INTERNATIONAL TELECOMMUNICATION UNION

ITU-T V.26*bis*

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

DATA COMMUNICATION

OVER THE TELEPHONE NETWORK

2400/1200 BITS PER SECOND MODEM STANDARDIZED FOR USE IN THE GENERAL SWITCHED TELEPHONE NETWORK

ITU-T Recommendation V.26 bis

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation V.26*bis* was published in Fascicle VIII.1 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

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Recommendation V.26 *bis*

2400/1200 BITS PER SECOND MODEM STANDARDIZED FOR USE IN THE GENERAL SWITCHED TELEPHONE NETWORK

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

The CCITT,

considering

(a) that there is a demand for data transmission at 2400 bit/s over the general switched telephone network;

(b) that a majority of connections over the general switched telephone network within some countries are capable of carrying data at 2400 bit/s;

(c) that a much lower proportion of international connections in the general switched telephone service are capable of carrying data at 2400 bit/s;

unanimously declares the view

(1) that transmission at 2400 bit/s should be allowed on the general switched telephone network. Reliable transmission cannot be guaranteed on every connection or routing and tests should be made between the most probable terminal points before a service is provided.

The CCITT expects that developments during the next few years in modern technology will bring about modems of more advanced design enabling reliable transmission to be given on a much higher proportion of connections.

Note - The provisions of this Recommendation are to be regarded as provisional in order to provide service where it is urgently required and between locations where it is expected that a reasonably satisfactory service can be given. The study of improved methods of transmission at 2400 bits/s or above over the general switched telephone network will be urgently continued with the aim of recommending a method of transmission which will enable a more reliable service to be given over a high proportion of the connections encountered in normal service.

(2) that the characteristics of the modems for this service shall provisionally be the following:

1 Principal characteristics

a) Use of a data signalling rate of 2400 bit/s with carrier frequency, modulation and coding, according to Recommendation V.26, Alternative B (see Note below) on the communication channel. Administrations and users should note that the performance of this modem on international connections may not always be suitable for this service without prior testing and conditioning if required.

b) Reduced rate capability at 1200 bit/s.

c) Inclusion of a backward channel at modulation rates up to 75 bauds, use of this channel being optional.

Note - Attention is drawn to the fact that there are some old-type modems currently in operation for which the coding method in accordance with Recommendation V.26, Alternative A, is used.

2 Line signals at 2400 and 1200 bit/s

2.1 The carrier frequency is to be 1800 ± 1 Hz. No separate pilot frequencies are provided. The power levels used will conform to Recommendation V.2.

2.2 *Phase distortion limits*

The transmitted line signal spectrum should have linear phase characteristics (to be obtained by means of filters or equalizers or digital means). The deviation of the phase distortion characteristic should not exceed the limits specified in Figure 1/V.26 *bis.*

