INTERNATIONAL TELECOMMUNICATION UNION

Radio Regulations

Edition of 1998

4 *ITU-R Recommendations incorporated by reference*

Geneva 1998

Note by the Secretariat

This revision of the Radio Regulations, complementing the Constitution and the Convention of the International Telecommunication Union, incorporates the decisions of the World Radiocommunication Conferences of 1995 (WRC-95) and of 1997 (WRC-97). The provisions of these Regulations apply provisionally as from 1 January 1999, unless otherwise specified (see also Article **S59** of this edition).

In preparing the Radio Regulations, edition of 1998, the Secretariat made editorial changes, where appropriate, to reflect:

– the ITU structural changes (world administrative radio conference to world radiocommunication conference, CCIR to ITU-R, IFRB to the Radiocommunication Bureau, Administrative Council to Council, etc.);

– the replacement of ex-CCIR Reports by ITU-R Recommendations;

– the renumbering of Radio Regulation provisions resulting from the simplification of the Radio Regulations.

The term "Member(s)" has been replaced by the term "Member State(s)‡" to correspond with the terminology employed currently within the ITU. The symbol "‡" indicates that this replacement was made by the Secretariat.

In addition, the term "the Bureau" has been used to refer to the Radiocommunication Bureau.

The following references to texts of these Radio Regulations appear in bold type:

– Articles, e.g. Article **S52**;

– Provision numbers, e.g. No. **S5.344**;

– Article table numbers, e.g. Table **S22-2**;

– Appendices, e.g. Appendix **S30A**;

– Resolutions, e.g. Resolution **46 (Rev.WRC-97)**;

– Recommendations, e.g. Recommendation **515 (Rev.WRC-97)**.

References to provision numbers which are not preceded by the letter "S" (usually after an oblique stroke in the case of double references) refer to provisions of the Radio Regulations, edition of 1990, revised in 1994.

As Articles **S5**, **S21** and **S22** applied provisionally as from 1 January 1997, they were published previously in Volume 4 of the Radio Regulations, Geneva, 1996. Where provisions in these Articles were modified by the World Radiocommunication Conference (Geneva, 1997), this has been indicated by the addition of "(WRC-97)" at the end of the text of the provision. Similarly, those provisions in these Articles which were abrogated by WRC-97 are shown by the addition of "(SUP - WRC-97)" following the provision number.

Abbreviations have generally been used for the names of world administrative radio conferences and world radiocommunication conferences. These abbreviations are shown on the next page.

Abbreviation	Conference
WARC Mar	World Administrative Radio Conference to Deal with Matters Relating to the Maritime Mobile Service (Geneva, 1967)
WARC-71	World Administrative Radio Conference for Space Telecommunications (Geneva, 1971)
WMARC-74	World Maritime Administrative Radio Conference (Geneva, 1974)
WARC SAT-77	World Broadcasting-Satellite Administrative Radio Conference (Geneva, 1977)
WARC-Aer2	World Administrative Radio Conference on the Aeronautical Mobile (R) Service (Geneva, 1978)
WARC-79	World Administrative Radio Conference (Geneva, 1979)
WARC Mob-83	World Administrative Radio Conference for the Mobile Services (Geneva, 1983)
WARC HFBC-84	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1984)
WARC Orb-85	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (First Session – Geneva, 1985)
WARC HFBC-87	World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (Geneva, 1987)
WARC Mob-87	World Administrative Radio Conference for the Mobile Services (Geneva, 1987)
WARC Orb-88	World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It (Second Session – Geneva, 1988)
WARC-92	World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992)
WRC-95	World Radiocommunication Conference (Geneva, 1995)
WRC-97	World Radiocommunication Conference (Geneva, 1997)
WRC-99	World Radiocommunication Conference, 1999[1]
WRC-01	World Radiocommunication Conference, 2001[2]

[1] This conference will be held in the year 2000.

[2] The date of this conference has not been finalised.

VOLUME 4

ITU-R Recommendations incorporated by reference

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RECOMMENDATION ITU-R M.257-3*

SEQUENTIAL SINGLE FREQUENCY SELECTIVE-CALLING SYSTEM FOR USE IN THE MARITIME MOBILE SERVICE

(1959-1970-1978-1995)

Summary

The Recommendation describes the sequential single frequency selective-calling (SSFC) system which may be used for calling ships until the system is superseded by the DSC system described in Recommendations ITU-R M.493 and ITU-R M.541.

The ITU Radiocommunication Assembly,

considering

a) that there is a need to define the characteristics of a sequential single-frequency selective calling system suitable for use with normal types of radio equipment on ships,

noting

1 that a sequential single frequency selective-calling system may be in operation until it is superseded by the digital selective-calling system described in Recommendation ITU-R M.493,

recommends

1 that the system to be used should have the characteristics given in Annex 1;

2 that the operational procedures described in Annex 2 should be observed.

ANNEX 1

Characteristics of the system

1 the selective call signal should consist of five figures representing the code number assigned to a ship for selective calling;

1.1 the audio-frequency signal applied to the input of the coast station transmitter should consist of consecutive audio-frequency pulses conforming to the following:

1.1.1 the audio frequencies used to identify the figures of the code number assigned to a ship should conform to the following series:

TABLE 1

Figure	1	2	3	4	5	6	7	8	9	0	Figure repetition
Audio frequency (Hz)	1 124	1 197	1 275	1 358	1 446	1 540	1 640	1 747	1 860	1 981	2 110

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

For example, the series of audio-frequency pulses corresponding to the selective call 12 133 would be 1 124-1 197-1 124-1 275-2 110 Hz, and the series corresponding to the code number 22 222 would be 1 197-2 110-1 197-2 110-1 197 Hz;

1.1.2 if the series of numbers represented by the use of only two frequencies, chosen from those in § 1.1.1, are reserved for calling predetermined groups of ships, then 100 different groups of numbers are available for allocation, according to the needs of administrations;

1.1.3 the waveforms of the audio-frequency generators should be substantially sinusoidal, not exceeding 2% total harmonic distortion;

1.1.4 the audio-frequency pulses should be transmitted sequentially;

1.1.5 the difference between the maximum amplitude of any audio-frequency pulses should not exceed 1 dB;

1.1.6 the duration of each audio-frequency pulse, measured between the half-amplitude points, should be 100 ms ± 10 ms;

1.1.7 the time interval between consecutive pulses, measured between the half-amplitude points, should be 3 ms ± 2 ms;

1.1.8 the rise and the decay time of each audio-frequency pulse, measured between the 10% and 90% amplitude points, should be 1.5 ms ± 1 ms;

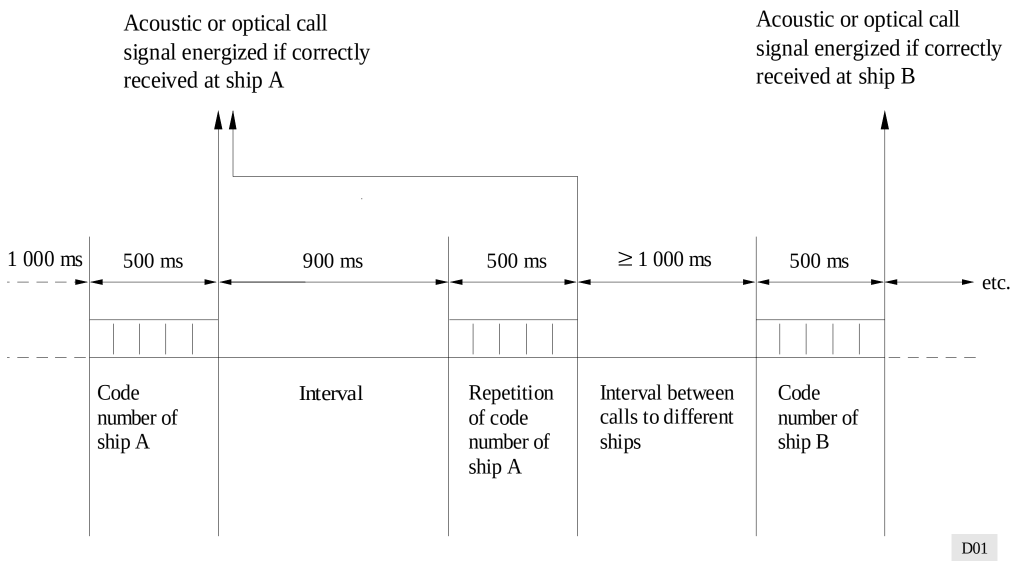
1.1.9 the frequency tolerance of the audio frequencies given in § 1.1.1 should be ± 4 Hz;

1.1.10 the selective call signal (ship's code number) should be transmitted twice with an interval of 900 ms ± 100 ms between the end of the first signal and the beginning of the second signal (Fig. 1);

1.1.11 the interval between calls from a coast station to different ships should be at least 1 s (Fig. 1); but the interval between calls to the same ship, or the same group of ships, should be at least 5 s;

FIGURE 1

Composition of selective call signals without additional information



2 If additional information is added to the selective call signal it should be as follows:

2.1 to identify the calling coast station four figures should be transmitted;

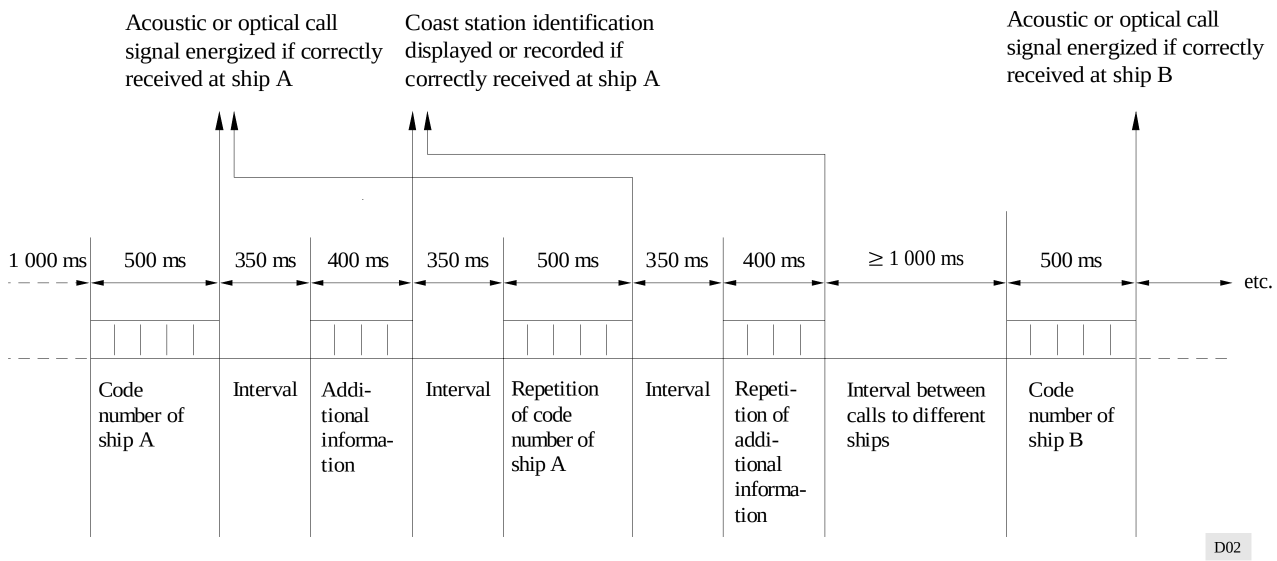
2.2 to identify the VHF channel on which a reply is required two "zeros" followed by two "figures" should be transmitted (see RR Appendix S18 [Appendix 18]);

2.3 the characteristics of the signals should conform to § 1.1.1 and 1.1.3 to 1.1.9 inclusive;

2.4 the composition of the signal should be as shown in the diagram (Fig. 2), the tolerance on the 350 ms interval being ± 30 ms;

FIGURE 2

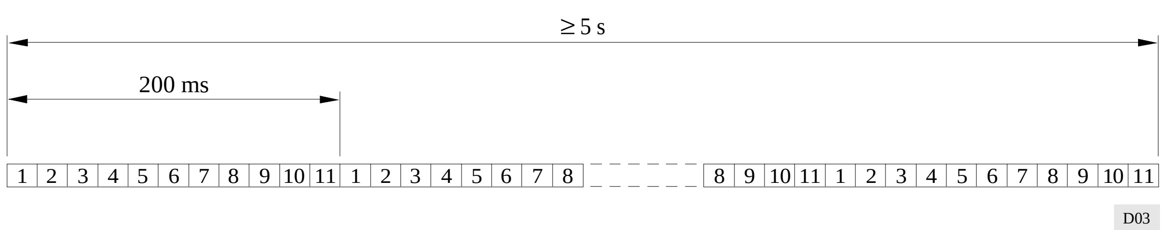
Composition of selective call signals with additional information



3 an "all ships call" to actuate the receiving selectors on all ships, regardless of their individual code numbers, should consist of a continuous sequential transmission of the eleven audio frequencies given in § 1.1.1. The parameters of the audio-frequency pulses should be in accordance with § 1.1.3, 1.1.4, 1.1.5 and 1.1.9. The duration of each audio-frequency pulse, measured between the half-amplitude points, should be 17 ms ± 1 ms and the interval between consecutive pulses, measured between half-amplitude points, should not exceed 1 ms (Fig. 3). The total duration of this "all ships call" signal should be at least 5 s;

FIGURE 3

Composition of the "all ships call" signal



4 receiving selectors on ships should operate reliably in any radio conditions acceptable for satisfactory communication;

5 the receiving selector should be designed to accept the signals as defined in § 1 and 3. However, bearing in mind that coast stations may transmit additional signals (e.g. coast station identification), it is important to ensure that during reception of a selective call the decoder should be re-set after 250 ± 40 ms if an incorrect digit or no digit is received;

6 the receiving selector should be so designed, constructed and maintained that it is resistant to atmospherics and other unwanted signals including selective-calling signals other than that for which the decoder has been set up;

7 the receiving selector should include an audible or visual means of indicating the receipt of a call and, if required, an additional facility allowing the determination of the identity of the calling station or the VHF channel on which to reply according to the needs of administrations;

8 in order to distinguish whether an incoming call is a normal selective call or an “all ships call”, the multiple actuation of the ship’s decoder by the “all ships call” signal (see § 3) can be used;

9 the indicating means mentioned in § 7 should be actuated on correct reception of the calling signal, no matter whether the correct registration has occurred on the first, or the second, or both parts of the calling signal transmitted by the coast stations;

10 the indicating means should remain actuated until re-set manually;

11 the receiving selector equipment should be as simple as is practicable, be capable of reliable operation over long periods with a minimum of maintenance, and could, with advantage, include facilities for self-testing.

ANNEX 2

Operational procedures

Method of calling (4669)

(1) The call shall consist of:

a) the selective call number or identification number or signal of the station called, followed by

b) the selective call number or identification number or signal of the station calling.

However, in the case of a coast station calling on VHF, the number of the channel to be used for the reply and for traffic may replace the identification number or signal of the coast station.

The call shall be transmitted twice.

(2) When a station called does not reply, the call should not normally be repeated until after an interval of at least five minutes and should not then normally be renewed until after a further interval of fifteen minutes.

(3) The use of an “all ships call” shall be confined to distress and urgency in the MF and HF bands and the announcement of vital navigational warnings in those bands; additionally it may be used for safety purposes in the VHF band. This call may only be used to supplement, if required, the distress procedure specified in RR Appendix S13 [Nos. 3101, 3102, 3116 and 3117] and shall in no circumstances be used in place of such procedures, in particular the alarm signals mentioned in RR Appendix S13 [Nos. 3268 and 3270].

Reply to calls

The reply to calls shall be made in accordance with the provisions of:

a) § 20 and 21 of Annex 1 to Recommendation ITU-R M.1170 when using Morse radiotelegraphy;

b) § 16, 17, 18 and 19 of Annex 1 to Recommendation ITU-R M.1171 when using radiotelephony.

Frequencies to be used

Selective calling may be carried out on the following calling frequencies:

500	kHz
2 170.5	kHz
4 125	kHz
4 417	kHz
6 516	kHz
8 779	kHz
13 137	kHz
17 302	kHz
19 770	kHz
22 756	kHz
26 172	kHz
156.8	MHz (see Note 1.

NOTE 1 – Selective calling on this frequency should normally be only in the direction coast station to ship or intership. Selective calls from ship to coast station should whenever possible be sent on other frequencies of RR Appendix S18 [Appendix 18], as appropriate.

RECOMMENDATION ITU-R TF.460-5

STANDARD-FREQUENCY AND TIME-SIGNAL EMISSIONS

(Question ITU-R 102/7)

(1970-1974-1978-1982-1986-1997)

The ITU Radiocommunication Assembly,

considering

a) that the World Administrative Radio Conference, Geneva, 1979, allocated the frequencies 20 kHz ± 0.05 kHz, 2.5 MHz ± 5 kHz (2.5 MHz ± 2 kHz in Region 1), 5 MHz ± 5 kHz, 10 MHz ± 5 kHz, 15 MHz ± 10 kHz, 20 MHz ± 10 kHz and 25 MHz ± 10 kHz to the standard-frequency and time-signal service;

b) that additional standard frequencies and time signals are emitted in other frequency bands;

c) the provisions of Article 33 (S26) of the Radio Regulations;

d) the continuing need for close cooperation between Radiocommunication Study Group 7 and the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the General Conference of Weights and Measures (CGPM), the Bureau International des Poids et Mesures (BIPM), the International Earth Rotation Service (IERS) and the concerned Unions of the International Council of Scientific Unions (ICSU);

e) the desirability of maintaining worldwide coordination of standard-frequency and time-signal emissions;

f) the need to disseminate standard frequencies and time signals in conformity with the second as defined by the 13th General Conference of Weights and Measures (1967);

g) the continuing need to make universal time (UT) immediately available to an uncertainty of one-tenth of a second,

recommends

1 that all standard-frequency and time-signal emissions conform as closely as possible to coordinated universal time (UTC) (see Annex 1); that the time signals should not deviate from UTC by more than one millisecond; that the standard frequencies should not deviate by more than 1 part in 10^{10}, and that the time signals emitted from each transmitting station should bear a known relation to the phase of the carrier;

2 that standard-frequency and time-signal emissions, and other time-signal emissions intended for scientific applications (with the possible exception of those dedicated to special systems) should contain information on the difference between UT1 and UTC (see Annexes 1 and 2);

3 that this document be transmitted by the Director of the Radiocommunication Bureau, to all administrations Members of the ITU, to IMO, ICAO, the CGPM, the BIPM, the IERS, the International Union of Geodesy and Geophysics (IUGG), the International Union of Radio Science (URSI) and the International Astronomical Union (IAU).

ANNEX 1

Time scales

A Universal time (UT)

Universal time (UT) is the general designation of time scales based on the rotation of the Earth.

In applications in which an imprecision of a few hundredths of a second cannot be tolerated, it is necessary to specify the form of UT which should be used:

UT0 is the mean solar time of the prime meridian obtained from direct astronomical observation;

UT1 is UT0 corrected for the effects of small movements of the Earth relative to the axis of rotation (polar variation);

UT2 is UT1 corrected for the effects of a small seasonal fluctuation in the rate of rotation of the Earth;

UT1 is used in this document, since it corresponds directly with the angular position of the Earth around its axis of diurnal rotation.

Concise definitions of the above terms and the concepts involved are available in the publications of the IERS (Paris, France).

B International atomic time (TAI)

The international reference scale of atomic time (TAI), based on the second (SI), as realized on the rotating geoid, is formed by the BIPM on the basis of clock data supplied by cooperating establishments. It is in the form of a continuous scale, e.g. in days, hours, minutes and seconds from the origin 1 January 1958 (adopted by the CGPM 1971).

C Coordinated universal time (UTC)

UTC is the time-scale maintained by the BIPM, with assistance from the IERS, which forms the basis of a coordinated dissemination of standard frequencies and time signals. It corresponds exactly in rate with TAI but differs from it by an integral number of seconds.

The UTC scale is adjusted by the insertion or deletion of seconds (positive or negative leap-seconds) to ensure approximate agreement with UT1.

D DUT1

The value of the predicted difference UT1 – UTC, as disseminated with the time signals is denoted DUT1; thus DUT1 ≈ UT1 – UTC. DUT1 may be regarded as a correction to be added to UTC to obtain a better approximation to UT1.

The values of DUT1 are given by the IERS in integral multiples of 0.1 s.

The following operational rules apply:

1 Tolerances

1.1 The magnitude of DUT1 should not exceed 0.8 s.

1.2 The departure of UTC from UT1 should not exceed ± 0.9 s (see Note 1).

1.3 The deviation of (UTC plus DUT1) should not exceed ± 0.1 s.

NOTE 1 – The difference between the maximum value of DUT1 and the maximum departure of UTC from UT1 represents the allowable deviation of (UTC + DUT1) from UT1 and is a safeguard for the IERS against unpredictable changes in the rate of rotation of the Earth.

2 Leap-seconds

2.1 A positive or negative leap-second should be the last second of a UTC month, but first preference should be given to the end of December and June, and second preference to the end of March and September.

2.2 A positive leap-second begins at 23h 59m 60s and ends at 0h 0m 0s of the first day of the following month. In the case of a negative leap-second, 23h 59m 58s will be followed one second later by 0h 0m 0s of the first day of the following month (see Annex 3).

2.3 The IERS should decide upon and announce the introduction of a leap-second, such an announcement to be made at least eight weeks in advance.

3 Value of DUT1

3.1 The IERS is requested to decide upon the value of DUT1 and its date of introduction and to circulate this information one month in advance. In exceptional cases of sudden change in the rate of rotation of the Earth, the IERS may issue a correction not later than two weeks in advance of the date of its introduction.

3.2 Administrations and organizations should use the IERS value of DUT1 for standard-frequency and time-signal emissions, and are requested to circulate the information as widely as possible in periodicals, bulletins, etc.

3.3 Where DUT1 is disseminated by code, the code should be in accordance with the following principles (except § 3.4 below):

– the magnitude of DUT1 is specified by the number of emphasized second markers and the sign of DUT1 is specified by the position of the emphasized second markers with respect to the minute marker. The absence of emphasized markers indicates DUT1 = 0;

– the coded information should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

Full details of the code are given in Annex 2.

3.4 DUT1 information primarily designed for, and used with, automatic decoding equipment may follow a different code but should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively, the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

3.5 Other information which may be emitted in that part of the time-signal emission designated in §§ 3.3 and 3.4 for coded information on DUT1 should be of a sufficiently different format that it will not be confused with DUT1.

3.6 In addition, UT1 – UTC may be given to the same or higher precision by other means, for example, by messages associated with maritime bulletins, weather forecasts, etc.; announcements of forthcoming leap-seconds may also be made by these methods.

3.7 The IERS is requested to continue to publish, in arrears, definitive values of the differences UT1 – UTC and UT2 – UTC.

ANNEX 2

Code for the transmission of DUT1

A positive value of DUT1 will be indicated by emphasizing a number, *n*, of consecutive second markers following the minute marker from second marker one to second marker, *n*, inclusive; *n* being an integer from 1 to 8 inclusive.

$$\text{DUT1} = (n \times 0.1)\ \text{s}$$

A negative value of DUT1 will be indicated by emphasizing a number, *m*, of consecutive second markers following the minute marker from second marker nine to second marker (8 + *m*) inclusive, *m* being an integer from 1 to 8 inclusive.

$$\text{DUT1} = -\,(m \times 0.1)\ \text{s}$$

A zero value of DUT1 will be indicated by the absence of emphasized second markers.

The appropriate second markers may be emphasized, for example, by lengthening, doubling, splitting or tone modulation of the normal second markers.

Examples:

FIGURE 1

DUT1 = + 0.5 s

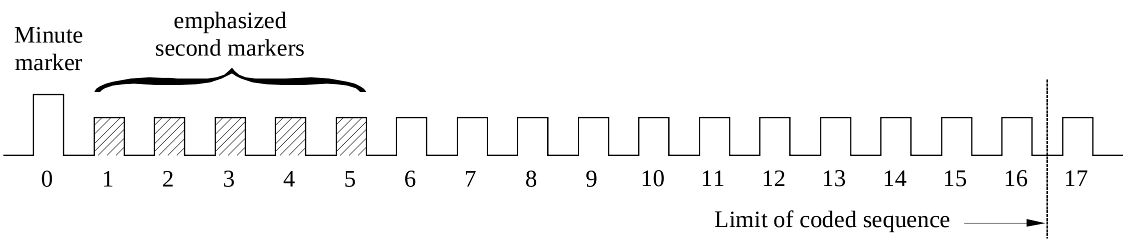
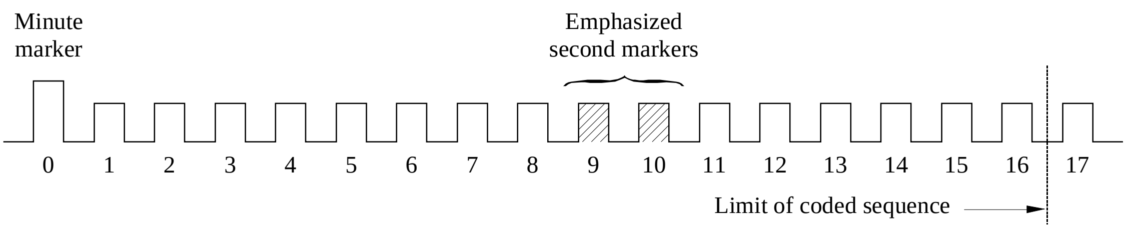


FIGURE 2

DUT1 = – 0.2 s



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ANNEX 3

Dating of events in the vicinity of a leap-second

The dating of events in the vicinity of a leap-second shall be effected in the manner indicated in the following figures:

FIGURE 3

Positive leap-second

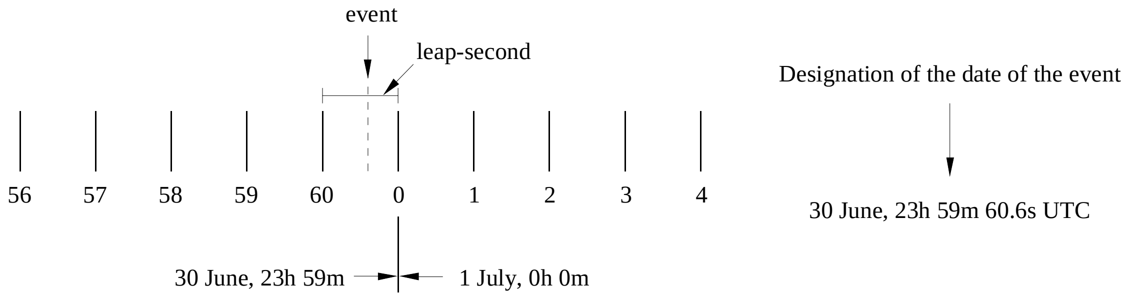
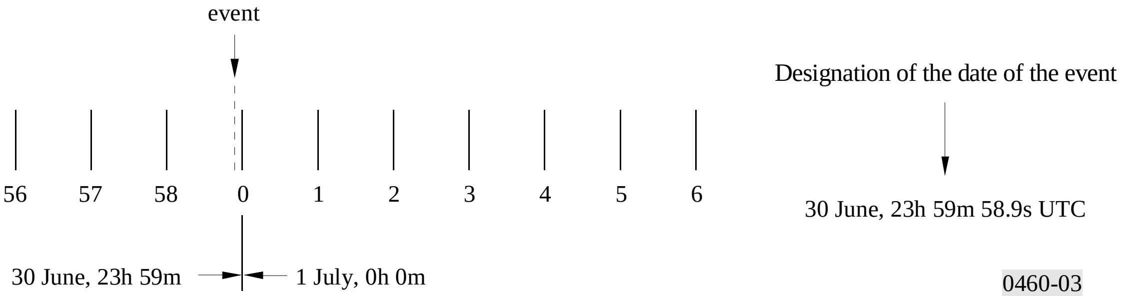


FIGURE 4

Negative leap-second



RECOMMENDATION ITU-R M.476-5*

DIRECT-PRINTING TELEGRAPH EQUIPMENT IN THE MARITIME MOBILE SERVICE**

(Question ITU-R 5/8)

(1970-1974-1978-1982-1986-1995)

Summary

The Recommendation provides in Annex 1 characteristics for error detecting and correcting systems for existing direct-printing telegraph equipment. Annex 1 contains the technical characteristics of the transmission, the code and the modes of operation to be employed in the maritime-mobile service. New equipment should conform to Recommendation ITU-R M.625.

The ITU Radiocommunication Assembly,

considering

a) that there is a requirement to interconnect mobile stations, or mobile stations and coast stations, equipped with start-stop apparatus employing the ITU-T International Telegraph Alphabet No. 2, by means of radiotelegraph circuits;

b) that direct-printing telegraphy communications in the maritime mobile service can be listed in the following categories:

b.a telegraph service between a ship and a coast station;

b.b telegraph service between a ship and an extended station (ship's owner) via a coast station;

b.c telex service between a ship and a subscriber of the (international) telex network;

b.d broadcast telegraph service from a coast station to one or more ships;

b.e telegraph service between two ships or between one ship and a number of other ships;

c) that those categories are different in nature and that consequently different degrees of transmission quality may be required;

d) that the categories given in b.a, b.b and b.c above may require a higher transmission quality than categories b.d and b.e for the reason that data could be handled through the services in the categories b.a, b.b and b.c, while the messages passed through the service of category b.d, and via the broadcast service of category b.e are normally plain language, allowing a lower transmission quality than that required for coded information;

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

** This Recommendation is retained in order to provide information concerning existing equipment, but will probably be deleted at a later date. New equipment should conform to Recommendation ITU-R M.625 which provides for the exchange of identification signals, for the use of 9 digit maritime mobile service identification signals and for compatibility with existing equipment built in accordance with this Recommendation.

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

e) that the service in category b.d and the broadcast service in category b.e cannot take advantage of an ARQ method, as there is in principle no return path;

f) that for these categories of service which by their nature do not allow the use of ARQ, another mode, i.e. the forward error-correcting (FEC) mode should be used;

g) that the period for synchronization and phasing should be as short as possible and should not exceed 5 s;

h) that most of the ship stations do not readily permit simultaneous use of the radio transmitter and radio receiver;

j) that the equipment on board ships should be neither unduly complex nor expensive,

recommends

1 that when an error-detecting and correcting system is used for direct-printing telegraphy in the maritime mobile service, a 7-unit ARQ system or a 7-unit forward acting, error-correcting and indicating time-diversity system, using the same code, should be employed;

2 that equipment designed in accordance with § 1 should meet the characteristics laid down in Annex 1.

ANNEX 1

1 General (Mode A, ARQ and Mode B, FEC)

1.1 The system in both Mode A (ARQ) and Mode B (FEC) is a single-channel synchronous system using the 7-unit error-detecting code as listed in § 2 of this Annex.

1.2 FSK modulation is used on the radio link at 100 Bd. The equipment clocks controlling the modulation rate should have an accuracy of better than 30 parts in 10^6.

NOTE 1 – Some existing equipments may not conform to this requirement.

1.3 The terminal input and output must be in accordance with the 5-unit start-stop ITU-T International Telegraph Alphabet No. 2 at a modulation rate of 50 Bd.

1.4 The class of emission is F1B or J2B with a frequency shift on the radio link of 170 Hz. When frequency shift is effected by applying audio signals to the input of a single-sideband transmitter, the centre frequency of the audio spectrum offered to the transmitter should be 1 700 Hz.

NOTE 1 – A number of equipments are presently in service, using a centre frequency of 1 500 Hz. These may require special measures to achieve compatibility.

1.5 The radio frequency tolerance of the transmitter and the receiver should be in accordance with Recommendation ITU-R SM.1137. It is desirable that the receiver employs the minimum practicable bandwidth (see also Report ITU-R M.585).

NOTE 1 – The receiver bandwidth should preferably be between 270 and 340 Hz.

2 Table of conversion

2.1 Traffic information signals

TABLE 1

Combi-nation No.	Letter case	Figure case	International Telegraph Alphabet No. 2 Code	Emitted 7-unit signal[1]
1	A	–	ZZAAA	BBBYYYB
2	B	?	ZAAZZ	YBYYBBB
3	C	:	AZZZA	BYBBBYY
4	D	⊠ [3]	ZAAZA	BBYYBYB
5	E	3	ZAAAA	YBBYBYB
6	F	[2]	ZAZZA	BBYBBYY
7	G	[2]	AZAZZ	BYBYBBY
8	H	[2]	AAZAZ	BYYBYBB
9	I	8	AZZAA	BYBBYYB
10	J	Audible signal	ZZAZA	BBBYBYY
11	K	(	ZZZZA	YBBBBYY
12	L	)	AZAAZ	BYBYYBB
13	M	.	AAZZZ	BYYBBBY
14	N	,	AAZZA	BYYBBYB
15	O	9	AAAZZ	BYYYBBB
16	P	0	AZZAZ	BYBBYBY
17	Q	1	ZZZAZ	YBBBYBY
18	R	4	AZAZA	BYBYBYB
19	S	’	ZAZAA	BBYBYYB
20	T	5	AAAAZ	YYBYBBB
21	U	7	ZZZAA	YBBBYYB
22	V	=	AZZZZ	YYBBBBY
23	W	2	ZZAAZ	BBBYYBY
24	X	/	ZAZZZ	YBYBBBY
25	Y	6	ZAZAZ	BBYBYBY
26	Z	+	ZAAAZ	BBYYYBB
27	← (Carriage return)		AAAZA	YYYBBBB
28	≡ (Line feed)		AZAAA	YYBBYBB
29	↓ (Letter shift)		ZZZZZ	YBYBBYB
30	↑ (Figure shift)		ZZAZZ	YBBYBBY
31	Space		AAZAA	YYBBBYB
32	Unperforated tape		AAAAA	YBYBYBB

(1) B represents the higher emitted frequency and Y the lower.

(2) At present unassigned (see ITU-T Recommendation F.1 C8). Reception of these signals, however, should not initiate a request for repetition.

(3) The pictorial representation shown is a schematic of ✠ which may also be used when equipment allows (ITU-T Recommendation F.1).

2.2 Service information signals

TABLE 2

Mode A (ARQ)	Emitted signal	Mode B (FEC)
Control signal 1 (CS1)	BYBYYBB	
Control signal 2 (CS2)	YBYBYBB	
Control signal 3 (CS3)	BYYBBYB	
Idle signal β	BBYYBBY	
Idle signal α	BBBBYYY	Phasing signal 1
Signal repetition	YBBYYBB	Phasing signal 2

3 Characteristics

3.1 Mode A (ARQ) (see Figs. 1 and 2)

A synchronous system, transmitting blocks of three characters from an information sending station (ISS) towards an information receiving station (IRS), which stations can, controlled by the control signal 3 (see § 2.2), interchange their functions.

3.1.1 Master and slave arrangements

3.1.1.1 The station that initiates the establishment of the circuit (the calling station) becomes the “master” station, and the station that has been called will be the “slave” station;

this situation remains unchanged during the entire time in which the established circuit is maintained, regardless of which station, at any given time, is the information sending station (ISS) or information receiving station (IRS);

3.1.1.2 the clock in the master station controls the entire circuit (see circuit timing diagram, Fig. 1);

3.1.1.3 the basic timing cycle is 450 ms, and for each station consists of a transmission period followed by a transmission pause during which reception is effected;

3.1.1.4 the master station transmitting time distributor is controlled by the clock in the master station;

3.1.1.5 the slave station receiving time distributor is controlled by the received signal;

3.1.1.6 the slave station transmitting time distributor is phase-locked to the slave station receiving time distributor; i.e. the time interval between the end of the received signal and the start of the transmitted signal (t_E in Fig. 1) is constant;

3.1.1.7 the master station receiving time distributor is controlled by the received signal.

3.1.2 The information sending station (ISS)

3.1.2.1 Groups the information to be transmitted into blocks of three characters (3×7 signal elements), including, if necessary, “idle signals β” to complete or to fill blocks when no traffic information is available;

3.1.2.2 emits a “block” in 210 ms after which a transmission pause of 240 ms becomes effective, retaining the emitted block in memory until the appropriate control signal confirming correct reception by the information receiving station (IRS) has been received;

3.1.2.3 numbers successive blocks alternately “Block 1” and “Block 2” by means of a local numbering device. The first block should be numbered “Block 1” or “Block 2” dependent on whether the received control signal (see § 3.1.4.5) is a control signal 1 or a control signal 2. The numbering of successive blocks is interrupted at the reception of:

– a request for repetition; or

– a mutilated signal; or

– a control signal 3 (see § 2.2);

3.1.2.4 emits the information of Block 1 on receipt of control signal 1 (see § 2.2);

3.1.2.5 emits the information of Block 2 on receipt of control signal 2 (see § 2.2);

3.1.2.6 emits a block of three “signal repetitions” on receipt of a mutilated signal (see § 2.2).

