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DATA COMMUNICATION OVER THE TELEPHONE NETWORK

14 400 BITS PER SECOND MODEM STANDARDIZED FOR USE ON POINT-TO-POINT 4-WIRE LEASED TELEPHONE-TYPE CIRCUITS

ITU-T Recommendation V.33

(Extract from the *Blue Book*)

NOTES

- 1 ITU-T Recommendation V.33 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.33

14 400 BITS PER SECOND MODEM STANDARDIZED FOR USE ON POINT-TO-POINT 4-WIRE LEASED TELEPHONE-TYPE CIRCUITS

(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 modem are as follows:

- a) fallback rate of 12 000 bits per second;
- b) capable of operating in a duplex mode with continuous carrier;
- c) combined amplitude and phase modulation with synchronous mode of operation;
- d) inclusion of an eight state trellis coded modulation;
- e) optional inclusion of a multiplexer for combining data rates of 12 000, 9600, 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 telephone network, half duplex or multipoint operation are for further study. Circuits should be of the special quality type, e.g. M.1020 [1] or M.1025 [2]. However, administrations and users may wish to note that modems conforming to this Recommendation, even assuming proper implementations, will not necessarily operate satisfactorily on all circuits conforming to M.1020 and M.1025; particularly where noise is at or near the specified limiting magnitude.

Note 2 - 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.

Note 3 - When the multiplexer option is installed, provisions in section 10 may supersede provisions given in other sections.

2 Line signals

2.1 The carrier frequency is to be 1800 ± 1 Hz. The power levels used will conform to Recommendation V.2.

2.2 Signal space coding

2.2.1 At 14 400 bits per second, the scrambled data stream to be transmitted is divided into groups of six consecutive data bits. As shown in Figure 1/V.33, the first two bits in time $Q1_n$ and $Q2_n$ in each group, are first differentially encoded into $Y1$ and $Y2$ according to Table 1A/V.33. The two differentially encoded bits $Y1_n$ and $Y2_n$ are used as input to a systematic convolutional encoder which generates a redundant bit $Y0_n$. This redundant bit and the six information-carrying bits $Y1_n$, $Y2_n$, $Q3_n$, $Q4_n$, $Q5_n$, and $Q6_n$ are then mapped into the coordinates of the signal element to be transmitted according to the signal space diagram shown in Figure 2/V.33.

2.2.2 At the fallback rate of 12 000 bit/s, the scrambled data stream to be transmitted is divided into groups of five consecutive data bits. The trellis coding scheme shown in Figure 1/V.33, is used with the modification that first, the line designated by $Q6_n$ is removed and second, the signal element mapping is now as shown in Figure 3/V.33.

2.2.3 Table 1 B/V.33 describes the differential encoding used for the 4800 bit/s rate signal in segment 3 of synchronizing signals (§ 8.3).

