits, the mean power per channel at a point of relative zero level should not be more than 21.6 µW (−16.7 dBm0). The pilot channel, where employed, should have a level of not more than 5.4 µW (−22.7 dBm0).

8 In service, the levels of the signals corresponding to continuous condition Z and continuous condition A should not differ by more than 1.7 dB in the same channel. Both of these levels must lie between ± 1.7 dB with reference to the level in § 7 above.

9 The condition A frequency is the higher of the two characteristic frequencies, and the condition Z frequency is the lower one (see Recommendation V.1 [1]).

10 In the absence of a channel-modulator control telegraph current, a frequency shall be transmitted that shall be within ± 20 Hz of the frequency normally transmitted for the condition A. It is not necessary for this transmission to take place immediately after the control current has been cut.

11 The frequency spectrum of the emitted signal, when transmitting 1:1 signals at the modulation rate of $2 f_p$ (f_p = frequency of modulation) should be in accordance with the limits specified in Figure 1/R.37, which shows the levels of the spectra of different components with respect to the amplitude of the non-modulated carrier as ordinates and the frequencies as abscissae.

12 The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to condition A when the receiving level has fallen to 23.5 dB below the nominal level. The alarm-control level is left to the choice of each Administration.

13 On delivery by the manufacturer of 200-baud/480-Hz frequency-modulated voice-frequency telegraph (FMVFT) equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel. These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken in accordance with Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within:

1) for equipment without crystal control ± 4 Hz;
2) for equipment with crystal control ± 0.8 Hz,

of their nominal value (see § 3 above) and the difference between the two characteristic frequencies is within the permitted tolerance of less than 6 Hz (see § 5 above). Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of interchannel interference is to be included in the measurement. These "unrelated signals" can conveniently be 1:1 signals from different generators at approximately 200 bauds but not synchronous to each other or to the signal on the channel under test.

a) The transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 5% for the degree of inherent isochronous distortion.

b) The level being maintained constant, but at a value different from the normal level, for all constant levels between 8.7 dB above the normal reception level and 17.4 dB below the normal reception level, the other conditions being the original measurement conditions: 7% for the degree of inherent isochronous distortion.

c) In the presence of interference by a single sine-wave frequency equal first to one and then to the other characteristic frequency, with a level of 20 dB below the signal level, the other conditions for the start of measurements being maintained: 10% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone).

d) By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf in Hz being not more than 10, and the initial conditions of the test otherwise being preserved: ($5 + 0.7\ \Delta f$ Hz)% for the degree of inherent isochronous distortion; the measurements shall be made after the transient effects of changing frequency have ceased.

e) Equipment with crystal control, with any climatic conditions specified for the tested equipment, the initial condition of the test otherwise being preserved: 8% for the degree of inherent isochronous distortion. The bias distortion caused by changes of climatic conditions should not be eliminated.

14 Frequency drifts on modern telephone-type circuits are generally less than 2 Hz. Hence it is not necessary to recommend frequency drift control. For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranteed, and on which the distortion resulting from the frequency drift is not acceptable, compensation seems necessary. Two methods can be used:

a) compensation for each channel up to about 15 Hz;

b) compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. The frequencies 3300 Hz or, preferably, 300 Hz are recommended for this pilot, with a tolerance of:

1) for equipment without crystal control ± 1 Hz

2) for equipment with crystal control ± 0.2 Hz.

The mean power emitted at the relative zero point on this frequency should not exceed −27.0 dBm0 or −22.7 dBm0 as appropriate (see § 7 and Tables 1/R.35 and 2/R.35 in Recommendation R.35, which are also applicable to equipment to this Recommendation).

15 The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the Administrations concerned.

Reference

[1] CCITT Recommendation *Equivalence between binary notation symbols and* the significant conditions of a two-condition code, Rec. V.1.

Recommendation R.38 B

STANDARDIZATION OF FMVFT SYSTEMS FOR A MODULATION RATE OF 200 BAUDS WITH CHANNELS SPACED AT 360 Hz USABLE ON LONG INTERCONTINENTAL BEARER CIRCUITS GENERALLY USED WITH A 3-kHz SPACING

(Geneva, 1964; amended at Geneva, 1972, 1976, 1980 and Malaga-Torremolinos, 1984)

1 Frequency-modulated voice-frequency telegraph (FMVFT) systems, with a spacing of 360 Hz between the mean frequencies, can accommodate seven channels. In the case of telephone bearer channels with 4-kHz spacing, channel position 8 can be used.

2 The nominal modulation rate is fixed at 200 bauds.

3 The nominal mean frequencies are 540 + (n − 1) 360 Hz, n being the channel position number. The mean frequency is defined as half the sum of the characteristic frequencies corresponding to the conditions A and Z. For the numbering of channels that has been adopted in the international service see Recommendation R.70 *bis.*

4 The mean frequencies at the sending end must not deviate by more than ± 3 Hz from their nominal value.

5 The difference between the two characteristic frequencies in the same channel is fixed at 180 Hz.

6 The maximum tolerance on this difference should be ± 4 Hz.

7 The unbalance due to the modulation process $\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z}$ should not exceed 2%,

where

F'_A and F'_Z are the two characteristic frequencies measured over a period of 10 s;

F'_0 is the mean static frequency measured $\frac{F'_A + F'_Z}{2}$;

F_l is the mean dynamic frequency measured with 1:1 rectangular signals during 10 s.

Measurements should be made applying to the input of the transmitter 1:1 rectangular signals with the build-up and hangover time below 1 µs and with the unbalance below 0.1%. In the event that in service the transmitter is controlled by an electro-mechanical relay (with a certain transit time), the measurement should also be made with that type of relay inserted between the 1:1 signal generator and the input to the transmitter. Both forms of measurements need not necessarily be included in the maintenance procedure but should be included in laboratory type tests.

Note – To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F'_A, F'_Z and F_l and to calculate the mean frequency F'_0 and the unbalance

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z}.$$

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

- the mean dynamic frequency F_l with 1:1 signals during 10 s;
- the mean dynamic frequency F_m with 2:2 signals during 10 s;

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z} = 4 \frac{|F'_0 - F_m|}{F'_A - F'_Z}$$

or to subtract:

$$|F_l - F_m| = \frac{1}{4} (F'_A - F'_Z)\, \delta \approx \frac{1}{4} (F_A - F_Z)\, \delta \leqslant 1.3 \text{ Hz}.$$

The absolute value of the difference between the two frequencies measured, F_l and F_m, must be less than 1.3 Hz.

8 The mean power per channel at relative zero level should not be more than 19.2 microwatts.

9 In service, the levels of the signals corresponding to continuous condition Z and continuous condition A should not differ by more than 1.7 dB in the same channel. Both of these levels must lie between ± 1.7 dB with reference to the level in § 8 above.

10 The condition A frequency is the higher of the two characteristic frequencies, and the condition Z is the lower one (see Recommendation V.1 [1]).

11 In the absence of a channel-modulator control telegraph current, a frequency shall be transmitted that shall be within ± 10 Hz of the frequency normally transmitted for the condition A. It is not necessary for this transmission to take place immediately after the control current has been cut.

12 The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to condition A when the receiving level has fallen to 23.5 dB below the nominal level. The alarm-control level is left to the choice of each Administration.

13 On delivery by the manufacturer of 200-baud/360-Hz FMVFT equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel. These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken in accordance with Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within ± 3 Hz of their nominal value (see § 4 above) and the difference between the two characteristic frequencies is within the permitted tolerance of less than 4 Hz (see § 6 above). Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of interchannel interference is to be included in the measurement. These "unrelated signals" can conveniently be 1:1 signals from different generators at approximately 200 bauds but not synchronous to each other or to the signal on the channel under test.

a) The transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 6% for the degree of inherent isochronous distortion.

b) The level being maintained constant, but at a value different from the normal level, for all constant levels between 8.7 dB above the normal reception level and 17.4 dB below the normal reception level, the other conditions being the original measurement conditions: 8% for the degree of inherent isochronous distortion.

c) In the presence of interference by a single sine-wave frequency equal first to one and then to the other characteristic frequency, with a level of 20 dB below the signal level, the other conditions for the start of measurements being maintained: 15% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone).

d) By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf being not more than 10; and the initial conditions of the test otherwise being preserved: $(6 + 1.2\ \Delta f\ \text{Hz})\%$ for the degree of inherent isochronous distortion; the measurements shall be made after the transient effects of changing frequency have ceased.

14 Frequency drifts on modern telephone-type circuits are generally less than 2 Hz. Hence, it is not necessary to recommend frequency drift control. For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranteed, and on which the distortion resulting from the frequency drift is not acceptable, compensation seems necessary. Two methods can be used:

– compensation for each channel up to about 15 Hz;

– compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. The frequency 300 Hz is recommended, with a tolerance of ± 1 Hz. The mean power emitted at the relative zero point on this frequency should not exceed that recommended for a telegraph channel in the case of a 24-channel group, i.e. −22.5 dBm0.

15 The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the Administrations concerned.

Reference

[1] CCITT Recommendation *Equivalence between binary notation symbols and the significant conditions of a two-condition code*, Vol. VIII, Fascicle VIII.1, Rec. V.1.

VOICE-FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(former CCIT Recommendation B.49, Geneva, 1956; amended at Geneva, 1964, Mar del Plata, 1968 and Geneva, 1976)

It is necessary to distinguish between the case in which the radio frequency used is below approximately 30 MHz, and the case in which the radio frequency used is greater than approximately 30 MHz.

1 Radio circuits the frequency of which is below approximately 30 MHz

1.1 In the case of radio circuits whose frequency is less than approximately 30 MHz, it appears that the use of amplitude-modulated voice-frequency telegraph systems, as defined by Recommendation R.31, cannot be recommended. In such a case, the nature of the telephone-type circuits available for telegraph operation may vary widely according to the radio system used, and several systems of telegraph transmission are available (e.g. two- or four-tone telegraph systems, frequency modulated systems, etc.).

1.2 However, frequency-shift systems are in use on many routes and the frequency-exchange method of operation is in use on long routes suffering from severe multipath distortion.

1.3 *Synchronous telegraphy operating at approximately 100 bauds* (see CCIR Recommendation 436-2 [1])

Radiotelegraph channels that operate synchronously at a modulation rate of 96 bauds and employ automatic error correction are being increasingly used. The channel arrangement shown in Table 1/R.39 is preferred for voice-frequency multi-channel frequency-shift systems operating at a modulation rate of approximately 100 bauds over HF radio circuits. For frequency-exchange systems, the central frequencies of Table 1/R.39 should be used, and should be paired in the manner found to be best suited to the propagation conditions of the route. (A typical arrangement would take alternate pairs giving 340 Hz between tones.)

TABLE 1/R.39

Central frequencies of voice-frequency frequency-shift telegraph channels with a channel separation of 170 Hz and a modulation index of about 0.8

(Frequency shift: ± 42.5 Hz or ± 40 Hz)

Channel position	Central frequency (Hz)	Channel position	Central frequency (Hz)
1	425	8	1615
2	595	9	1785
3	765	10	1955
4	935	11	2125
5	1105	12	2295
6	1275	13	2465
7	1445	14	2635
		15	2805

1.4 *Start-stop telegraphy at 50 bauds*

For several years, various Administrations have had in service, on certain selected circuits, equipment with a channel spacing of 120 Hz, the central frequencies and frequency deviations of which are in agreement with Recommendation R.35. The central frequencies of these systems are given in Table 2/R.39.

TABLE 2/R.39

Central frequencies of voice-frequency frequency-shift telegraph channels with a channel separation of 120 Hz and a modulation index of about 1.4

(Frequency shift: ± 35 Hz or ± 30 Hz)

Channel position	Central frequency (Hz)	Channel position	Central frequency (Hz)
1	420	11	1620
2	540	12	1740
3	660	13	1860
4	780	14	1980
5	900	15	2100
6	1020	16	2220
7	1140	17	2340
8	1260	18	2460
9	1380	19	2580
10	1500	20	2700

2 Radio circuits whose frequency is greater than approximately 30 MHz

The use of voice-frequency telegraphy on line-of-sight radio-relay links and on trans-horizon radio-relay systems is under study.

Reference

[1] CCIR Recommendation *Arrangement of voice-frequency telegraph channels working at a modulation rate of about 100 bauds over HF radio circuits*, Vol. III, Rec. 436-2, ITU, Geneva, 1978.

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SECTION 3

SPECIAL CASES OF ALTERNATING CURRENT TELEGRAPHY

Recommendation R.40

COEXISTENCE IN THE SAME CABLE OF TELEPHONY AND SUPRA-ACOUSTIC TELEGRAPHY

(former CCIT Recommendation B.17, Brussels, 1948; amended at Geneva, 1951)

The CCITT,

considering

(a) that this process provides only one telegraph channel, in addition to the telephone channel, and that it can be applied only in comparatively few cases (lightly loaded or unloaded circuits, which cannot be used for multi-channel carrier telephony);

(b) that in such cases, the Administrations and private operating agencies concerned could in most cases by common agreement contemplate the possibility of making use of some other more suitable process that would provide, in addition to the audio telephone channel, more than one telegraph channel;

unanimously declares the view

that the use of supra-acoustic telegraphy should not prejudice the quality of transmission over the adjacent telephone channel and that, in particular, it should not limit the band of frequencies necessary for good speech reproduction (300 to 3400 Hz at least).

Recommendation R.43

SIMULTANEOUS COMMUNICATION BY TELEPHONE AND TELEGRAPH ON A TELEPHONE-TYPE CIRCUIT

(former CCIT Recommendation B.50, Geneva, 1956; amended at Geneva, 1964 and 1980)

The CCITT,

considering

(a) that the use of a leased telephone-type circuit for simultaneous communication by telephone and telegraph is envisaged in Recommendations D.1 [1] and H.32 [2];

(b) that the CCITT has indicated conditions under which the simultaneous use of telephone-type circuits for telephony and telegraphy is technically tolerable;

(c) that standardization of the characteristics of equipment permitting simultaneous use of a telephone-type circuit for telephony and telegraphy is not justified, but that it is necessary to limit the power of the signals transmitted and to avoid the use of frequencies that will interfere with any telephone signalling equipment that may remain connected to the telephone-type circuit;

(d) that new demands for the allocation of particular frequencies for special purposes frequently arise and the number of frequencies used for any one purpose should not be unnecessarily extended;

(e) that the systems described below may be useful when the more modern systems advocated in Recommendation H.34 [3] are not feasible;

unanimously declares the view

(1) that in the case of the simultaneous use of a telephone-type circuit for telephony and telegraphy, the resulting maximum permissible 1-minute mean power loading shall not exceed 50 µW0 (i.e. −13 dBm0);

(2) that where frequency division multiplexing is employed, the general principle concerning the allocation of level to each type of service should be that the allowable mean signal power is proportional to the bandwidth assigned. This case is considered in more detail in Recommendation H.34 [3], resulting in the aggregate power of the telegraph signals being set a level not exceeding 10 µW0 (i.e. approximately −20 dBm0);

(3) that there should not be more than three circuits of this type in a frequency-division multiplexed group of 12 telephone-type circuits and that the number of circuits of this type set up on a wideband carrier system should not exceed the number of supergroups in the system;

(4) that the telegraph signals transmitted must not interfere with any signalling equipment that may remain connected to the telephone-type circuit,

and notes

that some Administrations have permitted the use, for simultaneous telephony and telegraphy of the frequencies 1680 Hz and 1860 Hz both for amplitude and for frequency modulation.

Note – If circuits equipped in accordance with the present Recommendation are used in a private network, it will be impossible to use push-button telephone sets or multifrequency signalling (e.g. Signalling System R2) in the network.

References

[1] CCITT Recommendation *General principles for the lease of international (continental and intercontinental) private leased telecommunication circuits*, Rec. D.1.

[2] CCITT Recommendation *Simultaneous communication by telephony and telegraphy on a telephone-type circuit*, Rec. H.32.

[3] CCITT Recommendation *Subdivision of the frequency band of a telephone-type circuit between telegraphy and other services*, Rec. H.34.

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)

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 interleaved element by element 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

$$\left.\begin{array}{l} \text{1A, 2A, 3A, 4A, 5A, 6A} \\ \text{–, 2B, 3B, 4B, 5B, 6B} \\ \text{1C, 2C, 3C, 4C, 5C, 6C} \end{array}\right\} \text{full rate}$$

(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:

A1, B1, A2, B2, etc. for 2-channel operation (where A1 is the first element of channel A etc.);

A1, 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	quarter rate
1B2, 2B2, 3B2, 4B2, 5B2, 6B2.	1C2, 2C2, 3C2, 4C2, 5C2, 6C2	
1B3, 2B3, 3B3, 4B3, 5B3, 6B3.	1C3, 2C3, 3C3, 4C3, 5C3, 6C3	
–, 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	half rate
–, 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	
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 (1B4) 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 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)

Code conversion table

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	Note 2	ZAZZA	AZAZZA
7	G	Note 2	AZAZZ	AAZAZZ
8	H	Note 2	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 α		permanent A polarity	AAAAAA
–	signal β		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.

INTERBAND TELEGRAPHY OVER OPEN-WIRE 3-CHANNEL CARRIER SYSTEMS

(New Delhi, 1960)

The CCITT,

considering

(a) It is considered necessary to introduce, for international traffic, an open-wire carrier system that uses common line repeaters for telephone and interband telegraph channels.

(b) This is important for some Administrations that desire to have a small number of telegraph channels (up to six) without having to use a *standard* voice-frequency telegraph system on one of the telephone circuits, thereby effecting an economy, as all the telephone circuits are retained entirely for telephone traffic.

(c) The arrangement of line frequencies as far as the telephone channels are concerned should be as specified in Recommendation G.361 [1].

unanimously declares the following view:

1 Four interband telegraph channels, for a modulation rate of 50 bauds, can be set up over an open-wire carrier system by the use of line repeaters common to the telephone channels and the telegraph channels provided that the system in question conforms to the Recommendation cited in [2].

2 The nominal frequencies of these four telegraph channels are as follows:

2.1 *Low-frequency direction of transmission:*

3.22 – 3.34 – 3.46 and 3.58 kHz.

2.2 *High-frequency direction of transmission:*

a) telephone channels occupying the frequency band 18 and 30 kHz:
30.42 – 30.54 – 30.66 and 30.78 kHz;

b) telephone channels occupying the frequency band 19 and 31 kHz:
18.22 – 18.34 – 18.46 and 18.58 kHz.

3 When in-band signalling is employed on the telephone channels (as opposed to out-band signallng outside the 4-kHz bandwidth), it becomes possible to provide two additional telegraph channels having the following nominal frequencies:

3.1 *Low-frequency direction of transmission:*

3.70 and 3.82 kHz.

3.2 *High-frequency direction of transmission:*

a) telephone channels occupying the frequency band 18 and 30 kHz:
30.18 and 30.30 kHz;

b) telephone channels occupying the frequency band 19 and 31 kHz:
18.70 and 18.82 kHz.

4 In those cases where, as a result of agreement between the Administrations concerned, the system employs an upper pilot of 17.800 kHz, the following frequencies may be used as alternatives to those specified in § 2.2 b) and § 3.2 b) above. This alternative arrangement permits, in certain types of systems, a more economical modulation process: 31.42 – 31.54 – 31.66 and 31.78 kHz, instead of 18.22 – 18.34 – 18.46 and 18.58 kHz, also 31.18 and 31.30 kHz instead of 18.70 and 18.82 kHz.

5 This Recommendation applies to amplitude-modulated telegraphy and to frequency-modulated telegraphy.

6 It is not considered desirable to standardize absolutely the power transmitted to the line as this may be dependent upon the conditions on the open-wire route. Under favourable conditions a recommendable value for the power on each telegraph channel would be -20 dBm0 (referred to one milliwatt at a point of zero relative level).

7 For amplitude modulation the tolerance on the sent frequency will be ± 6 Hz and for frequency modulation the tolerances given in Recommendation R.35 will apply.

8 In tests made on the local end, equipments should meet the distortion conditions described in § (2) of Recommendation R.50 for amplitude modulation, and those described in § 13 of Recommendation R.35 for frequency modulation.

9 The correspondence between the significant conditions described in § 15 of Recommendation R.31 and § 9 of Recommendation R.35 applies to these channels for interband telegraphy.

References

[1] CCITT Recommendaion *Systems providing three carrier telephone circuits on a pair of open-wire lines,* Rec. G.361.

[2] *Ibid.*, § 2.

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SECTION 4

TRANSMISSION QUALITY

Recommendation R.50

TOLERABLE LIMITS FOR THE DEGREE OF ISOCHRONOUS DISTORTION OF CODE-INDEPENDENT 50-BAUD TELEGRAPH CIRCUITS

(former CCIT Recommendation B.24, Arnhem, 1953; amended at Geneva, 1976 and 1980)

The CCITT,

considering

(a) that, to facilitate the study of plans for the establishment of international telegraph circuits, it is convenient to set limits for the degree of isochronous distortion of the telegraph circuits and channels;

(b) that, for whatever purpose normally used, these circuits should be capable of use with start-stop equipment;

(c) that, in certain cases, limits have been set by Recommendations R.57 and R.58 for the isochronous distortions of the trunk sections of circuits and for that of voice-frequency telegraph channels;

(d) that the limits laid down are those that should be evident in service conditions on telegraph circuits, excluding the local lines and terminal equipment,

unanimously declares the view

(1) that circuits (excluding local lines and terminal equipment) should be established and maintained in such a manner that the degree of isochronous distortion will not exceed 28% whether they are equipped with regenerative repeaters or not;

(2) that the degree of isochronous distortion of each channel that may form part of a circuit should be as small as possible, and should not in any case exceed 10%.

STANDARDIZED TEXT FOR DISTORTION TESTING OF THE CODE-INDEPENDENT ELEMENTS OF A COMPLETE CIRCUIT

(former CCIT Recommendation B.32, Warsaw, 1936; amended at Geneva, 1956, 1980 and Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that, for a precise definition of the degree of distortion in service permitting the comparison of results of measurements obtained under similar conditions in different places, it is advisable to standardize the wording of the text that should be transmitted for the test;

(b) that it is best to choose a text that can be received directly by start-stop equipment and that also presents a sequence of the combinations recognized as those that generally cause the maximum distortion,

unanimously declares the view

(1) that the text to transmit in the course of measurements of the degree of distortion in service should be as shown in Figure 1/R.51;

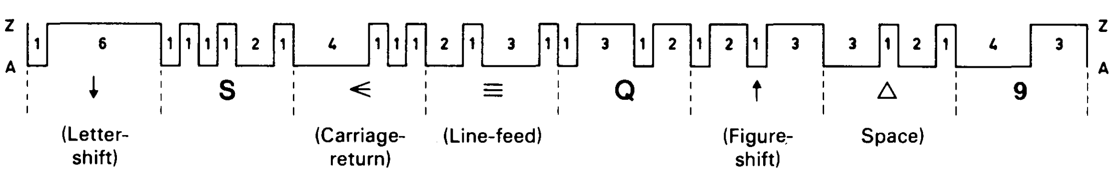


FIGURE 1/R.51

CCITT - 48211

this text corresponds to the following sequence of signals emitted by start-stop equipment:

letter-shift **S** carriage-return line-feed **Q** figure-shift space **9**,

and considering, on the other hand,

(c) that, in maintenance adjustments and in the various distortion measurements that may arise in the study of lines and equipment, it would be necessary to make use of a single apparatus offering the possibility of transmitting the different combinations of signals recognized as the most practical for this purpose;

(d) that the unification of the list of these combinations would permit comparison of results obtained in various places,

unanimously declares the view

(2) that it is appropriate to recommend the construction of special transmitters for distortion measurements, which could transmit:

i) the text specified in Figure 1/R.51 for measuring the degree of distortion,

ii) a periodical sequence of significant intervals, each of which has a duration of one unit interval,

iii) a periodical sequence of significant intervals, each of which has a duration of two unit intervals,

iv) a periodical sequence of significant intervals; a period consists of two significant intervals: an interval of condition Z whose duration is equal to one unit interval and an interval of condition A whose duration is equal to six unit intervals,

v) a periodical sequence of significant intervals; a period consists of two significant intervals: an interval of condition A whose duration is equal to one unit interval and an interval of condition Z whose duration is equal to six unit intervals;

(3) that for all new test equipment, the text specified in Recommendation R.51 *bis* (**QKS**) is preferred. In the interim, either text may be used for tests on code-indepedent systems. For tests on routes where code-dependent systems may be included, a text having characters with a mean length of at least 7.4 units must be used.

Recommendation R.51 *bis*

STANDARDIZED TEXT FOR TESTING THE ELEMENTS OF A COMPLETE CIRCUIT

(Geneva, 1980 and Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that, for testing telegraph transmission equipment it is advisable to standardize the wording of the text that should be transmitted for the test;

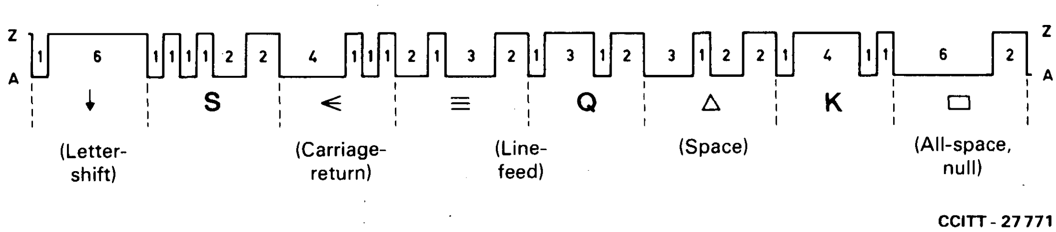
(b) that the text should form a short repetitive test message suitable for conducting routine tests on circuits that include code-dependent channels (International Telegraph Alphabet No. 2) and/or code-independent channels;

(c) that it is best to choose a text that can be received directly by start-stop equipment and that also presents a sequence of the combinations recognized as those that generally cause the maximum distortion;

(d) that the text should contain an equal number of unit elements of each binary condition and that it should be suitable for start-stop or isochronous measurement of distortion when used with code-independent transmission equipment,

unanimously declares the view

(1) that the text to transmit in the course of tests on telegraph transmission equipment should be as shown in Figure 1/R.51 *bis*;



Note – The stop element length alternates between 1 unit interval and 2 unit intervals on successive characters.

FIGURE 1/R.51 *bis*

QKS test message

(2) that when equipment capable of generating the foregoing text is not available, it is acceptable to use the text given in Recommendation R.51 for testing code-independent systems only.

Note – Test equipment capable of generating the text in Figure 1/R.51 *bis* should also be capable of generating 1:1, 2:2, 1:6 and 6:1 patterns for testing code-independent systems only (see § 2 in Recommendation R.51).

Recommendation R.52

STANDARDIZATION OF INTERNATIONAL TEXTS FOR THE MEASUREMENT OF THE MARGIN OF START-STOP EQUIPMENT

(former CCIT Recommendation B.33, Brussels, 1948; amended at Geneva, 1964 and 1980)

The CCITT,

considering

(a) that to test the effective margin of the receiver of a start-stop teleprinter it is desirable to standardize the content of the transmitted sequence of signals;

(b) that there is advantage in choosing a short text that can be directly printed within a single line by start-stop terminal equipments;

(c) that preferably the composition of the text used should include all alpha characters of the basic alphabet employed and be arranged in a format that is easy to read and to understand;

(d) that comparison of the margin measurements obtained would be facilitated by such arrangements,

unanimously declares the view

(1) that it is not necessary to standardize an international text for the measurement of the margin of a teleprinter;

(2) that, nevertheless, where teleprinters are required to receive information in languages based on the Latin alphabet, either of the following texts may be used:

VOYEZ LE BRICK GEANT QUE J'EXAMINE PRES DU WHARF

THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG

Recommendation R.53

PERMISSIBLE LIMITS FOR THE DEGREE OF DISTORTION ON AN INTERNATIONAL 50-BAUD/120-Hz VFT CHANNEL (FREQUENCY AND AMPLITUDE MODULATION)

(former CCIT Recommendation B.36, 1951; amended at Arnhem, 1953, Geneva, 1964, Mar del Plata, 1968 and Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that the numerous tests made on voice-frequency telegraph (VFT) equipment in service now make it possible to establish limits for the degree of distortion outside which a VFT channel must be regarded as being out of order;

(b) that these tests should be made with reversals and with standard text at the modulation rate used for adjustment;

(c) that, when equipment is put into service and when it is adjusted, the minimum distortion should be sought and therefore limits for the degree of distortion need not be established in this case,

unanimously declares the view

(1) that the degree of bias distortion of reversals (a sequence of equal length significant intervals each being equal to the unit interval) on an international VFT channel at the modulation rate employed for adjustment should not exceed a value corresponding to 4% at the standard modulation rate of 50 bauds;

(2) that the degree of isochronous distortion in service of an international VFT channel on the standardized text should not exceed 10%, and that the degree of inherent start-stop distortion, in service conditions, on standardized text, should not exceed 8%.

Note – These limits, except where otherwise stated, apply to a modulation rate of 50 bauds and take account of the accuracy of the measuring equipment. They are provisional and may be amended according to the technical development of voice-frequency telegraphy and of studies of telegraph distortion.

Recommendation R.54

CONVENTIONAL DEGREE OF DISTORTION TOLERABLE FOR STANDARDIZED START-STOP 50-BAUD SYSTEMS

(former CCIT Recommendation B.51, Geneva, 1956; amended at Geneva, 1964, and at Mar del Plata, 1968)

The CCITT,

considering

(a) that in telegraph communications used in the public telegram service, in the telex service and for leased circuits, over land lines and submarine cables, using 5-unit start-stop equipment at the modulation rate of 50-bauds, a maximum admissible rate of error of 3 per 100 000 alphabetic telegraph signals transmitted is recommended by Recommendation F.10 [1];

(b) that at present, interruptions of the telephone-type circuit account for a much higher error rate than that recommended by the CCITT;

(c) that to fix the objectives to be reached to curb interruptions and noise in telephone-type bearer circuits, it is of interest to indicate how this tolerable error rate of 3 per 100 000 telegraph signals can be distributed among the telegraph equipment and the circuits bearing the telegraph systems;

(d) that telegraph apparatus, particularly the transmitter and the receiver, is itself liable to fortuitous failures and it is difficult to distinguish between errors due to these causes and errors due to the probability that the degree of telegraph distortion can exceed the receiver margin, which cannot be ignored;

(e) but in planning telegraph circuits, it may be convenient to limit the conventional degree of gross start-stop distortion of complete circuits (including telegraph transmitting apparatus) to the nominal margin of the receiving apparatus;

(f) that moreover, if the individual degree to distortion at apparatus input exceeds the margin by about once in 100 000, the measurements show that the combined effect of telegraph distortion and fortuitous apparatus failures is manifested by an error rate of about 2 per 100 000 telegraph signals.

Note – The result is that the error rate due to interruptions and noise on telephone-type circuits carrying telegraph systems should not exceed 1 per 100 000.

unanimously declares the view

(1) that the conventional degree of distortion should be the individual degree of distortion whose probability of being exceeded is 1 in 100 000;

(2) that theoretical and planning studies should be carried out in such a way that the conventional degree of distortion at the receiver input is not more than the nominal margin.

Note 1 – The notion of conventional degree of distortion is useful above all for theoretical studies and planning.

Note 2 – For the relation between conventional degree of distortion and practical measurements, reference should be made to [2], [3] and [4].

References

[1] CCITT Recommendation *Character error rate objective for telegraph communication using 5-unit start-stop equipment,* Rec. F.10.

[2] *Conventional degree of distortion,* Blue Book, Vol. VII, Supplement No. 4, ITU, Geneva, 1964.

[3] *Relation between the results of routine measurements of distortion and the conventionl degree of distortion,* Blue Book, Vol. VII, Supplement No. 5, ITU, Geneva, 1964.

[4] CCITT – Question 7/IX, Annex, Blue Book, Vol. VII, ITU, Geneva, 1964.

Recommendation R.55

CONVENTIONAL DEGREE OF DISTORTION

(Geneva, 1964)

The CCITT,

considering

(a) that the conventional degree of distortion is (Definition 33.14, Recommendation R.140) the degree of distortion the probability of exceeding which, during a prolonged observation, equals a very small assigned value.

Note – The assigned value should be specified for each case of utilization.

(b) that for standardized start-stop 50-baud systems, the assigned value is 1 per 100 000 (Recommendation R.54);

(c) that to facilitate the use of the conventional degree of distortion and the comparison of studies and plans that have been established with the aid of the conventional degree, it is useful for the probability of being exceeded assigned to the conventional degree to be the same for all telegraph systems (including data transmissions), unless another probability of being exceeded has been assigned to the conventional degree of distortion for special studies.

unanimously declares the view

(1) that, unless otherwise specified by the Administrations and recognized private operating agencies concerned, the conventional degree of distortion is the degree of distortion whose probability of being exceeded is 1 in 100 000;

(2) that the conventional degree of distortion applies to individual distortion.

Recommendation R.57

STANDARD LIMITS OF TRANSMISSION QUALITY FOR PLANNING CODE-INDEPENDENT INTERNATIONAL POINT-TO-POINT TELEGRAPH COMMUNICATIONS AND SWITCHED NETWORKS USING 50-BAUD START-STOP EQUIPMENT

(former CCIT Recommendation B.25, 1951; amended at Arnhem, 1953, and New Delhi, 1960; see also Recommendation R.58)

The CCITT,

considering

(a) that Administrations must agree on the composition of the international section and the national sections before setting up an international point-to-point telegraph circuit;

(b) that for the interconnection of switched public or private national networks a plan for distributing telegraph distortion between national networks and international circuits connecting the international terminal exchanges is required;

(c) that for this purpose, provisional standards, based on the results of practical experience and on studies of the composition of telegraph distortion, should be laid down for Administrations;

(d) that on well-maintained channels, with modulation at the standard rate of 50 bauds, the values in Table 1/R.57 should not normally be exceeded on the trunk sections (see Recommendations R.53 and R.75). These values are valid whether the channels are amplitude or frequency modulated,

TABLE 1/R.57

Number of channels in tandem within the trunk circuit (excluding the local section at each end)	The limit of bias distortion on reversals at the modulation rate employed for adjustment shall be equivalent to the following values at 50 bauds	Limit of the degree of isochronous distortion on standardized text	Limit of the degree of inherent start-stop distortion, in service on standardized text
1	4%	10%	8%
2	7%	18%	13%
3	10%	24%	17%
4	12%	28%	21%
5	–	–	25%

unanimously declares the following view

1 In planning international point-to-point and switched telegraph communications, Administrations should use the following standard limits valid for start-stop equipment and for 50-baud channels conforming to CCITT Recommendations and set up by amplitude-modulation or frequency-modulation.

Note – Although the figures in Recommendation R.57 are for planning purposes, they do not correspond to conventional degrees of distortion but to routine measurements.

a) Limit of the degree of gross start-stop distortion, measured by a start-stop distortion measuring set at the beginning of the trunk section of the circuit (i.e. at the point where the circuit enters the long-distance line telegraph equipment) and including the effect of the emission distortion of the transmitting apparatus 12%

b) Limit of the degree of isochronous distortion on standardized text in the trunk section of the connection:

When one voice-frequency telegraph (VFT) channel is used for the communication 10%

When two VFT channels are used for the communication 18%

When three VFT channels are used for the communication 24%

When four VFT channels are used for the communication 28%

or

c) Limit of degree of inherent start-stop distortion on standardized text of the trunk section of the connection:

When one voice-frequency (VF) channel is used for the communication 8%

When two VF channels are used for the communication 13%

When three VF channels are used for the communication 17%

When four VF channels are used for the communication 21%

When five VF channels are used for the communication 25%

Note – The limits for the degrees of isochronous and start-stop distortions indicated under b) and c) above do not establish a law of correspondence between the degree of isochronous distortion and the degree of start-stop distortion; this law of correspondence depends on the composition of the distortion (relative magnitudes of characteristic and fortuitous distortion).

d) Limit of the degree of the gross start-stop distortion, measured by a start-stop distortion measuring set, which can be present in signals at the input of the extension circuit of the connection 30%

Note – The (physical) extension circuit (tail) (Definition 32.04, Recommendation R.140 [1]) is the permanent connection extending a telegraph station to a nearby centre, giving access to the long-distance network.

2 These standards take no account of the possibility of including regenerative repeaters in circuits.

3 These standards presuppose that the distortion introduced by the local section of the circuit is negligible, and that, should that not be so, Administrations should agree amongst themselves on the degree of distortion admissible in the various sections of the communication, and on the number of VFT channels that can be used.

4 Administrations should use them, in order to agree on the maximum number of VFT channels that may compose the international section of a circuit and in order to determine the characteristics of their national networks due to be connected to the networks of other countries, on the understanding that the isochronous distortion in service, originated by the trunk section, may not in any circumstances exceed 28%.

Reference

[1] CCITT Recommendation *Definitions of essential technical terms in the field of telegraph transmission*, Vol. VII, Fascicle VII.1, Rec. R.140, Yellow Book, Geneva, 1980.

Recommendation R.58

STANDARD LIMITS OF TRANSMISSION QUALITY FOR THE GENTEX AND TELEX NETWORKS

(New Delhi, 1960; amended at Geneva, 1964)

The CCITT,

considering

(a) that to permit the sharing of responsibility for the maintenance of a high-standard of transmission between countries participating in the establishment of switched connections, it is necessary to specify limiting values of distortion at the international terminal exchanges;

(b) that on the other hand, to enable national switched networks to be interconnected, it is necessary to have a distribution plan of the telegraph distortion between national networks and the international junction circuits connecting up the international switching centres (international terminal switching centres);

(c) that Figure 1/R.58 shows the points of entry and exit of the national network and the ends of the international junction circuit;

(d) that it is difficult to lay down standards applicable both to small and to large national networks. However, it has been possible to fix limit values for large countries and they could apply to the great majority of telex subscriber stations or gentex stations taking part in the international service,

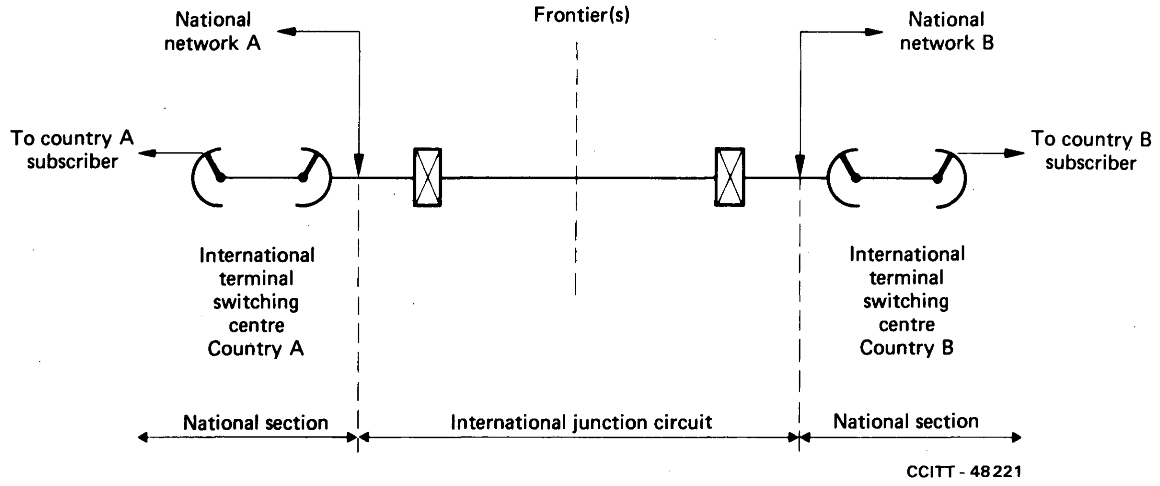


FIGURE 1/R.58

Network diagram

unanimously declares the following view

1 The following standards of transmission quality are observed for the interconnection of 50-baud national networks set up by means of telegraph channels and start-stop equipment in accordance with CCITT Recommendations (national gentex or telex networks):

a) Degree of gross start-stop distortion in service (i.e. including the effect of distortion due to the sending equipment and the exchanges) at the point of exit of the national network: not more than 22%.

Note – When a terminal country of an international connection possesses an intercontinental transit centre, that transit centre is considered as forming part of the national network.

b) Degree of inherent start-stop distortion of the international junction circuit: not more than 13%.

Note 1 – In establishing the 13% limit for the degree of start-stop distortion in the international junction circuit, account has been taken of the fact that, in a world telex or gentex chain, the junction circuit might quite often consist of two VFT channels in tandem. If the international junction circuit is established on a single channel, the 8% limit mentioned in Recommendation R.57 is applicable to that circuit.

Note 2 – No limit for distortion on the entry of the national network at the receiving end has been indicated in Recommendation R.58. The values mentioned in § 1 a) and § 1 b) above are adequate for planning purposes.

2 Although the degrees of distortion to be inserted in the Recommendations relative to the planning of networks are normally conventional degrees of distortion, the maximum values mentioned under § 1 above correspond to the results that would be provided by the routine measurements carried out in accordance with Recommendation R.5.

3 These limit values are applicable to large countries that are directly connected without switching in a transit country. The stations taking part in the international service that cannot satisfy condition § 1 a) above will have to be specially equipped, for example with distortion correctors.

4 Small countries (defined as countries in which all stations can be reached with not more than one long-distance telegraph circuit in the national network) will have to try to obtain values less than the maximum of 22% for the measurements corresponding to § 1 a) above.

5 The standard limits mentioned under § 1 above can also apply to private switched networks.

LIMITS ON SIGNAL TRANSFER DELAY FOR TELEGRAPH, TELEX AND GENTEX NETWORKS

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that it is necessary to define the overall maximum transfer delay and its distribution between national and international circuits;

(b) the need to divide the responsibility between Administrations involved in establishing international switching connections;

(c) that there are difficulties in specifying standard limits on transfer delay in a single telegraph channel on account of the variation in length and numbers of telephone channels connected in tandem on the bearer circuit;

(d) that the use of satellite communication links in the international telegraph, telex and gentex networks and the Maritime Mobile Service is increasing;

(e) that the increase in the signal transfer delay caused by the conditions mentioned above requires the specification of tolerable limits on signal transfer delay in the hypothetical reference connection;

(f) that the transfer delays on signalling elements inherent in the signalling types specified in the Series U Recommendations will be considerable on multiple tandem sections;

(g) the provision for hypothetical reference connections contained in Recommendation U.8,

unanimously declares the view that

1 When planning international connections on the 50-baud telegraph, telex and gentex networks, the overall maximum transfer delay should, in general, not exceed 4 seconds in the call setting-up phase and two seconds in the established phase of a call. The difference of both values should not exceed 950 ms for connections in which the terminating exchange automatically returns the answerback.

Note 1 – In the maritime mobile service, the maximum transfer delay will be exceeded due to the delays in the maritime mobile satellite system which can be expected to be approximately 2170 ms from the maritime terminal to the shore station in the call established phase. In the call setting-up phase, this delay is approximately 4500 ms.

Note 2 – This limit is not applicable to the case of the interconnection of existing networks which use code conversion facilities.

Note 3 – Because the main component of the transfer delay is in the maritime satellite link, then the difference in transfer delay between the call-connected signal and the answerback can be held within the permissible limits at the Maritime Satellite Switching Centre.

2 When setting up connections in the 50-baud telegraph, telex and gentex networks, the following maximum limits should, in general, not be exceeded:

2.1 *In national sections*

The maximum transfer delay of the call-connected signal should not exceed 1250 ms and the maximum signal transfer delay in the established phase of a call should not exceed 625 ms.

2.2 *In international sections*

The maximum transfer delay of the call-connected signal should not exceed 1500 ms and the maximum signal transfer delay in the established phase of a call should not exceed 750 ms.

Note 1 – A greater transmission delay on international links can be allowed by bilateral agreement if no satellite links are used for national purposes, provided the overall limits on signal transfer delay are not exceeded.

3 When considering signal transfer delay, the above tolerances (summarized in Table 1/R.58 *bis*) apply to the transmission path between any two terminals of the telegraph, telex or gentex networks and should be upheld for any connection. They may be exceeded only by the delays incurred in the maritime mobile satellite system.

Table 1/R.58 *bis* requires further study.

TABLE 1/R.58 *bis*

Maximum signal transfer delay times (ms)

(1)	Call connected signal (2)	Signal after through-connection (3)	Difference between columns (2) and (3) (4)
National section	1250	625	625
International section	1500	750	750
Overall transfer delay	4000	2000	2000 [a]
Maritime mobile service	4500	2170	2330

[a] Maximum value 950 ms when terminating exchange automatically returns the answerback.

Recommendation R.59

INTERFACE REQUIREMENTS FOR 50-BAUD START-STOP TELEGRAPH TRANSMISSION IN THE MARITIME MOBILE SATELLITE SERVICE

(Geneva, 1980; amended at Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that proper interworking with the international telegraph services must be ensured;

(b) that the coast-earth station equipment will interface with the international terrestrial telegraph networks and will therefore need to conform to CCITT Recommendations where applicable;

(c) that the ship earth station will include a local end with its termination consisting of start-stop equipment using International Telegraph Alphabet No. 2;

(d) that corresponding requirements are given in CCIR Recommendation 553, *unanimously recommends*

(1) that the coast earth station equipment interfacing with terrestrial telegraph channels should conform to Recommendation R.101 as applicable to 50-baud services:

a) for signals from the terrestrial network entering the coast earth station, the relevant points are given in Table 1/R.59;

b) for signals from the coast earth station entering the terrestrial network, the relevant points are given in Table 2/R.59;

(2) that the transmission characteristics of the ship earth station start-stop equipment should conform to Recommendation S.3 as applicable to 50-baud services,

TABLE 1/R.59

Parameter	Recommendation R.101
Input modulation rate	§ 2.1
Isolated character stop elements	§ 2.2
Minimum interval between start elements	§ 2.3
No restrictions on the use of combinations of International Telegraph Alphabet No. 2	§ 2.4
Effective net margin	§ 2.5
Minimum input start element duration	§ 2.6

TABLE 2/R.59

Parameter	Recommendation R.101
Output distortion	§ 3.1
Output modulation rate	§ 3.2
Minimum output stop element	§ 3.3

considering further

(e) that in the first generation INMARSAT system, telex characters are transmitted in synchronous channels using 6-unit frames in such a way that, due to speed differences between the on-board teleprinter and the satellite telex channel, periods of Z polarity equal to the duration of a telex character occasionally appear in the data stream;

(f) that this may cause difficulties when the ship earth station is operating towards automatic terminals, store-and-forward units, etc. in the international telex network,

recommends

(3) that, if practicable, future systems should be designed so that insertion of unnecessary periods of Z polarity is avoided when characters are to be retransmitted at cadence speed into the international telex network.

SECTION 5

CORRECTION OF SIGNALS

Recommendation R.60

CONDITIONS TO BE FULFILLED BY REGENERATIVE REPEATERS FOR START-STOP SIGNALS OF INTERNATIONAL TELEGRAPH ALPHABET No. 2

(former CCIT Recommendation B.20, 1952; amended at Geneva, 1956 and 1964, Mar del Plata, 1968 and Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that the duration of the transmitting start-stop cycle of terminal start-stop apparatus should be at least 7.4 units for apparatus operating at 50 and 75 bauds, 7.5 units for apparatus operating at 100 bauds;

(b) that the effective net margin should be greater than:

– 35% for signals sent by a transmitter having a nominal cycle equal to or greater than 7 units (for operation at 50 or 75 bauds),

– 30% for signals sent by a transmitter having a nominal cycle equal to or greater than 7.2 units (for operation at 100 bauds),

unanimously declares the view

(1) that regenerative repeaters for start-stop signals should operate at the nominal modulation rate of the signals that they are required to regenerate with a speed tolerance in service of ± 0.5%;

(2) the effective synchronous margin should be at least 40%;

(3) that the degree of synchronous start-stop distortion (see Definition 33.10, Recommendation R.140) of the retransmitted signals should not exceed 5%;

(4) that the significant instants corresponding to the beginning of the start signals emitted by the regenerative repeater should in no case be separated by less than 7 unit intervals (for operation at 50 or 75 bauds) or 7.2 unit intervals (for operation at 100 bauds).

SITING OF REGENERATIVE REPEATERS IN INTERNATIONAL TELEX CIRCUITS

(former CCIT Recommendation B.26, 1951; amended at Geneva, 1956 and 1964, Mar del Plata, 1968 and Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that insufficient experience has been acquired in the use of regenerative repeaters;

(b) that it nevertheless seems desirable to lay down a provisional rule governing the siting of regenerative repeaters, with a view to the preparation of plans for international telegraph communications by switching;

(c) that it would also appear desirable that the signals transmitted by an international terminal exchange should not be affected by a higher degree of distortion than those recommended in Recommendations R.57 and R.58,

unanimously declares the view

(1) that, when the transmission quality demands it, Administrations agree with one another on the necessity for inserting regenerative repeaters and for taking the necessary steps so that the location chosen ensures that the expenses are equally shared between the Administrations and is appropriate to the organization of their telex and general switching networks and to the quality of transmission that it is possible to provide on complete connections;

(2) that in the automatic intercontinental telex and gentex transit network (see Recommendation F.68 [1]), where regeneration is not inherently provided by time-division multiplex equipment or switches with inherent regeneration, start-stop regenerative repeaters shall be provided in the receive path of the connection at the intercontinental transit centre.

Note – Start-stop regenerative repeaters and time-division multiplex equipment in accordance with CCITT Recommendations are generally suitable only for normal (50-baud, 5-unit code) telex and gentex operation. Special uses of the automatic intercontinental transit network (cf. § 7 of Recommendation U.11), involving other codes and speeds, raise problems that have to be investigated.

Reference

[1] CCITT Recommendation *Establishment of the automatic intercontinental telex network*, Rec. F.68.

SECTION 6

TELEGRAPH MAINTENANCE

Recommendation R.70

DESIGNATION OF INTERNATIONAL TELEGRAPH CIRCUITS

(former CCIT Recommendation B.29, 1951;
amended at Arnhem, 1953, Mar del Plata, 1968
and Malaga-Torremolinos, 1984)

The CCITT,

unanimously declares the view

that international telegraph circuits should be designated:

(1) first, by the localities of terminal offices, arranged in alphabetical order according to the spelling of the country;

(2) by an indication of the service using the circuit according to the following table:

a) public telegram service circuit:
   - i) point-to-point circuit or circuit used for messages switching: TG
   - ii) trunk circuit of the public switching network (gentex): TGX
   - iii) subscriber's line from a telegraph office to its switching equipment: TGA

b) telex circuit (including circuits common to the telex and gentex services): TX

c) special circuits for private or special services:
   - i) point-to-point circuit or circuit used for message switching: TGP
   - ii) switched circuit or multi-point network circuit (broadcasting network, conference, circuits): TXP

d) service circuits:
   - i) point-to-point circuit: TS
   - ii) omnibus or selective ringing circuit section: TXS
   - iii) pilot channel for voice-frequency telegraph systems: TT

(3) by a serial number, using a separate continuous series for each group of circuits.

Note – To avoid confusion in the case of TGP and TXP circuits, the designation originally assigned to a leased circuit should not be reassigned to a new circuit until a period of at least two years has elapsed.

NUMBERING OF INTERNATIONAL VFT CHANNELS

(Mar del Plata, 1968)

The CCITT,

considering

(a) that in view of the introduction in the international service of voice-frequency telegraph (VFT) channels operated at various nominal modulation rates and having different pass-band spacing, and since the same (heterogeneous) system may include channels with different characteristics, it has become necessary to evolve a method of numbering VFT channels;

(b) that this numbering method must make it possible to recognize:

- the type of modulation (amplitude or frequency) on the channel,
- the nominal modulation rate and average channel spacing,
- the position of the channel in the frequency range;

(c) it must also be such that, in a heterogeneous system, any change in the composition of the channels does not change the numbers of the channels already set up in the system. The transformation of a homogeneous system into a heterogeneous one should not alter the numbers of the channels that are retained,

unanimously declares the view

(1) that the channels in an international VFT system should be numbered as shown in Table 1/R.70 *bis*;

TABLE 1/R.70 *bis*

Number allocation

Channel numbers	Channel spacing (Hz)	Type of modulation
001 - 024	120	amplitude
101 - 124	120	frequency
151 - 165	170	frequency
201 - 212	240	frequency
301 - 307	360	frequency
401 - 406	480	frequency

(2) that the number assigned to a channel should be selected from the series applicable to the type of channel and should correspond to its position in the multiplex table;

(3) An example of this procedure is given in Table 2/R.70 *bis.*

TABLE 2/R.70 *bis*

Numbering scheme

Mean frequency (Hz)	420	540	660	780	900	1020	1140	1260	1380	1500	1620	1740	1860	1980	2100	2220	2340	2460	2580	2700	2820	2940	3060	3180	In accordance with Recommendation R.31 / Recommendation R.35 } 50 bauds/120 Hz
Channel No.	001 101	002 102	003 103	004 104	005 105	006 106	007 107	008 108	009 109	010 110	011 111	012 112	013 113	014 114	015 115	016 116	017 117	018 118	019 119	020 120	021 121	022 122	023 123	024 124	

Mean frequency (Hz)	480	720	960	1200	1440	1680	1920	2160	2400	2640	2880	3120	Recommendation R.37 50 bauds / 100 bauds } 240 Hz
Channel No.	201	202	203	204	205	206	207	208	209	210	211	212	

Mean frequency (Hz)	600	1080	1560	2040	2520	3000	Recommendation R.38 A 200 bauds/480 Hz
Channel No.	401	402	403	404	405	406	

Mean frequency (Hz)	540	900	1260	1620	1980	2340	2700	3060	Recommendation R.38 B 200 bauds/360 Hz
Channel No.	301	302	303	304	305	306	307	308	

Mean frequency (Hz)	420	540	660	780	900	1020	1140	1260	1560	2040	2340	2460	2640	2880	3120	One example of the application of Recommendation R.36
Channel No.	101	102	103	104	105	106	107	108	403	404	117	118	210	211	212	2 channels-200 bauds/480 Hz 3 channels-100 bauds/240 Hz 10 channels-50 bauds/120 Hz

Recommendation R.71

ORGANIZATION OF THE MAINTENANCE OF INTERNATIONAL TELEGRAPH CIRCUITS

(former CCIT Recommendation B.30, Brussels, 1948; amended 1951 and at Geneva, 1956)

The CCITT,

considering

that, in order to ensure satisfactory cooperation between Administrations and private telegraph operating agencies interested in the maintenance of international telegraph circuits, and in order to ensure the maintenance of satisfactory transmission in the international telegraph service, it is necessary to unify the essential action to be taken for the establishment and maintenance of international telegraph circuits,

unanimously declares the view

1 Periodical maintenance measurements should be taken on international voice-frequency telegraph (VFT) systems, and documents relating to such measurements should be exchanged.

2 The responsibilities for the maintenance of satisfactory transmission, and (as and when necessary) the removal of faults on an international VFT system should be assumed by one of the terminal stations of the system to be known as the *system control station*. The said station is to be appointed for the purpose by the Administrations and private telegraph operating agencies concerned on the occasion of the establishment of the VFT system concerned. The system control station is to be entrusted with coordination of the execution of the maintenance measurements to which § 1 above relates.

3 The responsibilities for the maintenance of satisfactory transmission, and (as and when necessary) the removal of faults on an international telegraph system should be allocated between the different stations concerned as indicated below.

3.1 One station of the circuit should assume the principal responsibility for the maintenance of satisfactory service on the circuit. The station in question should be known as the *control station.*

3.2 This station should be equipped with testing equipment to enable it to make telegraph transmission measurements and in this connection it exercises an executive control over all the other stations on the circuit.

3.3 It should be appointed by agreement between the Administrations concerned on the occasion of the establishment of the telegraph circuits concerned. It should be, wherever possible, one of the terminal stations of the circuit, save in so far as otherwise agreed by the services concerned. For example, in the case of VFT circuits, the control station should be one of the terminal VFT stations as nominated by common agreement between the Administrations concerned.

3.4 The control station is responsible for coordinating all operations required when there is a breakdown in the circuit. It keeps a record of all circuit breakdowns. To facilitate supervision, a reference number must be allocated to each breakdown reported.

3.5 When a fault comes to the notice of another station on the circuit, this station should take steps to secure suitable action on the part of other stations concerned; but the control station is nevertheless responsible for ensuring that the fault is cleared as soon as possible.

3.6 The control station should be in a position to furnish all requisite information in reply to inquiries on the subject of faults – e.g. in regard to the time of any fault, the location of the fault, the orders given for dealing with it and the times of restoration of the circuit.

3.7 In order, however, to increase the flexibility of the organization and the rapidity of the removal of faults, the control station will confine itself in each foreign country to securing the cooperation of a station to be known as the *sub-control station* of the circuit. The sub-control station should assume, within its own territory, the responsibilities indicated above in the case of the control station and should therefore be equipped with testing equipment to enable it to make telegraph transmission measurements. Such delegation of responsibility shall not affect the authority of the control station, with which the primary responsibility for the maintenance of satisfactory service on the circuit will continue to rest.