FIGURE 1

A-Mode operation

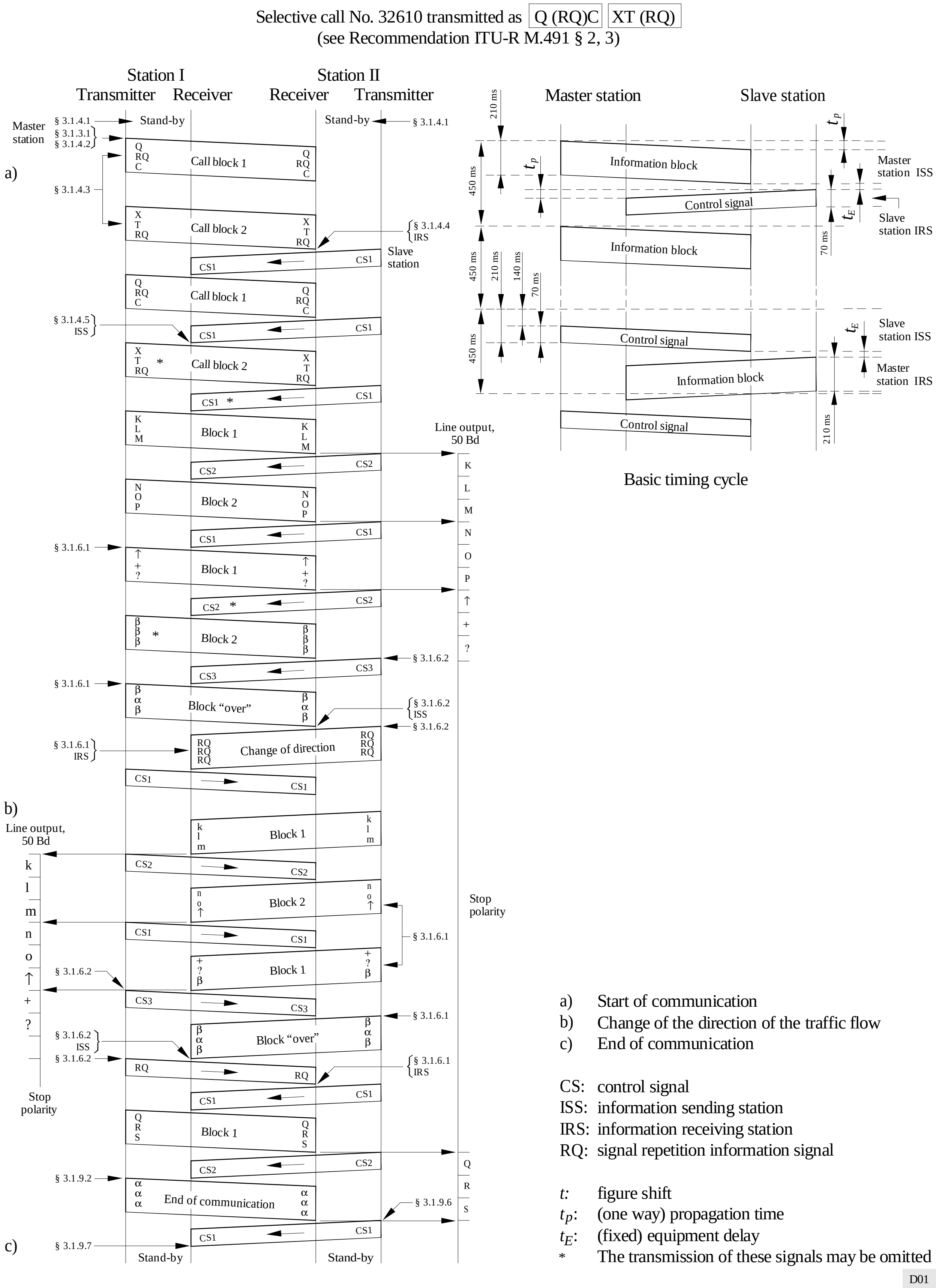
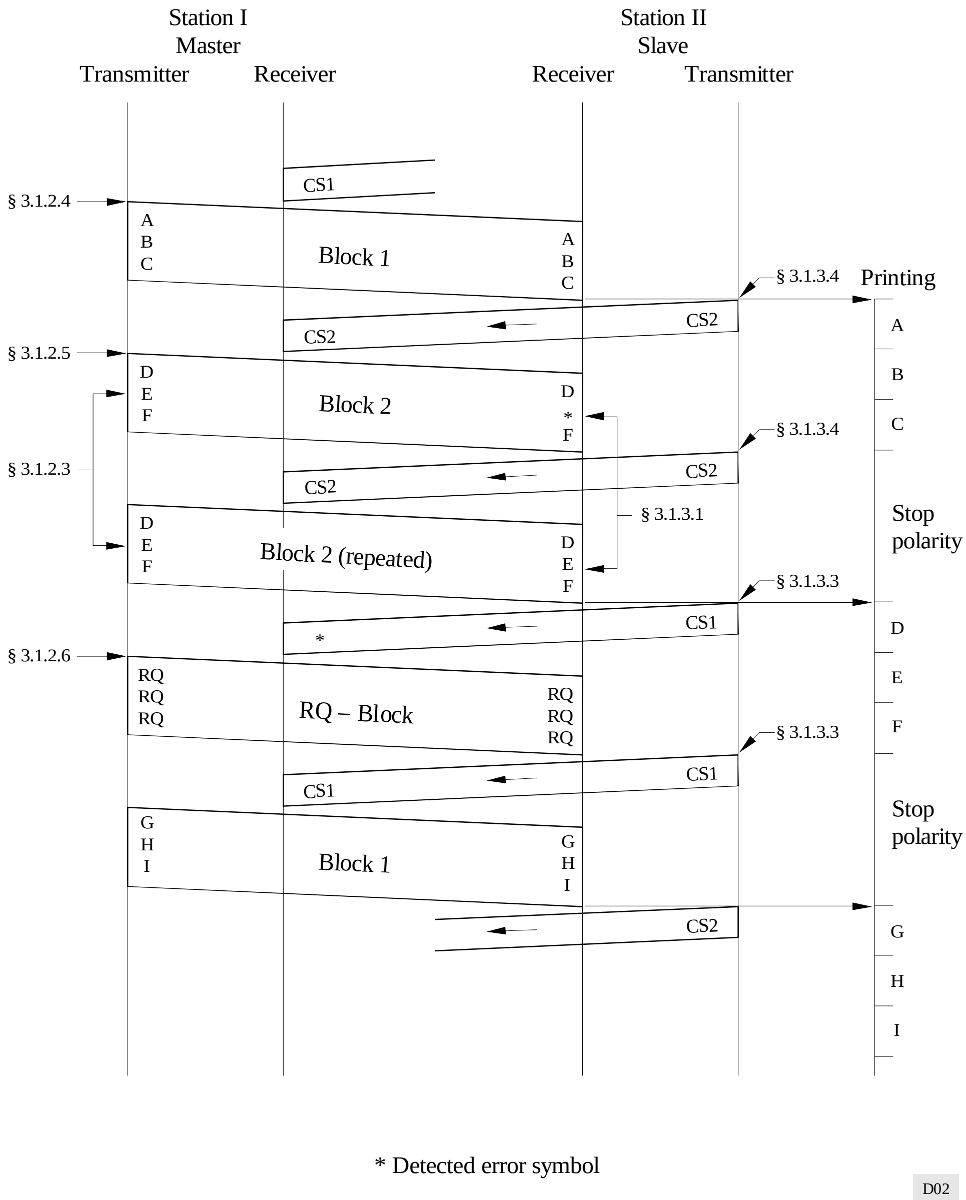


FIGURE 2

Mode A under error receiving conditions



* Detected error symbol

3.1.3 The information receiving station (IRS)

3.1.3.1 Numbers the received blocks of three characters alternately "Block 1" and "Block 2" by a local numbering device, the numbering being interrupted at the reception of:

– a block in which one or more characters are mutilated; or

– a block containing at least one "signal repetition"; (§ 3.1.2.6)

3.1.3.2 after the reception of each block, emits one of the control signals of 70 ms duration after which a transmission pause of 380 ms becomes effective;

3.1.3.3 emits the control signal 1 at the reception of:

– an unmutilated "Block 2", or

– a mutilated "Block 1", or

– "Block 1" containing at least one "signal repetition";

3.1.3.4 emits the control signal 2 at reception of:

– an unmutilated “Block 1”, or

– a mutilated “Block 2”, or

– a “Block 2” containing at least one “signal repetition”.

3.1.4 Phasing

3.1.4.1 When no circuit is established, both stations are in the “stand-by” position. In this stand-by position no ISS or IRS and no master or slave position is assigned to either of the stations;

3.1.4.2 the station desiring to establish the circuit emits the “call” signal. This “call” signal is formed by two blocks of three signals (see Note 1);

3.1.4.3 the call signal contains:

– in the first block: “signal repetition” in the second character place and any combination of information signals (see Note 2) in the first and third character place,

– in the second block: “signal repetition” in the third character place preceded by any combination of the 32 information signals (see Note 2) in the first and second character place;

3.1.4.4 on receipt of the appropriate call signal the called station changes from stand-by to the IRS position and emits the control signal 1 or the control signal 2;

3.1.4.5 on receipt of two consecutive identical control signals, the calling station changes into ISS and operates in accordance with § 3.1.2.4 and 3.1.2.5.

NOTE 1 – A station using a two block call signal, shall be assigned a number in accordance with RR Nos. S19.37, S19.83 and S19.92 to S19.95 [Nos. 2088, 2134 and 2143 to 2146];

NOTE 2 – The composition of these signals and their assignment to individual ships require international agreement (see Recommendation ITU-R M.491).

3.1.5 Rephasing (Note 1)

3.1.5.1 When reception of information blocks or of control signals is continuously mutilated, the system reverts to the “stand-by” position after a predetermined time (a preferable predetermined time would be the duration of 32 cycles of 450 ms), to be decided by the user, of continuous repetition; the station that is master station at the time of interruption immediately initiates rephasing along the same lines as laid down in § 3.1.4;

3.1.5.2 if, at the time of interruption, the slave station was in the IRS position, the control signal to be returned after phasing should be the same as that last sent before the interruption to avoid the loss of an information block upon resumption of the communication. (Some existing equipments may not conform to this requirement);

3.1.5.3 however, if, at the time of interruption, the slave station was in the ISS position, it emits, after having received the appropriate call blocks, either:

– the control signal 3; or

– the control signal 1 or 2 in conformity with § 3.1.4.4, after which control signal 3 is emitted to initiate changeover to the ISS position;

3.1.5.4 if rephasing has not been accomplished within the time-out interval of § 3.1.9.1, the system reverts to the stand-by position and no further rephasing attempts are made.

NOTE 1 – Some coast stations do not provide rephasing (see also Recommendation ITU-R M.492).

3.1.6 Change-over

3.1.6.1 The information sending station (ISS)

– Emits, to initiate a change in the direction of the traffic flow, the information signal sequence “Figure shift” – “Plus” (“figure case of *Z*”) – “Question mark” (“figure case of B”) (see Note 1) followed, if necessary, by one or more “idle signals β” to complete a block;

– emits, on receipt of a control signal 3, a block containing the signals “idle signal β” – “idle signal α” – “idle signal β”;

– changes subsequently to IRS after the reception of a “signal repetition”.

3.1.6.2 The information receiving station (IRS)

– Emits the control signal 3:

a) when the station wishes to change over to ISS,

b) on receipt of a block in which the signal information sequence “Figure shift” – “Plus” – (figure case of Z) – “Question mark” (figure case of B) terminates (see Note 1) or upon receipt of the following block. In the latter case, the IRS shall ignore whether or not one or more characters in the last block are mutilated:

– changes subsequently to ISS after reception of a block containing the signal sequence “idle signal β” – “idle signal α” – “idle signal β”;

– emits one “signal repetition” as a master station, or a block of three “signal repetitions” as a slave station, after being changed into ISS.

NOTE 1 – In the Telex network, the signal sequence combination No. 26 – combination No. 2, sent whilst the teleprinters are in the figure case condition, is used to initiate a reversal of the flow of information. The IRS is, therefore, required to keep track of whether the traffic information flow is in the letter case or figure case mode to ensure proper end-to-end operation of the system.

3.1.7 Output to line

3.1.7.1 the signal offered to the line output terminal is a 5-unit start-stop signal at a modulation rate of 50 Bd.

3.1.8 Answerback

3.1.8.1 The WRU (Who are you?) sequence, which consists of combination Nos. 30 and 4 in the ITU-T International Telegraph Alphabet No. 2, is used to request terminal identification.

3.1.8.2 The information receiving station (IRS), on receipt of a block containing the WRU sequence, which will actuate the teleprinter answerback code generator:

– changes the direction of traffic flow in accordance with § 3.1.6.2;

– transmits the signal information characters derived from the teleprinter answerback code generator;

– after transmission of 2 blocks of “idle signals β” (after completion of the answerback code, or in the absence of an answerback code), changes the direction of traffic flow in accordance with § 3.1.6.1.

NOTE 1 – Some existing equipments may not conform to this requirement.

3.1.9 End of communication

3.1.9.1 When reception of information blocks or of control signals is continuously mutilated, the system reverts to the “stand-by” position after a predetermined time of continuous repetition, which causes the termination of the established circuit (a preferable predetermined time would be the duration of 64 cycles of 450 ms);

3.1.9.2 the station that wishes to terminate the established circuit transmits an “end of communication signal”;

3.1.9.3 the “end of communication signal” consists of a block containing three “idle signal α”:

3.1.9.4 the “end of communication signal” is transmitted by the ISS;

3.1.9.5 if an IRS wishes to terminate the established circuit it has to change over to ISS in accordance with § 3.1.6.2;

3.1.9.6 the IRS that receives an “end of communication signal” emits the appropriate control signal and reverts to the “stand-by” position;

3.1.9.7 on receipt of a control signal that confirms the unmutilated reception of the “end of communication signal”, the ISS reverts to the “stand-by” position;

3.1.9.8 when after a predetermined number of transmissions (see Note 1) of the “end of communication signal” no control signal has been received confirming the unmutilated reception of the “end of communication signal”, the ISS reverts to the stand-by position and the IRS times out in accordance with § 3.1.9.1.

NOTE 1 – A preferable predetermined number would be four transmissions of the “end of communication signal”.

3.2 Mode B, forward error correction (FEC) (see Figs. 3 and 4)

A synchronous system, transmitting an uninterrupted stream of characters from a station sending in the collective B-mode (CBSS) to a number of stations receiving in the collective B-mode (CBRS), or from a station sending in the selective B-mode (SBSS) to one selected station receiving in the selective B-mode (SBRS).

3.2.1 The station sending in the collective or in the selective B-mode (CBSS or SBSS)

3.2.1.1 Emits each character twice: the first transmission (DX) of a specific character is followed by the transmission of four other characters, after which the retransmission (RX) of the first character takes place, allowing for time-diversity reception at 280 ms time space;

3.2.1.2 emits as a preamble to messages or to the call sign, alternately the phasing signal 1 (see § 2.2) and the phasing signal 2 (see § 2.2) whereby phasing signal 1 is transmitted in the RX, and phasing signal 2 in the DX position. At least four of these signal pairs (phasing signal 1 and phasing signal 2) should be transmitted.

3.2.2 The station sending in the collective B-mode (CBSS)

3.2.2.1 Emits during the breaks between two messages in the same transmission the phasing signals 1 and the phasing signals 2 in the RX and the DX position, respectively.

3.2.3 The station sending in the selective B-mode (SBSS)

3.2.3.1 Emits after the transmission of the required number of phasing signals (see § 3.2.1.2) the call sign of the station to be selected. This call sign is a sequence of four characters that represents the number code of the called station. The composition of this call sign should be in accordance with Recommendation ITU-R M.491. This transmission takes place in the time diversity mode according to § 3.2.1.1;

3.2.3.2 emits the call sign and all further signals in a 3B/4Y ratio, i.e. inverted with respect to the signals in Table 1 in the column "emitted 7-unit signal". Consequently, all signals, i.e. both traffic information signals and service information signals, following the phasing signals are transmitted in the 3B/4Y ratio;

3.2.3.3 emits the service information signal "idle signal β" during the idle time between the messages consisting of traffic information signals.

3.2.4 The station(s) receiving in the collective or in the selective B-mode (CBRS or SBRS)

3.2.4.1 Checks both characters (DX and RX), printing an unmutilated DX or RX character, or printing an error symbol or space, if both are mutilated.

3.2.5 Phasing

3.2.5.1 When no reception takes place, the system is in the "stand-by" position as laid down in § 3.1.4.1;

3.2.5.2 on receipt of the sequence *"phasing signal 1"* – *"phasing signal 2"*, or of the sequence *"phasing signal 2"* – *"phasing signal 1"*, in which phasing signal 2 determines the DX and phasing signal 1 determines the RX position, and at least one further phasing signal in the appropriate position, the system changes from "stand-by" to the CBRS position;

3.2.5.3 when started as CBRS the system changes to the SBRS (selectively called receiving station) position on receipt of the inverted characters representing its selective call number;

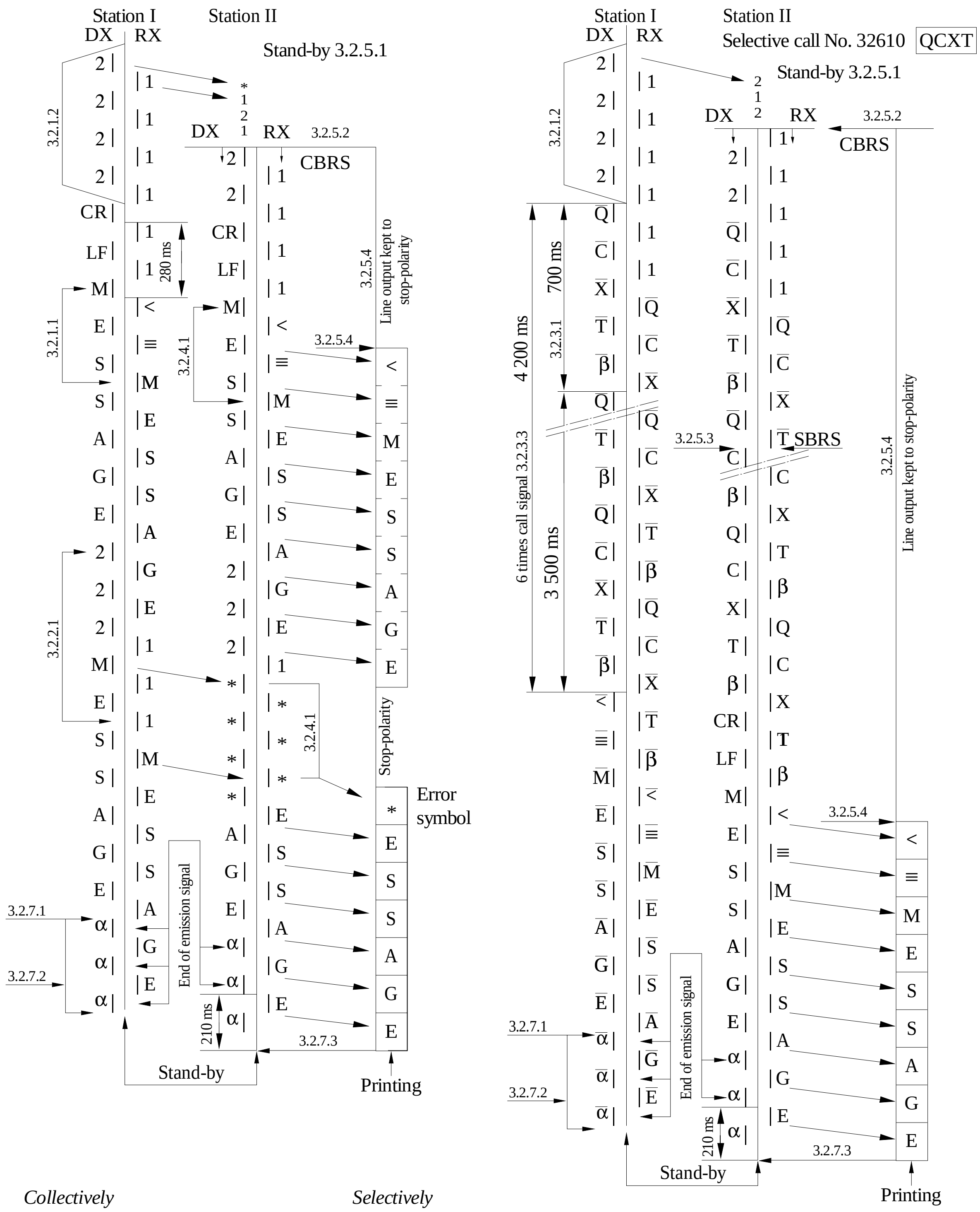
3.2.5.4 having been changed into the CBRS or into the SBRS position the system offers continuous stop-polarity to the line output terminal until either the signal "carriage return" or "line feed" is received;

3.2.5.5 when started as SBRS, the decoder re-inverts all the following signals received to the 3Y/4B ratio, so that these signals are offered to the SBRS in the correct ratio, but they remain inverted for all other stations;

3.2.5.6 both the CBRS and the SBRS revert to the stand-by position if, during a predetermined time, the percentage of mutilated signals received has reached a predetermined value.

FIGURE 3

B-mode operation



Collectively

1: phasing signal 1

2: phasing signal 2

<: carriage return (CR)

≡: line feed (LF)

* Detected error symbol

Overlined symbols (e.g. $\overline{M}$) are transmitted in the 3B/4Y ratio

Selectively

CBSS: B-mode - Sending collectively

CBRS: B-mode - Receiving collectively

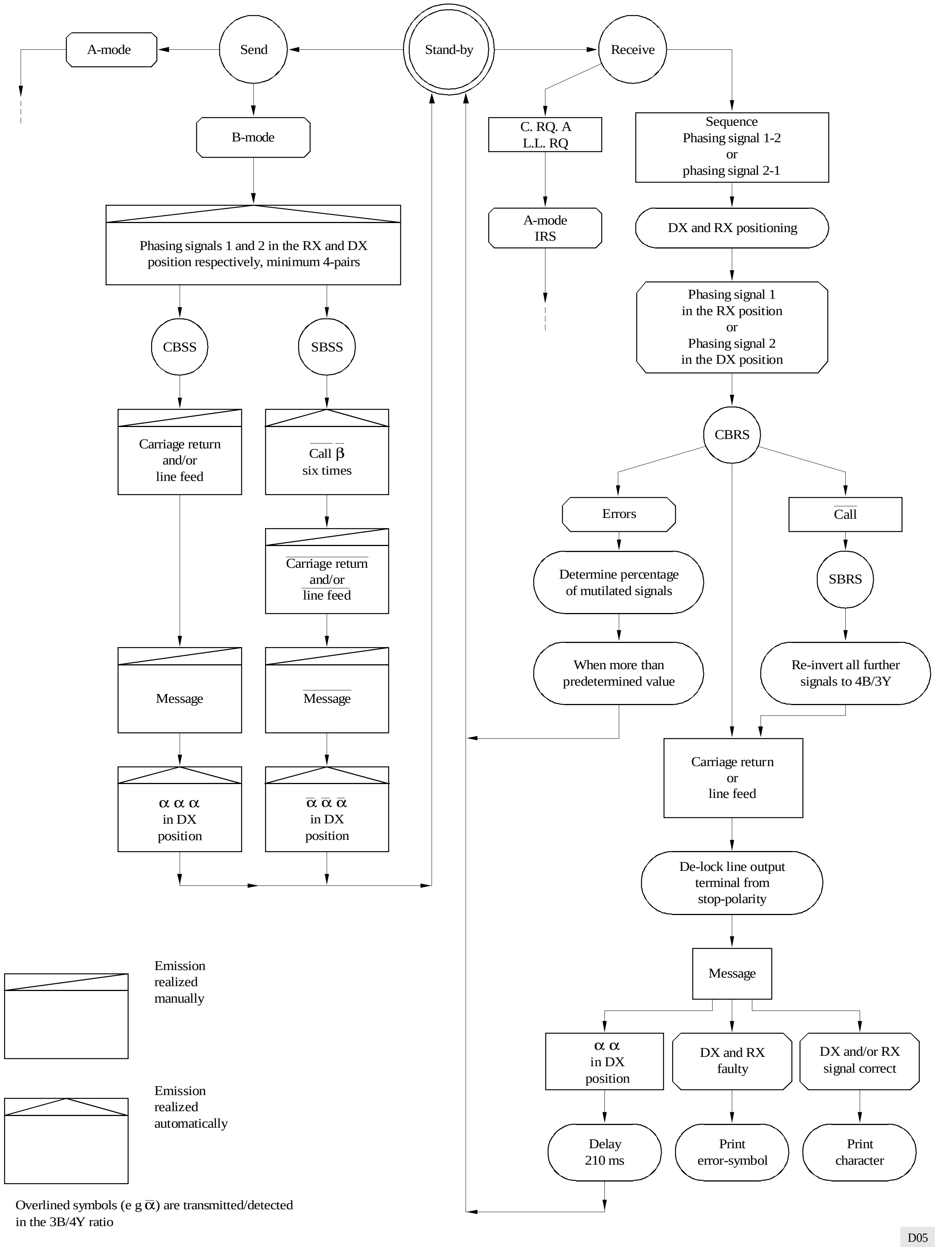
SBSS: B-mode - Sending selectively

SBRS: B-mode - Receiving selectively

D04

FIGURE 4

Flow chart showing processes in B-mode operation



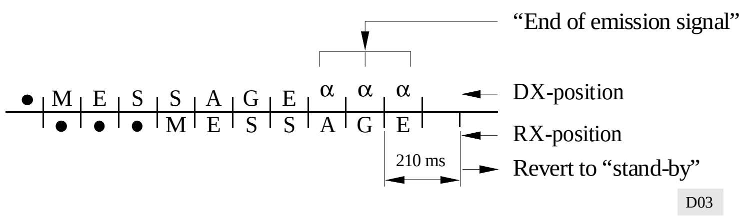
3.2.6 Output to line

3.2.6.1 The signal offered to the line output terminal is a 5-unit start-stop ITU-T International Telegraph Alphabet No. 2 signal at a modulation rate of 50 Bd.

3.2.7 End of emission

3.2.7.1 The station sending in the B-mode (CBSS or SBSS) that wishes to terminate the emission transmits the "end of emission signal";

3.2.7.2 the "end of emission signal" consists of three consecutive "idle signals α" (see § 2.2) transmitted in the DX position only, immediately after the last transmitted traffic information signal in the DX position, after which the station terminates its emission and reverts to the "stand-by" position;



3.2.7.3 the CBRS or the SBRS reverts to the "stand-by" position not less than 210 ms after receipt of at least two consecutive "idle signals α" in the DX position.

RECOMMENDATION ITU-R M.489-2*

TECHNICAL CHARACTERISTICS OF VHF RADIOTELEPHONE EQUIPMENT OPERATING IN THE MARITIME MOBILE SERVICE IN CHANNELS SPACED BY 25 kHz

(1974-1978-1995)

Summary

The Recommendation describes the technical characteristics of VHF radiotelephone transmitters and receivers (or transceivers) used in the maritime mobile service when operating in 25 kHz channels of Appendix S18 [Appendix 18] of the Radio Regulations (RR). It also contains those additional characteristics of transceivers required to operate digital selective calling.

The ITU Radiocommunication Assembly,

considering

a) that Resolution No. 308 of the World Administrative Radio Conference (Geneva, 1979) stipulated that:

– all maritime mobile VHF radiotelephone equipment shall conform to 25 kHz standards by 1 January 1983;

b) that RR Appendix S18 [Appendix 18] gives a table of transmitting frequencies which is based upon the principle of 25 kHz channel separations for the maritime mobile service;

c) that in Opinion 42, the International Electrotechnical Commission (IEC) has been invited to advise the ITU Radiocommunication Sector of any methods of measurement applicable to radio equipment used in land mobile services; and that such methods of measurement may also be suitable for radio equipment used in maritime mobile services;

d) that there is a need to specify the technical characteristics of VHF radiotelephone equipment operating in the maritime mobile service in channels spaced by 25 kHz,

recommends

1 that the following characteristics should be met by VHF (metric) FM radiotelephone equipment used for the maritime mobile services operating on the frequencies specified in RR Appendix S18 [Appendix 18].

1.1 General characteristics

1.1.1 The class of emission should be F3E/G3E.

1.1.2 The necessary bandwidth should be 16 kHz.

1.1.3 Only phase modulation (frequency modulation with a pre-emphasis characteristic of 6 dB/octave) should be used.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

1.1.4 The frequency deviation corresponding to 100% modulation should approach ± 5 kHz as nearly as practicable. In no event should the frequency deviation exceed ± 5 kHz. Deviation limiting circuits should be employed such that the maximum frequency deviation attainable should be independent of the input audio frequency.

1.1.5 Where duplex or semi-duplex systems are in use, the performance of the radio equipment should continue to comply with all the requirements of this Recommendation.

1.1.6 The equipment should be designed so that frequency changes between assigned channels can be carried out within 5 s.

1.1.7 Emissions should be vertically polarized at the source.

1.1.8 Stations using digital selective calling shall have the following capabilities:

a) sensing to determine the presence of a signal on 156.525 MHz (channel 70); and

b) automatic prevention of the transmission of a call, except for distress and safety calls, when the channel is occupied by calls.

1.2 Transmitters

1.2.1 The frequency tolerance for coast station transmitters should not exceed 5 parts in 10^6, and that for ship station transmitters should not exceed 10 parts in 10^6.

1.2.2 Spurious emissions on discrete frequencies, when measured in a non-reactive load equal to the nominal output impedance of the transmitter, should be in accordance with the provisions of RR Appendix S3 [Appendix 8].

1.2.3 The carrier power for coast stations should not normally exceed 50 W.

1.2.4 The carrier power for ship station transmitters should not exceed 25 W. Means should be provided to readily reduce this power to 1 W or less for use at short ranges, except for digital selective calling equipment operating on 156.525 MHz (channel 70) in which case the power reduction facility is optional (see also Recommendation ITU-R M.541 *recommends* 3.7).

1.2.5 The upper limit of the audio-frequency band should not exceed 3 kHz.

1.2.6 The cabinet radiated power should not exceed 25 µW. In some radio environments, lower values may be required.

1.3 Receivers

1.3.1 The reference sensitivity should be equal to or less than 2.0 µV, e.m.f., for a given reference signal-to-noise ratio at the output of the receiver.

1.3.2 The adjacent channel selectivity should be at least 70 dB.

1.3.3 The spurious response rejection ratio should be at least 70 dB.

1.3.4 The radio frequency intermodulation rejection ratio should be at least 65 dB.

1.3.5 The power of any conducted spurious emission, measured at the antenna terminals, should not exceed 2.0 nW at any discrete frequency. In some radio environments lower values may be required.

1.3.6 The effective radiated power of any cabinet radiated spurious emission on any frequency up to 70 MHz should not exceed 10 nW. Above 70 MHz, the spurious emissions should not exceed 10 nW by more than 6 dB/octave in frequency up to 1 000 MHz. In some radio environments, lower values may be required;

2 that reference should also be made to Recommendations ITU-R SM.331 and ITU-R SM.332 and to the relevant IEC publications on methods of measurement.

RECOMMENDATION ITU-R M.492-6*

OPERATIONAL PROCEDURES FOR THE USE OF DIRECT-PRINTING TELEGRAPH EQUIPMENT IN THE MARITIME MOBILE SERVICE

(Question ITU-R 5/8)

(1974-1978-1982-1986-1990-1992-1995)

Summary

The Recommendation provides in Annex 1 operational procedures for the use of direct-printing telegraph equipment in communication between a ship and a coast station in the selective ARQ-mode on a fully automated or semi-automated basis and to a number of ship stations or a single ship in the broadcast FEC-mode. It also specifies interworking between equipments in accordance with technical characteristics given in Recommendations ITU-R M.476 and ITU-R M.625. Appendix 1 contains procedures for setting up of calls.

The ITU Radiocommunication Assembly,

considering

a) that narrow-band direct-printing telegraph services are in operation using equipment as described in Recommendations ITU-R M.476, ITU-R M.625 and ITU-R M.692;

b) that an improved narrow-band direct-printing telegraph system providing automatic identification and capable of using the 9-digit ship station identity is described in Recommendation ITU-R M.625;

c) that the operational procedures necessary for such services should be agreed upon;

d) that, as far as possible, these procedures should be similar for all services and for all frequency bands (different operational procedures may be required in frequency bands other than the HF and MF bands);

e) that a large number of equipments complying with Recommendation ITU-R M.476 exist;

f) that interworking between equipments in accordance with Recommendations ITU-R M.476 and ITU-R M.625 is required, at least for a transitionary period,

recommends

1 that the operational procedures given in Annex 1 be observed for the use of narrow-band direct-printing telegraph equipment in accordance with either Recommendation ITU-R M.476 or ITU-R M.625 in the MF and HF bands of the maritime mobile service;

2 that when using direct-printing telegraphy or similar systems in any of the frequency bands allocated to the maritime mobile service, the call may, by prior arrangement, be made on a working frequency available for such systems.

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

ANNEX 1

Operational procedures

1 Mode A (ARQ)

1.1 Methods used for setting up narrow-band direct-printing telegraph communications between a ship station and a coast station in the ARQ-mode should be on a fully automatic or semi-automatic basis, insofar that a ship station should have direct access to a coast station on a coast station receiving frequency and a coast station should have direct access to a ship station on a coast station transmitting frequency.

1.2 However, where necessary, prior contact by Morse telegraphy, radiotelephony or other means is not precluded.

1.3 Through connection to a remote teleprinter station over a dedicated circuit or to a subscriber of the international telex network may be achieved by manual, semi-automatic or automatic means.

NOTE 1 – Before an international automatic service can be introduced, agreement has to be reached on a numbering plan, traffic routing and charging. This should be considered by both the ITU-T and the ITU-R.

NOTE 2 – Recommendations ITU-R M.476 (see § 3.1.5) and ITU-R M.625 (see § 3.8) make provision for automatic re-establishment of radio circuits by rephasing in the event of interruption. However, it has been reported that this procedure has, in some countries, resulted in technical and operational problems when radio circuits are extended into the public switched network or to certain types of automated switching or store-and-forward equipments. For this reason, some coast stations do not accept messages if the rephasing procedure is used.

NOTE 3 – When a connection is set up in the ARQ mode with the international telex network via a coast station, where practicable the general requirements specified in ITU-T Recommendation U.63 should be met.

1.4 When, by prior arrangement, unattended operation is required for communication from a coast station to a ship station, or between two ship stations, the receiving ship station should have a receiver tuned to the other station's transmitting frequency and a transmitter tuned or a transmitter capable of being tuned automatically to the appropriate frequency and ready to transmit on this frequency.

1.5 For unattended operation a ship station should be called selectively by the initiating coast or ship station as provided for by Recommendations ITU-R M.476 and ITU-R M.625. The ship station concerned could have available traffic stored ready for automatic transmission on demand of the calling station.

1.6 At the "over" signal, initiated by the calling station, any available traffic in the ship's traffic store could be transmitted.

1.7 At the end of the communication, an "end of communication" signal should be transmitted, whereupon the ship's equipment should automatically revert to the "stand-by" condition.

1.8 A "free channel" signal may be transmitted by a coast station where necessary to indicate when a channel is open for traffic. The "free channel" signals should preferably be restricted to only one channel per HF band and their duration should be kept as short as possible. In accordance with Article 18 of the Radio Regulations and recognizing the heavy loading of the frequencies available for narrow-band direct printing in the HF bands, "free channel" signals should not be used in future planned systems.

1.9 The format of the "free channel" signal should be composed of signals in the 7-unit error detecting code as listed in § 2 of Annex 1 to Recommendation ITU-R M.476 and § 2 of Annex 1 to Recommendation ITU-R M.625. Three of these signals should be grouped into a block, the middle signal being the "signal repetition" (RQ), the first signal of the block being any of the signals VXKMCF TBOZA and the third signal of the block being any of the signals VMPCYFS OIRZDA (see Recommendation ITU-R M.491). These signals should be indicated in the ITU List of Coast Stations.

Selections of new signals should preferably be chosen to correspond to the first two digits of that coast station's 4-digit identification number. If this is not possible because the characters needed are not listed above, or if this is not desired because this combination is already in use by another coast station, it is preferred that a combination of characters be selected from those listed above in the second part of each row, i.e. TBOZA for the first signal and OIRZDA for the third signal of the free channel block. The signals in the block are transmitted at a modulation rate of 100 Bd and the blocks are separated by pauses of 240 ms. For manual systems this "free channel" signal should be interrupted either by a period of no signal or by a signal or signals, that would enable an operator to recognize the "free channel" condition by ear. An aurally recognizable signal, e.g. a Morse signal, may be used alone as the "free channel" signal in manual systems. At least 8 blocks of the 7-unit signal should be transmitted before interruption.

1.10 In the case of single frequency operation, as described in Recommendation ITU-R M.692, the free channel signal should be interrupted by listening periods of at least 3 s.

1.11 General operational procedures for setting up calls between ship stations and between ship stations and coast stations are given below and specific procedures are given in Appendix 1.

1.12 Manual procedures

1.12.1 Ship to coast station

1.12.1.1 The operator of the ship station establishes communication with the coast station by A1A Morse telegraphy, telephony or by other means using normal calling procedures. The operator then requests direct-printing communication, exchanges information regarding the frequencies to be used and, when applicable, gives the ship station the direct-printing selective call number assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the ship station identity assigned in accordance with the Preface to List VII A.