TABLE 1A/V.33

Differential encoding for use with trellis coding

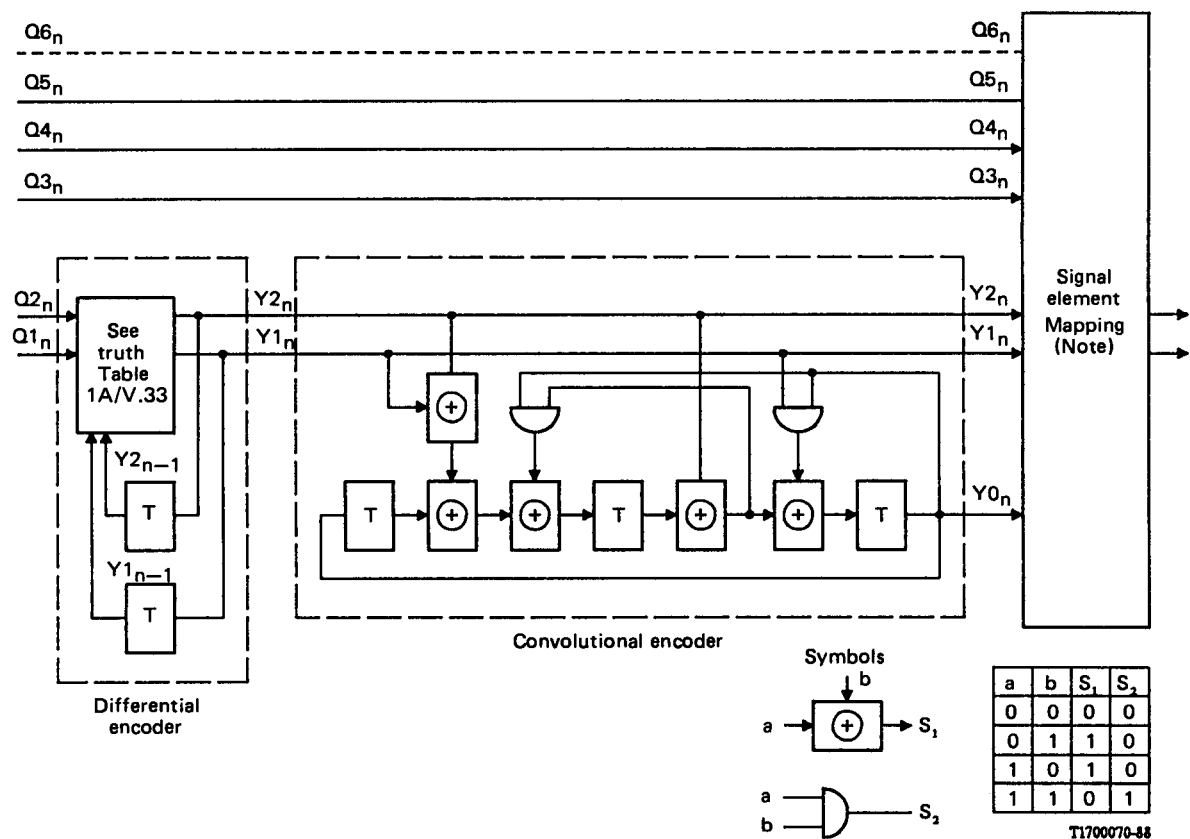
Inputs		Previous outputs		Outputs	
$Q1_n$	$Q2_n$	$Y1_{n-1}$	$Y2_{n-2}$	$Y1_n$	$Y2_n$
0	0	0	0	0	0
0	0	0	1	0	1
0	0	1	0	1	0
0	0	1	1	1	1
0	1	0	0	0	1
0	1	0	1	0	0
0	1	1	0	1	1
0	1	1	1	1	0
1	0	0	0	1	0
1	0	0	1	1	1
1	0	1	0	0	1
1	0	1	1	0	0
1	1	0	0	1	1
1	1	0	1	1	0
1	1	1	0	0	0
1	1	1	1	0	1

TABLE 1B/V.33

Differential quadrant coding for 4800 bit/s rate signal

Inputs		Previous outputs		Phase quadrant	Outputs		Signal element for 4800 bit/s	Coordinates	
$Q1_n$	$Q2_n$	$Y1_{n-1}$	$Y2_{n-1}$		$Y1_n$	$Y2_n$		Re	Im
0	0	0	0	+90°	0	1	D	-2	+6
0	0	0	1		1	1	A	-6	-2
0	0	1	0		0	0	C	+6	+2
0	0	1	1		1	0	B	+2	-6
0	1	0	0	0°	0	0	C	+6	+2
0	1	0	1		0	1	D	-2	+6
0	1	1	0		1	0	B	+2	-6
0	1	1	1		1	1	A	-6	-2
1	0	0	0	+180°	1	1	A	-6	-2
1	0	0	1		1	0	B	+2	-6
1	0	1	0		0	1	D	-2	+6
1	0	1	1		0	0	C	+6	+2
1	1	0	0	+270°	1	0	B	+2	-6
1	1	0	1		0	0	C	+6	+2
1	1	1	0		1	1	A	-6	-2
1	1	1	1		0	1	D	-2	+6

