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**USE ON RADIO CIRCUITS  
OF 7-UNIT SYNCHRONOUS SYSTEMS  
GIVING ERROR CORRECTION  
BY AUTOMATIC REPETITION**

**ITU-T Recommendation S.13**

(Extract from the *Blue Book*)

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## NOTES

1 ITU-T Recommendation S.13 was published in Fascicle VII.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 S.13

### USE ON RADIO CIRCUITS OF 7-UNIT SYNCHRONOUS SYSTEMS GIVING ERROR CORRECTION BY AUTOMATIC REPETITION

*(former CCIT Recommendation C.24, Geneva, 1956; amended at New Delhi, 1960,  
Geneva, 1964, Mar del Plata, 1968, and Geneva, 1972)*

*(This Recommendation corresponds to CCIR Recommendation 342-2, New Delhi, 1970)*

The CCITT,

*considering*

(a) that it is essential to be able to interconnect terminal start-stop apparatus employing International Telegraph Alphabet No. 2 by means of radiotelegraph circuits;

(h) that radiotelegraph circuits are required to operate under varying conditions of radio propagation, atmospheric noise and interference, which introduce varying degrees of distortion that may at times exceed the margin of the receiving apparatus;

(c) that, in consequence, the transmission of 5-unit code signals over radio circuits is liable to errors and that such errors are not automatically detectable by the receiving apparatus;

(d) that an effective means of reducing the number of wrongly printed characters is the use of codes permitting the correction of errors by detecting the errors and automatically causing repetition;

(e) that the method using synchronous transmission and automatic repetition (ARQ) is now well proven;

(f) that it is desirable to permit the correct phase to be established automatically on setting up a circuit;

(g) that certain circumstances can occur that result in a loss of the correct phase relationship between a received signal and the receiving apparatus;

(h) that it is desirable to permit the correct phase relationship to be re-established automatically after such a loss, without causing errors;

(i) that to avoid misrouting of traffic, it is essential to prevent phasing to a signal that has been unintentionally inverted;

(j) that in certain cases there is a need to subdivide one or more channels in order to provide a number of services at a proportionately reduced character rate;

(k) that the method of automatically achieving the correct phase relationship between the received signal and the sub-channelling apparatus should be an integral part of the phasing process;

(l) that compatibility with existing equipment designed in accordance with the former Recommendation S.13 (New Delhi, 1960) is a requirement,

*unanimously declares the view*

(1) that, when the direct use of a 5-unit code on a radio circuit gives an intolerable error rate and there is a return circuit, a 7-unit ARQ system using International Telegraph Alphabet No. 3 should be used;

(2) when automatic phasing of such a system is required, the system described in the Annex should be adopted as a preferred system;

(3) that equipment, designed in accordance with (2) above, should be provided with switching, to permit operation with equipment designed in accordance with Recommendation S.13, New Delhi, 1960;

(4) that the start-stop sections of the receiving and transmitting portions of the radiotelegraph circuit, points X and Y in Figure 1/S.12, should satisfy the conditions of Recommendations S.3 and S.12. In conformity with Recommendation S.12, the aggregate modulation rate for a 2-channel time-division multiplex system will be 96 bauds and for a 4-channel system will be 192 bauds;

(5) that if such systems are used in establishing telex connections, the signalling position should conform to the arrangements shown in Recommendations U. 11 [1], U.20 [2], U.21 [3], U.22 [4].

(5.1) For circuits on switched telegraph networks, the conditions of Recommendation U.20 [2] should apply. In this usage the polarity retransmitted by the terminal of the radio channel towards the start-stop section of the circuit during a repetition cycle shall be start polarity when the circuit is in the “free line” condition and stop polarity when the circuit is in the “busy circuit” condition.

(5.2) For point-to-point circuits, Administrations may adopt, at the terminal equipment under their jurisdiction, their own method of stopping and starting the motors of the receiving machines, based on Recommendation S.7. Signal  $\beta$  should normally be transmitted to indicate the idle circuit condition. However, for signalling purposes, the signals  $\alpha$  and  $\beta$  may be employed.