3.8 The sub-control station shall be appointed by the technical service of the Administration concerned. It shall furnish detailed information to the control station regarding faults occurring in its own country.

4 Administrations or private recognized telegraph operating agencies shall be free to organize the maintenance measurements on those portions of international point-to-point circuits and switched connections (including apparatus) that lie wholly within their control, but the methods adopted should be not less efficacious than those recommended for international circuits.

5 To facilitate the control of tests, circuits shall be divided into *test sections* (parts of a circuit between two telegraph stations). Each section shall be under the control of a *testing station* responsible for the localization and removal of faults on the section concerned. The testing station shall furnish detailed information as to the faults occurring in the section under its control to the sub-control station (or, if necessary, the control station).

6 In the case of VFT channels, each channel shall constitute a test section. The testing station will in this case be the principal VFT station at the end of the section concerned.

Recommendation R.72

PERIODICITY OF MAINTENANCE MEASUREMENTS TO BE CARRIED OUT ON THE CHANNELS OF INTERNATIONAL VFT SYSTEMS

(former CCIT Recommendation B.34, 1951; amended at New Delhi, 1960 and Geneva, 1964)

The CCITT,

considering

that, for technical supervision of operations, maintenance measurements on international voice-frequency telegraph (VFT) channels are necessary,

unanimously declares the view

(1) that maintenance measurements be carried out on international VFT channels once every three months (once every six months for 50-baud channels spaced at 240 Hz conforming to Recommendation R.35 *bis*);

(2) that there is no need to carry out measurements more frequently on channels making up long circuits or circuits used in a switched network;

(3) that, when it is observed that the number of maladjustments is too high, supplementary measurements should be performed by agreement between the Administrations concerned.

Recommendation R.73

MAINTENANCE MEASUREMENTS TO BE CARRIED OUT ON VFT SYSTEMS

(former CCIT Recommendation B.35, 1951; amended at New Delhi, 1960; Geneva, 1964; Mar del Plata, 1968 and Malaga-Torremolinos, 1984)

The CCITT,

in view of

Recommendation R.72 on the periodicity of maintenance measurements to be made on international voice-frequency telegraph (VFT) channels,

considering

that it should be clearly laid down what maintenance measurements are indispensable to ensure the correct operation of VFT channels, *unanimously declares the view*

(1) that maintenance measurements and any necessary adjustments of *amplitude-modulated* VFT channels should be made in the following order:

a) the power supply voltages;

b) the value of the frequency transmitted to line by the channel;

c) the output level of each send filter in condition Z and in condition A;

d) the output level of each send filter after the control current has been interrupted;

e) the output level of each receive filter in condition Z;

f) the degree of distortion with sequences of significant intervals each having a duration of one or two unit intervals. (It would be advisable for this measurement to be made at normal, maximum and minimum levels. All the modifications of level should be made after the receive filter.) The measurement and adjustments may be first carried out on local and then on line, or on line only, so as to minimize the degree of distortion;

g) the receiving relay if any (if the results obtained at point f) should make this desirable);

h) the threshold of the receiver;

i) the degree of distortion, in accordance with the method described in Recommendation R.5 and bearing in mind § (1) and § (2) of Recommendation R.74;

(2) that maintenance measurements and any necessary adjustments of *frequency-modulated* VFT channels should be made in the following order:

a) the power supply voltages;

b) the values of the frequencies transmitted to line by the channel;

c) the frequency emitted after the control current has been interrupted;

d) the output levels of each send filter for the characteristic frequencies A and Z;

e) the output levels of each receive filter for the characteristic frequencies A and Z, if possible;

f) the frequency drift, if the channel is used for this measurement (see below);

g) the degree of distortion with sequences of significant intervals each having a duration of one or two unit intervals; the measurement and adjustment should be first carried out on local and then on line, or on line only, so as to minimize the degree of distortion;

h) the receiving relay, if any;

i) the threshold of the receiver (at blocking);

j) the degree of distortion, in accordance with the method described in Recommendation R.5 and bearing in mind § (1) and § (2) of Recommendation R.74.

The measurement referred to in f) above must be carried out to check, where necessary, whether there is any frequency drift on the VFT bearer circuit by measuring the pilot frequency when the system is operated with one; otherwise, Administrations should agree to measure a characteristic frequency at the output of the line for a mutually determined channel. The result of this measurement will be compared with the result of the measurement made when this frequency is sent; the difference will show any drift due to transmission on the VFT bearer circuit;

(3) that, unless otherwise specified, the measurements should be effected at the nominal modulation rate of the channel (50, 100 or 200 bauds). However, if a 100-baud channel is operated with a rate of 50 bauds, in accordance with Recommendation R.35 *bis*, the measurements should be effected at the rate of 50 bauds and adjustments made if the limits mentioned for 50 bauds in Recommendation R.57 are no longer respected;

(4) that the results of the measurements made on the international channels should be exchanged directly by telegraph or telephone between the measuring stations, at the request of one of these stations;

(5) that, since maintenance work is a cause of interference on circuits in service, maintenance measurements should be made outside busy hours as far as possible;

(6) that, when maintenance measurements are carried out on circuits in operation, every precaution should be taken in accordance with Recommendation R.76 to avoid disturbances.

CHOICE OF TYPE OF TELEGRAPH DISTORTION-MEASURING EQUIPMENT

(former CCIT Recommendation B.52, Geneva, 1956;
amended at Geneva, 1964 and 1980)

The CCITT,

in view of

Recommendation R.90,

considering

(a) that measurements of isochronous distortion made with the text specified in Recommendation R.51 *bis* should normally be applied to code-independent telegraph channels;

(b) that it may in principle be desirable to measure the distortion of telegraph channels in terms of start-stop distortion;

(c) that all important terminals of voice-frequency telegraph systems are equipped with isochronous distortion-measuring equipment and that their replacement by start-stop instruments would be expensive,

unanimously declares the view

(1) that, for the maintenance of code-independent telegraph channels, isochronous distortion measuring equipment should normally be used;

(2) that Administrations may nevertheless, by common consent, use for this purpose start-stop distortion measuring equipment,

considering also

(d) that measurements of the quality of start-stop signals cannot normally be made without start-stop distortion measuring equipments;

(e) that the planning and establishment of telegraph networks are to be judged in terms of conventional degrees of start-stop distortion, and that degrees of start-stop distortion may also prove to be the best basis for calculations of the summation of degrees of distortion and for calculation of conventional start-stop distortion;

(f) that, for the maintenace of telegraph channels incorporating code-dependent systems, start-stop test equipment is essential,

unanimously declares the view

(3) that all international switching and testing centres (ISTCs) should be equipped with start-stop distortion-measuring equipment.

MAINTENANCE MEASUREMENTS ON CODE-INDEPENDENT INTERNATIONAL SECTIONS OF INTERNATIONAL TELEGRAPH CIRCUITS

(former CCIT Recommendation B.44, Arnhem, 1953; amended at New Delhi, 1960, and at Geneva, 1980 and Malaga-Torremolinos, 1984)

The CCITT,

in view of

Recommendations R.50, R.57 and R.90,

considering

(a) that, for the technical supervision of international telegraph circuits, it is necessary to make periodic measurements of distortion on their international sections when they are made up of two or more channels;

(b) that certain Administrations consider it desirable to have available apparatus for making simple measurements automatically and periodically, giving an indication of the performance rating and transmitting an alarm when this rating exceeds the limits permitted for automatic switched channels,

unanimously declares the view

(1) that it is desirable to make distortion measurements every three months on the international sections of international telegraph circuits made up of at least two channels;

(2) that these measurements should be made at a modulation rate of 50 bauds;

a) with sequences of significant intervals each having a duration of one or two unit intervals,

b) preferably with the standardized text specified in Recommendation R.51 *bis*;

(3) that the values shown in Table 1/R.75 for the inherent distortion in service (extracted from Recommendation R.57) must not be exceeded on the international section of a telegraph circuit;

TABLE 1/R.75

Number of channels in tandem within international section	The limit of bias distortion on sequences of significant intervals each having a duration of one or two unit intervals at the modulation rate employed for adjustment shall be equivalent to the following values at 50 bauds	Isochronous distortion with standardized text	Inherent start-stop distortion with standardized text
2	7%	18%	13%
3	10%	24%	17%
4	12%	28%	21%
5	–	–	25%

Note 1 — The above values are valid whether the channels are amplitude-modulated or frequency-modulated.

Note 2 — The columns giving the limits for degrees of isochronous distortion and start-stop distortion on the text are not intended to establish a law relating the degree of start-stop distortion to the degree of isochronous distortion; this law of relationship depends on the constitution of the distortion (relative magnitudes of characteristic and fortuitous distortion).

(4) that these values do not take into account the possibility of regenerative repeaters or other code-dependent systems in the international section;

(5) that, in future, measurements made with the apparatus mentioned in (b) above will no doubt make it possible to eliminate the maintenance measurements referred to above.

Recommendation R.75 *bis*

MAINTENANCE MEASUREMENTS OF CHARACTER ERROR RATE ON INTERNATIONAL SECTIONS OF INTERNATIONAL TELEGRAPH CIRCUITS

(Malaga-Torremolinos, 1984)

The CCITT,

in view of

Recommendations R.51 *bis* and R.54,

considering

(a) that, for the technical supervision of international telegraph circuits, it is necessary to make periodic character error rate measurements on their international sections when they are made up of two or more channels;

(b) that certain Administrations consider it desirable to have available apparatus for making simple measurements automatically and periodically, giving an indication of the performance rating and transmitting an alarm when this rating exceeds the limits permitted for automatic switched channels,

unanimously declares the view

(1) that it is desirable to make character error rate measurements after commissioning the transmission system and for maintenance purposes on the international sections of international telegraph circuits made up of at least two channels;

(2) that these measurements should be made at the nominal modulation rate of the circuit under test preferably with the stardardized text specified in Recommendation R.51 *bis*;

(3) that it is desirable to define the effective net margin as follows:

a) for regenerative equipment use the appropriate Recommendation,

b) non-regenerative equipment, error rate tests should use a margin of no less than 40% and should be made in conjunction with distortion measurements.

Note – Recommendation R.54 gives an allowable character error rate of 3 per 100 000 for the complete circuit. The proportion of this character error rate allowable on the international section only is for further study.

Recommendation R.76

RESERVE CHANNELS FOR MAINTENANCE MEASUREMENTS ON CHANNELS OF INTERNATIONAL VFT SYSTEMS

(former CCIT Recommendation B.38, 1951; amended at Geneva, 1964)

The CCITT,

considering

that it is desirable that maintenance measurements on the channels of international voice-frequency telegraph (VFT) systems should disturb communications as little as possible,

unanimously declares the view

(1) that, whenever possible, measurements on a working channel of a VFT system should be carried out only after the channel concerned has, if necessary, been replaced by a spare channel;

(2) and to this end, the CCITT considers that it is desirable that one channel should be reserved for this purpose in each VFT system.

(3) When this change is not possible, the channel user will be informed in advance that measurements or tests are about to be carried out on his circuit.

Recommendation R.77 [1)]

USE OF BEARER CIRCUITS FOR VOICE-FREQUENCY TELEGRAPHY

(former CCIT Recommendation B.39, Brussels, 1948; amended at New Delhi, 1960 and Mar del Plata, 1968)

1 Composition and nomenclature

Figure 1/R.77 illustrates the composition of an international voice-frequency telegraph (VFT) system and the nomenclature used.

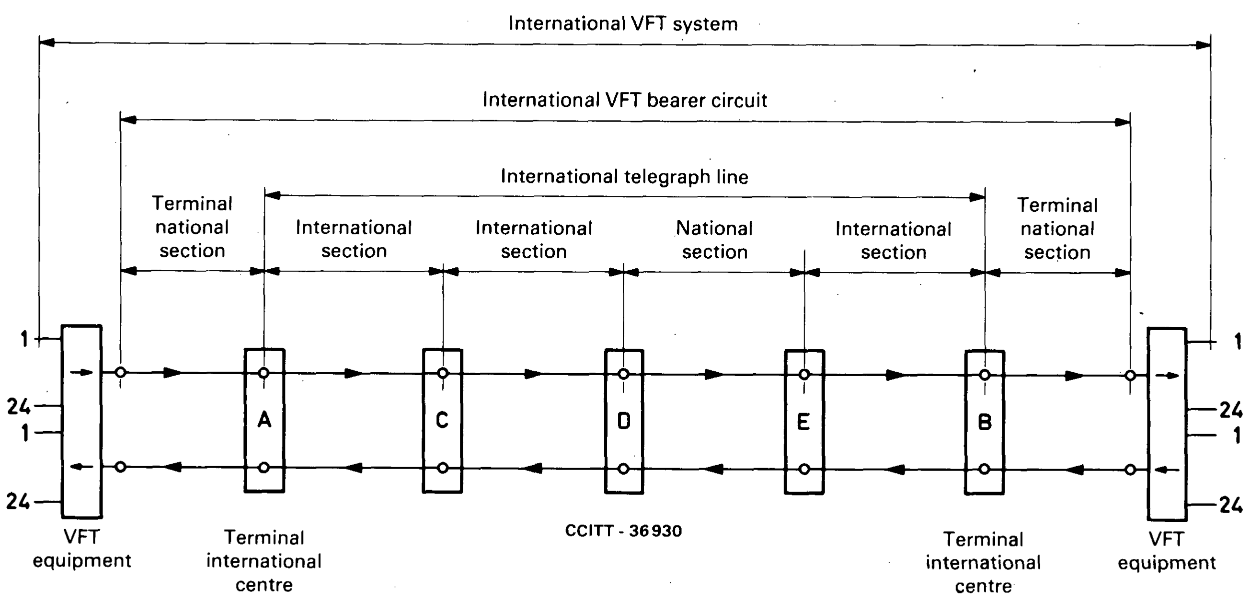
2 The international voice-frequency telegraph system

2.1 This is the whole of the assembly of apparatus and lines, including the terminal VFT equipment. In Figure 1/R.77 the system illustrated provides 24 duplex international telegraph circuits but other numbers of telegraph circuits can be provided.

2.2 *The international VFT bearer circuit*

2.2.1 Four-wire telephone-type circuits are used as VFT bearer circuits. The circuit comprises two unidirectional transmission paths, one for each direction of transmission, between the terminal VFT equipments.

2.2.2 The VFT bearer circuit consists of an international line together with any terminal national sections connecting the international line to the VFT terminal equipment and may be constituted entirely on carrier channels (on symmetric pair, coaxial pair or radio-relay systems) or an audio-frequency lines or combinations of such lines.



Note — At the intermediate centres C, D and E and at the terminal international centres A and B, the signals transmitted are at audio frequencies. At these points it is possible to make measurements.

FIGURE 1/R.77

The components of an international VFT system

1) See also Recommendation M.800 [1].

2.2.3 VFT bearer circuits have no terminating units, signalling equipment or echo suppressors.

2.3 *The international line of a VFT bearer circuit*

2.3.1 The internaional line of a VFT bearer circuit may be constituted by using a channel in a carrier group or channels in tandem on a number of groups. National and international sections can be interconnected to set up an international line. See Figure 1/R.77 but note that § 2.3.2 below details the preferred method. The international line could equally well be set up between, for example, only A and C or between C and D, in which case A and C, or C and D would be the terminal international centres.

2.3.2 Wherever possible an international line for a VFT bearer circuit should be provided on channels of a single carrier group, thereby avoiding intermediate audio-frequency points. In some cases, such a group may not exist or, for special routing reasons, it may not be possible to set up the international line in the preferred way. In such cases, the international line will consist of channels in tandem on two or more groups with or without audio sections, depending on the line available and the routing requirements.

2.4 *Terminal national sections connected to the international line of a VFT bearer circuit*

In many cases the VFT terminal equipment is remote from the terminal international centre of the international line (Figure 1/R.77), and such cases necessitate the provision of terminal national sections in order to establish international VFT bearer circuits. These sections may be in short-distance local audio cables, amplified or unamplified, or may be routed in long-distance carrier groups or amplified audio plant as available.

3 Reserve arrangements for international VFT bearer circuits

3.1 *General*

3.1.1 All necessary action should be taken to enable the duration of interruptions on international VFT bearer circuits to be reduced to a minimum and, for this purpose, it is expedient to standardize some of the methods to be adopted for replacing defective portions of the circuit.

3.1.2 Although it does not appear necessary for these methods to be the same in detail in every country, it would be advisable to reach agreement regarding the general directives to be followed.

3.1.3 The make-up of the reserve VFT bearer circuits will in general be similar to that of the normal VFT bearer circuits. However, if the VFT terminal equipment is not located at the terminal international centres, the line portion of an international telephone circuit can be used to replace only the international line of the VFT bearer circuit.

3.2 *Reserve international lines*

3.2.1 Wherever possible a reserve international line should be provided between the two terminal international centres by means of the international line of an international telephone circuit (between A and B in Figure 1/R.77).

3.2.2 The telephone circuit used as a reserve should be chosen wherever possible so as to follow a different route from that of the normal international line. Where this cannot be done, as much as possible of the circuit or its sections should be alternatively routed.

3.2.3 If there is a choice, the use of manually-operated circuits as reserve lines for VFT is technically and operationally preferable to the use of automatic circuits. It should be possible after prior agreement between the controlling officers at the international terminal exchanges concerned for an operator to break into a call in progress to advise the correspondents that the circuit is required and that the call should be transferred to another circuit if it lasts longer than six minutes.

3.2.4 If the reserve telephone circuit is automatic or semi-automatic a direct indication should be given at the changeover point. If it is not available when needed the reserve circuit should be blocked against any further call.

3.3 *Reserve sections for the sections of the international VFT bearer circuit*

3.3.1 Where it is not possible to provide reserve international circuits either because there are no suitable telephone circuits or because the number of telephone circuits does not permit the release of a circuit for reserve purposes, reserve sections should be provided wherever possible for each of the component sections. For these sections, national or international telephone lines or, where they exist, spare channels, circuits, etc., should be used.

3.4 *Reserve arrangements for the terminal national sections connecting the VFT terminal equipment to the international line*

3.4.1 Reserve sections should be provided by means of national telephone circuits or by the use of spare channels, particularly in the case of long sections and of sections forming part of a category B VFT bearer circuit (see [2]).

3.5 *Changeover arrangements from normal to reserve lines*

3.5.1 When an international telephone line (i.e. part of an international telephone circuit) is used to provide a reserve for the international line (or for one of its sections as mentioned in § 3.3 above), there should be changeover arrangements to enable the changeover from the normal line to the reserve line to be made as rapidly as possible. The changeover arrangements (Figure 2/R.77) should be such that on changeover, all signalling equipment, echo suppressors, etc., associated with the telephone circuit that is used as a reserve for the international line, are disconnected on the line side. When the fault is cleared on the normal line, it should be possible to join it to the signalling equipment, echo suppressors, etc., and put it into service as part of the telephone circuit until the agreed time for the restoration of the line to the normal routing. It is desirable to introduce as little disturbance as possible when changing back from reserve to normal. Arrangements of cords and parallel jacks can be devised to achieve this.

3.5.2 The changeover arrangements shown in Figure 2/R.77 could be applied to sections of the international line mentioned under § 3.3 above when it is not possible to obtain an overall reserve for the international line. Normal sections and the corresponding reserve sections should be routed via suitable changeover arrangements at the stations concerned.

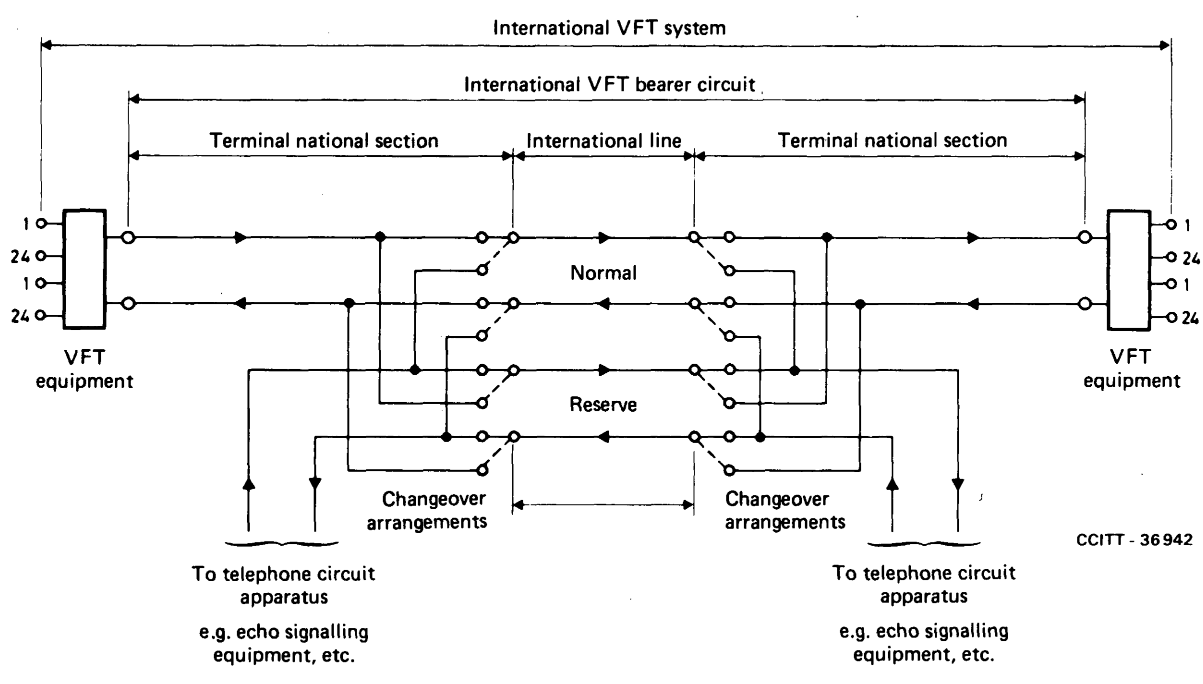


FIGURE 2/R.77

An example of how an international telephone line can be used as the reserve for the international line of an international VFT bearer circuit

3.5.3 Should the alarm indicating that the VFT bearer circuit is faulty be received by a station other than the group control station, this other station shall interrupt the return direction of the alarm channel towards the group control station in order to advise the latter to take the necessary action.

3.5.4 Making manual, automatic or semi-automatic international telephone circuits available for reserve circuits for voice-frequency telegraphy should be in accordance with the instructions issued and the arrangements made by the respective Administrations. Should the normal and reserve lines both be faulty, the technical services of the Administration concerned should take immediate joint action to find a temporary remedy.

3.6 *Designation and marking*

3.6.1 Normal and reserve circuits, etc., should be clearly distinguishable from other circuits both from the point of view of designation (see Recommendation M.140 [3]) and marking (see Recommendation M.810 [4]).

References

[1] CCITT Recommendation *Use of circuits for voice-frequency telegraphy*, Rec. M.800.

[2] CCITT. White Book, Preface to Vol. IV, ITU, Geneva, 1969.

[3] CCITT Recommendation *Designation of international circuits, groups, etc.*, Rec. M.140.

[4] CCITT Recommendation *Setting-up and lining-up an international voice-frequency telegraph link for public telegraph circuits (for 50, 100 and 200 baud modulation rates)*, Rec. M.810.

Recommendation R.78

PILOT CHANNEL FOR AMVFT SYSTEMS

(former CCIT Recommendation B.43, Arnhem, 1953; amended at New Delhi, 1960)

The CCITT,

considering

(a) that use of a pilot channel is suggested to give an alarm in the case of an abnormal drop in the receiving level of the bearer circuit in amplitude-modulated voice-frequency telegraph (AMVFT) systems;

(b) that service channels could have been used as pilot channels for this alarm signal, but since there is not always a service channel in each VF group, it is suggested that channels be chosen for the alarm signal,

unanimously declares the view

(1) that it is advisable to use a pilot channel to give an alarm in the case of an abnormal drop in the receiving level of the bearer circuit carrying an AMVFT system;

(2) that the level at which the alarm should work should be fixed by the Administration at the receiving end;

(3) that the pilot channel frequency should, as far as possible, be 300 Hz, transmitted with a power level corresponding to that of a frequency-modulated channel in accordance with Table 1/R.35;

(4) that, if such an arrangement cannot be adopted, the Administrations concerned should agree on the use of one of the standardized frequencies for the pilot channel used for alarm purposes.

Note – The case of 50-baud frequency-modulated systems is dealt with Recommendation R.35.

AUTOMATIC TESTS OF TRANSMISSION QUALITY ON TELEGRAPH CIRCUITS BETWEEN SWITCHING CENTRES WHERE NO REGENERATION IS INVOLVED

(Mar del Plata, 1968; amended at Geneva, 1972, 1976, 1980 and Malaga-Torremolinos, 1984)

Note – Where regeneration is involved, the automatic test arrangements are as described in Recommendation R.79 *bis.*

1 Purpose of automatic tests

1.1 A maintenance measurement on a telegraph circuit made in the course of routine maintenance measurements takes a relatively long time to carry out and occupies staff at both ends of the circuit. This applies as much to circuits in a satisfactory condition (the majority of cases) as to faulty circuits.

1.2 The purpose of automatic testing is to make it possible to perform rapid tests; circuits found to be "satisfactory" in the course of these will not be subjected to full maintenance tests and the maintenance staff can thus concentrate on making full tests of circuits identified as "doubtful" during the rapid tests.

1.3 Automatic tests should be organized in such a way that at one end at least of the group of circuits under test, no staff is required. This end of the circuit will then be said to be "in the passive position", while the end initiating the tests will be said to be "in the active position".

Note – Unless stated otherwise, the end of the circuit in the active position will be denoted by the letter A and the end of the circuit in the passive position by the letter B throughout this Recommendation.

2 Circuits tested

2.1 It must be possible for the end of the circuit in the active position to be connected up automatically with the automatic testing equipment at the passive end. Rapid automatic tests should therefore only be envisaged over circuits connected at the incoming end to an automatic circuit switching centre, i.e. on circuits of the telex and gentex networks.

2.2 For practical reasons, which will be explained later, tests are limited to circuits connecting two international switching centres. No tests are envisaged for the time being on chains of circuits set up through a transit switching centre.

2.3 If a trunk circuit system between two centres A and B is divided into groups of circuits made up, say, of a group of circuits confined to traffic from A to B, a group of circuits confined to traffic from B to A and a group of both-way circuits, station A can be in the active position only for the both-way circuits and the circuits confined to traffic from A to B; and, vice versa, station B will be active for tests concerned with traffic from B to A and may also be active on both-way circuits. Both-way circuits will therefore be tested twice as often as one-way circuits.

2.4 Separate tests must be made in each direction of transmission of the circuit being tested since, if tests are made in the two directions in tandem, an inadmissible bias distortion on the forward path can be masked by a bias distortion of opposite sense on the backward path.

3 Test station equipment

3.1 An automatic measurement station will consist of two main groups of equipment:

a) A transmission unit consisting of a text transmitter TT and a distortion monitor CD. The distortion monitor will be adjusted to a particular degree of distortion, called the decision level, in such a way that if the latter value is exceeded in the signals received during the measurement, the transmission channel being tested will be classified as "doubtful"; otherwise it will be classified as "satisfactory". (To allow for very occasional distortion of a fortuitous nature, a channel will be classified "doubtful" only if the decision level is exceeded *twice* during the measurement.)

b) A switching unit for access operations; selection and signalling on the A-to-B circuit to be operated in accordance with the characteristics of switching centre B, checking at station A the call-connected signal originating at station B; receiving the call, transmitting the call-connected signal and the identification signals when the station is in the passive position.

4 Test text: decision levels and decision signals

4.1 The text chosen for the tests is given in Recommendation R.51 *bis* (**QKS**). [See, however, § (2) below].

4.2 The choice of the decision level is complicated by the fact that, while most international telex or gentex circuits are made up of a single voice-frequency telegraph (VFT) channel, there are also links in which these circuits consist of two VFT channels in tandem. International circuits consisting of three inter-connected VFT channels in tandem are very rare and can be ignored as far as the organization of automatic maintenance tests is concerned (which means that these circuits can only with difficulty be subjected to automatic maintenance tests).

4.3 Recommendations R.57 and R.58 specify the following values for the limit of inherent start-stop distortion on standardized texts:

a) 8% for a switched network circuit consisting of a single VFT channel;

b) 13% for a switched network circuit consisting of two VFT channels.

4.4 Two decision levels are recommended, one corresponding to § 4.3 a) above and the other to § 4.3 b). Since automatic measurements are more stringent than measurements made on an oscilloscope by an operator, who might fail to notice a brief peaking in the degree of distortion, and since automatic tests are meant to detect genuinely doubtful circuits, it is recommended that the following decision levels should be adopted: 10% for § 4.3 a) and 14% for § 4.3 b) above.

4.5 However, on certain circuits set up in modern multi-channel VFT systems, the degrees of distortion normally prescribed can be less than the limits specified in Recommendations R.57 and R.58. A test carried out with decision levels of 10% (or 14%) could indicate that a circuit is "satisfactory" whereas in fact it is "doubtful". In such circuits, measurements may be made with artificial distortion of the signals. The equipment of the text transmitter should include an AR device (see Figure 1/R.79) that introduces an adjustable artificial degree of distortion on the signals transmitted on the forward path. In the active station the decision level in the distortion monitor CD situated on the backward path would then be reduced by the same value as that introduced in the transmission of the signals on the forward path. This device can be used to make more precise tests with the automatic testing device if this should prove to be necessary.

4.6 Distortion tests on the backward signalling path will commence as soon as possible after the start of the test signals on the forward signalling path.

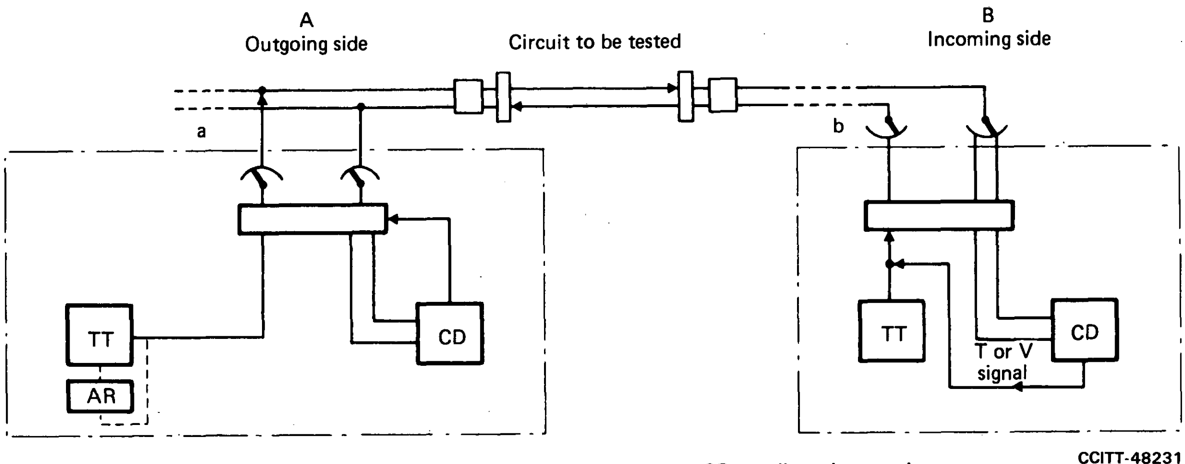
4.7 The test check results made at the passive station will be sent to the active station by means of the following decision signals:

a) combination No. 20 (letter **T**) of International Telegraph Alphabet No. 2 (ITA2) for an affirmative reply (satisfactory channel AB of the circuit);

b) combination No. 22 (letter **V**) for a negative reply (doubtful channel AB of the circuit).

5 Method of access

5.1 The circuits to be tested will be seized at the output of the switching equipment of A. A seized circuit will be marked "busy" at switching unit A (and at switching equipment B in the case of a both-way circuit). Station A will call test station B on the circuit seized for the tests in accordance with the selection and signalling system applicable to calls from A to B (indications given by country B).



A = station in active position
AR = device for adding an adjustable degree of artificial distortion
B = station in passive position
CD = distortion monitor
T = channel AB "satisfactory"
TT = text transmitter
V = channel AB "doubtful"

FIGURE 1/R.79

Typical equipment block diagram for automatic testing of transmission quality on telegraph circuits

5.2 In choosing between measurements with a decision level of 10% and measurements with a decision level of 14%, the simplest procedure is to give a station two call numbers, one for access to the 10% measuring equipment and the other for access to the 14% measuring equipment. These call numbers must be as short as possible and they should if possible be chosen from among the service position numbers. The call numbers for access to the distortion monitor should if possible be the same for both telex and gentex circuit tests.

5.3 Safeguards against seizure of test stations by telex subscribers are recommended. It is also recommended that calls made in connection with automatic tests should not be recorded by the traffic meters operating on the international circuits.

5.4 It would be useful if the outgoing access could be so arranged as to include the supervisory and other elements normally associated with the trunk circuits used for calls to make sure that these elements are not subject to faults liable to have an adverse effect on transmission. It is considered that normal switching equipment should be used to permit access to the testing equipment at the incoming end of the circuits. This will obviate the need for special access equipment and enable normal signalling functions to be tested in addition to transmission performance.

5.5 The identification of the station obtained should be indicated by the return of an answerback consisting of:

- one or two letters representing the telex network identification code of the country of the station,
- the letters **MAT**,
- the figures **10** or **14** depending on whether equipment with a 10% or a 14% decision-level adjustment is involved.

Depending on the characteristics of network B, transmission of the answerback will be initiated directly by the incoming call or by automatic command sent by A.

5.6 After the actual call-connected signal, calling station A will [after sending the *Who are you?* (WRU) code if necessary] receive one, two or three blocks of signals sent by network B: identification block, date and hour block, WRU block. The number of blocks depends on the characteristics of network B.

5.7 Network B will indicate that it is ready to accept test signals **QKS** by sending the ready-for-test (RFT) signal consisting of 4 × combination No. 11 (**K**) of ITA2.

6 Test procedure

6.1 The transmission tests will be carried out with 6 cycles of **QKS** signals. If use is made of predistortion at the active station, the tests on the forward path will be made with early and late distortion on alternate characters. The first character of each cycle (combination No. 29, letter-shift) will have early (short-start) distortion.

6.2 After verification of the RFT signal, the active equipment sends the cycles of test signals. On reception of the first of these signals, the passive station begins sending the test cycles. The passive station sends the decision signal after receiving and checking the test signals received and following the transmission of the test signals to the active station. On receiving signal **V** or **T**, the active station sends the clearing signal.

6.3 The automatic tests should take place in a slack period. To prevent collision between two international centres A trying to seize the same passive station B at the same time, a timetable for the automatic tests should be established by the Administrations concerned to enable Administrations to have access to a particular passive station one after the other.

6.4 To make sure that circuits that are busy when due to be tested, or on which busy conditions from the distant network are encountered when testing, are not overlooked during automatic testing, the Administrations concerned shall agree on when new attempts should be carried out on these circuits.

The CCITT therefore

declares the view

(1) that Administrations (or recognized private operating agencies) may organize between international switching and testing centres (ISTCs) an automatic maintenance test service for testing the international trunk circuits of telex and gentex networks with automatic switching consisting of one or two multi-channel VFT links connected in tandem. In those cases where regeneration is involved in the transmission or switching equipment, Recommendation R.79 *bis* should apply.

(2) The tests shall consist of measurements of the degree of gross start-stop distortion made independently in each direction of transmission of the trunk circuit with the test text specified in Recommendation R.51 *bis* (the **QKS** text). This will normally be transmitted with zero distortion [see also § (16) below]. It should be noted that there is equipment in use that applies the test text specified in Recommendation R.51 (the **Q9S** text).

(3) The tests shall check that, on each transmission direction of the circuit, the degree of gross start-stop distortion measured does not exceed a level called the "decision level", which is established at 10% if the channel consists of a single VFT channel or at 14% if the channel consists of two VFT channels in tandem. The tolerance for the degree of gross start-stop distortion at the transmission end shall be 0.5% and the tolerance for the decision level shall be ± 0.5%. A circuit shall be considered doubtful in the rapid tests if the degree of distortion measured on each transmission direction has more than once exceeded the appropriate decision level; otherwise it shall be considered satisfactory.

(4) Each test station shall have two access codes, one for access to measurements with a decision level of 10% and another if necessary for access to measurements with a decision level of 14%. These access codes shall be as short as the switching equipment to which the testing station is connected will permit.

(5) Each station shall have two identification groups as follows:

a) letter-shift carriage-return line-feed one or two letters representing the telex network identification code space **MAT** figure-shift **10** to identify 10% decision level equipment;

b) as above, but with **14** instead of **10** to identify 14% decision level equipment.

For networks that have to send an answer-back in accordance with Recommendation S.6 [1], the requisite additional letter-shifts will be added.

(6) In an ISTC, a station is normally in the passive condition. In this condition it can be seized by an incoming call for automatic tests and can participate in these tests without the intervention of an operator.

(7) If it wishes to initiate automatic tests on an AB circuit (i.e. one permitting a call from centre A to centre B), station A:

i) goes into the active position;

ii) checks that the AB circuit to be tested is not being used for a call and, if it is free, seizes this circuit on the outgoing side of switching equipment A. This seizure of the AB circuit marks the latter as busy at switching centre A;

iii) calls the automatic testing station B in accordance with the selection and signalling system to be used on circuit AB.

(8) As soon as station B, in the passive position, is seized by the call, it sends the call-connected signal. This will be followed by the identification sequence (either automatically returned or returned in response to the WRU sent by station A) and then by the RFT signal [consisting of 4 × combination No. 11 (**K**) of ITA2] with a delay not exceeding 500 ms after the end of the preceding block.

(9) Station A will receive the call-connected signal, the identification code and the RFT signal. It may be necessary either as part of the normal signalling requirements of network B or for maintenance purposes for network B to send the WRU signal to network A. Station A will always return its identification in response to the WRU signal. Station B will delay transmission of the RFT signal until the identification code has been received in response to the WRU signal. The RFT signal will be sent with a delay not exceeding 500 ms after the last character of this block has been received.

(10) The identification sequence returned by station A will correspond to that returned by station B with the exception that the characters indicating the decision level will be replaced by figure-shifts. In this case the identification code returned by station A will correspond to a total of 20 characters.

(11) Having verified that the RFT signal is correct, station A will then send six cycles of **QKS** signal with a delay not exceeding 500 ms from the end of the reception of the RFT signal. In the event that the block of signals representing the RFT signal proves to be erroneous or the signal was not received in the time permitted the circuit under test will be indicated as doubtful.

(12) As soon as it receives the first **QKS** signals, station B shall begin to transmit six cycles of **QKS** signals on the BA channel.

(13) The distortion monitor of station B will check whether or not the degree of distortion on the text signals received at B has more than once exceeded the decision level. If it has not, station B will send the signal **T** of ITA2 over channel BA. If it has, station B will send signal **V** of ITA2 over the BA channel. 500 ms (± 20%) shall elapse between the end of the reception at B of the last **QKS** cycle and the beginning of decision signal **V** or **T**.

(14) The distortion monitor of station A will check whether the degree of distortion of the test signals received at A exceeds the decision-level more than once. The decision will be indicated locally at A.

(15) After receiving signal **V** or signal **T**, station A will send the clearing signal to B within 500 ms. Any call set up for the automatic testing of a circuit shall be automatically cleared if it lasts longer than 30 s. The circuit on which a call has been released in this manner will be marked doubtful for further examination.

(16) Administrations may, if they wish, make use of automatic maintenance testing equipment for finer distortion measurements. For this purpose, they may, with a station in the active position, artificially predistort the signals sent (transmission distortion). The decision level in the distortion monitor of the active station will be reduced by the value of this predistortion. The station in the passive position will not have to intervene. In a test of this sort, the sending of the test text by the A station will be effected with early transmission distortion on alternate characters for the full duration of the 6 **QKS** cycles. The first character of each cycle (combination No. 29, letter-shift) will have early (short-start) distortion.

(17) Figure 1/R.79 shows a typical block diagram for the equipment. Figure 2/R.79 is a typical timing diagram for one test, showing the optional and mandatory signals. This timing diagram is common to Recommendations R.79 and R.79 *bis.*

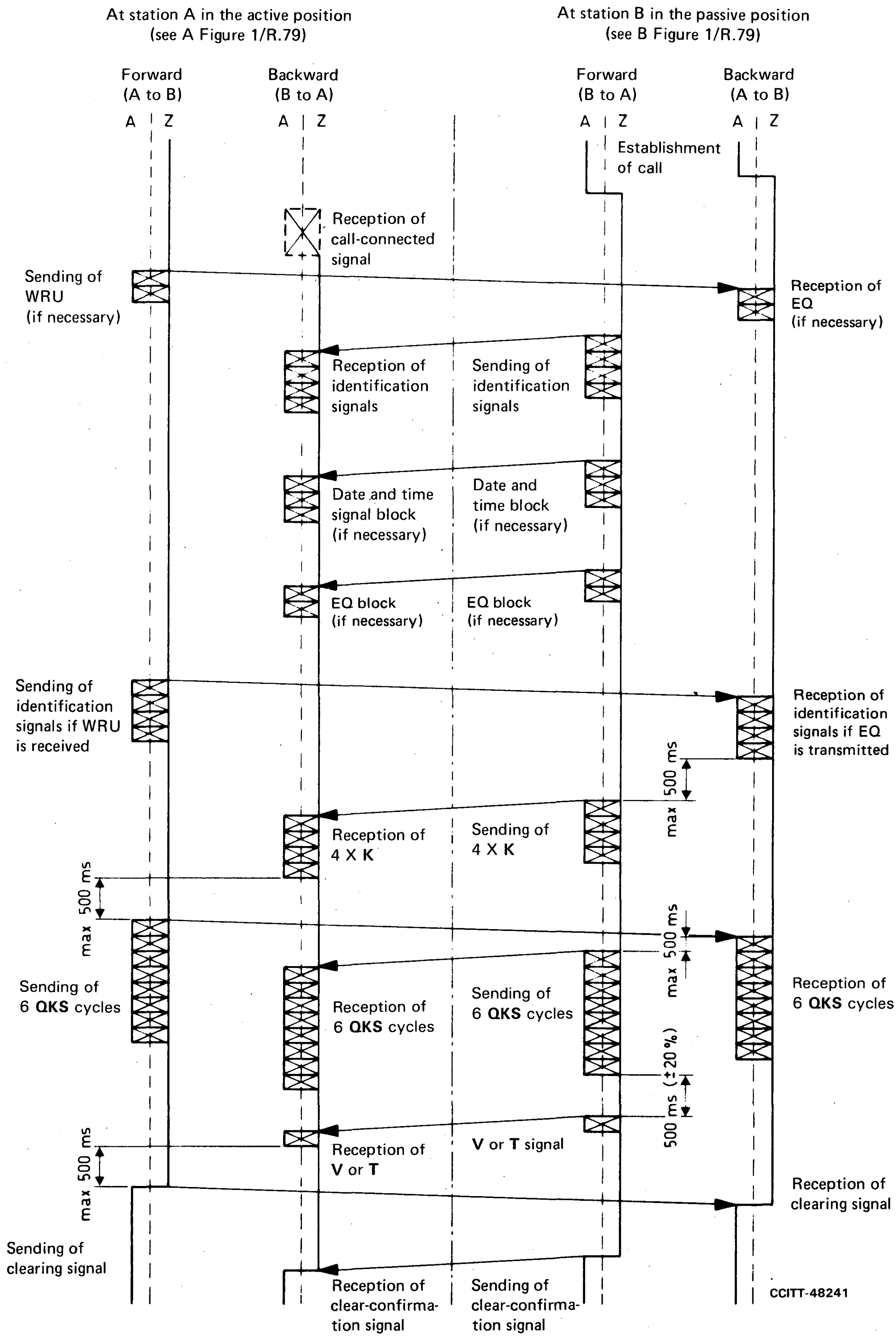


FIGURE 2/R.79

Timing diagram for automatic maintenance test
(applicable to Recommendations R.79 and R.79 *bis*)

Reference

[1] CCITT Recommendation *Characteristics of answerback units (ITA2)*, Rec. S.6.

AUTOMATIC TESTS OF TRANSMISSION QUALITY OF TELEGRAPH CIRCUITS BETWEEN SWITCHING CENTRES WHERE REGENERATION IS INVOLVED

(Geneva, 1976; amended at Geneva, 1980)

The CCITT,

considering

(a) that Recommendation R.79 describes automatic maintenance tests of transmission and switching equipment on circuits where no regeneration is involved and that may consist of one or two tandem-connected voice-frequency telegraph (VFT) links;

(b) that the transmission path of switched telegraph circuits may include forms of start-stop regeneration such as regenerative repeaters, time division multiplex (TDM) systems or regenerative switching equipment and therefore Recommendation R.79 needs to be extended to permit the automatic testing of switched telegraph circuits with regeneration;

(c) that regenerative repeaters, if any, are provided at (one or both) receiving ends of the international circuit only;

(d) that the correct operation of regenerative equipment may be tested by applying at the input a test message of predetermined format and at a level of predistortion equal to the effective in-service margin of the equipment; the signals retransmitted by the regenerator may be checked to ensure that the distortion level and speed tolerance are satisfactory, and as an additional precaution the format of the regenerated test message may be checked against that of the message intended to be used,

unanimously declares the view

that, where automatic tests of transmission quality are required on telegraph circuits between switching centres where regeneration is involved, the facilities described below may be made available to extend the functions of the test equipment described in Recommendation R.79.

1 The **QKS** test signal blocks transmitted by the test stations will be predistorted depending on the number of tandem links (maximum 2) in the circuit and their type (i.e., VFT or TDM conforming typically to Recommendation R.44) and the relative location of the regenerative devices, including the switching equipment. The levels of predistortion to be applied in each direction independently will be:

a) 26% where two VFT links exist before the point of regeneration;

b) 30% where one VFT link exists before the point of regeneration;

c) 40% where the transmission link is TDM conforming typically to Recommendation R.44 or no significant distortion is introduced prior to the point of regeneration.

Further information concerning the combinations of §§ 1 a), b) and c) above may be found in Table 1/R.79 *bis.*

2 The format of the test signal block will follow the **QKS** text described in Recommendation R.51 *bis*, which will commence with the letter-shift and will be completed six times. The stop element for each code combination of this **QKS** text will be as shown in Figure 1/R.51 *bis.*

TABLE 1/R.79 *bis*

Test combinations

Identification of test combination	Active station		Passive station		Transmission and switching configuration
	Transmit pre-distortion %	Receive decision level %	Transmit pre-distortion %	Receive decision level %	
					Symmetrical
11	26	8	26	8	2 VFT links followed by regeneration in each direction
12	30	8	30	8	1 VFT link followed by regeneration in each direction
13	40	6	40	6	TDM conforming typically to Recommendation R.44
					Non-symmetrical
15	0	8	30	10	1 VFT link, regeneration only at receive end at active terminal
16	0	8	26	14	2 VFT links, regeneration only at receive end at active terminal
17	30	10	0	8	1 VFT link, regeneration only at receive end at passive terminal
18	26	14	0	8	2 VFT links, regeneration only at receive end at passive terminal
10 14	0 0	10 14	0 0	10 14	Non-regenerated as described in Recommendation R.79

3 The required degree of start-stop predistortion will be introduced on a block of 6 cycles of **QKS** signals by shortening or lengthening the start elements of alternate characters. The first character of each cycle (combination No. 29, letter-shift) will have a shortened start element. After predistortion is applied, the nominal duration of each character will be maintained as shown in Figure 1/R.51 *bis* by means of complementary changes in stop lengths.

4 After transmission and verification of the ready-for-test (RFT) signal (4 × combination No. 11), each test station shall check that, during reception of the block of six cycles of the **QKS** text signals:

a) The degree of gross start-stop distortion of the regenerated output signals does not exceed 8%. This limit can be reduced to not more than 6% where TDM equipment conforming typically to Recommendation R.44, is employed. It is assumed that the regenerative device is located at the incoming end of the channel;

b) Each received character is verified as being without error against the format of the correct character sequence of the test message intended to be used.

5 The performance of a circuit will be considered satisfactory when checks on both directions of the circuit reveal that

- no character errors are detected, and
- the appropriate received distortion level is not exceeded more than once.

Circuits that fail to meet either of these checks will be considered doubtful.

6 Preferably each test station should have a number of access codes in addition to those described in § (4) of Recommendation R.79, when it is desired to test regenerated circuits automatically. This would involve a separate code's being allocated to each test combination required from this indicated in Table 1/R.79 *bis.*

7 For each access code provided at a test station, an individual identification group is required. The format of the identification group should be as follows:

letter-shift carriage-return line-feed one or two letters representing the telex network identification code space **MAT** figure-shift two digits identifying the test combination.

For networks that have to send an answer-back in accordance with Recommendation S.6 [1], the requisite additional letter-shifts will be added.

8 When only one access code in addition to those specified in Recommendation R.79 can be provided to gain access to the passive station, the following procedure would need to be adopted to enable the passive station to cooperate in the desired test.

a) The format of the passive station's identification group will be as follows:

letter-shift carriage-return line-feed one or two letters representing the telex network identification code space **MAT** figure-shift **00**.

For networks that have to send an answer-back in accordance with Recommendation S.6 [1], the requisite additional letter shifts will be added.

b) The passive station shall then transmit the *Who are you?* (WRU) block to the active station.

c) The active station shall reply to the WRU block by transmitting its identification in accordance with Table 1/R.79 *bis*, as required by the composition of the circuit.

d) The passive station, on receipt of this identification, shall adapt itself to the required received decision level and transmit distortion.

e) On completion of this action, the passive station shall transmit the RFT signal.

9 The active station will automatically verify that the appropriate identification group returned by the passive station corresponds to the test number required. In the event of an incorrect identification signal's being received, the active station will clear down the call and mark the circuit as doubtful.

10 The typical timing diagram of the test procedure appears as Figure 2/R.79. The intention is that the timing arrangements for the test procedure should apply to both Recommendations R.79 and R.79 *bis.*

Reference

[1] CCITT Recommendation *Characteristics of answerback units (ITA2)*, Rec. S.6.

Recommendation R.80

CAUSES OF DISTURBANCES TO SIGNALS IN VFT CHANNELS AND THEIR EFFECT ON TELEGRAPH DISTORTION

(former CCIT Recommendation B.41, 1951; amended at Arnhem, 1953 and Geneva, 1956 and 1964)

The CCITT,

considering

(a) that the great majority of international telegraph circuits are routed on voice-frequency telegraph (VFT) channels;

(b) that VFT channels are liable to disturbance from the following causes:

i) variations in the voltage and frequency of the source of telegraph carrier frequency due to variations in the power supply, and variations in the signalling load in the case where the carrier source supplies several channels;

ii) abrupt or gradual changes in the transmission equivalent of the telephone-type circuit;

iii) intelligible crosstalk from other telephone-type circuits, particularly near-end crosstalk;

iv) unintelligible crosstalk resulting from the cross-modulation of telephone-type circuits when operated by carrier currents;

v) noise induced from electrical power and traction systems;

vi) telegraph crosstalk from other telegraph channels, e.g. production of odd harmonics of the telegraph carrier frequencies in certain channels falling within the passband of other channels, intermodulation in filter coils, etc.;

vii) variations of power supplies affecting the amplifier and detector of the VFT channel and sometimes the receiving relay;

viii) the effects of mechanical vibration upon valves (microphonics) and relays;

ix) bad contacts (e.g. test points and valve bases) and badly soldered joints;

x) deterioration of component parts, e.g. ageing valves;

xi) failure of power supplies, e.g. on changeover from main to reserve supply;

xii) accidental disconnections made during the course of maintenance and construction work;

xiii) on overhead lines, effects of atmospheric electricity, frost, etc.;

(c) that the disturbances account for practically all the distortion in telegraph channels, except for characteristic distortion (which is chiefly a function of filter and amplifier-detector design), some bias (due to misadjustment of controls and relays, etc.) and, in the case of the lower frequency channels, the distortion that arises from the low ratio of carrier frequency to signalling frequency;

(d) that many of the causes of disturbance are individually negligible and the more important of the others have been found, in the experience of several Administrations, to be capable of elimination by careful maintenance both on the VFT equipment and at all points on the bearer circuit;

(e) that the CCITT is also studying the causes of disturbance in telephone circuits and the precautions to be taken to minimize their occurrence;

(f) that the results of the CCITT study will be of great importance to telegraphy;

(g) that, as a result of the considerable investigations already made by certain Administrations on the causes of disturbances in telephone and telegraph circuits, the relative order of importance of these causes appears to be approximately as follows:

i) *in the case of telephone circuits*:

- high resistance and unsoldered connections;
- noisy and microphonic valves, and poor contact between valve pins and valve holders;
- working parties engaged on cable operations;
- noisy and high-resistance U-links;
- changes in line level not compensated at the detector input;
- crosstalk;
- errors in setting up, for example incorrect equalization, line transformers incorrectly connected, faulty components;

ii) *in the case of VFT equipment*

- high resistance and unsoldered connections;
- valves deteriorated beyond permissible limits;
- bad contacts;
- faults on power changeover equipment;
- frequency error of the carrier supply;

unanimously declares the view

(1) that it is desirable for Administrations to undertake investigations of the causes, and frequency of occurrence of disturbances of VFT channels routed on the various types of bearer circuit likely to be employed for international telegraph circuits;

(2) that in doing these tests and in order that the results may be of the greatest use to telegraphy and telephony, the incidence of disturbances should be measured according to their duration as follows: less than 1 ms, 1 to 5 ms, 5 to 10 ms, 10 to 20 ms, 20 to 100 ms, 100 to 300 ms and those more than 300 ms;

(3) that the results should be classified according to the type of bearer circuit, viz. audio or carrier, cable or overhead line.

(4) Measurements of disturbances should be made at the direct current output of the VFT channel that is under observation.

Recommendation R.81

MAXIMUM ACCEPTABLE LIMIT FOR THE DURATION OF INTERRUPTION OF TELEGRAPH CHANNELS ARISING FROM FAILURE OF THE NORMAL POWER SUPPLIES

(former CCIT Recommendation B.40, 1951)

The CCITT,

considering

that in switched telegraph networks a 300-millisecond interruption of the telegraph current would be translated into a release of switches, and that the relays controlling the release are arranged to operate in slightly less than 300 ms,

unanimously declares the view

(1) that it is desirable that no interruption of the telegraph current should occur as a result of failure of a normal power supply.

(2) If, however, it is impracticable to avoid an interruption, then its duration should in no case exceed 150 ms.

Recommendation R.82

APPEARANCE OF FALSE CALLING AND CLEARING SIGNALS IN CIRCUITS OPERATED BY SWITCHED TELEPRINTER SERVICES

(former CCIT Recommendation B.42, 1951; amended at Arnhem, 1953 and Geneva, 1964)

The CCITT,

in view of

Recommendation R.80, on the causes of disturbances affecting signals in telegraph channels, and their effect on the distortion of telegraph signals,

considering

(a) that precautions should be taken with circuits used in switched teleprinter services to prevent the appearance of parasitic signals that would give rise to false calling and clearing signals;

(b) that special monitoring or indicating devices should be provided on voice-frequency telegraph (VFT) systems, the channels of which are used for international switched circuits;

(c) that special steps might well be taken to discover the causes of false signals due to transient changes in transmission level or momentary increases in noise level, on VFT circuits;

(d) that it would be desirable to draw up operating standards in this connection,

unanimously declares the view

(1) that the following precautions should be taken to avoid false calling and clearing signals:

- the security and stability of power supplies and of sources of carrier frequencies, both telegraph and telephone, should be ensured;
- a characteristic marking should be used to denote telegraph and telephone-type circuits used for the operation of switched teleprinter circuits, both in terminal and intermediate stations;
- precise instructions should be given to staff in order that false entry into the above-mentioned circuits may be avoided;
- the number of non-soldered connections should be reduced as much as possible, together with the number of break points; unsoldered connections, e.g. U-links and screw terminals, etc., should be checked with particular care. In this connection, attention is drawn to the methods of inspection by vibration tests;
- the amplitude of level variations in VFT bearers should be limited, and abrupt variations in the level should be particularly avoided;
- limit the crosstalk mentioned in Recommendation R.80;
- limit induced voltage caused by electric power and traction systems;
- limit the microphonics of valves in repeaters and of valves used in VFT;
- reduce the sensitivity of voice-frequency modulators to disturbing signals;
- avoid, in switched teleprinter services, the use of supervision signals having a short duration in relation to the transitory phenomena due to filters and time-constants in the level-regulators of VFT systems.

(2) These precautions, inasmuch as they concern telephone-type circuits used for voice-frequency telegraphy, must be taken simultaneously on normal and reserve circuits.

(3) For the permanent monitoring of VFT systems the channels of which are used for international switched circuits, it is advisable to use a pilot channel. An alarm should be given to indicate when either the system or the pilot channel is out of order (see Recommendation R.78).

(4) It would be advisable to record the transmission level, in order to discover and localize the causes of the false signals on circuits behaving particularly badly.

