INTERNATIONAL TELECOMMUNICATION UNION

ITU-T Q.277

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SPECIFICATIONS OF SIGNALLING SYSTEM No. 6

SIGNALLING LINK

ERROR CONTROL

ITU-T Recommendation Q.277

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation Q.277 was published in Fascicle VI.3 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.

6.7 ERROR CONTROL

6.7.1 *Error detection by the use of check bits*

The disturbance of a signal unit during transmission will be detected by the use of coders and decoders, connected at the transmitting and receiving terminals respectively. The coder will generate 8 check bits based on the polynomial $\mathbf{X^8 + X^2 + X + 1}$ (see Table 5/Q.277 for the matrix and for a typical implementation).

These check bits will constitute bits 21-28 of each signal unit and are inverted before transmission to provide protection against a single bit-slip of synchronization.

When the decoder at the receiving terminal has received all 28 bits of a signal unit after the check bits have been reinverted, it will indicate whether or not the signal unit has been checked correctly. This information will be stored for inclusion in the acknowledgement field of an ACU to be emitted in the return direction. An ACU will be transmitted after each 11 signal units to form a block (see Recommendation Q.251, § 1.1.2).

TABLE 5/Q.277

8 bit check order

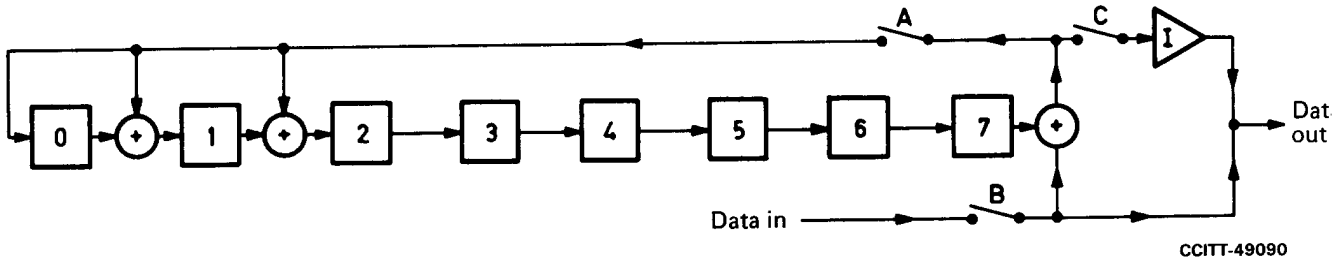
8 bit check code matrix

	1	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}	b_{17}	b_{18}	b_{19}	b_{20}
c_7	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
c_6	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**
c_5	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**
c_4	**1**	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**
c_3	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**
c_2	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**
c_1	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
c_0	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**

The *ones* in a row of the matrix under b_1 ... b_{20} indicate those bits that should be *added modulo 2* to determine the check bit indicated at that row.

The *inversion* of the check bits is shown in this matrix by column 1.

Typical shift register coder implementation



When information bits are being transmitted: Switches A and B closed, C open.
When check bits are being transmitted: Switches A and B open, C closed.
Shift registers in coders should be zero set at start.

8 bit check code

Polynomial: $p(x) = (x + 1)(x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + 1) = x^8 + x^2 + x + 1$.
Code name: Primitive polynomial plus parity check.
Information bits: b_1 ... b_{20}, check bits: c_7 ... c_0.
Sequence on the line: b_1 (first) b_2 ... b_{19} b_{20} c_7 c_6 ... c_1 c_0 (last).

6.7.2 *Error detection by data channel failure detection*

The data carrier failure detector or loss of frame alignment detector will supplement the error detection by use of check bits. Indication of data channel failure at any time during the process of reception will cause the rejection of signal units in the process of reception. Regardless of the result of decoding, the ACU should acknowledge the signal unit as received incorrectly.

6.7.3 *Error correction*

Correction is achieved by retransmission of the messages which are not acknowledged to have been received correctly. The *block structure* and the contents of the ACU have been described in Recommendations Q.251, § 1.1.2, and Q.259, § 3.3.1. The acknowledgement indicators should be transmitted in the same sequence as the signal unit to which they refer.

A retransmission to comply with the information in the ACU will be made possible by storing at the transmitting terminal the signal units with their block reference numbers at the time of emission. This record must be maintained until the receipt of the associated ACU, when the record of messages which are acknowledged to have been correctly received should be eliminated. In the case of multi-unit messages, the complete message should be retransmitted if any of its constituent signal units fail to check correctly. A multi-unit message may contain signal units which are transmitted in two adjacent blocks, but it must be ensured that the records of the constituent signal units of the multi-unit message remain until the acknowledgement indicators show that the complete multi-unit message has been received correctly.

In the unlikely event that a terminal is unable to accept a correctly-received signal unit, e.g. due to input buffer congestion, the appropriate acknowledgement indicator bit in the outgoing ACU is marked as if the signal unit were received in error.

The maximum permitted delay between the emission of a signal unit and the subsequent reception of the ACU containing the acknowledgement of this signal unit is as follows:

a) *Where the multi-block monitoring procedure is not used,* the maximum permitted delay between the emission of a signal unit and the subsequent handling of the received ACU containing the acknowledgement of that signal unit must not exceed the time taken to send 8 blocks (96 signal units). Of this time (96 signal units), the time for 64 signal units (maximum) is available for the loop propagation time of the data link (see Note 1). At a data rate of 2400 bit/s this caters for a loop propagation time of up to 740 ms (see Note 2).

b) *Where the multi-block monitoring procedure is used,* the maximum permitted delay between the emission of a signal unit and the subsequent handling of the received ACU containing the acknowledgement of that signal unit must not exceed the time taken to send 256 blocks (see Note 3). Of this time (up to 3072 signal units), all but about 32 signal units are available for the loop propagation time of the data link. At a data rate of 56 kbit/s, this caters for a loop propagation time of up to 1520 ms.

Note 1 - The number, 64 signal units, is based on the consideration that out of the total number of 96 signal units, 32 signal units are allocated as follows:

At the exchange emitting signal units:

emission of SU reception of ACU processing	not more than the time for sending 3 signal units

At the exchange receiving signal units:

reception of SU generation of ACU time in ACU queue emission of ACU time for drift compensation processing	not more than the time for sending 29 signal units

Note 2 - The time for sending 64 signal units is also equivalent to

448 ms at 4 kbit/s

32 ms at 56 kbit/s.

Note 3 - The full 256 blocks need not be bandied in all designs, e.g. block memory may be limited to that required for the expected range of loop propagation delays and data rates at which the terminal will be applied. If the error control loop cannot exceed 8 blocks, multi-block monitoring equipment need not be provided.

The messages, which are not acknowledged to have been correctly received should be presented for retransmission, at which time the record of their previous transmission should be eliminated. The exception to the general rule is that the following signalling system control units should never be retransmitted: acknowledgement, synchronization, multi-block monitoring, multi-block acknowledgement, and changeover.

All signal units in a block except the SYU, ACU, multi-block monitoring, multi-block acknowledgement, and changeover system control signal units must be retransmitted if the ACU, referring to that block, is not received correctly. This may arise owing to the fact that the ACU fails to check correctly on account of errors during transmission or owing to drift between the data streams in the two directions (see Recommendation Q.279).

The first three bits of the ACU (i.e. the beading code) may be used for identification purposes (see Recommendation Q. 259, § 3.3.2.2). If the ACU checks to be error-free and the beading is correct the probability of an undetected error is extremely small.