INTERNATIONAL TELECOMMUNICATION UNION

ITU-T V.26

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

DATA COMMUNICATION
OVER THE TELEPHONE NETWORK

2400 BITS PER SECOND MODEM STANDARDIZED FOR USE ON 4-WIRE LEASED TELEPHONE-TYPE CIRCUITS

ITU-T Recommendation V.26

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation V.26 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.

Recommendation V.26

2400 BITS PER SECOND MODEM STANDARDIZED FOR USE ON 4-WIRE LEASED TELEPHONE-TYPE CIRCUITS

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

On leased circuits, considering that there exist and will come into being many 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.

1 The principal characteristics for this recommended modem for transmitting data at 2400 bits per second on 4-wire leased point-to-point and multipoint circuits conforming to Recommendation M.1020 [1] are as follows:

a) it is capable of operating in a full-duplex mode;

b) four-phase modulation with synchronous mode of operation;

c) inclusion of a backward (supervisory) channel at modulation rates up to 75 bauds in each direction of transmission, the use of these channels being optional.

2 Line signals

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 *Division of power between the forward and backward channels*

If simultaneous transmission of the forward and backward channels occurs in the same direction, a backward channel shall be 6 dB lower in power level than the data channel.

2.3 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. At the receiver the dibits are decoded and the bits are reassembled in correct order. Two alternative arrangements of coding are listed in Table 1/V.26. The left-hand digit of the dibit is the one occurring first in the data stream.

TABLE 1/V.26

Dibit	Phase change (see Note)	
	Alternative A	Alternative B
00	0°	+ 45°
01	+ 90°	+ 135°
11	+ 180°	+ 225°
10	+ 270°	+ 315°

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

The meaning of phase change for alternatives A and B is illustrated by the line signal diagram in Figure 1/V.26.

2.4 *Synchronizing signal*

For the whole duration of the interval between the OFF to ON transitions of circuits 105 and 106, the line signal shall be that corresponding to the continuous transmission of dibit 11. This shall be known as the synchronizing signal.

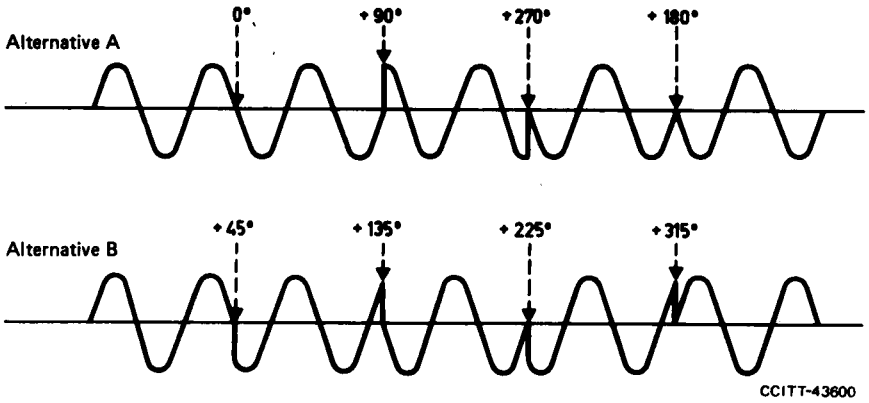

FIGURE 1/V.26

Note - Owing to several causes, the stability of timing recovery at the receiver is liable to be data-pattern sensitive. The presence of dibit 11 provides a stabilizing influence irrespective of the cause of lack of stability. Users are advised to include sufficient binary 1s in the data which will ensure that the dibit 11 will occur frequently. In certain cases, the use of a scrambling method may also facilitate timing recovery problems. However, prior agreement is required between users of a circuit.

3 Data signalling and modulation rates

The data signalling rate shall be 2400 bits per second ± 0.01%, i.e. the modulation rate is 1200 bauds ± 0.01%.

4 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.

5 Backward channel

The modulation rate, characteristic frequencies, tolerances, etc., to he as recommended for backward channel in Recommendation V.23.

6 Interchange circuits

6.1 *List of interchange circuits concerned* (see Table 2/V.26)

6.2 *Threshold and response times of circuit 109*

A fall in level of the incoming line signal to -31 dBm or lower for more than 10 ± 5 ms will cause circuit 109 to be turned OFF. An increase in level to -26 dBm or higher will, within 10 ± 5 ms, turn this circuit ON. The condition of circuit 109 for levels between -26 dBm and -31 dBm is not specified except that the signal level detector 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. These values shall be measured when the synchronizing signal as defined in § 2.4 above is being transmitted. It should be noted that the aforementioned times relate only to the defined function of circuit 109 and do not necessarily include the time for the modem to achieve bit synchronism.

Note - The signal levels specified above shall apply unless completion of Recommendation M.1020 [1] indicates otherwise.

TABLE 2/V.26

Interchange circuit		Forward (data) channel half-duplex or full-duplex (see Note)	
No.	Designation	Without backward channel	With backward channel
102	Signal ground or common return	X	X
103	Transmitted data	X	X
104	Received data	X	X
105	Request to send	X	X
106	Ready for sending	X	X
107	Data set ready	X	X
108/1	Connect data set to line	X	X
109	Data channel received line signal detector	X	X
113	Transmitter signal element timing (DTE source)	X	X
114	Transmitter signal element timing (DCE source)	X	X
115	Receiver signal element timing (DCE source)	X	X
118	Transmitted backward channel data	-	X
119	Received backward channel data	-	X
120	Transmit backward channel line signal	-	X
121	Backward channel ready	-	X
122	Backward channel received line signal detector	-	X

Note - 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 § 8).

6.3 *Response times of circuits 106, 121 and 122*

Circuit 106		
OFF to ON	65-100 ms (see Note 1) (Provisional)	25-45 ms (see Note 2) (Provisional)
ON to OFF	≤ 2 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 to 80 ms	

Note 1 - These times shall be used when infrequent operation of circuit 105 is required, e.g. as in many cases of point-to-point usage. Further study is required to verify the range quoted.

Note 2 - These times shall be used when frequent operation of circuit 105 is required, e.g. in many cases of multipoint usage. Further study is required with a view to reducing these times.

6.4 *Threshold of circuit 122*

- greater than -34 dBm: circuit 122 ON
- less than -39 dBm: circuit 122 OFF

The condition of circuit 122 for levels between -34 dBm and -39 dBm is not specified except that the signal detector 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.

6.5 *Fault condition of interchange circuits*

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

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

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

6.5.3 All other circuits not referred to above may use failure detection types 0 or 1.

7 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.

8 Electrical characteristics of interchange circuits

Use of electrical characteristics conforming to Recommendation V.28 is recommended together with the connector pin assignment plan specified by ISO 2110 [2].

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 Series V application which minimizes the number of interchange circuits.

9 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.

Reference

[1] CCITT Recommendation *Characteristics of special quality international leased circuits, with special bandwidth conditioning,* Vol. IV, Rec. M.1020.