(5) It is not yet possible to lay down operating standards in this connection.

Recommendation R.83

CHANGES OF LEVEL AND INTERRUPTIONS IN VFT CHANNELS

(former CCIT Recommendation B.53, Geneva, 1956;
amended at Geneva, 1964)

The CCITT,

considering

(a) that an alarming situation for the telegraph service has been created by interruptions on voice-frequency telegraph (VFT) channels, and by changes of level that have the same effect as interruptions;

(b) that the consequences are such that, at present, the error rate that is attributed to VFT channels is still very far above the tolerable limit fixed by considerations of operational requirements (see Recommendation R.54, a) and f);

(c) that certain Administrations have observed an improvement in the situation, and that this improvement seems to result from the measures taken by the telephone services, for instance, symmetric percussion tests, precautions in the switching or power supplies, etc.;

(d) that it has been confirmed that the number of interruptions increases markedly during the normal hours when maintenance staff are present, and is reduced when, despite very heavy traffic, maintenance is suspended, so that telegraph Administrations are now convinced that one of the principal causes of interruptions on telegraph channels is intervention by maintenance personnel and perhaps by operating personnel;

(e) that it has also been observed that the number of interruptions appears greater on international circuits than on national circuits,

unanimously declares the view

that the drive against interruptions should be continued vigorously and that, in order to observe the progress of this drive, Administrations should continue to make symmetric observations of the frequency and duration of interruptions on voice-frequency telegraph channels,

and draws the attention

of the maintenance Study Group especially to the study of practical measures to remedy the situation.

Recommendation R.90

ORGANIZATION FOR LOCATING AND CLEARING FAULTS IN INTERNATIONAL TELEGRAPH SWITCHED NETWORKS

(former CCIT Recommendation B.55, Geneva, 1956; amended at New Delhi, 1960) and Malaga Torremolinos, 1984)

The CCITT,

considering

(a) that it is desirable that faults affecting communication between stations on international switching networks (e.g. telex and gentex service) should be reported and cleared as quickly as possible;

(b) that it is necessary to unify the essential action to be taken and methods to be employed for locating and clearing faults;

(c) that, for this purpose, it is necessary to determine the essential testing equipment that is to be provided at the switching centres responsible for locating and clearing faults,

unanimously declares the view

1 that it is necessary to set up switching and testing centres (STCs), defined as switching centres equipped with measuring equipment for testing telex subscribers' and public station lines and equipment and also telegraph channels.

2 Each telex subscriber and each public station in the general switching service should have access to an STC for the purpose of reporting faults and cooperating in tests.

3 International switching and testing centres (ISTCs) are the STCs that are also international line-head offices.

4 All STCs should be subscribers to the telex network, both for the purpose of receiving fault reports and for communication for maintenance purposes. They should also be provided with a telephone subscriber's line.

5 Each STC should be responsible for coordinating action in locating and clearing faults on all station lines connected to the exchange and on all trunk circuits for which it is nominated as the controlling office. It should also cooperate with other STCs in locating faults on connections established through two or more exchanges.

5.1 It should carry out a preliminary location of faults by finding out whether they affect channels, switching gear or apparatus. The faults are then accurately located by the engineers responsible for each part of the circuit and the STC cooperates with them for this purpose. It may assume the direction of the fault-locating procedure should there be disagreement between these services. Internationally, it is responsible to the STCs of other countries with which it has telex connections.

5.2 The organization of the liaison between the STC and the different technical services is shown in Figure 1/R.90. The STCs must check that the performance given by the equipment involved in the switching service, i.e. VF channels, switching equipment and apparatus, is satisfactory.

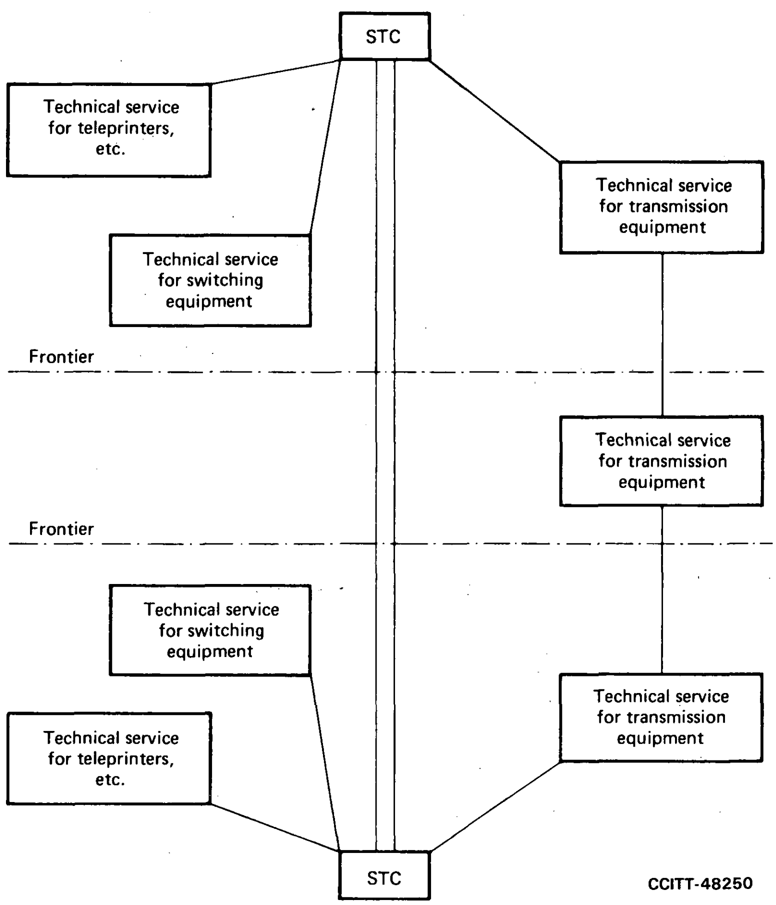


FIGURE 1/R.90

Maintenance organization

6 The staff employed at STCs should be selected with a view to avoiding language difficulties and should be conversant with all types of telegraph equipment used in the switching network, i.e. automatic or manual switching equipment, VFT equipment, telegraph machines and regenerative repeaters. The staff need not necessarily be fully competent to maintain all these items of equipment, but should have sufficient knowledge of them to be able to form an appreciation of the effect that faults on any of them may have on a switched connection. In addition, the staff of ISTCs should have some general knowledge of the types of equipment used in the countries to which they are connected, particularly of the signalling conditions that will be encountered.

7 Each STC should be provided with the following measuring equipment:

a) 50-baud start-stop distortion meter;

b) test transmitter for generating undistorted 50-baud start-stop signals;

c) apparatus to measure the modulation rate of teleprinters at a distance;

d) apparatus for measuring the speed and pulse ratio of dials, where appropriate;

e) apparatus for measurement of the condition of direct current lines; for example, continuity, resistance, insulation.

7.1 The arrangements for access to established connections for making test measurements should be such as not to cause interruptions or reduce the quality of transmission.

7.2 Considering that some Administrations have found it desirable to have available at the STC other items of apparatus to expedite the clearing of faults, all Administrations are invited to consider the utility of these devices, namely:

a) apparatus for measuring teleprinter margin;

b) recording distortion meters for testing established connections;

c) apparatus for measuring continuously, periodically and automatically, the distortion on subscribers' lines and apparatus.

8 The following procedure for reporting, locating and clearing faults should be adopted.

8.1 Faults should be reported to the STC concerned by the subscribers or operators who have experienced difficulty in operation. In the same way, it would be useful, in order to give the STCs a full picture of the situation, that the maintenance engineers should inform them of faults noted during the periodic maintenance operations. Faults should preferably be signalled by teleprinter, if their nature does not preclude this procedure.

8.2 A reference number should be given by the STC to the subscriber or service notifying the fault. This number can then be quoted in any subsequent inquiries as to the progress of fault clearance.

8.3 On account of the difficulties that may arise in the detection of faults on the international section of a communication (due to lack of knowledge of languages, etc.), care should be taken in each country to see that the national sections of the communication, including subscribers' lines and apparatus, are not involved before approaching the STC of the corresponding country.

8.4 Complete holding of a connection that is reported to be faulty should be avoided.

8.5 The STC notified of a fault should therefore begin by ascertaining that it is not located in the national section of the communication and for this purpose should, if necessary, approach the other STCs of its country concerned in the circuit. The STC of the distant country is then advised and, in turn, checks the national section routed over its network. The international section of the communication is not checked until the terminal national sections of telegraph circuits have been definitely exonerated. The STCs in different countries will communicate with one another, either directly or via their ISTCs, as determined by the Administrations concerned.

8.6 If the tests of the two local ends fail to reveal any fault conditions, the STC should report the fault to its ISTC, which will decide what further action, if any, is necessary. As a rule, isolated fault reports would not justify a test of all trunk circuits on a route, and it would be assumed that the condition giving rise to the fault would be cleared on the next routine adjustment. If however, several fault reports were received, some of which might have been due to a faulty circuit on a particular route, then a special routine test of all the circuits on the route might be justified.

8.7 In general, it is considered that the procedure will be broadly the same for manual, semi-automatic and automatic systems.

9 The abbreviations annexed below should be used in calls exchanged between services responsible for the maintenance of telegraph equipment.

ANNEX A

(to Recommendation R.90)

List of service abbreviations for maintenance of telegraph circuits

No.	*Abbreviation*	*Meaning*
30 *bis*	**BL**	Holding
30	**BL . . . SVP**	Please hold . . .
2	**BR TR . . .**	Bad transmission on . . .
39 *bis*	**CCT . . . IN**	I have restored circuit No. . . .
39	**CCT . . . IN SVP**	Please restore circuit No. . . .
38 *bis*	**CCT . . . OUT**	I have taken circuit No. . . . out of service
38	**CCT . . . OUT SVP**	Please take circuit No. . . . out of service
43	**CRD . . .**	The connection is released after selection on circuit No. . . .
37 *bis*	**CSR**	I am receiving your calling signal
8	**DER CCT**	Circuit faulty
51	**DER REG**	Register does not operate
52	**DER TAPE**	Your perforated tape is faulty
33	**DER VF . . .**	Fault on voice-frequency system . . .
7	**DERA**	Machine faulty
9	**DERPS**	Position equipment faulty
10	**DERR**	Fault now cleared
64	**DEVD**	Deviation of distributor speed at your end
23	**DEVS . . .**	Speed deviation is . . . %
16	**. . . DIS . . .**	The distortion on . . . is . . . %
62	**DS . . .**	Distribution switched over to . . .
25	**EDIS . . .**	The transmitter distortion is . . . %
1	**ICI . . .**	Here is . . .
53 *bis*	**LOOP . . .**	I have looped circuit . . .
53	**LOOP . . . SVP**	Please loop circuit . . .
24	**MAR . . .**	The margin is . . . %
18	**MEET . . .**	Meet me on circuit No. . . .
50	**N IND**	I am not receiving your answer-back code
40	**N PER A**	I am not receiving your permanent start polarity signal
41	**N PER Z**	I am not receiving your permanent stop polarity signal
66	**NARQ . . .**	Multiplex . . . unprotected; please re-establish automatic request for repetition (ARQ)

No.	*Abbreviation*	*Meaning*
31 *bis*	**NBL . . .**	Clearing
31	**NBL . . . SVP**	Please clear . . .
27	**NCFM . . .**	No call-confirmation signal on . . .
26	**NCS . . .**	No call-connected signal from . . .
11	**NDER**	No fault found
42	**NPS**	I am not receiving your proceed-to-select signal
28	**OCC OCC . . .**	Permanent busy signal from . . .
65	**OPH . . .**	Out of phase on system . . .
46	**PER A . . .**	Permanent start polarity on . . .
48	**PER A . . . SVP**	Please send permanent start polarity on . . .
47	**PER Z . . .**	Permanent stop polarity on . . .
49	**PER Z . . . SVP**	Please send permanent stop polarity on . . .
29	**PERC . . .**	Permanent call on . . .
63	**PH . . .**	Please phase system . . .
34 *bis*	**Q DIS A**	Is there bias distortion (prolonged start polarity) on the received signals?
35 *bis*	**Q DIS Z**	Is there bias distortion (prolonged stop polarity) on the received signals?
13	**QDIS . . .**	Please measure distortion on . . . and report result
37	**QRCS**	Are you receiving my calling signal?
3	**QREF**	Please give reference number
4	**QRES**	Please report result
15	**RAP . . . MNS**	I shall recall you in . . . minutes
14	**RAP . . . MNS SVP**	Please call me in . . . minutes
5	**REF . . .**	Reference number is . . .
6	**RES . . .**	Here is result of test on . . .
55	**RFC . . .**	I am receiving errors in 5-unit code. Please check channel No. . . .
70	**RMUT . . .**	I am receiving garbled signals on multiplex channel . . . please check your 7-unit code
54	**RQFS . . .**	Your repetition cycle transmission contains 7-unit code faults. Please check channel No. . . .
59	**RS . . .**	Reception switched over to . . .
44	**SIG 1/1 SVP**	Please send 1 : 1 signals
45	**SIG 2/2 SVP**	Please send 2 : 2 signals
61	**SS . . .**	Storage switched over to . . .
12	**TESTD . . . SVP**	Please send test message with . . . % distortion on . . .
67	**TRAS . . .**	Please send alpha signal on multiplex channel . . .
68	**TRBS . . .**	Please send beta signal on multiplex channel . . .
60	**TRS . . .**	Transmission switched over to . . .
21	**VERED**	Please check the transmitter distortion
22	**VERM**	Please check the margin

No.	Abbreviation	Meaning
20	**VERS**	Please check the speed
19	**VERX ...**	Please check subscriber No. ...
34	**ZKWA ...**	The received signals have ... % bias (start polarity prolonged)
35	**ZKWZ ...**	The received signals have ... % bias (stop polarity prolonged)
32	**ZOK**	I am receiving correctly
17	**ZSU**	Your signals are unreadable
71	**ZYA**	Cease traffic on all channels; send **As** on A channel for line-up
69	**ZYC**	Your transmitter is sending permanent ARQ
56	**ZYK ...**	Your keying on channel ... is affected; please check
57	**ZYM**	Change from single printer to multiplex
36	**ZYN**	Reduce the bias
58	**ZYP**	Change from multiplex to single printer

Recommendation R.91

GENERAL MAINTENANCE ASPECTS FOR THE MARITIME SATELLITE TELEX SERVICE

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that it is desirable to define the relationship between the maintenance organizations for the international telex service and the maritime satellite telex service;

(b) that it is advantageous that the maintenance procedures used in the maritime satellite telex service are similar to those used in the international telex service;

(c) that, from a maintenance and transmission point of view, the maritime satellite system may be regarded as analogous to a national network and the ship earth stations as somewhat analogous to subscriber terminals within that network;

(d) that the ship earth stations are connected to a coast earth station on a demand assignment basis and, therefore, the coast earth station may not have the direct responsibility for the maintenance of a particular ship earth station all the time;

(e) that the required staff and facilities may not be available at a ship earth station for maintenance purposes,

unanimously recommends

that the maintenance of telex circuits in the maritime satellite service should be based on the following principles:

1 The principles and methods for the maintenance of telegraph circuits contained in the Series R, Recommendations should be followed.

2 The coast earth stations or the associated telex switching centre should act as a control station for the maritime satellite telex circuits as defined in Recommendation R.71.

3 Similar principles as those defined in Recommendation M.1110 for the cooperation between maintenance elements of the INMARSAT system and the international telephone network should also apply to the INMARSAT system and the international telex network. The overall maintenance organization of the INMARSAT system is described in Recommendation M.1110.

4 The coast earth stations or the associated telex switching centres should act as STCs (switching and testing centres) as defined in Recommendation R.90 for access by ship earth stations for the purpose of fault reporting and testing.

4.1 The ship earth stations would access the STC at a coast earth station or its associated telex switching centre by using the telex access code 33 (technical assistance) as defined in Recommendation F.121.

4.2 Automatic test equipment at the STC is to be accessed by the telex access code 91 (automatic test line) as defined in Recommendation F.121.

Note – In the first generation INMARSAT system the test access will be to a termination which returns the "QUICK BROWN FOX ..." sequence.

5 In order to facilitate end-to-end testing of telex connections without involving a ship earth station, the maritime test terminal required by INMARSAT to be associated with each coast earth station should be used.

The description of the maritime test terminal and its capabilities is given in Recommendation M.1100.

SECTION 7

TIME DIVISION MULTIPLEXING

Recommendation R.100

TRANSMISSION CHARACTERISTICS OF INTERNATIONAL TDM LINKS

(Geneva, 1980)

Note – The application of TDM systems providing code- and speed-independent channels in addition to code- and speed-dependent channels is a subject for further study.

1 Analogue path links

1.1 Standard telephone carrier systems with 4-kHz and 3-kHz spaced channels permit homogeneous time division multiplex (TDM) telegraph systems, operated in association with 2400-bit/s data modems, to provide the capacities of telegraph channels shown in Table 1/R.100.

TABLE 1/R.100

Channel capacities of homogeneous TDM systems

TDM system type (see Note 1)	Quantity of channels provided by homogeneous system					
	50 baud	75 baud	100 baud	150 baud	200 baud	300 baud
Recommendation						
R.101, Alternative A	46	22	–	–	–	–
R.101, Alternative B	46	30	22	15	10	7
R.111	8	(see Note 2)	4	(see Note 2)	2	2

Note 1 – TDM systems complying with Recommendation R.101 provide code- and speed-dependent channels involving inherent regeneration of output signals. The provision of channels above 75 bauds for Recommendation R.101, Alternative A systems is the subject of further study.

TDM systems complying with Recommendation R.111 provide code- and speed-independent channels by a transition coding process that does not include regeneration of the output signals. Furthermore, these systems may have aggregate signalling rates of either 2.4, 4.8, 9.6 or 64 kbit/s.

Note 2 – The Recommendation R.111 homogeneous system configurations shown involve an aggregate rate of 2400 bit/s and 5% maximum isochronous distortion per channel due to sampling. 75- and 150-baud signals may be carried on nominal 100- and 200-baud channels respectively with proportionally less distortion.

1.2 A 4-wire link is required in association with the data modem employed to provide satisfactory transmission for the 2400-bit/s duplex aggregate signals of an international TDM system.

1.3 The data modem employed should preferably comply with the appropriate aspects of the Series V Recommendations. Multiple 2400-bit/s aggregates may be multiplexed onto the same 4-wire link using the appropriate internal multiplexing facilities of a Recommendation V.29 [1] modem. The reliability and availability of derived telegraph channels will, however, be highly dependent on the stability and characteristics of the bearer, modem and system arrangements adopted.

1.4 The conditions of use of international TDM links are generally similar to those for VFT links, described in Recommendation H.22 [2]. The requirements of the actual V-Series modem employed however, should be additionally respected.

Note – This subject is under study in Joint Working Party LTG, Study Group IV and Study Group IX.

1.5 PCM (pulse code modulation) telephone channels complying with Recommendation G.712 [3] are also generally suitable as bearers for TDM telegraph systems associated with modems complying with the Series V Recommendations. However, possible transmission arrangements involving tandem connection of a number of PCM channels require further study.

1.6 Recommendation R.111, in § 1.2.1, provides for the use of modems complying with the Recommendation cited in [4].

2 Digital path links

Note 1 – An international 64-kbit/s digital path using first-order 1544 or 2048 kbit/s multiplexers (Recommendations G.736 [5], G.737 [6], G.738 [7], G.739 [8]) can be used for routing:

- aggregate signals from telegraph TDM systems at 64 kbit/s (Recommendation R.111, § 1.2), and
- after time division multiplexing (Recommendations X.51 [9] and X.51 *bis* [10]), aggregate signals from telegraph TDM systems at 2.4 kbit/s (Recommendation R.101, § 8.4 and Recommendation R.111, § 2.2.1) and at 4.8 or 9.6 kbit/s (Recommendation R.111, § 2.2.1).

Note 2 – The maximum telegraph channel capacities for homogeneous systems and other parameters for such 64-kbit/s digital international links are the subject of further studies.

References

[1] CCITT Recommendation *9600 bits per second modem standardized for use on point-to-point 4-wire leased telephone-type circuits*, Rec. V.29.

[2] CCITT Recommendation *Transmission requirements of international voice-frequency telegraph links (at 50, 100 and 200 bauds)*, Rec. H.22.

[3] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Rec. G.712.

[4] CCITT Recommendation *Modems for synchronous data transmission using 60-108 kHz group band circuits*, Rec. V.36, § 1, f).

[5] CCITT Recommendation *Characteristics of synchronous digital multiplex equipment operating at 1544 kbit/s*, Rec. G.736.

[6] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s and operating synchronous 64 kbit/s digital access options*, Rec. G.737.

[7] CCITT Recommendation *Characteristics of a synchronous digital multiplex equipment operating at 2048 kbit/s*, Rec. G.738.

[8] CCITT Recommendation *Characteristics of an external access equipment operating at 2048 kbit/s and offering synchronous digital access at 64 kbit/s*, Rec. G.739.

[9] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks using 10-bit envelope structure*, Rec. X.51.

[10] CCITT Recommendation *Fundamental parameters of a 48-kbit/s user data signalling rate transmission scheme for the international interface between synchronous data networks using 10-bit envelope structure*, Rec. X.51 *bis*.

CODE AND SPEED DEPENDENT TDM SYSTEM FOR ANISOCHRONOUS TELEGRAPH AND DATA TRANSMISSION USING BIT INTERLEAVING

(Geneva, 1976; amended at Geneva, 1980 and Málaga-Torremolinos, 1984)

The CCITT,

considering

(a) that the economic transmission of large numbers of anisochronous telegraph and data services over a single telephone-type circuit may be achieved by using time-division multiplexing (TDM) techniques;

(b) that the multiplexing system should be capable of operating as a sub-multiplexer within a higher order TDM hierarchy as well as on an analogue telephone-type circuit in association with standard data modems;

(c) that the codes and speeds used for anisochronous telegraph and data transmission are well defined, permitting the application of simple code-dependent multiplexing techniques;

(d) that code-dependent multiplexing provides inherent regeneration of start-stop signals carried by the system;

(e) that, while it is foreseen that the main application would be for telex traffic, the multiplexing system should be capable of simultaneously transmitting the complete range of standard anisochronous speeds and codes likely to be required by users;

(f) that the multiplexing system should be capable of accepting for transmission all types of telex signals and of regenerating those signals at the channel outputs within the tolerances specified in the relevant CCITT Recommendations;

(g) that the multiplexing system should permit the efficient mixing of various combinations of anisochronous speeds, codes and signalling types in the same transmission system;

(h) that the minimum duration of signal transfer delay through the TDM system could be achieved by the transmission of interleaved elements;

unanimously declares the view

that, where bit-interleaved code and speed dependent TDM systems are used for anisochronous telegraph and data transmission with an aggregate bit rate of 2400 bit/s carried either by an analogue telephone-type circuit or by a higher order TDM, the equipment shall be constructed to comply with the following standard:

1 System capacity

1.1 The capacity of the system shall be 46 channels at 50 bauds (7.5 units including a stop element of 1.5 units).

1.2 For other modulation rates two alternatives are allowed.

1.2.1 *Alternative A*

1.2.1.1 Channels at 75 bauds (7.5 units including a stop element of 1.5 units) shall be accommodated. See § 5.5.2 below.

1.2.1.2 Further study is needed to accommodate other modulation rates.

1.2.2 *Alternative B*

1.2.2.1 The modulation rates and character structures shown in Table 1/R.101 shall be accommodated with the capacities indicated for homogeneous configurations.

1.2.2.2 The TDM system shall be capable of multiplexing the eight modulation rates shown in Table 1/R.101 simultaneously.

TABLE 1/R.101

System capacity (alternative B)

Modulation rate (bauds)	Character structure		Number of channels (homogeneous configuration)
	Character length (units)	Stop element (units)	
50	7.5	1.5	46
75	7.5	1.5	30
100	7.5 or 10	1.5 1	22
110	11	2	22
134.5	9	1	15
150	10	1	15
200	7.5, 10 or 11	1.5 1 2	10
300	10 or 11	1 2	7

2 Start-stop channel inputs

2.1 The modulation rate tolerance that shall be accepted on continuous incoming 50- and 75-baud start-stop signals with a stop element of 1.4 units shall be at least ± 1.4%.

2.2 When receiving characters at 50 or 75 bauds having nominally 1.5-unit stop elements, the system shall be capable of transmitting without error, isolated incoming characters that have a one-unit stop element, occurring at a maximum rate of one per second.

2.3 The minimum interval between start elements of undistorted successive continuous characters that may be presented at the channel input when the nominal modulation rate is 50 or 75 bauds shall be 145 5/6 or 97 2/9 ms respectively.

2.4 There shall be no restriction on the continuous transmission of all characters specified in § 1 above (e.g. combination No. 32 of International Telegraph Alphabet No. 2) when they are presented at the maximum permitted rate.

2.5 The effective net margin on all channel inputs when undistorted signals are received from a transmitter having a nominal character length and rate shall be at least 40%.

2.6 At the nominal signalling rate, an input character start element shall be rejected if equal to or less than 0.4 units duration and shall be accepted if equal to or more than 0.6 units duration.

2.7 Elements corresponding to start polarity (at the distant multiplexer output) shall be inserted in the aggregate stream in the case of:

a) unequipped channels;

b) equipped but unallocated channels;

c) open-circuit line condition at the local start-stop channel input.

2.8 The maximum tolerance on modulation rates other than 50 and 75 bauds shall be 1.8%.

3 Start-stop channel outputs

3.1 The maximum degree of gross start-stop distortion shall be 3% for all permitted modulation rates.

3.2 The maximum difference possible between the mean modulation rate of the channel output signals and the nominal modulation rate shall be 0.2%.

3.3 When characters having a nominal 1.5-unit stop element are presented at any input rate within the specified range of this Recommendation, the minimum stop element duration released at the output shall be 1.25 units.

3.4 When characters having a nominal 1- or 2-unit stop element are presented at any input rate within the specified range of this Recommendation, the minimum stop element duration released at the output shall be 0.8 or 1.8 units respectively.

3.5 Channel output shall be controlled as specified below in the event of recognition of any of the following failure conditions:

a) carrier loss signalled by the modem (OFF condition of received line signal detector – circuit CT109, Recommendation V.24 [1]);

b) loss of aggregate signal (defined as a period of 280 ms without a transition on the aggregate);

c) loss of synchronization.

3.6 Within 4 ms of the recognition of the failures described in § 3.5, the following shall occur to the channel outputs of the affected TDM:

3.6.1 Leased channels – two options shall be possible on a per channel basis:

a) set to steady start polarity;

b) set to steady stop polarity;

3.6.2 Circuit-switched service – two options shall be possible on a per channel basis:

a) steady start polarity at the channel output;

b) loopback of the channel towards the local end for a period of 5 ± 1 seconds, after which channel outputs shall revert to steady start polarity. Additionally for alternative B, the traffic path shall be maintained towards the distant multiplexer terminal during this loopback interval.

Note – The actions taken in case 3.6.2 a) shall ensure that, after recognition of failure, no 50-baud channel used for circuit-switched service shall produce an output pulse of stop polarity of longer than 20 ms or a series of 20-ms pulses of stop polarity. It should be noted that 20-ms pulses can cause difficulty with some switching equipment. The loopback option in 3.6.2 b) is provided in order to avoid clearance of established connections during short breaks and thus avoid excessive recall attempts.

3.7 The affected terminal shall signal its synchronization status to the distant terminal in accordance with §§ 6.3.5 for alternative A and 6.4.2 for alternative B. The distant terminal shall control its channel outputs in accordance with § 3.6 above with a delay that shall not exceed 600 ms (measured from the instant of failure), ignoring the propagation time of the bearer circuit. Alternatively, for alternative B, leased channels have the option, at the customer's request, of maintaining the traffic path in the unaffected direction.

4 Multiplexing details

4.1 Channel interleaving shall be on a bit basis.

4.2 Both start and stop elements of each input character shall be transmitted through the aggregate.

4.3 The transfer delay for 50- and 75-baud signals through a pair of terminals connected back-to-back (excluding the modems) shall not exceed 2.5 units. This delay shall be measured from the reception of the start element of a character at an input channel of one terminal until the corresponding start element is delivered from the output channel of the second terminal.

4.4 *Alternative A*

4.4.1 Multiplexing details for higher modulation rates remain for study.

4.5 *Alternative B*

4.5.1 The maximum transfer delay for all other permitted channel speeds for back-to-back terminals shall not exceed 3.5 units.

4.5.2 110-baud characters are conveyed on a 100-bit/s bearer channel by transmitting at least one stop element in the aggregate signal.

4.5.3 134.5-baud characters are conveyed on a 150-bit/s bearer channel by transmitting the necessary filling bits of stop polarity before the character start elements in the aggregate signal.

5 Frame structure

5.1 A unique subframe of 47 bits shall be used.

5.2 A 47-bit subframe shall consist of one synchronization bit in the first bit position and 46 traffic bits.

5.3 A fundamental frame consisting of two consecutive subframes shall be used.

5.4 Two alternative framing arrangements are allowed; however, the channel numbers used throughout this Recommendation represent the last two digits of a 4-digit numbering scheme - and are shown in Recommendation R.114. This channel numbering scheme (see Tables 3/R.101, 4/R.101 and 5/R.101) covers both framing arrangements.

5.5 *Alternative A*

5.5.1 Two scrambling techniques are used:

5.5.1.1 Alternate frame slots have inverted signal polarity. The chart of frame structure (see Table 2/R.101) indicates the pattern used. Channels not equipped are transmitted as A (start) polarity.

5.5.1.2 The channels are arranged for external interconnection with assignment of a sequence of channel numbers (channel 1 through channel 46). These channel numbers are distinct from frame slot assignment. (This is comparable to a VFT's having both a frequency assignment and a channel number.) The channel numbering sequence is scrambled with respect to the frame slot sequence. This technique is useful not only for ensuring a good distribution of transitions, but also for simplifying mixed speed programming.

TABLE 2/R.101

Frame for forty-six 50-baud channels with provision for 75-baud channels (Alternative A)

Subframe slot	Channel number	Aggregate polarity corresponding to Z polarity on low-speed channel	Channel speed
1	Not applicable		SYNC
2	02	A	50 [a]
3	01	Z	50
4	05	A	50
5	06	Z	50
6	09	A	50
7	10	Z	50
8	14	A	50
9	13	Z	50
10	17	A	50
11	18	Z	50
12	21	A	50
13	22	Z	50
14	25	A	50
15	26	Z	50
16	30	A	50
17	29	Z	50
18	33	A	50
19	34	Z	50
20	37	A	50
21	38	Z	50
22	41	A	50
23	42	Z	50

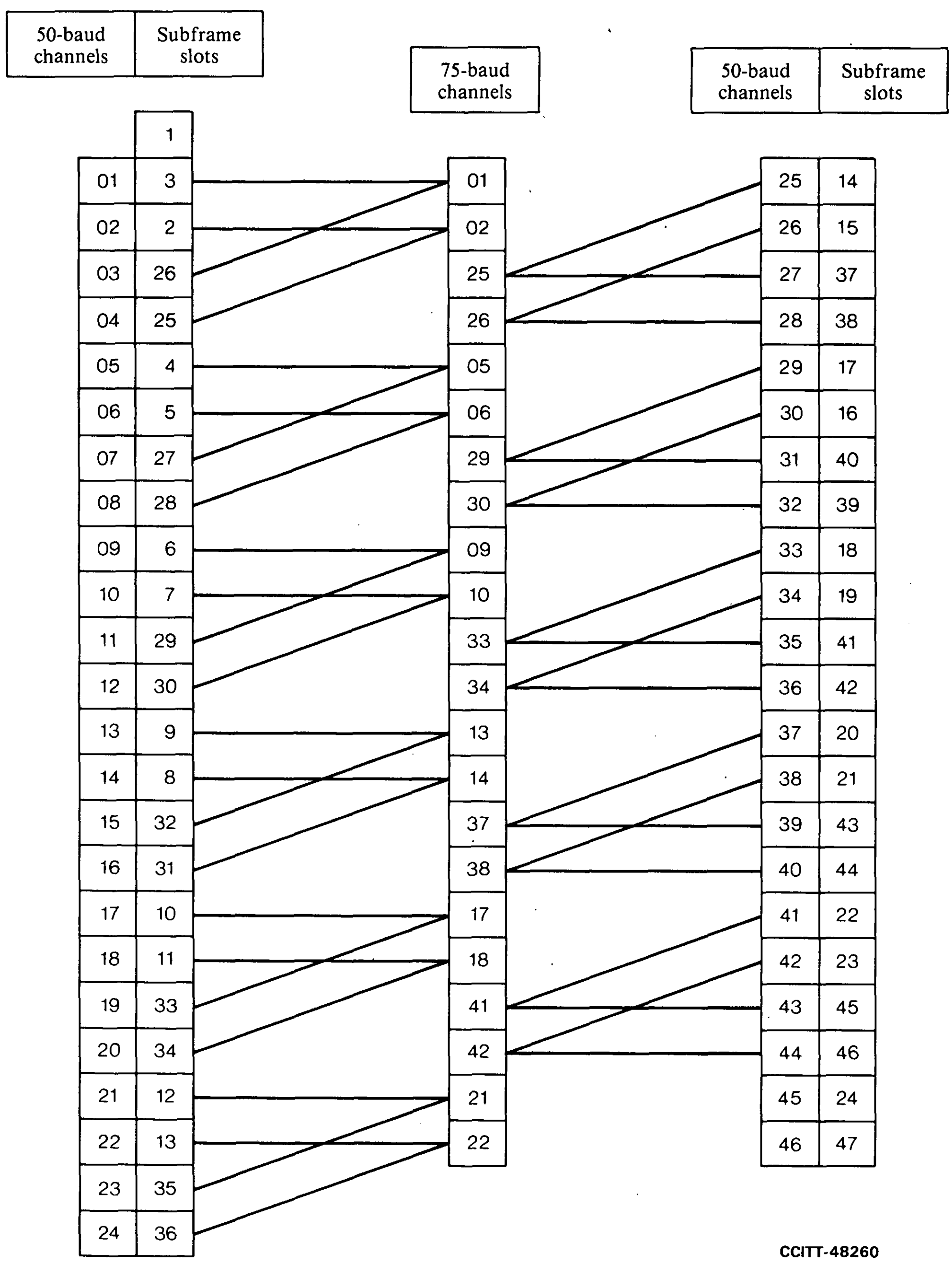
Subframe slot	Channel number	Aggregate polarity corresponding to Z polarity on low-speed channel	Channel speed
24	45	Z	50
25	04	A	50 [a]
26	03	Z	50
27	07	A	50
28	08	Z	50
29	11	A	50
30	12	Z	50
31	16	A	50
32	15	Z	50
33	19	A	50
34	20	Z	50
35	23	A	50
36	24	Z	50
37	27	A	50
38	28	Z	50
39	32	A	50
40	31	Z	50
41	35	A	50
42	36	Z	50
43	39	A	50
44	40	Z	50
45	43	A	50
46	44	Z	50
47	46	A	50

[a] Any horizontal pair, such as channels 02 and 04 (i.e. subframe slots 2 and 25), may be replaced by a 75-baud channel. (Slots 1, 24 and 47 excepted.) In this case "fill" pulses of A polarity must be inserted in each character following element numbers 2 and 5 (see the Recommendation cited in [2] for element numbers with International Telegraph Alphabet No. 2).

5.5.2 In Table 2/R.101, higher speed channels may be substituted for multiple low-speed channels. The resulting channel should bear the number of the lowest channel replaced. For example, when channels 02 and 04 are replaced by a 75-baud channel, the 75-baud channel should be known as channel 02. (See Table 3/R.101 for the relative numbering of 50- and 75-baud channels.)

TABLE 3/R.101

Channel numbering scheme for Alternative A

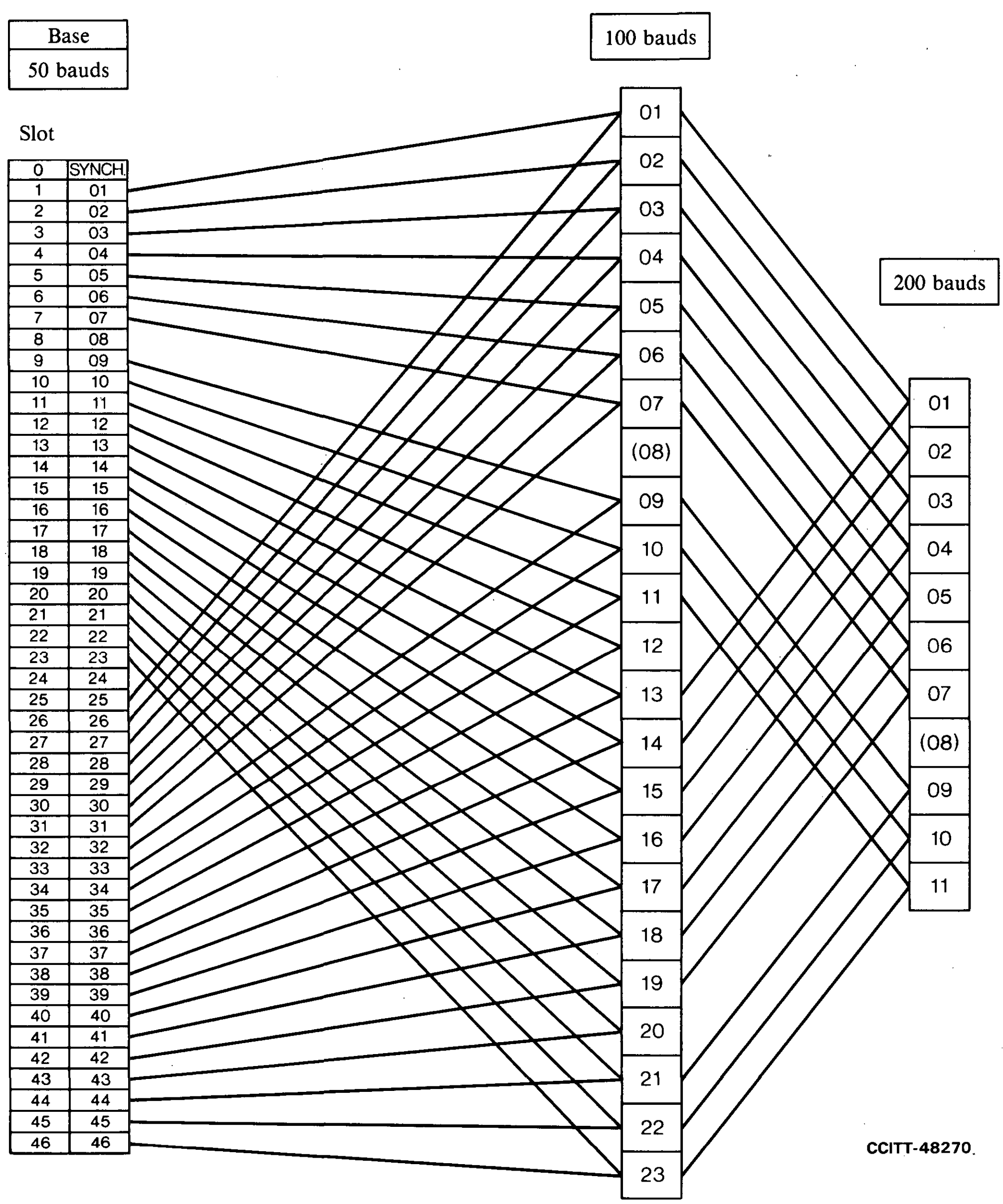


5.6 *Alternative B*

5.6.1 The channel allocation in the fundamental frame is shown in Table 6/R.101 in matrix form giving the relationship between individual low-speed channels and the corresponding traffic bits. The fundamental frame is represented as divided into four groups of 24 positions. The correspondence between positions in the matrix structure and bit numbers within the fundamental frame is shown in the bit number columns. The table also shows the distribution of positions within the specific groups for channels of different speeds and the corresponding channel numbering. (See also Tables 4/R.101 and 5/R.101.)

TABLE 4/R.101

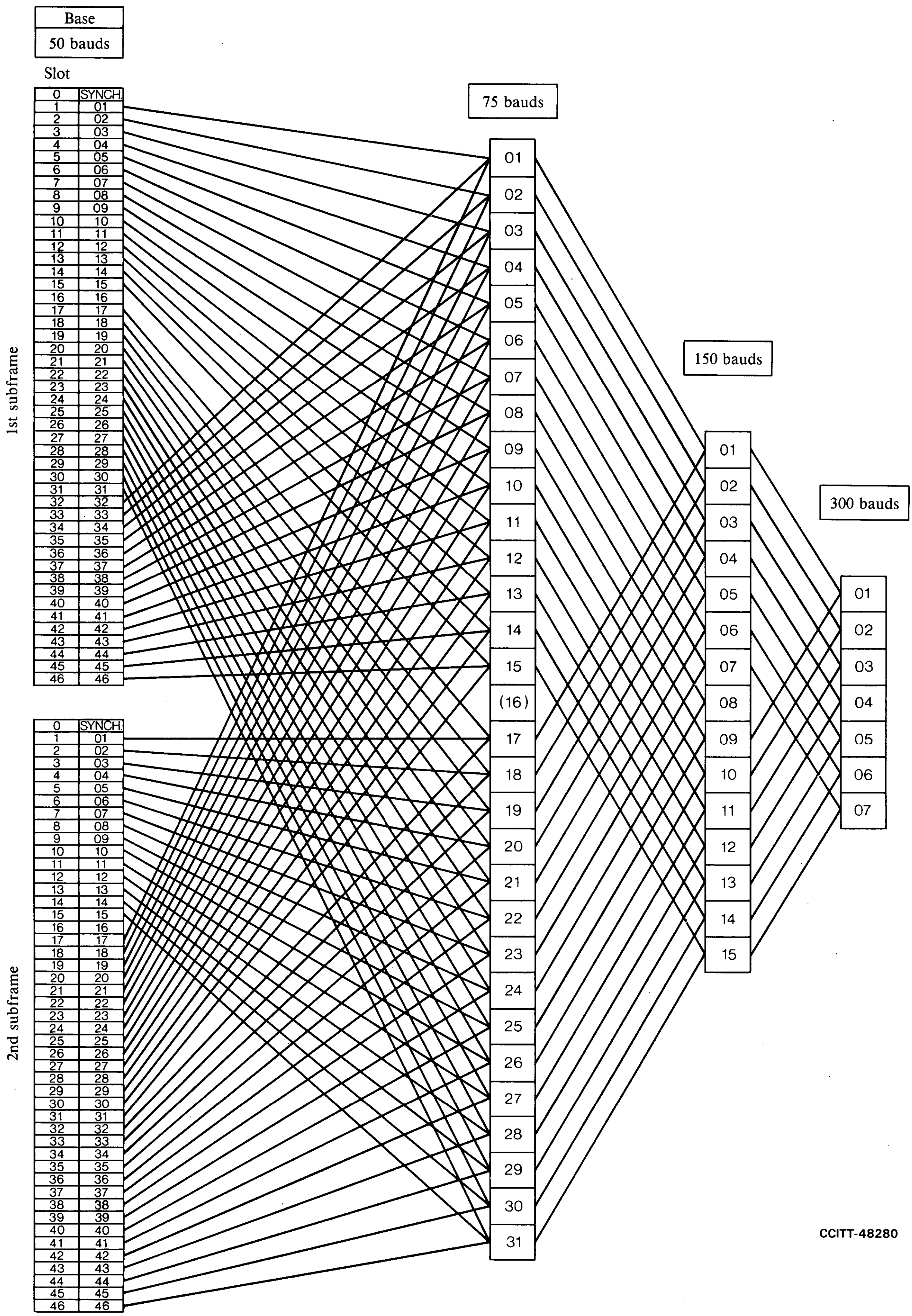
TDM channel numbering for Alternative B (50, 100 and 200 bauds)



Note – A higher rate channel cancels the use of all other channel numbers connected across to that channel number.

TABLE 5/R.101

TDM channel numbering for Alternative B (50, 75, 150 and 300 bauds)



Note – A higher rate channel cancels the use of all other channel numbers connected across to that channel number.

TABLE 6/R.101

Frame structure for Alternative B

		Subframe slot	Group one channel number						Subframe slot	Group two channel number						Subframe slot	Group three channel number						Subframe slot	Group four channel number					
Channel rate (bauds)			50	100	200	75	150	300		50	100	200	75	150	300		50	100	200	75	150	300		50	100	200	75	150	300
Fundamental frame	First subframe	0	Synchronization bit						1	01	01	01	01	01	01	2	02	02	02	02	02	02	3	03	03	03	03	03	03
		4	04	04	04	04	04	04	5	05	05	05	05	05	05	6	06	06	06	06	06	06	7	07	07	07	07	07	07
		8	08	x	x	08	08	x	9	09	09	09	09	09	01	10	10	10	10	10	10	02	11	11	11	11	11	11	03
		12	12	12	x	12	12	04	13	13	13	01	13	13	05	14	14	14	02	14	14	06	15	15	15	03	15	15	07
		16	16	16	04	x	x	x	17	17	17	05	17	01	01	18	18	18	06	18	02	02	19	19	19	07	19	03	03
		20	20	20	x	20	04	04	21	21	21	09	21	05	05	22	22	22	10	22	06	06	23	23	23	11	23	07	07
		24	24	x	x	24	08	x	25	25	01	01	25	09	01	26	26	02	02	26	10	02	27	27	03	03	27	11	03
		28	28	04	04	28	12	04	29	29	05	05	29	13	05	30	30	06	06	30	14	06	31	31	07	07	31	15	07
			Skipped						32	32	09	09	01	01	01	33	33	10	10	02	02	02	34	34	11	11	03	03	03
		35	35	12	x	04	04	04	36	36	13	01	05	05	05	37	37	14	02	06	06	06	38	38	15	03	07	07	07
		39	39	16	04	08	08	x	40	40	17	05	09	09	01	41	41	18	06	10	10	02	42	42	19	07	11	11	03
		43	43	20	x	12	12	04	44	44	21	09	13	13	05	45	45	22	10	14	14	06	46	46	23	11	15	15	07
	Second subframe	0	Synchronization bit						1				17			2				18			3				19		
		4				20			5				21			6				22			7				23		
		8				24			9				25			10				26			11				27		
		12				28			13				29			14				30			15				31		
		16				x			17				01			18				02			19				03		
		20				04			21				05			22				06			23				07		
		24				08			25				09			26				10			27				11		
		28				12			29				13			30				14			31				15		
			Skipped						32				17			33				18			34				19		
		35				20			36				21			37				22			38				23		
		39				24			40				25			41				26			42				27		
		43				28			44				29			45				30			46				31		

Note 1 – Blank slots in second subframe are as first subframe.

Note 2 – x = bit not available for corresponding channel bit rate.

Note 3 – 110- and 134.5-baud signals shall be transmitted on 100 and 150 bit/s bearer channels respectively and restituted with appropriate rate at the channel output. See also §§ 4.5.2 and 4.5.3 (Alternative B).

TABLE 7/R.101

Alternative B channel numbering

Channel rate (bauds)	Range of channel number n	Subframe slot(s) allocated to channel number n	
50	01 – 46	n	
75	01 – 15	n and $(n + 31)$ from first subframe and $(n + 16)$ from second subframe	See Notes 1 and 2
	17 – 31	n from first subframe and $(n - 16)$ and $(n + 15)$ from second subframe	
100	01 – 07	n and $(n + 24)$	See Note 3
	09 – 23	n and $(n + 23)$	
150	01 – 15	n and $(n + 16)$ and $(n + 31)$	
200	01 – 07	n and $(n + 12)$ and $(n + 24)$ and $(n + 35)$	See Note 3
	09 – 11	n and $(n + 12)$ and $(n + 23)$ and $(n + 35)$	
300	01 – 07	n and $(n + 8)$ and $(n + 16)$ and $(n + 24)$ and $(n + 31)$ and $(n + 39)$	

Note 1 – At 75 bauds, channel number n and $n + 16$ are interdependent, i.e. when channel n is used for 75 baud traffic, channel $n + 16$ must also be used for 75 bauds or remain unallocated.

Note 2 – Channel number 16 not used.

Note 3 – Channel number 08 not used.

Note 4 – 110- and 134.5-baud signals shall be transmitted on 100 and 150 bit/s bearer channels respectively and restituted with appropriate rate at the channel output. See also §§ 4.5.2 and 4.5.3 (Alternative B).

Note 1 – For all speeds other than 75 bauds, the second subframe in the fundamental frame is a repetition of the first subframe.

Note 2 – In each subframe one position within group 1 is skipped, i.e. allocated zero time in the aggregate signal.

5.6.2 Substitution of higher speed channels into a homogeneous 50-baud system configuration shall be made as follows:

2 × 75-baud channels	replaces 3 × 50-baud channels
1 × 100- or 110-baud channel	replaces 2 × 50-baud channels
1 × 150- or 134.5-baud channel	replaces 3 × 50-baud channels
1 × 200-baud channel	replaces 4 × 50-baud channels
1 × 300-baud channel	replaces 6 × 50-baud channels

5.6.3 All bits from groups 3 and 4 shall give inverted polarity.

5.6.4 The first, third and fifth bits of the synchronization pattern are contained in the first subframe. The second, fourth and sixth bits are contained in the second subframe (see § 6.4.2).

6 Synchronizing

6.1 The system shall not lose synchronism more than once per hour for a randomly distributed error rate of one part in 10^3.

6.2 Two synchronizing arrangements are allowed as follows on §§ 6.3 and 6.4.

6.3 *Alternative A*

6.3.1 The synchronizing bits shall be alternated between 1 and 0 in successive subframes during normal traffic periods.

6.3.2 The system shall declare loss of synchronism when 7 synchronizing bits are detected in error during a period of 1.5 to 2 seconds.

6.3.3 With two terminals connected back-to-back (excluding the modems), one terminal shall be capable of detecting loss of synchronism within 280 ms when its received aggregate signals are replaced by either steady start or steady stop polarity.

6.3.4 Under the conditions in § 6.1 above, after loss of synchronism has been recognized and the receive aggregate signals have been restored, the average time that may be taken for the terminal concerned to resynchronize and to connect normal data through to the low-speed channel outputs shall be less than 900 ms.

6.3.5 When one terminal recognizes loss of synchronism:

a) traffic transmitted to the other terminal shall be interrupted immediately;

b) the changes shown in Figures 1/R.101 and 2/R.101 shall occur in the synchronizing pattern.

6.4 *Alternative B*

6.4.1 A sync frame is defined as a sequence of three consecutive fundamental frames (i.e. six consecutive subframes) containing a synchronization word that consists of six equidistantly spaced bits.

6.4.2 The normal sync pattern transmitted when the TDM terminal receiver is correctly synchronized will be 100010. When the receiver is out of synchronism the transmitted pattern shall be 011101 (see § 6.4.5 below). The changeover shall only occur at the end of a sync frame.

6.4.3 Loss of synchronism is defined when three consecutive synchronization patterns are received in error.

6.4.4 When the received aggregate signal is replaced by steady start or steady stop polarity, the receiver terminal shall be capable of detecting loss of synchronism within 280 ms.

6.4.5 With two terminals connected back-to-back, loss of synchronism in one terminal shall be indicated at the other terminal within 240 ms, by inversion of the normal synchronization pattern. (See § 6.4.2 above.)

6.5 Receipt of the inverted sync pattern shall cause the terminal to force the aggregate traffic bits to the polarities corresponding to:

a) steady start at the start-stop channel input for channels that are used for circuit-switched service and that are in the free-line condition;

b) steady stop at the start-stop channel input for all other channels,

that is, both transmitted in accordance with § 5.6.3 above.

Normal data transmission

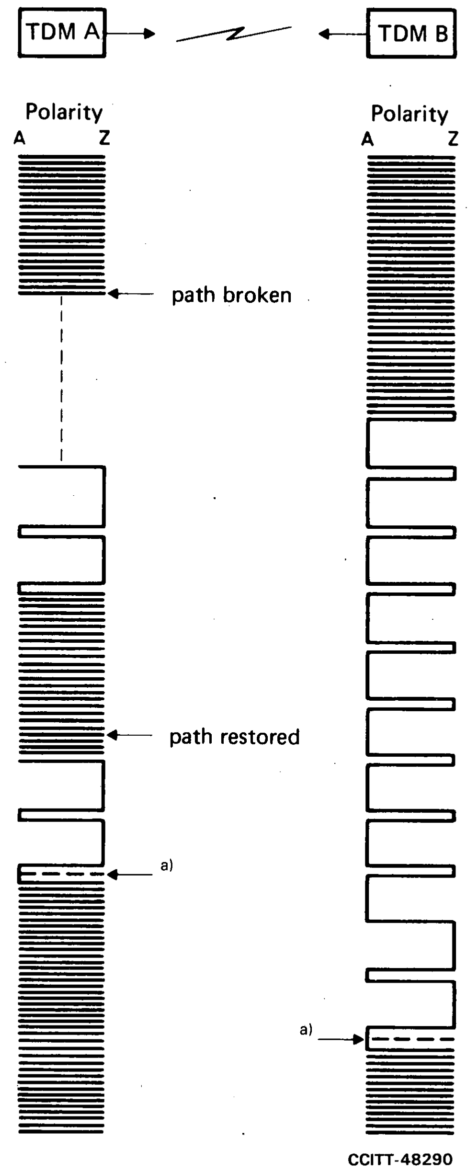
Interruption of A send path
(B receive path)

B detects OUT OF SYNC, sends SYNC REQUEST

A detects SYNC REQUEST, sends SYNC PREP and SYNC TERM, followed by data for 700 to 900 ms, ignoring further SYNC REQUESTS. This cycle repeats until link is restored. (For satellite operation the timer allows for 1.2 to 1.8 seconds, excluding incremental delays in other transmission equipment, total round trip propagation delay.)

When link is restored, B detects SYNC PREP and SYNC TERM. B sends SYNC PREP and SYNC TERM followed by data.

Normal data transmission

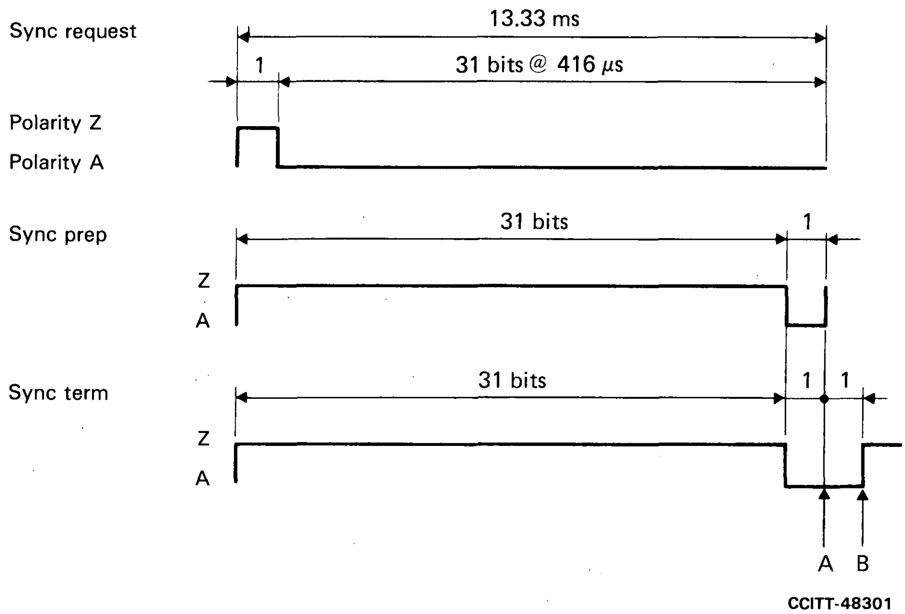


a) Aggregate time slot counters are reset to zero upon receipt of SYNC TERM. FRAME SYNC is the next bit transmitted. See description of SYNC TERM, which follows in Figure 2R/101.

Note – It should be noted that there is equipment (corresponding to Alternative A) in use that applies SYNC signals that are of inverted polarity to those shown in this Recommendation.

FIGURE 1/R.101

TDM synchronization procedure (Alternative A)



Note 1 – When synchronization is achieved, point A represents the time when aggregate time slot counters are reset to zero. The interval from A to B represents the frame SYNC pulse of the first subframe to be released after synchronization.

Note 2 – It should be noted that there is equipment (corresponding to Alternative A) in use that applies SYNC signals that are of inverted polarity to those shown in this Recommendation.

FIGURE 2/R.101

Synchronization signals (Alternative A)

6.6 Synchronism is defined as achieved when:

a) six identical synchronization patterns (i.e. six normal or six inverted synchronization patterns) have been consecutively received on a single bit position without error; and

b) within the same period, two or more consecutive identical synchronization patterns (i.e. normal or inverted sense) have not been received on any of the other bit positions in the 47-bit subframe.

The sense of the patterns in a) and b) may be different.

6.7 If condition a) in § 6.6 above is fulfilled while condition b) is not:

a) the search for synchronism is continued in the terminal concerned; and

b) this terminal shall force the transmitted aggregate traffic bits to the polarities indicated in § 6.5 above.

