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INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

V.35
(10/84)

SERIES V: DATA COMMUNICATION OVER THE TELEPHONE NETWORK

Wideband modems

Data transmission at 48 kilobits per second using 60-108 kHz group band circuits

ITU-T Recommendation V.35

Superseded by a more recent version

(Previously CCITT Recommendation)

Superseded by a more recent version

ITU-T V-SERIES RECOMMENDATIONS

DATA COMMUNICATION OVER THE TELEPHONE NETWORK

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FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation the term *recognized operating agency (ROA)* includes any individual, company, corporation or governmental organization that operates a public correspondence service. The terms *Administration*, *ROA* and *public correspondence* are defined in the *Constitution of the ITU (Geneva, 1992)*.

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation V.35

DATA TRANSMISSION AT 48 KILOBITS PER SECOND USING 60-108 kHz GROUP BAND CIRCUITS

(Mar del Plata, 1968; amended at Geneva, 1972 and 1976)

On leased circuits, considering that there exist and will come into being other modems with features designed to meet the requirements of the Administrations and users, this Recommendation in no way restricts the use of any other modems.

This is a particular system using a group reference pilot at 104.08 kHz.

Principal recommended characteristics to be used for simultaneous both-way operation are the following:

1 Input/output

Rectangular polar serial binary data.

2 Transmission rates

Preferred mode is synchronous at 48 000 ± 1 bit/s, with the following exceptions permissible:

a) Synchronous at 40 800 ± 1 bit/s when it is an operational necessity, or

b) Non-synchronous transmission of essentially random binary facsimile with element durations in the range 21 microseconds to 200 milliseconds.

NOTE – Operation at half data signalling rate shall be possible when the line characteristics do not permit the above data signalling rates.

3 Scrambler/descrambler

Synchronous data should be scrambled to avoid restrictions on the data input format. Such restrictions would be imposed by the need to have sufficient transitions for receiver clock stability, without short repetitive sequences of data signals which would result in high level discrete frequency components in the line signal. Synchronous data should be scrambled and descrambled by means of the logical arrangements described in Appendix I.

4 Modulation technique

The baseband signal (see § 5 below) should be translated to the 60-104 kHz band as an asymmetric sideband suppressed carrier AM signal with a carrier frequency of 100 kHz. A pilot carrier will be necessary to permit homochronous demodulation. To simplify the problem of recovery of the pilot carrier for demodulation the serial binary data signal should be modified as stated in § 5 below. The transmitted signal should correspond with the following:

a) The data carrier frequency should be 100 000 ± 2 Hz.

b) The nominal level of a frequency translated suppressed carrier 48 kbit/s encoded data baseband signal in the 60-104 kHz band should be equivalent to –5 dBm0.

c) A pilot carrier at –9 ± 0.5 dB relative to the nominal level of the signal in b) should be added such that the pilot carrier would be in phase, to within ± 0.04 radian, with a frequency translated continuous binary 1 input to the modulator.

d) The modulator should be linear, and the characteristics of the transmit bandpass filter should be such that the relative attenuation distortion and the relative envelope delay distortion in the range 64 to 101.5 kHz are less than 0.2 dB and 4 microseconds respectively.

5 Baseband signal

5.1 The scrambled synchronous or random non-synchronous serial binary data signal should be modified by the following transform:

$$\frac{pT_1}{1+pT_1} \text{ to remove the low-frequency components,}$$

where

p is the complex frequency operator, and

T_1 is 25/2π times the minimum binary element duration, i.e. 83 microseconds.

The value of T_1 shall have an accuracy of ± 2%.

In this form the signal is referred to as the baseband signal.

5.2 The baseband signal resulting from the transformation should not suffer impairment greater than that resulting from relative attenuation distortion or relative envelope delay distortion of 1.5 dB or 4 microseconds respectively, *and*

i) distortion due to modification of the baseband signal by the transform

$$\frac{pT_2}{1+pT_2}$$

where T_2 is 3.18 milliseconds; *or*

ii) distortion due to modification of the baseband signal by the transform

$$\left[\frac{pT_3}{1+pT_3}\right]^2$$

where T_3 is 6.36 milliseconds.

