



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

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STANDARDIZATION SECTOR
OF ITU

V.27 *ter*

DATA COMMUNICATION OVER THE TELEPHONE NETWORK

4800/2400 BITS PER SECOND MODEM STANDARDIZED FOR USE IN THE GENERAL SWITCHED TELEPHONE NETWORK

ITU-T Recommendation V.27 *ter*

(Extract from the *Blue Book*)

NOTES

- 1 ITU-T Recommendation V.27 *ter* 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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**4800/2400 BITS PER SECOND MODEM STANDARDIZED
FOR USE IN THE GENERAL SWITCHED TELEPHONE NETWORK**

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

The CCITT,

considering

(a) that there is a demand for data transmission at 4800 bits per second 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 4800 bits per second;

(c) that a lower proportion of international connections in the general switched telephone network are capable of carrying data at 4800 bits per second;

(d) that other international connections in the general switched telephone network may still support operations at 2400 bits per second using a built-in fallback capability;

unanimously declares the view

that transmission at 4800 bits per second 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. 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;

that the characteristics of the modem for transmission at 4800 bits per second over the general switched telephone network shall provisionally be the following:

1 Principal characteristics

- a) Use of data signalling rate of 4800 bits per second with 8-phase differentially encoded modulation as described in Recommendation V.27.
- b) Reduced rate capability at 2400 bits per second with 4-phase differentially encoded modulation as described in Recommendation V.26, Alternative A.
- c) Provision for a backward channel at modulation rates up to 75 bauds, use of this channel being optional.
- d) Inclusion of an automatic adaptive equalizer.

2 Line signals at 4800 and 2400 bits per second operation

2.1 Carrier frequency

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

2.1.1 Spectrum at 4800 bits per second

The 50% raised cosine energy spectrum shaping is equally divided between the receiver and transmitter. The energy density at 1000 Hz and 2600 Hz shall be attenuated $3.0 \text{ dB} \pm 2.0 \text{ dB}$ with respect to the maximum energy density between 1000 Hz and 2600 Hz.

2.1.2 Spectrum at 2400 bits per second

A minimum of 50% raised cosine energy spectrum shaping is equally divided between the receiver and transmitter. The energy density at 1200 Hz and 2400 Hz shall be attenuated 3.0 dB $\pm$ 2.0 dB with respect to the maximum energy density between 1200 Hz and 2400 Hz.

2.2 Division of power between the forward and backward channel

Equal division between the forward and backward channels is recommended (if provided).

2.3 Operation at 4800 bits per second

2.3.1 Data signalling and modulation rate

The data signalling rate shall be 4800 bits per second $\pm$ 0.01%, i.e. the modulation rate is 1600 bauds $\pm$ 0.01%.

2.3.2 Encoding data bits

The data stream to be transmitted is divided into groups of three consecutive bits (tribits). Each tribit is encoded as a phase change relative to the phase of the preceding signal element (see Table 1/V.27 *ter*). At the receiver, the tribits are decoded and the bits are reassembled in correct order. The left-hand digit of the tribit is the one occurring first in the data stream as it enters the modulator portion of the modem after the scrambler.

TABLE 1/V.27 *ter*

Tribit values			Phase change (see Note)
0	0	1	0°
0	0	0	45°
0	1	0	90°
0	1	1	135°
1	1	1	180°
1	1	0	225°
1	0	0	270°
1	0	1	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.

2.4 Operation at 2400 bits per second

2.4.1 Data signalling and modulation rate

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

2.4.2 Encoding data bits

At 2400 bits per second the data stream is divided into groups of two bits (dibits). Each dibit is encoded as a phase change relative to the phase of the immediately preceding signal element (see Table 2/V.27 *ter*). At the receiver, the dibits are decoded and the bits are reassembled in the correct order. The left-hand digit of the dibit is the one occurring first in the data stream as it enters the modulator portion of the modem after the scrambler.

TABLE 2/V.27 *ter*

Dibit values	Phase change (see Note)
00	0°
01	90°
11	180°
10	270°

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.

2.5 Operating sequences

2.5.1 Turn-ON sequence

During the interval between the OFF to ON transition of circuit 105 and the OFF to ON transition of circuit 106, synchronizing signals for proper conditioning of the receiving modem must be generated by the transmitting modem. These are signals to establish carrier detect, AGC if required, timing synchronization, equalizer convergence and descrambler synchronization.

The synchronizing signals are defined in two separate sequences with the long sequence used once at the beginning of the established connection and the short sequence used for subsequent turn-around in which the equalizer training pattern is used to update and refine equalizer convergence.

Two sequences are defined, i.e.:

- a) a short one for turn-around operation,
- b) a longer one for initial establishment of connection.

The sequence b) is only used after the first OFF to ON transition of circuit 105 following the OFF to ON transition of circuit 107, or at the OFF to ON transition of circuit 107 if the circuit 105 is already ON. After every subsequent OFF to ON transition of circuit 105, the sequence a) is used.

The sequences, for both data rates, are divided into five segments as in Table 3/V.27 *ter*.

2.5.1.1 The composition of Segment 3 is continuous 180° phase reversals on line for 14 symbol intervals in the case of sequence a), for 50 symbol intervals in the case of sequence b).

2.5.1.2 Segment 4 is composed of an equalizer conditioning pattern which is derived from a pseudo-random sequence generated by the polynomial:

$$1 + x^{-6} + x^{-7}$$

For operation at both 4800 bit/s and 2400 bit/s, the equalizer conditioning pattern is derived by using every third bit of the pseudo-random sequence defined by the polynomial. When the derived pattern contains a ZERO, 0° phase change is transmitted; when it contains a ONE, 180° phase change is transmitted. Segment 4 begins with 0°, 180°, 180°, 180°, 180°, 180°, 0°, . . . according to the derived pattern and continues for 58 symbol intervals in the case of sequence a) and for 1074 symbol intervals in the case of sequence b). An example of the detailed sequence generation is described in Appendix I.

2.5.1.3 Segment 5 commences transmission according to the encoding described in §§ 2.3 and 2.4 above with continuous data ONEs applied to the input of the data scrambler. Segment 5 is 8 symbol intervals. At the end of Segment 5, circuit 106 is turned ON and user data are applied to the input of the data scrambler.

2.5.1.4 The phase change sequences for Segments 4 and 5 for 4800 bit/s and 2400 bit/s are shown in Table 4/V.27 *ter*.