6.8 Under the conditions in § 6.1 above, after loss of synchronism has been recognized and the aggregate signals have been restored, the average time that may be taken for the terminal concerned to resynchronize and to connect normal data through to the low-speed channel outputs shall be less than 960 ms, excluding all transmission delays external to the R.101 TDM terminal equipment.

7 Telex signalling

7.1 Specifications for the signals used to establish, to clear and to control telex calls are laid down in Recommendations U.1 (types A and B), U.11 (type C) and U.12 (type D). Recommendation U.25 lists the modes of both-way telex signalling on a single circuit and the signalling combinations on a given aggregate that a TDM terminal shall be capable of handling.

7.2 Recommendation U.25 also lays down the tolerances on the control signals from a TDM terminal to telex and vice versa.

8 Aggregate signals and interface

8.1 The tolerance on the modulation rate of the send aggregate signals of the TDM system shall be ± 0.01%.

8.2 The maximum degree of isochronous distortion of the send aggregate signals of the TDM system shall be 4%.

8.3 The effective net margin of the aggregate receiver of the TDM system shall be at least 40%.

8.4 When the TDM system is operated with an aggregate speed of 2400 bit/s over an international analogue telephone-type circuit, it is preferred that a modem complying with the appropriate aspects of the Series V Recommendations be employed.

8.5 The electrical interface conditions and control signals between the TDM system and the bearer circuit shall comply with the appropriate Recommendations in the V and X Series.

9 System clock arrangements

9.1 The TDM system shall be capable of operating with either an internal or external transmit clock.

9.2 In the event of the failure of an external clock that may be used for the TDM transmit, the TDM shall continue to function locally for maintenance purposes using its own internal clock.

9.3 The receive clock for the TDM terminal shall be provided by the bearer circuit or higher order multiplex.

9.4 In the event of the failure of an external clock that may be used for the TDM receive, the TDM shall continue to function locally for maintenance purposes using its own internal clock.

9.5 The internal clock provided in the TDM terminal should have an accuracy of 0.01%.

10 System maintenance, control and alarms

10.1 One 50-baud channel may be allocated (on an optional basis) for maintenance purposes, where possible on a separate system using a parallel route. Where this option is exercised, channels 16 or 24 (subframe slots 16 or 24) in alternative B equipment or channel 45 (subframe slot 24) in alternative A equipment are preferred to minimize the effect on the derivation of higher-rate channels.

10.2 If the internal (logic) power supply of the TDM terminal fails and an external telegraph battery supply is employed, all local start-stop channel outputs shall be controlled to start polarity.

10.3 It shall be possible to reallocate individual start-stop channels for different services without removing the TDM terminal from service.

11 Link transmission system quality indicator

11.1 The synchronizing bits in the alternative A or B structures shall be monitored (on an optional basis) to provide information on the error rate of the aggregate.

11.2 For alternative A, the occurrence of an incorrect synchronizing bit (when the TDM is in synchronism) should be signalled to an internal or external equipment (see Note 1). Alternative B is for further study.

11.3 The interface between the telegraph muldex and the measuring equipment should be in accordance with national requirements.

11.4 Between the moment at which the TDM system has declared loss of synchronism and restoration of the latter, the invalid synchronization pulse shall not be generated.

12 Link transmission system availability indicator

12.1 The loss of synchronism of a synchronized TDM in alternative A or B shall be monitored (on an optional basis) to provide an indication of the transmission system availability.

12.2 The interface between the telegraph muldex and the measuring equipment (see Note 2) giving the out-of-service status should be in accordance with national requirements.

Note 1 – The external equipment may take the form of a simple indicating device or a computer system. The "dead time" of the device may be 20 ms, 150 ms, 1000 ms or a multiple of the (sub) frame length, this value being left for further study.

Wherever possible the error count values should be compared with the Recommendation R.54 requirement (one character in error for the complete transmission system in 100 000, characters).

Alarm values of a high count number in excess of the above criteria or a large deviation from a normal count value shall be advised to the corresponding Administration.

Note 2 – A measurement of unavailability (with respect to transmission system quality) includes breaks due to failure of transmission equipment and transmission propagation anomalies. The external equipment may take the form of a simple indicating device or a computer system. The "dead time" of the equipment shall be 300 ms or 1000 ms, the value being left for further study.

Wherever possible the long term availability shall be in accordance with CCIR Recommendation 557, namely 99.7%. It is recognized in this CCIR Recommendation, that in practice the objectives may fall in the range 99.5 to 99.9%, this value being left for further study.

References

[1] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Rec. V.24.

[2] CCITT Recommendation *Operational provisions for the international public telegram service*, Rec. F.1, § C8.

Recommendation R.102

4800 BIT/S CODE AND SPEED DEPENDENT AND HYBRID TDM SYSTEMS FOR ANISOCHRONOUS TELEGRAPH AND DATA TRANSMISSION USING BIT INTERLEAVING

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that there is a demand for a bit-interleaved code and speed dependent TDM system for anisochronous telegraph and data transmission using an aggregate bit rate of 4800 bit/s;

(b) that an increase of the economical transmission of large numbers of anisochronous telegraph and data signals, especially those of higher modulation rates e.g. 300 bauds, can be achieved by doubling the system capacity normally carried over a code and speed dependent TDM using an aggregate bit rate of 2400 bit/s;

(c) that the doubling of system capacity should be based on the already well defined time division multiplexing (TDM) technique used for the multiplexing system according to Recommendation R.101 retaining the frame structure of alternative B;

(d) that unit modularity, operation and maintenance should best be rationalized for both the basic Recommendation R.101 (alternative B) TDM and the expanded multiplexing system with the higher aggregate bit rate;

(e) that the expanded multiplexing system should permit the accommodation of code-dependent and code-independent (transparent) channels using the TDM hybrid technique according to Recommendation R.112;

(f) that the expanded multiplexing system should permit the accommodation of new facilities emerging in the future,

unanimously declares the view

that, where bit-interleaved code and speed dependent TDM systems with the provision for a limited use of code-independent (transparent) channels are used for anisochronous telegraph and data transmission with an aggregate bit rate of 4800 bit/s carried either by an analogue telephone-type circuit or by a higher order TDM, the equipment shall be constructed as an expanded multiplexing system to the basic Recommendation R.101 (alternative B) TDM to comply with the following standard:

1 System capacity

1.1 The capacity of the system shall be 92 channels at 50 bauds (7.5 units including a stop element of 1.5 units).

1.2 For other modulation rates see Table 1/R.102.

1.2.1 The modulation rates and character structures shown in Table 1/R.102 shall be accommodated with the capacities indicated for homogeneous configurations.

TABLE 1/R.102

System capacity

Modulation rate (bauds)	Character structure		Number of channels (homogeneous configuration)
	Character length (units)	Stop element (units)	
50	7.5	1.5	92
75	7.5	1.5	46
100	7.5 or 10	1.5 1	46
110	11	2	46
134.5	9	1	30
150	10	1	30
200	7.5, 10 or 11	1.5 1 2	22
300	10 or 11	1 2	15

Note – The system capacity for code-independent channels using the TDM hybrid technique according to Recommendation R. 112 is not covered by this table.

1.2.2 The TDM system shall be capable of multiplexing the eight modulation rates shown in Table 1/R.102 simultaneously.

1.2.3 The TDM system shall provide for a limited use of transparent channels. In using the TDM hybrid technique, the system capacity and the overall characteristics of the code-independent channel from the channel input to the channel output shall be in accordance with Recommendation R.112.

Note – The overall characteristics of code- and speed-dependent channels are the subject of this Recommendation and are specified in the following clauses.

2 Start-stop channel inputs

2.1 The modulation rate tolerance that shall be accepted on continuous incoming 50- and 75-baud start-stop signals with a stop element of 1.4 units shall be at least ± 1.4%.

2.2 When receiving characters at 50 or 75 bauds having nominally 1.5-unit stop elements, the system shall be capable of transmitting without error, isolated incoming characters that have a one-unit stop element, occuring at a maximum rate of one per second.

2.3 The minimum interval between start elements of undistorted successive continuous characters that may be presented at the channel input when the nominal modulation rate is 50 or 75 bauds shall be 145 5/6 or 97 2/9 ms respectively.

2.4 There shall be no restriction on the continuous transmission of all characters specified in § 1 above (e.g. combination No. 32 of International Telegraph Alphabet No. 2) when they are presented at the maximum permitted rate.

2.5 The effective net margin on all channel inputs when undistorted signals are received from a transmitter having a nominal character length and rate shall be at least 40%.

2.6 At the nominal signalling rate, an input character start element shall be rejected if equal to or less than 0.4 units duration and shall be accepted if equal to or more than 0.6 units duration.

2.7 Elements corresponding to start polarity (at the distant multiplexer output) shall be inserted in the aggregate stream in the case of:

a) unequipped channels;

b) equipped but unallocated channels;

c) open-circuit line condition at the local start-stop channel input.

2.8 The maximum tolerance on modulation rates other than 50 and 75 bauds shall be 1.8%.

3 Start-stop channel outputs

3.1 The maximum degree of gross start-stop distortion shall be 3% for all permitted modulation rates.

3.2 The maximum difference possible between the mean modulation rate of the channel output signals and the nominal modulation rate shall be 0.2%.

3.3 When characters having a nominal 1.5-unit stop element are presented at any input rate within the specified range of this Recommendation, the minimum stop element duration released at the output shall be 1.25 units.

3.4 When characters having a nominal 1- or 2-unit stop element are presented at any input rate within the specified range of this Recommendation, the minimum stop element duration released at the output shall be 0.8 or 1.8 units respectively.

3.5 Channel output shall be controlled as specified below in the event of recognition of any of the following failure conditions:

a) carrier loss signalled by the modem (OFF condition of received line signal detector – circuit CT109, Recommendation V.24 [1]);

b) loss of aggregate signal (defined as a period of 280 ms without a transition on the aggregate);

c) loss of synchronization.

3.6 Within 4 ms of the recognition of the failures described in § 3.5, the following shall occur to the channel outputs of the affected TDM:

3.6.1 Leased channels – two options shall be possible on a per channel basis:

a) set to steady start polarity;

b) set to steady stop polarity;

3.6.2 Circuit-switched service – two options shall be possible on a per channel basis:

a) steady start polarity at the channel output;

b) loopback of the channel towards the local end for a period of 5 ± 1 seconds, after which channel outputs shall revert to steady start polarity. Additionally, the traffic path shall be maintained towards the distant multiplexer terminal during this loopback interval.

Note – The actions taken in case 3.6.2 a) shall ensure that, after recognition of failure, no 50-baud channel used for circuit-switched service shall produce an output pulse of stop polarity of longer than 20 ms or a series of 20-ms pulses of stop polarity. It should be noted that 20-ms pulses can cause difficulty with some switching equipment. The loopback option in 3.6.2 b) is provided in order to avoid clearance of established connections during short breaks and thus avoid excessive recall attempts.

3.7 The affected terminal shall signal its synchronization status to the distant terminal in accordance with § 6.4. The distant terminal shall control its outputs in accordance with § 3.6 above with a delay that shall not exceed 600 ms (measured from the instant of failure), ignoring the propagation time of the bearer circuit. Alternatively, leased channels have the option, at the customer's request, of maintaining the traffic path in the unaffected direction.

4 Multiplexing details

4.1 Channel interleaving shall be on a bit basis.

4.2 Both start and stop elements of each input character shall be transmitted through the aggregate.

4.3 The transfer delay for 50- and 75-baud signals through a pair of terminals connected back-to-back (excluding the modems) shall not exceed 2.5 units. This delay shall be measured from the reception of the start element of a character at an input channel of one terminal until the corresponding start element is delivered from the output channel of the second terminal.

4.4 The maximum transfer delay for all other permitted channel speeds for back-to-back terminals shall not exceed 3.5 units.

4.5 75-baud characters are conveyed on a 100-bit/s bearer channel by transmitting filling bits in each character following element numbers 2 and 5 [2].

4.6 110-baud characters are conveyed on a 100-bit/s bearer channel by transmitting at least one stop element in the aggregate signal.

4.7 134.5-baud characters are conveyed on a 150-bit/s bearer channel by transmitting the necessary filling bits of stop polarity before the character start elements in the aggregate signal.

5 Frame structure

5.1 A unique subframe of 47 bits shall be used.

5.2 A 47-bit subframe shall consist of one synchronization bit in the first bit position and 46 traffic bits.

5.3 A fundamental frame consisting of two consecutive subframes shall be used.

5.4 One framing arrangement is allowed. The channel numbers used throughout this Recommendation represent the last two digits of a 4-digit numbering scheme – the first two digits are shown in Recommendation R.114. This channel numbering scheme is shown in Table 2/R.102 and in Table 3/R.102.

5.5 The channel allocation in the fundamental frame is shown in Table 4/R.102 in matrix form giving the relationship between individual low-speed channels and the corresponding traffic bits. The fundamental frame is represented as divided into four groups of 24 positions. The correspondence between positions in the matrix structure and bit numbers within the fundamental frame is shown in the bit number columns. The table also shows the distribution of positions within the specific groups for channels of different speeds and the corresponding channel numbering. (See also Tables 2/R.102 and 3/R.102.)

Note 1 – For all speeds other than 50 and 150 bauds, the second subframe in the fundamental frame is a repetition of the first subframe.

Note 2 – In each subframe one position within group 1 is skipped, i.e. allocated zero time in the aggregate signal.

5.6 Substitution of higher speed channels into a homogeneous 50-baud system configuration shall be made as follows:

1 × 75- or 100- or 110-baud channel	replaces 2 × 50-baud channels
1 × 150- or 134.5-baud channel	replaces 3 × 50-baud channels
1 × 200-baud channel	replaces 4 × 50-baud channels
1 × 300-baud channel	replaces 6 × 50-baud channels

5.7 All bits from groups 3 and 4 shall give inverted polarity.

5.8 The first, third and fifth bits of the synchronization pattern are contained in the first subframe. The second, fourth and sixth bits are contained in the second subframe (see § 6.4).

6 Synchronizing

6.1 The system shall not lose synchronism more than once per hour for a randomly distributed error rate of one part in 10^3.

6.2 One synchronizing arrangement is allowed as described in §§ 6.3 through 6.11.

6.3 A sync frame is defined as a sequence of three consecutive fundamental frames (i.e. six consecutive subframes) containing a synchronization word that consists of six equidistantly spaced bits.

6.4 The normal sync pattern transmitted when the TDM terminal receiver is correctly synchronized will be 100010. When the receiver is out of synchronism the transmitted pattern shall be 011101 (see § 6.7 below). The changeover shall only occur at the end of a sync frame.

6.5 Loss of synchronism is defined when three consecutive synchronization patterns are received in error.

6.6 When the received aggregate signal is replaced by steady start or steady stop polarity, the receiver terminal shall be capable of detecting loss of synchronism within 140 ms.

6.7 With two terminals connected back-to-back, loss of synchronism in one terminal shall be indicated at the other terminal within 120 ms, by inversion of the normal synchronization pattern. (See § 6.4 above.)

6.8 Receipt of the inverted sync pattern shall cause the terminal to force the aggregate traffic bits to the polarities corresponding to:

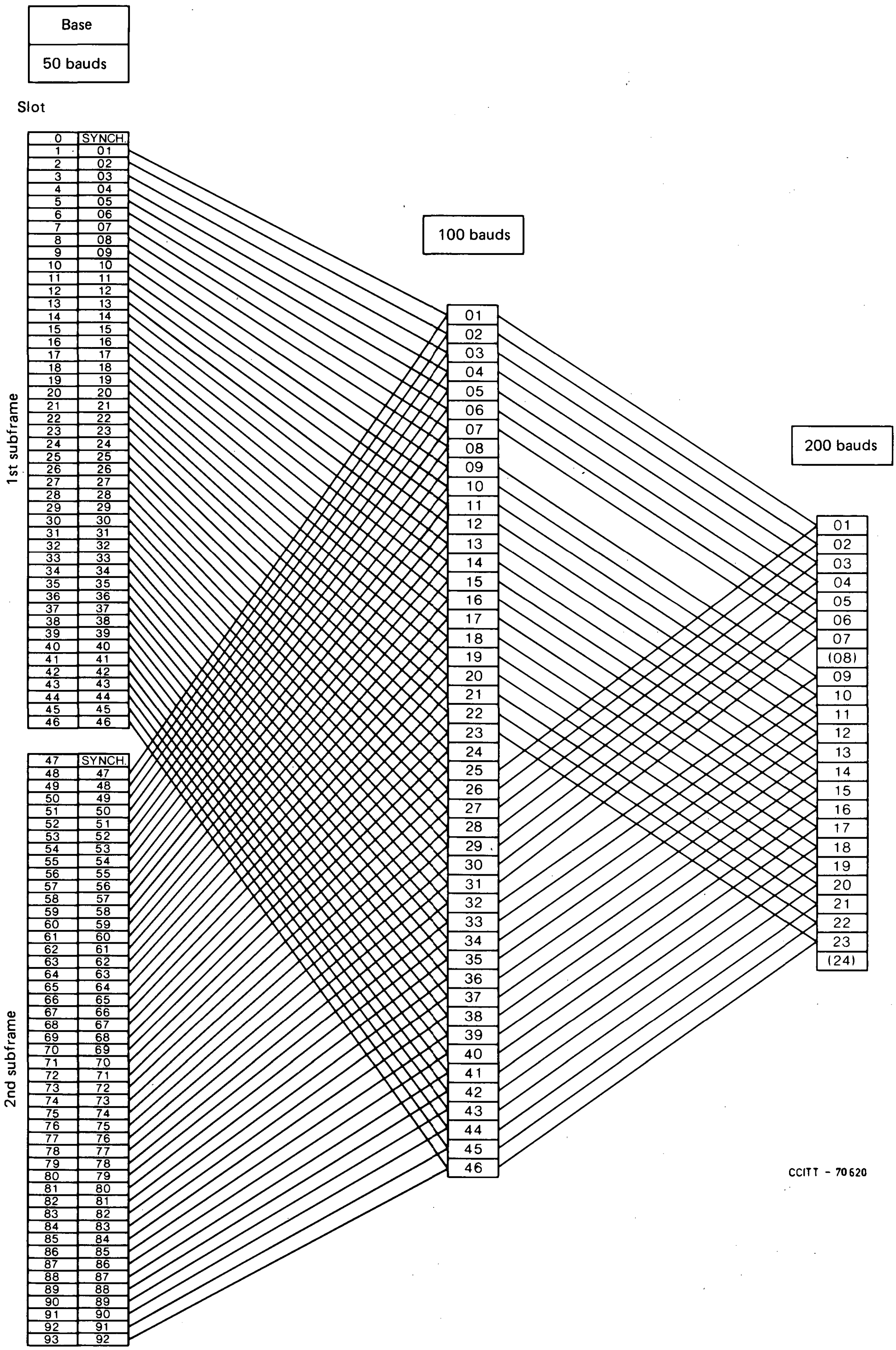
a) steady start at the start-stop channel input for channels that are used for circuit-switched service and that are in the free-line condition;

b) steady stop at the start-stop channel input for all other channels,

that is, both transmitted in accordance with § 5.7 above.

TABLE 2/R.102

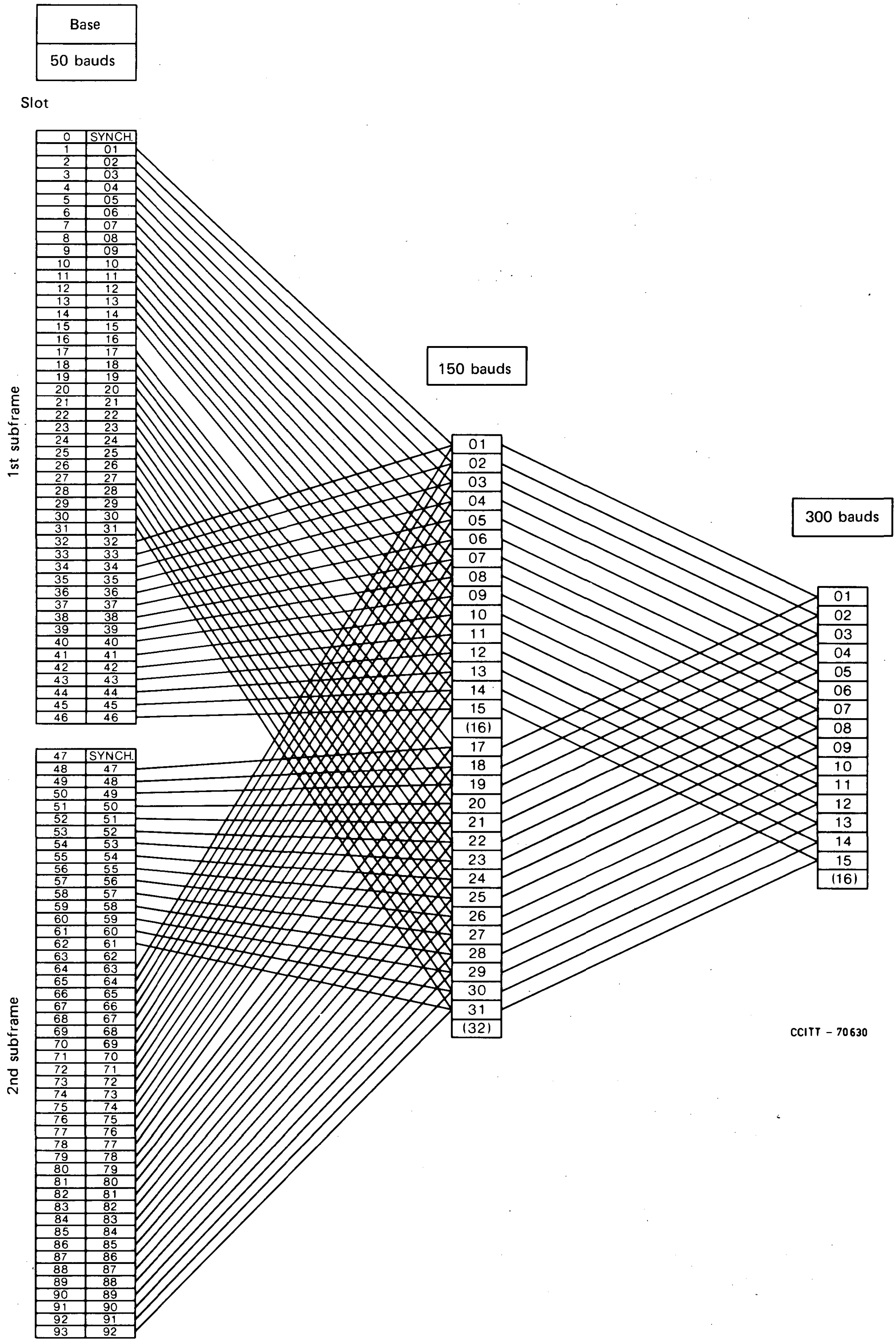
TDM-4800 channel numbering (50, 100 and 200 bauds)



Note – A higher rate channel cancels the use of all other channel numbers connected across to that channel number.

TABLE 3/R.102

TDM-4800 channel numbering (50, 150 and 300 bauds)



Note – A higher rate channel cancels the use of all other channel numbers connected across to that channel number.

TABLE 4/R.102

Channel allocation for each speed within the 94 bit frame

		Bit no.	Group 1 channel number						Bit no.	Group 2 channel number						Bit no.	Group 3 channel number						Bit no.	Group 4 channel number					
Channel speed (bauds)			50	100	200	–	150	300		50	100	200	–	150	300		50	100	200	–	150	300		50	100	200	–	150	300
Fundamental frame	First subframe	0	s	s	s	–	s	s	1	1	1	1	–	1	1	2	2	2	2	–	2	2	3	3	3	3	–	3	3
		4	4	4	4	–	4	4	5	5	5	5	–	5	5	6	6	6	6	–	6	6	7	7	7	7	–	7	7
		8	8	8	*x*	–	8	8	9	9	9	9	–	9	9	10	10	10	10	–	10	10	11	11	11	11	–	11	11
		12	12	12	12	–	12	12	13	13	13	13	–	13	13	14	14	14	14	–	14	14	15	15	15	15	–	15	15
		16	16	16	16	–	*x*	*x*	17	17	17	17	–	17	1	18	18	18	18	–	18	2	19	19	19	19	–	19	3
		20	20	20	20	–	20	4	21	21	21	21	–	21	5	22	22	22	22	–	22	6	23	23	23	23	–	23	7
		24	24	24	*x*	–	24	8	25	25	25	1	–	25	9	26	26	26	2	–	26	10	27	27	27	3	–	27	11
		28	28	28	4	–	28	12	29	29	29	5	–	29	13	30	30	30	6	–	30	14	31	31	31	7	–	31	15
			Skipped						32	32	32	9	–	1	1	33	33	33	10	–	2	2	34	34	34	11	–	3	3
		35	35	35	12	–	4	4	36	36	36	13	–	5	5	37	37	37	14	–	6	6	38	38	38	15	–	7	7
		39	39	39	16	–	8	8	40	40	40	17	–	9	9	41	41	41	18	–	10	10	42	42	42	19	–	11	11
		43	43	43	20	–	12	12	44	44	44	21	–	13	13	45	45	45	22	–	14	14	46	46	46	23	–	15	15
	Second subframe	47	s				5		48	47				17		49	48				18		50	49				19	
		51	50				20		52	51				21		53	52				22		54	53				23	
		55	54				24		56	55				25		57	56				26		58	57				27	
		59	58				28		60	59				29		61	60				30		62	61				31	
		63	62				*x*		64	63				1		65	64				2		66	65				3	
		67	66				4		68	67				5		69	68				6		70	69				7	
		71	70				8		72	71				9		73	72				10		74	73				11	
		75	74				12		76	75				13		77	76				14		78	77				15	
			Skipped						79	78				17		80	79				18		81	80				19	
		82	81				20		83	82				21		84	83				22		85	84				23	
		86	85				24		87	86				25		88	87				26		89	88				27	
		90	89				28		91	90				29		92	91				30		93	92				31	

Note 1 – s = synchronizing bit.

Note 2 – *x* = bit not available for corresponding channel speed.

Note 3 – 75-, 110- and 134.5-baud signals shall be transmitted on 100-, 100- and 150-bit/s bearer channels, respectively, and restituted with appropriate speed at the channel output. See also §§ 4.5, 4.6, and 4.7.

6.9 Synchronism is defined as achieved when:

a) six identical synchronization patterns (i.e. six normal or six inverted synchronization patterns) have been consecutively received on a single bit position without error; and

b) within the same period, two or more consecutive identical synchronization patterns (i.e. normal or inverted sense) have not been received on any of the other bit positions in the 47-bit subframe.

The sense of the patterns in a) and b) may be different.

6.10 If condition a) in § 6.9 above is fulfilled while condition b) is not:

a) the search for synchronism is continued in the terminal concerned; and

b) this terminal shall force the transmitted aggregate traffic bits to the polarities indicated in § 6.8 above.

6.11 Under the conditions in § 6.1 above, after loss of synchronism has been recognized and the aggregate signals have been restored, the average time that may be taken for the terminal concerned to resynchronize and to connect normal data through to the low-speed channel outputs shall be less than 480 ms, excluding all transmission delays external to the Recommendation R.101 TDM terminal equipment.

7 Telex signalling

7.1 Specifications for the signals used to establish, to clear and to control telex calls are laid down in Recommendations U.1 (types A and B), U.11 (type C) and U.12 (type D). Recommendation U.25 lists the modes of both-way telex signalling on a single circuit and the signalling combinations on a given aggregate that a TDM terminal shall be capable of handling.

7.2 Recommendation U.25 also lays down the tolerances on the control signals from a TDM terminal to telex and vice versa.

8 Aggregate signals and interface

8.1 The tolerance on the modulation rate of the send aggregate signals of the TDM system shall be ± 0.01%.

8.2 The maximum degree of isochronous distortion of the send aggregate signals of the TDM system shall be 4%.

8.3 The effective net margin of the aggregate receiver of the TDM system shall be at least 40%.

8.4 When the TDM system is operated with an aggregate speed of 4800 bit/s over an international analogue telephone-type circuit, it is preferred that a modem complying with the appropriate aspects of the Series V Recommendations be employed.

8.5 The electrical interface conditions and control signals between the TDM system and the bearer circuit shall comply with the appropriate Recommendations in the V and X Series.

9 System clock arrangements

9.1 The TDM system shall be capable of operating with either an internal or external transmit clock.

9.2 In the event of the failure of an external clock that may be used for the TDM transmit, the TDM shall continue to function locally for maintenance purposes using its own internal clock.

9.3 The receive clock for the TDM terminal shall be provided by the bearer circuit or higher order multiplex.

9.4 In the event of the failure of an external clock that may be used for the TDM receive, the TDM shall continue to function locally for maintenance purposes using its own internal clock.

9.5 The internal clock provided in the TDM terminal should have an accuracy of 0.01%.

10 System maintenance, control and alarms

10.1 One 50-baud channel may be allocated (on an optional basis) for maintenance purposes, where possible on a separate system using a parallel route. Where this option is exercised, channels 16 or 24 (subframe slots 16 or 24) are preferred to minimize the effect on the derivation of higher-rate channels.

10.2 If the internal (logic) power supply of the TDM terminal fails and an external telegraph battery supply is employed, all local start-stop channel outputs shall be controlled to start polarity.

10.3 It shall be possible to reallocate individual start-stop channels for different services without removing the TDM terminal from service.

References

[1] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Rec. V.24.

[2] CCITT Recommendation *Operational provisions for the international public telegram service*, Rec. F.1, § C8.

Recommendation R.105

DUPLEX STATISTICAL MULDEX, CONNECTING A GROUP OF GENTEX AND TELEX SUBSCRIBERS TO A TELEGRAPH EXCHANGE BY ASSIGNING VIRTUAL CHANNELS TO TIME SLOTS OF A BIT-INTERLEAVED TDM SYSTEM

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that the specifications of code and speed dependent TDM muldexes are already given in Recommendation R.101;

(b) that code and speed dependent TDM muldexes can be successfully used for connecting a group of gentex and telex subscribers to an exchange;

(c) that a considerable increase in the efficiency of muldex channel utilization may be achieved by concentration, i.e. allocating time slots to subscribers only while they are operating;

(d) that the busy-hour load generated by gentex and telex subscribers averages from 0.05 to 0.2 erlang;

(e) that both the virtual and assigned (fixed) telegraph channels can be set up on the same aggregate channel using the TDM method;

unanimously declares the view

that, when a bit-interleaved TDM system is used on gentex and telex subscriber lines for concentrating telegraph signals by assigning virtual channels to time slots in the 2400 bit/s aggregate bit stream, the equipment should meet the following requirements:

1 Channel types

1.1 The statistical muldex/concentrator should ensure that virtual channels are only allocated time slots in the 2400 bit/s aggregate bit stream for the duration of their seizure.

1.2 The statistical muldex/concentrator should also ensure that assigned (fixed) channels are permanently allocated specific time slots in the 2400 bit/s aggregate bit stream.

1.3 Virtual channels should ensure the connection of gentex and telex subscribers operating at 50 bauds and using the International Telegraph Alphabet No. 2 (ITA2) code who have an average load of 0.05 to 0.2 erlang. The use of other rates requires further study.

1.4 Assigned (fixed) channels should ensure data and telegraph signal transmission in compliance with Recommendation R.101, alternative B.

2 System capacity

2.1 The statistical muldex/concentrator should ensure the setting-up of virtual and assigned channels in any combination within the range of the 2400 bit/s aggregate rate.

2.2 When a system has only virtual channels, the number of connected subscribers with an average load of 0.05 to 0.1 erlang each should not exceed 256 and with an average load of 0.1 to 0.2 erlang each should not exceed 128. In either case, the percentage value of the failures to connect is not more than 0.1%.

2.3 When a system has only assigned (fixed) channels, their number, depending on the types and rates of the channels, should comply with Recommendation R.101, alternative B.

3 Multiplexing system specifications

Multiplexing scheme, frame structure, frame synchronization, aggregate signal parameters, interfaces, telegraph signal parameters at input-output and telegraph signal delay time should conform to Recommendation R.101, alternative B.

4 Virtual channel parameters

4.1 Virtual channels are intended for use on the telex network subscriber section with type A and type B signalling (Recommendation U.1).

4.2 Seizure of virtual channels may be from either end.

Note – Methods for decreasing the probability of call collisions, the value of this probability and the delay time in setting up a connection require further study.

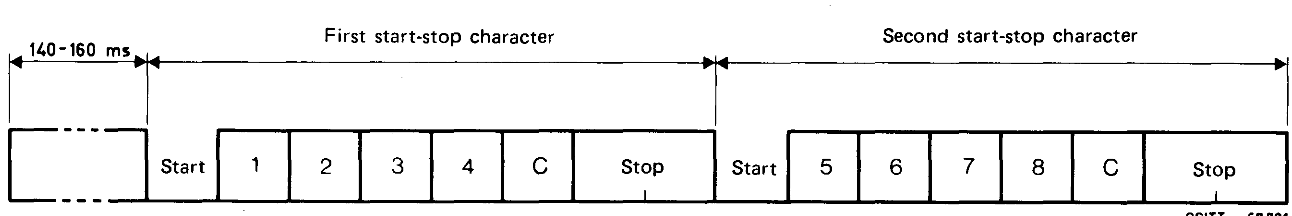
4.3 *In the initial state*, a virtual channel should be free and a start polarity should be transmitted over it between statistical muldex/concentrator assemblies.

4.4 *When a call arrives*, i.e. stop polarity with an interval of more than 150 ms, either from the subscriber side or from the exchange side, a virtual channel should be seized, and a stop polarity having a duration of 140-160 ms should be transmitted over it to the remote side followed by the transmission of two start-stop characters having a length of 8 units each in accordance with Figure 1/R.105.

The signal elements indicated as 1 to 8 are used for the transmission of an 8-digit conventional number indicating which subscriber (maximum $2^8 = 256$; see also § 2.2 above) is/should be connected to the equipment.

Elements indicated by "C" are vacant and can be used, e.g., for error-detecting when the number is transmitted to the opposite side; the error protection method is left for further study.

4.5 When the setting up of a virtual channel fails because all time slots are engaged by other virtual or assigned (fixed) channels, a busy signal, the structure of which is specified by current CCITT Recommendations should be returned to the calling subscriber side.



Note – Unit No. 1 of the code is the least significant; unit No. 8 of the code is the most significant.

FIGURE 1/R.105

Structure for transmission of the conventional number in the virtual channel

CODE AND SPEED INDEPENDENT TDM SYSTEM FOR ANISOCHRONOUS TELEGRAPH AND DATA TRANSMISSION

(Geneva, 1976; amended at Geneva, 1980 and Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that the use of voice-frequency telegraph (VFT) equipment on voice channels provided by frequency division multiplexing of a primary group or by time slots in a pulse code modulation (PCM) transmission system may not always be the optimum solution for telegraph and low-speed data transmission, if aspects of transmission quality, equipment complexity, technological progress, miniaturization, power consumption and overall cost are globally considered;

(b) that the economic transmission of telegraph and low-speed anisochronous data signals requiring code- and speed-independent channels may be achieved by using time division techniques;

(c) that a relatively simple TDM (time division multiplex) system, even if less efficient in bandwidth utilization, might be preferred in some (e.g. short-haul) applications;

(d) that Administrations might be interested in conserving code and speed independence inherent in VFT systems when replacing them by TDM systems;

(e) that code and speed independent transmission systems are capable of transmitting any type of digital signal (anisochronous, isochronous, telegraph, data, signalling for switching purposes);

(f) that a code and speed independent TDM system can adapt its inherent telegraph distortion to the needs of a network, depending on the number of circuits connected in tandem;

(g) that a code and speed independent TDM system can adapt to a number of different types of channels (each being defined by its maximum modulation rate and inherent distortion);

(h) that a basic 64 kbit/s telegraph multiplexer may provide interfaces for remote submultiplexers if required. The submultiplexers may be associated in some applications with Recommendations X.50 [1] and X.51 [2] data multiplexers and with telephone channel modems and/or baseband modems;

unanimously declares the following views

1 64 kbit/s aggregate

1.1 *General*

1.1.1 Where code and speed independent TDM systems for transmission of telegraph and low-speed anisochronous data signals utilize the whole 64 kbit/s capacity (e.g. provided by a PCM time slot or a primary group), the equipment shall be manufactured to comply with the following standards.

1.2 *Aggregate bearer channel*

1.2.1 The aggregate bearer channel may be a 64 kbit/s PCM time slot or a 64 kbit/s synchronous data modem in accordance with the Recommendation cited in [3]. The nominal data signalling rate is 64 000 bit/s with a tolerance of ± 1 bit/s.

1.3 *Frame structure*

1.3.1 The frame consists of 240 bits for information plus 16 symmetrically distributed service bits for framing and other purposes. The 16th bit of the frame is the first service bit. The frame synchronization pattern comprises the first 12 service bits in the sequence 101001010101.

1.3.2 The 13th service bit is used to inform the opposite multiplexer terminal of bearer failure as follows: 1 = no bearer failure; 0 = bearer failure. A minimum of three consecutive 0 conditions is the criterion for an alarm indication.

1.3.3 The 14th service bit is used to inform the opposite multiplexer terminal of frame alignment loss as follows: 1 = no loss of frame alignment; 0 = frame alignment loss (this may be accompanied by bearer failure). A minimum of three consecutive 0 conditions is the criterion for an alarm indication.

1.3.4 The time delay between detection of a bearer failure or frame alignment loss and the sending of the 0 condition is for further study.

1.3.5 The 15th service bit is provisionally fixed to 1 and its use is left for further study.

1.3.6 The 16th service bit (last bit of the frame) may be used for possible justification and is fixed to 1. However, the justification strategy, if used, must be agreed bilaterally.

1.3.7 The channel numbering scheme is specified in Recommendation R.114.

1.4 *Type of multiplexing*

1.4.1 Channel interleaving shall be on a bit basis.

1.4.2 The coding method shall be the transition coding process in accordance with Annex A below.

1.5 *Allocation of information bits*

1.5.1 The data signalling rate on the bearer for each multiplexed channel should be 250, 500, 1000, 2000 or 4000 bit/s corresponding to one, two, four, eight or sixteen bits per frame (symmetrically distributed) respectively.

1.5.2 The 64 kbit/s aggregate stream is divided into 60 kbit/s for information and 4 kbit/s for framing and other purposes.

1.5.3 The 60 kbit/s information bit stream may be subdivided into five bit streams of 12 kbit/s or, for national use or by bilateral agreement, into twenty bit streams of 3 kbit/s.

1.6 *Telegraph and data channels*

1.6.1 The nominal modulation rates are 50, 100, 200, 300, 600 and 1200 bauds. A mixture of these rates should be possible.

1.6.2 The maximum degree of inherent isochronous distortion due to the sampling process is 2.5, 5 or 7.5% according to the application as shown in Table 1/R.111, which gives the channel characteristics and full system capacity for various telegraph channel rates and for aggregate signalling rates of 64 kbit/s and below (see § 2 below).

1.6.3 Where applicable, spurious elements with duration of 1.6 ms (= 8%) or less shall be rejected and elements longer than 2 ms shall be accepted at the 50 baud channel input. The element lengths to be rejected or accepted at higher channel modulation rates is for further study.

1.7 *Frame alignment*

1.7.1 Frame realignment is ensured within three correct consecutive frame synchronization patterns, i.e. within 12 to 16 ms. In the absence of frame realignment, the telegraph channel outputs of the demultiplexer should be locked in their start polarity state for switched applications.

Note – Stop polarity might be required by some Administrations on a per channel basis for leased applications.

TABLE 1/R.111

Channel characteristics and system capacities

Nominal modulation rate (bauds)	Maximum degree of isochronous distortion due to sampling (%)	Theoretical maximum modulation rate (bauds)	Data signalling rate on the bearer per channel (bit/s)	Shortest isolated element (ms)	Maximum number of channels for an aggregate system of			
					64 kbit/s	9.6 kbit/s	4.8 kbit/s	2.4 kbit/s
50	5	83	250	4	240	32	16	8
	2.5	167	500	2	120	16	8	4
100	5	167	500	2	120	16	8	4
	2.5	333	1000	1	60	8	4	2
200	5	333	1000	1	60	8	4	2
300	7.5	333	1000	1	60	8	4	2
600 [a)]	7.5	666	2000	0.5	30	4	2	–
1200 [a)]	7.5	1333	4000	0.25	15	2	–	–

[a)] The number of channels indicated for modulation rates of 600 and 1200 bauds is for information only (homogeneous aggregates at these rates are not contemplated).

1.7.2 Three consecutive erroneous frame synchronization patterns should be regarded as the criterion for loss of frame alignment.

1.8 *Loss of telegraph input*

1.8.1 In the absence of any signal at a telegraph channel input, the multiplexer system should reproduce start polarity at the corresponding output.

Note – Stop polarity might be required by some Administrations on a per channel basis for leased applications.

1.9 *Bearer interface*

1.9.1 For the interface between the aggregate bearer and a PCM time slot, either a codirectional or contradirectional 64 kbit/s interface with the PCM equipment could be accepted. Even for a codirectional interface no stuffing device would be provided in the telegraph multiplexer, which would loop back the 64 kHz clock.

1.9.2 For the interface to a 64 kbit/s modem the interchange circuits of Table 2/R.111 should be provided (see the Recommendation cited in [4]).

1.10 *Telegraph interface*

1.10.1 The interface between the multiplexer and the telegraph circuits should be in accordance with national requirements.

TABLE 2/R.111

Circuit Number (cf. Recommendation V.24 [5])	Function
102 [a)]	Signal ground or common return
102b [b)]	DCE common return
103 [c)]	Transmitted data
104 [c)]	Received data
109	Data channel received line signal detector
113 [c) d)]	Transmitter signal element timing (DTE source)
114 [c) d)]	Transmitter signal element timing (DCE source)
115 [c)]	Receiver signal element timing

a) The provision of this conductor is optional.

b) This conductor is used in conjuntion with interchange circuit 109.

c) The electrical characteristics of the interchange circuits marked with a c) should be in accordance with Recommendation X.27 [6]. The circuits not so marked should be in accordance with Recommendation X.26 [7].

d) Either circuit 113 or 114 is to be used.

2 Aggregate bearer rates lower than 64 kbit/s

2.1 *General*

2.1.1 Where code and speed independent TDM systems for transmission of telegraph and low speed anisochronous data signals make use of capacities lower than 64 kbit/s, the equipment shall be manufactured to comply with the following standards:

2.2 *Aggregate bearer channels*

2.2.1 Aggregate rates of 2.4, 4.8 and 9.6 kbit/s shall be used. These rates can be provided either using modems in accordance with the Series V Recommendations or using data multiplexers in accordance with Recommendations X.50 [1] or X.51 [2].

2.3 *Frame structure*

2.3.1 The frame structure is independent of the frame structure of the 64 kbit/s data multiplexer or of the 64 kbit/s telegraph multiplexer. However, it must be designed to allow easy insertion of the carried telegraph channels on to the multiplexer defined in § 1 above (see also § 3 below).

2.3.2 For that purpose, one bit out of every six bits will carry framing information and other functions, which will result in effective binary rates of 2, 4 or 8 kbit/s with actual aggregate rates of 2.4, 4.8 and 9.6 kbit/s respectively.

2.3.3 The frame consists of 160 information bits plus 32 symmetrically distributed service bits for framing and other purposes. The sixth bit of the frame is the first service bit.

2.3.4 This frame is subdivided into two subframes each consisting of 80 information bits plus 16 symmetrically distributed service bits.

2.3.5 The subframe synchronization pattern comprises the first 12 service bits in the sequence 101001010101.

2.3.6 For the allocation of the 13th, 14th and 15th service bits, see §§ 1.3.2 to 1.3.5 above. The 16th service bit is set at 0 for the first subframe and at 1 for the second subframe.

2.4 *Type of multiplexing*

2.4.1 See § 1.4 above.

2.5 *Allocation of information bits*

2.5.1 The same data signalling rates as defined in § 1.5 should be used (250, 500 and 1000 bit/s and, where applicable, 2000 and 4000 bit/s).

2.5.2 Table 3/R.111 shows the number of information bits per frame for the different data signalling rates on the bearer channel. These information bits are symmetrically distributed among the 160 information bits of the frame.

TABLE 3/R.111

Number of information bits per frame

Data signalling rate on the bearer per channel (bit/s)	Number of information bits per frame for each channel in an aggregate system of		
	9.6 kbit/s	4.8 kbit/s	2.4 kbit/s
250	5	10	20
500	10	20	40
1000	20	40	80
2000	40	80	–
4000	80	–	–

2.6 *Telegraph and data channels*

2.6.1 See § 1.6 above.

2.7 *Frame alignment*

2.7.1 Frame realignment time is ensured within three correct consecutive subframe synchronization patterns. This frame realignment will be ensured within 40, 80 and 160 ms for aggregate rates of 9.6, 4.8 and 2.4 kbit/s respectively. In the absence of frame realignment the telegraph channel outputs of the demultiplexer should be locked in their start polarity state for switched applications.

Note – Stop polarity might be required by some Administrations on a per channel basis for leased applications.

2.7.2 See § 1.7.2 above.

2.8 *Loss of telegraph input*

2.8.1 See § 1.8 above.

2.9 *Bearer interface*

2.9.1 The interface between the telegraph aggregate and higher aggregate bearer channels should be as laid down in the relevant Recommendations for modems and data multiplexers.

2.10 *Telegraph interface*

2.10.1 See § 1.10 above.

3 Compatibility

3.1 For the different subrates of 2, 4 and 8 kbit/s, there should be 8, 16 and 32 information bits respectively distributed symmetrically within the 64 kbit/s aggregate frame.

3.2 The 160 information bits of the 2.4, 4.8 and 9.6 kbit/s aggregate rates should correspond to 20 groups of 8 bits, 10 groups of 16 and 5 groups of 32 bits respectively. These 8, 16 and 32 information bits should be made to correspond to the 8, 16 and 32 information bits of the 64 kbit/s frame by means of a special padding/depadding unit.

3.3 Some examples of possible implementations are given in Figures 1/R.111, 2/R.111 and 3/R.111 for illustration purposes only.

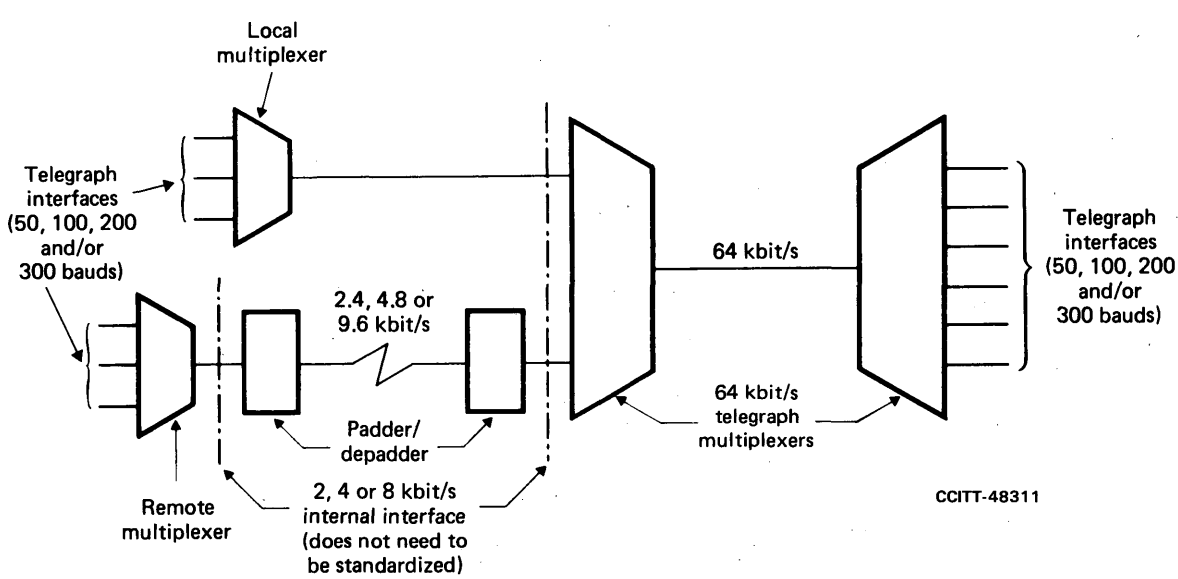


FIGURE 1/R.111

Integration of the lower aggregate rates defined in § 2 using a 64 kbit/s telegraph multiplexer with a compatible frame structure

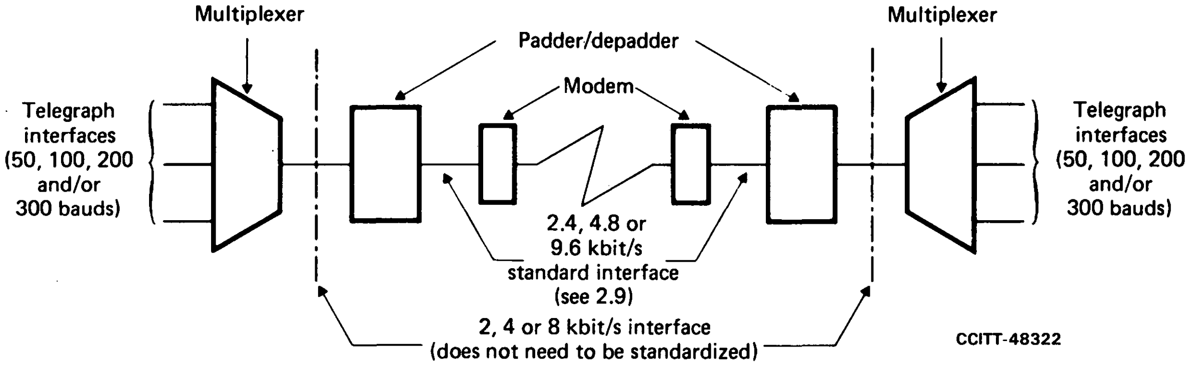


FIGURE 2/R.111

Routing of the lower aggregate rates by means of modems

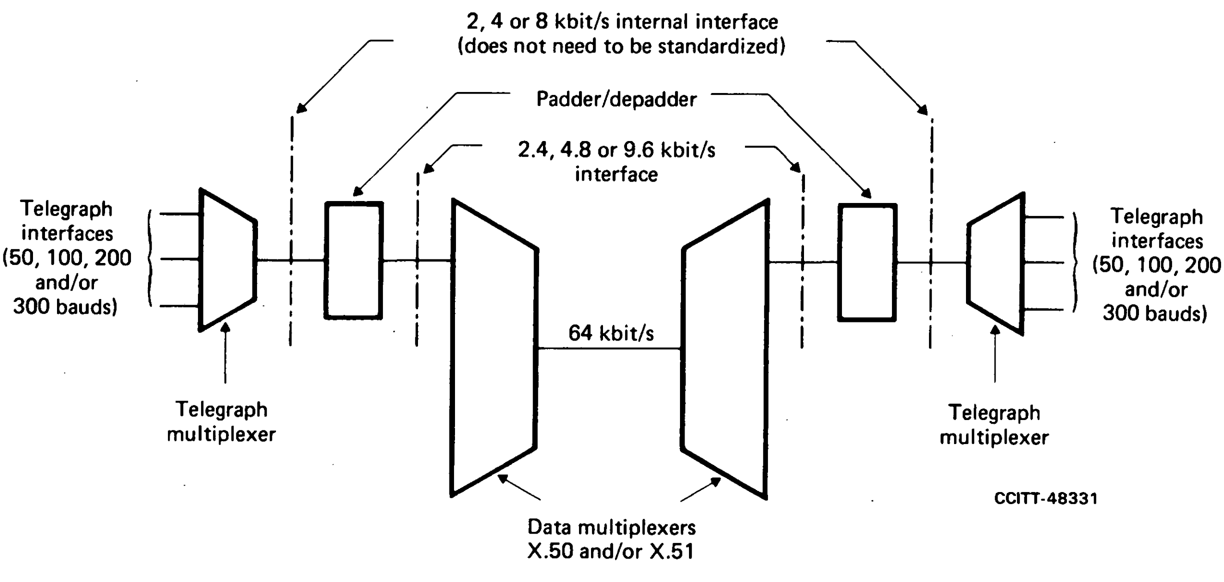


FIGURE 3/R.111

Routing of the lower aggregate rates over data multiplexers
(Recommendation X.50[1] and/or X.51[2])

ANNEX A

(to Recommendation R.111)

Transition coding process

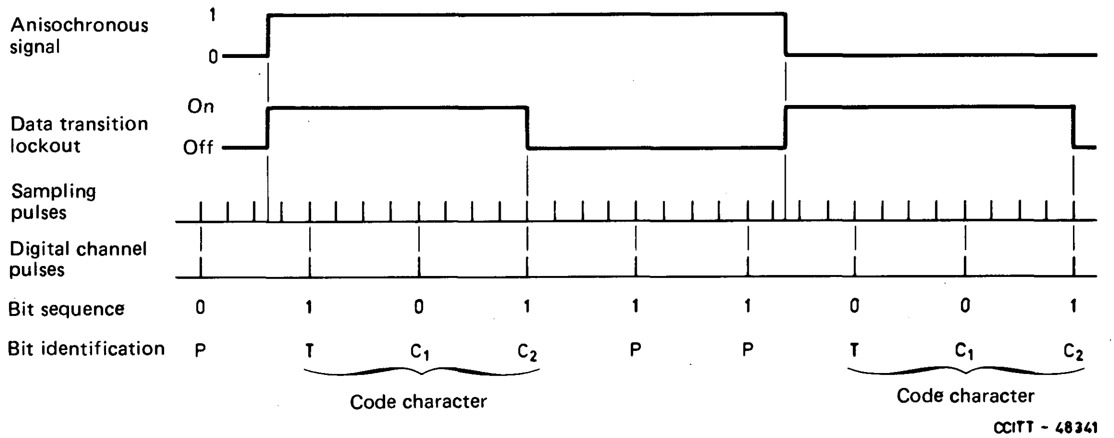


FIGURE A-1/R.111

Transition coding process

A.1 The sampling pulses are divided into groups of four and each transition of the anisochronous signal causes a code character of 3 bits to be generated at the rate of one bit for a group of 4 samples. The first T bit of this code character indicates the sense of transition while the two bits C_1 and C_2 translate into binary code the position of the transition in the relevant group.

A.2 Following the acceptance of a transition into the coding system, a "data transition lockout condition" which inhibits entry of further transitions shall persist until code characters T, C_1 and C_2 have been transmitted. Any transition which has been locked out in this manner shall enter the coder as soon as the lockout condition is removed and will be coded as if it had occurred in the first quarter of the next transmission period.

A.3 The code characters are transmitted over the digital channel at a rate of 1 bit per group of 4 sampling pulses and the subsequent bits P between the code characters confirm the polarity of the anisochronous signal at the relevant instant. The minimum number of P bits may be zero, so the maximum code character rate equals 1/3 of the maximum modulation rate allowed.

A.4 When the anisochronous signal has a permanent polarity, an error of one bit will never entail a continuous inversion of the decoded signal, but will cause a mutilation of this signal during a limited time. The duration of these mutilations is reduced to a minimum when the code characters are formed as shown in Table A-1/R.111.

TABLE A-1/R.111

Code character for a transition from 1 to 0 in the anisochronous signal			Code character for a transition from 0 to 1 in the anisochronous signal			Position of the transition in a group of four sampling pulses
T	C_1	C_2	T	C_1	C_2	
0	0	0	1	1	1	first quarter
0	0	1	1	1	0	second quarter
0	1	0	1	0	1	third quarter
0	1	1	1	0	0	fourth quarter

References

[1] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks*, Rec. X.50.

[2] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks using 10-bit envelope structure*, Rec. X.51.

[3] CCITT Recommendation *Modems for synchronous data transmission using 60-108 kHz group band circuits*, Rec. V.36, § 1 f).

[4] *Ibid.*, § 10.

[5] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Rec. V.24.

[6] CCITT Recommendation *Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications*, Rec. X.27.

[7] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications*, Rec. X.26.

Recommendation R.112

TDM HYBRID SYSTEM FOR ANISOCHRONOUS TELEGRAPH AND DATA TRANSMISSION USING BIT INTERLEAVING

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that there is a limited requirement on certain routes to provide for rates and codes not included in Table 1/R.101 which may be achieved by using time-division multiplexing (TDM) techniques;

(b) that wherever possible the rates and codes given in Table 1/R.101 should not be expanded in the future;

(c) that Administrations may be asked to provide code and speed independent channels for cryptography, for telemetry, for rates outside the Recommendation R.101 tolerance of ± 1.4%, where the rate and code may be changed frequently, and for maintenance purposes;

(d) that the aggregate bit rate may be limited to 2400 bit/s and TDM equipment may be required to pass code independent and code dependent traffic;

(e) that the bearer may not be suitable for using the backward channel as defined by Recommendation V.26, § 5 [1], or in the provision of telegraph channels above the Recommendation V.26 aggregate by the technique of subdivision of the frequency band as given in Recommendation H.34 [2],

unanimously declares the view

that where bit-interleaved TDM systems are used for code dependent and code independent anisochronous telegraph and data transmission with an aggregate rate of 2400 bit/s, carried either by analog telephone-type circuit or by higher order TDM system, the equipment should be constructed to comply with the following standards:

1 System capacity

1.1 The TDM system will be capable of multiplexing the rates shown in Table 1/R.101 for code dependent channels to alternative B.