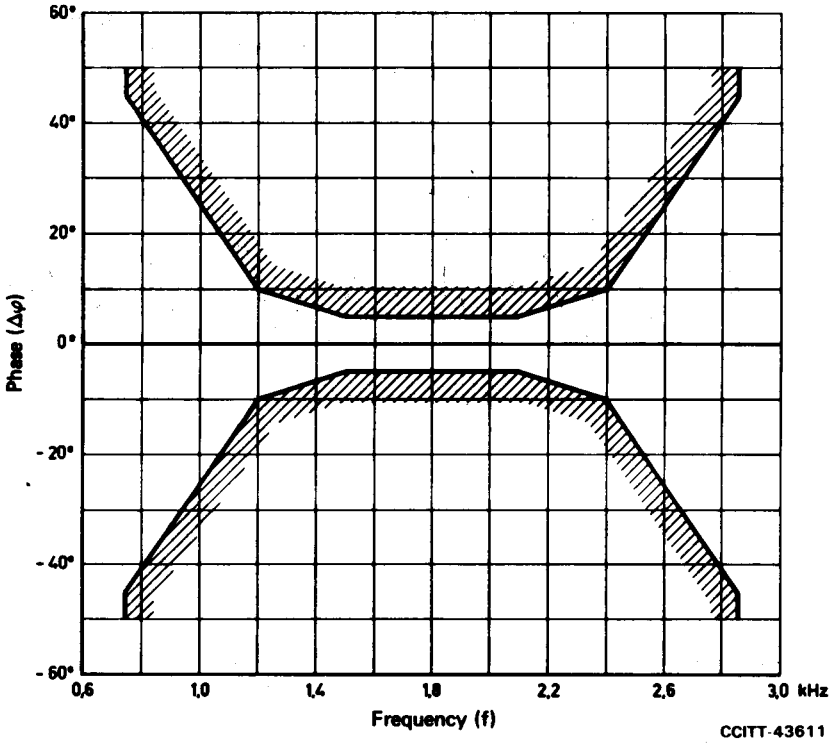

FIGURE 1/V.26 *bis*

Tolerance limit for phase distortion of the signal transmitted to the line

2.3 *Division of power between forward and backward channels*

Equal division of power between the forward and backward channels is recommended provisionally.

2.4 *Operation at 2400 bit/s*

2.4.1 The data stream to be transmitted is divided into pairs of consecutive bits (dibits). Each dibit is encoded as a phase change relative to the phase of the immediately preceding signal element (see Table 1/V.26 *bis).* At the receiver the dibits are decoded and the bits are reassembled in correct order. The left-hand digit of the dibit is the one occurring first in the data stream.

The meaning of phase change is illustrated by the line signal diagram given in Figure 2/V.26 *bis*.

TABLE 1/V.26 *bis*

Dibit	Phase change (see Note)
00	+ 45°
01	+ 135°
11	+ 225°
10	+ 315°

Note - The phase change is the actual on-line phase shift in the transition region from the centre of one signalling element to the centre of the following signalling element.

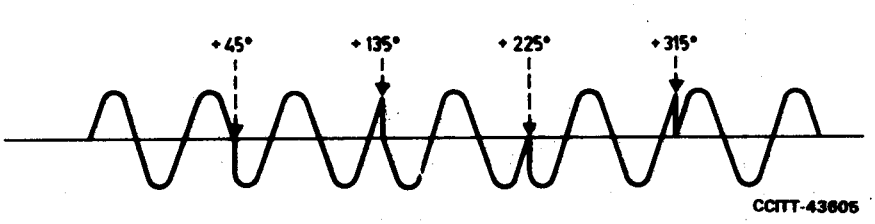

FIGURE 2/V.26 *bis*

2.4.2 *Synchronizing signal*

For the whole duration of the interval between the OFF to ON transitions of circuits 105 or 107 and 106, the line signal shall be that corresponding to the continuous transmission of dibit 11. This shall be known as the synchronizing signal (see § 5.2.2 below).

Note - Owing to several causes the stability of timing recovery at the receiver is liable to be data-pattern sensitive. The presence of dibit I I provides a stabilizing influence irrespective of the cause of lack of stability. Users are advised to include sufficient binary ls in the data which will ensure that the dibit 11 will occur frequently.

2.4.3 *Data signalling and modulation rates*

The data signalling rate shall be 2400 bit/s ± 0.01%, i.e. the modulation rate is 1200 bauds ± 0.01%.

2.5 *Operation at 1200 bit/s*

2.5.1 Coding and modulation used are 2-phase differential modulation with binary 0 for +90° and binary 1 for + 270°.

2.5.2 The data signalling rate shall be 1200 bit/s ± 0.01%, the modulation rate remains at 1200 bauds ± 0.01%.

3 Received signal frequency tolerance

Noting that the carrier frequency tolerance allowance at the transmitter is ± 1 Hz and assuming a maximum frequency drift of ± 6 Hz in the connection between the modems, then the receiver must be able to accept errors of at least ± 7 Hz in the received frequencies.