1.12.1.2 The operator of the coast station then establishes direct-printing communication on the frequency agreed, using the appropriate identification of the ship.

1.12.1.3 Alternatively the operator of the ship station, using the direct-printing equipment, calls the coast station on a predetermined coast station receive frequency using the identification of the coast station assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the coast station identity assigned in accordance with the Preface to List VII A.

1.12.1.4 The operator of the coast station then establishes direct-printing communication on the corresponding coast station transmit frequency.

1.12.2 Coast station to ship

1.12.2.1 The operator of the coast station calls the ship station by A1A Morse telegraphy, telephony or other means, using normal calling procedures.

1.12.2.2 The operator of the ship station then applies the procedures of § 1.12.1.1 or § 1.12.1.3.

1.12.3 Intership

1.12.3.1 The operator of the calling ship station establishes communication with the called ship station by A1A Morse telegraphy, telephony, or by other means, using normal calling procedures. The operator then requests direct-printing communication, exchanges information regarding the frequencies to be used and, when applicable, gives the direct-printing selective call number of the calling ship station assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the ship station identity assigned in accordance with the Preface to List VII A.

1.12.3.2 The operator of the called ship station then establishes direct-printing communication on the frequency agreed, using the appropriate identification of the calling ship.

1.13 Procedures for automatic operation

1.13.1 Ship to coast station

1.13.1.1 The ship station calls the coast station on a predetermined coast station receive frequency, using the direct-printing equipment and the identification signal of the coast station assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the coast station identity assigned in accordance with the Preface to List VII A.

1.13.1.2 The coast station's direct-printing equipment detects the call and the coast station responds directly on the corresponding coast station transmit frequency, either automatically or under manual control.

1.13.2 Coast station to ship

1.13.2.1 The coast station calls the ship station on a predetermined coast station transmit frequency, using the direct-printing equipment and the ship station direct-printing selective call number assigned in accordance with Recommendation ITU-R M.476 or ITU-R M.625 as appropriate, or the ship station identity assigned in accordance with the Preface to List VII A.

1.13.2.2 The ship station's direct-printing equipment tuned to receive the predetermined coast station transmit frequency detects the call, whereupon the reply is given in one of the following ways:

a) the ship station replies either immediately on the corresponding coast station receive frequency or at a later stage, using the procedure of § 1.12.1.3; or

b) the ship station's transmitter is automatically started on the corresponding coast station receive frequency and the direct-printing equipment responds by sending appropriate signals to indicate readiness to receive traffic automatically.

1.14 Message format

1.14.1 Where the appropriate facilities are provided by the coast station, traffic may be exchanged with the telex network:

a) in a conversational mode where the stations concerned are connected directly, either automatically or under manual control; or

b) in a store-and-forward mode where traffic is stored at the coast station until the circuit to the called station can be set up, either automatically or under manual control.

1.14.2 In the shore-to-ship direction, the message format should conform to normal telex network practice (see also Appendix 1, § 2).

1.14.3 In the ship-to-shore direction, the message format should conform to the operational procedures specified in Appendix 1, § 1.

2 Mode B (FEC)

2.1 Messages may, by prior arrangement, be sent in the B mode from a coast station or a ship station to a number of ships or to a single ship, preceded if desired by the selective call code of the ship(s) concerned where:

2.1.1 a receiving ship station is not permitted or not able to use its transmitter, or

2.1.2 communications are intended for more than one ship, or

2.1.3 unattended reception of the B mode is required and automatic acknowledgement is not necessary.

In such cases, the ship station receivers should be tuned to the appropriate coast or ship station transmitting frequency.

2.2 All B mode messages should start with "carriage return" and "line feed" signals.

2.3 When the ship station receives phasing signals in the B mode, its teleprinter should start automatically and should stop automatically when reception of the emission ceases.

2.4 Ship stations may acknowledge the reception of B mode messages by A1A Morse telegraphy, telephony or by other means.

3 Inter-working between equipments in accordance with Recommendations ITU-R M.476 and ITU-R M.625

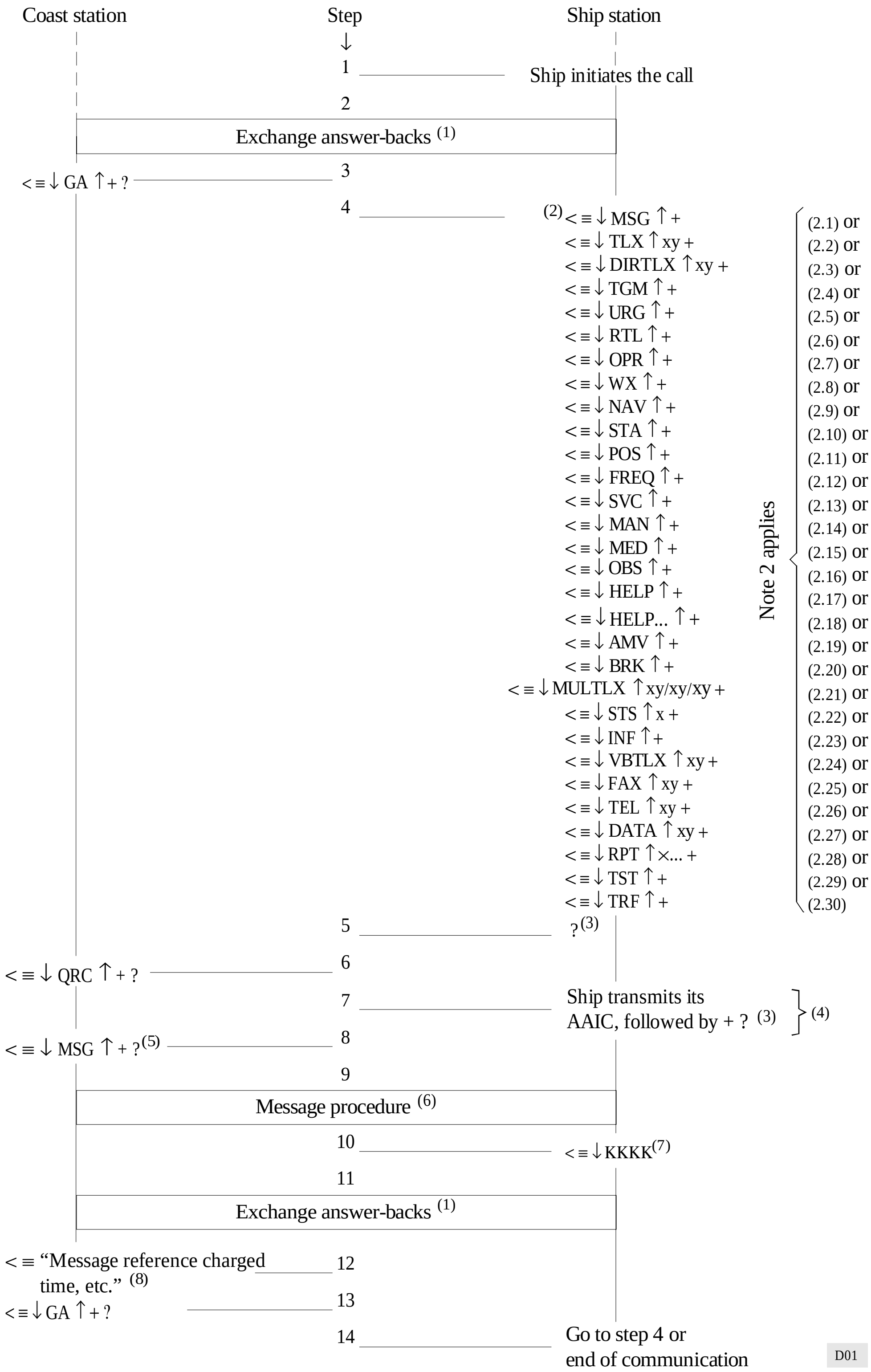
3.1 Recommendation ITU-R M.625 provides for automatic inter-working with equipment which is in accordance with Recommendation ITU-R M.476. The criteria for determining whether one or both stations are of the Recommendation ITU-R M.476 type are the length of the call signal and the composition of the call blocks.

3.2 If both stations have equipment in accordance with Recommendation ITU-R M.625, automatic station identification is a part of the automatic call set-up procedures. However, if one or both stations have equipment in accordance with Recommendation ITU-R M.476, no automatic station identification takes place. For this reason, and because Recommendation ITU-R M.625 accommodates the use of the 9-digit ship station identity for the direct-printing equipment call signal, it is desirable that all new equipment be in accordance with Recommendation ITU-R M.625 at the earliest practicable time.

3.3 In order to attain full compatibility with the large number of existing equipment, it will be necessary to assign both a 9-digit and a 5- (or 4-) digit identity (i.e. 7- and 4-signal call signals) to such new stations. Ship and coast station lists should contain both signals.

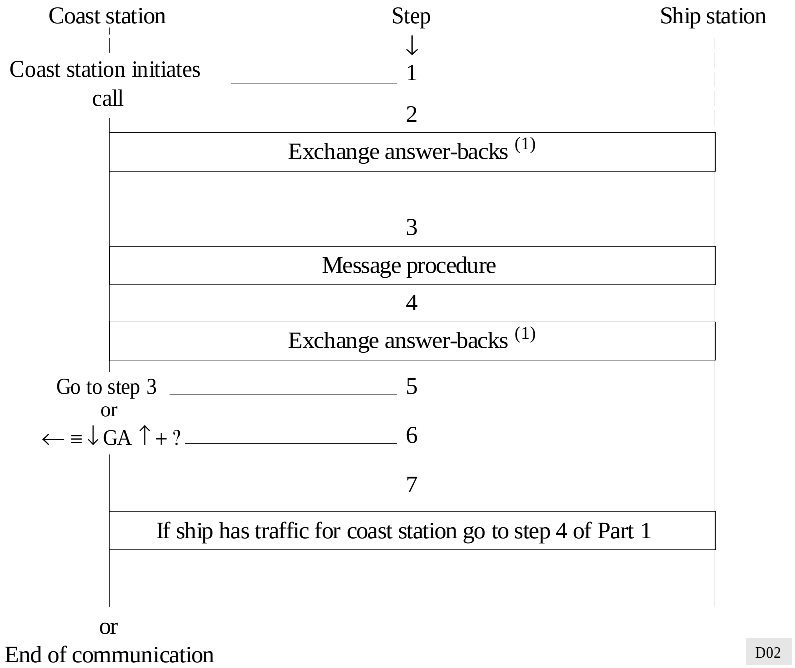
APPENDIX 1

1 Procedure for setting up a call in the ship-to-coast station direction



2 Procedure for setting up a call in the coast-to-ship station direction

Operation in the direction coast station to ship may need to be in the store-and-forward mode owing to the fact that radio propagation conditions may not allow the setting up of a call at the intended time.



Notes relative to § 1 and 2:

(1) a) In automatic operation the answer-back exchange is initiated and controlled by the coast station. For calls set up by the ship station the answer-back exchange in manual operation may be initiated by the ship station.

For calls set up by the coast station the answer-back exchange in manual operation is initiated by the coast station, thereby defining the order in which the exchange takes place.

b) Answer-back code as defined in ITU-T Recommendations F.130 for ship stations and F.60 for coast stations.

(2) A coast station need not provide all of the facilities indicated. However, where specific facilities are provided, the facility codes indicated should be used. The facility "HELP" should always be available.

(2.1) MSG indicates that the ship station needs to immediately receive any messages held for it at the coast station.

(2.2) TLX ↑ xy indicates that the following message is for immediate connection to a store-and-forward facility located at the coast station.

y indicates the subscriber's national telex number.

x is used where applicable to indicate the country code (ITU-T Recommendation F.69) preceded by 0 (when applicable). (Where the store-and-forward system is remote from the coast station, TLX alone may be used.)

TLXA may optionally be used instead of TLX which indicates that ship wishes to be advised (using the normal shore-to-ship procedures) when the message has been delivered to the indicated telex number.

(2.3) DIRTLX ↑ xy indicates that a direct telex connection is required.

y indicates the subscriber's national telex number.

x is used where applicable to indicate the country code (ITU-T Recommendation F.69) preceded by 0 (when applicable).

RDL + may optionally be used to indicate that the last DIRTLX ↑ xy telex number should be redialled.

(2.4) TGM indicates that the following message is a radio telegram.

(2.5) URG indicates that the ship station needs to be connected immediately to a manual assistance operator and an audible alarm may be activated. This code should only be used in case of emergency.

(2.6) RTL indicates that the following message is a radio telex letter.

(2.7) OPR indicates that connection to a manual assistance operator is required.

(2.8) WX indicates that the ship station needs to immediately receive weather information.

(2.9) NAV indicates that the ship station needs to immediately receive navigational warnings.

(2.10) STA indicates that the ship station needs to immediately receive a status report of all store-and-forward messages which have been sent by that ship station, but which the ship station has not already received on retransmitted or non-delivered information (see also ([6])). STA ↑ x may also be used where the ship station needs to immediately receive a status report of such a message where x indicates the message reference provided by the coast station.

(2.11) POS indicates that the following message contains the ship's position. Some administrations use this information to assist in the subsequent automatic transmission or reception of messages (e.g. for calculating the optimum traffic frequency and/or the appropriate directional antennas to use).

(2.12) FREQ indicates that the following message indicates the frequency on which the ship is keeping watch.

(2.13) SVC indicates that the following message is a service message (for subsequent manual attention).

(2.14) MAN indicates that the following message is to be stored and manually forwarded to a country which cannot be accessed automatically.

(2.15) MED indicates that an urgent medical message follows.

(2.16) OBS indicates that the following message is to be sent to the meteorological organization.

(2.17) HELP indicates that the ship station needs to immediately receive a list of available facilities within the system.

(2.18) If information is needed on the application of procedures for individual facilities at a coast station, request for further details concerning the specific procedure can be obtained by the facility code HELP followed by the appropriate facility code for which the information is needed, e.g.: < ≡ ↓HELP DIRTLX ↑+ indicates that the ship station needs information on the procedures (action by ship operator) for ordering a dialogue-mode connection with a telex network subscriber via the coast station.

(2.19) AMV indicates that the following message is to be sent to the AMVER organization.

(2.20) BRK indicates that the use of the radio path is to be immediately discontinued (for use where the ship's operator can only use a teleprinter for controlling the ARQ equipment).

(2.21) MULTLX ↑ xy/xy/xy + indicates that the following message is a multiple address message for immediate connection to a store-and-forward facility located at the coast station.

y indicates the subscriber's national telex number.

x is used where applicable to indicate the country code (ITU-T Recommendation F.69) preceded by 0 (when applicable).

Each separate xy indicates a different telex number to which the same message should be forwarded. At least two separate telex numbers should be included.

MULTLXA may optionally be used instead of MULTLX which indicates that the ship wishes to be advised (using the normal shore-to-ship procedures) when the messages have been delivered to the indicated telex numbers.

(2.22) STS ↑ x + indicates that the following message is for transmission to a ship using a store-and-forward facility located at the coast station. x indicates the addressed ship's 5- or 9-digit identity number.

(2.23) INF indicates that the ship station needs to immediately receive information from the coast station's database. Some administrations provide a variety of different database information in which case INF returns a directory listing and a subsequent facility code is used to select the desired information.

(2.24) VBTLX ↑ xy indicates that the following message should be dictated, by the coast station, to a voicebank (voice messaging) telephone number for subsequent retrieval by the addressee, and that a copy of the message should be forwarded to telex number xy. The voicebank telephone number should be included in the first line of the message text.

(2.25) FAX ↑ xy indicates that the following message should be forwarded, via the PSTN, by facsimile to the telephone number xy.

(2.26) TEL ↑ xy indicates that the following message should be telephoned, by the coast station, to the telephone number xy.

(2.27) DATA ↑ xy indicates that the following message should be forwarded by the coast station using data facilities to the subscriber number xy (via the PSTN).

(2.28) RPT ↑ xy… indicates that the ship needs to receive, using the ARQ mode, a specific identified message (e.g., earlier transmitted in the FEC mode), if still available for automatic retransmission. x… is used as the message identifier.

(2.29) TST indicates that the ship needs to receive an automatically transmitted test text (e.g. "the quick brown fox …").

(2.30) TRF indicates that the ship needs to receive information, automatically transmitted, on tariffs currently applicable to the coast station.

(3) The symbol "?" is not necessary where the coast station is automatic. It is normally required only for manual systems.

(4) In cases where the coast station requires information about the relevant Accounting Authority Identification Code (AAIC), this information should be provided by the ship operator on receipt of the combination < ≡ ↓ QRC ↑ + from the coast station.

Some coast stations may request additional information, e.g. ship's name, call sign, etc.

(5) This sequence may be preceded where necessary by suitable prompts or facility selection information and, if appropriate, any consequent ship station reply, or may be deleted where not applicable (e.g. where facility codes WX, NAV, STA, MSG or HELP are input at step 4). Where facility code DIRTLX ↑ xy was input at step 4, this sequence may be replaced by the distant end answer-back or by any service signal (e.g. NC, OCC, etc.) received from the telex network.

(6) Message procedures depend on which facility is used:

For TLX where the store-and-forward system is remote from the coast station, ITU-T Recommendation F.72 may apply. Where the store-and-forward system is located at the coast station, the complete information content of the message sent at this step will be forwarded to the subscriber whose telex number is given by xy.

For DIRTLX, see ITU-T Recommendation F.60.

For TGM, see ITU-T Recommendations F.1 and F.31.

For SVC and MED, the message will normally be plain text and no specific message procedure is required.

For RTL, the message will be plain text but should include the postal address of the addressee.

For STA, the appropriate status information is returned to the ship in accordance with ITU-T Recommendation F.72, § 11.3 and 11.4.

For POS and FREQ, specific national procedures may apply.

(7) This sequence of 4 K's "KKKK" (4 combination No. 11 signals in the letter case) indicates that any network connection should be cleared but that the radio path should be maintained and that the procedure should immediately proceed to step 11. This sequence may be used elsewhere in the procedure in which case the procedure reverts to step 3.

(8) This step is optional and may not apply to all facilities.

RECOMMENDATION ITU-R M.541-8*

OPERATIONAL PROCEDURES FOR THE USE OF DIGITAL SELECTIVE-CALLING EQUIPMENT IN THE MARITIME MOBILE SERVICE

(Question ITU-R 9/8)

(1978-1982-1986-1990-1992-1994-1995-1996-1997)

Summary

The Recommendation contains the operational procedures for digital selective-calling (DSC) equipment whose technical characteristics are given in Recommendation ITU-R M.493. The Recommendation contains four annexes. In Annexes 1 and 2 the provisions and procedures are described for distress and safety calls and for non-distress and safety calls, respectively. In Annexes 3 and 4 the operational procedures for ships and for coast stations are described and Annex 5 lists the frequencies to be used for DSC.

The ITU Radiocommunication Assembly,

considering

a) Resolution No. 311 and Recommendation No. 312 of the World Administrative Radio Conference (Geneva, 1979) (WARC-79);

b) that digital selective-calling (DSC) will be used as described in Recommendation ITU-R M.493;

c) that the requirements of Chapter IV of the 1988 Amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974, for the Global Maritime Distress and Safety System (GMDSS) are based on the use of DSC for distress alerting on terrestrial frequencies and that operational procedures are necessary for transition to, and implementation of, that system;

d) that, as far as is practicable, operational procedures in all frequency bands and for all types of communications should be similar;

e) that DSC may provide a useful supplementary means of transmitting a distress call in addition to the provisions of transmitting the distress call by existing methods and procedures in the Radio Regulations (RR);

f) that conditions when alarms have to be actuated should be specified,

recommends

1 that the technical characteristics of equipment used for DSC in the maritime mobile service should be in conformity with the relevant ITU-R Recommendations;

2 that the operational procedures to be observed in the MF, HF and VHF bands for DSC should be in accordance with Annex 1 for distress and safety calls and Annex 2 for other calls;

3 that provisions should be made at stations equipped for DSC for:

3.1 the manual entry of address, type of call, category and various messages into a DSC sequence;

3.2 the verification and if necessary the correction of such manually formed sequences;

3.3 a specific aural alarm and visual indication to indicate receipt of a distress or urgency call or a call having distress category. It should not be possible to disable this alarm and indication. Provisions should be made to ensure that they can be reset only manually;

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the ITU Telecommunication Standardization Sector (ITU-T).

3.4 aural alarm(s) and visual indication for calls other than distress and urgency. The aural alarm(s) may be capable of being disabled;

3.5 such visual indicators to indicate:

3.5.1 type of received call address (to all stations, to a group of stations, geographical, individual);

3.5.2 category;

3.5.3 identity of calling station;

3.5.4 numerical or alpha-numerical type of information, e.g. frequency information and telecommand;

3.5.5 type of "end of sequence" character;

3.5.6 detection of errors, if any;

3.6 monitoring the VHF channel used for digital selective-calling purposes to determine the presence of a signal and, except for distress and safety calls, provide facilities for automatically preventing the transmission of a DSC call until the channel is free;

3.7 ship originated routine all-ships calls on VHF should be transmitted at a power level of 1 W or less. Integrated VHF DSC equipment should automatically reduce power for transmission of these calls;

4 that the equipment should be simple to operate;

5 that the operational procedures given in Annex 3, which are based on the relevant procedures from Annexes 1 and 2 and from the RR, be used as guidance for ships and coast stations;

6 that the frequencies used for distress and safety purposes using DSC are those contained in Annex 4 to this Recommendation (see also RR Article 38 (Appendix S13, Part A2)).

NOTE 1 – The following definitions are used throughout this Recommendation:

Single frequency: the same frequency is used for transmission and reception;

Paired frequencies: frequencies which are associated in pairs; each pair consisting of one transmitting and one receiving frequency;

International DSC frequencies: those frequencies designated in the RR for exclusive use for DSC on an international basis;

National DSC frequencies: those frequencies assigned to individual coast stations or a group of stations on which DSC is permitted (this may include working frequencies as well as calling frequencies). The use of these frequencies must be in accordance with the RR;

Automatic DSC operation at a ship station: a mode of operation employing automatic tunable transmitters and receivers, suitable for unattended operation, which provide for automatic call acknowledgements upon reception of a DSC and automatic transfer to the appropriate working frequencies;

Call attempt: one or a limited number of call sequences directed to the same stations on one or more frequencies and within a relatively short time period (e.g. a few minutes). A call attempt is considered unsuccessful if a calling sequence contains the symbol RQ at the end of the sequence and no acknowledgement is received in this time interval.

ANNEX 1

Provisions and procedures for distress and safety calls

1 Introduction

The terrestrial elements of the GMDSS adopted by the 1988 Amendments to the International Convention for SOLAS, 1974, are based on the use of DSC for distress and safety communications.

1.1 Method of calling

The provisions of Chapter NIX (SVII) are applicable to the use of DSC in cases of distress, urgency or safety.

2 DSC distress call and message

The DSC “distress call” provides for alerting, self-identification, ship’s position including time, nature of distress and contains both the distress call (RR No. 3091 and 3092 (Appendix S13, Part A3, § 4)) and the distress message (RR No. 3093 and 3094 (Appendix S13, Part A3, § 5)) as defined in the RR.

3 Procedures for DSC distress calls

3.1 Transmission by a mobile unit in distress

3.1.1 The DSC equipment should be capable of being preset to transmit the distress call on at least one distress alerting frequency.

3.1.2 The distress call shall be composed in accordance with Recommendation ITU-R M.493; the ship’s position information, the time at which it was taken and the nature of distress should be entered as appropriate. If the position of the ship cannot be entered, then the position information signals shall be transmitted automatically as the digit 9 repeated ten times. If the time cannot be included, then the time information signals shall be transmitted automatically as the digit 8 repeated four times.

3.1.3 Distress call attempt

At MF and HF a distress call attempt may be transmitted as a single frequency or a multi-frequency call attempt. At VHF only single frequency call attempts are used.

3.1.3.1 Single frequency call attempt

A distress call attempt should be transmitted as 5 consecutive calls on one frequency. To avoid call collision and the loss of acknowledgements, this call attempt may be transmitted on the same frequency again after a random delay of between 3½ and 4½ min from the beginning of the initial call. This allows acknowledgements arriving randomly to be received without being blocked by retransmission. The random delay should be generated automatically for each repeated transmission, however it should be possible to override the automatic repeat manually.

At MF and HF, single frequency call attempts may be repeated on different frequencies after a random delay of between 3½ and 4½ min from the beginning of the initial call. However, if a station is capable of receiving acknowledgements continuously on all distress frequencies except for the transmit frequency in use, then single frequency call attempts may be repeated on different frequencies without this delay.

3.1.3.2 Multi-frequency call attempt

A distress call attempt may be transmitted as up to 6 consecutive (see Note 1) calls dispersed over a maximum of 6 distress frequencies (1 at MF and 5 at HF). Stations transmitting multi-frequency distress call attempts should be able to receive acknowledgements continuously on all frequencies except for the transmit frequency in use, or be able to complete the call attempt within 1 min.

Multi-frequency call attempts may be repeated after a random delay of between 3½ and 4½ min from the beginning of the previous call attempt.

NOTE 1 – A VHF call may be transmitted simultaneously with an MF/HF call.

3.1.4 Distress

In the case of distress the operator should:

3.1.4.1 enter the desired mode of the subsequent communication and if time permits, enter the ship’s position and time (see Note 1) it was taken and the nature of distress (see Note 1);

NOTE 1 – If these are not provided automatically.

3.1.4.2 select the distress frequency(ies) to be used (see Note 1 of § 3.1.4.1);

3.1.4.3 activate the “distress call” attempt by a dedicated distress button.

3.1.5 Cancellation of an inadvertent distress call

A station transmitting an inadvertent distress call shall immediately cancel the alert over each channel on which the distress call was transmitted. For this purpose, a "distress cancellation" call in the format indicated in Recommendation ITU-R M.493, Fig. 4c) may be transmitted with own ship’s maritime mobile service identity (MMSI) inserted as identification of ship in distress.

This distress cancellation should be followed immediately by the voice cancellation procedure as described in Annex 3 (§ 1.7).

3.2 Reception

The DSC equipment should be capable of maintaining a reliable watch on a 24-hour basis on appropriate DSC distress alerting frequencies.

3.3 Acknowledgement of distress calls

Acknowledgements of distress calls should be initiated manually.

Acknowledgements should be transmitted on the same frequency as the distress call was received.

3.3.1 Distress calls should normally be acknowledged by DSC only by appropriate coast stations. Coast stations should, in addition, set watch on radiotelephony and, if the «mode of subsequent communication» signal in the received distress call indicates teleprinter, also on narrow-band direct-printing (NBDP) (see Recommendation ITU-R M.493). In both cases, the radiotelephone and NBDP frequencies should be those associated with the frequency on which the distress call was received.

3.3.2 Acknowledgements by coast stations of DSC distress calls transmitted on MF or HF should be initiated with a minimum delay of 1 min after receipt of a distress call, and normally within a maximum delay of 2 ¾ min. This allows all calls within a single frequency or multi-frequency call attempt to be completed and should allow sufficient time for coast stations to respond to the distress call. Acknowledgements by coast stations on VHF should be transmitted as soon as practicable.

3.3.3 The acknowledgement of a distress call consists of a single DSC acknowledgement call which should be addressed to “all ships” and include the identification (see Recommendation ITU-R M.493) of the ship whose distress call is being acknowledged.

3.3.4 Ship stations should, on receipt of a distress call, set watch on an associated radiotelephone distress and safety traffic frequency and acknowledge the call by radiotelephony. If a ship station continues to receive a DSC distress call on an MF or VHF channel, a DSC acknowledgement should be transmitted to terminate the call and should inform a coast station or coast earth station by any practicable means.

3.3.5 The automatic repetition of a distress call attempt should be terminated automatically on receipt of a DSC distress acknowledgement.

3.3.6 When distress and safety traffic cannot be successfully conducted using radiotelephony, an affected station may indicate its intention (using an “all ships” DSC call, with the category distress, and normally indicating the frequency of the associated NBDP channel) to conduct subsequent communications on the associated frequency for NBDP telegraphy.

3.4 Distress relays

Distress relay calls should be initiated manually.

3.4.1 A distress relay call should use the telecommand signal “distress relay” in accordance with Recommendation ITU-R M.493 and the calling attempt should follow the procedures described in § 3.1.3 to 3.1.3.2 for distress calls.

3.4.2 Any ship, receiving a distress call on an HF channel which is not acknowledged by a coast station within 5 min, should transmit a distress relay call to the appropriate coast station.

3.4.3 Distress relay calls transmitted by coast stations, or by ship stations addressed to "all ships", should be acknowledged by ship stations using radiotelephony. Distress relay calls transmitted by ships should be acknowledged by a coast station transmitting a "distress relay acknowledgement" call in accordance with the procedures for distress acknowledgements given in § 3.3 to 3.3.3.

4 Procedures for DSC urgency and safety calls (see Note 1)

4.1 DSC, on the distress and safety calling frequencies, should be used by coast stations to advise shipping, and by ships to advise coast stations and/or ship stations, of the impending transmission of urgency, vital navigational and safety messages, except where the transmissions take place at routine times. The call should indicate the working frequency which will be used for the subsequent transmission of an urgent, vital navigational or safety message.

4.2 The announcement and identification of medical transports should be carried out by DSC techniques, using appropriate distress and safety calling frequencies. Such calls should use the category "urgency", and telecommand "medical transport" and be addressed to "all ships".

4.3 The operational procedures for urgency and safety calls should be in accordance with the relevant parts of Annex 2, § 2.1 or 2.2.

NOTE 1 **–** Use of the DSC distress and safety calling frequencies for urgency and safety calls is acceptable, technically, provided that the total channel loading is maintained below 0.1 E.

5 Testing the equipment used for distress and safety calls

Testing on the exclusive DSC distress and safety calling frequencies should be avoided as far as possible by using other methods. There should be no test transmissions on the DSC calling channel on VHF. However, when testing on the exclusive DSC distress and safety calling frequencies on MF and HF is unavoidable, it should be indicated that these are test transmissions (see RR No. N 3068 (S31.3)). The test call should be composed in accordance with Recommendation ITU-R M.493 (see Table 6) and the call should be acknowledged by the called coast station. Normally there would be no further communication between the two stations involved.

ANNEX 2

Provisions and procedures for calls other than distress and safety

1 Frequency/channels

1.1 As a rule, paired frequencies should be used at HF and MF, in which case an acknowledgement is transmitted on the frequency paired with the frequency of the received call. In exceptional cases for national purposes a single frequency may be used. If the same call is received on several calling channels, the most appropriate shall be chosen to transmit the acknowledgement. A single frequency channel should be used at VHF.

1.2 International calling

The paired frequencies listed in RR Appendix 31 (Appendix S17, Part A) and in Annex 5 of this Recommendation should be used for international DSC calling.

1.2.1 At HF and MF international DSC frequencies should only be used for shore-to-ship calls and for the associated call acknowledgements from ships fitted for automatic DSC operation where it is known that the ships concerned are not listening to the coast station's national frequencies.

1.2.2 All ship-to-shore DSC calling at HF and MF should preferably be done on the coast station's national frequencies.

1.3 National calling

Coast stations should avoid using the international DSC frequencies for calls that may be placed using national frequencies.

1.3.1 Ship stations should keep watch on appropriate national and international channels. (Appropriate measures should be taken for an even loading of national and international channels.)

1.3.2 Administrations are urged to find methods and negotiate terms to improve the utilization of the DSC channels available, e.g.:

– coordinated and/or joint use of coast station transmitters;

– optimizing the probability of successful calls by providing information to ships on suitable frequencies (channels) to be watched and by information from ships to a selected number of coast stations on the channels watched on-board.

1.4 Method of calling

1.4.1 The procedures set out in this section are applicable to the use of DSC techniques, except in cases of distress, urgency or safety, to which the provisions of RR Chapter NIX (SVII) are applicable.

1.4.2 The call shall contain information indicating the station or stations to which the call is directed, and the identification of the calling station.

1.4.3 The call should also contain information indicating the type of communication to be set up and may include supplementary information such as a proposed working frequency or channel; this information shall always be included in calls from coast stations, which shall have priority for that purpose.

1.4.4 An appropriate digital selective calling channel chosen in accordance with the provisions of RR Nos.43235 to 4323AB (S52.128 to S52.137) or Nos. 4323AJ to 4323AR (S52.145 to S52.153), as appropriate, shall be used for the call.

2 Operating procedures

The technical format of the call sequence shall be in conformity with the relevant ITU-R Recommendations.

The reply to a DSC requesting an acknowledgement shall be made by transmitting an appropriate acknowledgement using DSC techniques.

Acknowledgements may be initiated either manually or automatically. When an acknowledgement can be transmitted automatically, it shall be in conformity with the relevant ITU-R Recommendations.

The technical format of the acknowledgement sequence shall be in conformity with the relevant ITU-R Recommendations.

For communication between a coast station and a ship station, the coast station shall finally decide the working frequency or channel to be used.

The forwarding traffic and the control for working for radiotelephony shall be carried out in accordance with Recommendation ITU-R M.1171.

A typical DSC calling and acknowledgement sequence contains the following signals (see Recommendation ITU-R M.493).

Composition of a typical DSC calling and acknowledgement sequence

Signal	*Method of composition*
– format specifier	selected
– address	entered
– category	selected
– self-identification	pre-programmed
– telecommand information	selected

– frequency information (if appropriate) entered

– telephone number (semi-automatic/automatic ship-to-shore connections only) entered

– end of sequence signal selected (see Note 1).

NOTE 1 – If the calling sequence EOS signal incorporates a request for acknowledgement “RQ” (117) an acknowledgement is mandatory and shall incorporate the EOS signal “BQ” (122).

The method of composing a DSC sequence is illustrated in the flow diagram of Fig. 5.

2.1 Coast station initiates call to ship

Figures 1 and 2 illustrate the procedures below in flow chart and by time sequence diagram respectively.

2.1.1 There are two categories of calls for commercial communications:

– routine call;

– ship’s business call (see Recommendation ITU-R M.493, Annex 1, § 6.4.1).

2.1.2 If a direct connection exists between the calling subscriber and the coast station, the coast station asks the calling subscriber for the approximate position of the ship.

2.1.3 If the ship’s position cannot be indicated by the caller, the coast station operator tries to find the location in the information available at the coast station.

2.1.4 The coast station checks to see whether the call would be more appropriate through another coast station (see § 1.3.2).

2.1.5 The coast station checks to see whether the transmission of a DSC is inappropriate or restricted (e.g. ship not fitted with DSC or barred).

2.1.6 Assuming a DSC is appropriate the coast station composes the calling sequence as follows:

– selects format specifier,

– enters address of the ship,

– selects category,

– selects telecommand information,

– inserts working frequency information in the message part of the sequence, if appropriate,

– usually selects “end of sequence” signal “RQ”. However, if the coast station knows that the ship station cannot respond or the call is to a group of ships the frequency is omitted and the end of sequence signal should be 127, in which case the following procedures (§ 2.1.13 to 2.1.15) relating to an acknowledgement are not applicable.

2.1.7 The coast station verifies the calling sequence.

The call shall be transmitted once on a single appropriate calling channel or frequency only. Only in exceptional circumstances may a call be transmitted simultaneously on more than one frequency.

2.1.8 The coast station operator chooses the calling frequencies which are most suitable for the ship’s location.

2.1.8.1 After checking as far as possible that there are no calls in progress, the coast station operator initiates the transmission of the sequence on one of the frequencies chosen. Transmission on any one frequency should be limited to no more than 2 call sequences separated by intervals of at least 45 s to allow for reception of an acknowledgement from the ship, or exceptionally (see Recommendation ITU-R M.493) to one “call attempt” consisting of up to five transmissions.

2.1.8.2 If appropriate, a “call attempt” may be transmitted, which may include the transmission of the same call sequence on other frequencies (if necessary with a change of working frequency information to correspond to the same band as the calling frequency) made in turn at intervals of not less than 5 min, following the same pattern as in § 2.1.8.1.

2.1.9 If an acknowledgement is received further transmission of the call sequence should not take place.

The coast station shall then prepare to transmit traffic on the working channel or frequency it has proposed.

2.1.10 The acknowledgement of the received call should only be transmitted upon receipt of a calling sequence which terminates with an acknowledgement request.

2.1.11 When a station called does not reply, the call attempt should not normally be repeated until after an interval of at least 15 min. The same call attempt should not be repeated more than five times every 24 h. The aggregate of the times for which frequencies are occupied in one call attempt, should normally not exceed 1 min.

The following procedures apply at the ship:

2.1.12 Upon receipt of a calling sequence at the ship station, the received message is recorded and an appropriate indication is activated as to whether the call category is "routine" or "ship's business". The category does not affect the DSC procedures at the ship.

2.1.13 When a received call sequence contains an end of sequence signal RQ, an acknowledgement sequence should be composed and transmitted in accordance with § 2.

The format specifier and category information should be identical to that in the received calling sequence.

2.1.13.1 If the ship station is not equipped for automatic DSC operation, the ship's operator initiates an acknowledgement to the coast station after a delay of at least 5 s but no later than 4½ min of receiving the calling sequence, using the ship-to-shore calling procedures detailed in § 2.2. However the transmitted sequence should contain a "BQ" end of sequence signal in place of the "RQ" signal.