1.2 The code and rate independent channels will reside in one 150 baud or 300 baud channel (i.e. replaces three or six 50 baud code dependent channels respectively).

1.3 The characteristics of the code independent channels should follow the limits shown in Table 1/R.112.

TABLE 1/R.112

Characteristics of code independent channels and system capacity

Nominal modulation rate (bauds)	Maximum degree of isochronous distortion due to sampling (%)	Theoretical maximum modulation rate (bauds)	Data signalling rate on the bearer per channel (bit/s)	Duration of the shortest isolated element (ms)	Maximum number of channels for an aggregate rate of 2400 bit/s
50	8.3	51.06	153.2	6.5	15
100	8.3	102.12	306.4	3.25	7

2 Channel inputs

2.1 The nominal modulation rate will be 50 or 100 bauds; the theoretical maximum modulation rate shall be 51.06 or 102.12 bauds.

2.2 The transition coding process of telegraph signals is in accordance with Recommendation R.111.

Note – In the case of a 100 baud channel it is not possible to subdivide the frame exactly and hence a transmit buffer is required to minimize telegraph distortion. The buffer should not delay the characters by more than half a frame, i.e. by three time slots of the corresponding 300 baud channel as per Recommendation R.101, alternative B (see also § 4.2 below). The details of this method are for further study.

2.3 Where applicable, spurious elements with duration of 1.6 ms (= 8%) or less shall be rejected and elements longer than 2 ms shall be accepted at the 50 baud channel input. The element lengths to be rejected or accepted at higher channel modulation rates is for further study.

3 Channel outputs

3.1 The maximum degree of inherent isochronous distortion due to the sampling process shall be 8.3%.

Note – The long-term system distortion on a tandem connection of transition encoded channels of an independent TDM system approximates in the worst case to the arithmetic summation of the individual link distortions.

3.2 After a TDM link failure, actions described in §§ 3.5 and 3.6 of Recommendation R.101, should be taken on the derived channel output.

4 Multiplexing details

4.1 The multiplexing details are in accordance with Recommendation R.101, alternative B on a bit basis.

4.2 The maximum transfer delay (excluding the modem) for 50 and 100 baud code and rate independent channels for back-to-back terminals shall not exceed 50 and 35 ms respectively. The values of the delay are subject to further study.

5 Frame structure

This is as defined in Recommendation R.101 alternative B.

6 Synchronizing

This is defined in Recommendation R.101, alternative B.

7 Aggregate signals and interface, system clock arrangements and system control and alarms

These are defined in Recommendation R.101.

8 Channel numbering scheme of code independent channels

A modified version of the channel numbering technique defined in Recommendation R.114 should be used.

Note – The details are for further study.

References

[1] CCITT Recommendation *2400 bit per second modem standardized for use of 4-wire leased telephone-type circuits*, Rec. V.26.

[2] CCITT Recommendation *Sub-division of the frequency band of a telephone-type circuit between telegraph and other services*, Rec. H.34.

Recommendation R.114

NUMBERING OF INTERNATIONAL TDM CHANNELS

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that in view of the introduction in the international service of time division multiplex (TDM) channels with different characteristics, configured for various nominal modulation rates and for different character structures, it has become necessary to evolve a method of numbering TDM channels;

(b) that this numbering method must make it possible to recognize:

– the type of TDM (code-dependent or code-independent);

– the nominal modulation rate and (in the case of code-dependent TDM) the character length;

– the position of the channel in the frame,

unanimously declares the view

1 The channels in an international TDM system conforming to Recommendation R.101 should be numbered as shown in Table 1/R.114.

2 The number assigned to a channel should be selected from the series applicable to the type of channel and should correspond to its position in the multiplex tables in Recommendation R.101.

3 The channels in an international TDM system conforming to Table 1/R.111 should be numbered as shown in Table 2/R.114.

4 The channels in systems conforming to Table 1/R.111 should be numbered in the same way as their positions in the frame; i.e. in the sequence from 1 to 255 excluding the channel numbers that are multiples of 16. In establishing a channel having a rate of more than 50 baud, the number assigned coincides with the number of the first 50 baud channel taking part in the integration.

5 The channel numbering for other types of TDM is the subject of further study.

TABLE 1/R.114

Numbering scheme for TDM systems conforming to Recommendation R.101

Nominal modulation rate (bauds)	Channel numbers
50	0501 - 0546
75	0701 - 0742 (for alternative A). See Table 3/R.101 for numbers not used 0701 - 0731 (for alternative B, 0716 not used)
100	1001 - 1023 (for 10 unit, 1008 not used) 1701 - 1723 (for 7½ unit, 1708 not used)
110	1101 - 1123 (1108 not used)
134.5	1301 - 1315
150	1501 - 1515
200	2001 - 2011 (for 10 unit, 2008 not used) 2101 - 2111 (for 11 unit, 2108 not used) 2701 - 2711 (for 7½ unit, 2708 not used)
300	3001 - 3007 (for 10 unit) 3101 - 3107 (for 11 unit)

TABLE 2/R.114

Numbering scheme for TDM systems conforming to Table 1/R.111

Nominal modulation rate (bauds)	Maximum distortion (%)	Channel numbers
50	5	5001 - 5255 (The numbers 16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 192, 208, 224 and 240 are not used)
100	5	6001 - 6127 (The numbers 16, 32, 48, 64, 80, 96 and 112 are not used)
200 (300)	5 (7.5)	7001 - 7063 (The numbers 16, 32 and 48 are not used)
600	7.5	8001 - 8031 (The number 16 is not used)
1200	7.5	8101 - 8115

Recommendation R.115

MAINTENANCE LOOPS FOR TDM-SYSTEMS

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) the increasing use of TDM transmission systems;

(b) the volume of information circulating on data and telegraph transmmission networks;

(c) the savings to be made by reducing interruption time on such links;

(d) the importance of being able to determine responsibilities between the several parties who, of necessity, are involved in maintenance questions for the networks;

(e) the advantages of standardization regarding maintenance,

unanimously declares the following:

1 The locating of faults can be facilitated in many cases by looping and other maintenance procedures in the TDM equipments. These maintenance facilities allow local or remote measurements to be carried out optionally by the Administrations and/or users concerned.

2 Location of the loops

The maintenance loops are positioned in order to make it possible for the Administrations to locate faults to the following function blocks:

- aggregate modem;
- TDM central logic;
- tributary interface unit;
- aggregate line;
- subscriber line.

The loops necessary to fulfil the above listed demands are shown in Figure 1/R.115. Additional loops may be used for the location of faulty boards but these loops are relevant to each particular manufacturer's implementation and are not included here. The number of maintenance loops may be extended to include the subscriber terminal equipment. These loops are left for further study.

3 Names, types and definitions of the loops

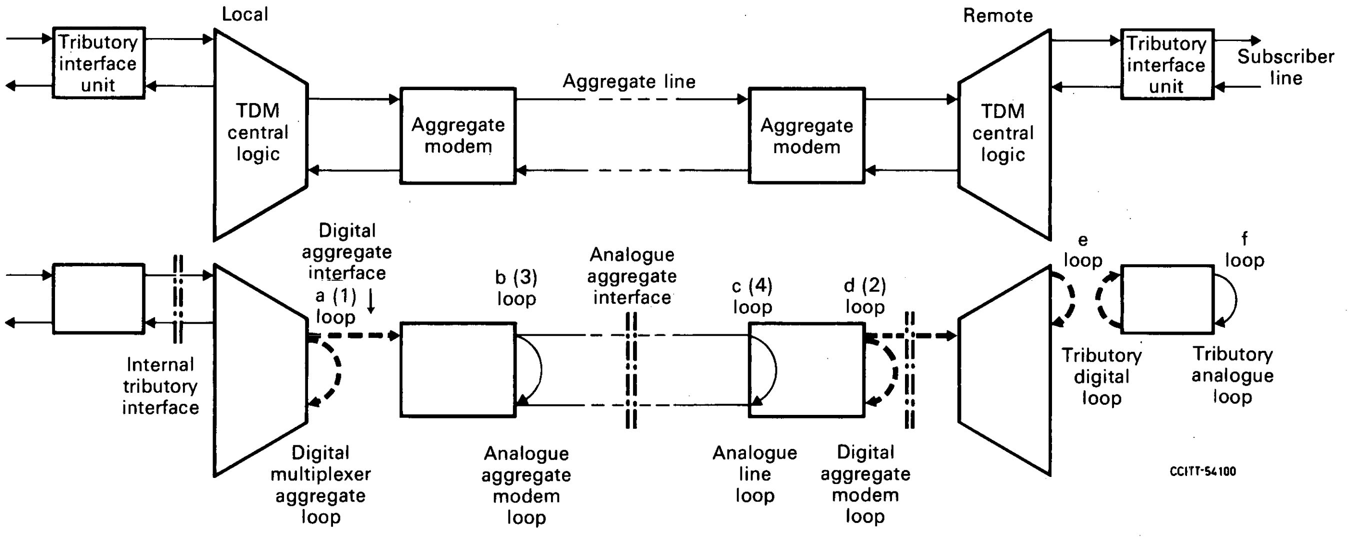
See Figure 1/R.115.

3.1 *Loop a – digital multiplexer aggregate loop*

This loop is a one-way or optionally an echo-back loop (see Figures 2/R.115 and 3/R.115) that shall connect the aggregate data output to the aggregate data input of the TDM central logic. This loop shall be accomplished as close as possible to the digital aggregate interface.

3.2 *Loop b – analogue aggregate modem loop*

This loop is a one-way loop or optionally an echo-back loop (see Figures 2/R.115 and 3/R.115). With this loop, the line signal from the output of the aggregate modem is looped back to the input of the aggregate modem. The loop should include the maximum number of aggregate modem components used in normal working.



Note 1 – A symmetrical set of loops exists as seen from the remote side.

Note 2 – Figures within parenthesis are the loop numbers according to Recommendation V.54.

FIGURE 1/R.115

Maintenance loops

3.3 *Loop c – analogue line loop*

This loop is a one-way loop or optionally an echo-back loop (see Figures 2/R.115 and 3/R.115). With this loop, the incoming line signal at the receiver input of the aggregate modem is looped back to the outgoing direction of the line. It is noted that it may not be possible to correctly receive data that has been sent over the looped circuit.

3.4 *Loop d – digital aggregate modem loop*

This loop is a one-way loop or optionally an echo-back loop (see Figures 2/R.115 and 3/R.115). In this loop the received aggregate digital data from the modem is looped back to the originating side. This loop shall be located as close as possible to the digital aggregate interface.

3.5 *Loop e – tributary digital loop*

This loop is a one-way loop (see Figure 2/R.115) with the output polarity towards the subscriber line strapable to A or Z polarity. Optionally a both-way loop (see Figure 4/R.115) may be used. Through this loop the channel data as received from the aggregate is looped back to the aggregate towards the distant TDM equipment. This loop shall be accomplished as close as possible to the internal tributary interface which can be located on the tributary interface unit or in the TDM central logic.

3.6 *Loop f – tributary analogue loop*

This loop is a one-way loop (see Figure 2/R.115). With this loop, the tributary signal to be sent to the subscriber is looped back towards the multiplex system. This loop shall be accomplished at the subscriber line interface and shall include as many parts of the tributary interface unit as possible. As long as the loop is set the subscriber connection is interrupted.

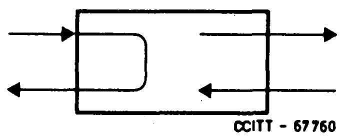


FIGURE 2/R.115

One-way loop

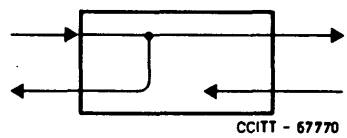


FIGURE 3/R.115

Echo-back loop

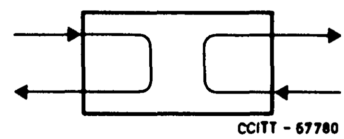


FIGURE 4/R.115

Both-way loop

4 Use of the loops

Loops c and d may be used under remote control on international links after bilateral agreements only.

5 Methods of control

5.1 Two types of control might be possible:

a) *Local control of a loop*

A loop is locally controlled when the loop request originates at the location of the equipment to be looped.

b) *Remote control of a loop*

A loop is remotely controlled when the loop request originates at a location other than that of the equipment to be looped.

5.2 When the aggregate modem is using a standard interface to the TDM-equipment, the implementation of the echo-back function and the controls through the digital aggregate interface of loops b, c and d are left for further study.

5.3 The control of loops a, b, c and d should be supervised by a time-out function. The time-out function shall automatically open the loop after a specified time period, measured from the closing of the loop. The length of the time period is left for further study.

6 Control signalling

6.1 *Alternative A*

When the maintenance facilities are controlled by the software within an exchange, a maintenance centre or a TDM terminal, a control signalling code (CSC) is used where the control signalling characters on the selected maintenance channel shall be in accordance with Table 1/R.115 (see also Recommendation U.12, Table 8/U.12).

TABLE 1/R.115

CSC character number	Parity	Data				Decimal equivalent of data
	b_4	b_3	b_2	b_1	b_0	
1	0	0	0	0	0	0
2	1	0	0	0	1	1
3	1	0	0	1	0	2
4	0	0	0	1	1	3
5	1	0	1	0	0	4
6	0	0	1	0	1	5
7	0	0	1	1	0	6
8	1	0	1	1	1	7
9	1	1	0	0	0	8
10	0	1	0	0	1	9

A complete control signalling code character consists of one start element (Start), followed by four information elements (b_0, b_1, b_2, b_3) one parity element (b_4),and a stop element (Stop) of nominally one and a half unit element, see Figure 5/R.115.

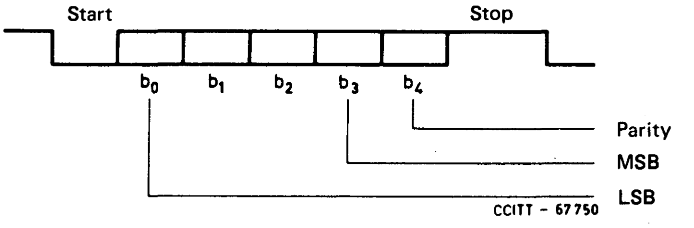


FIGURE 5/R.115

Complete control signalling code (CSC)

Bit b_0 is the least significant bit (LSB) and b_3 is the most significant bit (MSB). For the transmission of decimal numbers from 0 up to 99 the binary code should be used. The 8 binary bits should be split into two characters, No. 1 and No. 2, character No. 1 holding the least significant bits and character No. 2 the most significant bits.

6.2 *Alternative B*

When maintenance facilities do not use control signal according to Recommendation U.12, the signalling characters on the maintenance channel selected must conform to International Alphabet No. 5 (IAS).

6.3 *Maintenance channel signalling*

Standardization of signalling on the maintenance channel is left for further study.

7 Routing of the maintenance control signals

One 50 baud channel, or a channel of more than 50 bauds may be allocated (on an optional basis) for maintenance purposes, where possible on a separate system using a parallel route. Where this option is exercised the allocation of the maintenance channel is specified within the respective CCITT Recommendation or bilaterally between Administrations.

The selected maintenance channel should only be used for the transmission of alarms, supervision and remote control signals.

When there is no possibility to use a separate system on a parallel route the control of the loops c and d is left for further study.

8 Application

It may be possible to apply the described maintenance technique to multiplexors conforming to Recommendations R.101, R.111 and other standardized multiplexors.

9 Use of the maintenance channel

Use of the maintenance channel for purposes other than loop control is left for further study.

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SECTION 8

TRANSMISSION QUALITY ABOVE 50 BAUDS

Recommendation R.120

TOLERABLE LIMITS FOR THE DEGREE OF ISOCHRONOUS DISTORTION OF CODE-INDEPENDENT TELEGRAPH CIRCUITS OPERATING AT MODULATION RATES OF 75, 100 AND 200 BAUDS

(Geneva, 1976; amended at Geneva, 1980)

The CCITT,

considering

(a) that, to facilitate the study of plans for the establishment of international telegraph circuits, it is convenient to set limits for the degree of isochronous distortion of telegraph circuits and channels;

(b) that, for whatever purposes normally used, these circuits should be capable of use with start-stop equipment;

(c) that, until detailed transmission planning standards are established for the trunk sections of international telegraph circuits operating at modulation rates of 75, 100 and 200 bauds, the distortion limits mentioned below should be regarded as provisional standards;

(d) that the limits laid down are those that should be evident in service conditions on telegraph circuits, excluding the local lines and terminal equipment,

unanimously declares the view

(1) that circuits (excluding local lines and terminal equipment) should be established and maintained in such a manner that the degree of isochronous distortion will not exceed the limits shown in Table 1/R.120, irrespective of whether any form of regeneration is provided in the circuit or not;

TABLE 1/R.120

Modulation rate (bauds)	Maximum degree of isochronous distortion permitted
75	28%
100	24%
200	32%

(2) that the degree of isochronous distortion of each channel that may form part of a circuit should be as small as possible, and should not in any case exceed 10%.

STANDARD LIMITS OF TRANSMISSION QUALITY FOR START-STOP USER CLASSES OF SERVICE 1 AND 2 ON ANISOCHRONOUS DATA NETWORKS

(Geneva, 1976)

The CCITT,

considering

(a) that, to permit the sharing of responsibility for the maintenance of a high standard of transmission quality on switched connections between anisochronous data networks referred to in Recommendation X.1 [1], it is necessary to specify limiting values of distortion on signals leaving the international gateway centre of each network;

(b) that, on the other hand, to enable national switched networks to be interconnected, it is necessary to have a distribution plan of the telegraph distortion between national networks and the international junction circuits connecting the international gateway switching centres;

(c) that it is difficult to lay down standards applicable both to small and to large national networks;

(d) that it should be possible to fix limit values for large countries and they should apply to the great majority of user locations taking part in the international service,

unanimously declares the view

1 The following standards of transmission quality should be observed for the interconnection of national anisochronous data networks set up by means of transmission channels and start-stop terminal equipment in accordance with CCITT Recommendations to provide service for user classes of service 1 and 2 to Recommendation X.1 [1] (up to and including 300 bit/s).

1.1 The degree of gross start-stop distortion in service (i.e. including the effect of distortion due to the sending terminal equipment and the switching centres) at the point of exit of the national network should provisionally not exceed 22%.

Note – The international gateway exchange of a country is considered as forming part of the national network of that country.

1.2 The degree of inherent start-stop distortion of the international junction circuit should provisionally not exceed 13%.

Note 1 – In establishing the provisional 13% limit for the degree of start-stop distortion in the international junction circuit account has been taken of the fact that in a global connection, the international junction circuit might consist of 2 channels in tandem. If the international junction circuit is established on a single channel, an 8% provisional limit would be applicable to that circuit.

Note 2 – No limit for distortion on the entry to an international gateway centre at the receiving end has been indicated in this Recommendation. The values mentioned in §§ 1.1 and 1.2 above are adequate for planning purposes.

2 The provisional limit values mentioned above are applicable to large countries that are directly interconnected without switching in a transit country. Where national networks are unable to satisfy § 1.1 above, signal regeneration will be required.

3 Small countries (defined as countries in which all user terminal equipment can be reached via not more than one carrier channel in the national network) will have to try to obtain values less than the maximum 22% distortion mentioned in § 1.1 above.

4 The provisional standard limits mentioned under § 1 above can also apply to private switched telegraph and anisochronous data networks.

Reference

[1] CCITT Recommendation *International user classes of service in public data networks*, Rec. X.1.

SECTION 9

DEFINITIONS

Recommendation R.140

DEFINITIONS OF ESSENTIAL TECHNICAL TERMS IN THE FIELD OF TELEGRAPH TRANSMISSION

(Geneva, 1980 amended at Malaga-Torremolinos, 1984)

Note – Each term is designated by a number in the original CCITT numbering scheme and additionally by the nearest equivalent number in Chapter 721 of the IEV.

02 SERIES – GENERAL TRANSMISSION PROCESSES

02.081 **hypothetical reference connection (in telegraphy); hypothetical reference circuit** (deprecated)

F: communication fictive de référence (en télégraphie); circuit fictif de référence (terme déconseillé)

S: conexión ficticia de referencia (en telegrafía); circuito ficticio de referencia (desaconsejado)

Hypothetical connection made up for two terminals in the world telex network, or other telegraph network, corresponding in principle to the most onerous case in order to study the transmission and switching characteristics necessary to ensure satisfactory operation.

721.33.14

02.24 **subtelephone telegraphy**

F: télégraphie infra-téléphonique

S: telegrafía infratelefónica; telegrafía infraacústica

Telegraphy using a frequency band below that part of the audio range usually employed in telephone transmission.

02.25 **super-telephone telegraphy**

F: télégraphie supra-téléphonique

S: telegrafía supratelefónica; telegrafía supraacústica

Telegraphy using a frequency band above that part of the audio range usually employed in telephone transmission.

31 SERIES – GENERAL ALPHABETIC TELEGRAPHY

31.01 **code character**

F: caractère (télégraphique)

S: carácter de código

The set of conventional elements established by the code to enable the transmission of a written character (letter, figure, punctuation sign, arithmetical sign, etc.) or the control of a particular function (spacing, shift, line-feed, carriage return, phase correction, etc.); this set of elements being characterized by the variety, the duration and the relative position of the component elements (or by some of these features).

Note – The French and English terms are not equivalent.

31.011 **telegraph signal**

F: signal télégraphique

S: señal telegráfica

A signal representing all or part of one or more telegraph messages.

721.31.03

31.02 **signal element**

F: élément de signal

S: elemento de señal

Each of the parts constituting a signal and distinguished from the others by one or more characteristics such as its nature, magnitude, duration and relative position.

721.21.06

31.021 **transition**

F: transition

S: transición

A transient phenomenon separating two successive signal elements having different significant conditions.

721.21.28

31.022 **change-over**

F: mutation

S: cambio

A change from one significant condition to another.

721.21.27

31.023 **character signal**

F: signal de caractère

S: señal de carácter

A set of signal elements representing a character.

721.22.10

31.024 **character format**

F: format de caractère

S: formato de carácter

A general description of a character signal, indicating for example the number of unit elements it contains.

31.05 **start signal**

F: signal de départ

S: señal de arranque

In start-stop transmission, a signal preceding each group of signal elements which prepares the receiving device for the reception of the elements of the group.

721.22.15

31.051 **start element**

F: élément de départ

S: elemento de arranque

A start signal limited to one signal element generally having the duration of a unit interval.

721.22.16

31.06 **stop signal**

F: signal d'arrêt

S: señal de parada

In start-stop transmission, a signal following each group of signal elements which prepares the receiving device for the reception of the subsequent start signal, or brings the device to rest.

721.22.17

31.061 **stop element**

F: élément d'arrêt

S: elemento de parada

A stop signal limited to one signal element having any duration equal to or greater than a specified minimum value.

721.22.18

31.07 **telegraph code**

F: code télégraphique

S: código telegráfico

A system of rules and conventions according to which a succession of significant conditions representing a message should be formed and translated in alaphabetic telegraphy.

721.31.05

31.08 **telegraph alphabet**

F: alphabet télégraphique

S: alfabeto telegráfico

A convention indicating correspondence between a set of characters and a set of groups of elements which represent them.

721.31.07

31.081 **n-unit code alphabet**

F: alphabet d'un code à n moments

S: alfabeto de código de n unidades

A telegraph alphabet indicating correspondence between a set of characters and a set of n-unit code combinations.

721.31.08

31.082 **international telegraph alphabet No. 1 (ITA1)**

F: alphabet télégraphique international n° 1 (ATI n° 1)

S: alfabeto telegráfico internacional N.° 1 (ATI N.° 1)

A telegraph alphabet using a two-condition five-unit code, used in Baudot synchronous telegraphy.

Note – This alphabet is specified by Article 16 of the Telegraph Regulations, Geneva 1958.

721.31.09

31.083 **international telegraph alphabet No. 2 (ITA2)**

F: alphabet télégraphique international n° 2 (ATI n° 2)

S: alfabeto telegráfico internacional N.° 2 (ATI N.° 2)

An alphabet using a two-condition five-unit code, used in start-stop telegraphy generally for teleprinters.

Note – This alphabet is specified in Recommendation S.1.

721.31.10

31.084 **international telegraph alphabet No. 3 (ITA3)**

F: alphabet télégraphique international n° 3 (ATI n° 3)

S: alfabeto telegráfico internacional N.° 3 (ATI N.° 3)

An alphabet using the two-condition seven-unit constant-ratio code.

Note – This alphabet is defined by CCIR Recommendation 342-2 or CCITT Recommendation S.13 (1972).

721.31.11

31.085 **international telegraph alphabet No. 4 (ITA4)**

F: alphabet télégraphique international n° 4 (ATI n° 4)

S: alfabeto telegráfico internacional N.° 4 (ATI N.° 4)

An alphabet using a two-condition six-unit code for the time division multiplex synchronous telegraphy, comprising in particular two code combinations corresponding to the permanent conditions A and Z, so that the multiplex channel can be operated in a switched network.

Note – This alphabet is defined in Recommendation R.44 (1968).

721.31.12

31.086 **international alphabet No. 5 (IA5)**

F: alphabet international n° 5 (AI n° 5)

S: alfabeto internacional N.° 5 (AI N° 5)

An alphabet using a two-condition eight-unit code with seven primary information elements and one parity check element, comprising in particular upper and lower case characters, diacritical signs and miscellaneous control functions.

Note – The character coding rules using the seven primary elements are the subject of Recommendation V.3 (1972).

721.31.13

31.09 **character**

F: caractère (d'écriture)

S: carácter

A member of a set of elements agreed upon to be used for organisation, representation or control of information.

Note – Characters may be letters, digits, punctuation marks or other symbols and, by extension, function controls such as space, shift, carriage return or line-feed contained in a message.

721.22.09

31.10 **equal-length code**

F: code à moments

S: código de igual longitud

A code, the character signals of which are composed of the same number of unit elements.

721.22.21

31.11 **n-unit code**

F: code à n moments; code à n éléments (unitaires)

S: código de n unidades; código de n elementos unitarios

Equal-length code according to which the character signals are composed of n unit elements.

721.22.22

31.111 **code combination**

F: combinaison de code

S: combinación de código

A combination of n-unit elements formed in accordance with an n-unit code which assigns a significant condition to each of the unit elements.

721.22.23

31.112 **code element**

F: élément de code

S: elemento de código

A unit element constituting part of a character signal from the arrangements of which a code combination is formed.

Note – Figure 1/R.140 shows an example of the use of this term.

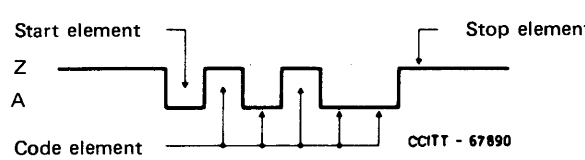

FIGURE 1/R.140

Example of the use of the term code element

31.113 **redundant code**

F: code redondant

S: código redundante

A code using more signal elements than strictly necessary to represent the contents of the message.

For example:

1. A seven-unit code, such as International Telegraph Alphabet No. 3 which uses only character signals made of four unit elements of A condition and three unit elements of Z condition, is redundant.

2. A five-unit code, using all the characters of International Telegraph Alphabet No. 2, is not redundant.

721.27.23

31.12 **code conversion**

F: conversion de code

S: conversión de código

The conversion from a representation of coded information to another representation of the same information in accordance with another code.

Example: Conversion of character signals or groups of character signals in one telegraph code into corresponding signals or groups of signals in another code.

721.21.21

31.14 **semateme** (not used in English)

F: sématème (à l'émission)

S: sematema

Contiguous succession in time of significant conditions.

721.31.14

31.15 **restitution**

F: restitution

S: restitución

The formation of a succession in time of signifcant conditions resulting from a received signal.

721.31.15

31.211 **significant condition**

F: état significatif

S: estado significativo; condición significativa

Condition of a signal element defining the meaning of that signal element, in accordance with a code.

Note – This condition can be a function of the value of the signal element e.g. amplitude, frequency, phase or a combination of these.

721.21.22

31.22 **significant interval**

F: intervalle significatif

S: intervalo significativo

Time interval between two consecutive significant instants.

721.21.30

31.23 **theoretical duration of a significant interval**

F: durée théorique d'un intervalle significatif

S: duración teórica de un intervalo significativo

The exact duration prescribed for a significant interval.

Note – In determining this duration, the standardized and, where necessary, the mean modulation rate has to be taken into account.

721.21.31

31.24 **significant instant**

F: instant significatif

S: instante significativo

That instant at which a change-over occurs.

Note – The instant of change from one significant condition to another.

721.21.29

31.25 **restitution delay**

F: délai de restitution [retard à la restitution]

S: retardo de restitución; retardo en la restitución

Transfer time of a significant instant between a transmitter and the corresponding receiver.

31.26 **unit interval**

F: intervalle unitaire

S: intervalo unitario

The shortest theoretical duration of a significant interval.

Note – In telegraphy the unit interval is the same as the minimal interval.

31.27 **modulation rate**

F: rapidité de modulation

S: velocidad de modulación

The reciprocal of the duration of the unit interval or of the shortest theoretical duration of signal element.

721.22.26

31.271 **character rate**

F: rapidité de transfert de caractères

S: velocidad de caracteres

The average number of characters transferred per unit time between two points.

721.22.29

31.272 **binary rate**

F: débit binaire

S: velocidad binaria

The aggregate rate in a transmission path expressed in bits per second.

Note 1 – The transmission rate is given by:

$$\sum_{i=1}^{i=m} \frac{1}{T_i} \log_2 n_i$$

where

m is the number of parallel transmission channels,

T_i is the shortest theoretical duration of signal element for the ith channel expressed in seconds, and

n_i is the number of significant conditions of the modulation in the ith channel.

For a single channel (serial transmission) it reduces to: $\frac{1}{T} \log_2 n$;

with two-condition modulation ($n = 2$), it is $1/T$.

For a parallel transmission with equal minimum intervals and equal number of significant conditions on each channel, it is:

$$m \left(\frac{1}{T}\right) \log_2 n;$$

with two-condition modulation it reduces to m/T.

Note 2 – The symbol of the unit of binary rate is bit/s.

721.22.30

31.273 **effective character rate**

F: cadence utile de transfert

S: velocidad efectiva de caracteres

The average number of binary digits, characters or blocks transferred per unit time between two points and accepted as valid at the reception.

721.22.31

31.28 **baud (Bd)**

F: baud (Bd)

S: baudio (Bd)

The unit of modulation rate; the number of bauds is equal to the reciprocal of the duration in seconds of the shortest signal element or of the unit interval in such signal.

Note – For example, if the duration of the unit interval is 20 ms, the modulation rate is 50 bauds.

721.22.27

31.29 **isochronous**

F: isochrone

S: isócrono

Pertaining to a signal or a time-varying phenomenon characterized by significant instants separated by time intervals having a duration theoretically equal to the duration of a unit interval or to an integral multiple of this duration.

721.22.01

31.291 **anisochronous**

F: anisochrone

S: anisócrono

Pertaining to a signal or a time-varying phenomenon characterized by significant instants separated by time intervals having durations not constrained to be all equal to the duration of a unit interval or to an integral multiple of this duration.

721.22.02

31.30 **start-stop telegraph signal**

F: signal télégraphique arythmique

S: señal telegráfica arrítmica

A telegraph signal containing sequences of unit elements, each sequence being of equal duration and corresponding to a transmitted character and preceded by a start element and followed by a period of condition Z, the duration of which is not fixed.

721.22.03

31.35 **number of significant conditions**

F: valence

S: valencia (número de estados significativos)

Number of different significant conditions that a signal element can assume in accordance with a code.

721.21.23

31.351 **two condition [three condition] [four condition]**

F: bivalent [etc.]

S: bivalente [trivalente] [tetravalente]; de dos estados, etc.

A qualifying term indicating that the number of significant conditions used is two [three] [four].

721.21.24-26

31.37

(For the countries of English language: the English and French terminologies do not correspond.)

marking; spacing (see also Definition 31.38)

mark; space

F: travail; repos

S: trabajo, reposo

Designation of the two significant conditions of a binary modulation (or restitution).

	The English term "marking" or "mark"	*French term*
1.	In Morse, corresponds to those portions of dot and dash signals that, for example, when actuating a Morse inker, will cause the inker to mark the paper.	**1. Travail**
2.	In printing telegraphy, corresponds to the significant condition that results in an active selecting operation in a receiving apparatus.	**2. Repos** or **travail** according to the system
	Note 1 – In start-stop automatic transmission, the term corresponds to the perforation of a hole in the tape.	idem
	Note 2 – In standardized start-stop telegraphy the term corresponds to the "stop" element.	**Repos**
3.	In isochronous systems, the term that is arbitrarily assigned to one or the other of the two signalling conditions.	**3. Repos** or **travail** according to the system

	The English term "spacing" or "space"	
1.	In Morse, corresponds to the spaces separating marking signals and to the spaces separating complete characters.	**1. Repos**
2.	In printing telegraphy, corresponds to the significant condition that results in a passive selecting operation in a receiving apparatus.	**2. Travail** or **repos** according to the system

	French term
Note 1 – In start-stop automatic transmission the term corresponds to the absence of perforation in the tape.	**Travail** or **repos** according to the system
Note 2 – In standardized start-stop telegraphy the term corresponds to the "start" element.	**Travail**
3. In isochronous systems, the term that is assigned to the non-marking signalling condition.	**3. Travail** or **repos** according to the system

The CCITT has recommended that those terms should not be used in telegraph circuit diagrams, but that the letters A and Z should be used to represent the two significant conditions of a binary modulation (see Definition 31.38).

The French term "travail"

applies to the significant condition that:	*English term*
1. In Morse corresponds to the recording of an impression on the paper;	**1. Mark**
2. In International Telegraph Alphabet No. 2, corresponds to the "start" element of a start-stop signal and to the absence of perforation in the tape in start-stop automatic transmission.	**2. Space**

The French term "repos"

applies to the significant condition that:	
1. In Morse corresponds to spaces;	**1. Space**
2. In International Telegraph Alphabet No. 2, corresponds to the "stop" element of a start-stop signal and to the perforation of the tape in start-stop automatic transmission.	**2. Mark**

31.38 **position A, position Z**

F: position A, position Z

S: posición A, posición Z

Representation of the positions occupied by the moving parts (for example, relay armatures) in a circuit diagram.

1 In a diagram representing a complete telegraph connection, operated by binary modulation, the positions that all the moving parts in the connection should simultaneously occupy, so that the electro-magnet of the receiver shall be in a given position (A or Z), should be designated in the same way as this position.

2 Position A is that which corresponds to the start signal of a standardized start-stop apparatus: position Z is that which then corresponds to the stop signal.

3 In the case of a point-to-point start-stop circuit, the moving parts should all be shown in position Z.

4 In the case of a diagram of a switched connection, the moving parts should all be shown in the position corresponding to the free condition of the circuits. Thus, for example, in the standardized international telex system, the position in question is A.

31.381 **A (Z) condition**

F: état A (Z)

S: estado A (o estado Z)

The significant condition of a start element (stop element) in start-stop transmission.

Note – For other representations see the table of equivalence in Recommendation V.1.

721.22.19

31.3811 **A (Z) element**

F: moment A (Z)

S: elemento A (o elemento Z)

In a code combination, a unit element to which is assigned the A (Z) condition.

721.22.24-25

31.3812 **idle circuit condition**

F: état de repos (d'un circuit)

S: estado de circuito en reposo

The characteristic state of the circuit in an established connection when it is transmitting neither character signals nor supervisory signals.

721.33.56

31.39 **unit element**

F: élément unitaire

S: elemento unitario

A signal element having a duration equal to the unit interval.

721.21.33

31.42 **Morse code**

F: code Morse

S: código Morse

A two-condition telegraph code in which characters are represented by groups of dots and dashes, these groups being separated by spaces.

721.31.25

31.43 **dot** (in Morse code)

F: point (en code Morse)

S: punto (en código Morse)

A signal element of mark condition and of duration of one unit interval followed by a signal element of space condition having a nominal duration of one unit interval.

721.31.28

31.44 **dash** (in Morse code)

F: trait (en code Morse)

S: raya (en código Morse)

A signal element of mark condition and of a duration of three unit intervals followed by a signal element of space condition having a nominal duration of one unit intervals.

721.31.29

31.45 **space** (between characters and words in Morse code)

F: espace (entre deux caractères, deux mots en code Morse)

S: espacio (entre caracteres y entre palabras, en código Morse)

A signal element of space condition and nominal duration of two unit intervals between characters and six unit intervals between words.

721.31.30

31.451 **space condition (in Morse code only)**

F: repos (en code Morse)

S: reposo (en código Morse)

Designation given to one of the two significant conditions in Morse code, the other condition being designated "mark".

721.31.27

31.452 **mark condition (in Morse code only)**

F: travail (en code Morse)

S: trabajo (en código Morse)

Designation given to one of the two significant conditions in Morse code.

721.31.26

32 SERIES – TELEGRAPH CHANNELS

32.01 **telegraph channel**

F: voie de transmission télégraphique

S: canal telegráfico

A means of transmission of telegraph signals in one direction between two points.

Note 1 – A telegraph channel may be characterized by the number of significant conditions, by the nominal modulation rate and by the code format it is designed to admit.

Example: A 50 baud channel for two-condition modulation.

Note 2 – Several telegraph channels may share a common path; for example each channel is allocated a particular frequency band or particular time slot.

721.33.01

32.011 **complete telegraph channel**

F: voie télégraphique complète

S: canal telegráfico completo

A telegraph channel between two terminal sets.

Note – A retransmitter with storage of signals is considered as a terminal set and terminates a complete channel.

721.33.03

32.012 **sub-channel**

F: sous-voie

S: subcanal

A tributary channel which is allocated a proportion of a standard channel rate.

Example: A transmission channel obtained by time-division and which is allocated a submultiple of an actual character transfer rate of a standard channel.

721.33.51

32.014 **multiple channel**

F: multivoie

S: multicanal

Pertaining to or designating a telegraph transmission system in which two or more channels are used for transmission of a character signal propagating in the same direction between the same two points.

721.33.21

32.015 **transmit channel**

F: voie d'émission

S: canal de emisión

The designation at a terminal or other equipment, of a channel used for transmitting.

721.33.09

32.016 **receive channel**

F: voie de réception

S: canal de recepción

The designation at a terminal or other equipment, of a channel used for receiving.

721.33.10

32.017 **serial transmission**

F: transmission série

S: transmisión serie

Transmission of the signal elements of a telegraph signal at successive time intervals, either contiguous or not.

721.33.16

32.018 **parallel transmission**

F: transmission parallèle

S: transmisión paralelo

The simultaneous transmission of the signal elements of a telegraph character signal on separate channels.

721.33.17

32.019 **start-stop transmission**

F: transmission arythmique

S: transmisión arrítmica

A transmission process using start-stop signals.

721.22.07

32.0110 **synchronous transmission**

F: transmission synchrone

S: transmisión síncrona

Transmission using isochronous signals in which the sending and receiving instruments are operating continuously in a constant time difference between corresponding significant instants.

721.22.05

32.0111 **synchronous system**

F: télégraphie synchrone

S: sistema síncrono

A system of alphabetic telegraphy using synchronous transmission.

721.31.17

32.0112 **element synchronism**

F: synchronisme élémentaire

S: sincronismo de los elementos

In synchronous transmission, the condition in which the rate of the local timing coincides completely with the rate of the received signal elements.

721.33.43

32.0113 **element synchronization**

F: synchronisation élémentaire

S: sincronización de los elementos

The action of adjustment of element synchronism.

721.33.44

32.0114 **code independent channel**

F: voie indépendante du code

S: canal independiente del código

Telegraph channel capable of transmitting telegraph signals irrespective of the code used.

721.51.31

32.0115 **code dependent channel**

F: voie dépendante du code

S: canal dependiente del código

A telegraph channel capable of transmitting telegraph signals only in a specified n-unit code format.

32.0116 **transparency**

F: transparence

S: transparencia

Possibility to transmit any telegraph signal with the only condition that a specified modulation rate cannot be exceeded.

32.02 **telegraph circuit**

F: circuit télégraphique

S: circuito telegráfico

A pair of associated telegraph channels permitting transmission in both directions between two points.

721.33.04

32.06 **telegraph repeater**

F: translation (télégraphique)

S: repetidor (traslator) telegráfico

A device which can receive telegraph signals and immediately retransmit them with the same meaning on the next line section.

721.33.11

32.071 **modulation converter**

F: translation convertisseuse de modulation

S: convertidor de modulación

A telegraph repeater in which the input and output signals are represented with the same code, but use different types of modulation.

721.33.13

32.08 **code converter**

F: convertisseur de code

S: convertidor de código

Telegraph repeater which can accomplish a code conversion.

721.34.52

32.081 **speed conversion**

F: conversion de rapidité

S: conversión de velocidad

The conversion of the modulation rate of the received signal to a different modulation rate suitable for the subsequent equipment.

721.22.28

32.09 **broadcast repeater**

F: translation pour diffusion

S: repetidor de difusión

A repeater connecting several channels, one incoming and the other outgoing.

32.10 **conference repeater**

F: translation pour conférence

S: repetidor para conferencias

A telegraph repeater connecting several circuits, which receives signals from any one of the circuits and automatically retransmits them over all the others.

32.11 **telegraph regenerative repeater**

F: régénérateur (télégraphique)

S: repetidor regenerativo telegráfico

A telegraph repeater designed to retransmit signals free from telegraph distortion.

721.33.12

32.12 **direct current transmission**

F: transmission par courant continu

S: transmisión en corriente continua

A form of transmission of telegraph signals where significant conditions are effected by the direct application of voltages supplied from direct current sources.

721.24.01

32.13 **single current transmission**

F: transmission par simple courant

S: transmisión a simple polaridad (por corriente simple)

Direct current transmission effected by applying voltages of the same polarity, producing currents of the same direction.

721.24.02

32.131 **on-off transmission**

F: transmission par tout ou rien

S: transmisión cerrado-abierto

A two-condition single current transmission where one significant condition is represented by applied zero voltage and no current in the circuit.

721.24.04

32.14 **double current transmission**

F: transmission par double courant

S: transmisión a doble polaridad (por corriente doble)

A form of two-condition direct current transmission effected by applying to a wire two voltages of opposite polarity, producing currents of opposite directions.

721.24.03

32.15 **closed-circuit working**

F: transmission par fermeture de circuit ou par envoi de courant

S: funcionamiento en circuito cerrado

Single-current transmission in which a current flows in the circuit while the transmitting device is at rest.

32.16 **open-circuit working**

F: transmission par ouverture (rupture) de circuit ou par interruption de courant (par batterie centrale)

S: funcionamiento en circuito abierto

Single-current transmission in which no current flows in the circuit while the transmitting device is at rest.

32.17 **simplex; half duplex** (deprecated)

F: simplex; à l'alternat; semi-duplex (déconseillé dans ce sens)

S: símplex; semidúplex (desaconsejado)

Designating or pertaining to a mode of operation or the equipment concerned, by which information can be transmitted in either direction but not simultaneously, between two points.

721.23.15

32.18 **duplex; full duplex** (deprecated)

F: duplex; bilatéral simultané

S: dúplex; dúplex completo (desaconsejado)

Designating or pertaining to a mode of operation or the equipment concerned, by which information can be transmitted in both directions simultaneously between two points.

721.23.16

32.26 **unidirectional**

F: unilatéral

S: unidireccional

Pertaining to a link where the transfer of the user's information can occur in one preassigned direction only.

721.23.21

32.28 **carrier transmission**

F: transmission par courants porteurs

S: transmisión por portadoras

A transmission in which the telegraph signals from a transmitter modulate an alternating current.

721.25.01

32.29 **amplitude modulation**

F: modulation d'amplitude

S: modulación de amplitud

In telegraphy, modulation in which the significant conditions are represented by alternating currents of different amplitude.

721.25.05

32.30 **frequency modulation**

F: modulation de fréquence (ou modulation en fréquence)

S: modulación de frecuencia

In telegraphy, modulation in which the significant conditions are represented by alternating currents of different frequency.

Note – The representative function of the modulation signal may be continuous or discontinuous at the significant instants.

32.31 **frequency shift keying (FSK); frequency shift modulation**

F: modulation par déplacement de fréquence; (MDF)

S: modulación por desplazamiento de frecuencia (MDF)

Phase continuous frequency modulation in which the frequency of a periodic sinusoidal oscillation is varied between a set of discrete values, each value representing a significant condition of a modulating telegraph signal.

721.25.06

32.311 **telegraph discriminator**

F: discriminateur télégraphique

S: discriminador telegráfico

A device for converting frequency shift telegraphy signals into direct current transmission signals.

721.34.55

32.312 **phase shift keying (PSK); phase shift modulation**

F: modulation par déplacement de phase (MDP)

S: modulación por desplazamiento de fase

Telegraph transmission by phase modulation in which each change from one significant condition to another is characterized in steady-state by specified changes of phase of the oscillatory source or of the sinusoidal wave.

721.25.07

32.32 **frequency-exchange modulation; two tone modulation**

F: modulation par mutation de fréquences

S: modulación por cambios opuestos de frecuencia; modulación de dos frecuencias

A frequency modulation method in which the change from one frequency to another is not necessarily phase continuous.

32.34 **multiplex**

F: multiplex

S: múltiplex

Designating or pertaining to an installation in which a common transmission channel is divided into several separate channels each capable of transmitting signals independently in the same direction.

721.23.04

32.341 **multiplexing**

F: multiplexage

S: multiplexación; multiplexión

A process for combining independent signals from several separate tributary channels for transmission in the same direction over a common channel.

721.23.05

32.342 **demultiplexing**

F: démultiplexage

S: demultiplexación; demultiplexión

A process applied to a multiplex signal for recovering signals combined within it and for restoring the distinct individual channels of these signals.

721.23.06

32.343 **multiplexer**

F: multiplexeur

S: multiplexor

An equipment for effecting multiplexing.

721.23.07

32.344 **demultiplexer**

F: démultiplexeur

S: demultiplexor

An equipment for effecting demultiplexing.

721.23.08

32.345 **muldex; muldem**

F: muldex; muldem

S: múldex; múldem

An assembly of a multiplexer and a demultiplexer operating in opposite directions of transmission in the same equipment.

721.23.09

32.346 **homogeneous multiplex**

F: multiplex homogène

S: múltiplex homogéneo

A multiplex in which all the individual channels are for the same modulation rate.

Note – In addition to the modulation rate it is sometimes necessary to define conditions for all channels such as the character length.

721.23.13

32.347 **heterogeneous multiplex**

F: multiplex hétérogène

S: múltiplex heterogéneo

A multiplex in which all the individual channels are not for the same modulation rate or character rate, etc.

Note – For the signalling rate condition we can add additional conditions.

721.23.14

32.348 **homogeneous structure**

F: structure homogène

S: estructura homogénea

Pertaining to a group of individual channels in a multiplex system all of which have the same properties, e.g. modulation rate, character format, inherent telegraph distortion.

32.349 **aggregate signal**

F: signal composite

S: señal global; señal compuesta; señal multiplexada

Signal transmitted over the common multiplex channel.

721.23.10

32.3410 **tributary channel**

F: voie affluente

S: canal afluente

An individual input channel to a multiplexer.

32.35 **time division multiplexing (TDM)**

F: multiplexage par répartition dans le temps (MRT); multiplexage temporel

S: multiplexación por división en el tiempo (MDT); multiplexación temporal; multiplexión temporal

Multiplexing in which a separate periodic time interval is allocated to each tributary channel in the common channel.

721.23.11

32.351 **frame**

F: trame

S: trama

A repetitive set of consecutive timeslots constituting a complete cycle of a signal in which the relative position of each timeslot in the cycle can be identified.

Example: In a time division multiplex system with a binary aggregate signal a frame is the smallest periodically repeated bit group containing bits from all individual channels together with bits carrying auxiliary information.

721.25.21

32.352 **subframe**

F: sous-trame

S: subtrama

A fixed number of time slots within a frame, which comply with the definition of a frame, but constitute a shorter cycle than the original frame.

721.25.22

32.353 **frame alignment**

F: verrouillage de trame

S: alineación de trama

The state in which the frame generated by the receiving equipment has a desired constant phase relationship with the frame of the received signal, so that the individual timeslots in each frame can be uniquely identified.

721.25.23

32.354 **frame resynchronization**

F: resynchronisation de trame

S: resincronización de trama

The act of re-establishing lost frame alignment.

32.355 **synchronization bit**

F: bit de synchronisation

S: bit de sincronización; bit de sincronismo

A binary digit which is used for frame synchronization.

721.33.45

32.356 **character-interleaved transmission**

F: transmission multiplex à caractères entrelacés

S: transmisión con entrelazado de caracteres

Time-division multiplex telegraphy in which characters are transmitted sequentially on a common channel, the characters coming from each independent channel in turn without separation of the unit elements of each character.

721.33.27

32.357 **bit-interleaved transmission**

F: transmission multiplex à moments entrelacés

S: transmisión con entrelazado de bits

Time-division multiplex telegraphy in which the signal elements of each character signal are transmitted on the common channel separated by signal elements belonging to other characters coming from different channels.

721.33.28

32.358 **character cycle**

F: cycle de caractère

S: ciclo de carácter

The period in which each tributory channel of a time-division multiplex has completed one character in the common channel.

721.33.42

32.36 **frequency division multiplexing (FDM)**

F: multiplexage par répartition en fréquence (MRF)

S: multiplexación por división de frecuencia (MDF); multiplexión por división de frecuencia

Multiplexing in which a separate frequency band is allocated to each tributary channel in common channel.

721.23.12

32.37 **voice frequency telegraphy (VFT)**

F: télégraphie harmonique; télégraphie à fréquences vocales

S: telegrafía armónica (TA)

Carrier telegraphy in which the frequency band of the modulated alternating current lies in the telephone frequency band.

721.33.22

32.371 **multi-channel voice-frequency telegraphy (MCVFT)**

F: télégraphie harmonique

S: telegrafía armónica multicanal (TAMC)

A telegraph transmission within a telephone type channel using frequency-division multiplexing.

721.33.22

32.372 **single channel voice frequency telegraphy (SCVFT)**

F: télégraphie harmonique à une voie

S: telegrafía armónica monocanal

Voice frequency telegraphy providing a single telegraph channel in a telephone type channel.

32.373 **telephone-type channel**

F: voie de type téléphonique

S: canal de tipo telefónico

A transmission channel of characteristics suitable for the transmission of speech but which is used for the transmission of other signals.

721.23.01

32.374 **telephone-type circuit**

F: circuit de type téléphonique

S: circuito de tipo telefónico

A pair of associated telephone-type channels permitting transmission in both directions between two points.

721.23.02

32.38 **voice frequency multiplex aggregate**

F: faisceau de télégraphie harmonique

S: haz de circuitos de telegrafía armónica

The set of voice-frequency multiplex telegraph circuits simultaneously accommodated in a telephone type channel.

721.33.23

32.49 **phantom circuit**

F: circuit fantôme

S: circuito fantasma

An additional circuit derived from the conductors of two metallic circuits, with the two conductors of each metallic circuit effectively being used in parallel.

Example: A telegraph circuit superposed on two telephone circuits.

721.24.06

32.50 **earth-return phantom circuit**

F: circuit approprié; circuit télégraphique fantôme avec retour par la terre

S: circuito fantasma con vuelta por tierra

An additional circuit derived from the conductors of a metallic circuit, with these two conductors effectively being used in parallel, and with return through the earth or the sea between the end points.

Example: A telegraph circuit superposed on a telephone circuit, with earth-return.

721.24.07

32.51 **earth-return double phantom circuit**

F: (circuit) approprié de fantôme; (circuit) approprié de combiné; circuit télégraphique superfantôme avec retour par la terre

S: circuito superfantasma con vuelta por tierra

An additional earth-return circuit derived from two pairs of metallic conductors used in parallel.

721.24.08

32.52 **double phantom circuit**

F: circuit superfantôme

S: circuito superfantasma

An additional circuit derived from the conductors of two phantom circuits, with the four conductors of each phantom circuit effectively being used in parallel.

721.24.09

32.55 **interband telegraphy**

F: télégraphie interbandes

S: telegrafía interbanda

A form of carrier transmission in which the telegraph channel is situated in a narrow band between two telephone channels.

721.25.14

32.56 **intraband transmission**

F: télégraphie intrabande

S: telegrafía intrabanda

A carrier telegraphy in a narrow band of frequencies appropriated inside the frequency band of a telephone channel to permit simultaneously a telephone transmission and a transmission by a discretely-timed signal.

721.25.15

32.57 **speech plus simplex (S + S) equipment**

F: équipement univocal

S: equipo telefonía más símplex; equipo T + S

Equipment for intraband telegraphy providing a simplex telegraph circuit by the use of a single telegraph carrier frequency.

721.25.16

32.58 **speech plus duplex (S + D) equipment**

F: équipement bivocal

S: equipo telefonía más dúplex; equipo T + D

Equipment for intraband telegraphy providing a duplex telegraph circuit by the use of two telegraph carrier frequencies.

721.25.17

32.61 **nominated reserved circuit**

F: circuit de secours (pour la télégraphie harmonique)

S: circuito de reserva especializado

A circuit, normally available for telephone traffic, which is allocated for the operation of a multi-channel telegraph system when the main, or primary, circuit becomes faulty.

721.33.15

32.631 **Baudot telegraphy**

F: télégraphie Baudot

S: telegrafía Baudot

Synchronous telegraphy, generally character interleaved telegraphy, using the International Telegraph Alphabet No. 1.

721.33.29

32.632 **Van Duuren radiotelegraph system; teleprinting over radio circuits (TOR)**

F: radiotélégraphie Van Duuren; TOR (teleprinting over radio circuits)

S: sistema de radiotelegrafía Van Duuren

A radiotelegraphy system with correction by repetition, in general time-division multiplex in two or four channels and using the Van Duuren code.

Note – The main characteristics are defined in Recommendation 342-2 of CCIR, Geneva 1982.

721.33.30

32.633 **signal repetition**

F: signal de répétition

S: señal de repetición

A function signal which is used in an error detecting and feedback system to request a repetition or to precede a retransmission.

Note – In the International Telegraph Alphabet No. 3 this signal corresponds to the code combination AZZAZAA.

721.27.35

32.634 **repetition cycle**

F: cycle de répétition

S: ciclo de repetición

A sequence of characters, the minimum number of which is determined by the loop time-delay of an error detecting and feed-back system. This delay is necessary to provide automatic repetition of information.

721.27.36

32.635 **RQ cycle; request cycle**

F: cycle RQ; cycle de demande

S: ciclo RQ; ciclo de petición

The repetition cycle requested in an error detecting and feedback system when a multilation is detected.

Note – See CCIR Recommendation 342-2.

721.27.37

32.636 **BQ cycle; response cycle**

F: cycle BQ; cycle de réponse

S: ciclo BQ; ciclo de respuesta

The repetition cycle transmitted in an error detecting and feedback system when signal repetition is received.

Note – See CCIR Recommendation 342-2.

721.27.38

32.637 **non-print cycle**

F: cycle sans impression

S: ciclo sin impresión

The operating time of a receiver in an error detecting and feedback system, initiated by the detection of a mutilation or by a signal repetition that has the same duration as a repetition cycle and during which all signals received are prevented from producing printing.

Note – See CCIR Recommendation 342-2.

721.27.39

32.638 **gated RQ**

F: pointage de RQ

S: punteado de RQ

A procedure in which a check is made for the presence of a signal repetition during the non-print cycle.

Note – See CCIR Recommendation 342-2.

721.27.40

32.639 **tested RQ**

F: contrôle de RQ

S: control de RQ; prueba de RQ

A procedure in which a check is made for the presence of a signal repetition and for the ratio of the number of elements A to the number of elements Z in each of the characters received after the signal repetition within the non-print cycle.

Note – See CCIR Recommendation 342-2.

721.27.41

32.640 **testing repetition cycle**

F: cycle de répétition contrôlé

S: ciclo de repetición controlado

A non-print cycle in which a check is made for the presence of a signal repetition and for the correct ratio of the number of elements A to the number of elements Z in all the characters received.

Note – See CCIR Recommendation 342-2.

721.27.42

33 SERIES – QUALITY OF TELEGRAPH TRANSMISSION

33.01 **perfect signal**

F: signal parfait

S: señal perfecta

A telegraph signal such that all the significant intervals are associated with correct significant conditions and conform accurately to their theoretical durations.

721.26.01

33.02 **ideal instant**

F: instants idéals

S: instante ideal

The instant with which the significant instant (if existing) would coincide in certain conditions to be specified for each particular case.