## ANNEX A

(to Recommendation S.13)

### A.1 *Conversion table*

A.1.1 Table A-1/S.13 shows the correspondence between International Telegraph Alphabet No. 3 used in 7-unit ARQ systems and International Telegraph Alphabet No. 2 (defined in the Recommendation cited in [5]).

### A.2 *Repetition cycles*

A.2.1 Four characters for normal circuits that are not subject to excessive propagation time. The cycle should comprise one signal repetition and three stored characters.

A.2.2 Eight characters on circuits for which the four-character repetition cycle is inadequate. The cycle should comprise one signal repetition, three signals  $\beta$  and four stored characters, or one signal repetition and seven stored characters.

### A.3 *Channel arrangement*

#### A.3.1 *Channel A*

A.3.1.1 For equipments employing a 4-character repetition cycle: one character inverted followed by three characters erect [see (a) of Figure A-1/S.13].

A.3.1.2 For equipments employing an 8-character repetition cycle: one character inverted followed by seven characters erect [see (a) of Figure A-2/S.13].

#### A.3.2 *Channel B*

A.3.2.1 For equipments employing a 4-character repetition cycle: one character erect followed by three characters inverted [see (b) of Figure A-1/S.13].

A.3.2.2 For equipments employing an 8-character repetition cycle: one character erect followed by seven characters inverted [see (b) of Figure A-2/S.13].

#### A.3.3 *Channel C*

As for Channel B [see (c) of Figures A-1/S.13 and A-2/S.13].

#### A.3.4 *Channel D*

As for Channel A [see (d) of Figures A-1/S.13 and A-2/S.13].

TABLE A- 1 /S.13

Code conversion table

Combination No. in International Telegraph Alphabet No. 2	Letter case	Figure case	Code in International Telegraph Alphabet No. 2 (see Note 1)	Code in International Telegraph Alphabet No. 3 (see Note 1)
1	<b>A</b>	–	ZZAAA	AAZZAZA
2	<b>B</b>	?	ZAAZZ	AAZZAAZ
3	<b>C</b>	:	AZZZA	ZAAZZAA
4	<b>D</b>	Note 2	ZAAZA	AAZZZAA
5	<b>E</b>	3	ZAAAA	AZZZAAA
6	<b>F</b>	} Note 2 {	ZAZZA	AAZAAZZ
7	<b>G</b>		AZAZZ	ZZAAAAZ
8	<b>H</b>		AAZAZ	ZAZAAZA
9	<b>I</b>		8	AZZAA
10	<b>J</b>	Note 2	ZZAZA	AZAAAZZ
11	<b>K</b>	(	ZZZZA	AAAZAZZ
12	<b>L</b>	)	AZAAZ	ZZAAAZA
13	<b>M</b>	.	AAZZZ	ZAZAAAZ
14	<b>N</b>	,	AAZZA	ZAZAZAA
15	<b>O</b>	9	AAAZZ	ZAAAZZA
16	<b>P</b>	0	AZZAZ	ZAAZAZA
17	<b>Q</b>	1	ZZZAZ	AAAZZAZ
18	<b>R</b>	4	AZAZA	ZZAAZAA
19	<b>S</b>	'	ZAZAA	AZAZAZA
20	<b>T</b>	5	AAAAZ	ZAAAZAZ
21	<b>U</b>	7	ZZZAA	AZZAAZA
22	<b>V</b>	=	AZZZZ	ZAAZAAZ
23	<b>W</b>	2	ZZAAZ	AZAAZAZ
24	<b>X</b>	/	ZAZZZ	AAZAZZA
25	<b>Y</b>	6	ZAZAZ	AAZAZAZ
26	<b>Z</b>	+	ZAAAZ	AZZAAAZ
27	Carriage-return		AAAZA	ZAAAAZZ
28	Line-feed		AZAAA	ZAZZAAA
29	Letter-shift		ZZZZZ	AAAZZZA
30	Figure-shift		ZZAZZ	AZAAZZA
31	Space		AAZAA	ZZAZAAA
32	Not normally used		AAAAA	AAAAZZZ
–	Signal repetition		–	AZZAZAA
–	Signal $\alpha$		(permanent A polarity)	AZAZAAZ
–	Signal $\beta$		(permanent Z polarity)	AZAZZAA

Note 1 - Symbols A and Z have the meanings defined in [6].