4 Backward channel

4.1 *Modulation rate and characteristic frequencies for* the *backward channel*

The modulation rate and characteristic frequencies for the backward channel are as follows:

	F_Z (symbol 1, mark)	F_A (symbol 0, space)
Modulation rate up to 75 bauds	390 Hz	450 Hz

In the absence of any signal on the backward channel interface, the condition Z signal is to be transmitted.

4.2 *Tolerances on the characteristic frequencies of the backward channel*

As the backward channel is a VF telegraph-type channel, the frequency tolerances should be as recommended in Recommendation R.35 [1] for frequency-shift voice-frequency telegraphy.

The ± 6 Hz frequency drift in the connection between the modems postulated in § 3 above would produce additional distortion in the backward channel. This should be taken into account in the design.

5 Interchange circuits

5.1 *List of essential interchange circuits*

The list of interchange circuits essential for the modems when used on the general switched telephone network, including terminals equipped for manual calling or answering or automatic calling or answering is given in Table
2/V.26 *bis.*

5.2 *Response times of circuits 106, 109, 121 and 122* (see Table 3/V.26 *bis*)

5.2.1 Circuit 109 response times are the times that elapse between the connection or removal of the test synchronizing signal to or from the modem receive line terminals and the appearance of the corresponding ON and OFF condition on circuit 109.

The level of the test synchronizing signal should fall within the level range between 3 dB above the actual OFF to ON threshold of the received line signal detector and the maximum admissible level of the received signal. At all levels within this range, the measured response times shall be within the specified limits.

5.2.2 Circuit 106 response times are from the connection to an ON or OFF condition on:

- circuit 105 to the appearance of the corresponding ON or OFF condition on circuit 106; or
- circuit 107 (where circuit 105 is not required to initiate the synchronizing signal) to the appearance of the corresponding ON or OFF condition on circuit 106.

TABLE 2/V.26 *bis*

Interchange circuit		Forwad (data) channel one-way system (see Note 1)				Forwad (data) channel either-way system (see Note 1)	
		Without backward channel		With backward channel		Without	With
No.	Designation	Transmit end	Receive end	Transmit end	Receive end	backward channel	backward channel
102	Signal ground or common return.	X	X	X	X	X	X
103	Transmitted data.	X		X		X	X
104	Received data.		X			X	X
105	.	X		X	X	X	X
106	Request to send.	X		X		X	X
	Ready for sending.						
107	Data set ready.	X	X	X	X	X	X
108/1 or	Connect data set to line.						
108/2	Data terminal ready.	X	X	X	X	X	X
(see Note 2)							
109	Data channel received line						
	signal detector.		X		X	X	X
111	Data signalling rate selector (DTE source).	X	X	X	X	X	X
113	Transmitter signal element timing (DTE source).	X		X		X	X
114	Transmitter signal element timing (DCE source).	X		X		X	X
115	Receiver signal element timing (DCE source).		X		X	X	X
118	Transmitted backward channel data.				X		X
119	Received backward channel data.			X			X
120	Transmitted backward channel line signal.				X		X
121	. Backward channel ready.			X			X
122	Backward channel received line signal detector.						X

125	Calling indicator.	X	X	X	X	X	X

Note 1 - All essential interchange circuits and any others which are provided shall comply with the functional and operational requirements of Recommendation V.24. All interchange circuits indicated by X shall be properly terminated in the data terminal equipment and in the data circuit-terminating equipment in accordance with the appropriate Recommendation for electrical characteristics (see § 7).

Note 2 - This circuit shall be capable of operation as circuit 108/1 or circuit 108/2 depending on its use.