Note – It will be necessary to indicate, in each particular case, how these ideal instants are determined.

a) *Start-stop signal*

The ideal instant associated with the start element is the instant at which this element begins. The ideal instant associated with each of the other elements is *n* times the theoretical unit interval later than the ideal instant of the start element of the same signal, *n* being the rank of this element in the signal.

The standardized unit interval should be taken as the theoretical unit interval. The interval corresponding to the real mean modulation rate can also be taken, provided that it is specified.

The instant corresponding to the beginning of the start element of a signal should be known as the reference ideal instant for this signal.

b) *Isochronous signal*

An ideal reference instant can be chosen arbitrarily. All the others are deduced from it by intervals equal to the corresponding theoretical significant intervals.

In the absence of any other deciding reason, the reference ideal instant shall be chosen so that the mean value of the deviations with respect to it is equal to zero.

721.26.02

33.03 incorrect signal

F: signal incorrect

S: señal incorrecta

A telegraph signal in which the significant conditions of one or more elements differ from the kind prescribed by the code.

721.26.04

33.04 telegraph distortion; time distortion

F: distorsion télégraphique

S: distorsión telegráfica

The undesired effect on a telegraph signal, when the significant instants do not coincide with the corresponding ideal instant.

Note – A telegraph signal suffers from telegraph distortion when the significant intervals have not all exactly their theoretical durations.

721.26.03

33.041 transmitter distortion

F: distorsion à l'émission

S: distorsión en la emisión; distorsión en el emisor

The telegraph distorsion of a transmitter measured at the output under specified standard conditions.

721.26.19

33.06 degree of individual distortion (of a particular significant instant)

F: degré de distorsion individuelle (d'un instant significatif)

S: grado de distorsión individual (de un instante significativo determinado)

The ratio of the algebraic value of the displacement in time of a given significant instant from the corresponding ideal instant, to a specified unit interval.

Note 1 – By convention the displacement is considered positive when the significant instant occurs after the ideal instant, and conversely it is considered negative when it occurs before.

Note 2 – The degree of individual distortion is usually expressed as a percentage.

721.26.05

33.07 degree of isochronous distortion

F: degré de distorsion isochrone

S: grado de distorsión isócrona

1) Ratio of the maximum measured difference, irrespective of sign, between the actual and the theoretical intervals separating any two significant instants, these instants not necessarily being consecutive, to the mean unit interval.

2) The algebraic difference between the highest and the lowest value of the degree of individual distortion referred to the mean duration of the unit interval for the significant instants of an isochronous signal.

The degree of distortion is expressed as a percentage.

Note – The result of the measurement should be completed by an indication of the period, usually limited, of the observation. For a prolonged modulation (or restitution) it will be appropriate to consider the probability that an assigned value of the degree of distortion will be exceeded.

721.26.06

33.08 degree of start-stop distortion

F: degré de distorsion arythmique

S: grado de distorsión arrítmica

1) In start-stop transmission the ratio of the maximum measured difference, irrespective of sign, between the actual and theoretical intervals separating any significant instant from the significant instant of the start element immediately preceding it, to the unit interval.

2) The highest absolute value of the degrees of individual distortion of the significant instants of a start-stop signal which is reached within a specified time interval.

The degree of distortion of a start-stop modulation, restitution or signal is usually expressed as a percentage.

Note 1 – The result of the measurement should be completed by an indication of the period, usually limited, of the observation. For a prolonged modulation (or restitution) it will be appropriate to consider the probability that an assigned value of the degree of distortion will be exceeded.

Note 2 – By convention the start-stop distortion may be considered positive when the significant instant occurs after the ideal instant and conversely, negative when it occurs before.

721.26.07

33.09 **degree of gross start-stop distortion**

F: degré de distorsion arythmique global

S: grado de distorsión arrítmica global

The degree of start-stop distortion determined when the assumed unit interval is exactly that appropriate to the nominal modulation rate.

Note – By convention the gross start-stop distortion may be considered positive when the significant instant occurs after the ideal instant and conversely, negative when it occurs before.

721.26.08

33.10 **degree of synchronous start-stop distortion; degree of start-stop distortion at the actual mean modulation rate**

F: degré de distorsion arythmique au synchronisme; degré de distorsion arythmique à la rapidité réelle moyenne

S: grado de distorsión arrítmica en el sincronismo; grado de distorsión en el sincronismo a la velocidad media real de modulación

The degree of start-stop distortion determined when the assumed unit interval is that appropriate to the actual mean modulation rate.

Note 1 – In practice the degree of synchronous start-stop distortion is measured by adjusting the scanning rate of the distortion measuring set.

Note 2 – As for Definition No. 33.07.

Note 3 – For the determination of the actual mean modulation rate, account is only taken of those significant instants of modulation (or restitution) that correspond to a change of condition in the same sense as that occurring at the beginning of the start element.

721.26.09

33.12 **degree of standardized test distortion**

F: degré de distorsion d'essai normalisé

S: grado de distorsión normalizado de prueba

The degree of individual distortion of the received signal measured during a specified period of time when the signal at the sending end is perfect and corresponds to a specified text.

721.26.10

33.13 **inherent distortion (of a transmission channel)**

F: distorsion propre

S: distorsión propia (de un canal de transmisión)

The telegraph distortion of a received signal at the output of a transmission channel when the signal at the input is a perfect signal.

Note 1 – The inherent distortion includes all the distortions produced in the channel such as bias distortion, characteristic distortion and fortuitous distortion.

Note 2 – The concept of inherent distortion can be extended to the constituents such as a telegraph relay, telegraph repeater or exchange.

721.26.11

33.14 **conventional degree of distortion**

F: degré conventionnel de distorsion

S: grado convencional de distorsión

The degree of individual distortion which has a very small assigned probability of being exceeded over a prolonged period of time.

721.26.17

33.15 **characteristic distortion**

F: distorsion caractéristique

S: distorsión característica

The telegraph distortion caused by transients which are produced by the transmission of the signal in a transmission channel of specific characteristics.

Note – Characteristic distortion is a function of the form of the input signal.

721.26.14

33.16 **fortuitous distortion**

F: distorsion fortuite; [distorsion irrégulière]; [distorsion accidentelle]

S: distorsión fortuita

The telegraph distortion resulting from random events affecting the channel or equipments and such that the degree of individual distortion of any significant instant is unpredictable.

721.26.15

33.17 **bias distortion**

F: distorsion biaise

S: distorsión asimétrica

The telegraph distortion effecting a two-condition telegraph signal when the mean degrees of individual distortion are different from the two directions of change-over.

721.26.12

33.18 **cyclic distortion**

F: distorsion cyclique

S: distorsión cíclica

A telegraph distortion which is due to events having a periodic character such that the degrees of individual distortion themselves show a periodic character in the sequence of the significant instants.

721.26.16

33.19 **character error rate of a telegraph connection**

F: taux d'erreur sur les caractères d'une connexion télégraphique

S: tasa de errores en los caracteres de una conexión telegráfica

Ratio of the number of characters of a message incorrectly received (after automatic translation where applicable) to the number of characters of the message.

Note 1 – A telegraph connection may have a different character error rate for the two directions of transmission.

Note 2 – The statement of the error rate will be accompanied by that of the time interval, generally limited, during which the observation was made. For a connection established for a sufficiently long time, the probability of exceeding an assigned value of error rate could be considered.

33.23 **efficiency factor in time (of a transmission with automatic repetition for the correction of errors)**

F: facteur d'efficacité dans le temps (d'une transmission avec correction d'erreurs par répétition)

S: factor de eficacia (o eficacia) en el tiempo (de una transmisión con corrección de errores por repetición automática)

Ratio of the time necessary to transmit a text automatically without repetition, at a specified modulation rate, to the time actually taken to receive the same text with error control by repetition for a given error rate.

Note – The actual conditions in which the measurement is made should be specified, in particular the duration of the measurement.

721.27.34

33.24 **mutilation**

F: mutilation

S: mutilación

A defect such that a signal element becomes changed from one significant condition to another.

721.27.01

33.26 **controlling station (on a circuit)**

F: station directrice (sur un circuit)

S: estación directora (de un circuito)

A station located on the circuit and having the responsibility for the quality of transmission on the circuit.

33.261 **system control station**

F: station directrice (dans un système)

S: estación directora de sistema

A terminal station of a multichannel system which is responsible for maintenance and clearance of faults on the system.

721.52.56

33.27 **sub-control station**

F: station sous-directrice

S: estación subdirectora

A station, located on the circuit, responsible to the controlling testing station, and having responsibility for the quality of transmission on the section of the circuit within its territory.

33.29 **test section**

F: section d'essais

S: sección de pruebas

The section of a channel that is contained between two stations having measuring equipment enabling tests of telegraph transmission to be made.

33.31 **error correction by detection and repetition (ARQ)**

F: correction d'erreurs par détection et répétition (ARQ)

S: corrección de errores por detección y repetición

Error correction using an error detecting code in which every mutilation discovered at the receiving end causes the sending to the transmitting end, over the return channel, of a function signal which orders the repetition of a fixed sequence of the last signals sent.

721.27.21

33.32 **precorrection**

F: précorrection

S: precorrección

Application of an artificial telegraph distortion to signals at the sending end of a channel, in order to completely or partly compensate for the effect of the characteristic distortion of this channel.

721.27.43

33.33 **error detecting code**

F: code détecteur d'erreurs

S: código detector de errores

A redundant code in which the rules of construction are such that any error causing departures from this construction can be automatically detected.

721.27.27

33.35 **error correcting code**

F: code de correction des erreurs

S: código corrector de errores

An error detecting code which also permits the automatic correction of a proportion of the detected errors without using a backward channel.

721.27.28

SECTION 10

AVAILABILITY AND RELIABILITY OF INTERNATIONAL TELEGRAPH CIRCUITS

Recommendation R.150

AUTOMATIC PROTECTION SWITCHING OF DUAL DIVERSITY BEARERS

(Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that Recommendation R.54 lays down a character error rate objective for telegraph communication;

(b) Recommendation M.201 concerning transmission path restoration for service protection;

(c) that the availability and reliability of international telegraph transmission may be improved by providing automatic protection switching of dual, diversely routed bearers to carry TDM aggregates conforming to Recommendation R.101;

(d) that the principle of automatic switching between dual diversity routed bearers may also apply to other telegraph channel multiplexers such as TDM systems conforming to Recommendation R.111 or frequency-modulated voice frequency telegraph (FMVFT) systems conforming to Recommendation R.35, etc.,

unanimously declares the following view

1 It may be desirable to take measures to protect the quality and availability of derived international telegraph channels against bearer breaks or degradation, for example:

i) where the bearer is prone to relatively frequent interruptions (for example, long-haul bearers in intercontinental relations), such that the provisions of Recommendation R.54 may not be met for a significant proportion of the time;

ii) where the number of derived telegraph channels carried on a given telephone-type circuit or other bearer becomes considerable (e.g. in excess of 50).

2 An effective method of counteracting bearer faults is the use of automatic protection switching between dual diversely routed bearers. In this technique, a pair of bearers with geographically diverse paths is selected (e.g. one cable, one satellite), ensuring a low probability of simultaneous outages of both bearers. At the sending end for each direction, the multiplexer aggregate or aggregates are connected to both bearers continuously. At the receiving end for each direction, facilities are provided to select automatically either of the two incoming aggregate signals, using as criteria loss of sync or frame alignment from the TDM or loss of line signal (FMVFT or TDM).

3 Annex A shows methods of implementing protection switching of telegraph bearers.

ANNEX A

(to Recommendation R.150)

Protection switching methods for telegraph aggregates

A.1 *System configurations*

A.1.1 Figures A-1/R.150 and A-2/R.150 illustrate simple applications of automatic protection switching between dual, diversely routed telegraph bearers. The aggregate output at each end is transmitted on both bearers continuously. At each end a Bearer Switchover Unit (BSU) automatically (and independently of action at the distant end) selects one of the incoming aggregates from the two bearers and feeds it to the multiplexer (TDM or FMVFT).

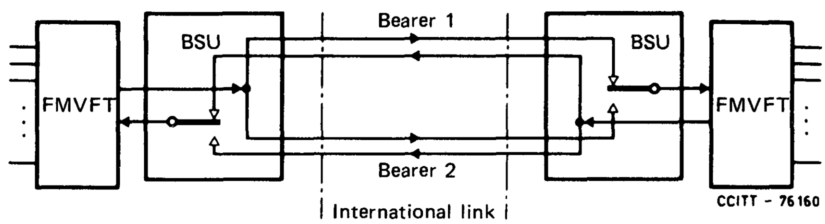

FIGURE A-1/R.150
FMVFT arrangement

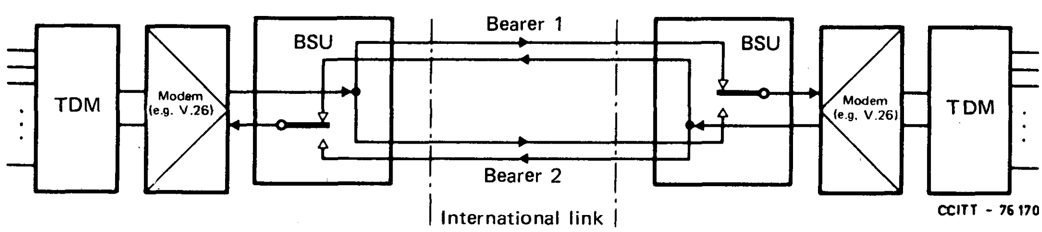

FIGURE A-2/R.150
Single TDM arrangement

A.1.2 Two of the many further possible configurations using higher order digital multiplexers are shown in block form in Figures A-3/R.150 and A-4/R.150.

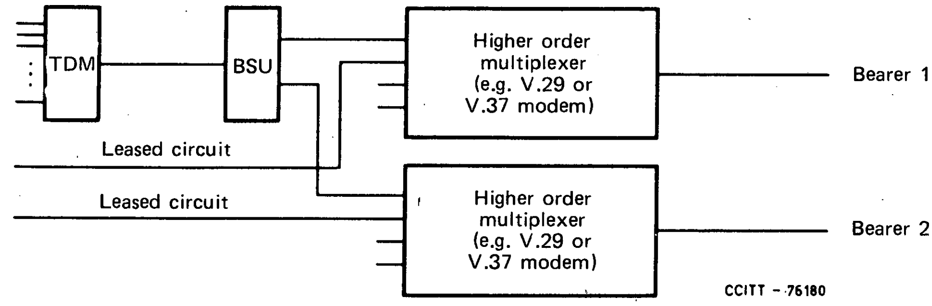

FIGURE A-3/R.150

Arrangement for protected TDM multiplexed with leased data circuits

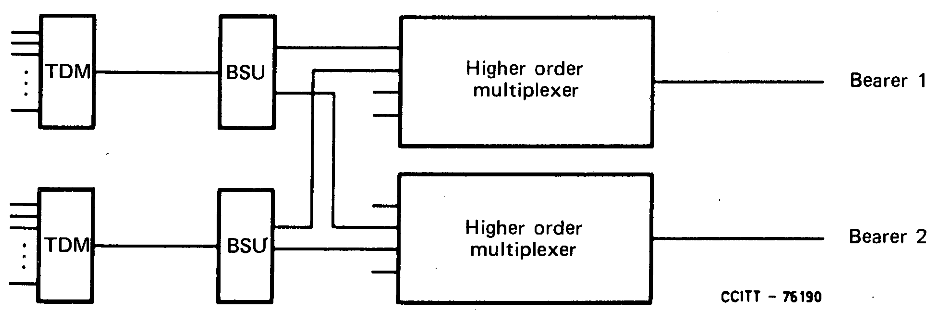

FIGURE A-4/R.150

Arrangement for two protected TDMs

A.2 *Bearer routing*

For protection switching to be effective, every effort should be made to diversify the routing of the two bearers. On the international portion, one bearer might be carried by cable and the other by satellite for example. Common equipment needs to be avoided in both the international transmission systems and any relevant national extensions to them.

A.3 *Bearer switchover unit*

A.3.1 The BSU splits the multiplexer send path for simultaneous transmission on both bearers. In the case of TDM, the split will be made before or after the modems as required, i.e. the aggregate signal is split in either its digital or its analogue form.

A.3.2 The BSU monitors the appropriate circuit and equipment parameters on the receive path of both bearers. It switches the multiplexer aggregate input from one bearer to the other as follows:

a) after a continuous period of between one and two seconds [1] when there is:
   - insufficient signal (where the BSU is in the analogue path) or loss of keying (where the BSU is in the digital path) on the currently selected bearer; and/or
   - loss of local [2] sync (Recommendation R.101) or frame alignment (Recommendation R.111) within the associated TDM;

[1] The shortening of this delay for Recommendation R.111 TDM aggregates is for further study.

[2] Advice from the distant TDM that it has lost sync or frame alignment will not of itself cause the BSU to switch over.

Note – An optional third condition "the other bearer (the bearer not currently in use) has not been detected as faulty within the previous two seconds" is left for further study.

b) once a switchover has occurred, a further switchover due to bearer failure on the newly selected path shall be inhibited for a period of either 8 or 12 seconds[1] and an alarm signal given.

A.3.3 When TDM systems are used, the BSU switches the received aggregate signal either in its digital or analogue form.

When switching the TDM aggregate in digital form, the following leads must also be switched:

– received line signal detector (e.g. Recommendation V.24 circuit 109) if required by the TDM;

– receiver signal element timing (e.g. Recommendation V.24 circuit 115).

A.3.4 The logic controlling the above functions shall be designed to be secure, minimizing the risk of a BSU fault that could affect both bearer paths.

[1] The shortening of this delay for Recommendation R.111 TDM aggregates is for further study.

PART II

Series S Recommendations

ALPHABETICAL TELEGRAPH TERMINAL EQUIPMENT

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SECTION 1

START-STOP TERMINALS

Recommendation S.1

INTERNATIONAL TELEGRAPH ALPHABET No. 2

(Malaga-Torremolinos, 1984)

1 Introduction

1.1 This Recommendation defines the repertoire of the graphic and control characters used in International Telegraph Alphabet No. 2 (ITA2) and the coded representation of these characters for communication purposes. It also contains provisions concerning the use of certain specific combinations.

1.2 The coded character set of ITA2 is based on a 5-unit-structure.

1.3 ITA2 is also defined in Recommendation F.1 for the international public telegram service, and it is specified in Recommendation F.60 that it should also be used for the telex service. It may also be used for other applications, such as specialized or leased circuits.

1.4 For definitions concerning alphabetic telegraphy, see definitions in Recommendation R.140 and the International Electrotechnical Vocabulary (IEV), Chapter 721.

2 Character repertoire

2.1 Graphic characters that have a corresponding signal in ITA 2 are:

- the 26 latin alphabetic characters: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z;
- decimal figures: 0 1 2 3 4 5 6 7 8 9;
- punctuation marks and miscellaneous signs:

Full Stop	.
Comma	,
Colon or division sign	:
Question mark	?
Apostrophe	'
Cross or addition sign	+
Hyphen or dash or subtraction sign	–
Fraction bar or division sign	/
Equal sign or double hyphen	=
Left-hand bracket (parenthesis)	(
Right-hand bracket (parenthesis)	)

2.2 Three graphic characters (such as accented letters and currency signs) may be applied for national or private use (see § 4.2)

2.3 This Recommendation does not define the particular printing style, font or case (capital or small letters) of graphic characters, nor does it define the layout of keyboards in teleprinters or similar terminal devices.

2.4 The control characters provided in ITA2 are:

- "Who are you?" (operation of the answerback unit of the corresponding installation)
- operation of an audible signal of the corresponding installation;
- carriage return;
- line-feed;
- letter-shift;
- figure-shift;
- space or blank;
- all-space or null (no tape perforation).

3 Coding

3.1 The 32 combinations available in ITA2 are produced by a sequence of five units, each of which may assume one of two significant conditions (A or Z), as shown in Table 1/S.1.

3.2 Condition A corresponds to start polarity, no perforation in paper tape and symbol 0 of the binary notation. Condition Z corresponds to stop polarity, perforation in paper tape and symbol 1 in the binary notation.

For the equivalent frequency and amplitude modulation corresponding to conditions A and Z in voice-frequency telegraph equipment, see Recommendation V.1 and the relevant Series R Recommendations.

Note 1 – The level and polarity of voltage and current corresponding to conditions A and Z (e.g. in the local end with its termination) are national options and hence are not defined internationally.

Note 2 – The terms "start" and "stop", "space" and "mark" have also been used to describe conditions A and Z respectively (see definition 31.37 in Recommendation R.140).

4 Particular combinations

4.1 In accordance with Recommendation S.8 and the Series U Recommendations, "WRU" (who are you? combination No. 4 in figure case), is used to operate the answerback unit of the corresponding instrument in the international telex and gentex services, and may also provide a printed symbol (as in Table 2/S.1)

4.2 Since some Administrations assign combination Nos. 6, 7 and 8 in figure case for internal use whereas others do not, it is desirable to avoid varying interpretation in these circumstances that might result if they were used freely in international services. Consequently the use of combination Nos. 6, 7 and 8 in figure case is not defined and therefore should not be used in international services, except by direct agreement between Administrations; and it is recommended:

- that, in all services, they should be shown in some special manner on the keyboards and:
- that services in which they are not used should place on the secondary position on the printing blocks (or on the equivalent mechanism) an arbitrary sign, for the letters F, G and H such as, for instance, a square. The appearance of such sign on the paper is to indicate an abnormal impression.

4.3 Combination No. 10 "audible signal", may also provide a printed symbol (as in Table 2/S.1)

4.4 Combinations Nos. 29 and 30, "letter-shift" and "figure-shift", respectively, are used to place the terminal installation in the "letter" or "figure" position, so that:

- any combination No. 1 to 26 received engenders a printed signal in the "letter" case (second column of Table 1/S.1) if the last shift signal received is a "letter-shift" signal;
- any combination No. 1 to 26 received engenders a printed signal in the "figure" case (third column of Table 1/S.1) if the last shift signal received is a "figure-shift" signal", except as noted for combinations Nos. 4 and 10 in §§ 4.1 and 4.3.

TABLE 1/S.1

International Telegraph Alphabet No. 2 (ITA2)

Combination number	Letter case	Figure case	Coding				
			1	2	3	4	5
1	A	–	Z	Z	A	A	A
2	B	?	Z	A	A	Z	Z
3	C	:	A	Z	Z	Z	A
4	D	See § 4.1	Z	A	A	Z	A
5	E	3	Z	A	A	A	A
6	F	See § 4.2	Z	A	Z	Z	A
7	G	See § 4.2	A	Z	A	Z	Z
8	H	See § 4.2	A	A	Z	A	Z
9	I	8	A	Z	Z	A	A
10	J	Audible Signal	Z	Z	A	Z	A
11	K	(	Z	Z	Z	Z	A
12	L	)	A	Z	A	A	Z
13	M	.	A	A	Z	Z	Z
14	N	,	A	A	Z	Z	A
15	O	9	A	A	A	Z	Z
16	P	0	A	Z	Z	A	Z
17	Q	1	Z	Z	Z	A	Z
18	R	4	A	Z	A	Z	A
19	S	'	Z	A	Z	A	A
20	T	5	A	A	A	A	Z
21	U	7	Z	Z	Z	A	A
22	V	=	A	Z	Z	Z	Z
23	W	2	Z	Z	A	A	Z
24	X	/	Z	A	Z	Z	Z
25	Y	6	Z	A	Z	A	Z
26	Z	+	Z	A	A	A	Z
27	Carriage-return		A	A	A	Z	A
28	Line-feed		A	Z	A	A	A
29	Letter-shift	See § 4.5	Z	Z	Z	Z	Z
30	Figure-shift	See § 4.5	Z	Z	A	Z	Z
31	Space		A	A	Z	A	A
32	See § 4.7		A	A	A	A	A

4.5 Combinations Nos. 29 (letter-shift), 30 (figure-shift) and 32 (all-space, null or no tape perforation) shall not affect the spacing movement of terminal machines, except where their reception is indicated by printing a symbol, as mentioned in § 5 below.

4.6 *Use of capital and small letters*

4.6.1 In ITA2, it is possible to use teleprinters with two series of letter characters, capital and small letters.

4.6.2 It is possible to use sequences of the shift combinations of ITA2 for transfer from one series to the other.

4.6.3 If this possibility is used, it is essential to obtain compatibility with teleprinters having only one series of letter characters.

4.7 *Use of combination No. 32*

4.7.1 Combination No. 32 can be used in certain sequences of switching signals; these uses are set out in Recommendations U.11, U.20, U.22 and S.4.

4.7.2 Combination No. 32 must not be used during the phase of communication (after a call is set up) in the international telex service.

4.7.3 Combination No. 32 can be used during the phase of communication after a call is set up in domestic national service or by bilateral agreement between two Administrations, as a command signal for certain functions, e.g. transfer to a national alphabet other than ITA2;

4.7.4 Combination No. 32 must not be used for transfer from one form of characters to another while remaining within ITA2, nor for transfer from one international telegraph alphabet to another.

5 Graphic representation of control characters

Where a graphic indication of the reception or transmission of certain control characters is required, this should be effected by printing the symbols shown in Table 2/S.1.

TABLE 2/S.1

Printed symbols for control characters

Function	Combination No.	Case	Symbol	Alphabetic representation
Who are you? (WRU)	4	Figure	⌧ (see Note 1)	EQ
Audible signal (bell)	10	Figure	⍾	BL
Carriage-return	27	Either	$<$	CR
Line-feed	28	Either	$\equiv$	LF
Letter-shift	29	Either	↓	SL or LS
Figure-shift	30	Either	↑	SF or FS
Space	31	Either	Δ	SP
All-space: Null	32	Either	□	NU

Note 1 – The pictorial representation shown is a schematic of ✠, which may also be used when equipment allows.

Note 2 – Each alphabetic representation is to be considered as a single symbol. It may occupy one position on a printed or displayed line.

TRANSMISSION CHARACTERISTICS OF THE LOCAL END WITH ITS TERMINATION (ITA2)

(based on former Recommendations S.3, S,3 bis *and S.3* ter, *Geneva, 1976, 1980 and Malaga-Torremolinos, 1984)*

The CCITT,

considering

(a) that this Recommendation defines the characteristics, from the transmission point of view, of the local end with its termination when start-stop equipment uses International Telegraph Alphabet No. 2 (see Recommendation S.4 and the Recommendation cited in [1]);

(b) that this Recommendation applies – except where otherwise specified (for example, the case of regenerative repeaters, which is covered by Recommendation R.60 – to start-stop apparatus in the wide sense of the terms as defined in [2]: i.e. it includes reperforators, service signals sent by switching equipment, the signals from answerback units, automatic transmitters, etc.;

(c) that some equipment (using telegraph modems in accordance with Recommendation R.20, or single current working, for instance) cannot be separated during operation from its supply and repeater devices; hence the measurements under operating conditions must apply to the *local end with its termination* (see [3]).

(d) that the characteristics laid down below are those that should be evident in service conditions on local ends with their terminations that are likely to be connected to the international network. It should be noted, however, that in the case of d.c. transmission they apply to such local ends with their terminations only if the influence of the line in the local end produces negligible distortion. In the case of equipment using telegraph modems the modem-to-modem distortion as given in Recommendation R.20 must be included.

unanimously declares the view:

1 General characteristics

1.1 The nominal modulation rate should be 50, 75 or 100 bauds.

1.2 The difference between the real mean modulation rate of signals when in service and the nominal modulation rate should not exceed:

a) ± 0.1% for new-generation electronic equipment first placed in service after 1980; or

b) ± 0.75% for other equipment.

1.3 For 50-baud working, the nominal duration of the transmitting cycle should be at least 7.4 units (preferably 7.5), the stop element lasting for at least 1.4 units (preferably 1.5).

Note – Administrations are recommended to withdraw from the international service equipment not meeting this Recommendation. If this cannot be done immediately then, in view of the special difficulties that are encountered in the regeneration of automatically transmitted 7-unit start-stop signals, it is recommended that urgent attention should be given to the replacement of 7-unit automatic transmitters by 7.5- (or 7.4 minimum) unit automatic transmitters.

1.4 For 75-baud working, the nominal duration of the transmitting cycle should be at least 7.4 units (preferably 7.5) the stop element lasting for at least 1.4 units (preferably 1.5). Administrations should not authorize the use of terminal machines with a cycle of less than that value.

1.5 For 100-baud working, the nominal duration of the transmitting cycle should be at least 7.5 units, the stop element lasting for at least 1.5 units.

1.6 To accommodate the shortest signal that may be emitted by, for example, a regenerative repeater (see Recommendation R.60), the receiver must be able to translate correctly in service the signals coming from a source that appears to have a nominal transmit cycle equal to or greater than:

– 7 units at 50 or 75 bauds; or

– 7.2 units at 100 bauds.

2 Transmitter characteristics

2.1 The degree of gross start-stop distortion of transmitted signals, measured at the output of the local end with its termination, must not exceed:

a) 5% for 50 or 100 baud equipment using d.c. transmission;

Note – There is older equipment in service having a transmitter distortion of 10%.

b) 10% for 50 baud equipment using a telegraph modem;

c) 12% for 100 baud equipment using a telegraph modem;

The appropriate value applies to all working conditions.

Note that the figures in b) and c) need to be increased by 2% and 3% respectively where the received frequencies are subject to an error ± 6 Hz at the distant modem.

2.2 It is recommended that the measurement should be made with a start-stop distortion measuring set for a period in accordance with Recommendation R.5.

3 Receiver characteristics

3.1 For signals corresponding to a nominal transmit cycle equal to or greater than 7 units at 50 or 75 bauds or 7.2 units at 100 bauds, the effective net margin [4] should not be less than:

a) 40% for 50- or 75-baud equipment using d.c. transmission;

Note – There is older equipment in service having a receiver margin of 35%.

b) 35% for 50- or 75-baud equipment using a telegraph modem;

c) 30% for 100-baud equipment using d.c. transmission (this value requires further study);

d) 23% for 100-baud equipment using a telegraph modem (this value requires further study).

Note that the figures in b) and d) need to be reduced by 2% and 3% respectively where the received frequencies are subject to an error of ± 6 Hz.

3.2 It is recommended that the measurement should be made under the following conditions, in service:

– 7.5-unit cycle for the signals transmitted by the measuring equipment;

– use of either some of the standardized texts specified in Recommendation R.52;

– test with the appropriate degree of start element distortion, long and short;

– reading the margin when less than one error per sentence of Recommendation R.52 is obtained. (The margin is the lesser of the two values of the degree of distortion obtained from the two measurements.)

Note – It will be up to Administrations using some other measuring method to work out for their own use figures to give equivalent results to those that would have been obtained by the recommended method.

References

[1] CCITT Recommendation *Operational provisions for the international public telegram service*, Rec. F.1, § C.

[2] CCITT Definition: *Start-stop apparatus*, Vol. X, Fascicle X.1 (Terms and Definitions).

[3] CCITT Definition: *Local end with its termination*, Vol. X, Fascicle X.1 (Terms and Definitions).

[4] CCITT Definitions: *Net margin, Effective margin (of an apparatus), Normal, or not, margin of start-stop apparatus,* Vol. X, Fascicle X.1 (Terms and Definitions).

SPECIAL USE OF CERTAIN CHARACTERS OF THE INTERNATIONAL TELEGRAPH ALPHABET No. 2

(former CCIT Recommendations C.7, C.8 and C.12; modified at New Delhi, 1960, Geneva, 1964, 1972, 1976, 1980 and Malaga-Torremolinos, 1984)

1 Sequences of combinations used for special purposes

As quoted in Recommendations F.1, F.30, R.79, R.79 *bis*, S.11, S.15, U.21 and U.22, certain sequences of combinations from International Telegraph Alphabet No. 2 are devoted to special purposes (see Table 1/S.4) and they should not be used for other purposes when the equipment on such networks introduces special facilities for which these sequences are reserved. These are:

1) **ZCZC** start-of-message signal in retransmission systems using perforated tape or equivalent devices;

2) + + + + end-of-input signal;

3) **NNNN** end-of-message signal, a switching signal in switching systems using perforated tape or equivalent devices for retransmission; also used for restoring the waiting signal device in accordance with Recommendation U.22 ;

4) **CCCC** for switching into circuit, by remote control, a reperforator (or equivalent device);

5) **SSSS** for switching into circuit data transmission equipment, in accordance with Recommendation S.15. In addition, this sequence may be used for switching into circuit, by remote control, equipment operating with a nationally standardized alphabet;

6) **FFFF** for switching out of circuit, by remote control, a reperforator (or equivalent device);

7) **KKKK** ready-for-test signal, for automatic tests of transmission quality, in accordance with Recommendations R.79 or R.79 *bis*;

8) **KLKL** for switching into circuit, by remote control, a reader (or equivalent device);

9) **XXXXX** error signal when using automatic error correction devices (see Recommendation F.1]).

Note – The sequences of secondaries of these combinations – although they are not to be used for the purposes devoted to these sequences – are subject to the same restrictions in use, the equipment having to recognize only the sequence of combinations. In international services these sequences are:

+ : + :	corresponding to **ZCZC**	(combinations Nos. 26, 3, 26, 3),
ZZZZ	corresponding to + + + +	(combinations Nos. 26, 26, 26, 26),
, , , ,	corresponding to **NNNN**	(combinations Nos. 14, 14, 14, 14),
: : : :	corresponding to **CCCC**	(combinations Nos. 3, 3, 3, 3),
' ' ' '	corresponding to **SSSS**	(combinations Nos. 19, 19, 19, 19),
((((	corresponding to **KKKK**	(combinations Nos. 11, 11, 11, 11),
()()	corresponding to **KLKL**	(combinations Nos. 11, 12, 11, 12),
/ / / / /	corresponding to **XXXXX**	(combinations Nos. 24, 24, 24, 24, 24).

10) the line-feed signal (combination No. 28) followed by 4 carriage-return signals (combination No. 27) for the operator-recall signal on a telex connection made over a radiotelegraph circuit (see Recommendation U.21);

11) **HHHH** to prevent transmission of the delay signals described in Recommendation U.22 made up from combination No. 32 as described in § 2 below.

12) **TTT** . . . to stop transmission from the distant terminal as described in Recommendation F.60.

TABLE 1/S.4

The use of various sequences of combinations for special purposes

Purpose of sequence	Sequence of combinations recommended	Method of operation		
		Message switching (including storage)	Through switching (without message storage)	Point-to-point operation
Start of message	26 3 26 3	Required in most systems	Could be useful in special cases	Not ordinarily required
Suppression of delay signals	8 8 8 8	Not required (delay signal not envisaged)	Required for some types of message (e.g. cypher) when routed over synchronous error-corrected radiotelegraph channels	Not required on public systems (delay signal not envisaged)
End of input	26 26 26 26	Could be useful in special cases	Could be useful in special cases	Not ordinarily required
End of message	14 14 14 14	Essential in most systems to separate individual message at relay centres and to control message switching	Required only when it is necessary positively to reconnect delay signal facility after use of suppression of delay signals facility	Not ordinarily required
Connection of reperforator (or equivalent device)	3 3 3 3	Not normally used (as storage is incorporated in the system); could be used for connection and disconnection of a supplementary storage device	Could be useful for special purposes; requires special equipment at point of reception	Could be useful for special purposes; requires special equipment at point of reception
Disconnection at distance of reperforator (or equivalent device)	6 6 6 6			
Connection of data equipment	19 19 19 19	Not normally used	Used for switching into data transmission equipment in association with telex networks	Could be useful for special purposes
Ready for test	11 11 11 11	Not normally used	Used for automatic maintenance of telex circuits	Could be useful for special purposes
Error signal	24 24 24 24 24	Not required	Used for automatic correction of operator errors	Could be useful for special purposes; requires special equipment at point of reception
Interruption of terminals	20 20 20 ...			

2 Use of combination No. 32

In addition to the purposes described in Recommendation S.1, combination No. 32 can be used for the following purposes:

2.1 Combination No. 32, repeated at intervals of 1.2 seconds, can be used as a delay signal to indicate that the error-correcting device is controlling a repetition.

2.2 Combination No. 32, repeated at intervals of 5 seconds, can be used as a delay signal to indicate that the storage device is not yet empty.

2.3 The reception of combination No. 32 shall not cause any spacing of the paper on tape-printing or page-printing teleprinters.

Note – §§ 1, 10) and 1, 11) as well as §§ 2.1 and 2.2 apply directly only to start-stop equipment operating at 50 bauds, since this is the modulation rate for telex. However, in the event of suitable synchronous error-correcting systems being used for the interconnection of start-stop circuits that operate at higher modulation rates, similar facilities might be desirable and could be provided by similar means.

Recommendation S.5

STANDARDIZATION OF PAGE-PRINTING START-STOP EQUIPMENT AND COOPERATION BETWEEN PAGE-PRINTING AND TAPE-PRINTING START-STOP EQUIPMENT (ITA2)

(Brussels, 1948; amended at New Delhi 1960, Geneva, 1964, 1976 and 1980)

The CCITT,

unanimously declares the view

(1) that the number of characters that the line of text in page-printing equipment may contain should be fixed at 69;

(2) that tape- or page-printing start-stop equipment should, with a view to interworking, be fitted with:

a) two keys for the transmission of the carriage-return and line-feed signals;

Note – New equipment may, in addition, be fitted with a single key for both carriage-return and line-feed, in accordance with the procedures described in Recommendation F.60 [1].

b) means to draw attention of the operator to the need to transmit carriage-return and line-feed signals in time to prevent overprinting on the 69th character;

Note – New equipment may, in addition, be fitted with means preventing the input of any printing character after the 69th character of a line. This condition is signalled to the operator optically and/or acoustically. The carriage-return function cancels the signal and releases the input of characters.

(3) that for controlling the alarm, several "figures J" signals, one carriage-return signal and one line-feed signal should be transmitted in the order indicated;

(4) that such Administrations as are desirous of confirming on a tape machine the reception or transmission of the carriage-return and line-feed signals shall effect this confirmation by printing:

a) the symbol $<$ for the carriage-return signal;

b) the symbol $\equiv$ for the line-feed signal;

(5) that, if the printing of the symbols indicated in § 4 above is not desired, the reception of at least one of these signals shall nevertheless cause the paper to move forward. When only one of these signals causes the paper to move forward, it should preferably be the line-feed.

Reference

[1] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60.

Recommendation S.6

CHARACTERISTICS OF ANSWERBACK UNITS (ITA2)

(based on former Recommendations S.6 [1], *S.6 bis* [2] *and S.6 ter* [3], *Geneva, 1976, 1980 and Malaga-Torremolinos, 1984)*

The CCITT,

considering

(a) Recommendations F.60 [4] and F.21 [5] concerning the telex and gentex services respectively;

(b) that start-stop equipment is capable of receiving communications without the help of an operator;

(c) that this advantage is useful to users of the international telegraph services that employ International Telegraph Alphabet No. 2 (ITA2);

(d) that it is therefore desirable that the identity of either the calling or the called party should be capable of being checked;

(e) that it may be necessary to verify the correct functioning of the line and of the distant terminal equipment;

(f) that it is desirable to give confidence to the calling party that the reception of the called station's answer-back code is related to the proper working of that station as a whole,

unanimously declares the view

(1) that a code transmitter filling the requirements specified below should be supplied for the subscribers' sets taking part in the international telex and gentex services and, upon request, for other telegraph services using start-stop equipment and ITA2;

(2) that operation of the code transmitter should be effected by the sequence of signals figure-shift **D** (combinations Nos. 30 and 4) in ITA2;

(3) that, for services[1] other than gentex, the answerback code emission should be composed of a series of 20 signals, as follows:

1 letter-shift or figure-shift;

1 carriage-return;

1 line-feed;

16 signals chosen by each Administration for the subscriber's code signal;

1 letter-shift; (optional – see the Recomendation cited in [8]);

(4) that, for the gentex service[1], the answerback code emission should be composed of a series of 20 signals, as follows:

1 carriage-return,

1 line-feed,

1 figure-shift,

16 signals chosen by each Administration in accordance with Recommendation F.21 [5],

1 letter-shift;

(5) that, when a telex or gentex answer-back code includes less than 16 significant characters chosen by the Administration, the necessary number of filling characters should be inserted in accordance with Recommendation F.60 [4] or F.21 [5] respectively;

(6) that, for services other than telex and gentex, when the answerback code includes less than 16 significant characters, it is necessary to insert as many letter-shifts as are necessary, by distributing them among the significant characters, to make up the total of 16 signals. This would give the calling subscriber the chance of noting clearly the end of the requested code transmission;

(7) that if a complex installation connected to the telex network incorporates both outgoing-only terminals and terminals which may be called, then the call number of the group of terminals which may be called, or of one of them, should appear in the answerback code of the outgoing-only terminal.

Administrations may also wish to apply this to public installations connected to the telex network which not only transmit but also receive and distribute messages;

(8) that the answerback signals should comply with the transmission characteristics specified in Recommendation S.3;

(9) that the delay between the beginning of reception of the start unit of combination No. 4 by the equipment in the "figures" position and the beginning of the start unit of the first signal in the answerback sent by this equipment should lie between:

- 150 and 600 ms for 50-baud equipment;
- 100 and 600 ms for 75-baud equipment;
- 75 and 600 ms for 100-baud equipment;

[1] As regards the information to be conveyed by answerback codes and the order of presentation of that information, reference should be made to the Recommendation cited in [6] for the telex service or to Recommendation F.21 [5] for the gentex service or to Recommendation F.130 [7] for maritime mobile services.

(10) that the start-stop equipment in the telex service should be designed so that reperforators should not perforate the *Who are you?* (WRU) signal (figure-shift **D**);

(11) that manufacturers should be informed that the answer-back mechanism should preferably be constructed so that the 20 positions in the answer-back code may be freely used for any combination in ITA2.

References

[1] CCITT Recommendation *Characteristics of answer-back units for start-stop apparatus of the telex service*, Green Book, Vol. VII, Rec. S.6, ITU, Geneva, 1973.

[2] CCITT Recommendation *Answer-back units for 75-baud start-stop apparatus in accordance with International Alphabet No. 2*, Green Book, Vol. VII, Rec. S.6 *bis*, ITU, Geneva, 1973.

[3] CCITT Recommendation *Answer-back units for 100-baud start-stop apparatus in accordance with International Alphabet No. 2*, Green Book, Vol. VII, Rec. S.6 *ter*, ITU, Geneva, 1973.

[4] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60.

[5] CCITT Recommendation *Composition of answer-back codes for the international gentex service*, Rec. F.21.

[6] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60, § 3.4.2.

[7] CCITT Recommendation *Maritime answer-back codes*, Rec. F.130.

[8] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60, § 3.4.2.4.

Recommendation S.7

CONTROL OF TELEPRINTER MOTORS

(former CCIT Recommendation C.13; amended at Arnhem, 1953, and Geneva, 1976)

The CCITT,

considering

(a) that, in the case of public and private point-to-point circuits, it is desirable that the teleprinter motors should be started with the commencement of traffic signalling and stopped with the cessation of such signalling;

(b) that the general practice on such circuits is to utilize a time-delay device associated with the teleprinter which allows of such operation,

unanimously declares the view

(1) that, in the case of public and private point-to-point circuits, the terminal apparatus shall be so equipped as to allow of the starting and stopping of the teleprinter motors with the commencement and completion respectively of the traffic;

(2) that these facilities shall normally be provided by means of a time-delay device incorporated in the teleprinter, whereby the teleprinter motor is started immediately upon commencement of the signalling of traffic and is stopped within a time not less than 45 seconds after the last traffic signal;

considering

(c) that more strict unification of the delay-time of these automatic devices might give rise to serious technical complications;

(d) that precautions should thus be taken lest an operator, should transmit signals while the motor of his apparatus is still rotating, to an apparatus in which the motor has just stopped,

unanimously declares the view

(3) that, in the case of a pause in transmission for a period equal to or longer than 30 seconds, operators or subscribers are recommended to send a letter-shift (combination No. 29 in International Telegraph Alphabet No. 2) and to wait at least 2 seconds after the emission of this signal before recommencing transmission;

considering

(e) that, for reasons associated with the unification of terminal apparatus and for others, certain Administrations have expressed a preference for the utilization of a method whereby calling and clearing signals are used, as in the telex service, to effect the starting and stopping of the teleprinter motors,

unanimously declares the view

(4) that, notwithstanding (2) above, Administrations can, if they find it convenient, arrange between themselves to use an alternative method whereby the teleprinter motor is started by the use of a call signal, and stopped by the use of a clearing signal. In such cases the calling and clearing signals employed should conform to those standardized for the telex service, namely Recommendation U.1 [1].

Reference

[1] CCITT Recommendation *Signalling conditions to be applied in the international telex service,* Rec. U.1.

Recommendation S.8

INTERCONTINENTAL STANDARDIZATION OF THE MODULATION RATE OF START-STOP APPARATUS AND OF THE USE OF COMBINATION No. 4 IN FIGURE CASE

(former CCIT Recommendations C.5 and C.11, Arnhem, 1953)

The CCITT,

considering

(a) that the standardized modulation rate recommended for start-stop apparatus employed in international (including intercontinental) service is 50 bauds, in accordance with Recommendation S.3;

(b) that there are nevertheless certain areas (notably in the USA) in which a different modulation rate for start-stop apparatus is employed;

(c) that, even though it is recognized that universal adoption of a standardized modulation rate would be advantageous in the intercontinental service, it is not possible at present to secure universal adoption of a standard;

(d) that it is essential to do everything possible to facilitate the establishment of intercontinental services, notwithstanding differences in modulation rates that may exist between the start-stop apparatus employed;

(e) that there are in existence methods, employing automatic storage equipment in the circuit, that enable start-stop apparatus having different modulation rates to interwork;

(f) that, furthermore, on certain intercontinental circuits, e.g. radio circuits, the employment of special forms of synchronous equipment in association with storage equipment is sometimes essential and is already in use in the intercontinental sections of start-stop circuits.

unanimously declares the view

(1) that, when it is necessary in the intercontinental service to operate between start-stop apparatus having a modulation rate of 50 bauds and start-stop apparatus having a non-standard modulation rate, then conversion equipment, for example automatic storage and retransmission equipment must be inserted in the international circuits concerned in a manner to be agreed bilaterally between the Administrations and/or private recognized operating agencies concerned;

considering

(g) that the use of different signs or functions for combination No. 4 in the figure case of International Telegraph Alphabet No. 2 on start-stop apparatus having to work together in the same system leads to operational difficulties that ultimately amount to rendering the use of this combination impossible;

(h) that the use of this combination to operate the answer-back unit, by allowing the caller to check the connection and the satisfactory working of his correspondent's apparatus, results in a considerable reduction in the time of establishing the communication, thereby facilitating operation of the service,

unanimously declares the view

(2) that combination No. 4 (figure case) of International Telegraph Alphabet No. 2 should be reserved exclusively, both in international service and in intercontinental service, for operating the answer-back unit;

(3) that, in intercontinental service, when apparatus not permitting the use of the answer-back unit is being operated, the methods of using combination No. 4 (figure case), should be the subject of bilateral agreement between the Administrations and/or private recognized operating agencies concerned.

Recommendation S.9

SWITCHING EQUIPMENT OF START-STOP APPARATUS

(former CCIT Recommendation F.60; modified at New Delhi, 1960 and Geneva, 1980)

The CCITT,

considering

Recommendation U.1 [1] relative to signalling conditions to be applied in the international telex service and Recommendation F.60 [2] relative to operational provisions for the international telex service,

unanimously declares the view

(1) that start-stop apparatus used in the telex service should be so equipped, or provided with the necessary devices, to permit of operation in accordance with Recommendations U.1 [1] and F.60 [2];

(2) that, if a subscriber's apparatus is such that he can use his teleprinter outside communication periods in order to prepare perforated tapes, for local checking of those tapes, for staff training, etc., the possibility of taking the answer-back may be delayed for a period not exceeding 3 seconds after connection of the called subscriber.

References

[1] CCITT Recommendation *Signalling conditions to be applied in the international telex service*, Rec. U.1.

[2] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60.

Recommendation S.10

TRANSMISSION AT REDUCED CHARACTER TRANSFER RATE OVER A STANDARDIZED 50-BAUD TELEGRAPH CHANNEL

(Geneva, 1972)

The CCITT,

considering

(a) that there is a requirement for transmission at reduced character transfer rates on leased telegraph circuits;

(b) that the cost of devices to subdivide a standardized 50-baud telegraph channel for simultaneous use by a number of users is relatively high;

(c) that a number of Administrations meet the demand for transmission at reduced character transfer rates by providing a separate standardized 50-baud telegraph channel for each user and that the number of transmitted characters per minute is then limited by controlling the operation of the telegraph machine;

(d) that, in the case of a pause in transmission for a period equal to or longer than 30 seconds, operators or subscribers are recommended to send a letter-shift (combination No. 29 in International Telegraph Alphabet No. 2) and to wait at least 2 seconds after the emission of this signal before recommencing transmission [Recommendation S.7, § (3)],

unanimously declares the view

(1) that the preferred method of providing transmission at reduced character transfer rate on standardized 50-baud telegraph channels is an arrangement that employs one transmitted character followed by a period of stop polarity, the duration of which is determined in accordance with (2) and (3) below;

(2) for quarter-speed operation (100 characters per minute), the duration of the period of stop polarity required is equivalent to 3 character periods;

(3) for half-speed operation (200 characters per minute) the duration of the period of stop polarity required is equivalent to 1 character period.

Recommendation S.11

USE OF START-STOP REPERFORATING EQUIPMENT FOR PERFORATED TAPE RETRANSMISSION

(former CCIT Recommendation C.19, Arnhem, 1953; amended at New Delhi, 1960 and Geneva, 1980)

The CCITT,

considering

(a) that when a station is equipped with receiving reperforating equipment, it is often necessary to clear the perforated tape of the perforator to ensure transmission of the last characters of a message received during the perforation of the first characters of the next message;

(b) this operation of clearing the tape may lead to mutilation of the beginning of the message that is being perforated (particularly if insufficient message separation signals have been transmitted);

unanimously declares the view:

(1) It is recommended that arrangements be made to avoid the mutilation of signals transmitted at the head of a message and received on start-stop reperforating equipment.

(2) If the reperforator is provided with local means for feeding the paper, not more than one multilated signal should be tolerated. The wording of the message must make allowances for this fact.

(3) It is recommended that *message separation* signals should be sent at the end of a batch of telegrams following a given route at centres equipped with receiving reperforators. The choice of the type and number of signals to be sent for this purpose is left for agreement between the Administrations concerned. Use of a series of letter-shifts appears particularly desirable for this purpose.

(4) If the reperforator is to be switched into circuit and out of circuit under control of the transmitting station, the following sequences of signals should be used:

combination No. 3 repeated 4 times (**CCCC**) for switching the reperforator into circuit by remote control;

combination No. 6 repeated 4 times (**FFFF**) for switching the reperforator out of circuit by remote control.

(5) These operations may equally well be controlled by the secondaries of **CCCC** and **FFFF** but, for convenience in operating the primary signals, **CCCC** or **FFFF** only should be used by operating staff.

(6) If the **FFFF** sequence has not been received before the arrival of the clearing signal (or the end-of-message signal), receipt of the clearing signal (or the end-of-message signal) should cause disconnection of the reperforator. However, reception of the **FFFF** sequence should have no effect if the reperforator was previously connected by the operator at the receiving station. The **CCCC** and **FFFF** sequences should not affect the reperforator at the transmitting terminal.

Recommendation S.12

CONDITIONS THAT MUST BE SATISFIED BY SYNCHRONOUS SYSTEMS OPERATING IN CONNECTION WITH STANDARD 50-BAUD TELEPRINTER CIRCUITS

(former CCIT Recommendation C.23, Geneva, 1956; amended at New Delhi, 1960 and Geneva, 1980)

The CCITT,

considering, on the one hand,

(a) that the receiving portion of the sending end of the synchronous system can be linked to a start-stop receiver operating at the nominal modulation rate of 50 bauds,

unanimously declares the view

(1) that the receiving portion of the sending end of the synchronous system shall satisfy the conditions laid down for 50-baud operation in §§ 1.6 and 3.1 of Recommendation S.3, it being understood that start-stop signals would be received from a source complying with §§ 1.1, 1.2 and 1.3 of Recommendation S.3;

considering, on the other hand,

(b) that the retransmitting portion of the receiving end of the synchronous system can be linked to a start-stop transmitter having special characteristics, because of the high speed stability of synchronous systems;

unanimously declares the view

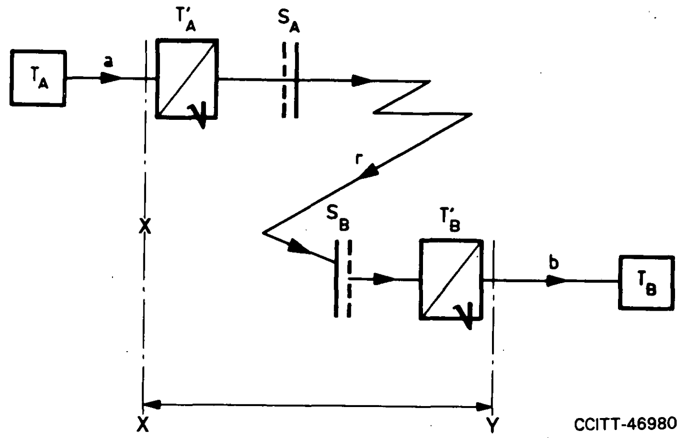
(2) that the start-stop signals provided by the retransmitting portion of the receiving termination of the synchronous system shall have the following characteristics:

a) nominal modulation rate, 50-bauds;

b) gross start-stop distortion of the signals, less than 5%;

c) interval between the beginning of successive start elements, 145 $^5/_6$ milliseconds with a tolerance of $\pm$ 1/10^6.

Note – For a better understanding of the Recommendation, the general arrangement of a communication system involving transmission over a synchronous channel is shown in Figure 1/S.12.



In this diagram:

T_A and T_B are start-stop teleprinters.

T'_A and T'_B are repeaters with or without storage.

a and b represent the networks connecting teleprinters T_A and T_B to the repeaters T'_A and T'_B. These networks may comprise any number of channels in tandem, relays or regenerative repeaters.

S_A and S_B are the distributors of the synchronous system, the complexity of which it is not necessary to state.

r denotes a synchronous radiotelegraph channel.

It is agreed that, for the study of this question, the synchronous system includes all the equipment shown between lines X and Y on the diagram.

The input and output of the synchronous system are thus directly connected to the start-stop networks.

FIGURE 1/S.12
Synchronous system

Recommendation S.13

USE ON RADIO CIRCUITS OF 7-UNIT SYNCHRONOUS SYSTEMS GIVING ERROR CORRECTION BY AUTOMATIC REPETITION

(former CCIT Recommendation C.24, Geneva, 1956; amended at New Delhi, 1960, Geneva, 1964, Mar del Plata, 1968, and Geneva, 1972)

(This Recommendation corresponds to CCIR Recommendation 342-2, New Delhi, 1970)

The CCITT,

considering

(a) that it is essential to be able to interconnect terminal start-stop apparatus employing International Telegraph Alphabet No. 2 by means of radiotelegraph circuits;

(b) that radiotelegraph circuits are required to operate under varying conditions of radio propagation, atmospheric noise and interference, which introduce varying degrees of distortion that may at times exceed the margin of the receiving apparatus;

(c) that, in consequence, the transmission of 5-unit code signals over radio circuits is liable to errors and that such errors are not automatically detectable by the receiving apparatus;

(d) that an effective means of reducing the number of wrongly printed characters is the use of codes permitting the correction of errors by detecting the errors and automatically causing repetition;

(e) that the method using synchronous transmission and automatic repetition (ARQ) is now well proven;

(f) that it is desirable to permit the correct phase to be established automatically on setting up a circuit;

(g) that certain circumstances can occur that result in a loss of the correct phase relationship between a received signal and the receiving apparatus;

(h) that it is desirable to permit the correct phase relationship to be re-established automatically after such a loss, without causing errors;

(i) that to avoid misrouting of traffic, it is essential to prevent phasing to a signal that has been unintentionally inverted;

(j) that in certain cases there is a need to subdivide one or more channels in order to provide a number of services at a proportionately reduced character rate;

(k) that the method of automatically achieving the correct phase relationship between the received signal and the sub-channelling apparatus should be an integral part of the phasing process;

(l) that compatibility with existing equipment designed in accordance with the former Recommendation S.13 (New Delhi, 1960) is a requirement,

unanimously declares the view

(1) that, when the direct use of a 5-unit code on a radio circuit gives an intolerable error rate and there is a return circuit, a 7-unit ARQ system using International Telegraph Alphabet No. 3 should be used;

(2) when automatic phasing of such a system is required, the system described in the Annex should be adopted as a preferred system;

(3) that equipment, designed in accordance with (2) above, should be provided with switching, to permit operation with equipment designed in accordance with Recommendation S.13, New Delhi, 1960;

(4) that the start-stop sections of the receiving and transmitting portions of the radiotelegraph circuit, points X and Y in Figure 1/S.12, should satisfy the conditions of Recommendations S.3 and S.12. In conformity with Recommendation S.12, the aggregate modulation rate for a 2-channel time-division multiplex system will be 96 bauds and for a 4-channel system will be 192 bauds;

(5) that if such systems are used in establishing telex connections, the signalling position should conform to the arrangements shown in Recommendations U.11 [1], U.20 [2], U.21 [3], U.22 [4].