If such an acknowledgement cannot be transmitted within 5 min of receiving the calling sequence then the ship station should instead transmit a calling sequence to the coast station using the ship-to-shore calling procedure detailed in § 2.2.

2.1.13.2 If the ship is equipped for automatic DSC operation, the ship station automatically transmits an acknowledgement with an end of sequence signal "BQ". The start of the transmission of this acknowledgement sequence should be within 30 s for HF and MF or within 3 s for VHF after the reception of the complete call sequence.

2.1.13.3 If the ship is able to comply immediately the acknowledgement sequence should include a telecommand signal which is identical to that received in the calling sequence indicating that it is able to comply.

If no working frequency was proposed in the call, the ship station should include a proposal for a working frequency in its acknowledgement.

2.1.13.4 If the ship is not able to comply immediately the acknowledgement sequence should include the telecommand signal 104 (unable to comply), with a second telecommand signal giving additional information (see Recommendation ITU-R M.493).

At some later time when the ship is able to accept the traffic being offered, the ship's operator initiates a call to the coast station using the ship-to-shore calling procedures detailed in § 2.2.

2.1.14 If a call is acknowledged indicating ability to comply immediately and communication between coast station and ship station on the working channel agreed is established, the DSC call procedure is considered to be completed.

2.1.15 If the ship station transmits an acknowledgement which is not received by the coast station then this will result in the coast station repeating the call (in accordance with § 2.1.11). In this event the ship station should transmit a new acknowledgement. If no repeated call is received the ship station should transmit an acknowledgement or calling sequence in accordance with § 2.1.13.1.

FIGURE 1

Flow chart of operational procedures for calling in the shore-to-ship direction

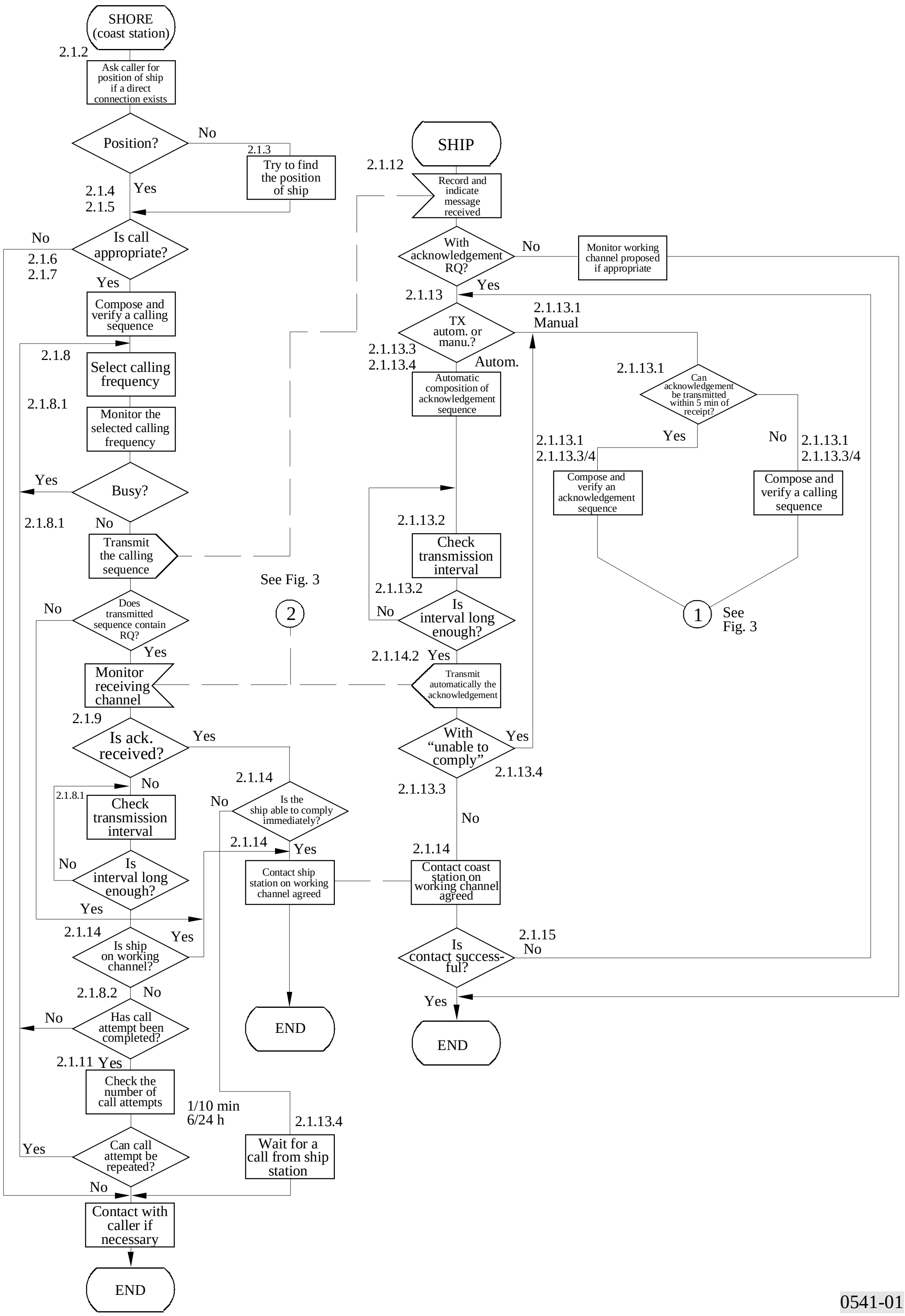
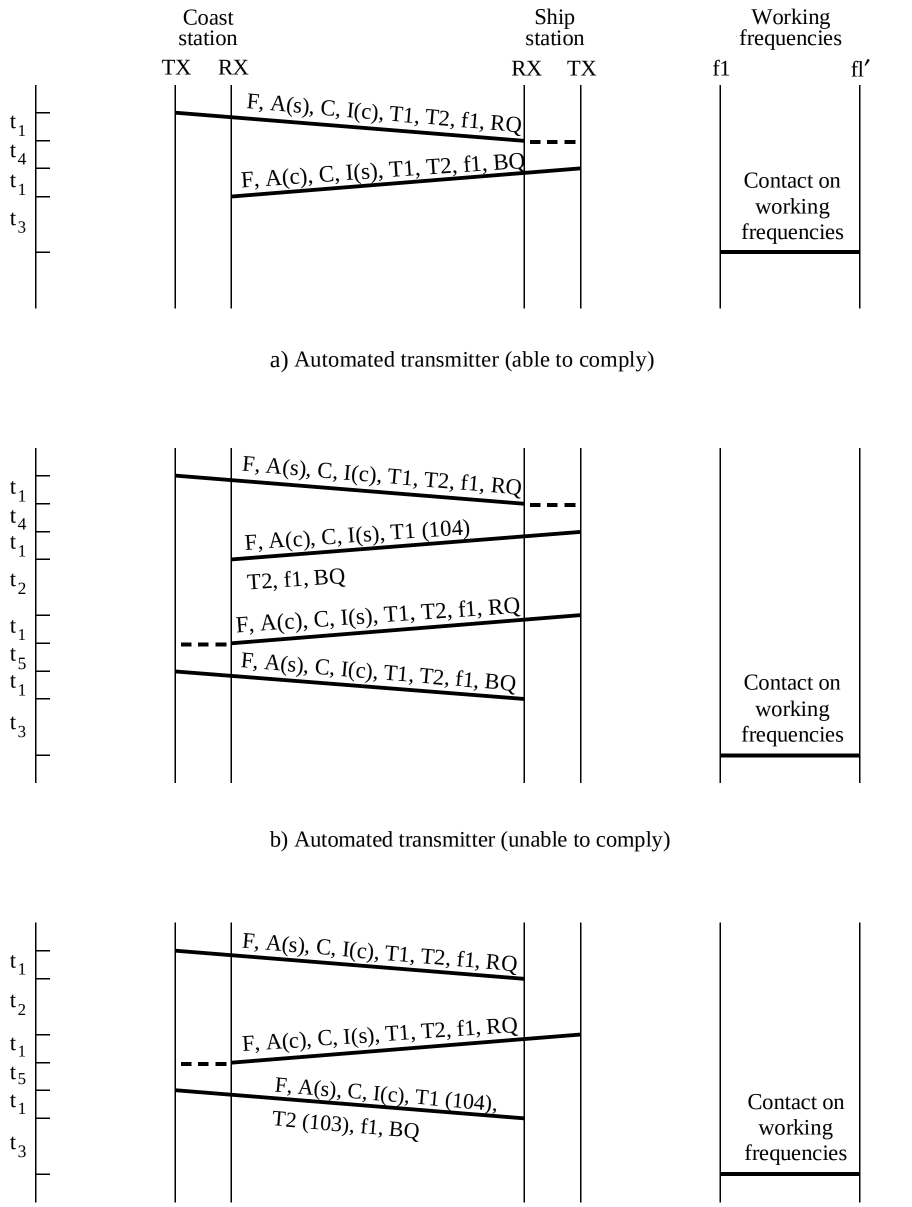


FIGURE 2

Examples of timing diagrams for calling in shore-to-ship direction



c) Ship transmitter not automated. Ship makes a delayed (>5 min) response to coast station and encounters queue on working frequency

t_1: transmission time of a DSC sequence

t_2: interval between the DSC reception at the ship and transmission from the ship after the operator's appearance in the radio room (from several minutes up to several hours)

t_3: transition time from calling to working frequency including, if necessary, the time for working channel clearing (queue waiting time)

t_4: as defined in § 2.1.13.2

t_5: time for coast station to prepare acknowledgement (see § 2.2.6)

F : format specifier

A : called station address

I : calling station self-identification

(suffix (c) or (s) indicates coast station or ship station respectively)

C : category

T1 : first telecommand signal, (104) indicates unable to comply

T2 : second telecommand signal, (103) indicates queue

f1, f1′ : working frequencies

RQ, BQ : end of sequence signals

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2.2 Ship station initiates call to coast station (see Note 1)

Figures 3 and 4 illustrate the procedures below in flow chart and by time sequence diagram respectively.

This procedure should also be followed both as a delayed response to a call received earlier from the coast station (see § 2.1.13.1) and to initiate traffic from the ship station.

NOTE 1 – See Recommendations ITU-R M.689 and ITU-R M.1082 for further details of procedures applicable only to the semi-automatic/automatic services.

2.2.1 The ship composes the calling sequence as follows:

– selects the format specifier,

– enters address,

– selects the category,

– selects the telecommand information,

– inserts working frequency information in the message part of the sequence if appropriate,

– inserts telephone number required (semi-automatic/automatic connections only),

– selects the "end of sequence" signal RQ.

2.2.2 The ship verifies the calling sequence.

2.2.3 The ship selects the single most appropriate calling frequency preferably using the coast station's nationally assigned calling channels, for which purpose it shall send a single calling sequence on the selected frequency.

2.2.4 The ship initiates the transmission of the sequence on the frequency selected after checking as far as possible that there are no calls in progress on that frequency.

2.2.5 If a called station does not reply, the call sequence from the ship station should not normally be repeated until after an interval of at least 5 min for manual connections, or 5 s or 25 s in the case of semi-automatic/automatic VHF or MF/HF connections respectively. These repetitions may be made on alternative frequencies if appropriate. Any subsequent repetitions to the same coast station should not be made until at least 15 min have elapsed.

2.2.6 The coast station should transmit an acknowledgement sequence (after checking as far as possible that there are no calls in progress on the frequency selected), after a delay of at least 5 s but not later than 4½ min for manual connections, or, within 3 s for semi-automatic/automatic connections, containing the format specifier, the address of the ship, the category, the coast station self-identification and:

– if able to comply immediately on the working frequency suggested, the same telecommand and frequency information as in the call request;

– if no working frequency was suggested by the ship station then the acknowledgement sequence should include a channel/frequency proposal;

– if not able to comply on the working frequency suggested but able to comply immediately on an alternative frequency, the same telecommand information as in the call request but an alternative working frequency;

– if unable to comply immediately the telecommand signal 104 with a second telecommand signal giving additional information. For manual connections only, this second telecommand signal may include a queue indication.

The end of sequence signal BQ should also be included.

2.2.7 For manual connections, if a working frequency is proposed in accordance with § 2.2.6 but this is not acceptable to the ship station, then the ship station should immediately transmit a call to the coast station indicating (by the use of telecommand signals 104 and 108) that it cannot comply on that frequency.

2.2.7.1 The coast station should then transmit an acknowledgement in accordance with § 2.2.6 either accepting the ship station's original suggested frequency or proposing a second alternative.

FIGURE 3

Flow chart of operational procedures for calling in the ship-to-shore direction

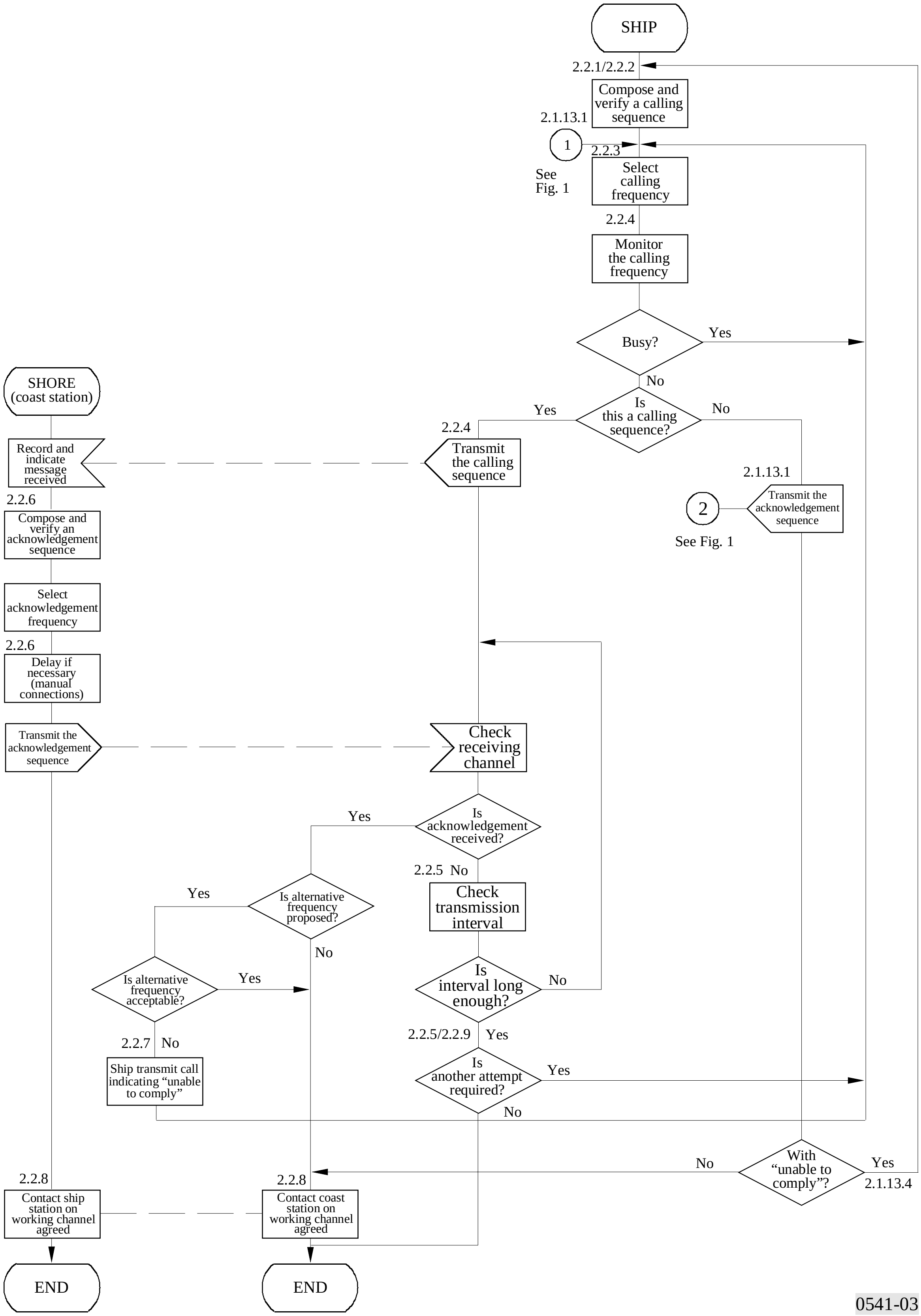
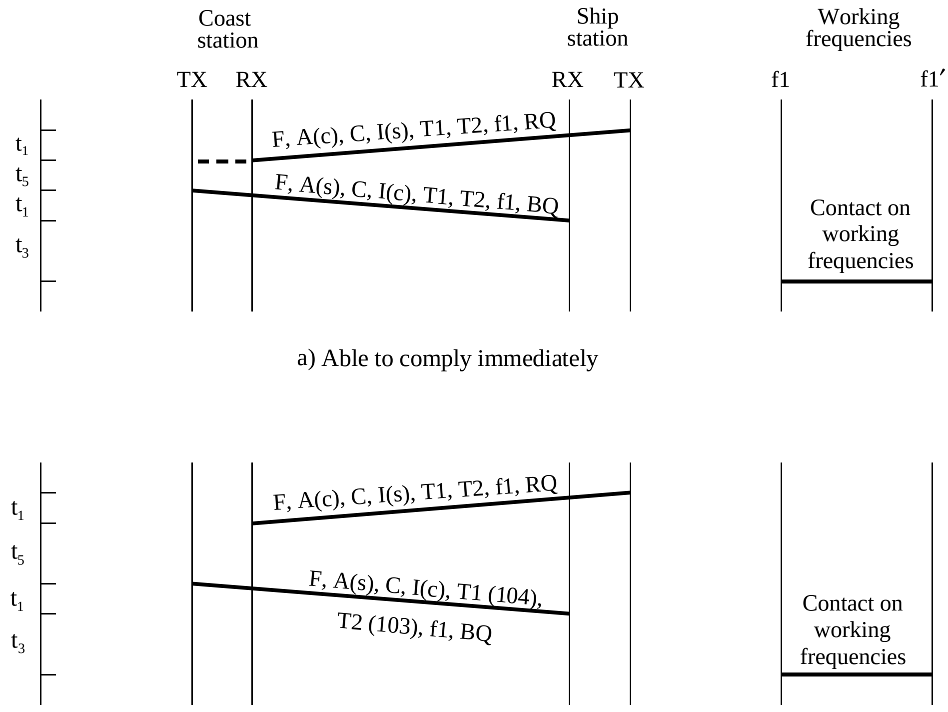


FIGURE 4

Examples of timing diagrams for calling in ship-to-shore direction



b) Queue exists on working frequency

t_1 : transmission time of a DSC sequence
t_3 : transition time from calling to working frequency including, if necessary, the time for working channel clearing (queue waiting time)
t_5 : time for coast station to prepare acknowledgement (see § 2.2.6)
F : format specifier
A : called station address
I : calling station self-identification { suffix (c) or (s) indicates coast station or ship station respectively
C : category
T1 : first telecommand signal, (104) indicates unable to comply
T2 : second telecommand signal, (103) indicates queue
f1, f1’ : working frequencies
RQ, BQ : end of sequence signals

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2.2.8 If an acknowledgement is received further transmission of the call sequence should not take place. On receipt of an acknowledgement which indicates ability to comply, the DSC procedures are complete and both coast station and ship station should communicate on the working frequencies agreed with no further exchange of DSC calls.

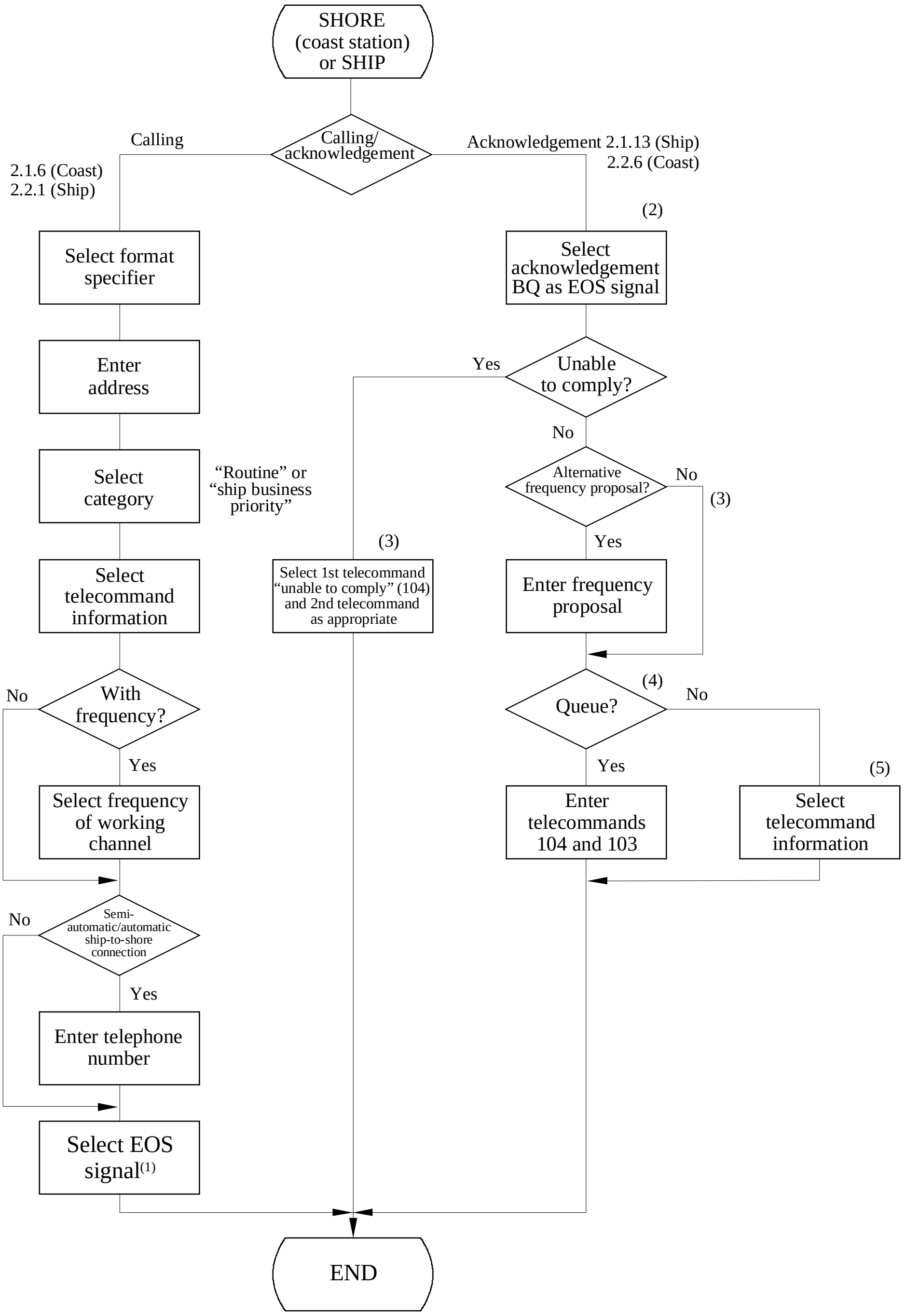
2.2.9 If the coast station transmits an acknowledgement which is not received at the ship station then the ship station should repeat the call in accordance with § 2.2.5.

2.3 Ship station initiates call to ship station

The ship-to-ship procedures should be similar to those given in § 2.2, where the receiving ship station complies with the procedures given for coast stations, as appropriate, except that, with respect to § 2.2.1, the calling ship should always insert working frequency information in the message part of the calling sequence.

FIGURE 5

Composition procedures for calling and acknowledgement sequences
(for calls other than distress and safety)



(1) Normally acknowledgement RQ may automatically be selected as an EOS signal of a calling sequence to an individual station.

(2) The format specifier and the category are automatically transferred from the received call.The self-ID in the received sequence is automatically transferred into the address part of acknowledgement sequence by selecting acknowledgement BQ.

(3) The frequency information is automatically transferred from the received call.

(4) This procedure is only for coast stations.

(5) When able to comply, and no queue exists, then the telecommand information is automatically transferred from the received call.

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ANNEX 3

Operational procedures for ships for DSC communications on MF, HF and VHF

Introduction

Procedures for DSC communications on MF and VHF are described in § 1 to 5 below.

The procedures for DSC communications on HF are in general the same as for MF and VHF. Special conditions to be taken into account when making DSC communications on HF are described in § 6 below.

1 Distress

1.1 Transmission of DSC distress alert

A distress alert should be transmitted if, in the opinion of the Master, the ship or a person is in distress and requires immediate assistance.

A DSC distress alert should as far as possible include the ship's last known position and the time (in UTC) when it was valid. The position and the time may be included automatically by the ship's navigational equipment or may be inserted manually.

The DSC distress alert is transmitted as follows:

– tune the transmitter to the DSC distress channel (2 187.5 kHz on MF, channel 70 on VHF (see Note 1)).

  NOTE 1 – Some maritime MF radiotelephony transmitters shall be tuned to a frequency 1 700 Hz lower than 2 187.5 kHz, i.e. 2 185.8 kHz, in order to transmit the DSC alert on 2 187.5 kHz;

– if time permits, key in or select on the DSC equipment keyboard

  – the nature of distress,

  – the ship's last known position (latitude and longitude),

  – the time (in UTC) the position was valid,

  – type of subsequent distress communication (telephony),

in accordance with the DSC equipment manufacturer's instructions;

– transmit the DSC distress alert (see Note 2);

– prepare for the subsequent distress traffic by tuning the transmitter and the radiotelephony receiver to the distress traffic channel in the same band, i.e. 2 182 kHz on MF, channel 16 on VHF, while waiting for the DSC distress acknowledgement.

  NOTE 2 – Add to the DSC distress alert, whenever practicable and at the discretion of the person responsible for the ship in distress, the optional expansion in accordance with Recommendation ITU-R M.821, with additional information as appropriate, in accordance with the DSC equipment manufacturer's instructions.

1.2 Actions on receipt of a distress alert (see Note 1)

Ships receiving a DSC distress alert from another ship should normally not acknowledge the alert by DSC since acknowledgement of a DSC distress alert by use of DSC is normally made by coast stations only.

Only if no other station seems to have received the DSC distress alert, and the transmission of the DSC distress alert continues, the ship should acknowledge the DSC distress alert by use of DSC to terminate the call. The ship should then, in addition, inform a coast station or a coast earth station by any practicable means.

Ships receiving a DSC distress alert from another ship should also defer the acknowledgement of the distress alert by radiotelephony for a short interval, if the ship is within an area covered by one or more coast stations, in order to give the coast station time to acknowledge the DSC distress alert first.

Ships receiving a DSC distress alert from another ship shall:

– watch for the reception of a distress acknowledgement on the distress channel (2 187.5 kHz on MF and channel 70 on VHF);

– prepare for receiving the subsequent distress communication by tuning the radiotelephony receiver to the distress traffic frequency in the same band in which the DSC distress alert was received, i.e. 2 182 kHz on MF, channel 16 on VHF;

– acknowledge the receipt of the distress alert by transmitting the following by radiotelephony on the distress traffic frequency in the same band in which the DSC distress alert was received, i.e. 2 182 kHz on MF, channel 16 on VHF:

  – "MAYDAY",

  – the 9-digit identity of the ship in distress, repeated 3 times,

  – "this is",

  – the 9-digit identity or the call sign or other identification of own ship, repeated 3 times,

  – "RECEIVED MAYDAY".

NOTE 1 – Ships out of range of a distress event or not able to assist should only acknowledge if no other station appears to acknowledge the receipt of the DSC distress alert.

1.3 Distress traffic

On receipt of a DSC distress acknowledgement the ship in distress should commence the distress traffic by radiotelephony on the distress traffic frequency (2 182 kHz on MF, channel 16 on VHF) as follows:

– "MAYDAY",

– "this is",

– the 9-digit identity *and* the call sign or other identification of the ship,

– the ship's position in latitude and longitude or other reference to a known geographical location,

– the nature of distress and assistance wanted,

– any other information which might facilitate the rescue.

1.4 Transmission of a DSC distress relay alert

A ship knowing that another ship is in distress shall transmit a DSC distress relay alert if

– the ship in distress is not itself able to transmit the distress alert,

– the Master of the ship considers that further help is necessary.

The DSC distress relay alert is transmitted as follows:

– tune the transmitter to the DSC distress channel (2 187.5 kHz on MF, channel 70 on VHF),

– select the distress relay call format on the DSC equipment,

– key in or select on the DSC equipment keyboard:

  – All Ships Call or the 9-digit identity of the appropriate coast station,

  – the 9-digit identity of the ship in distress, if known,

  – the nature of distress,

  – the latest position of the ship in distress, if known,

  – the time (in UTC) the position was valid (if known),

  – type of subsequent distress communication (telephony);

– transmit the DSC distress relay call;

– prepare for the subsequent distress traffic by tuning the transmitter and the radiotelephony receiver to the distress traffic channel in the same band, i.e. 2 182 kHz on MF and channel 16 on VHF, while waiting for the DSC distress acknowledgement.

1.5 Acknowledgement of a DSC distress relay alert received from a coast station (see Note 1 of § 1.2 of this Annex)

Coast stations, after having received and acknowledged a DSC distress alert, may if necessary, retransmit the information received as a DSC distress relay call, addressed to all ships, all ships in a specific geographical area, a group of ships or a specific ship.

Ships receiving a distress relay call transmitted by a coast station shall not use DSC to acknowledge the call, but should acknowledge the receipt of the call by radiotelephony on the distress traffic channel in the same band in which the relay call was received, i.e. 2 182 kHz on MF, channel 16 on VHF.

Acknowledge the receipt of the distress alert by transmitting the following by radiotelephony on the distress traffic frequency in the same band in which the DSC distress relay alert was received:

– "MAYDAY",

– the 9-digit identity or the call sign or other identification of the calling coast station,

– "this is",

– the 9-digit identity or call sign or other identification of own ship,

– "RECEIVED MAYDAY".

1.6 Acknowledgement of a DSC distress relay alert received from another ship

Ships receiving a distress relay alert from another ship shall follow the same procedure as for acknowledgement of a distress alert, i.e. the procedure given in § 1.2 above.

1.7 Cancellation of an inadvertent distress alert (distress call)

A station transmitting an inadvertent distress alert shall cancel the distress alert using the following procedure:

1.7.1 Immediately transmit a DSC "distress cancellation" if provided in accordance with Recommendation ITU-R M.493, § 8.3.2 e.g. with own ship's MMSI inserted as identification of ship in distress. In addition cancel the distress alert aurally over the telephony distress traffic channel associated with each DSC channel on which the "distress call" was transmitted.

1.7.2 Monitor the telephony distress traffic channel associated with the DSC channel on which the distress was transmitted, and respond to any communications concerning that distress alert as appropriate.

2 Urgency

2.1 Transmission of urgency messages

Transmission of urgency messages shall be carried out in two steps:

– announcement of the urgency message,

– transmission of the urgency message.

The announcement is carried out by transmission of a DSC urgency call on the DSC distress calling channel (2 187.5 kHz on MF, channel 70 on VHF).

The urgency message is transmitted on the distress traffic channel (2 182 kHz on MF, channel 16 on VHF).

The DSC urgency call may be addressed to all stations or to a specific station. The frequency on which the urgency message will be transmitted shall be included in the DSC urgency call.

The transmission of an urgency message is thus carried out as follows:

Announcement:

– tune the transmitter to the DSC distress calling channel (2 187.5 kHz on MF, channel 70 on VHF);

– key in or select on the DSC equipment keyboard:

  – All Ships Call or the 9-digit identity of the specific station,

  – the category of the call (urgency),

  – the frequency or channel on which the urgency message will be transmitted,

  – the type of communication in which the urgency message will be given (radiotelephony),

  in accordance with the DSC equipment manufacturer's instructions;

– transmit the DSC urgency call.

Transmission of the urgency message:

– tune the transmitter to the frequency or channel indicated in the DSC urgency call;

– transmit the urgency message as follows:

  – "PAN PAN", repeated 3 times,

  – "ALL STATIONS" or called station, repeated 3 times,

  – "this is",

  – the 9-digit identity *and* the call sign or other identification of own ship,

  – the text of the urgency message.

2.2 Reception of an urgency message

Ships receiving a DSC urgency call announcing an urgency message addressed to all ships shall NOT acknowledge the receipt of the DSC call, but should tune the radiotelephony receiver to the frequency indicated in the call and listen to the urgency message.

3 Safety

3.1 Transmission of safety messages

Transmission of safety messages shall be carried out in two steps:

– announcement of the safety message,

– transmission of the safety message.

The announcement is carried out by transmission of a DSC safety call on the DSC distress calling channel (2 187.5 kHz on MF, channel 70 on VHF).

The safety message is normally transmitted on the distress and safety traffic channel in the same band in which the DSC call was sent, i.e. 2 182 kHz on MF, channel 16 on VHF.

The DSC safety call may be addressed to all ships, all ships in a specific geographical area or to a specific station.

The frequency on which the safety message will be transmitted shall be included in the DSC call.

The transmission of a safety message is thus carried out as follows:

Announcement:

– tune the transmitter to the DSC distress calling channel (2 187.5 kHz on MF, channel 70 on VHF);

– select the appropriate calling format on the DSC equipment (all ships, area call or individual call);

– key in or select on the DSC equipment keyboard:
  – specific area or 9-digit identity of specific station, if appropriate,
  – the category of the call (safety),
  – the frequency or channel on which the safety message will be transmitted,
  – the type of communication in which the safety message will be given (radiotelephony),

  in accordance with the DSC equipment manufacturer's instructions;
– transmit the DSC safety call.

Transmission of the safety message:

– tune the transmitter to the frequency or channel indicated in the DSC safety call;
– transmit the safety message as follows:
  – "SECURITE", repeated 3 times,
  – "ALL STATIONS" or called station, repeated 3 times,
  – "this is",
  – the 9-digit identity *and* the call sign or other identification of own ship,
  – the text of the safety message.

3.2 Reception of a safety message

Ships receiving a DSC safety call announcing a safety message addressed to all ships shall NOT acknowledge the receipt of the DSC safety call, but should tune the radiotelephony receiver to the frequency indicated in the call and listen to the safety message.

4 Public correspondence

4.1 DSC channels for public correspondence

4.1.1 VHF

The VHF DSC channel 70 is used for DSC for distress and safety purposes as well as for DSC for public correspondence.

4.1.2 MF

International and national DSC channels separate from the DSC distress and safety calling channel 2 187.5 kHz are used for digital selective-calling on MF for public correspondence.

Ships calling a coast station by DSC on MF for public correspondence should preferably use the coast station's national DSC channel.

The international DSC channel for public correspondence may as a general rule be used between ships and coast stations of different nationality. The ships transmitting frequency is 2 189.5 kHz, and the receiving frequency is 2 177 kHz.

The frequency 2 177 kHz is also used for DSC between ships for general communication.

4.2 Transmission of a DSC call for public correspondence to a coast station or another ship

A DSC call for public correspondence to a coast station or another ship is transmitted as follows:

– tune the transmitter to the relevant DSC channel;
– select the format for calling a specific station on the DSC equipment;
– key in or select on the DSC equipment keyboard:
  – the 9-digit identity of the station to be called,
  – the category of the call (routine),

  - the type of the subsequent communication (normally radiotelephony),
  - a proposed working channel if calling another ship. A proposal for a working channel should NOT be included in calls to a coast station; the coast station will in its DSC acknowledgement indicate a vacant working channel,

  in accordance with the DSC equipment manufacturer's instructions;
- transmit the DSC call.

4.3 Repeating a call

A DSC call for public correspondence may be repeated on the same or another DSC channel, if no acknowledgement is received within 5 min.

Further call attempts should be delayed at least 15 min, if acknowledgement is still not received.

4.4 Acknowledgement of a received call and preparation for reception of the traffic

On receipt of a DSC call from a coast station or another ship, a DSC acknowledgement is transmitted as follows:

- tune the transmitter to the transmit frequency of the DSC channel on which the call was received,
- select the acknowledgement format on the DSC equipment,
- transmit an acknowledgement indicating whether the ship is able to communicate as proposed in the call (type of communication and working frequency),
- if able to communicate as indicated, tune the transmitter and the radiotelephony receiver to the indicated working channel and prepare to receive the traffic.

4.5 Reception of acknowledgement and further actions

When receiving an acknowledgement indicating that the called station is able to receive the traffic, prepare to transmit the traffic as follows:

- tune the transmitter and receiver to the indicated working channel;
- commence the communication on the working channel by:
  - the 9-digit identity or call sign or other identification of the called station,
  - "this is",
  - the 9-digit identity or call sign or other identification of own ship.

It will normally rest with the ship to call again a little later in case the acknowledgement from the coast station indicates that the coast station is not able to receive the traffic immediately.

In case the ship, in response to a call to another ship, receives an acknowledgement indicating that the other ship is not able to receive the traffic immediately, it will normally rest with the called ship to transmit a call to the calling ship when ready to receive the traffic.

5 Testing the equipment used for distress and safety

Testing on the exclusive DSC distress and safety calling frequency 2 187.5 kHz should be avoided as far as possible by using other methods.

No test transmission should be made on VHF DSC calling channel 70.