Note 2 - See Recommendation S.4.

### A.3.5 Order of transmission

A.3.5.1 Characters of Channels A and B are transmitted consecutively [see (e) of Figures A-1/S.13 and A-2/S.13].

A.3.5.2 Elements of Channel C are interleaved with those of Channel A [see (g) of Figures A-1/S.13 and A-2/S.13].

A.3.5.3 Elements of Channel D are interleaved with those of Channel B [see (g) of Figures A-1/S.13 and A-2/S.13].

A.3.5.4 In the aggregate signal, A elements precede those of C, and B elements precede those of D [see (g) of Figures A-1/S.13 and A-2/S.13].

A.3.5.5 The first erect character on A, transmitted after the inverted character on A, is followed by the erect character on B [see (e) of Figures A-1/S.13 and A-2/S.13].

A.3.5.6 The erect character on C is followed by the inverted character on D [see (f) of Figures A-1/S.13 and A-2/S.13].

A.3.5.7 The inverted character on A is element-interleaved with the erect character on C [see (g) of Figures A-1/S.13 and A-2/S.13].

#### A.4 *Subchannel arrangement*

A.4.1 The character transmission rate of the fundamental subchannel should be a quarter of the standard character rate.

A.4.2 Subchannels should be numbered 1, 2, 3 and 4 consecutively.

A.4.3 Where a 4-character repetition cycle is used, subchannel 1 should be that subchannel which has opposite keying polarity to the other three subchannels of the same main channel [see (a), (b), (c) and (d) of Figure A-3/S.13]. When an 8-character repetition cycle is used, subchannel 1 should be that subchannel which has alternately erect and inverted keying polarity [see (e), (f), (g) and (h) of Figure A-3/S.13].

A.4.4 When subchannels of half-character rate, or three-quarter-character rate are required, combinations of the fundamental subchannels should be arranged as shown in Table A-2/S.13.

#### A.5 *Designation of aggregate signal*

To assist in identifying the signal condition when applying the aggregate telegraph signal to modulate the radio channel, the designation for the aggregate signal should be used as shown in Table A-3/S.13.