TABLE 3/V.26 *bis*

Response times

Circuit 106		
OFF to ON	750 ms to 1400 ms (see Note 1)	a) 65 ms to 100 ms (see Note 2) b) 200 ms to 275 ms (see Note 2)
ON to OFF	≤ 2 ms	
Circuit 109		
OFF to ON	300 ms to 700 ms (see Note 1)	5 ms to 15 ms (see Note 1)
ON to OFF	5 ms to 15 ms	
Circuit 121		
OFF to ON	80 ms to 160 ms	
ON to OFF	≤ 2 ms	
Circuit 122		
OFF to ON	< 80 ms	
ON to OFF	15 ms to 80 ms	

Note 1 - For automatic calling and answering, the longer response times of circuits 106 and 109 are to be used during call establishment only.

Note 2 - The choice of response times depends upon the system application: a) limited protection given against line echoes; b) protection given against line echoes.

Note 3 - The above parameters and procedures, particularly in the case of automatic calling and answering are provisional and are the subject of further study. Especially the shorter response times for circuit 109 may need revision to prevent remnants of the synchronizing signal from appearing on circuit 104.

5.3 *Threshold of data channel and backward channel received line signal detectors*

Level of received line signal at receive line terminals of modem for all types of connections, i.e. general switched telephone network or non-switched leased telephone circuits:

- greater than -43 dBm: circuits 109/122 ON
- less than -48 dBm: circuits 109/122 OFF

The condition of circuits 109 and 122 for levels between -43 dBm and -48 dBm is not specified except that the signal detectors shall exhibit a hysteresis action such that the level at which the OFF to ON transition occurs is at least 2 dB greater than that for the ON to OFF transition.

Where transmission conditions are known and allowed, it may be desirable at the time of modem installation to change these response levels of the received line signal detector to less sensitive values (e.g. -33 dBm and -38 dBm respectively).

5.4 *Clamping in half-duplex mode*

The DCE, when operating in half-duplex mode on a 2-wire line, shall hold, where implemented:

a) circuit 104 in the binary 1 condition and circuit 109 in the OFF condition when circuit 105 is in the ON condition and, where required to protect circuit 104 from false signals, for a period of 150 ± 25 ms following the ON to OFF transition on circuit 105; the use of this additional delay is optional, based on system considerations;

b) circuit 119 in the binary 1 condition and circuit 122 in the OFF condition when circuit 120 is in the ON condition and, where required to protect circuit 119 from false signals, for a time interval following the ON to OFF transition on circuit 120. The specific duration of this time interval is left for further study. The additional delay is optional, based on system considerations.

5.5 *Fault condition of interchange circuits*

(See Recommendation V.28, § 7 for association of the receiver failure detection types.)

5.5.1 The DTE should interpret a fault condition on circuit 107 as an OFF condition using failure detection type 1.

5.5.2 The DCE should interpret a fault condition on circuits 105 and 108 as an OFF condition using failure detection type 1.

5.5.3 All other circuits not referred to above may use failure detection type 0 or 1.

6 Timing arrangements

Clocks should be included in the modem to provide the data terminal equipment with transmitter signal element timing, circuit 114 and receiver signal element timing, circuit 115. Alternatively, the transmitter signal element timing may be originated in the data terminal equipment instead of in the data circuit-terminating equipment and be transferred to the modem via circuit 113.

7 Electrical characteristics of interchange circuits

Use of electrical characteristics conforming to Recommendation V.28 is recommended together with the connector and pin assignment plan specified by ISO 21 1 0.

Note - Manufacturers may wish to note that the long-term objective is to replace electrical characteristics specified in Recommendation V.28, and that Study Group XVII has agreed that the work shall proceed to develop a more efficient, all balanced, interface, for the V-Series application which minimizes the number of interchange circuits.

8 The following information is provided to assist equipment manufacturers:

The data modem should have no adjustment for send level or receive sensitivity under the control of the operator.

9 When echo control device disabling is required, it is recommended that the procedures specified in Recommendation V.25 be followed.

10 Fixed compromise equalizer

A fixed compromise equalizer shall be incorporated into the receiver. The characteristics of this equalizer may be selected by Administrations but this should be the matter for further study.

Reference

[1] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 50 bauds*, Vol. VII, Rec. R.35.