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STANDARDIZATION SECTOR
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V.29

DATA COMMUNICATION OVER THE TELEPHONE NETWORK

9600 BITS PER SECOND MODEM STANDARDIZED FOR USE ON POINT-TO-POINT 4-WIRE LEASED TELEPHONE-TYPE CIRCUITS

ITU-T Recommendation V.29

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation V.29 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.29

9600 BITS PER SECOND MODEM STANDARDIZED FOR USE ON POINT-TO-POINT 4-WIRE LEASED TELEPHONE-TYPE CIRCUITS

(Geneva, 1976; amended at Geneva, 1980, Malaga-Torremolinos, 1984, and at Melbourne, 1988)

1 Introduction

This modem is intended to be used primarily on special quality leased circuits, e.g. Recommendation M.1020 [1] or M.1025 [2] circuits but this does not preclude the use of this modem over circuits of lower quality at the discretion of the Administration concerned (see Notes 1 and 2).

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.

The principal characteristics of this recommended modem for transmitting data at 9600 bits per second on leased circuits are as follows:

- a) fallback rates of 7200 and 4800 bits per second;
- b) capable of operating in a duplex or half-duplex mode with continuous or controlled carrier;
- c) combined amplitude and phase modulation with synchronous mode of operation;
- d) inclusion of an automatic adaptive equalizer;
- e) optional inclusion of a multiplexer for combining data rates of 7200, 4800 and 2400 bits per second (see Note 3).

Note 1 - The principal use of this recommended modem is on 4-wire leased circuits. Other applications, such as stand-by operation on the switched network, should be points for further study.

The types of special quality circuits, e.g. M.1020 [1] or M.1025 [2] should be studied.

Note 2 - The values of some circuit characteristics, for example, noise and nonlinear distortion, are subject to further study.

Note 3 - When the multiplexer option is installed, provisions in § 12 may supersede provisions given in other sections.

Note 4 - Attention should be given to the selection of appropriate equalization techniques in the modem implementation, if acceptable performance on circuits conforming to Recommendation M.1025 is desired.

2 Line signals

2.1 The carrier frequency is to be 1700 ± 1 Hz. No separate pilot frequencies are provided. The power levels used will conform to Recommendation V.2.

2.2 Signal space coding

2.2.1 At 9600 bits per second, the scrambled data stream to be transmitted is divided into groups of four consecutive data bits (quadbits). The first bit (Q1) in time of each quadbit is used to determine the signal element amplitude to be transmitted. The second (Q2), third (Q3) and fourth (Q4) bits are encoded as a phase change relative to the phase of the immediately preceding element (see Table 1/V.29). The phase encoding is identical to Recommendation V.27.

The relative amplitude of the transmitted signal element is determined by the first bit (Q1) of the quadbit and the absolute phase of the signal element (see Table 2/V.29). The absolute phase is initially established by the synchronizing signal as explained in § 8 below.

Figure 1/V.29 shows the absolute phase diagram of transmitted signal elements at 9600 bits per second.

At the receiver the quadbits are decoded and the data bits are reassembled in correct order.

2.2.2 At the fallback rate of 7200 bits per second, the scrambled data stream to be transmitted is divided into groups of three consecutive data bits. The first data bit in time determines Q2 of the modulator quadbit. The second and third data bits determine Q3 and Q4 respectively of the modulator quadbit. Q1 of the modulator quadbit is a data ZERO for each signal element. Signal elements are determined in accordance with § 2.2.1 above. Figure 2/V.29 shows the absolute phase diagram of the transmitted signal elements at 7200 bits per second.

2.2.3 At the fallback rate of 4800 bits per second (see Table 3/V.29), the scrambled data stream to be transmitted is divided into groups of two consecutive data bits. The first data bit in time determines Q2 of the modulator quadbit and the second data bit determines Q3 of the modulator quadbit. Q1 of the modulator quadbit is a data ZERO for each signal element. Q4 is determined by inverting the modulo 2 sum of Q2 + Q3. The signal element is then determined in accordance with § 2.2.1 above. Figure 3/V.29 shows the absolute phase diagram of transmitted signal elements at 4800 bits per second.

The phase changes are identical with Recommendation V.26 (alternative A) and the amplitude is constant with a relative value of 3.

TABLE 1/V.29

Q2	Q3	Q4	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.

TABLE 2/V.29

Absolute phase	Q1	Relative signal element amplitude
0°, 90°, 180°, 270°	0	3
	1	5
45°, 135°, 225°, 315°	0	$\sqrt{2}$
	1	$3\sqrt{2}$

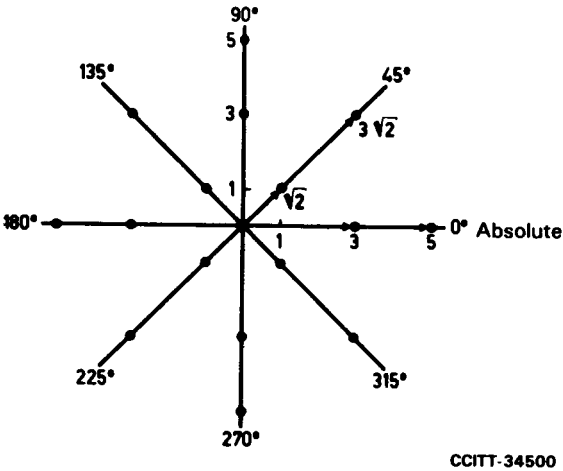


FIGURE 1/V.29

Signal space diagram at 9600 bit/s

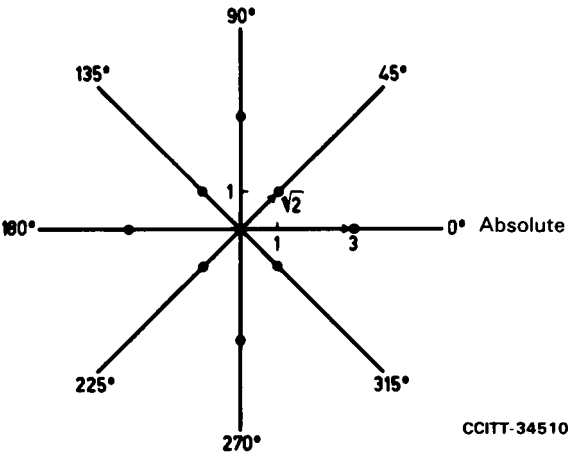


FIGURE 2/V.29

Signal space diagram at 7200 bit/s