#### A.6 *Diagrams*

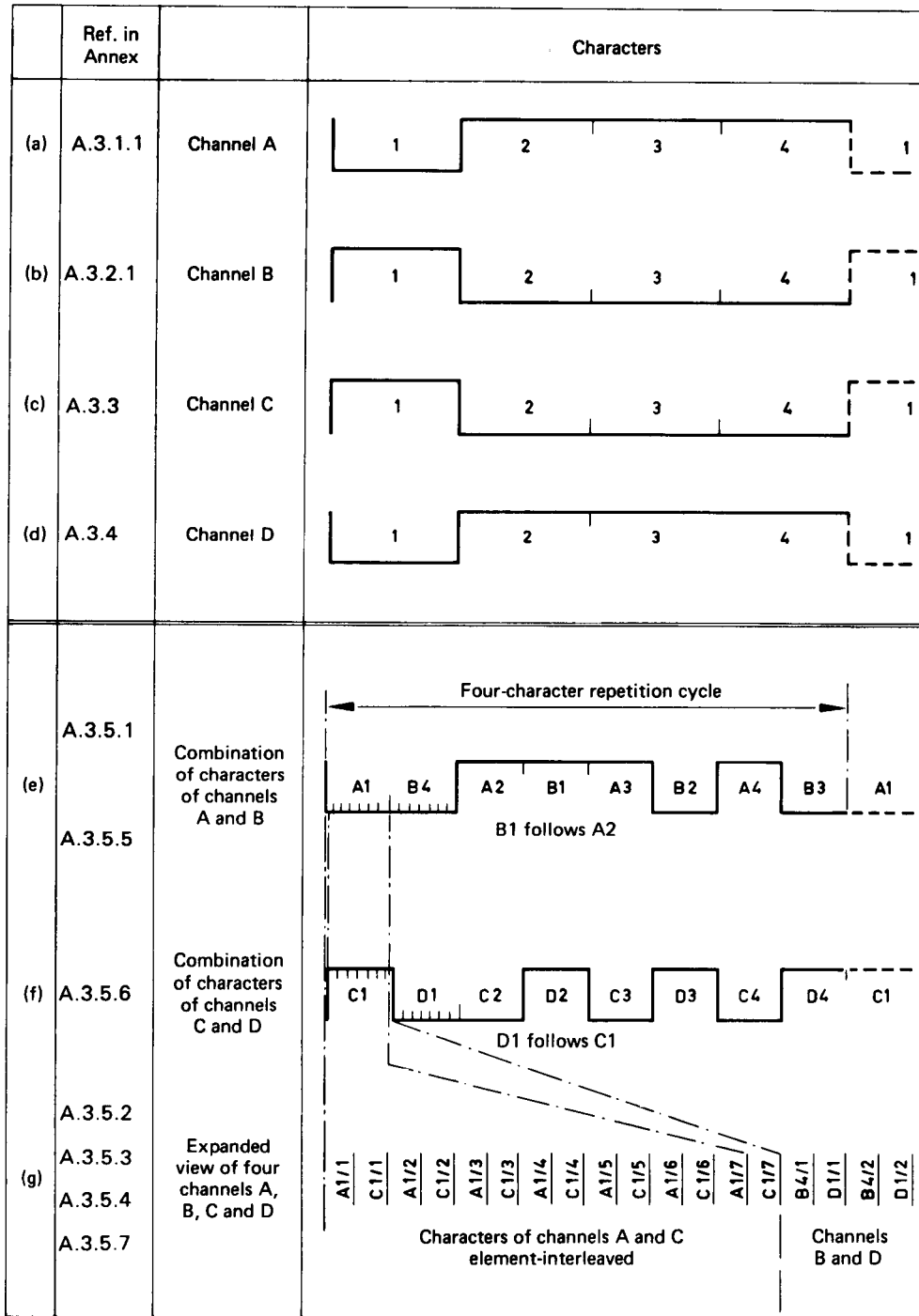
As a result of the characteristics specified in §§ A.2, A.3 and A.4 above, the transmission of characters will be as shown in Figures A-1/S.13, A-2/S.13 and A-3/S.13.

#### A.7 *Automatic phasing*

A.7.1 Automatic phasing should normally be used. It should be initiated either:

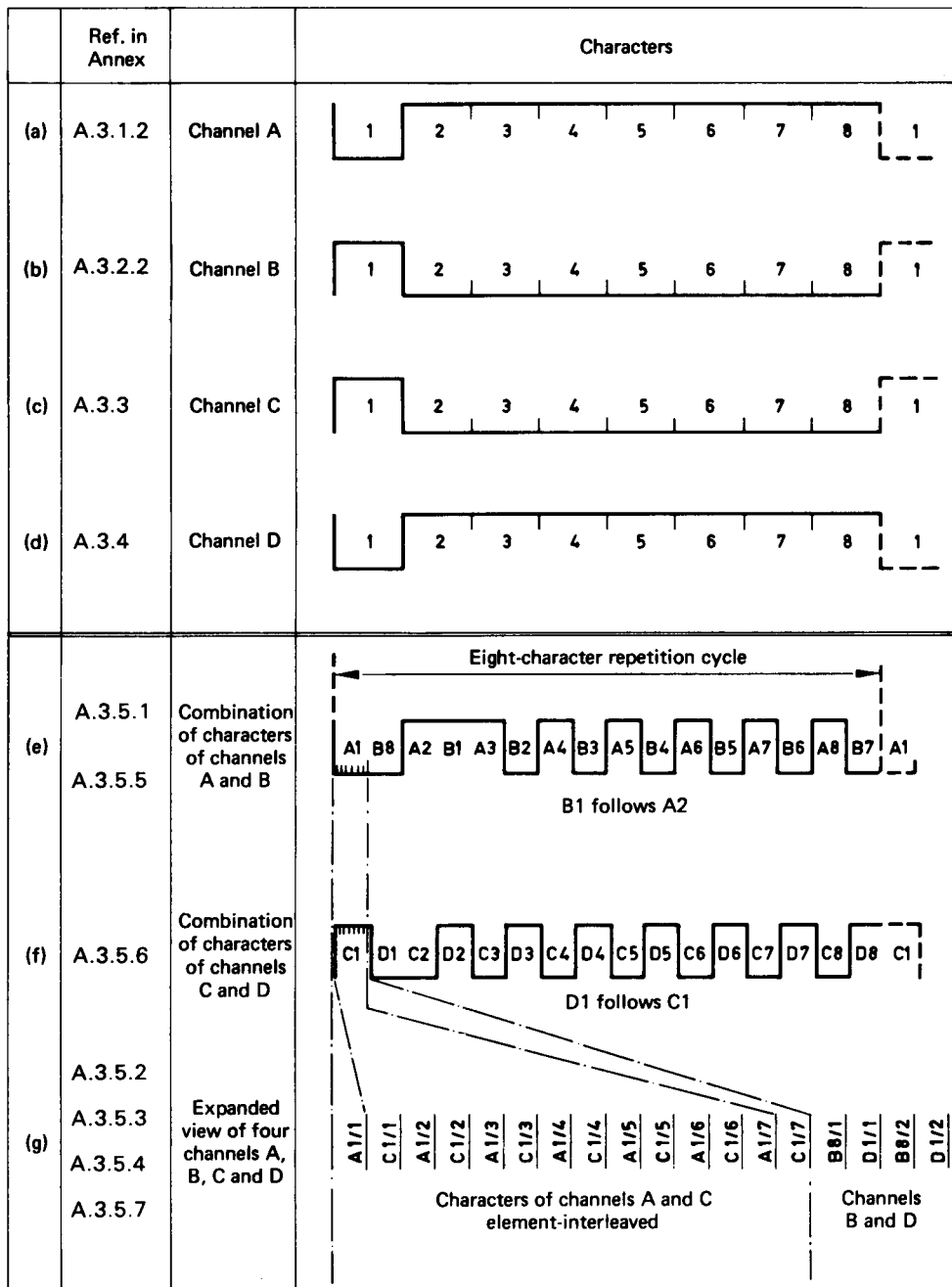
- a) after a waiting period during which cycling due to the receipt of errors has occurred continuously on both channels on a 2-channel system, or on at least two main channels of a 4-channel system;
- b) after equal counts of A and Z elements have been made over at least two consecutive system cycles whilst continuous cycling due to the receipt of errors is occurring on all main channels.

A.7.2 When the slave station is phasing, it should transmit in each channel, in place of the signal repetition, a 7-element signal in which all seven elements are of the same polarity, all other characters in the repetition cycle being transmitted unchanged.