5.3 The frequency range for §§ 5.1 and 5.2 is 0 to 36 kHz.

6 Voice channel

A service speech channel provided as an integral part of this system should correspond to channel 1 of a 12-channel system, i.e. as a lower sideband SSB signal in the 104-108 kHz band.

a) The characteristics of this channel may be less stringent than those of a telephone circuit in accordance with Recommendation G.232 [1].

b) This voice channel is optional.

7 Group reference pilots

7.1 Provision should be made for facilitating the injection of a group reference pilot of 104.08 kHz from a source external to the modem.

7.2 The protection of the group reference pilot should conform to Recommendation H.52 [2].

8 Adjacent channel interference

8.1 When transmitting scrambled synchronous serial binary data at 48 kbit/s on the data channel, the out-of-band energy in a 3-kHz band centered at any frequency in the range 1.5 to 58.5 kHz or 105.5 to 178.5 kHz should not exceed –60 dBm0.

8.2 When a signal at 0 dBm0 at any frequency in the range 0 to 60 or 104 to 180 kHz is applied to the carrier input terminals, the resulting crosstalk measured in the demodulated data baseband should not exceed a level equivalent to –40 dBm0.

9 Line characteristics

The characteristics of a channel over which this equipment can be expected to operate satisfactorily should be as given in reference [3].

10 Interface

10.1 The interchange circuits should be as shown in Table 1/V.35.

Table 1/V.35

Number	Function
102	Signal ground or common return
103 ∅	Transmitted data
104 ∅	Received data
105	Request to send
106	Ready for sending
107	Data set ready
109	Data channel receive line signal detector
114 ∅	Transmitter signal element timing
115 ∅	Receiver signal element timing

10.2 The electrical characteristics of the interchange circuits marked ∅ should be as described in Appendix II; the circuits not marked should conform to Recommendation V.28.

Appendix I

Scrambling process

I.1 Definitions

I.1.1 applied data bit

The data bit which has been applied to the scrambler but has not affected the transmission at the time of consideration.

I.1.2 next transmitted bit

The bit which will be transmitted as a result of scrambling the applied data bit.

I.1.3 earlier transmitted bits

Those bits which have been transmitted earlier than the next transmitted bit. They are numbered sequentially in reverse time order, i.e. the first earlier transmitted bit is that immediately preceding the next transmitted bit.

I.1.4 adverse state

The presence of any one of certain repetitive patterns in the earlier transmitted bits.

I.2 Scrambling process

The binary value of the next transmitted bit shall be such as to produce odd parity when considered together with the twentieth and third earlier transmitted bits and the applied data bit unless an adverse state is apparent, in which case the binary value of the next transmitted bit shall be such as to produce even instead of odd parity.