(5.1) For circuits on switched telegraph networks, the conditions of Recommendation U.20 [2] should apply. In this usage the polarity retransmitted by the terminal of the radio channel towards the start-stop section of the circuit during a repetition cycle shall be start polarity when the circuit is in the "free line" condition and stop polarity when the circuit is in the "busy circuit" condition.

(5.2) For point-to-point circuits, Administrations may adopt, at the terminal equipment under their jurisdiction, their own method of stopping and starting the motors of the receiving machines, based on Recommendation S.7. Signal β should normally be transmitted to indicate the idle circuit condition. However, for signalling purposes, the signals α and β may be employed.

ANNEX A

(to Recommendation S.13)

A.1 *Conversion table*

A.1.1 Table A-1/S.13 shows the correspondence between International Telegraph Alphabet No. 3 used in 7-unit ARQ systems and International Telegraph Alphabet No. 2 (defined in the Recommendation cited in [5]).

A.2 *Repetition cycles*

A.2.1 Four characters for normal circuits that are not subject to excessive propagation time. The cycle should comprise one signal repetition and three stored characters.

A.2.2 Eight characters on circuits for which the four-character repetition cycle is inadequate. The cycle should comprise one signal repetition, three signals β and four stored characters, or one signal repetition and seven stored characters.

TABLE A-1/S.13

Code conversion table

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. 3 (see Note 1)
1	**A**	–	ZZAAA	AAZZAZA
2	**B**	?	ZAAZZ	AAZZAAZ
3	**C**	:	AZZZA	ZAAZZAA
4	**D**	Note 2	ZAAZA	AAZZZAA
5	**E**	**3**	ZAAAA	AZZZAAA
6	**F**		ZAZZA	AAZAAZZ
7	**G**	Note 2	AZAZZ	ZZAAAAZ
8	**H**		AAZAZ	ZAZAAZA
9	**I**	**8**	AZZAA	ZZZAAAA
10	**J**	Note 2	ZZAZA	AZAAAZZ
11	**K**	(	ZZZZA	AAAZAZZ
12	**L**	)	AZAAZ	ZZAAAZA
13	**M**	.	AAZZZ	ZAZAAAZ
14	**N**	,	AAZZA	ZAZAZAA
15	**O**	**9**	AAAZZ	ZAAAZZA
16	**P**	**0**	AZZAZ	ZAAZAZA
17	**Q**	**1**	ZZZAZ	AAAZZAZ
18	**R**	**4**	AZAZA	ZZAAZAA
19	**S**	'	ZAZAA	AZAZAZA
20	**T**	**5**	AAAAZ	ZAAAZAZ
21	**U**	**7**	ZZZAA	AZZAAZA
22	**V**	=	AZZZZ	ZAAZAAZ
23	**W**	**2**	ZZAAZ	AZAAZAZ
24	**X**	/	ZAZZZ	AAZAZZA
25	**Y**	**6**	ZAZAZ	AAZAZAZ
26	**Z**	+	ZAAAZ	AZZAAAZ
27	Carriage-return		AAAZA	ZAAAAZZ
28	Line-feed		AZAAA	ZAZZAAA
29	Letter-shift		ZZZZZ	AAAZZZA
30	Figure-shift		ZZAZZ	AZAAZZA
31	Space		AAZAA	ZZAZAAA
32	Not normally used		AAAAA	AAAAZZZ
–	Signal repetition		–	AZZAZAA
–	Signal α		(permanent A polarity)	AZAZAAZ
–	Signal β		(permanent Z polarity)	AZAZZAA

Note 1 – Symbols A and Z have the meanings defined in [6].

Note 2 – See Recommendation S.4.

A.3 *Channel arrangement*

A.3.1 *Channel A*

A.3.1.1 For equipments employing a 4-character repetition cycle: one character inverted followed by three characters erect [see (a) of Figure A-1/S.13].

A.3.1.2 For equipments employing an 8-character repetition cycle: one character inverted followed by seven characters erect [see (a) of Figure A-2/S.13].

A.3.2 *Channel B*

A.3.2.1 For equipments employing a 4-character repetition cycle: one character erect followed by three characters inverted [see (b) of Figure A-1/S.13].

A.3.2.2 For equipments employing an 8-character repetition cycle: one character erect followed by seven characters inverted [see (b) of Figure A-2/S.13].

A.3.3 *Channel C*

As for Channel B [see (c) of Figures A-1/S.13 and A-2/S.13].

A.3.4 *Channel D*

As for Channel A [see (d) of Figures A-1/S.13 and A-2/S.13].

A.3.5 *Order of transmission*

A.3.5.1 Characters of Channels A and B are transmitted consecutively [see (e) of Figures A-1/S.13 and A-2/S.13].

A.3.5.2 Elements of Channel C are interleaved with those of Channel A [see (g) of Figures A-1/S.13 and A-2/S.13].

A.3.5.3 Elements of Channel D are interleaved with those of Channel B [see (g) of Figures A-1/S.13 and A-2/S.13].

A.3.5.4 In the aggregate signal, A elements precede those of C, and B elements precede those of D [see (g) of Figures A-1/S.13 and A-2/S.13].

A.3.5.5 The first erect character on A, transmitted after the inverted character on A, is followed by the erect character on B [see (e) of Figures A-1/S.13 and A-2/S.13].

A.3.5.6 The erect character on C is followed by the inverted character on D [see (f) of Figures A-1/S.13 and A-2/S.13].

A.3.5.7 The inverted character on A is element-interleaved with the erect character on C [see (g) of Figures A-1/S.13 and A-2/S.13].

A.4 *Subchannel arrangement*

A.4.1 The character transmission rate of the fundamental subchannel should be a quarter of the standard character rate.

A.4.2 Subchannels should be numbered 1, 2, 3 and 4 consecutively.

A.4.3 Where a 4-character repetition cycle is used, subchannel 1 should be that subchannel which has opposite keying polarity to the other three subchannels of the same main channel [see (a), (b), (c) and (d) of Figure A-3/S.13]. When an 8-character repetition cycle is used, subchannel 1 should be that subchannel which has alternately erect and inverted keying polarity [see (e), (f), (g) and (h) of Figure A-3/S.13].

A.4.4 When subchannels of half-character rate, or three-quarter-character rate are required, combinations of the fundamental subchannels should be arranged as shown in Table A-2/S.13.

A.5 *Designation of aggregate signal*

To assist in identifying the signal condition when applying the aggregate telegraph signal to modulate the radio channel, the designation for the aggregate signal should be used as shown in Table A-3/S.13.

A.6 *Diagrams*

As a result of the characteristics specified in §§ A.2, A.3 and A.4 above, the transmission of characters will be as shown in Figures A-1/S.13, A-2/S.13 and A-3/S.13.

A.7 *Automatic phasing*

A.7.1 Automatic phasing should normally be used. It should be initiated either:

a) after a waiting period during which cycling due to the receipt of errors has occurred continuously on both channels on a 2-channel system, or on at least two main channels of a 4-channel system;

b) after equal counts of A and Z elements have been made over at least two consecutive system cycles whilst continuous cycling due to the receipt of errors is occurring on all main channels.

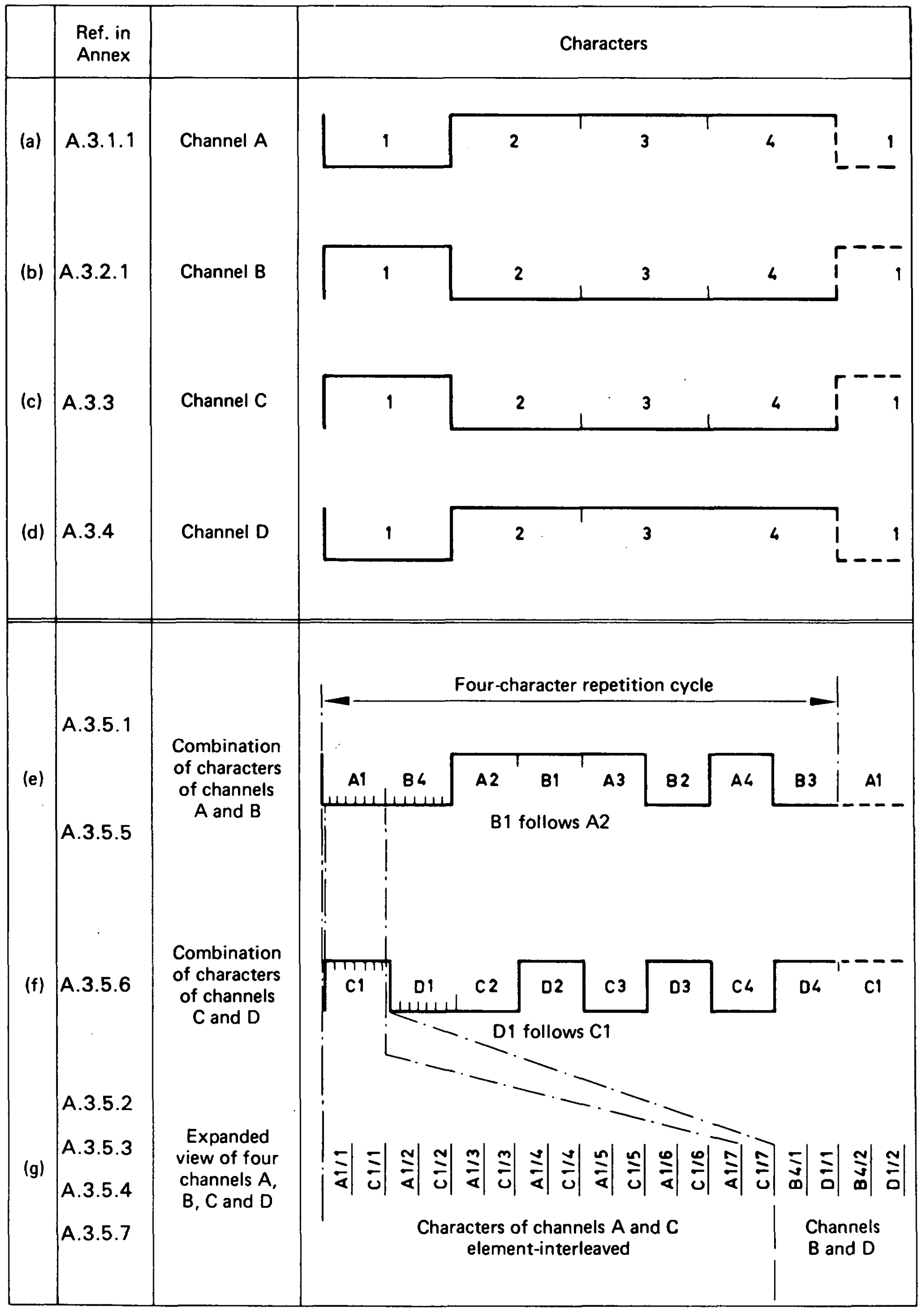


FIGURE A-1/S.13

Channel arrangement for a four-character repetition cycle

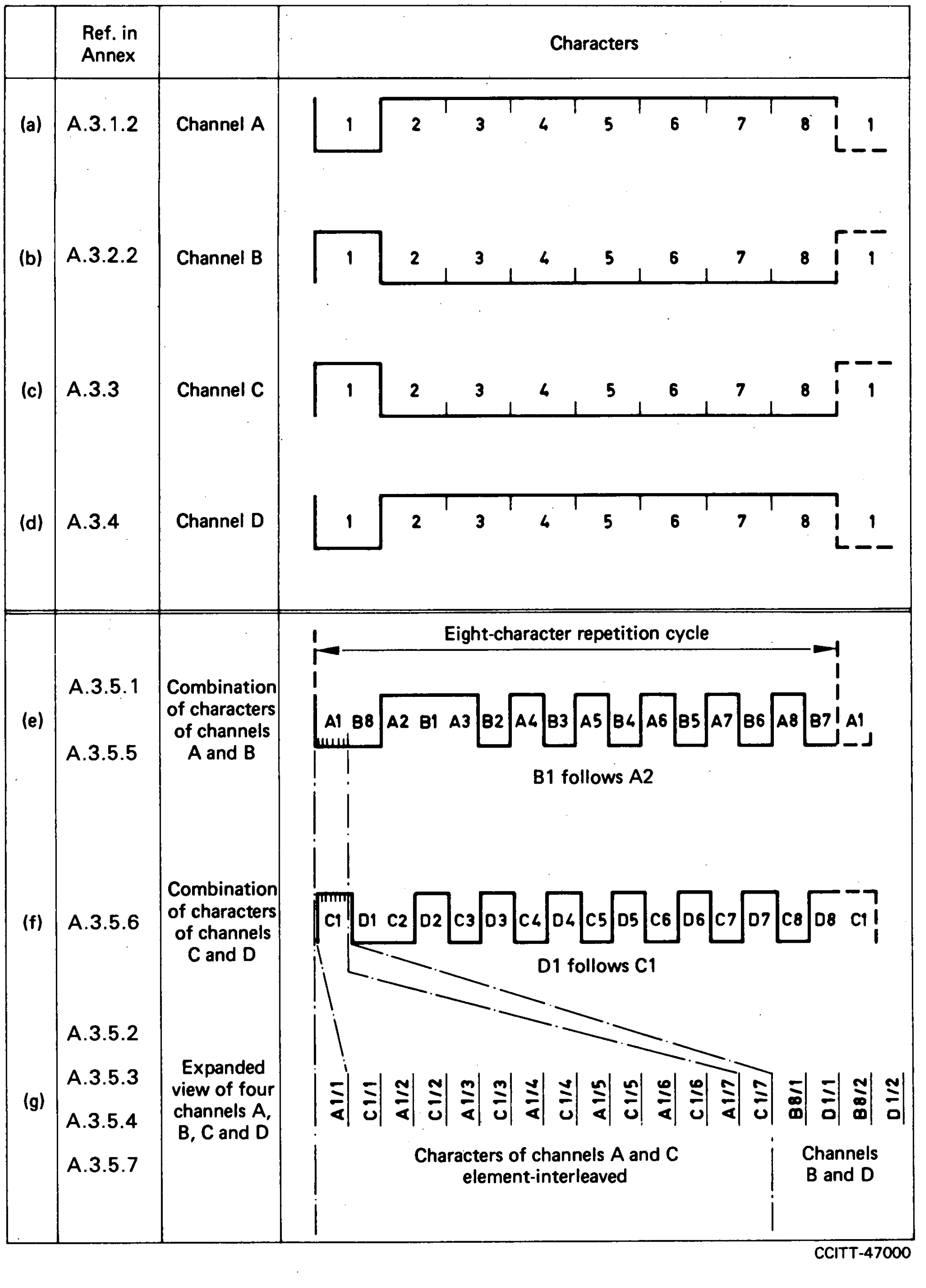


FIGURE A-2/S.13
Channel arrangement for an eight-character repetition cycle

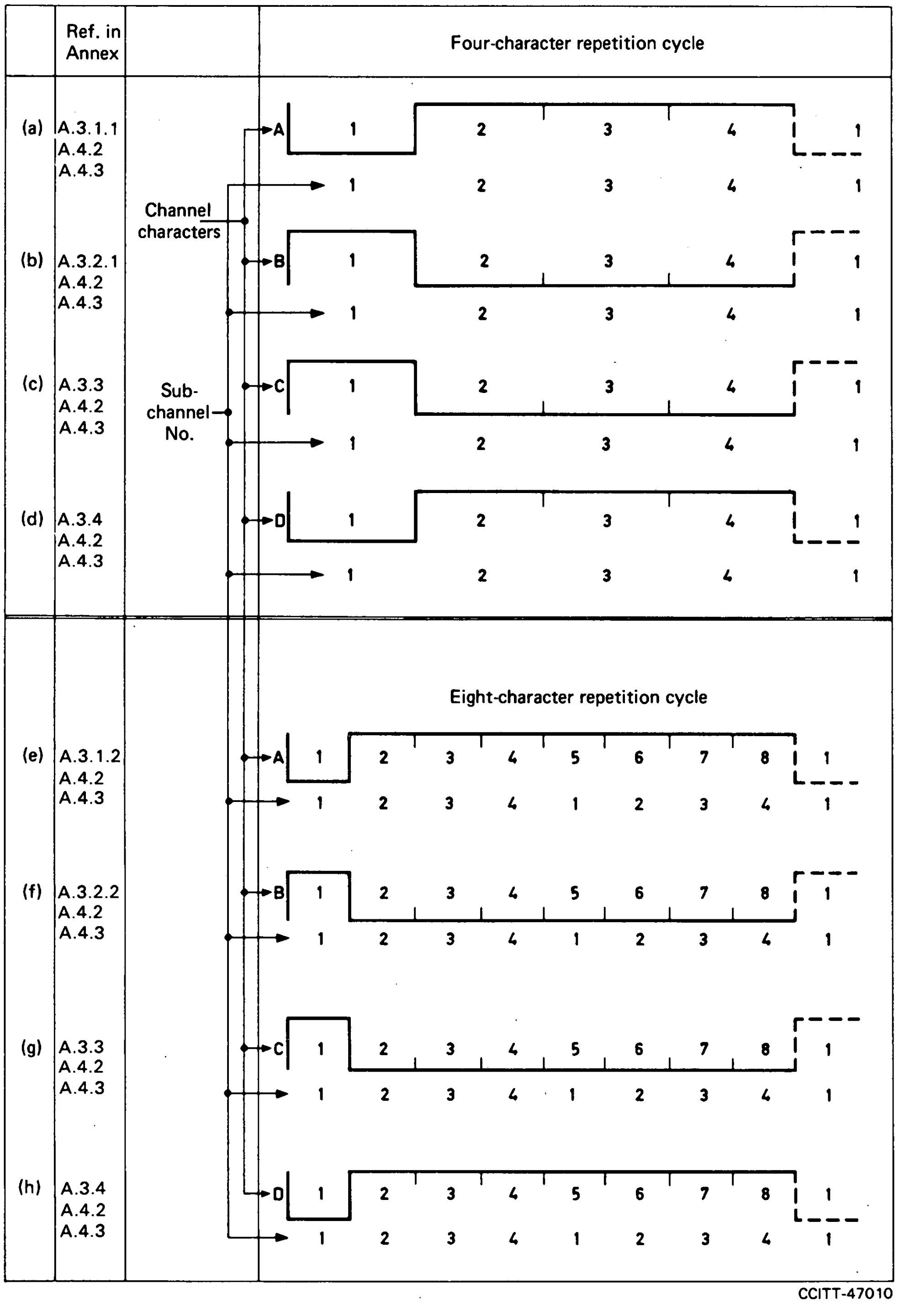


FIGURE A-3/S.13
Subchannelling arrangements for a four- and eight-character repetition cycle

TABLE A-2/S.13

Proportion of full-channel character rate	Combination of fundamental subchannels
(1) quarter (2) quarter (3) half	No. 1 No. 3 Nos. 2 and 4
(1) half (2) half	Nos. 1 and 3 Nos. 2 and 4
(1) quarter (2) three-quarters	No. 1 Nos. 2, 3 and 4

TABLE A-3/S.13

Seven-unit code condition	Aggregate signal condition	
	Erect character	Inverted character
A	B	Y
Z	Y	B

Note – With a frequency shift system, the higher frequency should correspond to aggregate condition B and the lower frequency should correspond to aggregate condition Y.

A.7.2 When the slave station is phasing, it should transmit in each channel, in place of the signal repetition, a 7-element signal in which all seven elements are of the same polarity, all other characters in the repetition cycle being transmitted unchanged.

References

[1] CCITT Recommendation *Telex and gentex signalling on intercontinental circuits used for intercontinental automatic transit traffic (Type C signalling)*, Rec. U.11.

[2] CCITT Recommendation *Telex and gentex signalling on radio channels (synchronous 7-unit systems affording error correction by automatic repetition)*, Rec. U.20.

[3] CCITT Recommendation *Operator recall on a telex call set up on radiotelegraph circuit*, Rec. U.21.

[4] CCITT Recommendation *Signals indicating delay in transmission on calls set up by means of synchronous systems with automatic error correction by repetition*, Rec. U.22.

[5] CCITT Recommendation *Operational provisions for the international public telegram service*, Rec. F.1, § C.8.

[6] CCITT Definition: *Position A; position Z*, Vol. X, Fascicle X.1 (Terms and Definitions).

Recommendation S.14

SUPPRESSION OF UNWANTED RECEPTION IN RADIOTELEGRAPH MULTI-DESTINATION TELEPRINTER SYSTEMS

(former CCIT Recommendation C.22, Geneva, 1956; amended at New Delhi, 1960)

The CCITT,

considering

(a) that in a radiotelegraph system in which a radio teleprinter transmitter broadcasts messages simultaneously to a number of receiving stations, this broadcast is sometimes required only by a restricted number of these stations;

(b) that it is desirable in such cases to prevent the reception of the message at the other offices to avoid wastage of paper;

(c) that such wastage can be avoided by the use of selective calling systems whereby only those stations required to receive the transmission are connected whilst it is in progress;

(d) that various technical methods are available for achieving this, using either pulse signalling (e.g. by dial), or signalling with 5-unit signals;

(e) that a wide variety of systems may be devised based upon the methods in (d) above;

(f) that such systems are normally used only for special services in which agreement can be reached on the particular type of system to be adopted;

unanimously declares the view

(1) that, when it is desired to avoid wastage of paper at receiving stations in radiotelegraph multi-destination teleprinter systems, a selective calling system should be used;

(2) that it is neither necessary nor desirable to recommend the use of any particular type of system for international use.

Recommendation S.15

USE OF THE TELEX NETWORK FOR DATA TRANSMISSION AT 50 BAUDS

(former Recommendation V.10, Geneva, 1964; amended at Mar del Plata, 1968)

The CCITT,

considering

(a) that the telex network is well adapted for the economical transmission of data at fairly slow speeds, for the equipment required for binary transmission of data by telex stations, over and above the normal equipment, is relatively simple;

(b) but that some limits have to be imposed on data transmission codes used in the telex network because of:

- the need to make sure that telex calls will not be abruptly released;
- exaggerated distortion that may be introduced by amplitude-modulation voice-frequency telegraph systems when an excessively long-duration start (condition A) modulation element appears in a signal;

– the fact that in some networks there is regenerative repetition of start-stop signals, which can be handled only as if they were constructed like five-unit start-stop information signals;
– the possibility that certain long-distance calls may be established over synchronous systems that can handle only five-unit start-stop signals;

(c) that the limitation due to regenerative repeaters and synchronous systems imposes the use of a five-unit start-stop code for information, hence § 1 of the Recommendation (the more general procedure) deals with data transmission with a five-unit code on start-stop systems. But in certain circumstances alphabets with more than five units can be used for data transmission; hence § 2 of the Recommendation.

unanimously declares the following view:

1 Data transmission with a five-unit code on start-stop systems

1.1 Telex calls for data transmission may be set up in the international telex network, subject to the following provisions:

1.2 The call shall be set up between the caller and the called subscriber in accordance with the procedure recommended for the setting-up of a telex call and its supervision by exchange of answer-back codes (Recommendations F.60 [1] and U.1 [2]).

1.3 When one of the subscribers concerned wishes to introduce data transmission equipment into the connection, he shall transmit the sequence SSSS (or '''') of combination No. 19 from International Telegraph Alphabet No. 2 (signal for transfer to data). Upon reception of this sequence of combinations, the data transmission or reception equipment, as the case may be, shall be connected to the line. This changeover to the data position may be effected:

a) manually at both terminals;
b) automatically at both terminals;
c) manually at one terminal and automatically at the other.

In order to avoid any misunderstanding between the stations concerned, the calling operator should first check the equipment of the distant station (whether manual changeover or automatic changeover).

1.3.1 *Manual changeover at both terminals*

1.3.1.1 Once the connection has been set up, the following procedure should be followed.

1.3.1.2 The operator of the calling station sends the sequence of four combinations No. 19. This sequence should not connect the data equipment locally.

1.3.1.3 Upon reception of the SSSS (or '''') sequence, the operator of the called station likewise sends the sequence of four combinations No. 19, and then connects his data equipment to the line.

1.3.1.4 Upon reception of this answer sequence, the calling operator connects his data equipment to the line.

1.3.2 *Automatic changeover at both terminals*

1.3.2.1 Once the connection has been set up, the following procedure should be followed:

1.3.2.2 The calling station sends the sequence of four combinations No. 19 and must connect its data equipment to the line automatically within less than 500 milliseconds, starting from the end of transmission of the last signal of this sequence.

1.3.2.3 Reception of the sequence at the other terminal of the connection connects the called station to the data equipment line automatically within less than 500 milliseconds, starting from the end of reception of the last signal of this sequence.

1.3.2.4 The data transmission should not commence before the end of the 500-millisecond delay.

1.3.3 *Calling station with manual changeover and called station with automatic changeover*

1.3.3.1 Once the connection has been set up, the following procedure is followed:

1.3.3.2 The operator of the calling station sends the sequence of four combinations No. 19, and then immediately connects his data equipment to the line.

1.3.3.3 Upon reception of the sequence of four combinations No. 19 at the called station, the data equipment must be connected to the line within less than 500 milliseconds, starting from the end of reception of this sequence.

1.3.3.4 The data signals should not be transmitted before the end of the 500-millisecond delay.

1.3.4 *Calling station with automatic changeover and called station with manual changeover*

1.3.4.1 Once the connection has been set up, the following procedure should be followed:

1.3.4.2 The calling station invites its called correspondent, by a brief preliminary message, to send the sequence of four combinations No. 19. This message must not include within itself the sequence of four combinations No. 19. If the calling station is not equipped with a teleprinter attended by an operator, this preliminary message must be sent automatically.

1.3.4.3 The operator of the called station then sends the sequence of four combinations No. 19 and immediately connects his data equipment to the line.

1.3.4.4 Upon reception of this sequence at the calling station, connection of the data equipment to the line must be effected within less than 500 milliseconds, starting from the end of reception of the last combination No. 19 of the sequence.

1.3.4.5 Transmission of the data signals should not begin before the end of the 500-millisecond delay.

Note – The arrangements envisaged throughout § 1.3 above run counter to the inclusion of the sequence of four combinations No. 19 in the answer-back code of telex lines equipped with a simulator and at the same time in the answer-back of teleprinters equipped with an automatic device for changeover to data transmission. (This fact should be borne in mind in the further study of this Recommendation.)

1.4 The sequence of four combinations No. 19 will make ineffective, where necessary:

- devices that might conceivably emit signals disturbing to data transmissions, in particular the answer-back or, possibly, the delay signal used in connection with error-correcting synchronous radio systems (Recommendation U.22 [3]);
- devices that might be falsely operated by data signals, such as devices for operator-recall (Recommendation U.21 [4]).

1.5 Data transmission should be made by means of start-stop formed according to the structure of International Telegraph Alphabet No. 2 (ITA2). Users should be left free to decide how combinations should be allocated to the various components of the alphabet (of course ITA2 itself may be used).

1.6 When error control is necessary, one of the following methods of error control may be used:

- return of information to the transmitting station (information feedback system);
- block tansmission with check characters at the end of the block;
- character-by-character transmission with check bits (in the case of five-unit signals with redundancy).

1.7 Unless the exception stated in § 1.8 below is employed at the end of the data transmission, the telex clearing signal described in Recommendation U.1 [2] shall be emitted. This will cause the call to be cleared down and the terminal equipment to return to the telex position, and will cause the devices that might have been rendered inoperative on certain special circuits (see § 1.4 above) to go back to normal. This clearing signal must set off the clear-confirmation (see Recommendation U.1 [2]).

Note – Users may expect that some combinations No. 32, possibly followed by other combinations, may be received before the connection is cleared.

1.8 As soon as the telex connection has been transferred to the data transmission equipment, the transmission must be controlled by the data equipment at each terminal. If it is useful, for some reason, to return to telex operation, the data terminal equipment must control the transfer back to telex. This possibility of returning to the telex condition is used by a subscriber who considers it useful, after a data transmission, to return to teleprinter operation for a telex connection, instead of sending the clearing signal as mentioned in § 1.7 above. This return should be accompanied by the re-entry into service of the answer-back device. This control may be caused:

a) by the transmission of a special data signal over the line, causing the receiving installation to return to the telex position. The received data terminal equipment must send the same signal in the reverse direction to the opposite terminal before it causes transfer to the telex condition. This mutual signalling identifies the situations at the two terminals;

b) by a local control causing return to the telex situation, set off if no data or supervisory signal is transmitted or received during a given time interval agreed upon by the users.

Note – Telex connections that include error-correcting synchronous radio systems often insert long pauses into the message and due attention should be paid to this in selecting the agreed interval.

For these control operations, a special circuit should be set aside in the interface connecting the data terminal equipment to the transfer device.

Note – The provisions of § 1.8 above could be applied with advantage to the case of telex lines not equipped with teleprinter equipment but simply with answer-back unit simulators.

1.9 The signals transmitted by the data transmission devices must meet the requirements of §§ 1.1, 1.2, 1.3 and 2.1 in Recommendation S.3. The receiving equipment of the data reception devices must meet the requirements of §§ 1.1, 1.2, 1.6 and 3.1 in Recommendation S.3.

2 Data transmission with codes different from the start-stop code of ITA2

2.1 The attention of Administrations is drawn to the fact that it is impossible to send signals other than those of a five-unit start-stop code over international connections via time-division multiplex sections specially designed for a five-unit code. However, telex connections for data transmission may be set up over such relations in the conditions set out in § 1 of this Recommendation for the transmission of messages composed of signals different from those of the five-unit start-stop code. A service of this nature may be obtained by regrouping the units of these signals in the form of five-unit signals. Such regrouping calls for the use of additional code converters at the sending and receiving terminals.

2.2 Between telex networks that can take signals different from those of the five-unit start-stop code (that is to say, when telex calls between such networks do not call for regenerative repeaters, or for certain synchronous systems that would clash with them), by agreement between the Administrations concerned, data transmission with data transmission alphabets using these signals may be made, subject to the following:

a) Application of the procedure described under 1.2;

b) Application of the procedure described under 1.3;

c) Application of the procedure described under 1.4;

d) Use of a code with a modulation rate of 50 bauds should avoid composition of signals having more than seven consecutive elements of start polarity. (This limit is imposed to avoid clearing the connection unexpectedly in the exchanges as well as not to introduce excessive distortion on AMVFT channels.) Data may be transmitted by start-stop, or isochronously;

e) When error control is necessary, one of the following methods of error control may be used:
   - return of information to the transmission station (information feedback system);
   - block transmission with check characters at the end of the block;
   - character-by-character protection by means of a parity check or a constant ratio code, for example the seven-unit code standardized in Recommendation S.13 (International Telegraph Alphabet No. 3).

   In all cases item d) above should be taken into consideration;

f) Application of the procedure described under 1.7.;

g) Application of the procedure described under 1.8.

References

[1] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60.

[2] CCITT Recommendation *Signalling conditions to be applied in the international telex service*, Rec. U.1.

[3] CCITT Recommendation *Signals indicating delay in transmission on calls set up by means of synchronous systems with automatic error correction by repetition*, Rec. U.22.

[4] CCITT Recommendation *Operator recall on a telex call set up on a radiotelegraph circuit*, Rec. U.21.

Recommendation S.16

CONNECTION TO THE TELEX NETWORK OF AN AUTOMATIC TERMINAL USING A V.24 [1] DCE/DTE INTERFACE

(Former Recommendation V.11, Mar del Plata, 1968; amended at Geneva, 1980 and Malaga-Torremolinos, 1984)

1 General

1.1 This Recommendation describes a method of originating and answering calls on the 50-baud telex network by means of an automatic terminal that uses interchange circuits defined in Recommendation V.24 [1] for the interface between the data terminal equipment (DTE) and the data circuit terminating equipment (DCE). In addition this Recommendation covers manual calling with automatic switching to data processing or other off-line equipment and reply by teleprinter with automatic switching to a DTE.

1.2 A distinction is drawn between the two types of automatic calling in national telex networks – dial selection (using dial pulses in accordance with Recommendation U.2 [2]) and keyboard selection using 50-baud teleprinter signals [International Telegraph Alphabet No. 2 (ITA2)].

2 DCE/DTE interface

2.1 The interchange circuits used for the interface between the DCE and the DTE are defined in Recommendation V.24 [1] and comply with the technical specifications in either Recommendation V.28 [3] or Recommendation V.10 [4]. Thus the correspondance between the voltages and the significant states is as shown in Table 1/S.16.

TABLE 1/S.16

Correspondence between significant states

Circuit condition	Logic level	Voltage level		Signal	Condition
		Rec. V.28	Rec. V.10		
ON	0	$\geq +3$ V	$\geq +0.3$ V	Start	A
OFF	1	≤ -3 V	≤ -0.3 V	Stop	Z

2.2 The circuits used for automatic reply (see Figures 1 and 2/S.16), are CT 102, 103, 104, 107, 108/2, 125 and 132.

2.3 The circuits used for automatic calling with dial selection (see Figure 1/S.16) are those listed in § 2.2 supplemented by CT 202, 206, 207, 208, 209, 210, 211 and 213. The 200-series circuits are not connected directly to the DCE but to an automatic calling equipment (ACE) built into the DCE, which explains the presence of CT 202 to 213. These circuits may be used by a single DTE connected to a single DCE/ACE.

2.4 The circuits used for automatic calling with keyboard selection (see Figure 2/S.16) are those listed in § 2.2 supplemented by CT 202, which is connected directly from the DTE to the DCE.

2.5 Where a DTE has access through a DCE to several telex lines of the public network, the DCE shall select for each call attempt one telex line and one only (which need not be the same one as for the preceding attempt) and in no case is the DCE allowed to present the same call simultaneously on more than one telex line. The calling and answering procedure and signalling between DTE and DCE are identical, after connection to a telex line, with those that are used when a DCE is connected to one telex line only, which are described in the diagrams below.

2.6 If several DTE are connected to the telex network through the same DCE, each DTE shall make its call attempts to the network using the procedure described in this Recommendation. On the other hand, when it is in the answering position for a call coming from the telex network, the DCE is responsible for handling the calls intended for the DTE concerned using the procedure described in Recommendation F.71 [5] on the interconnection of the telex network with private teleprinter networks. As soon as the DCE has selected the DTE concerned, the answering signal to the call at the DTE/DCE interface and the signalling on the telex line will be identical to those used in the case of a single DTE as described in the diagrams below.

2.7 In the timing diagrams below (see Annexes A to E), the ON condition in the interchange circuits is denoted by a solid line and the OFF condition by the absence of a line. For CT 103 and 104,* means that the DCE connects them to line and ø means that the DCE disconnects them from the line.

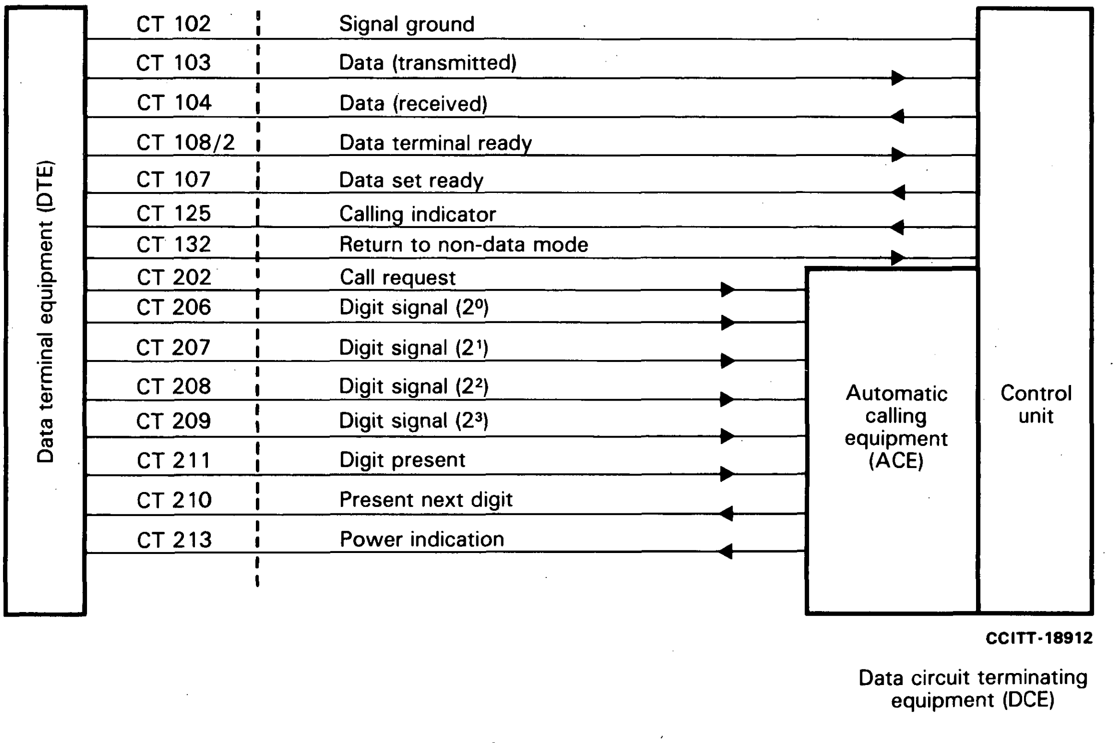


FIGURE 1/S.16
Interface for automatic calling (dial selection)

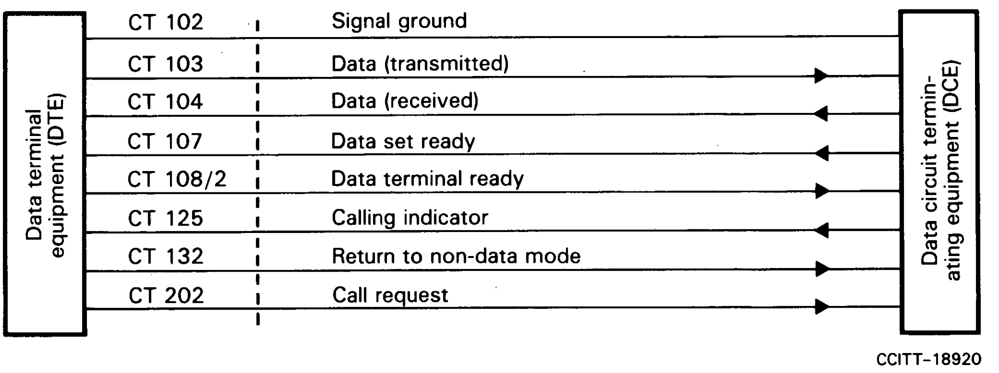


FIGURE 2/S.16

Interface for automatic calling (keyboard selection)

Notes to Figures 1/S.16 and 2/S.16

a) CT 106 and 109, which are unnecessary for telegraph operation, have been suppressed. CT 107 indicates that the DCE is ready to receive the selection information.

b) With keyboard selection, the selection signals (start-stop ITA2) are of the same type as the "data" signals. They are therefore transmitted serially by the DTE on CT 103.

c) CT 108/2, which is mainly used to indicate that the DTE is ready to receive a call, also serves, when OFF, to initiate clearing of a call.

d) CT 203 is not essential since the proceed-to-select signal is indicated by CT 107 and, in the event of call collision in automatic calling, the simultaneous ON condition of CT 125 and 202 informs the DTE that it must abandon its call attempt to permit acceptance of the incoming call.

e) CT 202 may also be suppressed by assigning the calling function to CT 108/2. The latter, which should then be designated CT 108/1, would fulfil the functions of CT 108/2 and 202.

3 Signalling

3.1 These interfaces may be used with the three following types of telex signalling:

- type A (keyboard selection);
- type B (keyboard selection);
- type B (dial selection).

3.2 The signalling between the DCE and the national telex exchange is not standardized by the CCITT. The signalling protocol shown in the timing diagrams (Annexes A to E below) are only examples to indicate the interdependence between the signalling on the subscriber lines and the status of the interchange circuits.

3.3 Automatic calling with type B signalling and dial selection is described in Annex A. Automatic calling with either type A or B signalling and keyboard selection is described in Annex B. The other annexes are common to all types of signalling.

3.4 The **SSSS** sequence (four times combination No. 19 in ITA2), if required, is transmitted either after the exchange of answer-back codes and through-connection, if network-controlled, or, otherwise, after reception of the call-connected signal. The purpose of the **SSSS** sequence is to indicate that the exchange of "data" is about to start and that no further "telex" signals that might disturb the exchange of data should be transmitted or interpreted. It enables the equipment that is required for the exchange of data, which may then commence after a 500 ms delay, as specified in Recommendation S.15. This sequence may be omitted where an exchange of messages in ITA2 is to take place, providing disabling of the answer-back function is not considered necessary.

3.5 In the event of reply by teleprinter, the last character of the **SSSS** sequence initiates automatic switching to the DTE.

3.6 A special data signal may be sent by the DTE to cause the distant terminal to return to the telex mode of operation.

3.7 The DTE must comply with Recommendation U.40 [6] concerning ineffective attempts. It must be able to interpret at least the following service signals: OCC, ABS, NA, NP, NC, NCH, DER.

4 Modes of operation – timing diagrams

4.1 The various modes of operation and equipment configurations are illustrated in the annexes below as follows:

Annex	*Subject*	*Signalling*
A	Automatic call by DTE (dial selection)	Type B (dial selection)
B	Automatic call by DTE (keyboard selection)	Types A and B (keyboard)
C	Teleprinter + DTE (manual call with manual or automatic switching to DTE)	All types
D	Answering by DTE	All types
E	Teleprinter answering (with automatic switching to DTE)	All types

4.2 The following abbreviations and signs are used in Annexes A to E:

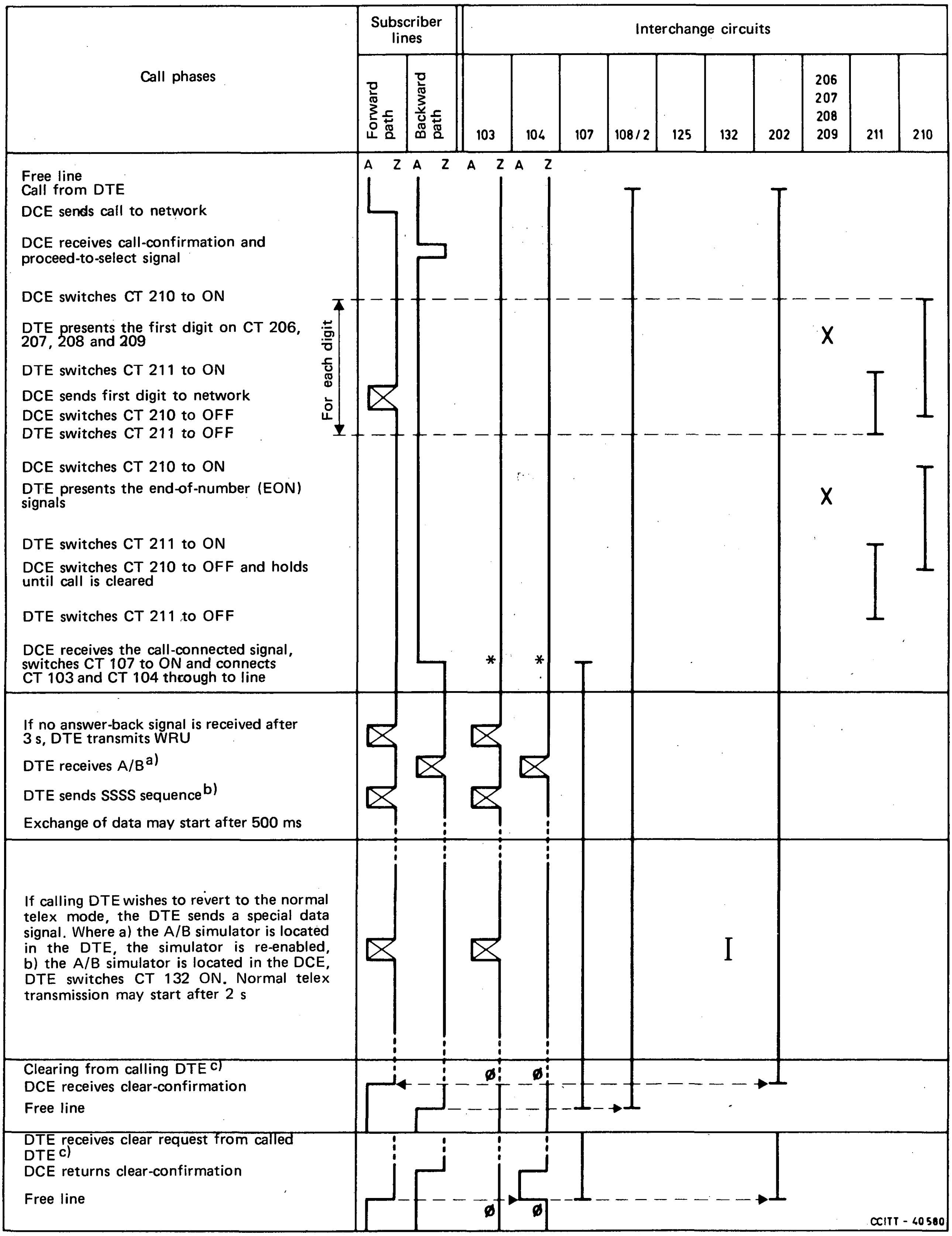
A/B	telex answer-back code
DCE	data circuit terminating equipment
DTE	data terminal equipment
ms	millisecond
SSSS	transfer sequence (see § 3.4 above)
s	second
WRU	"Who are you?" sequence (combination No. 4 in figure case)
*	CT 103 and 104 connected to line
ø	CT 103 and 104 disconnected from line
– – – –	a broken line indicates that the circuit may be either ON or OFF

ANNEX A

(to Recommendation S.16)

Automatic call by DTE

(dial selection)



a) If an A/B simulator is provided in the DCE, then this must not respond to the WRU.

b) This SSSS sequence is recognized by:

a) the DTE, if the A/B simulator is located in the DTE;

b) the DCE, if the A/B simulator is located in the DCE.

In either case the A/B simulator is disabled.

c) If the A/B simulator is located in the DCE and is disabled, it is re-enabled.

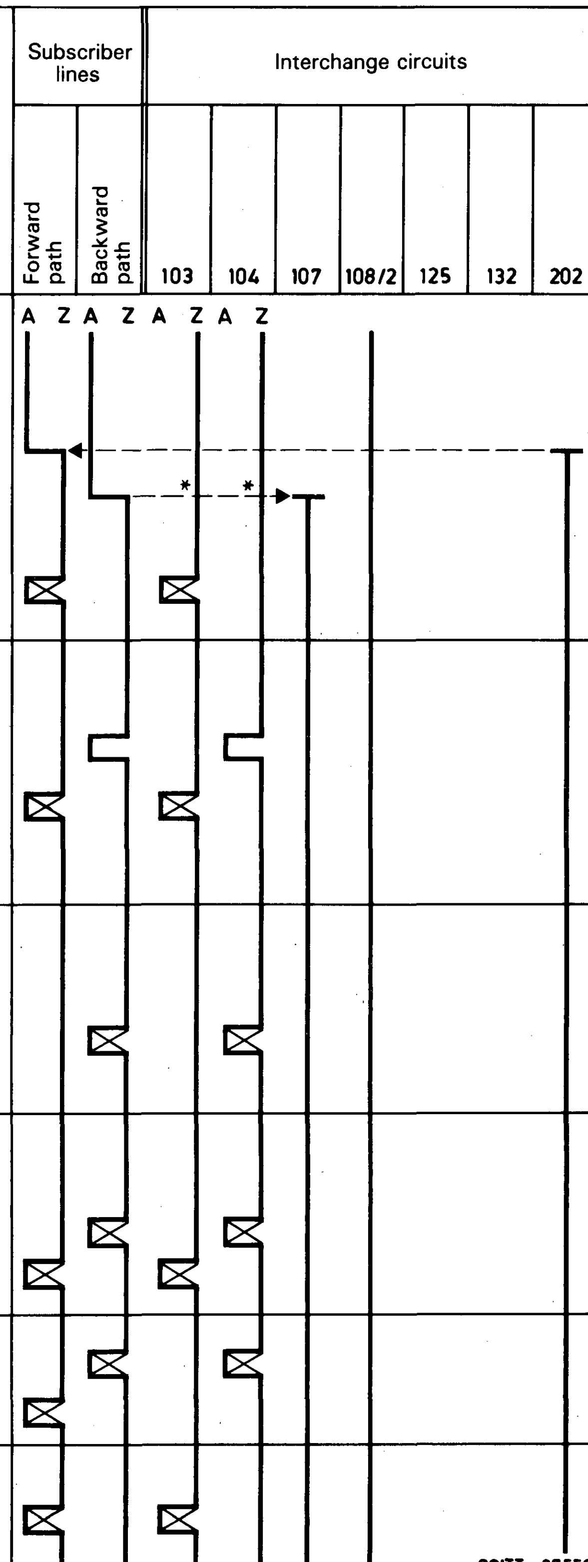
ANNEX B

(to Recommendation S.16)

Automatic call by DTE

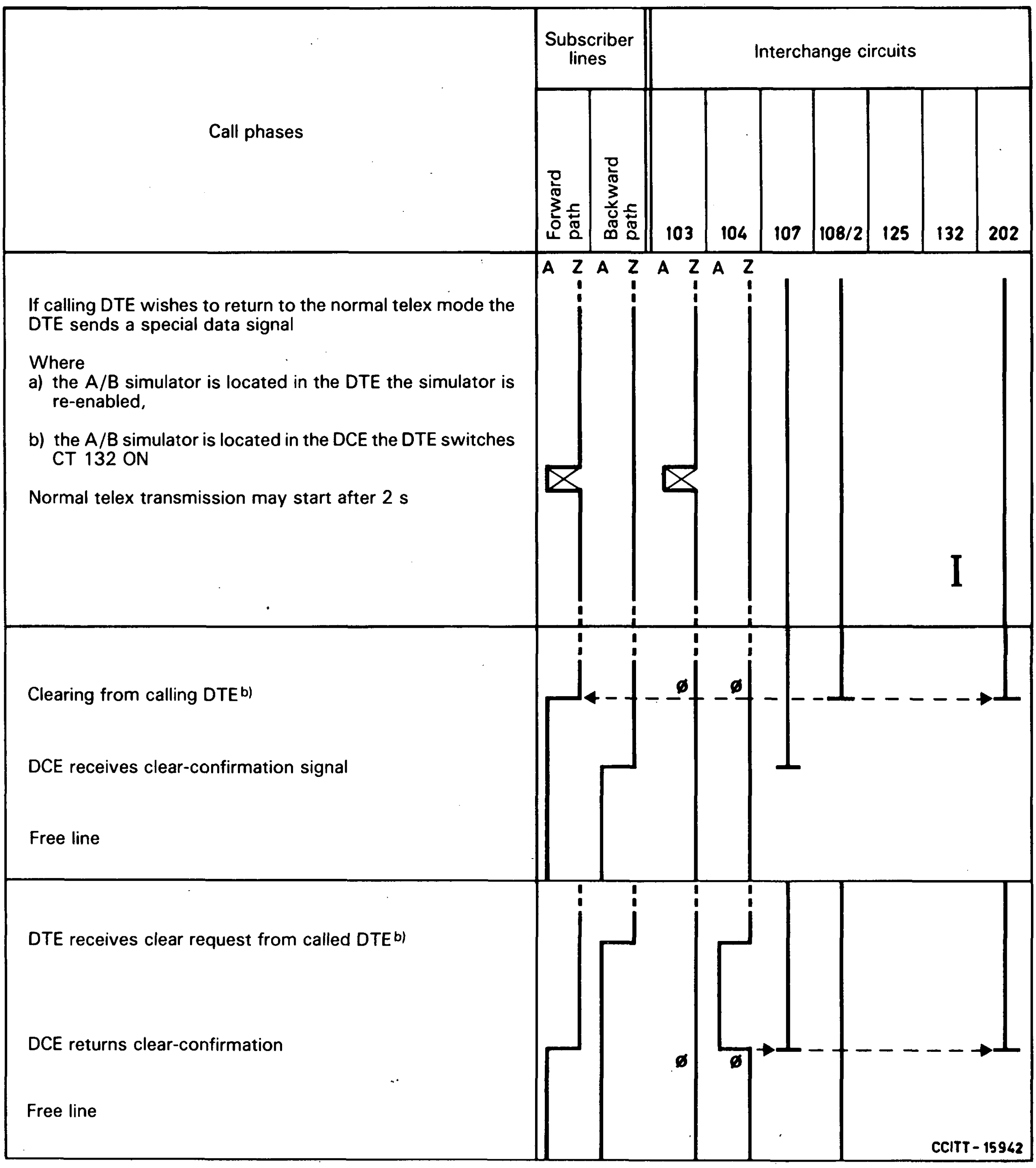
(keyboard selection)

Call phases
Free line Call from DTE, DCE sends call to network DCE receives call-confirmation and (where appropriate) proceed-to-select signal DTE sends selection signals
a) Case where call-connected signal is received: DTE receives call-connected signal If WRU signal is not sent automatically by network, DTE sends it
b) Case where call-connected signal is replaced by A/B of called terminal: In cases a) and b), DTE receives called terminals A/B
If exchange of A/Bs is initiated by the network: Case a) A/B simulator provided in DTE DTE receives WRU signal DTE returns its A/B
Case b) A/B simulator provided in DCE DCE receives WRU signal DCE returns its A/B
DTE sends SSSS sequence a) Exchange of data may start after 2 s



Automatic call by DTE (cont'd)

(keyboard selection)



a) This SSSS sequence is recognized by:
a) the DTE, if the A/B simulator is located in the DTE;
b) the DCE, if the A/B simulator is located in the DCE.
In either case the A/B simulator is disabled.

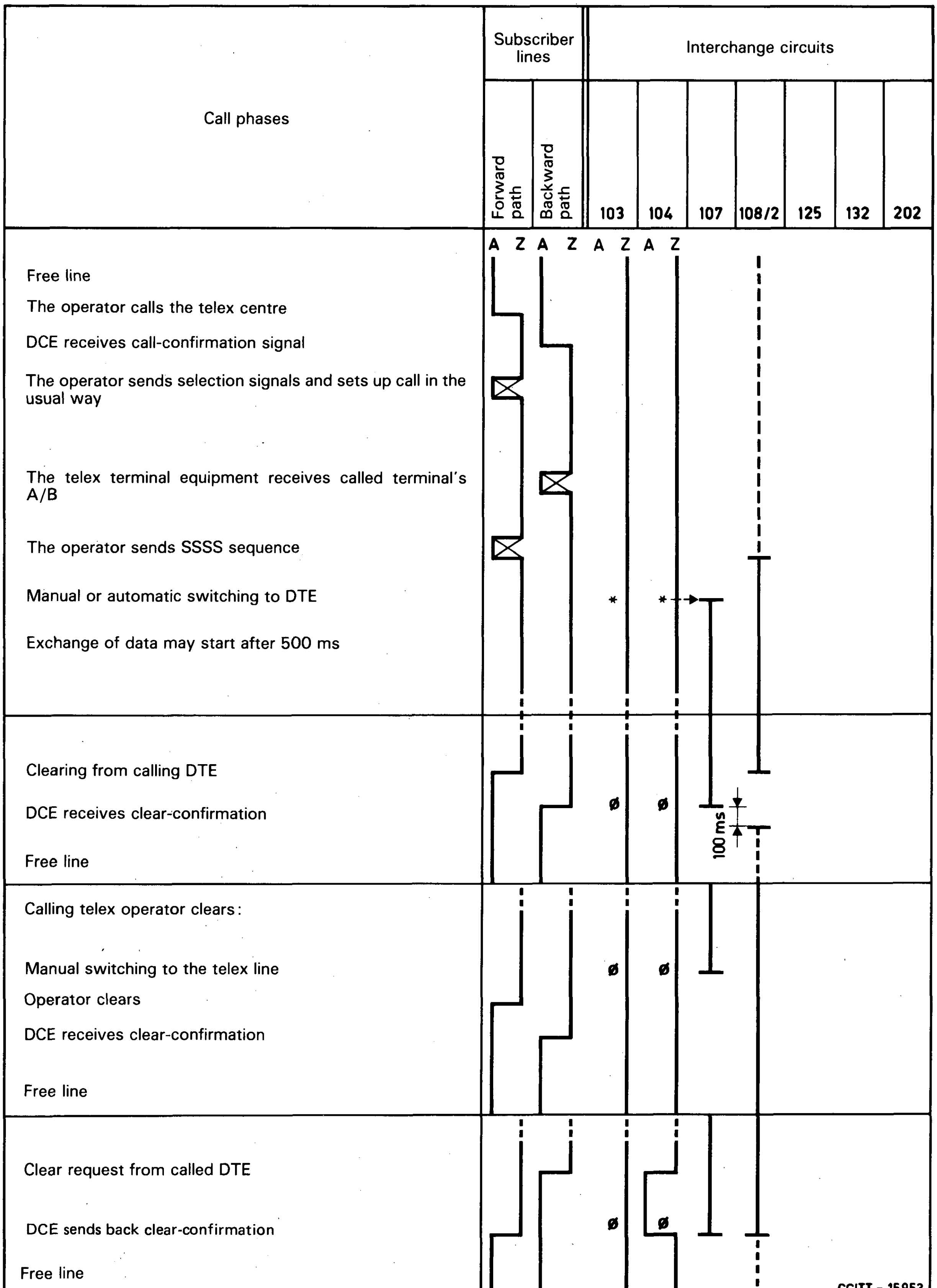
b) If the A/B simulator is located in the DCE and is disabled, it is re-enabled.