Test calls should be transmitted by the ship station and acknowledged by the called coast station. Normally there would be no further communication between the two stations involved.

A test call to a coast station is transmitted as follows:

- tune the transmitter to the DSC distress and safety calling frequency 2 187.5 kHz,
- key in or select the format for the test call on the DSC equipment in accordance with the DSC equipment manufacturer's instructions,
- key in the 9-digit identity of the coast station to be called,

– transmit the DSC call after checking as far as possible that no calls are in progress on the frequency,

– wait for acknowledgement.

6 Special conditions and procedures for DSC communication on HF

General

The procedures for DSC communication on HF are – with some additions described in § 6.1 to 6.5 below – equal to the corresponding procedures for DSC communications on MF/VHF.

Due regard to the special conditions described in § 6.1 to 6.5 should be given when making DSC communications on HF.

6.1 Distress

6.1.1 Transmission of DSC distress alert

DSC distress alert should be sent to coast stations – e.g. in A3 and A4 sea areas on HF – and on MF and/or VHF to other ships in the vicinity.

The DSC distress alert should as far as possible include the ship's last known position and the time (in UTC) it was valid. If the position and time is not inserted automatically from the ship's navigational equipment, it should be inserted manually.

Ship-to-shore distress alert

Choice of HF band

Propagation characteristics of HF radio waves for the actual season and time of the day should be taken into account when choosing HF bands for transmission of DSC distress alert.

As a general rule the DSC distress channel in the 8 MHz maritime band (8 414.5 kHz) may in many cases be an appropriate first choice.

Transmission of the DSC distress alert in more than one HF band will normally increase the probability of successful reception of the alert by coast stations.

DSC distress alert may be sent on a number of HF bands in two different ways:

a) either by transmitting the DSC distress alert on one HF band, and waiting a few minutes for receiving acknowledgement by a coast station;

   if no acknowledgement is received within 3 min, the process is repeated by transmitting the DSC distress alert on another appropriate HF band etc.;

b) or by transmitting the DSC distress alert at a number of HF bands with no, or only very short, pauses between the calls, without waiting for acknowledgement between the calls.

It is recommended to follow procedure a) in all cases, where time permits to do so; this will make it easier to choose the appropriate HF band for commencement of the subsequent communication with the coast station on the corresponding distress traffic channel.

Transmitting the DSC alert (see Note 1):

– tune the transmitter to the chosen HF DSC distress channel (4 207.5, 6 312, 8 414.5, 12 577, 16 804.5 kHz) (see Note 2);

– follow the instructions for keying in or selection of relevant information on the DSC equipment keyboard as described in § 1.1;

– transmit the DSC distress alert.

NOTE 1 – Ship-to-ship distress alert should normally be made on MF and/or VHF, using the procedures for transmission of DSC distress alert on MF/VHF described in § 1.1.

NOTE 2 – Some maritime HF transmitters shall be tuned to a frequency 1 700 Hz lower than the DSC frequencies given above in order to transmit the DSC alert on the correct frequency.

In special cases, for example in tropical zones, transmission of DSC distress alert on HF may, in addition to ship-to-shore alerting, also be useful for ship-to-ship alerting.

6.1.2 Preparation for the subsequent distress traffic

After having transmitted the DSC distress alert on appropriate DSC distress channels (HF, MF and/or VHF), prepare for the subsequent distress traffic by tuning the radiocommunication set(s) (HF, MF and/or VHF as appropriate) to the corresponding distress traffic channel(s).

If method b) described in § 6.1.1 has been used for transmission of DSC distress alert on a number of HF bands:

– take into account in which HF band(s) acknowledgement has been successfully received from a coast station;

– if acknowledgements have been received on more than one HF band, commence the transmission of distress traffic on one of these bands, but if no response is received from a coast station then the other bands should be used in turn.

The distress traffic frequencies are:

HF (kHz):

Telephony	4 125	6 215	8 291	12 290	16 420
Telex	4 177.5	6 268	8 376.5	12 520	16 695

MF (kHz):

Telephony	2 182
Telex	2 174.5

VHF: Channel 16 (156.800 MHz).

6.1.3 Distress traffic

The procedures described in § 1.3 are used when the distress traffic on MF/HF is carried out by *radiotelephony*.

The following procedures shall be used in cases where the distress traffic on MF/HF is carried out by *radiotelex*:

– The forward error correcting (FEC) mode shall be used unless specifically requested to do otherwise;

– all messages shall be preceded by:

  – at least one carriage return,

  – line feed,

  – one letter shift,

  – the distress signal MAYDAY;

– The ship in distress should commence the distress telex traffic on the appropriate distress telex traffic channel as follows:

  – carriage return, line feed, letter shift,

  – the distress signal "MAYDAY",

  – "this is",

  – the 9-digit identity and call sign or other identification of the ship,

  – the ship's position if not included in the DSC distress alert,

  – the nature of distress,

  – any other information which might facilitate the rescue.

6.1.4 Actions on reception of a DSC distress alert on HF from another ship

Ships receiving a DSC distress alert on HF from another ship shall *not* acknowledge the alert, but should:

– watch for reception of a DSC distress acknowledgement from a coast station;

– while waiting for reception of a DSC distress acknowledgement from a coast station:

  prepare for reception of the subsequent distress communication by tuning the HF radiocommunication set (transmitter and receiver) to the relevant distress traffic channel in the same HF band in which the DSC distress alert was received, observing the following conditions:

  – if radiotelephony mode was indicated in the DSC alert, the HF radiocommunication set should be tuned to the radiotelephony distress traffic channel in the HF band concerned;

  – if telex mode was indicated in the DSC alert, the HF radiocommunication set should be tuned to the radiotelex distress traffic channel in the HF band concerned. Ships able to do so should additionally watch the corresponding radiotelephony distress channel;

  – if the DSC distress alert was received on more than one HF band, the radiocommunication set should be tuned to the relevant distress traffic channel in the HF band considered to be the best one in the actual case. If the DSC distress alert was received successfully on the 8 MHz band, this band may in many cases be an appropriate first choice;

  – if no distress traffic is received on the HF channel within 1 to 2 min, tune the HF radiocommunication set to the relevant distress traffic channel in another HF band deemed appropriate in the actual case;

  – if no DSC distress acknowledgement is received from a coast station within 3 min, and no distress communication is observed going on between a coast station and the ship in distress:

    – transmit a DSC distress relay alert,

    – inform a Rescue Coordination Centre (RCC) via appropriate radiocommunications means.

6.1.5 Transmission of DSC distress relay alert

In case it is considered appropriate to transmit a DSC distress relay alert:

– considering the actual situation, decide in which frequency bands (MF, VHF, HF) DSC distress relay alert(s) should be transmitted, taking into account ship-to-ship alerting (MF, VHF) and ship-to-shore alerting;

– tune the transmitter(s) to the relevant DSC distress channel, following the procedures described in § 6.1.1 above;

– follow the instructions for keying in or selection of call format and relevant information on the DSC equipment keyboard as described in § 1.4;

– transmit the DSC distress relay alert.

6.1.6 Acknowledgement of a HF DSC distress relay alert received from a coast station

Ships receiving a DSC distress relay alert from a coast station on HF, addressed to all ships within a specified area, should NOT acknowledge the receipt of the relay alert by DSC, but by *radiotelephony* on the telephony distress traffic channel in the same band(s) in which the DSC distress relay alert was received.

6.2 Urgency

Transmission of urgency messages on HF should normally be addressed:

– either to all ships within a specified geographical area,

– or to a specific coast station.

Announcement of the urgency message is carried out by transmission of a DSC call with category urgency on the appropriate DSC distress channel.

The transmission of the urgency message itself on HF is carried out by radiotelephony or radiotelex on the appropriate distress traffic channel in the same band in which the DSC announcement was transmitted.

6.2.1 Transmission of DSC announcement of an urgency message on HF

– choose the HF band considered to be the most appropriate, taking into account propagation characteristics for HF radio waves at the actual season and time of the day; the 8 MHz band may in many cases be an appropriate first choice;

– tune the HF transmitter to the DSC distress channel in the chosen HF band;

– key in or select call format for either geographical area call or individual call on the DSC equipment, as appropriate;

– in case of area call, key in specification of the relevant geographical area;

– follow the instructions for keying in or selection of relevant information on the DSC equipment keyboard as described in § 2.1, including type of communication in which the urgency message will be transmitted (radiotelephony or radiotelex);

– transmit the DSC call; and

– if the DSC call is addressed to a specific coast station, wait for DSC acknowledgement from the coast station. If acknowledgement is not received within a few minutes, repeat the DSC call on another HF frequency deemed appropriate.

6.2.2 Transmission of the urgency message and subsequent action

– tune the HF transmitter to the distress traffic channel (telephony or telex) indicated in the DSC announcement;

– if the urgency message is to be transmitted using *radiotelephony*, follow the procedure described in § 2.1;

– if the urgency message is to be transmitted by *radiotelex*, the following procedure shall be used:

  – use the forward error correcting (FEC) mode unless the message is addressed to a single station whose radiotelex identity number is known;

  – commence the telex message by:

    – at least one carriage return, line feed, one letter shift,

    – the urgency signal "PAN PAN",

    – "this is",

    – the 9-digit identity of the ship and the call sign or other identification of the ship,

    – the text of the urgency message.

Announcement and transmission of urgency messages addressed to all HF equipped ships within a specified area may be repeated on a number of HF bands as deemed appropriate in the actual situation.

6.2.3 Reception of an urgency message

Ships receiving a DSC urgency call announcing an urgency message shall NOT acknowledge the receipt of the DSC call, but should tune the radiocommunication receiver to the frequency and communication mode indicated in the DSC call for receiving the message.

6.3 Safety

The procedures for transmission of DSC safety announcement and for transmission of the safety message are the same as for urgency messages, described in § 6.2, *except* that:

– in the DSC announcement, the category SAFETY shall be used,

– in the safety message, the safety signal "SECURITE" shall be used instead of the urgency signal "PAN PAN".

6.4 Public correspondence on HF

The procedures for DSC communication for public correspondence on HF are the same as for MF.

Propagation characteristics should be taken into account when making DSC communication on HF.

International and national HF DSC channels different from those used for DSC for distress and safety purposes are used for DSC for public correspondence.

Ships calling a HF coast station by DSC for public correspondence should preferably use the coast station's national DSC calling channel.

6.5 Testing the equipment used for distress and safety on HF

The procedure for testing the ship's equipment used for DSC distress, urgency and safety calls on HF by transmitting DSC test calls on HF DSC distress channels is the same as for testing on the MF DSC distress frequency 2 187.5 Hz.

ANNEX 4

Operational procedures for coast stations for DSC communications on MF, HF and VHF

Introduction

Procedures for DSC communications on MF and VHF are described in § 1 to 5 below.

The procedures for DSC communications on HF are in general the same as for MF and VHF. Special conditions to be taken into account when making DSC communications on HF are described in § 6 below.

1 Distress (see Note 1)

1.1 Reception of a DSC distress alert (distress call)

The transmission of a distress alert indicates that a mobile unit (a ship, aircraft or other vehicle) or a person is in distress and requires immediate assistance. The distress alert is a digital selective call using a distress call format (distress call).

Coast stations in receipt of a distress call shall ensure that it is routed as soon as possible to an RCC. The receipt of a distress call is to be acknowledged as soon as possible by the appropriate coast station.

NOTE 1 – These procedures assume that the RCC is sited remotely from the DSC coast station; where this is not the case, appropriate amendments should be made locally.

1.2 Acknowledgement of a DSC distress alert (distress call)

The coast station shall transmit the acknowledgement on the distress calling frequency on which the call was received and should address it to all ships. The acknowledgement shall include the identification of the ship whose distress call is being acknowledged.

The acknowledgement of a DSC distress call is transmitted as follows:

– use a transmitter which is tuned to the frequency on which the distress call was received;

– in accordance with the DSC equipment manufacturer's instructions, key in or select on the DSC equipment keyboard (see Note 1):

  – distress call acknowledgement,

  – 9-digit identity of the ship in distress,

  – nature of distress,

  – distress coordinates,

  – the time (in UTC) when the position was valid.

  NOTE 1 – Some or all of this information might be included automatically by the equipment;

– transmit the acknowledgement;

– prepare to handle the subsequent distress traffic by setting watch on radiotelephony and, if the "mode of subsequent communication" signal in the received distress call indicates teleprinter, also on NBDP, if the coast station is fitted with NBDP. In both cases, the radiotelephone and NBDP frequencies should be those associated with the frequency on which the distress call was received (on MF 2 182 kHz for radiotelephony and 2 174.5 kHz for NBDP, on VHF 156.8 MHz/channel 16 for radiotelephony; there is no frequency for NBDP on VHF).

1.3 Transmission of a DSC distress relay alert (distress relay call)

Coast stations shall initiate and transmit a distress relay call in any of the following cases:

– when the distress of the mobile unit has been notified to the coast station by other means and a broadcast alert to shipping is required by the RCC; and

– when the person responsible for the coast station considers that further help is necessary (close cooperation with the appropriate RCC is recommended under such conditions).

In the cases mentioned above, the coast station shall transmit a shore-to-ship distress relay call addressed, as appropriate, to all ships, to a selected group of ships, to a geographical area or to a specific ship.

The distress relay call shall contain the identification of the mobile unit in distress, its position and other information which might facilitate rescue.

The distress relay call is transmitted as follows:

– use a transmitter which is tuned to the frequency for DSC distress calls (2 187.5 kHz on MF, 156.525 MHz/channel 70 on VHF);

– in accordance with the DSC equipment manufacturer's instructions, key in or select on the DSC equipment keyboard (see Note 1 of § 1.2 of this Annex):

  – distress relay call,

  – the format specifier (all ships, group of ships, geographical area or individual station),

  – if appropriate, the address of the ship, group of ships or geographical area (not required if the format specifier is "all ships"),

  – 9-digit identity of the ship in distress, if known,

  – nature of distress,

  – distress coordinates,

  – the time (in UTC) when the position was valid;

– transmit the distress relay call;

– prepare for the reception of the acknowledgements by ship stations and for handling the subsequent distress traffic by switching over to the distress traffic channel in the same band, i.e. 2 182 kHz on MF, 156.8 MHz/channel 16 on VHF.

1.4 Reception of a distress relay alert (distress relay call)

If the distress relay call is received from a ship station, coast stations on receipt of the distress relay call shall ensure that the call is routed as soon as possible to an RCC. The receipt of the distress relay call is to be acknowledged as soon as possible by the appropriate coast station using a DSC distress relay acknowledgement addressed to the ship station. If the distress relay call is received from a coast station, other coast stations will normally not have to take further action.

2 Urgency

2.1 Transmission of a DSC announcement

The announcement of the urgency message shall be made on one or more of the distress and safety calling frequencies using DSC and the urgency call format.

The DSC urgency call may be addressed to all ships, to a selected group of ships, to a geographical area or to a specific ship. The frequency on which the urgency message will be transmitted after the announcement shall be included in the DSC urgency call.

The DSC urgency call is transmitted as follows:

– use a transmitter which is tuned to the frequency for DSC distress calls (2 187.5 kHz on MF, 156.525 MHz /channel 70 on VHF);

– in accordance with the DSC equipment manufacturer’s instructions, key in or select on the DSC equipment keyboard (see Note 1 of § 1.2 of this Annex):

  – the format specifier (all ships call, group of ships, geographical area or individual station),

  – if appropriate, the address of the ship, group of ships or geographical area (not required if the format specifier is “all ships”),

  – the category of the call (urgency),

  – the frequency or channel on which the urgency message will be transmitted,

  – the type of communication in which the urgency message will be transmitted (radiotelephony);

– transmit the DSC urgency call.

After the DSC announcement, the urgency message will be transmitted on the frequency indicated in the DSC call.

3 Safety

3.1 Transmission of a DSC announcement

The announcement of the safety message shall be made on one or more of the distress and safety calling frequencies using DSC and the safety call format.

The DSC safety call may be addressed to all ships, to a group of ships, to a geographical area or to a specific ship. The frequency on which the safety message will be transmitted after the announcement shall be included in the DSC safety call.

The DSC safety call is transmitted as follows:

– use a transmitter which is tuned to the frequency for DSC distress calls (2 187.5 kHz on MF, 156.525 MHz/channel 70 on VHF);

– in accordance with the DSC equipment manufacturer’s instructions, key in or select on the DSC equipment keyboard (see Note 1 of § 1.2 of this Annex):

  – the format specifier (all ships call, group of ships, geographical area or individual station),

  – if appropriate, the address of the ship, group of ships or geographical area (not required if the format specifier is “all ships”),

  – the category of the call (safety),

  - the frequency or channel on which the safety message will be transmitted,
  - the type of communication in which the safety message will be transmitted (radiotelephony);
- transmit the DSC safety call.

After the DSC announcement, the safety message will be transmitted on the frequency indicated in the DSC call.

4 Public correspondence

4.1 DSC frequencies/channels for public correspondence

4.1.1 VHF

The frequency 156.525 MHz/channel 70 is used for DSC for distress and safety purposes. It may also be used for calling purposes other than distress and safety, e.g. public correspondence.

4.1.2 MF

For public correspondence national and international frequencies are used which are different from the frequencies used for distress and safety purposes.

When calling ship stations by DSC, coast stations should use for the call, in the order of preference:

- a national DSC channel on which the coast station is maintaining watch;
- the international DSC calling channel, with the coast station transmitting on 2 177 kHz and receiving on 2 189.5 kHz. In order to reduce interference on this channel, it may be used as a general rule by coast stations to call ships of another nationality, or in cases where it is not known on which DSC frequencies the ship station is maintaining watch.

4.2 Transmission of a DSC call to a ship

The DSC call is transmitted as follows:

- use a transmitter which is tuned to the appropriate calling frequency;
- in accordance with the DSC equipment manufacturer’s instructions, key in or select on the DSC equipment keyboard (see Note 1 of § 1.2 of this Annex):
  - the 9-digit identity of the ship to be called,
  - the category of the call (routine or ship’s business),
  - the type of subsequent communication (radiotelephony),
  - working frequency information;
- after checking as far as possible that there are no calls in progress, transmit the DSC call.

4.3 Repeating a call

Coast stations may transmit the call twice on the same calling frequency with an interval of at least 45 s between the two calls, provided that they receive no acknowledgement within that interval.

If the station called does not acknowledge the call after the second transmission, the call may be transmitted again on the same frequency after a period of at least 30 min or on another calling frequency after a period of at least 5 min.

4.4 Preparation for exchange of traffic

On receipt of a DSC acknowledgement with the indication that the called ship station can use the proposed working frequency, the coast station transfers to the working frequency or channel and prepares to receive the traffic.

4.5 Acknowledgement of a received DSC call

Acknowledgements shall normally be transmitted on the frequency paired with the frequency of the received call. If the same call is received on several calling channels, the most appropriate channel shall be chosen for transmission of the acknowledgement.

The acknowledgement of a DSC call is transmitted as follows:

– use a transmitter which is tuned to the appropriate frequency;

– in accordance with the DSC equipment manufacturer's instructions, key in or select on the DSC equipment keyboard (see Note 1 of § 1.2 of this Annex):

  – the format specifier (individual station),

  – 9-digit identity of the calling ship,

  – the category of the call (routine or ship's business),

  – if able to comply immediately on the working frequency suggested by the ship station, the same frequency information as in the received call,

  – if no working frequency was suggested by the calling ship station, then the acknowledgement should include a channel/frequency proposal,

  – if not able to comply on the working frequency suggested, but able to comply immediately on an alternative frequency, the alternative working frequency,

  – if unable to comply immediately the appropriate information in that regard;

– transmit the acknowledgement (after checking as far as possible that there are no calls in progress on the frequency selected) after a delay of at least 5 s, but not later than 4½ min.

4.6 Preparation for exchange of traffic

After having transmitted the acknowledgement, the coast station transfers to the working frequency or channel and prepares to receive the traffic.

5 Testing the equipment used for distress and safety calls

Testing on the exclusive DSC distress and safety calling frequencies should be avoided as far as possible by using other methods. There should be no test transmissions on the DSC calling frequency 156.525 MHz/channel 70. However, when testing on the exclusive DSC distress and safety calling frequency 2 187.5 kHz is unavoidable, it should be indicated that these are test transmissions (e.g. special test calls).

Test calls should be transmitted by the ship station and acknowledged by the called coast station. Normally there would be no further communications between the two stations involved.

Acknowledgement of a DSC test call

The acknowledgement of a DSC test call is transmitted as follows:

– use a transmitter which is tuned to 2 187.5 kHz;

– in accordance with the DSC equipment manufacturer's instructions, key in or select on the DSC equipment keyboard:

  – test call acknowledgement,

  – 9-digit identity of the calling ship station;

– transmit the acknowledgement.

6 Special conditions and procedures for DSC communication on HF

General

The procedures for DSC communication on HF are – with some additions described in § 6.1 to 6.4 below – equal to the corresponding procedures for DSC communications on MF/VHF.

Due regard to the special conditions described in § 6.1 to 6.4 should be given when making DSC communications on HF.

6.1 Distress

6.1.1 Reception and acknowledgement of a DSC distress alert on HF

Ships in distress may in some cases transmit the DSC distress alert on a number of HF bands with only short intervals between the individual calls.

The coast station shall transmit DSC acknowledgement on all HF DSC distress channels on which the DSC alert was received in order to ensure as far as possible that the acknowledgement is received by the ship in distress and by all ships which received the DSC alert.

6.1.2 Distress traffic

The distress traffic should, as a general rule, be initiated on the appropriate distress traffic channel (radiotelephony or NBDP) in the same band in which the DSC alert was received.

For distress traffic by NBDP the following rules apply:

– all messages shall be preceded by at least one carriage return, line feed, one letter shift and the distress signal MAYDAY;

– FEC broadcast mode should normally be used.

  ARQ mode should be used only when considered advantageous to do so in the actual situation and provided that the radiotelex number of the ship is known.

6.1.3 Transmission of DSC distress relay alert on HF

HF propagation characteristics should be taken into account when choosing HF band(s) for transmission of DSC distress relay alert.

IMO Convention ships equipped with HF DSC for distress and safety purposes are required to keep continuous automatic DSC watch on the DSC distress channel in the 8 MHz band and on at least one of the other HF DSC distress channels.

In order to avoid creating on board ships uncertainty regarding on which band the subsequent establishment of contact and distress traffic should be initiated, the HF DSC distress relay alert should be transmitted on one HF band at a time and the subsequent communication with responding ships be established before eventually repeating the DSC distress relay alert on another HF band.

6.2 Urgency

6.2.1 Transmission of urgency announcement and message on HF

For urgency messages by NBDP the following apply:

– the urgency message shall be preceded by at least one carriage return, line feed, one letter shift, the urgency signal PAN PAN and the identification of the coast station;

– FEC broadcast mode should normally be used.

  ARQ mode should be used only when considered advantageous to do so in the actual situation and provided that the radiotelex number of the ship is known.

6.3 Safety

6.3.1 Transmission of safety announcements and messages on HF

For safety messages by NBDP the following apply:

– the safety message shall be preceded by at least one carriage return, line feed, one letter shift, the safety signal SECURITE and the identification of the coast station;

– FEC broadcast mode should normally be used.

  ARQ mode should be used only when considered advantageous to do so in the actual situation and provided that the radiotelex number of the ship is known.

6.4 Testing the equipment used for distress and safety

The procedures for ships testing their equipment used for DSC distress, urgency and safety calls on HF DSC distress channels and the acknowledgement of the test call by the coast station are the same as for testing on the MF DSC distress frequency 2 187.5 kHz.

ANNEX 5

Frequencies used for DSC

1 The frequencies used for distress and safety purposes using DSC are as follows (see also RR Article 38 (Appendix S13, Part A2)):

2 187.5	kHz
4 207.5	kHz
6 312	kHz
8 414.5	kHz
12 577	kHz
16 804.5	kHz
156.525	MHz (Note 1)

NOTE 1 – The frequency 156.525 MHz may also be used for DSC purposes other than distress and safety.

2 The frequencies assignable on an international basis to ship and coast stations for DSC, for purposes other than distress and safety, are as follows:

2.1 Ship stations (see Note 1)

458.5			kHz
2 177 (Note 2)	2 189.5		kHz
4 208	4 208.5	4 209	kHz
6 312,5	6 313	6 313.5	kHz
8 415	8 415.5	8 416	kHz
12 577.5	12 578	12 578.5	kHz
16 805	16 805.5	16 806	kHz
18 898.5	18 899	18 899.5	kHz
22 374.5	22 375	22 375.5	kHz
25 208.5	25 209	25 209.5	kHz
		156.525	MHz (Note 3)

2.2 Coast stations (see Note 1)

455.5			kHz
2 177			kHz
4 219.5	4 220	4 220.5	kHz
6 331	6 331.5	6 332	kHz
8 436.5	8 437	8 437.5	kHz
12 657	12 657.5	12 658	kHz
16 903	16 903.5	16 904	kHz
19 703.5	19 704	19 704.5	kHz
22 444	22 444.5	22 445	kHz
26 121	26 121.5	26 122	kHz
		156.525	MHz (Note 3)

NOTE 1 – The following (kHz) paired frequencies (for ship/coast stations) 4 208/4 219.5, 6 312.5/6 331, 8 415/8 436.5, 12 577.5/12 657, 16 805/16 903, 18 898.5/19 703.5, 22 374.5/22 444 and 25 208.5/26 121 are the first choice international frequencies for DSC.

NOTE 2 – The frequency 2 177 kHz is available to ship stations for intership calling only.

NOTE 3 – The frequency 156.525 MHz is also used for distress and safety purposes (see Note 1 of § 1 of this Annex).

3 In addition to the frequencies listed in § 2 above, appropriate working frequencies in the following bands may be used for DSC:

415-526.5	kHz	(Regions 1 and 3)
415-525	kHz	(Region 2)
1 606.5-4 000	kHz	(Regions 1 and 3)
1 605-4 000	kHz	(Region 2) (For the band 1 605-1 625 kHz, see RR No. 480 (S5.89))
4 000-27 500	kHz	
156-174	kHz	

RECOMMENDATION ITU-R M.625-3*

DIRECT-PRINTING TELEGRAPH EQUIPMENT EMPLOYING AUTOMATIC IDENTIFICATION IN THE MARITIME MOBILE SERVICE**

(Question ITU-R 5/8)

(1986-1990-1992-1995)

Summary

The Recommendation provides in Annex 1 characteristics of direct-printing telegraph equipment employing a 7-unit ARQ method for selective communication, a 7-unit FEC method for broadcast mode and automatic identification to be used for newly developed equipment to provide compatibility with existing equipment conforming to Recommendation ITU-R M.476.

The ITU Radiocommunication Assembly,

considering

a) that there is a requirement to interconnect ship stations or ship stations and coast stations, equipped with start-stop apparatus employing the ITU-T International Telegraph Alphabet No. 2, by means of radiotelegraph circuits;

b) that direct-printing telegraph equipment in the maritime mobile service is used for:

– telex and/or telegraph service between a ship station and a subscriber of the (international) telex network;

– telegraph service between a ship station and a coast station or between two ship stations;

– telegraph service between a ship station and an extended station (ship owner) via a coast station;

– telegraph service in a broadcast mode from a coast station, or a ship station, to one or more ship stations;

c) that the broadcast mode cannot take advantage of an ARQ method, as a return path is not used;

d) that for the broadcast mode a forward error-correcting (FEC) method should be used;

e) that the period for synchronization and phasing should be as short as possible;

f) that most of the ship stations do not readily permit the simultaneous use of radio transmitter and receiver;

g) that a direct-printing telegraph system employing error-detecting and error-correcting methods in accordance with Recommendation ITU-R M.476, is in actual operation;

h) that the increased use of direct-printing telegraph equipment has emphasized the importance of an unambiguous identification of both stations when a circuit is established or re-established;

j) that unambiguous identification could be accomplished by the exchange of self-identification signals between the ARQ equipments at the 7-unit level;

k) that Appendix 43 of the Radio Regulations (RR), Recommendation ITU-R M.585 and ITU-T Recommendations E.210 and F.120 provide for a comprehensive system of assigning maritime mobile service identities;

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

** Newly developed equipment should conform to the present Recommendation which provides for compatibility with existing equipment built in accordance with Recommendation ITU-R M.476.

l) that, in the interest of having a unique identity assigned to each ship station for distress and safety and other telecommunication purposes, the address capability should allow the use of maritime mobile service identities in accordance with the provisions of Appendix 43 of the RR;

m) that equipment built in accordance with Recommendation ITU-R M.476 cannot provide for the use of maritime mobile service identities mentioned in § k);

n) that there is a need to provide for compatibility to the extent possible with equipments built in accordance with Recommendation ITU-R M.476; however, unambiguous identification of both stations cannot be achieved when circuits are established with equipments built in accordance with Recommendation ITU-R M.476,

recommends

1 that for direct-printing telegraph circuits in the maritime mobile service, a 7-unit ARQ method should be employed;

2 that for the direct-printing telegraph service in the broadcast mode, a 7-unit forward acting error-correcting method, using time diversity, should be employed;

3 that equipment designed in accordance with § 1 and 2 should employ automatic identification and have the characteristics given in Annex 1.

ANNEX 1

CONTENTS

1 General (mode A (ARQ) and mode B (FEC))

1.1 The system in both Mode A (ARQ) and Mode B (FEC) is a single-channel synchronous system using the 7-unit constant ratio error-detecting code as listed in § 2.2 and 2.3.

1.2 FSK modulation is used on the radio link at 100 Bd. The equipment clock controlling the modulation rate should have an accuracy of 30 parts in 10^6 or better.

1.3 The class of emission is F1B or J2B with a frequency shift on the radio link of 170 Hz. When frequency shift is effected by applying audio signals to the input of a single-sideband transmitter, the centre frequency of the audio spectrum applied to the transmitter should be 1 700 Hz.

1.4 The radio-frequency tolerance of the transmitter and the receiver should be in accordance with Recommendation ITU-R SM.1137. It is desirable that the receiver employs the minimum practicable bandwidth (see also Report ITU-R M.585).

NOTE 1 – The receiver 6 dB bandwidth should preferably be between 270 and 340 Hz.

1.5 For direct connection to the international telex network, the line input and output signals should be in accordance with the 5-unit start-stop International Telegraph Alphabet No. 2, at a modulation rate of 50 Bd.

1.6 Equipment designed in accordance with this Recommendation is likely to contain high speed digital circuitry. Special care should be taken to avoid interference to other equipment and to minimize susceptibility to interference from other equipment or electrical lines on board ship (see also Recommendation ITU-R M.218).

1.7 When operating in mode A (ARQ), the called station employs a constant time interval between the end of the received signal and the start of the transmitted signal (t_E in Fig. 1). In the case of long propagation distances it is essential to have this t_E as short as practicable. However, in the case of short distances it may be desirable to introduce a longer time interval, e.g. 20-40 ms, to accommodate receiver desensitization at the calling station. This time interval can be introduced at the called station either in the ARQ equipment or in the radio equipment.

2 Conversion tables

2.1 General

Several kinds of "signals" are used in the system, such as:

– traffic information signals,

– service information signals (control signals, idle signals, signal repetition),

– identification signals,

– check-sum signals.

2.2 Traffic information signals

These signals are used during communication to convey the message information which is passed from an information sending station to one or more information receiving stations. Table 1 lists the traffic information signals which may be used.

2.3 Service information signals

These signals are used to control the procedures taking place over the radio circuit and do not form part of the transmitted messages. Service information signals are not normally printed or displayed. Table 2 lists the service information signals which may be used.

TABLE 1

Combination No.	Traffic information signals		International Telegraph Alphabet No. 2 Code (1)	Transmitted 7-unit signal (2)
	Letter-case	Figure case	Bit position (3) 1 2 3 4 5	Bit position (3) 1 2 3 4 5 6 7
1	A	–	ZZAAA	BBBYYYB
2	B	?	ZAAZZ	YBYYBBB
3	C	:	AZZZA	BYBBBYY
4	D	⊠ (4)	ZAAZA	BBYYBYB
5	E	3	ZAAAA	YBBYBYB
6	F	(5)	ZAZZA	BBYBBYY
7	G	(5)	AZAZZ	BYBYBBY
8	H	(5)	AAZAZ	BYYBYBB
9	I	8	AZZAA	BYBBYYB
10	J	⍾ (Audible signal)	ZZAZA	BBBYBYY
11	K	(	ZZZZA	YBBBBYY
12	L	)	AZAAZ	BYBYYBB
13	M	.	AAZZZ	BYYBBBY
14	N	,	AAZZA	BYYBBYB
15	O	9	AAAZZ	BYYYBBB
16	P	0	AZZAZ	BYBBYBY
17	Q	1	ZZZAZ	YBBBYBY
18	R	4	AZAZA	BYBYBYB
19	S	’	ZAZAA	BBYBYYB
20	T	5	AAAAZ	YYBYBBB
21	U	7	ZZZAA	YBBBYYB
22	V	=	AZZZZ	YYBBBBY
23	W	2	ZZAAZ	BBBYYBY
24	X	/	ZAZZZ	YBYBBBY
25	Y	6	ZAZAZ	BBYBYBY
26	Z	+	ZAAAZ	BBYYYBB
27	← (Carriage return)		AAAZA	YYYBBBB
28	≡ (Line feed)		AZAAA	YYBBYBB
29	↓ (Letter shift)		ZZZZZ	YBYBBYB
30	↑ (Figure shift)		ZZAZZ	YBBYBBY
31	△ (Space)		AAZAA	YYBBBYB
32	□ No information		AAAAA	YBYBYBB

(1) A represents start polarity, Z represents stop polarity (see also Recommendation ITU-R M.490).

(2) B represents the higher emitted frequency and Y the lower (see also Recommendation ITU-R M.490).

(3) The bit in bit position 1 is transmitted first; B = 0, Y = 1.

(4) The pictorial representation shown is a schematic of ✠ which may also be used when equipment allows (ITU-T Recommendation F.1, § C9).

(5) At present unassigned (see ITU-T Recommendation F.1, § C8). Reception of these signals, however, should not initiate a request for repetition.

TABLE 2

Mode A (ARQ)	Transmitted signal	Mode B (FEC)
Control signal 1 (CS1)	BYBYYBB	
Control signal 2 (CS2)	YBYBYBB	
Control signal 3 (CS3)	BYYBBYB	
Control signal 4 (CS4)	BYBYBBY	
Control signal 5 (CS5)	BYYBYBB	
Idle signal β	BBYYBBY	Idle signal β
Idle signal α	BBBBYYY	Phasing signal 1, Idle signal α
Signal repetition (RQ)	YBBYYBB	Phasing signal 2

2.4 Identification and check-sum numbers and signals

Identification and check-sum numbers and signals are used in the automatic identification procedure in order to provide a means by which, during the establishment or re-establishment of a radio circuit, the stations concerned are clearly and unambiguously identified to each other. The relationship between the transmitted identification signals and their equivalent numbers is shown in Table 3a; Table 3b indicates the conversion from check-sum numbers to the transmitted check-sum signals.

TABLE 3a

Identification signal (IS)	Equivalent number (N)
A	19
B	11
C	6
D	18
E	13
F	8
I	15
K	3
M	4
O	14
P	5
Q	2
R	16
S	9
T	10
U	12
V	0
X	1
Y	7
Z	17

TABLE 3b

Check-sum number (CN)	Check-sum signal (CK)
0	V
1	X
2	Q
3	K
4	M
5	P
6	C
7	Y
8	F
9	S
10	T
11	B
12	U
13	E
14	O
15	I
16	R
17	Z
18	D
19	A

2.5 Check-sum signal derivation

These identification signals IS1, IS2, IS3, IS4, IS5, IS6 and IS7 are converted into their equivalent numbers N1, N2, N3, N4, N5, N6 and N7 respectively, in accordance with Table 3a. The three numbers N1, N2 and N3 are added and the sum is translated into one check-sum number CN1 using modulo 20-addition. This process is repeated for the numbers N3, N4 and N5 resulting in a check-sum number CN2 and for the numbers N5, N6 and N7 resulting in a check-sum number CN3, as follows:

$$N1 \oplus N2 \oplus N3 = CN1$$

$$N3 \oplus N4 \oplus N5 = CN2$$

$$N5 \oplus N6 \oplus N7 = CN3$$

where $\oplus$ denotes modulo 20-addition.

The last conversion is from check-sum numbers CN1, CN2 and CN3 into "check-sum signal 1", "check-sum signal 2" and "check-sum signal 3" respectively, in accordance with Table 3b.

Example:

The seven identification signals of station 364775427 are: P E A R D B Y (see Recommendation ITU-R M.491).

The check-sum derivation will be as follows:

P E A R D B Y $\rightarrow$ 5 13 19 16 18 11 7

5 $\oplus$ 13 $\oplus$ 19 = 17 (37-20)

19 $\oplus$ 16 $\oplus$ 18 = 13 (53-20-20)

18 $\oplus$ 11 $\oplus$ 7 = 16 (36-20)

17 13 16 $\rightarrow$ Z E R

where $\oplus$ denotes modulo 20-addition.