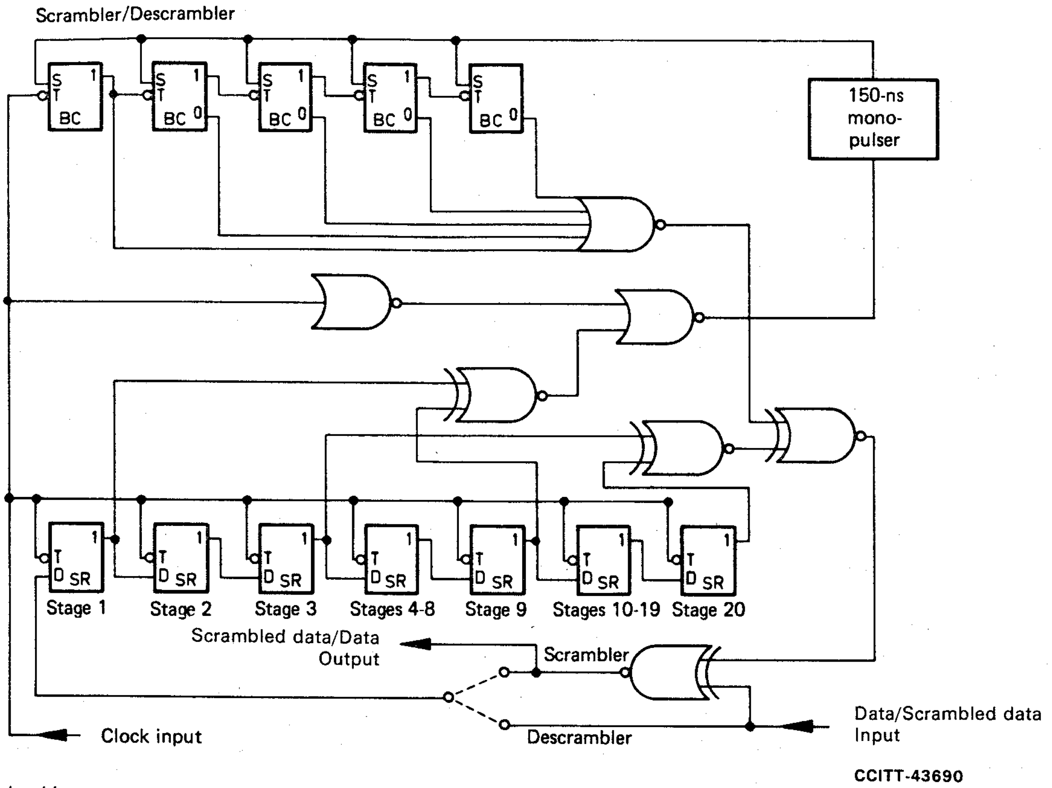
An adverse state shall be apparent only if the binary values of the p^{th} and $(p + 8)^{th}$ earlier transmitted bits have not differed from one another when p represents all the integers from 1 to q inclusive. The value of q shall be such that, for $p = (q + 1)$, the p^{th} and $(p + 8)^{th}$ earlier transmitted bits had opposite binary values and $q = (31 + 32\ r)$, r being 0 or any positive integer.

At the time of commencement, i.e. when no earlier bits have been transmitted, an arbitrary 20-bit pattern may be assumed to represent the earlier transmitted bits. At this time also it may be assumed that the p^{th} and $(p + 8)^{th}$ earlier transmitted bits have had the same binary value when p represents all the integers up to any arbitrary value. Similar assumptions may be made for the descrambling process at commencement.

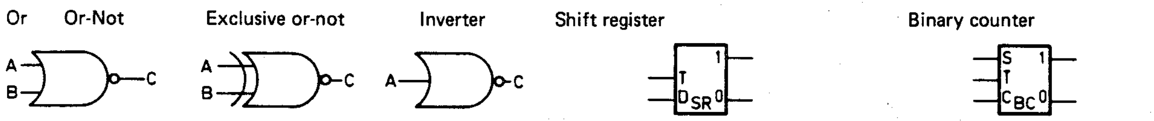
NOTE 1 – From this it can be seen that received data cannot necessarily be descrambled correctly until at least 20 bits have been correctly received and any pair of these bits, separated from each other by seven other bits, have differed in binary value from one another.

NOTE 2 – It is not possible to devise a satisfactory test pattern to check the operation of the Adverse State Detector (ASD) because of the large number of possible states in which the 20-stage shift register can be at the commencement of testing. For those modems in which it is possible to bypass the scrambler and the descrambler and to strap the scrambler to function as a descrambler, the following method may be used. A 1 : 1 test pattern is transmitted with the ASD of the scrambler bypassed. If the ASD of the descrambler is functioning correctly the descrambled test pattern will contain a single element error every 32 bits, i.e. 90 000 errors per minute for a modem operating at 48 kbit/s indicates that the descrambler is functioning correctly. The operation of the ASD of the scrambler may be checked in a similar manner with the scrambler strapped as a descrambler and the descrambler bypassed.