ANNEX C

(to Recommendation S.16)

Teleprinter + DTE

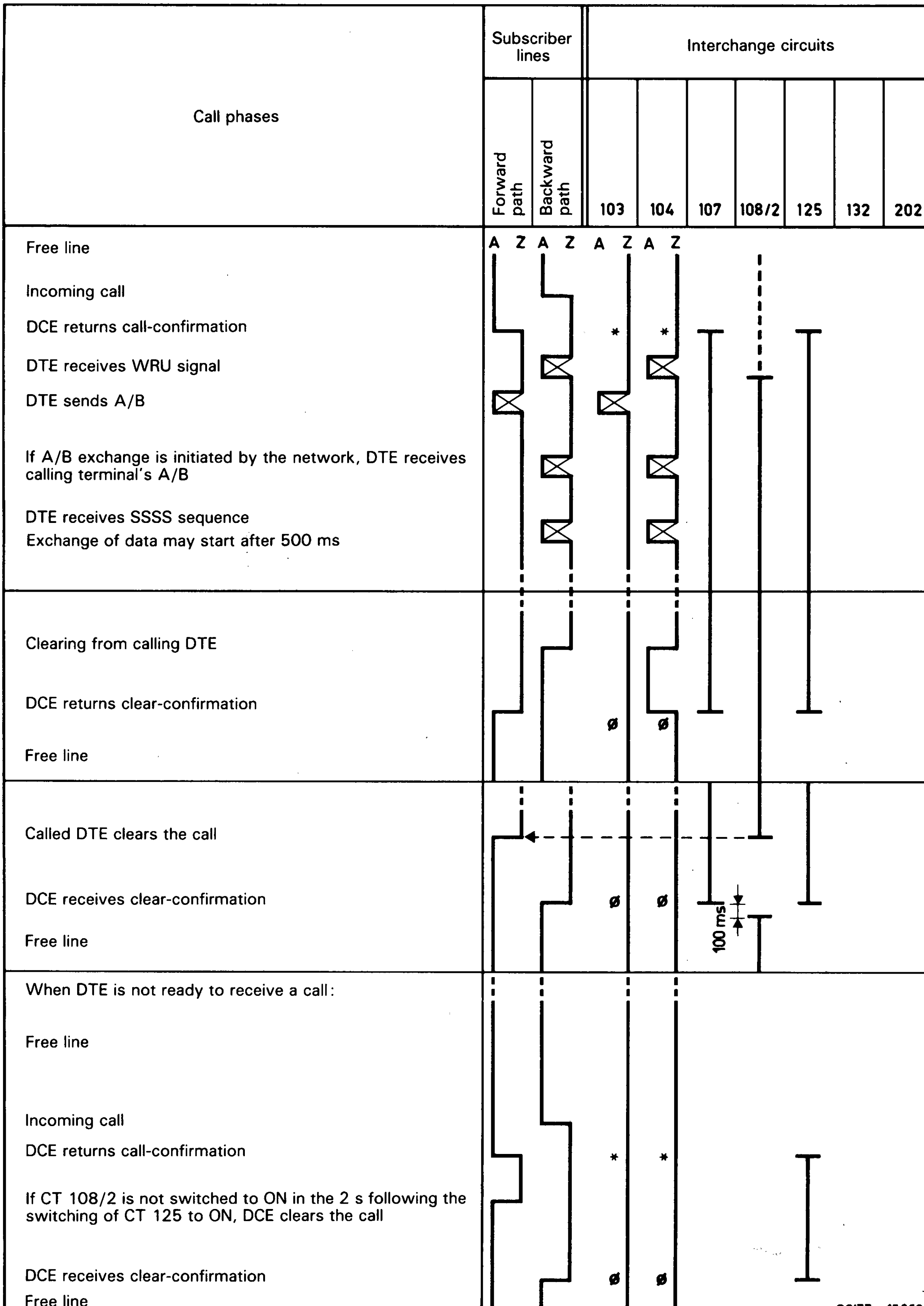
(Manual call with manual or automatic switching to DTE)



ANNEX D

(to Recommendation S.16)

Answering by DTE

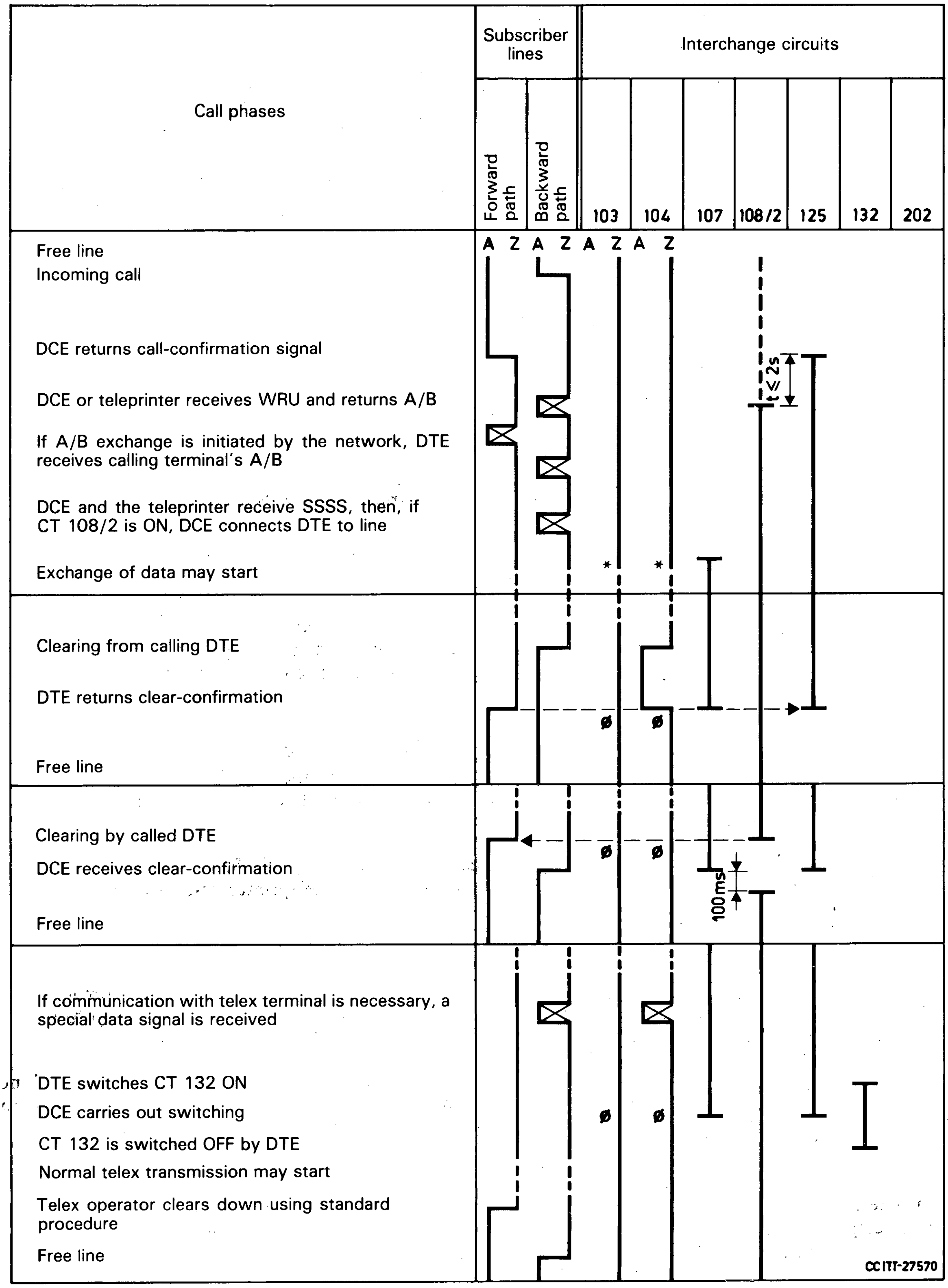


ANNEX E

(to Recommendation S.16)

Teleprinter answering

(with automatic switching to DTE)



References

[1] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Rec. V.24.

[2] CCITT Recommendation *Standardization of dials and dial pulse generators for the international telex service*, Rec. U.2.

[3] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits*, Rec. V.28.

[4] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications*, Rec. V.10.

[5] CCITT Recommendation *Interconnection of private teleprinter networks with the telex network*, Rec. F.71.

[6] CCITT Recommendation *Reactions by automatic terminals connected to the telex network in the event of ineffective call attempts or signalling incidents*, Rec. U.40.

Recommendation S.17

ANSWER-BACK UNIT SIMULATORS

(former Recommendation V.13, Mar del Plata, 1968)

1 The answer-back code must be released by a device capable of recognizing the *Who are you?* signal in International Telegraph Alphabet No. 2 (five-unit code). Hence, this device must keep in a store unit the *figures* situation indicated by combination No. 30 received before combination No. 4 of this alphabet.

2 In view of the procedure adopted for the use of the sequence of four No. 19 combinations as the signal for passage from the telex position to the data position in terminal equipment, the introduction of this sequence (four times combination No. 19) in the 20 signals of the simulator answer-back code is to be avoided, since it is incompatible with the procedure already adopted.

Note – It should be noted that, for the same reason of procedure, this four times combination No. 19 sequence should not be introduced in the answer-back code signals of a teleprinter associated with a manual or automatic call-transfer device.

3 The composition of the signals of the answer-back unit simulator can obviously be used for identification of the station obtained by the station that requests the call. If the identification is negative, it is up to this calling station to interrupt the unwanted connection.

Note – On the other hand, it was agreed that identification in the opposite direction could not be achieved in a simple way by the answer-back unit simulator, since the answer-back code to be checked in this direction is that of the opposite station, which is normally the one that has requested the connection.

4 In a telex installation intended for data transmission and equipped with an answer-back unit simulator instead of a teleprinter, the device for changeover from telex to data working – by the passage of the sequence of four combinations No. 19 – must be automatic.

5 The characteristics of the answer-back unit simulator should conform with Recommendation S.6.

CONVERSION BETWEEN INTERNATIONAL TELEGRAPH ALPHABET No. 2 AND INTERNATIONAL ALPHABET No. 5

(Geneva, 1980)

The CCITT,

considering

(a) that the Recommendation cited in [1] defines International Telegraph Alphabet No. 2 (ITA2), which is used, for example, in the international telex service;

(b) that International Alphabet No. 5 (IA5), defined in Recommendation T.50 [2], has been established jointly by the CCITT and the International Organization for Standardization (ISO) for use in data transmission (for example);

(c) that rules for converting from ITA2 to IA5 and vice versa are desirable to facilitate interworking, for example between terminals in the international telex service and terminals in data networks;

(d) that a suitable set of rules has been drawn up in collaboration with ISO;

(e) that for specific user applications some variations in the tables below may be developed and applied by bilateral agreement;

(f) that this Recommendation does not define whether the alphabetic characters of ITA2 are represented as capital or small letters;

unanimously recommends

that the following rules for conversion should apply.

1 Conversion from ITA2 to IA5

1.1 The conversion of characters shall be as specified in Table 1/S.18.

1.2 Annex A, together with Table A-1/S.18, provides information on alternative conversions that are in general use in some countries.

2 Conversion from IA5 to ITA2

2.1 The conversion of characters shall be as specified in Table 2/S.18.

2.2 The control characters of positions 0/1, 0/2, 0/3, 0/4, 0/6, 1/0, 1/5, 1/6 and 1/7 are generally not converted because they are removed from the character string by the link control equipment.

2.3 Characters for which there are no direct equivalents shall be represented by the single character question mark (**?**), unless prior agreement has been made between the interchange parties.

2.4 The greater number of code combinations available in IA5 means that not every character can be translated unambiguously into a single ITA2 character. Use of a single character, rather than a multi-character representation, will minimize formatting problems.

2.5 Annex A together with Table A-2/S.18 provide information on some alternative conversions that are in use in some countries.

TABLE 1/S.18

Conversion from ITA2 to IA5

ITA2 combination number	ITA2 letter case	IA5 Character (See Note 3)	IA5 Coding	IA5 Character (See Note 3)	IA5 Coding	ITA2 figure case	IA5 Character	IA5 Coding
1	**A**	**A**	4/1	**a**	6/1	**-**	**-**	2/13
2	**B**	**B**	4/2	**b**	6/2	?	?	3/15
3	**C**	**C**	4/3	**c**	6/3	:	:	3/10
4	**D**	**D**	4/4	**d**	6/4	WRU	ENQ (See Note 1)	0/5
5	**E**	**E**	4/5	**e**	6/5	**3**	**3**	3/3
6	**F**	**F**	4/6	**f**	6/6	National use	(See Note 4)	
7	**G**	**G**	4/7	**g**	6/7	National use	(See Note 4)	
8	**H**	**H**	4/8	**h**	6/8	National use	(See Note 4)	
9	**I**	**I**	4/9	**i**	6/9	**8**	**8**	3/8
10	**J**	**J**	4/0	**j**	6/10	BELL	BEL	0/7
11	**K**	**K**	4/11	**k**	6/11	(	(	2/8
12	**L**	**L**	4/12	**l**	6/12	)	)	2/9
13	**M**	**M**	4/13	**m**	6/13	.	.	2/14
14	**N**	**N**	4/14	**n**	6/14	,	,	2/12
15	**O**	**O**	4/15	**o**	6/15	**9**	**9**	3/9
16	**P**	**P**	5/0	**p**	7/0	**0**	**0**	3/0
17	**Q**	**Q**	5/1	**q**	7/1	**1**	**1**	3/1
18	**R**	**R**	5/2	**r**	7/2	**4**	**4**	3/4
19	**S**	**S**	5/3	**s**	7/3	'	'	2/7
20	**T**	**T**	5/4	**t**	7/4	**5**	**5**	3/5
21	**U**	**U**	5/5	**u**	7/5	**7**	**7**	3/7
22	**V**	**V**	5/6	**v**	7/6	=	=	3/13
23	**W**	**W**	5/7	**w**	7/7	**2**	**2**	3/2
24	**X**	**X**	5/8	**x**	7/8	/	/	2/15
25	**Y**	**Y**	5/9	**y**	7/9	**6**	**6**	3/6
26	**Z**	**Z**	5/10	**z**	7/10	+	+	2/11

ITA2 combination number	ITA2 character (either case)	IA5 character	IA5 coding
27	Carriage-return	FE_5	0/13
28	Line-feed	FE_2	0/10
29	Letter-shift	(See Note 2)	
30	Figure-shift	(See Note 2)	
31	Space	SP	2/0
32	Not normally used	(See Note 4)	0/0

Note 1 – This character is used only to operate the answer-back unit of the corresponding instrument in the international public services.

Note 2 – These characters have no corresponding function in IA5. Conversion equipment operates the appropriate shift and discards the characters.

Note 3 – Small or capital letters may be used, however intermixing of small and capital letters is not allowed.

Note 4 – These characters have no international allocation.

TABLE 2/S.18

Conversion from IA5 to ITA2

	0	1	2	3	4	5	6	7
0	NUL / ?	DLE / ?	SP / SP	0 / 0	@ / ?	P / P	` / ?	p / P
1	SOH / ?	DC_1 / ?	! / ?	1 / 1	A / A	Q / Q	a / A	q / Q
2	STX / ?	DC_2 / ?	" / ?	2 / 2	B / B	R / R	b / B	r / R
3	ETX / ?	DC_3 / ?	# / ?	3 / 3	C / C	S / S	c / C	s / S
4	EOT / ?	DC_4 / ?	¤ / ?	4 / 4	D / D	T / T	d / D	t / T
5	ENQ / WRU	NAK / ?	% / ?	5 / 5	E / E	U / U	e / E	u / U
6	ACK / ?	SYN / ?	& / ?	6 / 6	F / F	V / V	f / F	v / V
7	BEL / BEL	ETB / ?	' / '	7 / 7	G / G	W / W	g / G	w / W
8	FE_0 / ?	CAN / ?	(/ (	8 / 8	H / H	X / X	h / H	x / X
9	FE_1 / ?	EM / ?	) /)	9 / 9	I / I	Y / Y	i / I	y / Y
10	FE_2 / LF	SUB / ?	* / ?	: / :	J / J	Z / Z	j / J	z / Z
11	FE_3 / ?	ESC / ?	+ / +	; / ?	K / K	[/ ?	k / K	{ / ?
12	FE_4 / ?	IS_4 / ?	, / ,	< / ?	L / L	\ / ?	l / L	| / ?
13	FE_5 / CR	IS_3 / ?	– / –	= / =	M / M	] / ?	m / M	} / ?
14	SO / ?	IS_2 / ?	. / .	> / ?	N / N	^ / ?	n / N	‾ / ?
15	Si / ?	IS_1 / ?	/ / /	? / ?	O / O	_ / ?	o / O	DEL / removed

Key: IA5 / ITA2

CCITT-43810

Note – Characters allocated to letter case or figure case are specified in Table 1/S.18. The current converted character must be preceded by the appropriate shift character if a change of case is required, i.e. if the last shift that occurred differs from the required one.

ANNEX A

(to Recommendation S.18)

Alternative conversions between IA5 and ITA2

A.1 Recommendation S.18 permits alternative conversions for characters that have no direct equivalents, provided these conversions are agreed between interchange parties. Other alternatives may be used.

A.2 Tables A-1/S.18 and A-2/S.18 list conversions that are in use in some countries.

A.3 In some nationally adapted applications of ITA2 and IA5, special conversion rules are required because national characters have been allocated in different orders in the coded character sets concerned.

A.4 NUL is equivalent to *all space* (combination No. 32 or NU) in ITA2.

TABLE A-1/S.18

Examples of alternative conversions from ITA2 to IA5

ITA2				IA5		
Alternative	Case	Combination No.	Character	Character	Code	Remarks
a)	Figure Figure Figure	6 7 8	National use	SUB SUB SUB	1/10 1/10 1/10	
b)	Figure Figure Figure	6 7 8	National use		5/11 5/12 5/13	See § A.3
c)	Figure Figure Figure	6 7 8	National use		7/11 7/12 7/13	See § A.3
d)	Either Either	29 30	Letter shift Figure shift	IS_2 IS_1	1/14 1/15	
e)	Either Either	29 30	Letter shift Figure shift	DEL DEL	7/15 7/15	
f)	As e) but with additional agreement that only shift characters following the first one are converted to 7/15. The first one is treated according to Table 1/S.18.					
g)	Either	32	NU	NUL	0/0	See § A.4

Table A-1/S.18 p.209

TABLE A-2/S.18

Examples of alternative conversions from IA5 to ITA2

<table>
<tr><th colspan="2">IA5</th><th colspan="2">ITA2</th><th rowspan="2">Remarks</th></tr>
<tr><th>Code</th><th>Character</th><th>Characters</th><th>Combinations</th></tr>
<tr><td>0/0</td><td>NUL</td><td>NU</td><td>32</td><td>See § A.4</td></tr>
<tr><td>0/1
0/2
0/3
0/4
0/6
1/1
1/5
1/6
1/7</td><td>SOH
STX
ETX
EOT
ACK
DLE
NAK
SYN
ETB</td><td>)?)</td><td>12 (right parenthesis)
2 (question mark)
12 (right parenthesis)
in figure case</td><td>Alternative conversions where characters not removed from the character string by the link control equipment or by convention</td></tr>
<tr><td>0/8
0/9
0/11
0/12
0/14
0/15
1/1
1/2
1/3
1/4
1/8
1/9
1/10
1/11
1/12
1/13</td><td>FE_0
FE_1
FE_3
FE_4
SO
SI
DC_1
DC_2
DC_3
DC_4
CAN
EM
SUB
ESC
IS_4
IS_3</td><td>)?)</td><td>12 (right parenthesis)
2 (question mark)
12 (right parenthesis)
in figure case</td><td></td></tr>
<tr><td>1/14
1/15</td><td>IS_2
IS_1</td><td>Letter-shift
Figure-shift</td><td>29
30</td><td>See also Table A-1/S.18. Combinations 29 and 30 may be used with either case</td></tr>
<tr><td>2/1
2/2
2/3
2/4
2/5
2/6
2/10
3/11
3/12
3/14
4/0
5/14
5/15
6/0
7/11
7/12
7/13
7/14</td><td>!
"
#
¤
%
&
*
;
<
>
@
^
_
`
{
|
}
‾</td><td>(?)</td><td>11 (left parenthesis)
2 (question mark)
12 (right parenthesis)
in figure case</td><td></td></tr>
<tr><td>5/11
5/12
5/13</td><td>[
\
]</td><td>National use options</td><td>6
7 in figure case
8</td><td>See § A.3</td></tr>
<tr><td>7/11
7/12
7/13</td><td>{
|
}</td><td>National use options</td><td>6
7 in figure case
8</td><td>See § A.3</td></tr>
<tr><td>7/15</td><td>DEL</td><td>Letter-shift</td><td>29</td><td></td></tr>
</table>

Note – Use of *new line* requires additional agreement between the interchange parties.

References

[1] CCITT Recommendation *Operational provisions for the international public telegram service*, Rec. F.1, § C.

[2] CCITT Recommendation *International Alphabet No. 5*, Rec. T.50.

CALLING AND ANSWERING IN THE TELEX NETWORK WITH AUTOMATIC TERMINAL EQUIPMENT

(Geneva, 1980)

1 General

1.1 This Recommendation describes a method of originating and answering calls on the 50-baud telex network by means of an automatic terminal using a simple telegraph-type interface for the exchange of data or messages.

1.2 The equipment that processes these data or messages at the terminal is referred to as the data terminal equipment (DTE). It should be able to carry out automatically all the operations required to set up and clear down calls as well as the sending and receiving of information at 50 bauds on the telex network.

1.3 The data circuit terminating equipment (DCE) constitutes the frontier between the DTE and the telex network and offers the possibility of remote maintenance. The DCE effects all signal conversions between the DTE and the telex subscriber line. The DCE may be either a separate unit or a built-in component of the DTE.

2 DCE/DTE interface

2.1 The interchange circuits used for the interface (if any) between the DCE and the DTE are defined in Recommendation V.24 [1] and comply with the technical specifications in either Recommendation V.28 [2] or Recommendation V.10 [3]. Thus the correspondence between the voltages and the significant states is as shown in Table 1/S.16.

2.2 The DCE/DTE interface consists of three circuits: CT 103 and 104 for the transmission and reception of both data and control signals and CT 102 for the signal ground or common return. Figure 1/S.19 illustrates the interface configuration.

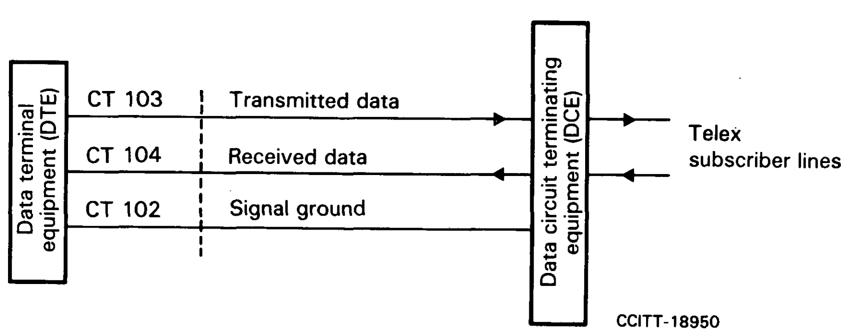


FIGURE 1/S.19
Interface configuration

2.3 In addition to its use for sending data or messages once a call has been established, CT 103 carries all the control signals produced by the DTE and needed by the telex network to set up and clear down connections. Similarly CT 104, in addition to its use for receiving data or messages once a call has been established, carries all the control signals produced by the DCE and needed by the network to set up and clear down connections.

2.4 During a call that has been set up and in the setting-up phase, as well as in all intervals between signals, the DTE maintains CT 103 and the DCE maintains CT 104 on Z polarity.

3 Signalling

3.1 This interface may be used with any of the telex signalling variants in use in national networks.

3.2 The signalling between the DCE and the national telex exchange is not standardized by the CCITT. The signalling protocol shown in the timing diagram (Figure 3/S.19) is only an example. However, since it is based on Type A signalling, for Type B signalling the call establishment phase should be read as shown in Figure 2/S.19.

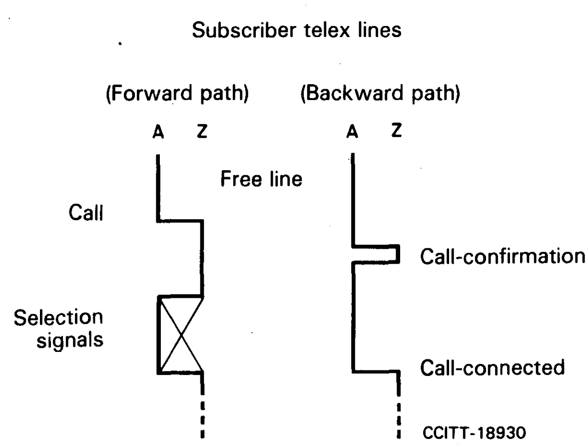


FIGURE 2/S.19
Type B call establishment

3.3 Figure 3/S.19 shows CT 103 (forward path) and CT 104 (backward path) for both the calling and called DTEs. Consequently it covers both calling and answering with an automatic terminal, but the procedures described are applicable to a calling or called DTE in communication with a DTE operated in accordance with one of the procedures described in Recommendation S.16 or manually. The particular case shown is that of a successful call with clearing initiated by the calling DTE.

3.4 The **SSSS** sequence (four times combination No. 19 in International Telegraph Alphabet No. 2) normally precedes and announces the exchange of data, which may commence after a delay of 500 ms, as specified in Recommendation S.15. This sequence may be omitted where an exchange of message in ITA2 is to take place, providing disabling of the answer-back function is not considered necessary.

3.5 The DTE must comply with Recommendation U.40 [4] concerning reactions to ineffective call attempts. It must be able to interpret at least the following service signals: OCC, ABS, NA, NP, NC, NCH, DER.

3.6 If a call collision is detected, the DTE must abandon its call attempt to permit acceptance of the incoming call.

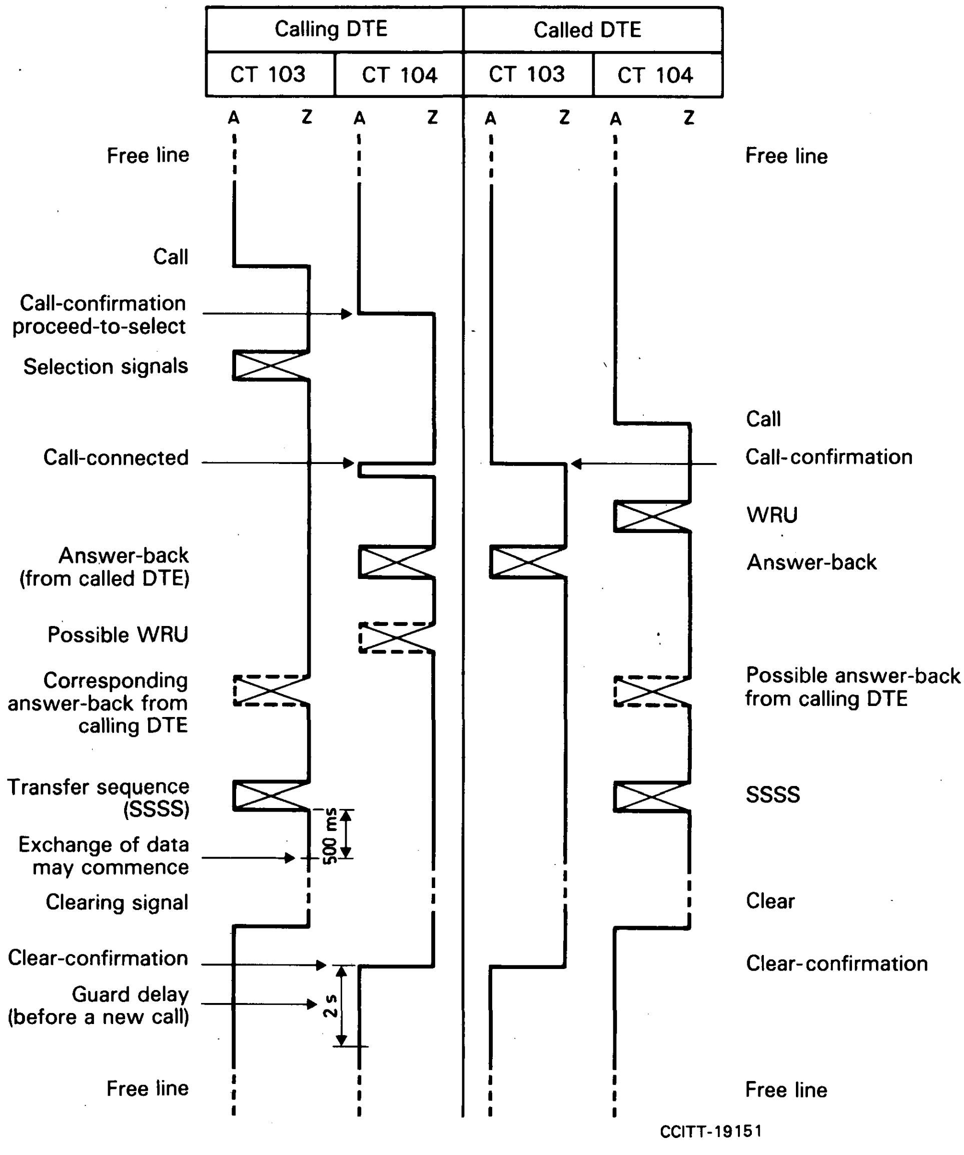


FIGURE 3/S.19
Timing diagram

References

[1] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Rec. V.24.

[2] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits*, Rec. V.28.

[3] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications*, Rec. V.10.

[4] CCITT Recommendation *Reactions by automatic terminals connected to the telex network in the event of ineffective call attempts or signalling incidents*, Rec. U.40.

AUTOMATIC CLEARING PROCEDURE FOR A TELEX TERMINAL

(Geneva, 1980)

The CCITT,

considering

(a) that new equipment should be capable of automatic performance of functions that would normally require an operator;

(b) that those operator functions that involve repetitive work or idle waiting on the part of an operator should be considered most immediately for automation of a terminal;

(c) that one of the most straightforward operator functions that could benefit from automatic assistance is the clearing of a call;

(d) that conditions for automatic establishments of calls are laid down in Recommendation U.40 [1] whereas this Recommendation assumes that an operator is present to initiate the calling condition;

unanimously recommends

that the following procedure should be adopted for new equipment to assist operators by automatically providing a clearing down procedure following automatic transmission of a message.

1 The activation of this automatic procedure should be under the control of the operator, so that either manual control, or automatic control, can be selected according to the requirements of a particular call.

2 It is assumed that connection to the desired subscriber has already been established, and that the correctness of this connection has been confirmed by examination of the answer-back sequence received from the called subscriber.

3 It is also assumed that the message to be transmitted is ready for release to line via the automatic transmitter.

4 The subsequent procedure may be described as a series of steps as follows:

a) Operate the special control that initiates the following automatic transmission and clearing procedure.

b) (Optional, according to national requirements). The equipment transmits a WRU signal in order to obtain a sample of the answer-back sequence of the called subscriber. This sequence is stored for subsequent checking.

Note – If step b) is not implemented it may be desirable to modify the subsequent procedure. For example, step h) may also be eliminated, with corresponding changes to step g) and step k). Also, if this check procedure is not considered to be necessary, it may be desirable to reduce the period of alarm in step m) to less than 30 seconds before the terminal automatically clears the call.

c) Automatic transmission is started.

d) At any time during the automatic transmission the detection of incoming signals, or transmission failure, will cause an alarm to be raised, as at step l). Automatic transmission will also be stopped. If the incoming signals are not sustained, but consist of only an isolated pulse or a single spurious character, the automatic transmission may be resumed after a maximum delay of one second. The alarm may continue until clearance of the call.

Note – Transmission failure may be detected as, for example, failure of paper tape feed or loss of transmitted signals.

e) The end of automatic transmission is detected locally by the tape-out contacts of the tape reader, or by the recognition of the transmission of an end of message pattern or by other means arranged within the terminal.

f) The terminal then automatically transmits the combinations No. 30 (figure-shift) and No. 4 (WRU) and awaits reception of the called subscriber's answer-back.

g) If the called subscriber's answer-back is received in less than six seconds the terminal immediately follows it by step h), otherwise it proceeds to step k).

h) If the received answer-back code is the same as the stored answer-back (step b) the terminal makes step i), otherwise it proceeds to step l).

i) The terminal transmits its own answer-back signal.

j) A clearing signal is initiated, and maintained until a clear confirm signal is recognized. This is followed by assumption of the free line condition.

k) If the called subscriber's answer-back is not received within six seconds, or if it differs in more than one character from that stored in step b), then step f), the transmission of figure-shift and WRU is repeated once more. If this results in the reception of a called subscriber's answer-back that is identical with that stored in step b), then the terminal proceeds to step i), otherwise to step l).

l) An alarm is operated to attract an operator's attention. This alarm may be the same as that used for combination No. 10 (Bell) or it may be a separate alarm provided for the purpose.

m) If the operator does not cancel the alarm and restore manual control of the terminal functions within 30 seconds, the terminal moves to step i), sending its own answer-back and automatically clearing the call.

Note – In the case of a connection's being established over a circuit involving storage, e.g. involving error correction facilities, the six-seconds period of waiting for an answer-back may be inadequate. The manual control of the procedure by the operator, following the alarm, is considered necessary in this case.

Reference

[1] CCITT Recommendation *Reactions by automatic terminals connected to the telex network in the event of ineffective call attempts or signalling incidents*, Rec. U.40.

Recommendation S.21

USE OF DISPLAY SCREENS IN TELEX MACHINES

(Geneva, 1980)

The CCITT,

considering

(a) that any terminal machine connected to the telex network should meet the basic operational and technical requirements laid down in Recommendations F.60 [1], S.3, S.4, S.6, S.8 and S.9;

(b) that a visual display screen facilitates message preparation and automatic calling in the telex service;

(c) that it is important that the operator should not be interrupted in his work of preparing messages by an incoming call, except that the operator may need to be alerted if combination No. 10 in figure case in International Telegraph Alphabet No. 2 is received on the incoming line;

(d) that customer confidence in correct delivery of a telexed message requires that all signals sent or received by a telex terminal should be recorded in a permanent form;

unanimously declares the following views

1 Transmission of the answer-back should be in accordance with Recommendations S.6 and S.9.

2 It is essential that any telex terminal include a printer that records at least all the signals sent or received on the line. Such signals do not necessarily need to be presented on the display screen.

3 It should be possible to transmit a message prepared on the screen automatically to line and simultaneously to the local printer.

4 When a call is received, the operator should be able to prepare or to continue preparing a message by means of the keyboard, the display screen and, possibly, storage equipment. All characters received from or transmitted to line should be printed.

5 The format and content of the message appearing on the screen should be identical to those that will subsequently appear on the page copy of the calling and called subscriber's printers.

6 All the lines on the screen, except in a possible reserved area, should be available to display a message. This message may be

a) a message being prepared;

b) a message already stored in a memory;

c) a message incoming from the line.

Note 1 – In cases a) and b) the screen should constitute a *window* that the operator can move line by line over the message or the stored part of the message. It is highly desirable that the movement of the *window* over the message should stop automatically when there are no more stored characters, the last recorded line being visible at the top of the screen.

Note 2 – In case c) it is desirable that:

– the message received, apart from being printed, can be stored in the memory at the end of the call;

– that the operator can converse with his correspondent, all the characters transmitted or received being visible on the screen.

7 A reserved area of the screen, where the operator cannot write anything, may be set aside in order to warn the operator:

a) that the memory is almost exhausted; or

b) that the visible portion of the message does not include the beginning of the message.

8 The display screen and its memory should employ a line length of 69 printing characters.

Note – This number of characters may not be strictly equivalent to the number sent to line, because the code used in the memory may not be the one used in telex calls.

9 It is very important that it should be possible to erase the message only at the command of the operator and not automatically at the end of transmission, so that the operator can send the same message to other addressees.

Reference

[1] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60.

USE OF "CONVERSATION IMPOSSIBLE" RESPONSE TO J/BELL SIGNALS FROM A TELEX TERMINAL

(Geneva, 1980)

The CCITT,

considering

(a) that conventional telex terminals incorporate a facility that allows an operator at one end of an established connection to attract the attention of an operator at the other end, this being achieved by transmitting J/BELL (combination No. 10 in International Telegraph Alphabet No. 2) in figure case;

(b) that technological developments and changing customer requirements have led to the introduction of the page-printing, receive-only, telex terminal, which, because of the absence of a keyboard, makes any conversational mode of operation impossible;

(c) that this limitation is not indicated to a calling station at the time the connection is established and may well result in wasted circuit time through attempts to establish contact with the called station via the J/BELL facility;

(d) that automatic calling and/or answering terminals employing data terminal equipment (DTE) and data circuit terminating equipment (DCE), in accordance with Recommendation S.16, are unlikely to have a conversational mode of operation;

(e) that technological developments and changing operational requirements may lead to the retention of messages in storage until a suitable opportunity to print-out arises;

unanimously declares the following views

1 Where a telex terminal is incapable of a conversational mode of operation, either through the absence of a keyboard or for local operational reasons, then it is highly desirable, at least in new equipment, that such a terminal be able to automatically return an appropriate service signal sequence on receipt of one or more ITA2 combination No. 10 characters (i.e. BELL signals) when preceded by ITA2 combination No. 30 (i.e. figure-shift).

2 The recommended sequence of signals to be returned in such circumstances should incorporate the code expression.

CI Conversation impossible

in conformity with the Recommendation cited in [1].

3 The complete sequence incorporating the code expression **CI** should have a format that corresponds with the Recommendation cited in [2], concerning service signals for ineffective calls, except that it should not be followed by the clearing signal.

4 As operators often key several repetitions of J/BELL (in figure-case) when attempting to contact a distant operator, a delay of 0.5-1.0 seconds should precede the transmission of the sequence, the delay to be measured from the stop element of the last J/BELL combination detected, there being no further characters received in that period.

References

[1] CCITT Recommendation *Operational provisions for the international telex service*, Rec. F.60, § 4.1.

[2] CCITT Recommendation *Signalling conditions to be applied in the international telex service*, Rec. U.1, § 10.1.2.

STANDARDIZATION OF BASIC MODEL PAGE-PRINTING MACHINE USING INTERNATIONAL ALPHABET No. 5

(Geneva, 1972; amended at Geneva, 1976)

The CCITT,

considering

(a) that the basic model page-printing machine is defined as having certain basic features for receiving (including printing) and/or transmitting;

(b) Recommendations T.50 [1], V.4 [2] and X.4 [3];

unanimously declares the view

1 The sets of graphics to be used should be either:

- a set of 95 characters consisting of columns 2 to 7 in the code table of International Alphabet No. 5 excluding the character DEL; or
- a smaller set of 64 characters consisting of columns 2 to 5 of the code table of International Alphabet No. 5.

If the machine is designed only for the smaller set of characters, the logic of the machine must be such that it prints the appropriate capital letters even when it receives a code combination for small letters.

Note – The interpretation, by 64-character machines, of other than alphabetic characters in columns 6 and 7 of the code table is at the discretion of Administrations for the time being.

2 The number of characters that the line of text of the basic model page-printing machine may contain should be fixed at 80.

3 To ensure the new-line function on direct printing machines:

- the transmitter must send at least n characters;
- the receiver must operate correctly on receipt of n characters.

For speeds up to and including 20 characters per second, $n = 4$. At 27.3 (corresponding to 300 bauds) and 30 characters per second, $n = 6$. The n characters consist of:

- one format effector CR (position 0/13 in International Alphabet No. 5);
- one format effector LF (position 0/10 in International Alphabet No. 5);
- the appropriate remaining number of non-printing and non-carriage moving characters (but the CR character is allowed);

4 The time elapsing between the application of power to the motor of a machine and the machine's running up to speed and being ready to receive or send characters should not exceed 600 ms. Where the machine is used in a switched network, this elapsed time shall start from the instant when an incoming call is received at the interface.

Note – Manufacturers should endeavour to minimize this time.

References

[1] CCITT Recommendation *International Alphabet No. 5*, Rec. T.50.

[2] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public telephone networks*, Rec. V.4.

[3] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Rec. X.4.

TRANSMISSION CHARACTERISTICS FOR START-STOP DATA TERMINAL EQUIPMENT USING INTERNATIONAL ALPHABET No. 5

(Geneva, 1972; amended at Geneva, 1976)

The CCITT,

considering

(a) that taking into account Recommendations T.50 [1] and X.4 [2], this Recommendation applies to the characteristics, from the transmission point of view, at the interchange point between data circuit-terminating equipment and start-stop data terminal equipment using International Alphabet No. 5. Except where otherwise specified, *data terminal equipment* in this Recommendation should be understood to mean *start-stop apparatus* in the wide sense of the term, as defined in [3] i.e. it includes reperforators, service signals sent by switching equipment, signals from answer-back units, automatic transmitters, etc.;

(b) that, bearing in mind the definition of User Class of Service 1 in Recommendation X.1 [4], where it is specified that a signalling rate of 300 bit/s, a structure of 11 units per character and start-stop operation shall be used for address selection, call progress signals and data transfer;

(c) that the characteristics laid down below are those that should be evident in service conditions at the interchange point between data terminal equipment and data circuit-terminating equipment;

unanimously declares the view:

1 Equipment characteristics

1.1 The nominal modulation rate should be:

a) 300 bauds; or

b) 200 bauds.

1.2 The difference between the real mean modulation rate of the signals when in service and the nominal rate should not exceed ± 0.1%.

1.3 The nominal duration of the transmitting cycle should be at least 11 units, the stop element lasting for at least 2 units.

1.4 The receiver must be able to translate correctly in service the signals coming from a source that appears to have a nominal transmit cycle equal to or greater than 10 units.

2 Transmitter characteristics

2.1 The degree of gross start-stop distortion of transmitted signals, measured at the interchange point between data terminal equipment and data circuit-terminating equipment, must not exceed 5%. This value applies to all working conditions of the equipment under consideration encountered during normal service, whether the signals are transmitted separately or whether they succeed one another at the maximum rate compatible with the modulation rate.

2.2 It is recommended that the measurement should be made with a start-stop distortion measuring set for two consecutive periods, each of about 15 seconds (corresponding to about 1200 transitions at 200 bauds or 1800 transitions at 300 bauds). Early distortion should be observed during one period and late distortion during the other.

3 Receiver characteristics

3.1 The effective net margin measured at the interchange point between data terminal equipment and data circuit-terminating equipment should not be less than 40% for signals corresponding to a nominal transmit cycle equal to or greater than 10 units.

3.2 It is recommended that the measurement should be made under the following conditions, in service:

- 11-unit cycle for the signals transmitted by the measuring apparatus;
- use of one of the signal trains specified in Recommendation S.33;
- first test with an identical distortion rate on all transitions of the signal train, obtained by lengthening the start element;
- a second test with the same rate of identical distortion on all the transitions of the signal train, but obtained in this case by shortening the start element;
- reading the margin when one error per test sentence is obtained (the margin is the lesser of the two values of the degree of distortion obtained from the two measurements);
- the length of the start element or of any data element must in no case be less than 50% of the theoretical unit element.

Note – It will be up to Administrations using some other measuring method to work out for their own use figures to give equivalent results to those which would have been obtained by the recommended method.

References

[1] CCITT Recommendation *International Alphabet No. 5*, Rec. T.50.

[2] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Rec. X.4.

[3] CCITT Definitions: *Start-stop apparatus*, Vol. X, Fascicle X.1 (Terms and Definitions).

[4] CCITT Recommendation *International user classes of service in public data networks*, Rec. X.1.

Recommendation S.32

ANSWER-BACK UNITS FOR 200- AND 300- BAUD START-STOP MACHINES IN ACCORDANCE WITH RECOMMENDATION S.30

(Geneva, 1972; amended at Geneva, 1976)

The CCITT,

considering

(a) that start-stop machines are capable of receiving communications without the aid of an operator;

(b) that it may be necessary to verify the correct functioning of the line and of the distant terminal equipment;

unanimously declares the view

that if the use of an automatic answer-back unit is requested, it would be advisable:

1) to effect the operation of the code transmitter by the control character ENQ, position 0/5 in the code table of International Alphabet No. 5 (Recommendation T.50 [1]);

2) to compose the code-emission by a series of 20 signals, as follows:

   1 CR (position 0/13 in the code table),

   1 LF (position 0/10 in the code table),

   2 non-printing, non-carriage moving signals (but which may include CR),

   16 signals chosen for the subscriber comprising the identification of the machine;

3) when the code signal does not comprise 16 characters, to distribute them by inserting at the beginning as many fill signals (such as DEL or NUL) as are necessary to make up the total of 16 signals;

4) that the answer-back signals follow Recommendations X.4 [2] and S.31;

5) that the delay between the reception of the beginning of the start unit of control character ENQ and the beginning of the start unit of the first signal of the answer-back sent by the machine should lie between one and four character periods.

References

[1] CCITT Recommendation *International Alphabet No. 5*, Rec. T.50.

[2] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Rec. X.4.

Recommendation S.33

STANDARDIZATION OF AN INTERNATIONAL TEXT FOR THE MEASUREMENT OF THE MARGIN OF START-STOP MACHINES USING INTERNATIONAL ALPHABET No. 5

(Geneva, 1972)

The CCITT

unanimously declares the view

(1) that it is not necessary to standardize a single international text for the measurement of the margin of a teleprinter;

(2) that nevertheless it would be of interest to recommend to the operating Administrations the use of one or other of the following texts (based on the international reference version of International Alphabet No. 5):

a) in case of application of the 95-character set (columns 2 to 7 in the code table):

VoyeZ Le BricK GeanT QuE J'ExaminE PreS Du WharF 123 456 7890 + – × : = ¤ % ( )

ThE QuicK BrowN FoX JumpS OveR ThE LazY DoG 123 456 7890 + – × : = ¤ % ( )

b) in case of application of the 64-character set (columns 2 to 5 in the code table):

VOYEZ LE BRICK GEANT QUE J'EXAMINE PRES DU WHARF 123 456 7890 + – × : = ¤ % ( )

THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 123 456 7890 + – × : = ¤ % ( )

SECTION 7

DEFINITIONS

Recommendation S.140

DEFINITIONS OF ESSENTIAL TECHNICAL TERMS RELATING TO APPARATUS FOR ALPHABETIC TELEGRAPHY

The definitions given below have been identified as necessary for studies in the field of alphabetic telegraphy apparatus.

Sub-numbers in the 34.ZZ range signify definitions derived from definitions with number 34.ZZ in the ITU List of Definitions of Essential Telecommunications Terms.

Sub-numbers in the 721.34.YY range signify correspondence with definitions in the International Electrotechnical Vocabulary (IEV) of the International Electrotechnical Commission (IEC).

1 subscriber's installation

F: installation d'abonné

S: instalación de abonado

The lines, the terminals and any extension, private exchange, control units and any other equipment located at the subscriber's premises.

721.34.01

2 (telegraph) **terminal**

F: terminal (télégraphique)

S: terminal (telegráfico)

Pertaining to or designating equipments connected to the end of the subscriber's line or telegraph circuit, which can either establish or receive calls, or store and retransmit signals, and which can be uniquely identified.

721.34.02

3 **start-stop apparatus**

F: appareil arythmique

S: aparato arrítmico

Telegraph apparatus designed for a start-stop system.

721.34.14
34.14

4 **teleprinter; teletypewriter** (USA)

F: téléimprimeur; télétype (marque de fabrique, terme à proscrire), *téléscripteur* (terme à proscrire dans ce sens)

S: teleimpresor

A start-stop apparatus comprising an alphanumeric keyboard transmitter with a printing character receiver.

721.34.15
34.15

5 **page teleprinter**

F: téléimprimeur à (impression sur) page

S: teleimpresor en página

A teleprinter which prints characters in page formation.

721.34.16

6 **tape teleprinter**

F: téléimprimeur à (impression sur) bande

S: teleimpresor en cinta

A teleprinter which prints characters in a single line on a continuous paper tape.

721.34.17

7 **alphanumeric keyboard**

F: clavier alphanumérique

S: teclado alfanumérico

A device comprising an assembly of alphanumeric keys and function keys the operation of which controls the transmitter of a telegraph apparatus.

721.34.18

8 **storage keyboard**

F: clavier à enregistreur

S: teclado con almacenamiento

An alphanumeric keyboard in which the combination set up by the depression of a key does not directly control the transmitter but is transferred to one or more sets of storage members for subsequent control of the transmitter.

721.34.21
34.51

9 **tape-reading head; tape-reader**

F: lecteur de bande

S: lector de cinta

A device which reads a recording tape and produces signals corresponding to the data recorded on the tape.

721.34.22
34.29

10 (teleprinter) **control unit**

F: coffret de commande (d'un téléimprimeur)

S: unidad de control (de un teleimpresor)

Unit associated with a teleprinter and containing the necessary auxiliary equipment for operating this instrument on a switched network.

721.34.23

11 **direct printer**

F: récepteur traducteur imprimeur

S: impresor directo

Telegraph printer used in systems employing unequal length codes such as morse-code, two-condition cable code, in which printing is performed directly from the incoming signals.

721.34.24

12 (tape) **perforator**

F: perforateur (de bande); perforatrice

S: perforador (de cinta); perforadora

An apparatus which records telegraph signals on a paper tape by combination of holes punched in accordance with a predetermined code.

721.34.25
34.35

13 **keyboard perforator**

F: perforateur à clavier

S: perforador de teclado

A perforator in which the punching is controlled by an alphanumeric keyboard.

721.34.26
34.34

14 **printing perforator**

F: perforateur imprimeur

S: perforador impresor

A tape perforator which, when perforating, also prints on the tape the corresponding character or the symbol representing the function control.

721.34.27
34.36

15 **reperforator; receiving perforator**

F: récepteur-perforateur

S: reperforador; receptor-perforador

A receiver comprising essentially a tape perforator controlled by the received telegraph signals or data signals.

721.34.28
34.35

16 **printing-reperforator**

F: récepteur-perforateur imprimeur

S: reperforador impresor

A reperforator which, when perforating, also prints on the tape the corresponding character or the symbol representing the function control.

721.34.29
34.37

17 **telegraph transmitter**

F: émetteur (télégraphique); transmetteur (terme déconseillé)

S: transmisor telegráfico

A device for the transmitting telegraph signals over a telegraph channel.

72.34.33
34.23

18 **keyboard transmitter**

F: émetteur à clavier

S: transmisor de teclado

A telegraph transmitter controlled by an alphanumeric keyboard.

721.34.34

19 **automatic transmitter**

F: émetteur automatique; transmetteur automatique (terme déconseillé)

S: transmisor automático

Telegraph transmitter in which the forming of the signals is not controlled by any operator, but is actuated from a signal recording medium.

721.34.35
34.27

20 **automatic numbering transmitter**

F: émetteur à numérotation automatique (des messages)

S: transmisor de numeración automática

An automatic transmitter in which provision is made for automatically transmitting a serial number before each message.

721.34.36
34.30

21 **automatic retransmitter**

F: réémetteur (télégraphique); retransmetteur (terme déconseillé)

S: retransmisor automático

An apparatus which automatically retransmits telegraph signals in accordance with recorded incoming signals.

721.34.37
34.42

22 **perforated-tape retransmitter**

F: réémetteur à bande perforée; retransmetteur à bande perforée (terme déconseillé)

S: retransmisor de cinta perforada

An automatic retransmitter comprising a reperforator feeding a tape directly into an automatic transmitter.

721.34.38

23 **coupled reperforator and tape reader; fully automatic reperforator transmitter distributor** (USA) **(FXRD)**

F: réémetteur à bande perforée (à lecture complète); réémetteur FRXD

S: reperforador y lector de cinta acoplados

A perforated tape retransmitter which ensures the retransmission of all the signals recorded by perforation including the last one.

721.34.39
34.39

24 **automatic retransmitter with controlled tape-feed mechanism**

F: émetteur automatique à commande par impulsions

S: retransmisor automático controlado por impulsos

An automatic transmitter in which the movement of the perforated tape is controlled by pulses from an external synchronizing device, for example in the case of a time-division multiplex system.

721.34.40
34.28

25 **answerback unit**

F: émetteur automatique d'indicatif

S: transmisor automático de indicativo

That part of a telegraph terminal which transmits automatically its answerback code on receipt of the "Who are you" signal.

721.34.41
34.26

26 **answerback unit simulator**

F: simulateur d'émetteur d'indicatif

S: simulador de transmisor automático de indicativo

A device or program routing, not a part of a teleprinter, but which performs the same function as the answerback unit on receipt of a specific "Who are you" signal.

721.34.42

27 **tape printer**

F: lecteur imprimeur

S: lector impresor

Apparatus which reads the signals recorded, for instance, on perforated tape and prints the corresponding characters on a paper tape or page without the intervention of transmission.

For exemple, a Morse printer or a five-unit printer.

721.34.43

28 **half-duplex apparatus**

F: appareil (fonctionnant) à l'alternat

S: aparato semidúplex

Apparatus comprising a transmitter and receiving part, the arrangement of which allows for transmission in both directions but not simultaneously.

721.34.49

29 **code converter**

F: transcodeur; convertisseur de code

S: convertidor de código; transcodificador

Equipment which accomplishes a code conversion.

721.34.52
32.08

30 **telegraph modulator**

F: modulateur télégraphique

S: modulador telegráfico

A modulator controlled by a telegraph signal.

721.34.53

31 **telegraph demodulator**

F: démodulateur télégraphique

S: demodulador telegráfico

A demodulator controlled by a telegraph signal.

721.34.54

32 **telegraph discriminator**

F: discriminateur télégraphique

S: discriminador telegráfico

A discriminator for converting frequency shift telegraphy signals into direct current transmission signals.

721.34.55

33 **telegraph radioconverter**

F: convertisseur de signaux radiotélégraphiques; détecteur de signaux (radiotélégraphiques)

S: convertidor de señales radiotelegráficas

A device which accepts telegraph signals at audio frequency or intermediate frequency and converts them into signal elements capable of operating a telegraph recorder.

721.34.56

34 **margin** (of a receiver or terminal)

F: marge (d'un récepteur ou terminal)

S: margen (de un receptor o terminal)

The maximum value of a degree of individual distortion compatible with correct translation by a printer receiver or terminal, when the signals arrive at the input under specified conditions.

721.26.22
34.03

35 **net margin**

F: marge nette

S: margen neto

The margin when the modulation rate at the input of the apparatus has its nominal value.

721.26.23
34.031

36 **effective margin** (of a given apparatus)

F: marge effective (d'un appareil donné)

S: margen efectivo (de un aparato dado)

The margin measured on a specified receiver under actual operating conditions.

721.26.24
34.04

37 **nominal margin** (of a type of apparatus)

F: marge nominale (d'un type d'appareil)

S: margen nominal (de un tipo de aparato)

The minimum value specified for the effective margin of equipment of a given type when working under standard operating and adjustment conditions.

721.26.25
34.05

38 **theoretical margin**

F: marge théorique

S: margen teórico

The margin that could be evaluated from the manufacturing data of the equipment, assuming that it is working under perfect conditions.

721.26.26
34.06

39 **margin** (of a start-stop apparatus)

F: marge (d'un appareil arythmique)

S: margen (de un aparato arrítmico)

The maximum value of the degree of gross start-stop distortion compatible with the correct translation by a start-stop apparatus of all the character signals appearing either singly, or at the maximum rapidity corresponding to the standard modulation rate.

721.26.27
34.07

40 **synchronous (start-stop) margin**

F: marge au synchronisme (d'un appareil arythmique)

S: margen de sincronismo (de un aparato arrítmico)

The maximum value of the margin of a start-stop apparatus obtained by adjusting the modulation rate of the input signals to the most favourale value with respect to the time-base characteristics of the receiver.

721.26.28
34.09

41 **margin of a synchronous receiver**

F: marge d'un récepteur synchrone

S: margen de un receptor síncrono

The margin of a synchronous receiver determined by the degree of isochronous distortion.

721.26.29
34.091

Printed in Switzerland — ISBN 92-61-02271-5