Result:

CK1 becomes “Z” (combination No. 26, see Table 1)

CK2 becomes “E” (combination No. 5, see Table 1)

CK3 becomes “R” (combination No. 18, see Table 1)

3 Characteristics, mode A (ARQ)

3.1 General

The system operates in a synchronous mode transmitting blocks of three signals from an information sending station (ISS) towards an information receiving station (IRS). A control signal is transmitted from the IRS to the ISS after reception of each block indicating correct reception or requesting retransmission of the block. These stations can interchange their functions.

3.2 Master and slave arrangements

3.2.1 The station that initiates the establishment of the radio circuit (the calling station) becomes the “master” station, and the station being called will be the “slave” station. This situation remains unchanged during the entire time that the established radio circuit is maintained, regardless of which station, at any given time, is the information sending station (ISS) or the information receiving station (IRS).

3.2.2 The clock in the master station controls the timing of the entire circuit (see circuit timing diagram, Fig. 1). This clock should have an accuracy of 30 parts in 10^6 or better.

3.2.3 The basic timing cycle is 450 ms and consists for each station of a transmission period followed by a transmission pause during which reception is effected.

3.2.4 The master station transmit timing is controlled by the clock in the master station.

3.2.5 The clock controlling the timing of the slave station is phase-locked to the signal received from the master station, i.e. the time interval between the end of the received signal and the start of the transmitted signal (t_E in Fig. 1) is constant (see also § 1.7).

3.2.6 The master station receive timing is phase-locked to the signal received from the slave station.

3.3 The information sending station (ISS)

3.3.1 The ISS groups the information to be transmitted into blocks of three signals (3 × 7 signal elements).

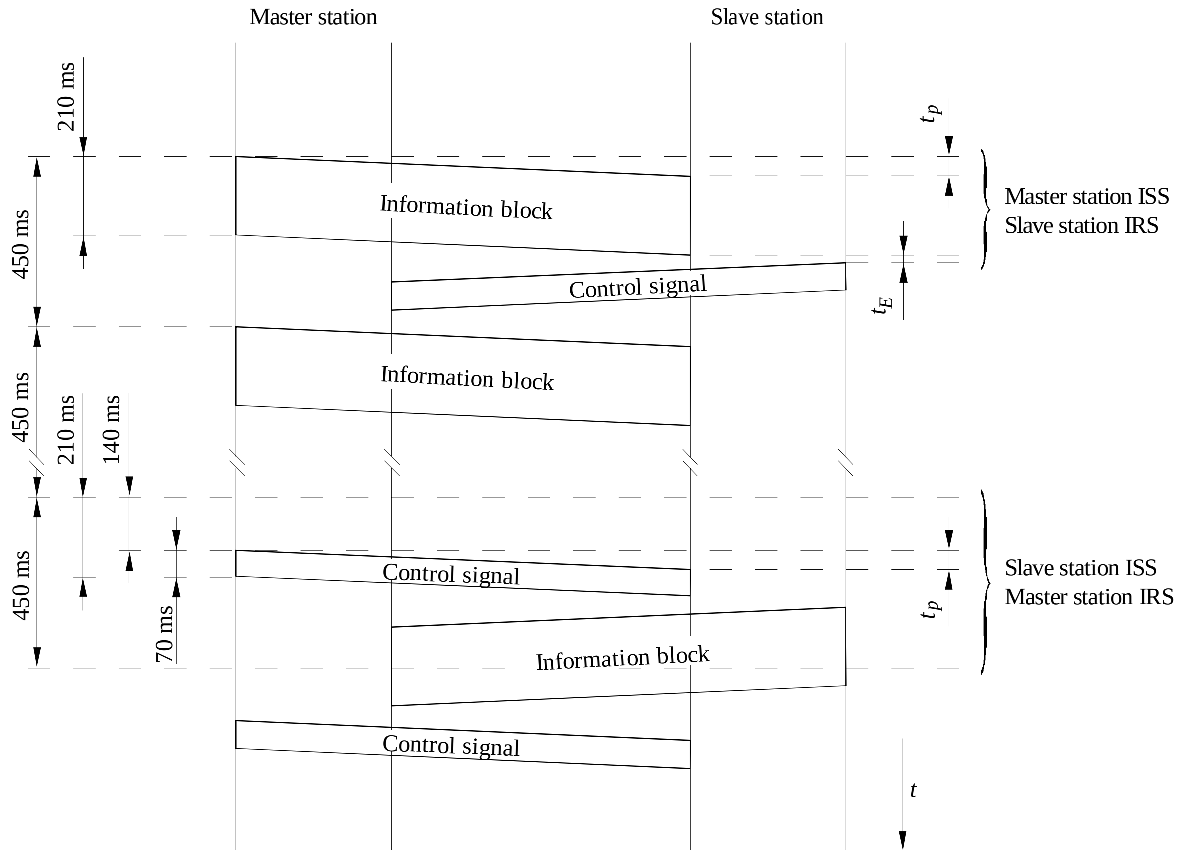
3.3.2 The ISS sends a block in 210 ms (3 × 70 ms) after which a transmission pause of 240 ms becomes effective.

3.4 The information receiving station (IRS)

3.4.1 After the reception of each block the IRS sends one signal of 70 ms duration (7-signal elements), after which a transmission pause of 380 ms becomes effective.

FIGURE 1

Basic timing diagram



t_p : (one-way) propagation time
t_E : equipment delay (see also § 1.7)

3.5 Phasing procedure

3.5.1 When no circuit is established, both stations are in the "stand-by" condition. In this condition neither of the stations is designated master, slave, ISS or IRS.

3.5.2 The "call signal" contains either four or seven identification signals as applicable. The identification signals are listed in Table 3a. The composition of these "call signals" should be in accordance with Recommendation ITU-R M.491.

3.5.2.1 The equipment should be capable of operating with both 4-signal and 7-signal identity procedures and automatically employing the appropriate procedure for either, as indicated by the composition of the "call signal" received from a calling station or by the number of digits (4, 5 or 9) supplied to the equipment of a calling station to identify the station to be called.

3.5.3 The "call signal" (Note 1) contains:

– in "call block 1": in the first, second and third character places respectively: the first identification signal, the service information signal "signal repetition" and the second identification signal of the called station;

– in "call block 2": in the first, second and third character places respectively, either:

  – in the case of a 4-signal call identity: the third and the fourth identification signals of the called station and "signal repetition"; or

  – in the case of a 7-signal call identity: "signal repetition", and the third and fourth identification signals of the called station;

– in the case of a 7-signal call identity in "call block 3": the last three identification signals of the called station.

NOTE 1 – A station using a two block call signal shall be assigned a number in accordance with RR Nos. 2088, 2134 and 2143 to 2146.

A station capable of using a three block call signal, shall employ the maritime identification digits required in accordance with RR Appendix 43 when communicating with stations also capable of using a three block call signal.

3.5.4 The station required to establish the circuit becomes the master station and sends the "call signal" until it receives an appropriate control signal; however, if the circuit has not been established within 128 cycles (128 × 450 ms), the station changes into the "stand-by" condition and waits for a time of at least 128 cycles before sending the same "call signal" again.

3.5.5 The called station becomes the slave station and changes from the "stand-by" to the IRS condition:

– in the case of a 4-signal call identity following the consecutive reception of "call block 1" and "call block 2", after which it sends "control signal 1" until the first information block has been received;

– in the case of a 7-signal call identity following the reception of the three call blocks in succession after which it sends "control signal 4" until "identification block 1" has been received.

3.5.6 On receipt of two consecutive identical signals "control signal 1" or "control signal 2" the calling station changes to the ISS condition and proceeds directly with the transmission of traffic information (see § 3.7) without automatic identification.

NOTE 1 – Equipment built in accordance with Recommendation ITU-R M.476 sends "control signal 1" or "control signal 2" on receipt of the appropriate "call signal".

3.5.7 On receipt of "control signal 3" during the phasing procedure, the calling station immediately changes to the "stand-by" condition, and waits 128 cycles before sending the same "call signal" again.

NOTE 1 – Equipment built in accordance with Recommendation ITU-R M.476 may send "control signal 3" on receipt of the appropriate "call signal", if the called station is rephasing and was in the ISS condition at the moment of interruption.

3.5.8 On receipt of "control signal 5" during the phasing procedure, the calling station starts the "end-of-communication" procedure in accordance with § 3.7.14, and waits at least 128 cycles before sending the same "call signal" again. During this waiting time the station is in the "stand-by" condition.

3.6 Automatic identification

Only applicable in the case of a 7-signal call identity.

3.6.1 On receipt of "control signal 4" the calling station changes to the ISS condition and starts the identification procedure. During the identification cycle, information is exchanged about the identities of both stations; the ISS transmits its identification blocks and the IRS returns the check-sum signals derived from its identity in accordance with § 2.5. On receipt of each check-sum signal, the calling station compares this signal with the appropriate check-sum signal locally derived from the identification signals transmitted in the call blocks. If they are identical, the calling station continues with the following procedure, otherwise the procedure of § 3.6.12 is followed.

3.6.2 The ISS sends "identification block 1" containing its own first identification signal, "idle signal α" and its second identification signal in the first, second and third character places respectively.

3.6.3 On receipt of "identification block 1" the called station sends "check-sum signal 1", derived from its identity.

3.6.4 On receipt of "check-sum signal 1" the calling station sends "identification block 2" containing the first, second and third character places respectively, "idle signal α", its third identification signal and its fourth identification signal.

3.6.5 On receipt of "identification block 2" the called station sends "check-sum signal 2", derived from its identity.

3.6.6 On receipt of "check-sum signal 2" the calling station sends "identification block 3" containing its fifth, sixth and seventh identification signals in the first, second and third character places respectively.

3.6.7 On receipt of "identification block 3" the called station sends "check-sum signal 3", derived from its identity.

3.6.8 On receipt of the last check-sum signal the calling station sends the "end-of-identification block" containing three "signal repetition" signals.

3.6.9 On receipt of the "end-of-identification block" the called station sends, either:

– "control signal 1", thus starting the traffic flow in accordance with § 3.7; or

– "control signal 3", if the called station is required to start the traffic flow in the ISS condition (in accordance with § 3.7.11).

3.6.10 On receipt of "control signal 1" the calling station ends the identification cycle and starts the traffic flow by transmitting "information block 1" in accordance with § 3.7.

3.6.11 On receipt of "control signal 3" the calling station ends the identification cycle and starts the traffic flow with the change-over procedure in accordance with § 3.7.11.

3.6.12 If any received check-sum signal is not identical to the locally derived check-sum signal, the calling station retransmits the previous identification block. On receipt of this identification block, the called station sends the appropriate check-sum signal once more.

On receipt of this check-sum signal the calling station compares again. If they are still not identical, and the received check-sum signal is the same as the previous one, the calling station initiates the "end of communication" procedure in accordance with § 3.7.14; otherwise the calling station transmits the previous identification block again. Any identification block should not be retransmitted more than four times due to reception of wrong check-sum signals, after which, if the required check-sum signal is still not received, the calling station reverts to the "stand-by" condition.

3.6.13 If, due to mutilated reception, the calling station does not receive:

– "control signal 4", it continues transmitting the "call signal";

– "check-sum signal 1", it retransmits "identification block 1";

– "check-sum signal 2", it retransmits "identification block 2";

– "check-sum signal 3", it retransmits "identification block 3";

– "control signal 1" or "control signal 3", it retransmits the "end-of-identification block",

taking into account the time limit mentioned in § 3.6.18.

3.6.14 If, due to mutilated reception, the called station does not receive a block during the identification cycle, it transmits a "signal repetition", taking into account the time limit mentioned in § 3.6.18.

3.6.15 If during the identification cycle the calling station receives a "signal repetition", it retransmits the previous block.

3.6.16 If, due to retransmission of an identification block by the calling station, the identification signals as received by the called station are not identical, the called station sends "signal repetition" until two identical consecutive identification blocks are received after which the corresponding check-sum signal is transmitted, taking into account the time limit mentioned in § 3.6.18.

3.6.17 If during the identification cycle the called station receives the "end-of-communication block" (containing three "idle signals α"), it sends a "control signal 1" and reverts to the "stand-by" condition.

3.6.18 When reception of signals during the identification cycle is continuously mutilated, both stations revert to the "stand-by" condition after 32 cycles of continuous repetition.

3.6.19 Each station should retain the identity of the other station for the duration of the connection (see § 3.7.1) and this information should be accessible locally, e.g. by means of a display or on a separate output circuit for external use. However, this identity information should not appear on the output line to the network.

3.7 Traffic flow

3.7.1 At all times after the start of the traffic flow and until the station reverts to the "stand-by" condition, the station should retain the following information:

– whether it is in the master or slave condition;

– the identity of the other station (when applicable);

– whether it is in the ISS or IRS condition;

– whether the traffic flow is in the letter case or figure case condition.

3.7.2 The ISS transmits the traffic information in blocks, each block consisting of three signals. If necessary, "idle signals β" are used to complete or to fill information blocks when no traffic information is available.

3.7.3 The ISS retains the transmitted information block in memory until the appropriate control signal confirming correct reception by the IRS has been received.

3.7.4 For internal use, the IRS numbers the received information blocks alternately "information block 1" and "information block 2" dependent on the first transmitted control signal. The numbering is interrupted at the reception of, either:

– an information block in which one or more signals are mutilated; or

– an information block containing at least one "signal repetition".

3.7.5 The IRS sends "control signal 1" at the reception of, either:

– an unmutilated "information block 2"; or

– a mutilated "information block 1"; or

– an "information block 1" containing at least one "signal repetition".

3.7.6 The IRS sends "control signal 2" at the reception of, either:

– an unmutilated "information block 1"; or

– a mutilated "information block 2"; or

– an "information block 2" containing at least one "signal repetition".

3.7.7 For internal use, the ISS numbers successive information blocks alternately "information block 1" and "information block 2". The first block should be numbered "information block 1" or "information block 2" dependent on whether the received control signal is a "control signal 1" or a "control signal 2". The numbering is interrupted at the reception of, either:

– a request for repetition; or

– a mutilated control signal; or

– a "control signal 3".

3.7.8 On receipt of "control signal 1" the ISS sends "information block 1".

3.7.9 On receipt of "control signal 2" the ISS sends "information block 2".

3.7.10 On receipt of a mutilated control signal the ISS sends a block containing three "signal repetitions".

3.7.11 Change-over procedure

3.7.11.1 If the ISS is required to initiate a change in the direction of the traffic flow, the station sends the signal sequence ("↑" combination No. 30), "+" (combination No. 26), "?" (combination No. 2) followed, if necessary, by one or more "idle signals β" to complete the information block.

3.7.11.2 On receipt of the signal sequence ("+", "?" (combination No. 26 and combination No. 2)) with the traffic flow in the figure case condition, the IRS sends "control signal 3" until an information block containing the signals "idle signal β", "idle signal α", "idle signal β" has been received.

NOTE 1 – The presence of "idle signals β" between the signals "+" and "?" should not inhibit the response of the IRS.

3.7.11.3 If the IRS is required to initiate a change in the direction of the traffic flow, it sends "control signal 3".

3.7.11.4 On receipt of "control signal 3" the ISS sends an information block containing "idle signal β", "idle signal α" and "idle signal β" in the first, second and third character places respectively.

3.7.11.5 On receipt of the information block containing the service information signals "idle signal β", "idle signal α" and "idle signal β", the IRS changes to ISS and sends, either:

– an information block containing three "signal repetitions", if it is the slave station; or

– one "signal repetition", if it is the master station,

until either "control signal 1" or "control signal 2" is received, taking into account the time limit mentioned in § 3.7.12.1.

3.7.11.6 The ISS changes to IRS after the reception of, either:

– an information block containing three "signal repetitions" if it is the master station; or

– one "signal repetition" if it is the slave station,

and sends either "control signal 1" or "control signal 2" depending on whether the preceding control signal was "control signal 2" or "control signal 1", respectively, after which the traffic flow starts in the appropriate direction.

3.7.12 Time-out procedure

3.7.12.1 When reception of information blocks or of control signals is continuously mutilated, both stations revert to the "rephase" condition after 32 cycles of continuous repetition, in accordance with § 3.8.

3.7.13. Answer-back procedure

3.7.13.1 If the ISS is required to request terminal identification, the station sends the signals "↑" (combination No. 30) and "⊠" (combination No. 4) followed, if necessary, by one or more "idle signals β" to complete the information block.

3.7.13.2 On receipt of an information block containing the traffic information signal "⊠" (combination No. 4) with the traffic flow in the figure case condition, the IRS:

– changes the direction of the traffic flow in accordance with § 3.7.11;

– transmits the traffic information signals derived from the teleprinter answer-back code generator;

– transmits, after completion of the answer-back code, or in the absence of an answer-back code, two information blocks of three "idle signals β";

– changes the direction of the traffic flow in accordance with § 3.7.11, and reverts to IRS.

3.7.14 End-of-communication procedure

3.7.14.1 If the ISS is required to terminate the established circuit, it sends the "end-of-communication block" containing three "idle signals α", until the appropriate "control signal 1" or "control signal 2" has been received; however, the number of transmissions of the "end-of-communication block" is limited to four, after which the ISS reverts to the "stand-by" condition.

3.7.14.2 On receipt of the "end-of-communication block" the IRS sends the appropriate control signal indicating correct reception of this block, and reverts to the "stand-by" condition.

3.7.14.3 On receipt of the control signal that confirms the unmutilated reception of the "end-of-communication block", the ISS reverts to the "stand-by" condition.

3.7.14.4 If the IRS is required to terminate the established circuit, it has first to change over to the ISS condition, in accordance with § 3.7.11, before the termination can take place.

3.8 Rephasing procedure

3.8.1 If during the traffic flow, reception of information blocks or control signals is continuously mutilated, both stations change to the "rephase" condition after 32 cycles of continuous repetition. Rephasing is the automatic re-establishment of the previous circuit immediately following interruption of that circuit as a result of continuous repetition (see § 3.7.12).

NOTE 1 – Some coast stations do not provide for rephasing. Therefore, it should be possible to disable the rephasing procedure.

3.8.2 After changing to the "rephase" condition the master station immediately initiates the rephasing procedure. This procedure is the same as the phasing procedure; however, in the case of a 7-signal call identity, instead of "control signal 4" the rephasing slave station will transmit "control signal 5" after the reception of the appropriate "call signal" transmitted by the rephasing master station.

3.8.3 When "control signal 5" is received by the master station, automatic identification takes place along the same lines as laid down in § 3.6. However, on receipt of the "end-of-identification block", containing three "signal repetitions":

3.8.3.1 If, at the time of interruption, the slave station was in the IRS condition, it sends either:

– "control signal 1" if the last correctly received block before the interruption occurred as an "information block 2"; or

– "control signal 2" if the last correctly received block before the interruption occurred was an "information block 1".

3.8.3.2 If, at the time of interruption, the slave station was in the ISS condition, it sends "control signal 3", to initiate change-over to the IRS condition. When the change-over is completed, i.e. after correct reception of the block containing three "signal repetitions" by the master station, the master station sends either:

– "control signal 1" if the last correctly received block before the interruption occurred was an "information block 2"; or

– "control signal 2" if the last correctly received block before the interruption occurred was an "information block 1".

3.8.4 On receipt of "control signal 4", during the rephasing procedure the master station sends one "end-of-communication block" containing three "idle signals α" after which it continues with the rephasing attempt.

3.8.5 On receipt of each identification block, the slave station compares the received identification signals with the previously stored identity of the master station and:

– if the signals are identical, the slave station continues with the procedure by sending the appropriate check-sum signal;

– if the signals are not identical, the slave station initiates the "end-of-communication" procedure in accordance with § 3.7.14 and remains in the "rephase" condition.

3.8.6 On receipt of a block containing three "idle signals α", the slave station sends one "control signal 1" and remains in the "rephase" condition.

3.8.7 In the case of a 4-signal call identity, the rephasing master station:

– upon receipt of two consecutive signals "control signal 1" or "control signal 2" resumes directly with the transmission of traffic information if the slave station was in the IRS condition, or initiates the change-over procedure in accordance with § 3.7.11.1 if the slave station was in the ISS condition;

– upon receipt of two consecutive signals "control signal 3" proceeds directly with the change-over procedure in accordance with § 3.7.11.4 if the slave station was in the ISS condition.

3.8.8 In the case of a 4-signal call identity, the slave station on receipt of the appropriate "call signal" sends:

– if, at the time of interruption, the slave station was in the IRS condition, either:

  – "control signal 1" if it had correctly received "information block 2" before the interruption occurred; or

  – "control signal 2" if it had correctly received "information block 1" before the interruption occurred;

– if, at the time of interruption, the slave station was in the ISS condition, "control signal 3" to initiate change-over to the ISS condition.

3.8.9 If rephasing has not been accomplished within the time-out interval of 32 cycles, both stations revert to the "stand-by" condition and no further rephasing attempts are made.

3.9 Summary of service blocks and service information signals

3.9.1 Service blocks

X_1 - RQ - X_2 : "Call block 1" containing the 1st and 2nd identification signals.

X_3 - X_4 - RQ : "Call block 2" for a 4-signal call identity containing the 3rd and 4th identification signals.

RQ - X_3 - X_4 : "Call block 2" for a 7-signal call identity containing the 3rd and 4th identification signals.

X_5 - X_6 - X_7 : "Call block 3" for a 7-signal call identity containing the 5th, 6th and 7th identification signals.

Y_1 - α - Y_2 : "Identification block 1" containing self-identification signals 1 and 2 and request for the 1st check-sum signal.

α - Y_3 - Y_4 : "Identification block 2" containing self-identification signals 3 and 4 and request for the 2nd check-sum signal.

Y_5 - Y_6 - Y_7 : "Identification block 3" containing self-identification signals 5, 6 and 7 and request for the 3rd check-sum signal.

RQ - RQ - RQ : If occurring within the automatic identification procedure, indicates the end of that procedure and requests the appropriate control signal.

During the traffic flow, indicates request for repetition of the last control signal or in the change-over procedure response to β - α - β.

β - α - β : Block to change the direction of the traffic flow.

α - α - α : Block to initiate the end-of-communication procedure.

3.9.2 Service information signals

CS1 : Request for "information block 1" or "call signal" has been correctly received during phasing/rephasing (only in the case of a 4-signal call identity).

CS2 : Request for "information block 2".

CS3 : IRS requests change of traffic flow direction.

CS4 : "Call signal" has been correctly received during phasing.

CS5 : "Call signal" has been correctly received during rephasing.

RQ : Request for retransmission of the last identification or information block or in the change-over procedure, response to β - α - β.

4 Characteristics, mode B (FEC)

4.1 General

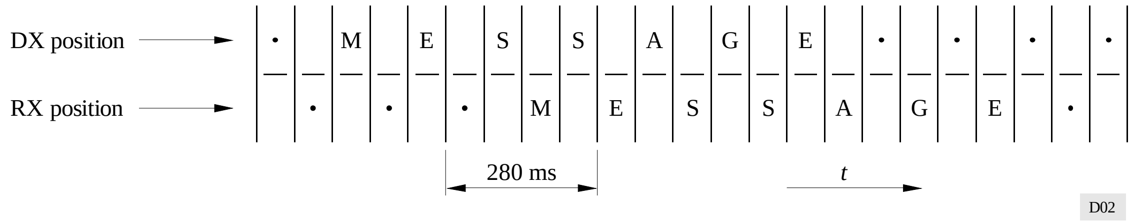
The system operates in a synchronous mode, transmitting an uninterrupted stream of signals from a station sending in the collective B-mode (CBSS) to a number of stations receiving in the collective B-mode (CBRS), or from a station sending in the selective B-mode (SBSS) to one or more selected stations receiving in the selective B-mode (SBRS).

4.2 The sending station (CBSS and SBSS)

The sending station, both in collective and in selective B-mode, sends each signal twice: the first transmission (DX) of a specific signal is followed by the transmission of four other signals, after which the retransmission (RX) of the first signal takes place, allowing for time-diversity reception at 280 ms (4 × 70 ms) time space (see Fig. 2).

FIGURE 2

Time-diversity transmission



4.3 The receiving station (CBRS and SBRS)

The receiving station, both in collective and selective B-mode, checks both signals (DX and RX), and uses the unmutilated one. When both signals appear as unmutilated but different, then both signals should be considered as mutilated.

4.4 Phasing procedure

4.4.1 When no circuit is established, both stations are in the "stand-by" condition and no sending or receiving condition is assigned to either of the stations.

4.4.2 The station required to transmit information becomes the sending station and sends alternately "phasing signal 2" and "phasing signal 1", whereby "phasing signal 2" is transmitted in the DX position and "phasing signal 1" in the RX position. At least sixteen of these signal pairs should be transmitted.

4.4.3 On receipt of the signal sequence "phasing signal 1"-"phasing signal 2", or of the signal sequence "phasing signal 2"-"phasing signal 1", in which "phasing signal 2" determines the DX position and "phasing signal 1" determines the RX position, and at least two further phasing signals in the appropriate position, the station changes to the CBRS condition and offers continuous stop-polarity to the line output terminal until either the traffic information signal "←" (combination No. 27) or "≡" (combination No. 28) is received.

4.5 Selecting calling procedure (selective B-mode)

4.5.1 After the transmission of the required number of phasing signals, the SBSS sends the "call signal", which consists of six transmissions of a sequence, each consisting of the identification signals of the station to be selected followed by an "idle signal β". This transmission takes place using time-diversity in accordance with § 4.2.

4.5.2 The SBSS sends the "call signal" and all further information signals in a 3B/4Y ratio, i.e. inverted with respect to the information signals in Tables 1 and 2 and the identification signals in Table 3a.

4.5.3 The "call signal" contains either four, or seven identification signals as applicable. The identification signals are listed in Table 3a. The composition of these "call signals" should be in accordance with Recommendation ITU-R M.491.

4.5.4 Following unmutilated reception of one complete signal sequence representing its inverted identification signals, the CBRS changes to the SBRS condition and continues offering stop-polarity to the line output terminal until either the traffic information signal; "←" (combination No. 27) or "≡" (combination No. 28) is received.

4.5.5 The station in the SBRS condition accepts the subsequent information signals received with the 3B/4Y ratio, all other stations reverting to the "stand-by" condition.

4.6 Traffic flow

4.6.1 Immediately prior to the transmission of the first traffic signals the sending station transmits the information signals "←" (combination No. 27) and "≡" (combination No. 28), and starts transmitting traffic.

4.6.2 A CBSS sends, during breaks in the information flow, “phasing signals 1” and “phasing signals 2” in the RX and DX positions respectively. At least one sequence of four consecutive phasing signal pairs should occur for every 100 signals sent in the DX position during traffic flow.

4.6.3 A SBSS sends, during breaks in the information flow, “idle signals β”.

4.6.4 On receipt of either the traffic combination signal “←” (combination No. 27) or “≡” (combination No. 28), the receiving station starts printing the received traffic information signals.

NOTE 1 – The term “printing” is used in § 4.6.4 and 4.6.5 to denote the transfer of traffic signals to the output device.

4.6.5 The receiving station checks both signals received in the DX and RX position:

– printing an unmutilated DX or RX signal; or

– printing a “Δ” (combination No. 31), or alternatively an “error character” (to be user-defined) if both DX and RX signals are mutilated or appear unmutilated but are different.

4.6.6 A receiving station reverts to the “stand-by” condition if, during a predetermined time, the percentage of mutilated signals received has reached a predetermined value.

4.6.7 End-of-transmission

4.6.7.1 A station sending in the B-mode (CBSS or SBSS) should terminate the transmission by sending at least 2 s of consecutive “idle signals α”, immediately after the last transmitted traffic information signals after which the station reverts to the “stand-by” condition.

4.6.7.2 The receiving station reverts to the “stand-by” condition not less than 210 ms after receipt of at least two consecutive “idle signals α” in the DX position.

FIGURE 3

Phasing procedure with automatic identification in the case of a 7-signal call identity (mode A)

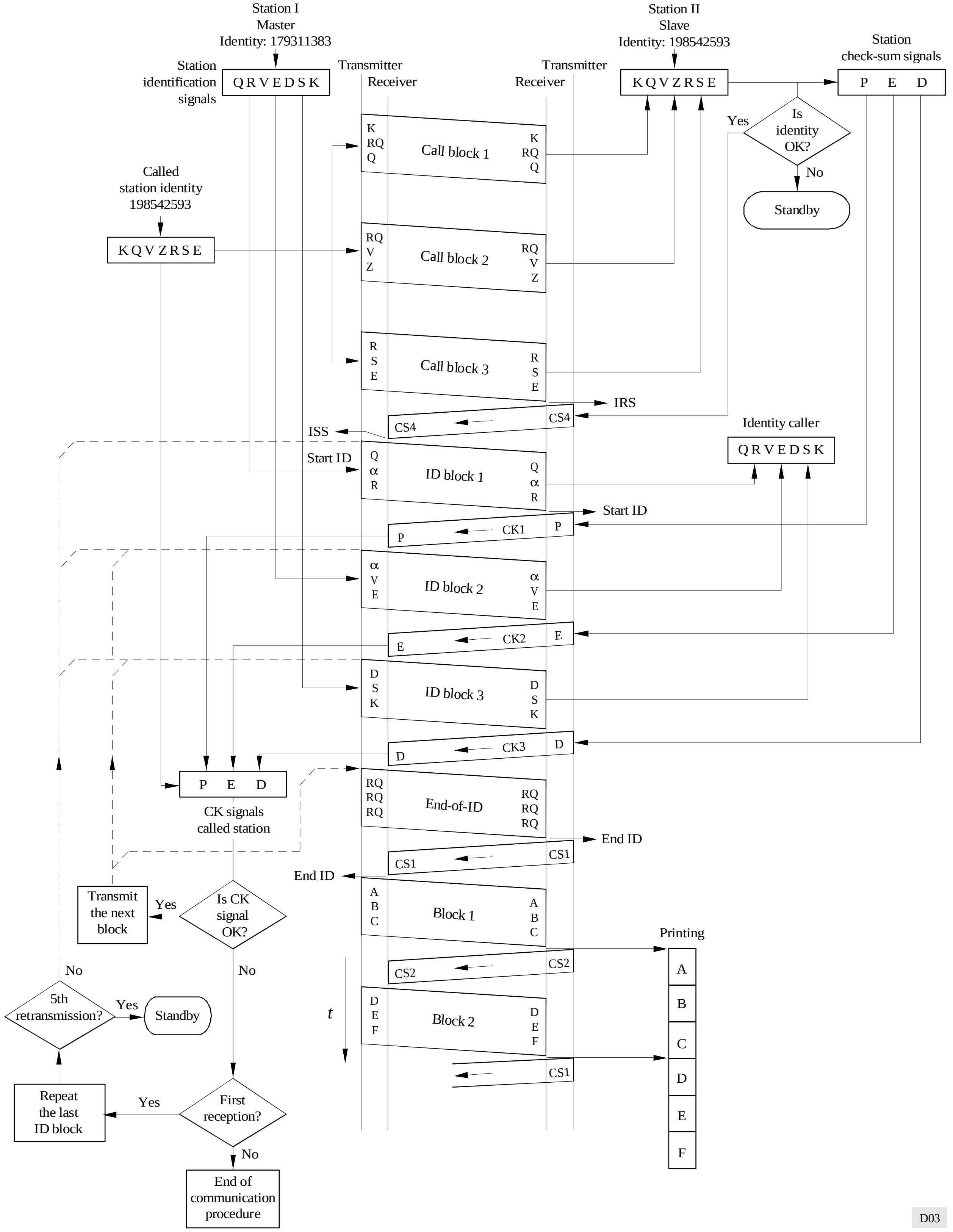


FIGURE 4

Rephasing procedure with automatic identification in the case of a 7-signal call identity (station II was ISS)

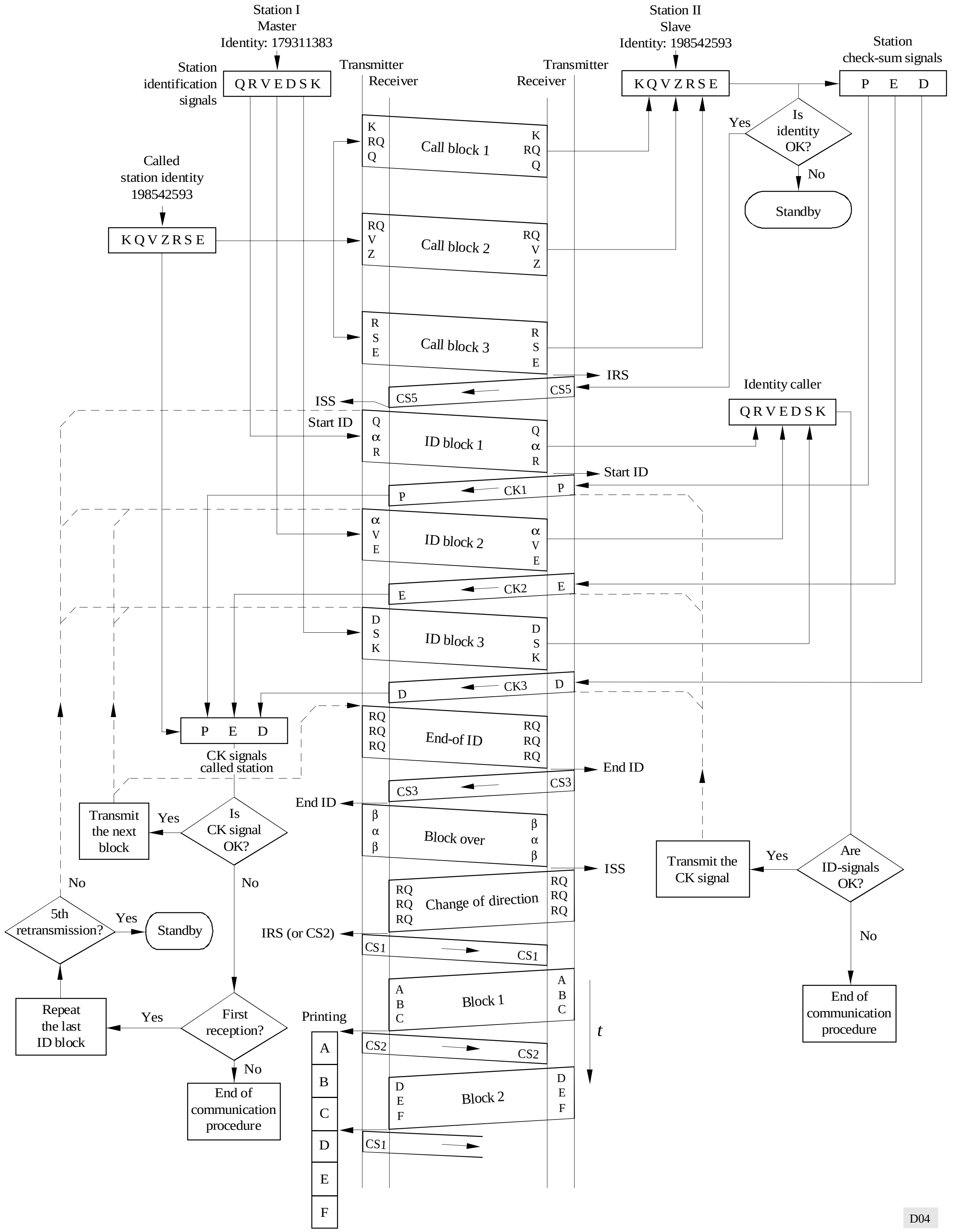


FIGURE 5

Traffic flow with change-over procedure and end-of-communication

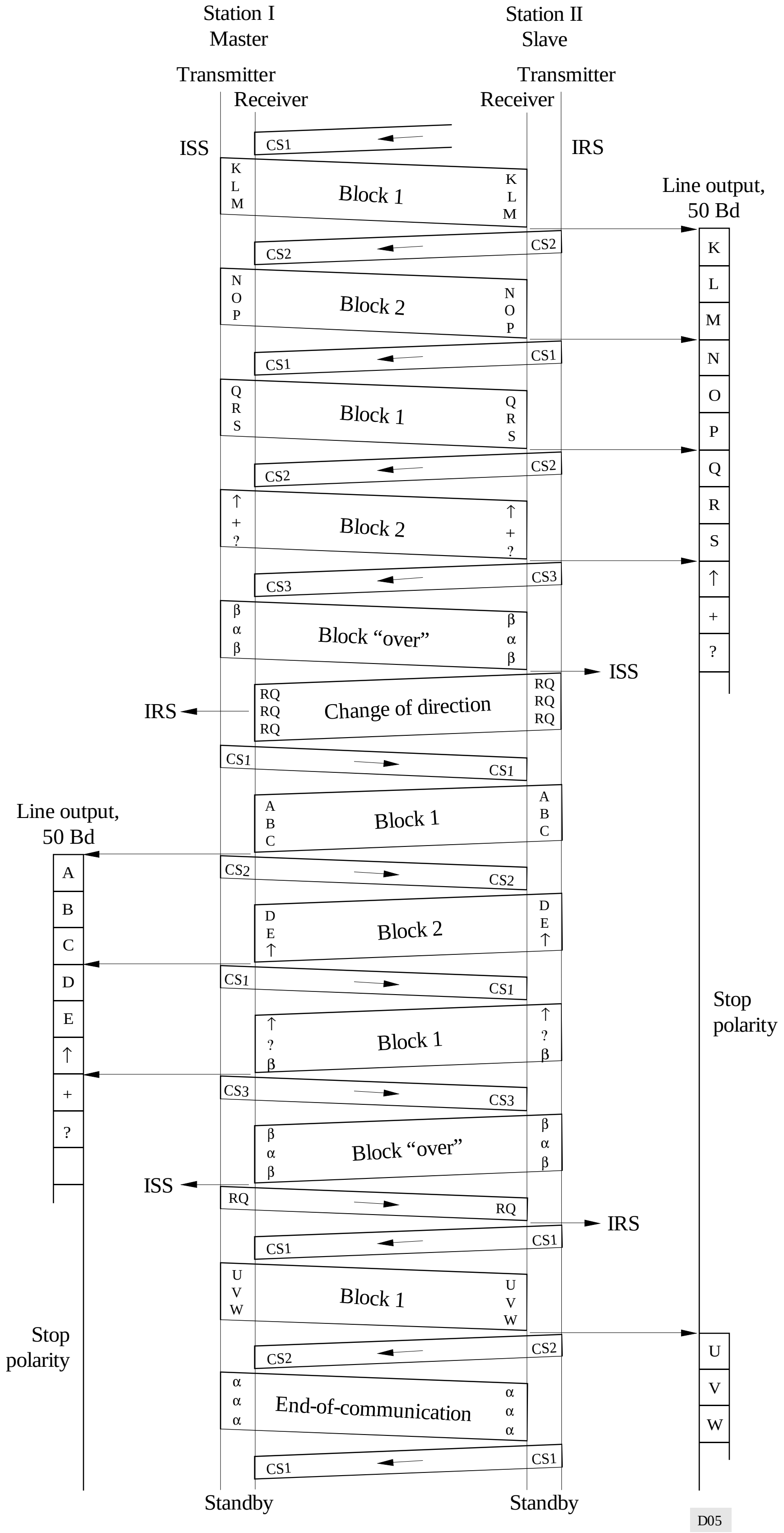


FIGURE 6

Phasing procedure with automatic identification in the condition of mutilated reception in the case of a 7-signal call identity