I.3 Figure I-1/V.35 is given as an indication only, since with another technique this logical arrangement might take another form.



Symbol truth tables



Or-Not:

A	B	C
0	0	1
0	1	0
1	1	0
1	0	0

Exclusive or-not:

A	B	C
0	0	1
0	1	0
1	1	1
1	0	0

Inverter:

A	C
1	0
0	1

Shift register:

T	D	1 output	0 output
1	Q	–	–
0	–	Q	$\bar{Q}$

Q is either 0 or 1

Binary counter:

T	1 output	0 output
1	Q	$\bar{Q}$
0	$\bar{Q}$	Q

S	1 output	0 output
0	Q	$\bar{Q}$
1	1	0

(Reset)

NOTE – Negative-going transitions of clocks (i.e. 1 to 0 transitions) coincide with data transitions. This is self-synchronizing.

Figure I-1/V.35 – An example of scrambler and descrambler circuitry

Appendix II

Electrical characteristics for balanced double-current interchange circuits

II.1 Scope

The electrical characteristics specified here apply to interchange circuits to Recommendation V.35.

II.2 Cable

The interface cable should be a balanced twisted multi-pair type with a characteristic impedance between 80 and 120 ohms at the fundamental frequency of the timing waveform at the associated terminator.

II.3 Generator

This circuit should comply with the following requirements:

a) source impedance in the range 50 to 150 ohms;

b) resistance between short-circuited terminals and circuit 102: 150 ± 15 ohms (the tolerance is subject to further study);

c) when terminated by a 100-ohm resistive load the terminal-to-terminal voltage should be 0.55 volt ± 20% so that the A terminal is positive to the B terminal when binary 0 is transmitted, and the conditions are reversed to transmit binary 1;

d) the rise time between the 10% and 90% points of any change of state when terminated as in c) should be less than 1% of the nominal duration of a signal element or 40 nanoseconds, whichever is the greater;

e) the arithmetic mean of the voltage of the A terminal with respect to circuit 102, and the B terminal with respect to circuit 102 (d.c. line offset), should not exceed 0.6 volt when terminated as in c).

II.4 Load

The load should comply with the following:

a) input impedance in the range 100 ± 10 ohms, substantially resistive in the frequency range of operation;

b) resistance to circuit 102 of 150 ± 15 ohms, measured from short-circuited terminals (the tolerance on this resistance is subject to further study).

II.5 Electrical safety

A generator or load should not be damaged by connection to earth potential, short-circuiting, or cross-connection to other interchange circuits.

II.6 Performance in the presence of noise

A generator, as in § II.3 above, connected via a cable as in § II.2 above to a load, as in § II.4 above, should operate without error in the presence of longitudinal noise or d.c. common return potential differences (circuit 102 offset) as follows:

a) with ± 2 volts (peak) noise present longitudinally, i.e. algebraically added to both load input terminals simultaneously with respect to the common return, *or*

b) with ± 4 volts circuit 102 offset;

c) if circuit 102 offset and longitudinal noise are present simultaneously, satisfactory operation should be achieved when:

$$\frac{\text{circuit 102 offset}}{2} + \text{longitudinal noise (peak)} = 2 \text{ volts or less.}$$

NOTE – It has been proposed to perform a test under inclusion of a cable length corresponding to the actual operation. This point is for further study.

References

[1] CCITT Recommendation *12-channel terminal equipments*, Vol. III, Rec. G.232.

[2] CCITT Recommendation *Transmission of wide-spectrum signals (data, facsimile, etc.) on wideband group links*, Vol. III, Rec. H.52.

[3] CCITT Recommendation *Characteristics of group links for the transmission of wide-spectrum signals*, Vol. III, Rec. H.14, § 2.