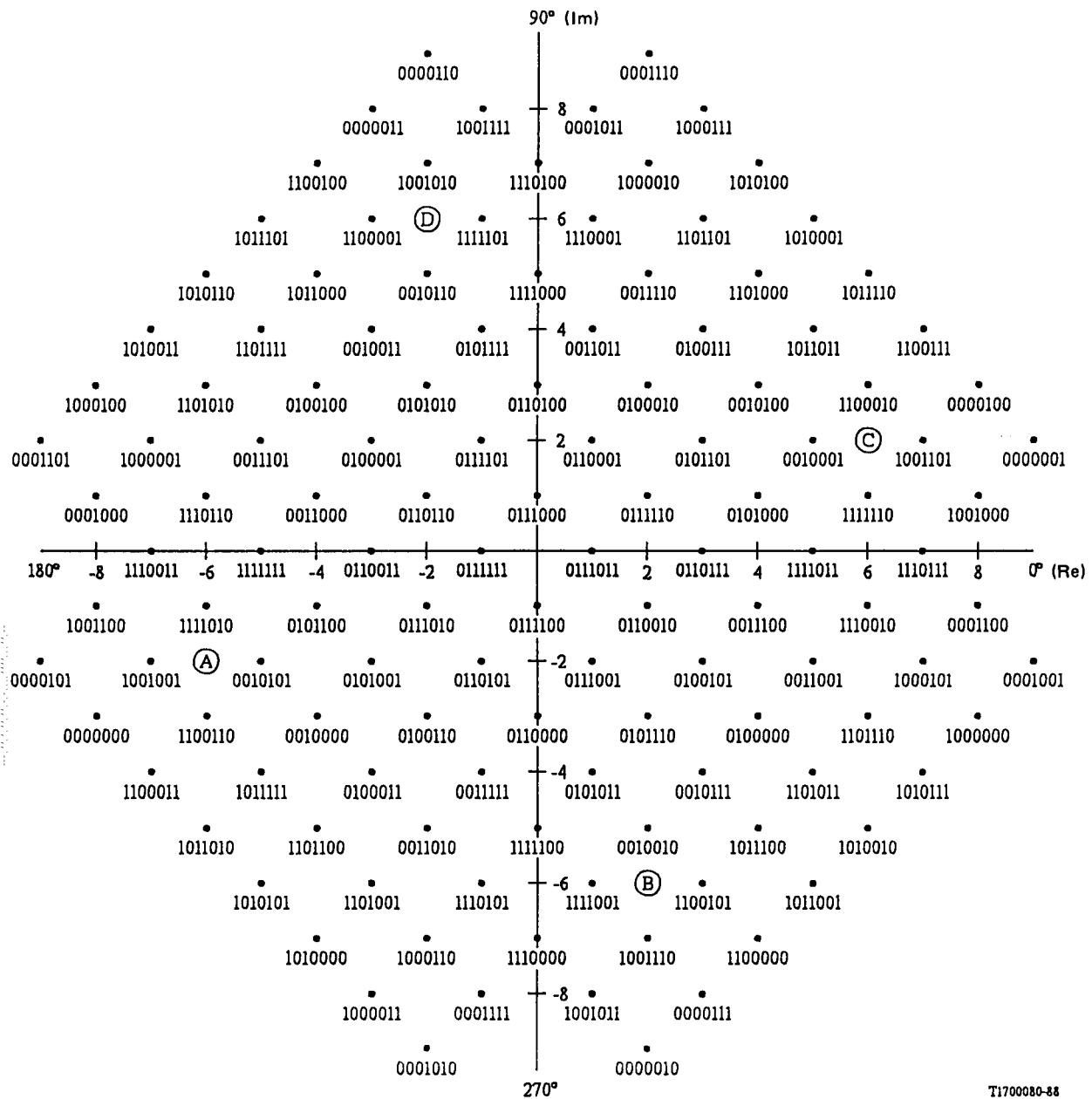
Note - Q1 is the first bit in time.



Note - See Figure 2/V.33 for 14 400 bit/s rate, Figure 3/V.33 for 12 000 bit/s.

FIGURE 1/V.33

Trellis coder at 14 400 bit/s and 12 000 bit/s



T1700080-88

Binary numbers refer to $Q_{6n}, Q_{5n}, Q_{4n}, Q_{3n}, Y_{2n}, Y_{1n}, Y_{0n}$,

A, B, C, D refer to synchronizing signal elements

FIGURE 2/V.33

Signal space diagram and mapping for trellis-coded modulation at 14 400 bit/s