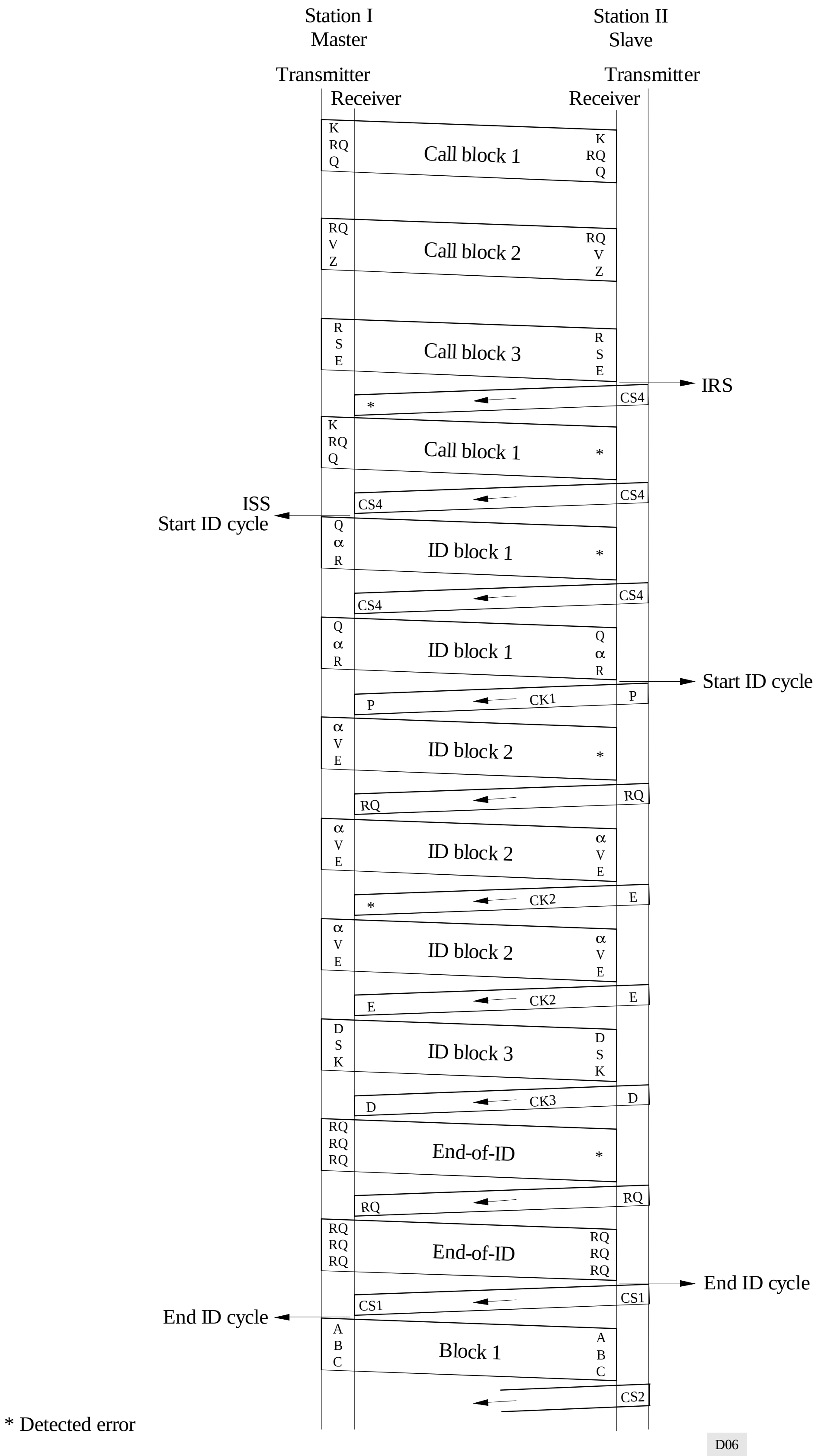


FIGURE 7

Traffic flow in the condition of mutilated reception

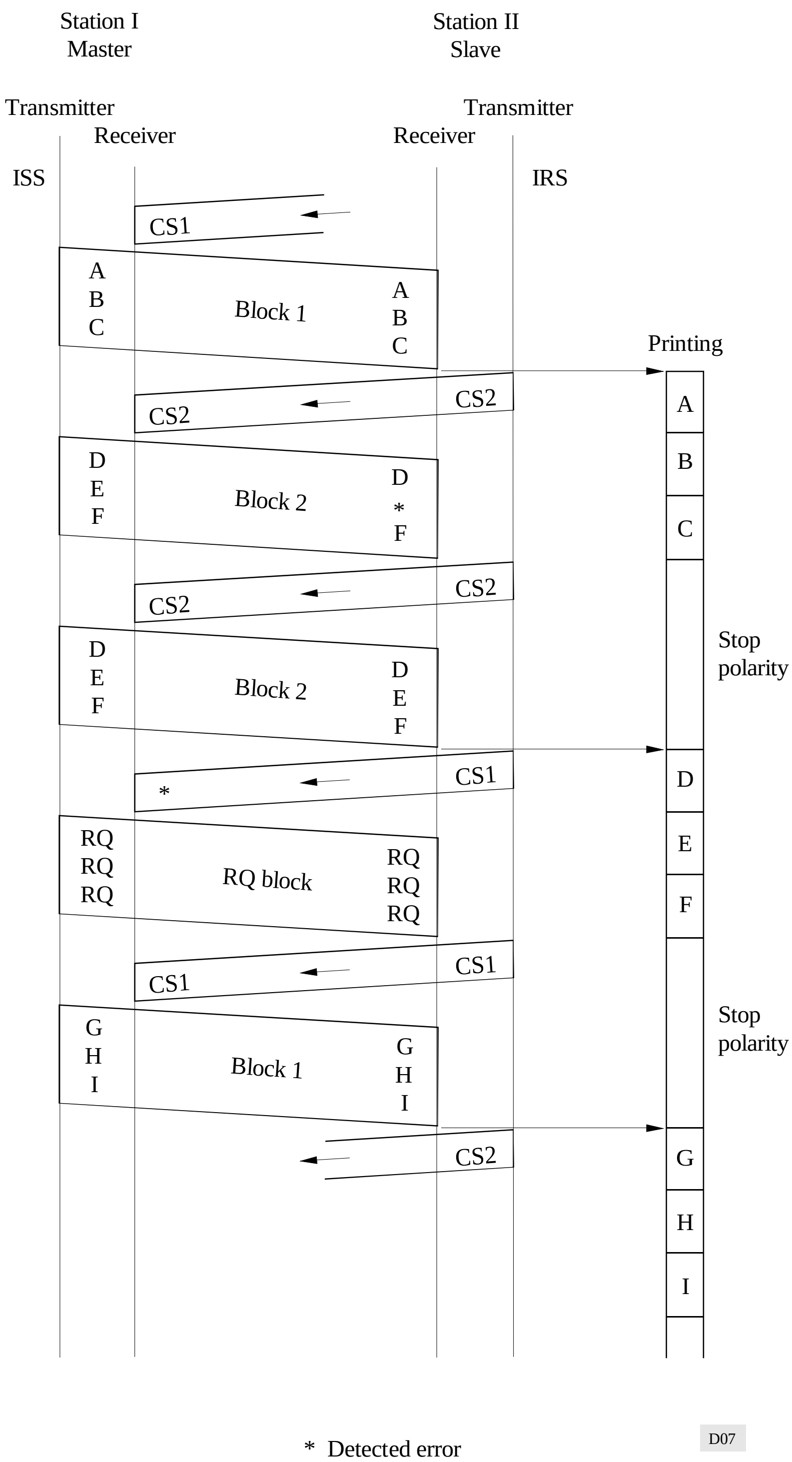
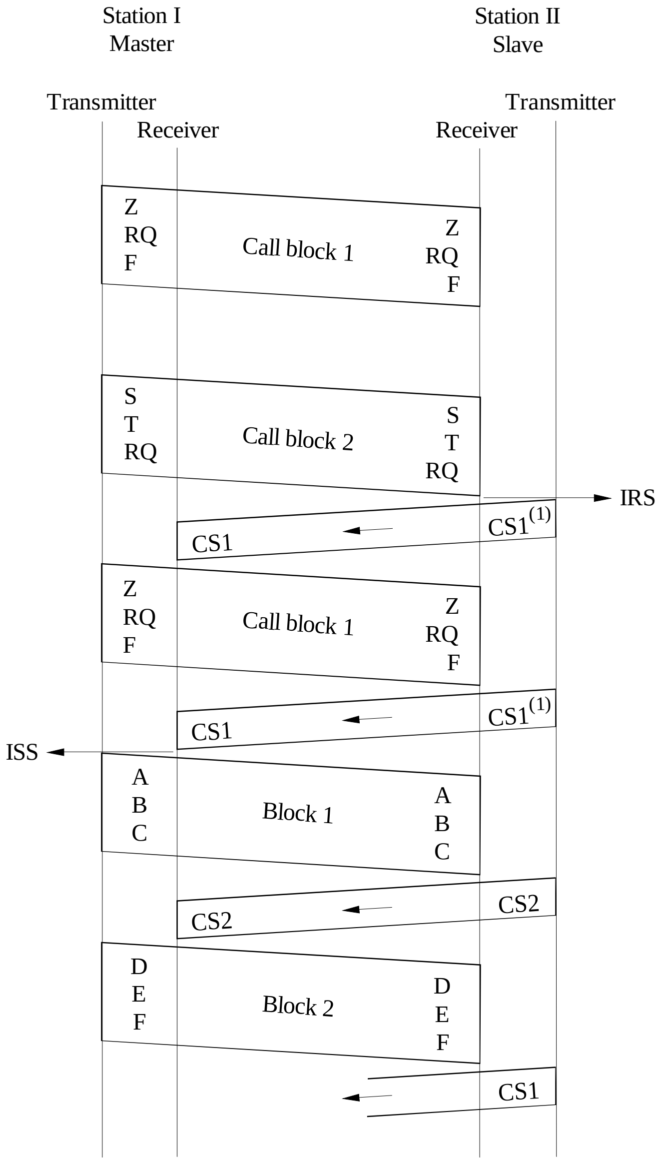


FIGURE 8

Phasing procedure in the case of a 4-signal call identity

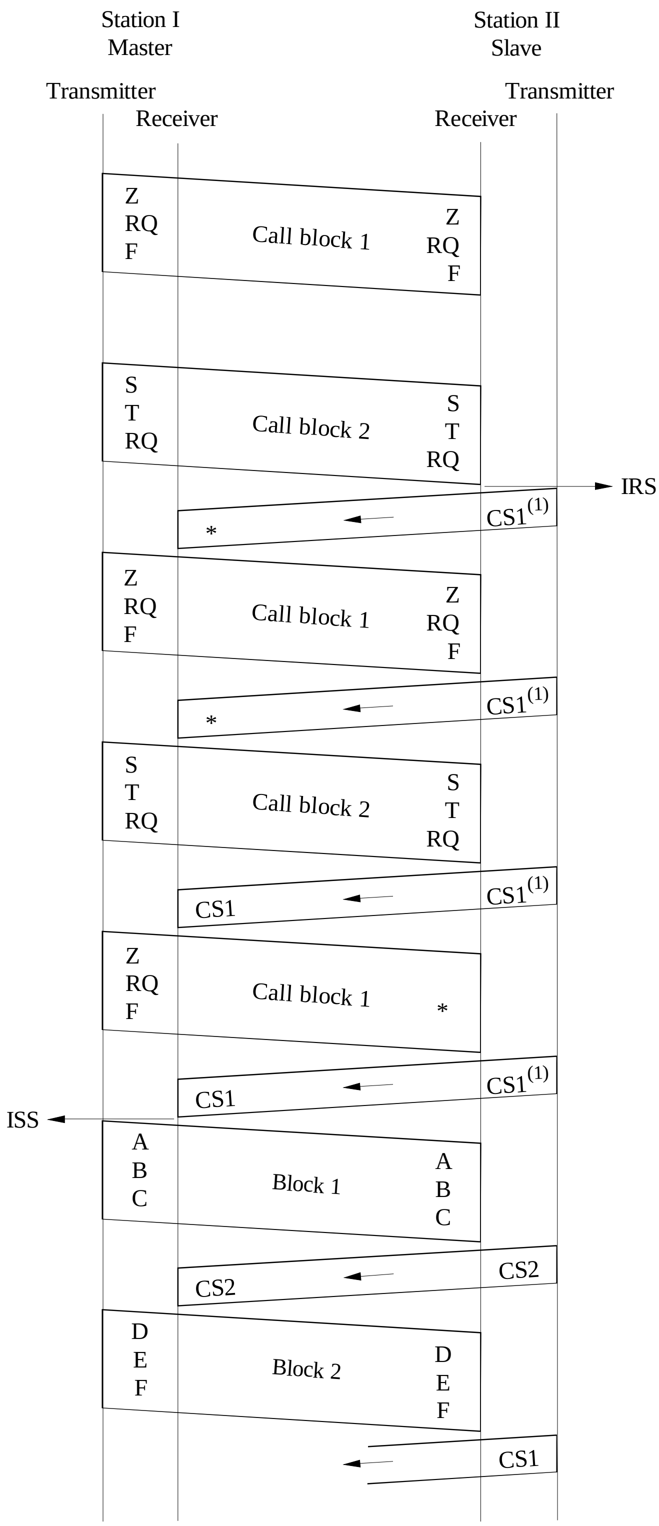


(1) With some equipment built in accordance with Recommendation ITU-R M.476 this could be CS2.

D08

FIGURE 9

Phasing procedure in the condition of mutilated reception in the case of a 4-signal call identity

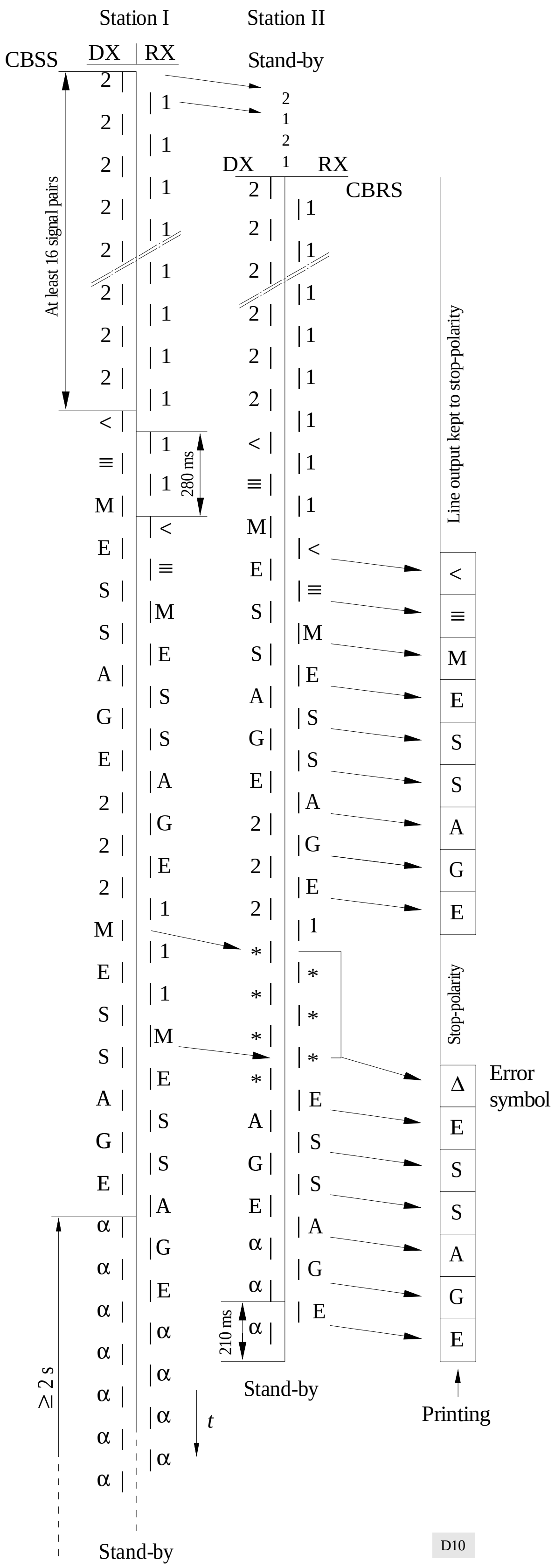


* Detected error
(1) With some equipment built in accordance with Recommendation ITU-R M.476 this could be CS2.

D09

FIGURE 10

Collective B-mode operation



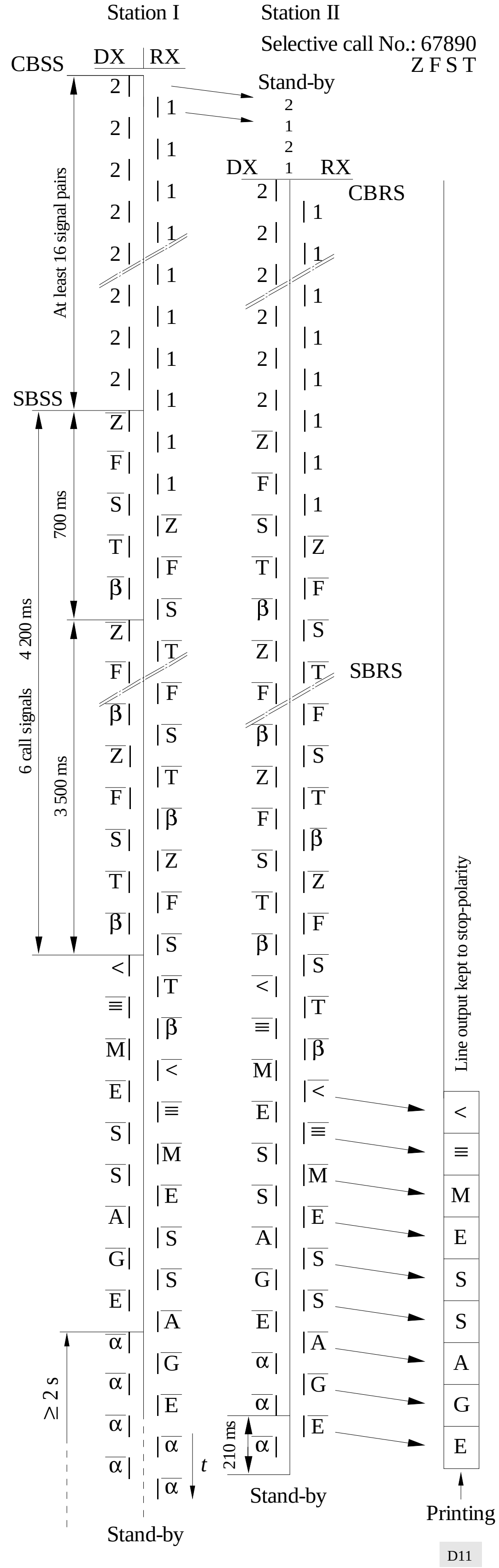
1: phasing signal 1

2: phasing signal 2

∗ Detected error

FIGURE 11

Selective B-mode operation in the case of a 4-signal call identity



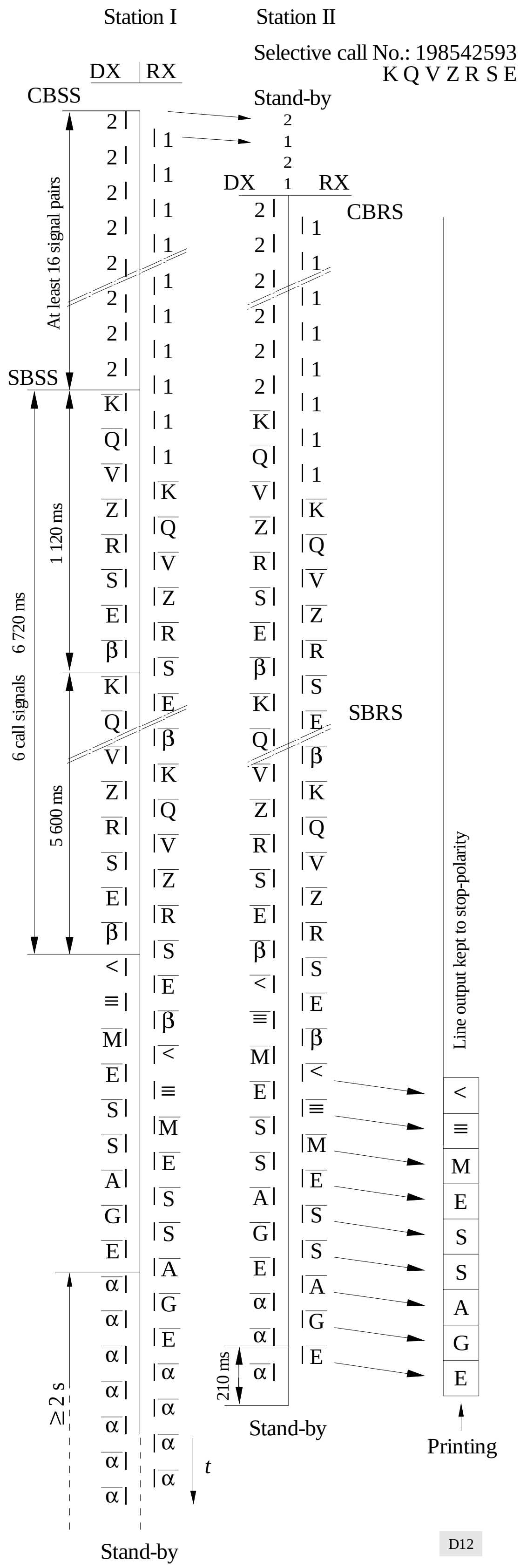
1: phasing signal 1

2: phasing signal 2

Overlined symbols (e.g. $\overline{M}$) are in the 3B/4Y ratio

FIGURE 12

Selective B-mode operation in the case of a 7-signal call identity



1: phasing signal 1

2: phasing signal 2

Overlined symbols (e.g. $\overline{\text{M}}$) are in the 3B/4Y ratio

APPENDICES TO ANNEX 1

APPENDIX 1

SDL diagrams (mode A)

1 General

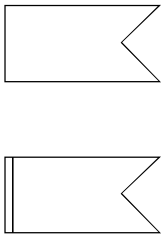
The specification and description language (SDL) is described in ITU-T Recommendation Z.100.

The following graphical symbols have been used*:

State

D13

– A “state” is a condition in which the action of a process is suspended awaiting an input.

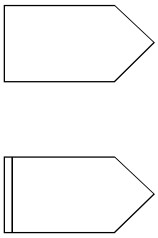


External input

Internal input

D14

– An “input” is an incoming signal which is recognized by a process.

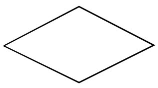


External output

Internal output

D15

– An “output” is an action which generates a signal which in turn acts as an input elsewhere.



Decision

D16

---

* *Note by the Secretariat:*

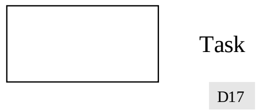
A “connector” is represented by the following graphical symbol:

(n) $_{\text{x-y (z)}}$

where:

n : connector reference
x : number of the sheet
y : number of the Appendix (omitted when it occurs in the same Appendix).
z : number of occurrences.

– A “decision” is an action which asks a question to which the answer can be obtained at that instant and chooses one of several paths to continue the sequence.



– A “task” is any action which is neither a decision nor an output.

2 Phasing procedure with automatic identification in the case of a 7-signal call identity (calling station)

2.1 The SDL diagrams are given in Appendix 2.

2.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_0	128 cycles	02, 03, 04	1
n_1	128 cycles	00	1
n_2	32 cycles	05, 06, 07, 08	2, 3

3 Rephasing procedure with automatic identification in the case of a 4-signal call identity (calling station)

3.1 The SDL diagrams are given in Appendix 3.

3.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_5	32 cycles	00, 02, 03, 04	1
		05, 06, 07, 08	2, 3
n_1	128 cycles		1
n_2	32 cycles	05, 06, 07, 08	2, 3

4 Phasing procedure without automatic identification in the case of a 4-signal call identity (calling station)

4.1 The SDL diagrams are given in Appendix 4.

4.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_0	128 cycles	02, 03	1
n_1	128 cycles	00	1

5 Rephasing procedure without automatic identification in the case of a 4-signal call identity (calling station)

5.1 The SDL diagrams are given in Appendix 5.

5.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_5	32 cycles	00, 02, 03	1
n_1	128 cycles		1

6 Phasing procedure with automatic identification in the case of a 7-signal call identity (called station)

6.1 The SDL diagrams are given in Appendix 6.

6.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_2	32 cycles	05, 06, 07, 08	2, 3

7 Rephasing procedure with automatic identification in the case of a 7-signal call identity (called station)

7.1 The SDL diagrams are given in Appendix 7.

7.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_5	32 cycles	00, 01, 02, 03, 04	1
		05, 06, 07, 08	2, 3
n_2	32 cycles	05, 06, 07, 08	2, 3

8 Phasing procedure without automatic identification in the case of a 4-signal call identity (called station)

8.1 The SDL diagrams are given in Appendix 8.

9 Rephasing procedure without automatic identification in the case of a 4-signal call identity (called station)

9.1 The SDL diagrams are given in Appendix 9.

9.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_5	32 cycles	00, 01, 03	1

10 Traffic flow in the case of a 4-signal call identity and in the case of a 7-signal call identity (station is in the ISS position)

10.1 The SDL diagrams are given in Appendix 10.

10.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_3	32 cycles	09, 10, 13	1, 3
n_4	4 cycles	11, 12	2
n_1	128 cycles	12	2
n_5	32 cycles	11, 12, 13, 14	2, 3

11 Traffic flow in the case of a 4-signal call identity and in the case of a 7-signal call identity (station is in the IRS position)

11.1 The SDL diagrams are given in Appendix 11.

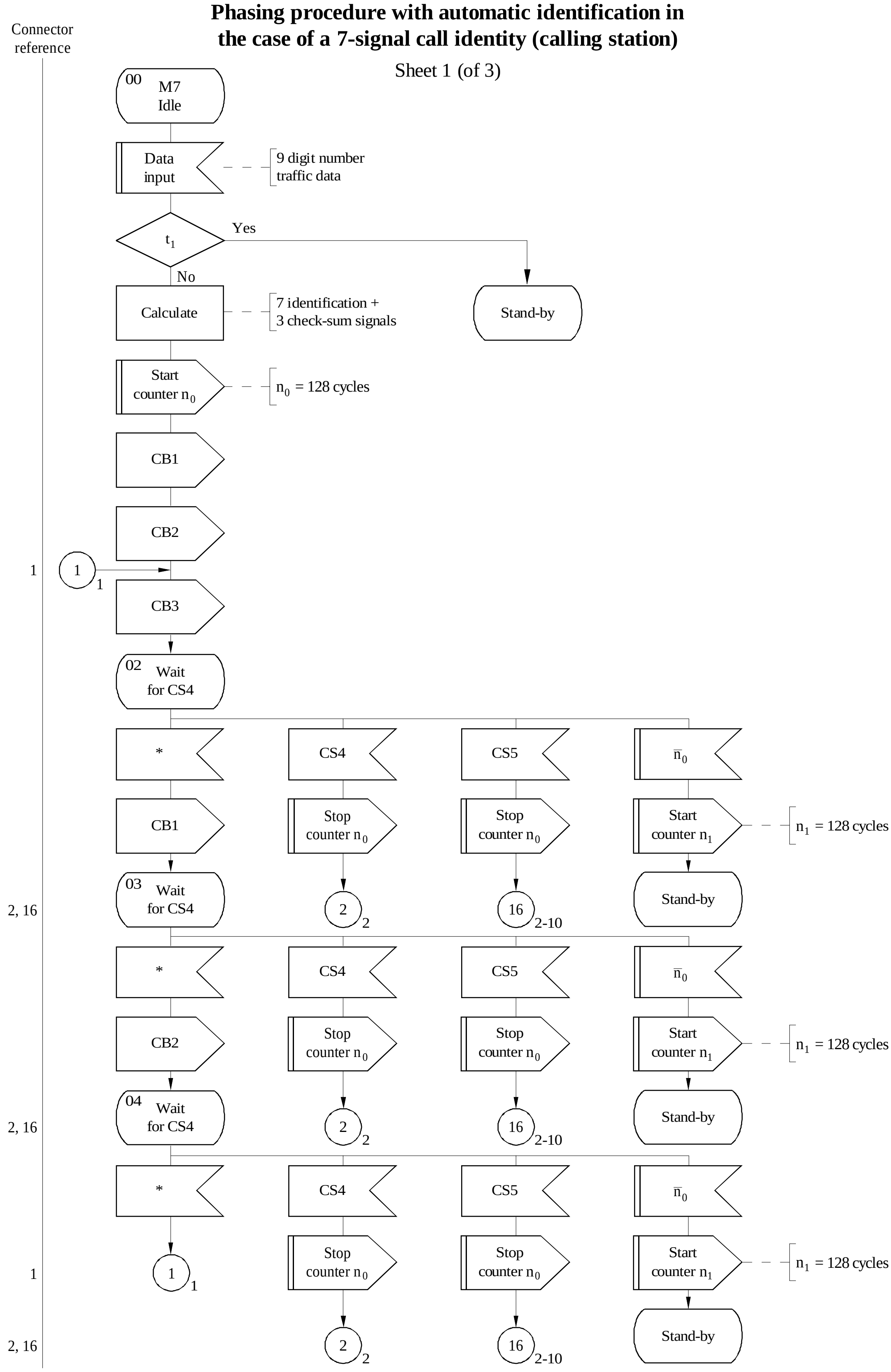
11.2 The following supervisory counters are used in the diagrams:

Counter	Time-out	State	Sheet
n_3	32 cycles	09, 10, 11	1, 2
n_5	32 cycles	09, 10, 11, 12	1, 2

APPENDIX 2

Phasing procedure with automatic identification in the case of a 7-signal call identity (calling station)

Sheet 1 (of 3)

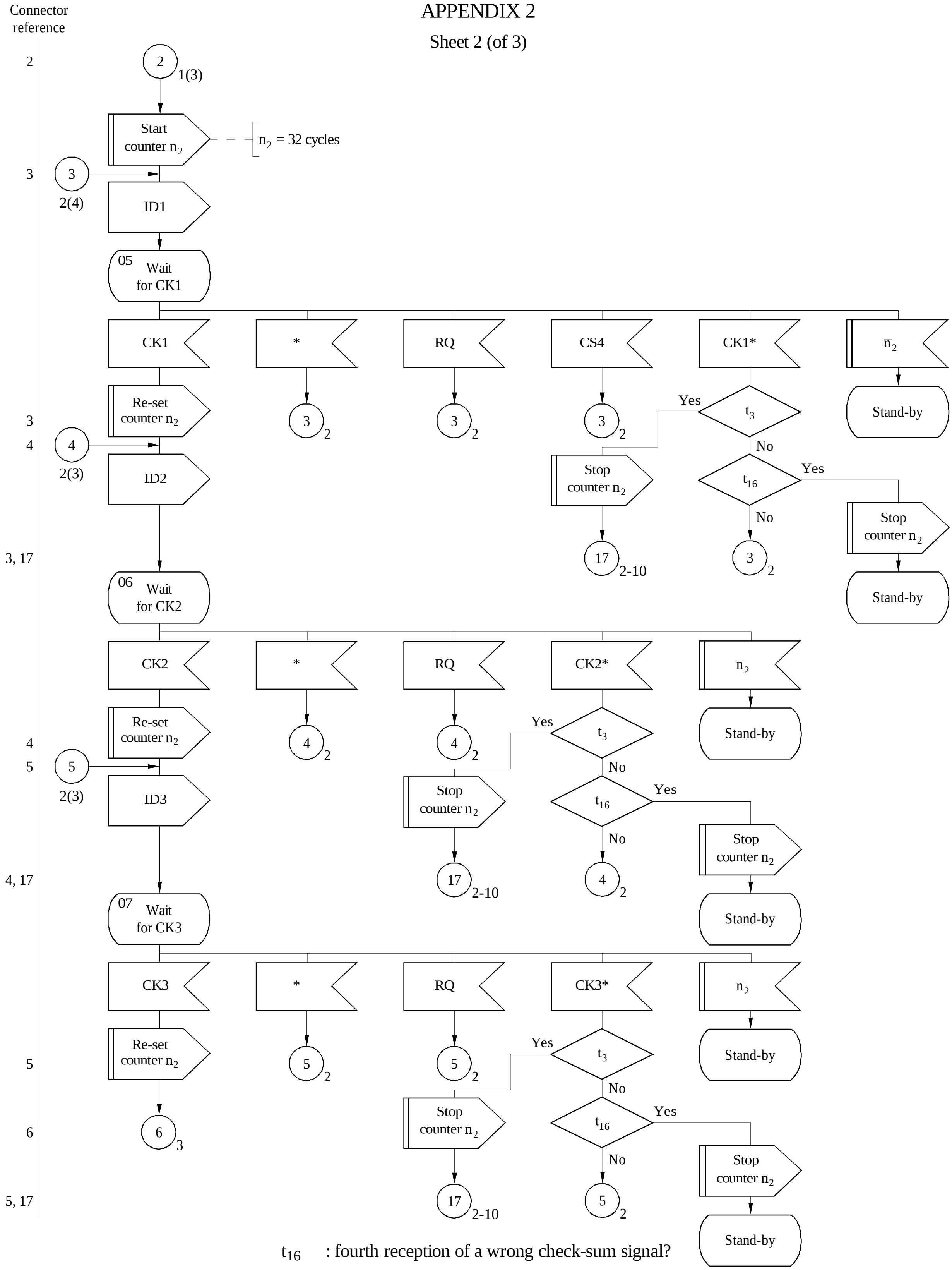


t_1: call identity the same as the one before and $n_1 > 0$?

* Detected error, invalid signal or no signal at all

APPENDIX 2

Sheet 2 (of 3)



t_{16} : fourth reception of a wrong check-sum signal?

t_3 : same wrong check-sum signal one cycle before?