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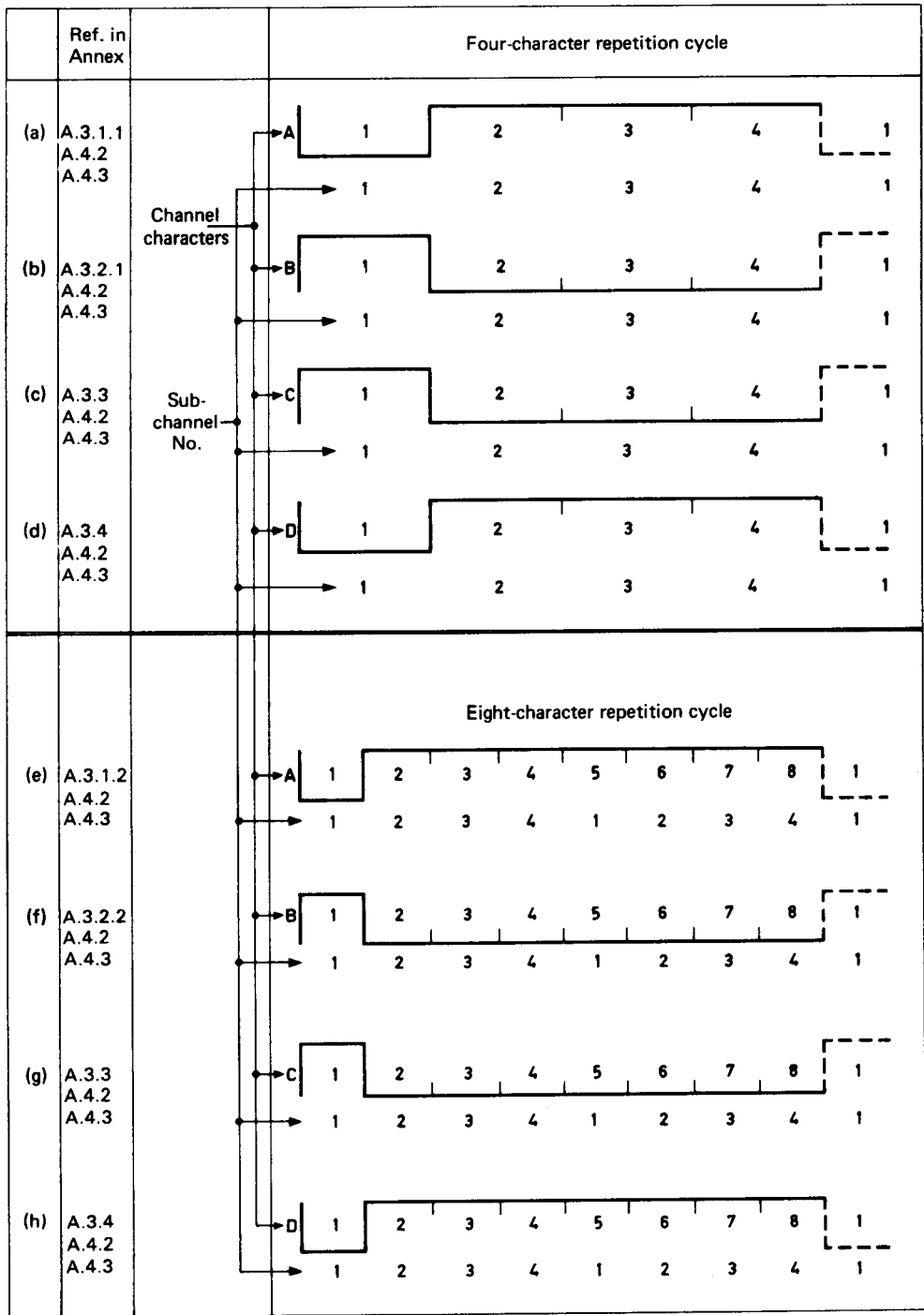
FIGURE A-1/S.13  
Channel arrangement for a four-character repetition cycle



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FIGURE A-2/S.13  
Channel arrangement for an eight-character repetition cycle





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FIGURE A-3/S.13  
Subchannelling arrangements for a four- and eight-character repetition cycle

TABLE A-2/S.13

Proportion of full-channel character rate	Combination of fundamental subchannels
(1) quarter (2) quarter (3) half	No. 1 No. 3 Nos. 2 and 4
(1) half (2) half	Nos. 1 and 3 Nos. 2 and 4
(1) quarter (2) three-quarters	No. 1 Nos. 2, 3 and 4

TABLE A-3/S.13

Seven-unit code condition	Aggregate signal condition	
	Erect character	Inverted character
A	B	Y
Z	Y	B

*Note* - With a frequency shift system, the higher frequency should correspond to aggregate condition B and the lower frequency should correspond to aggregate condition Y.

### References

- [1] CCITT Recommendation *Telex and gentex signalling on intercontinental circuits used for intercontinental automatic transit traffic (Type C signalling)*, Rec. U.11.
- [2] CCITT Recommendation *Telex and gentex signalling on radio channels (synchronous 7-unit systems affording error correction by automatic repetition)*, Rec. U.20.
- [3] CCITT Recommendation *Operator recall on a telex call set up on radiotelegraph circuit*, Rec. U.21.
- [4] CCITT Recommendation *Signals indicating delay in transmission on calls set up by means of synchronous systems with automatic error correction by repetition*, Rec. U.22.
- [5] CCITT Recommendation *Operational provisions for the international public telegram service*, Rec. F.1, § C.8.
- [6] CCITT Definition: *Position A; position Z*, Vol. X, Fascicle X.1 (Terms and Definitions).