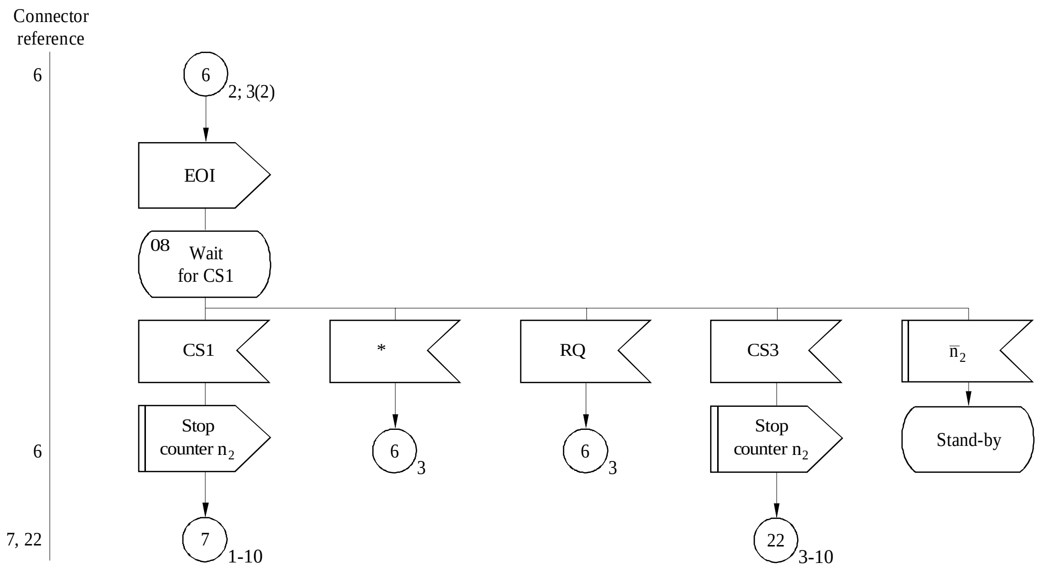
CKn*: wrong check-sum signal

* Detected error, invalid signal or no signal at all

D19

APPENDIX 2

Sheet 3 (of 3)



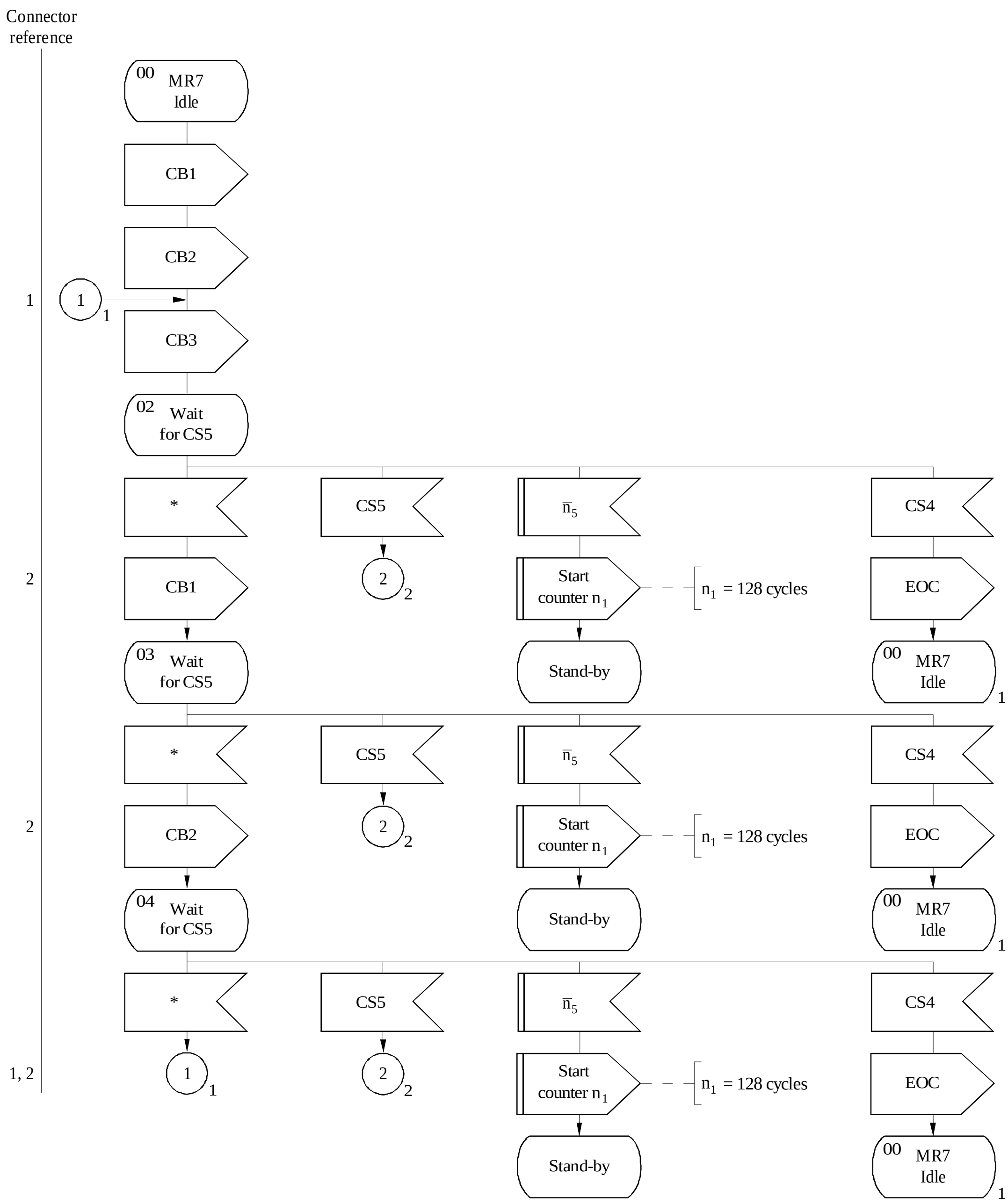
* Detected error, invalid signal or no signal at all

D20

APPENDIX 3

Rephasing procedure with automatic identification in the case of a 7-signal call identity (calling station)

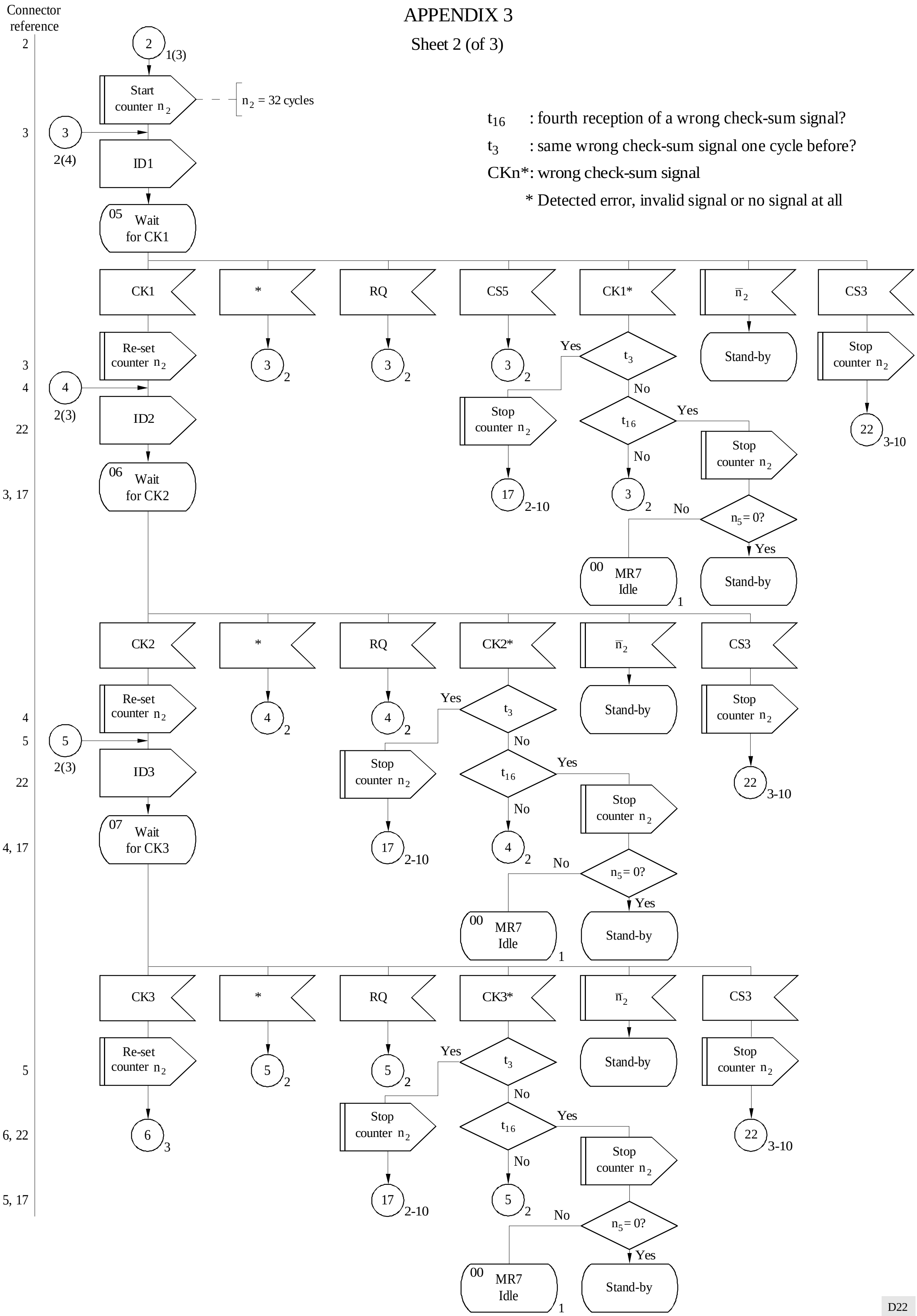
Sheet 1 (of 3)



* Detected error, invalid signal or no signal at all

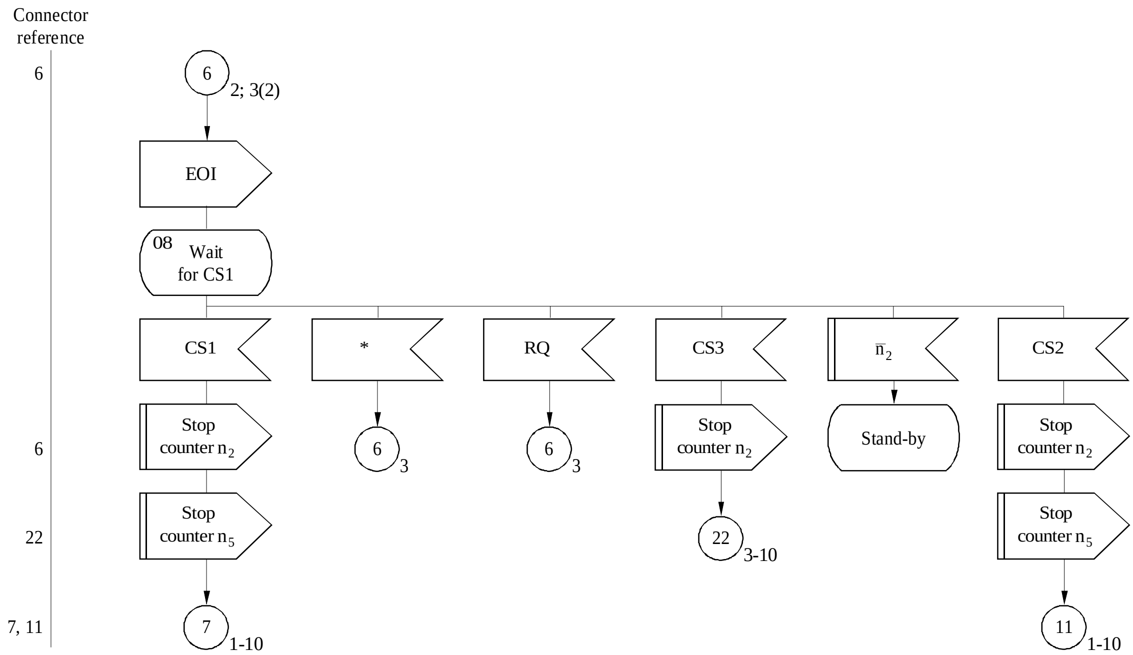
APPENDIX 3

Sheet 2 (of 3)



APPENDIX 3

Sheet 3 (of 3)



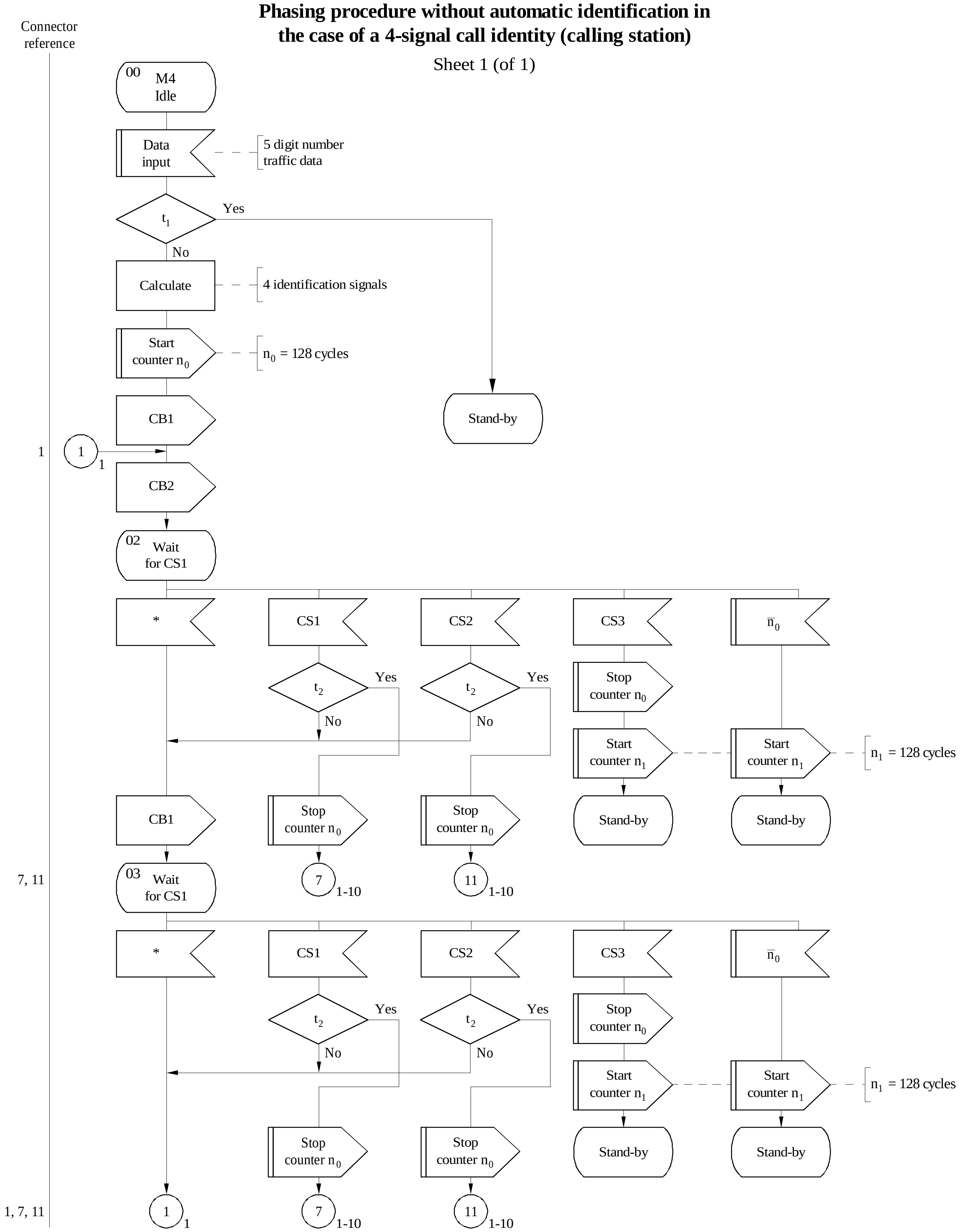
* Detected error, invalid signal or no signal at all

D23

APPENDIX 4

Phasing procedure without automatic identification in the case of a 4-signal call identity (calling station)

Sheet 1 (of 1)



t_1: call identity the same as the one before and $n_1 > 0$?

t_2: same control signal one cycle before?

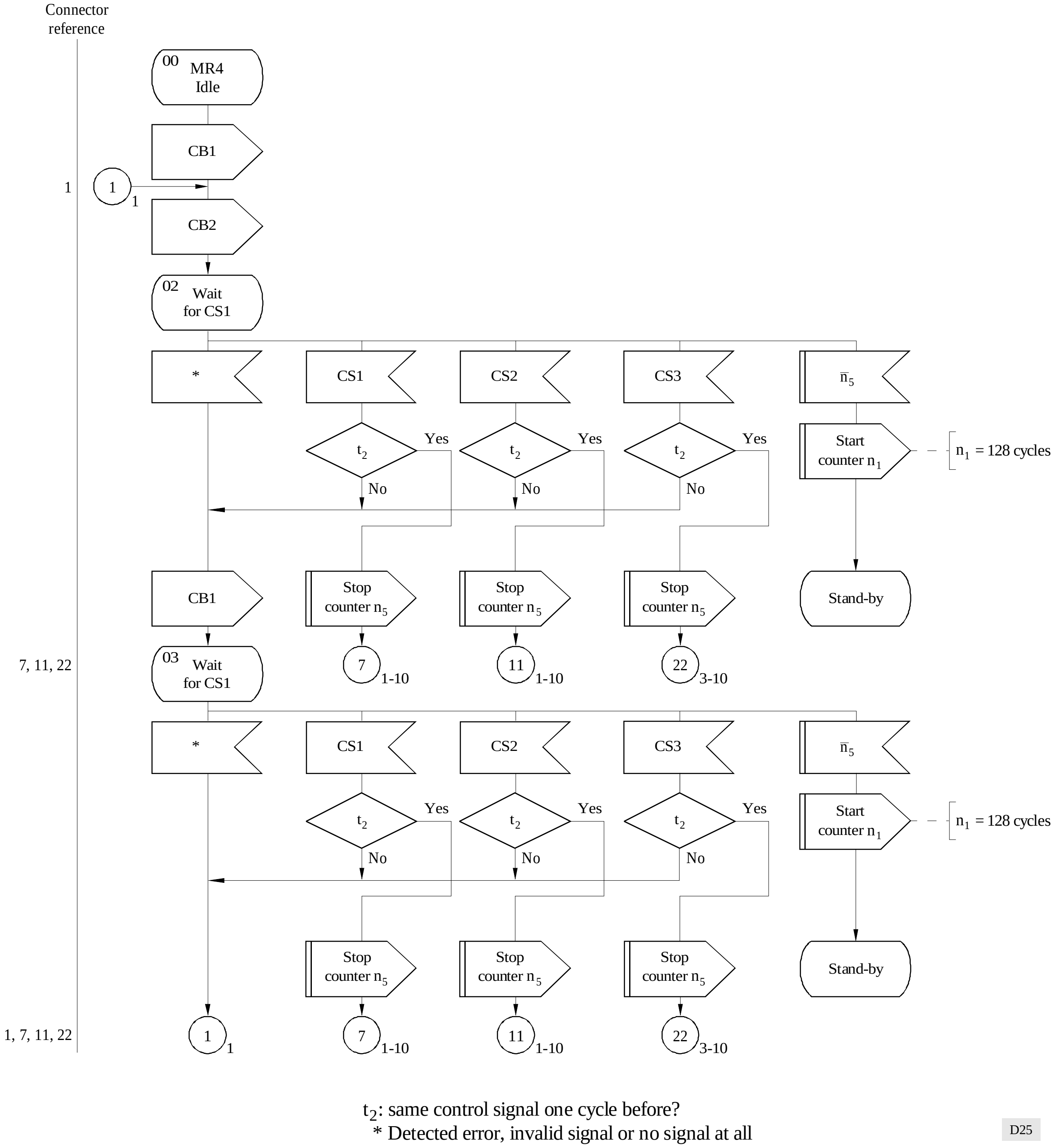
* Detected error, invalid signal or no signal at all

D24

APPENDIX 5

Rephasing procedure without automatic identification in the case of a 4-signal call identity (calling station)

Sheet 1 (of 1)



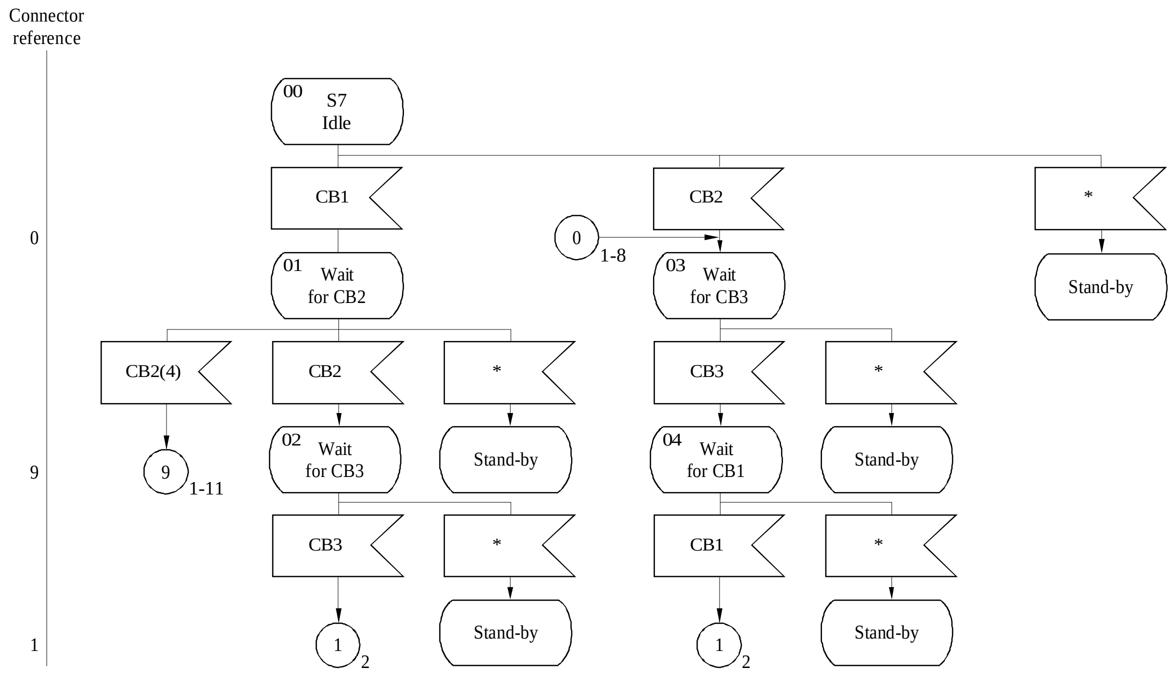
t_2: same control signal one cycle before?

* Detected error, invalid signal or no signal at all

APPENDIX 6

Phasing procedure with automatic identification in the case of a 7-signal call identity (called station)

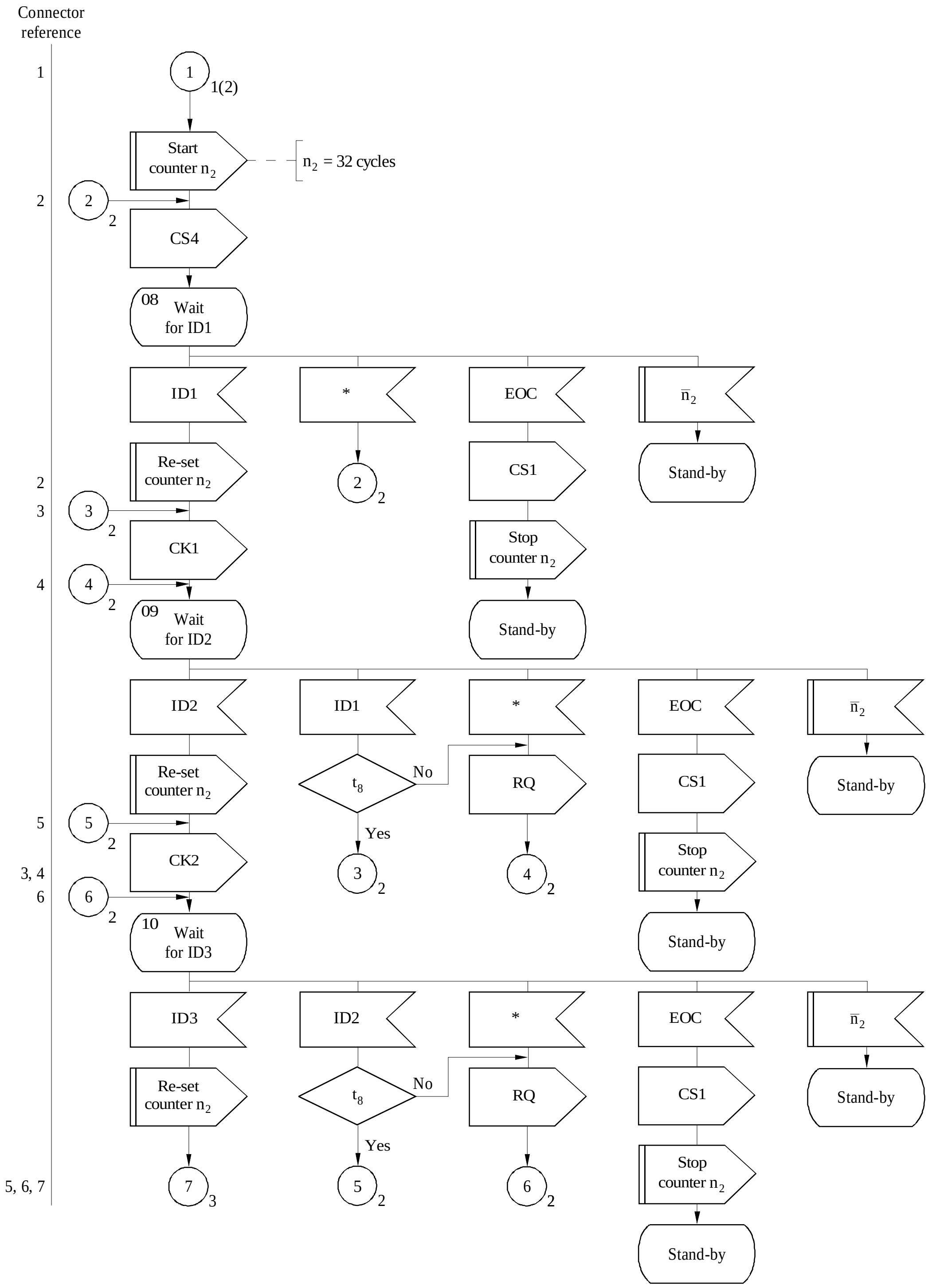
Sheet 1 (of 3)



* Detected error, invalid signal or no signal at all

APPENDIX 6

Sheet 2 (of 3)



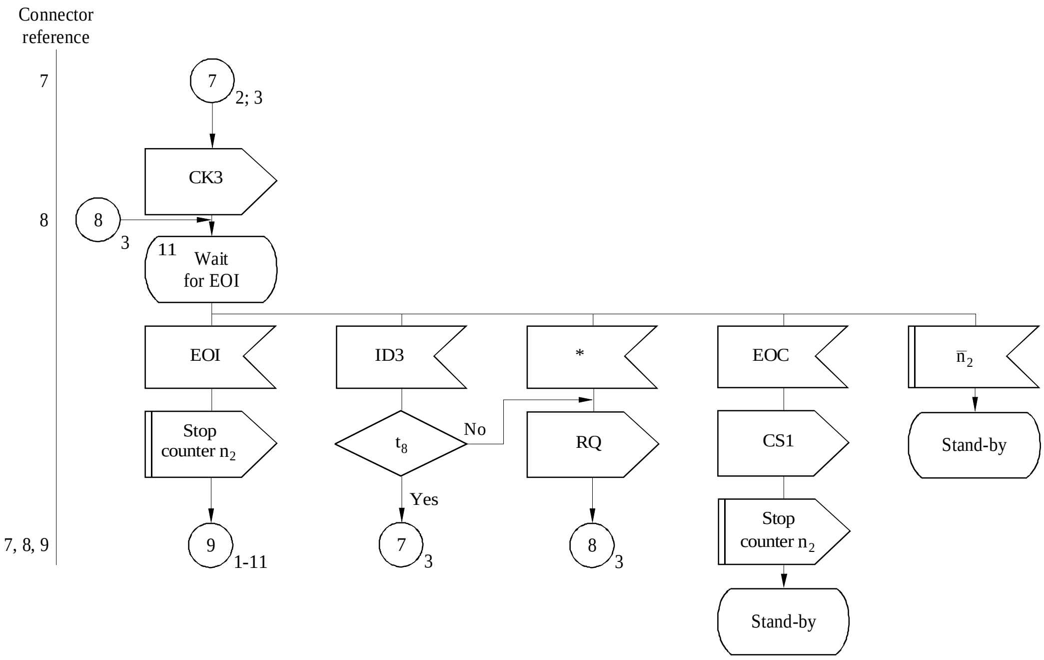
t_3: same ID-block one cycle before?

* Detected error, invalid signal or no signal at all

D27

APPENDIX 6

Sheet 3 (of 3)



t_3: same ID-block one cycle before?

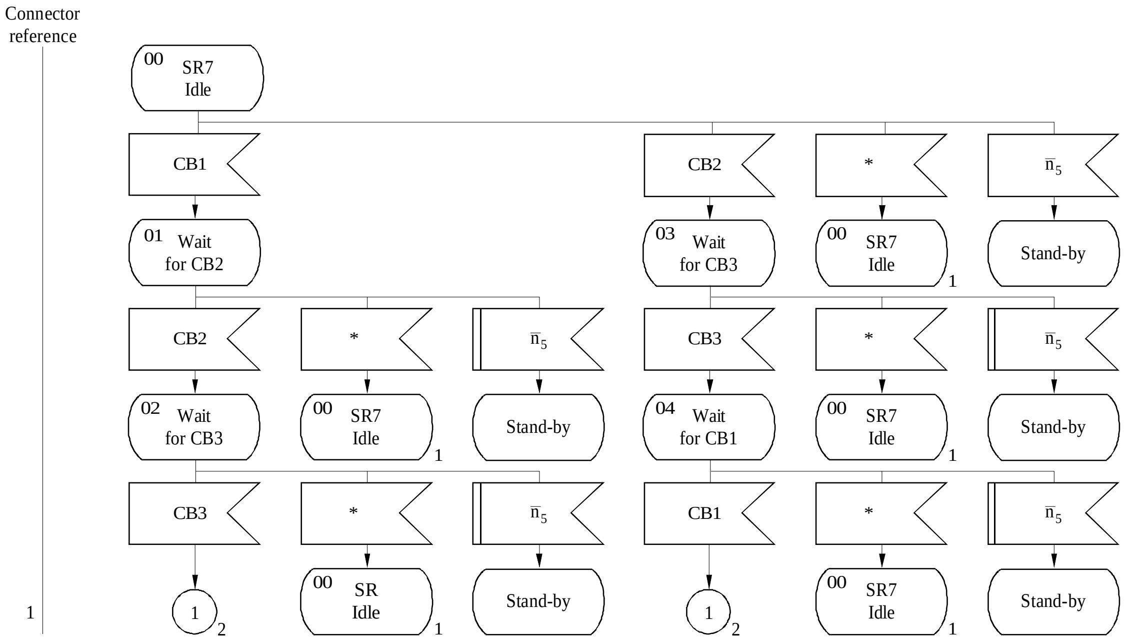
* Detected error, invalid signal or no signal at all

D28

APPENDIX 7

Rephasing procedure with automatic identification in the case of a 7-signal call identity (called station)

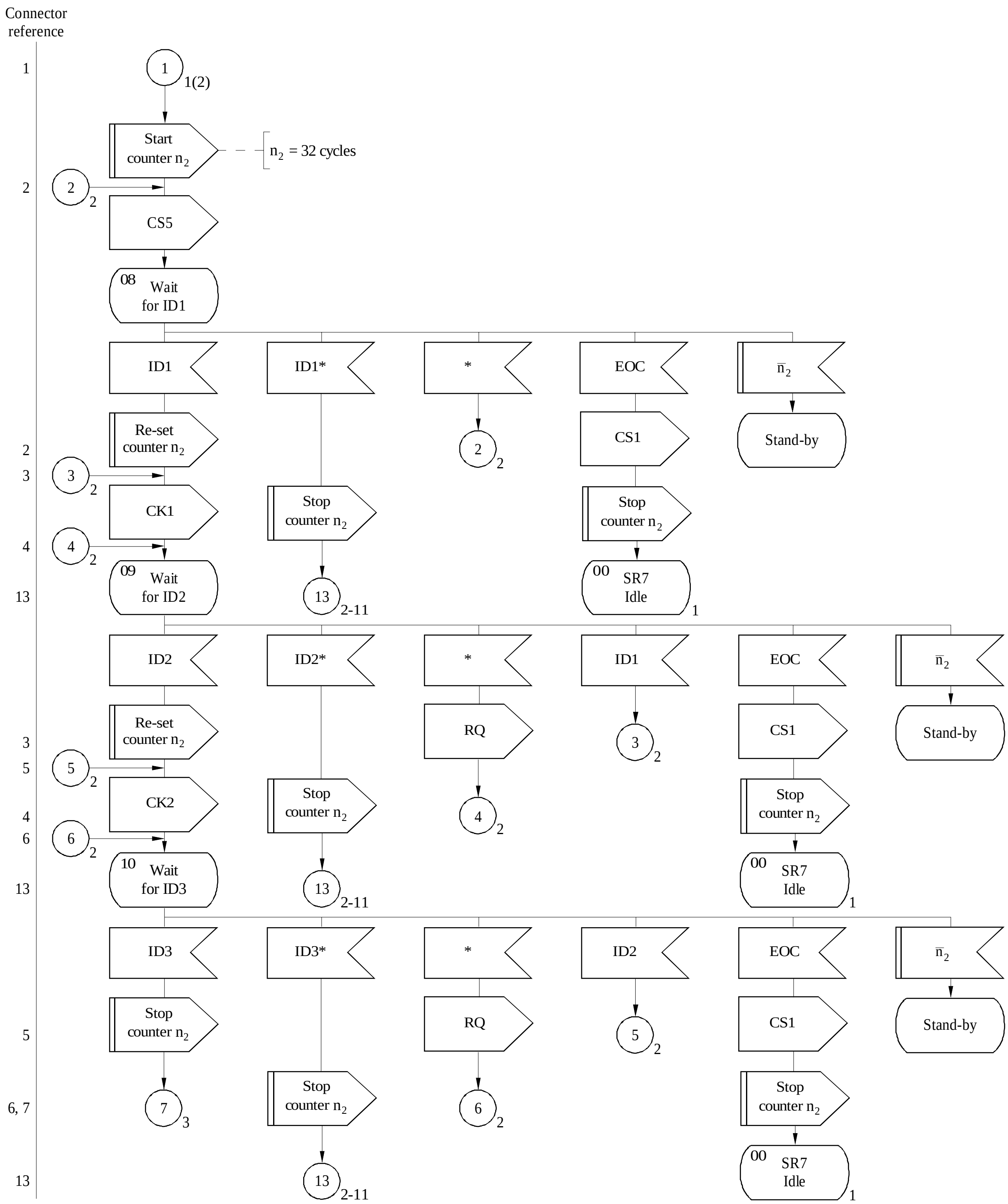
Sheet 1 (of 3)



* Detected error, invalid signal or no signal at all

APPENDIX 7

Sheet 2 (of 3)



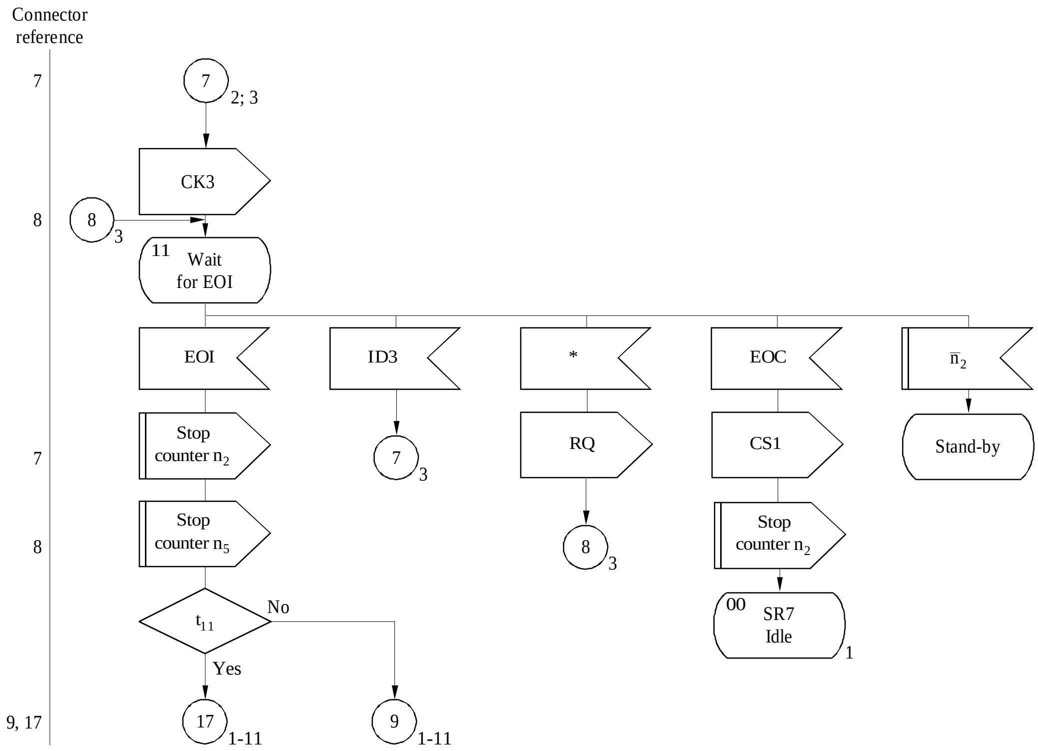
IDn* : wrong identification signal(s)

* Detected error, invalid signal or no signal at all

D30

APPENDIX 7

Sheet 3 (of 3)



t_{11}: block 2 was the last received block at the moment the interruption occurred?

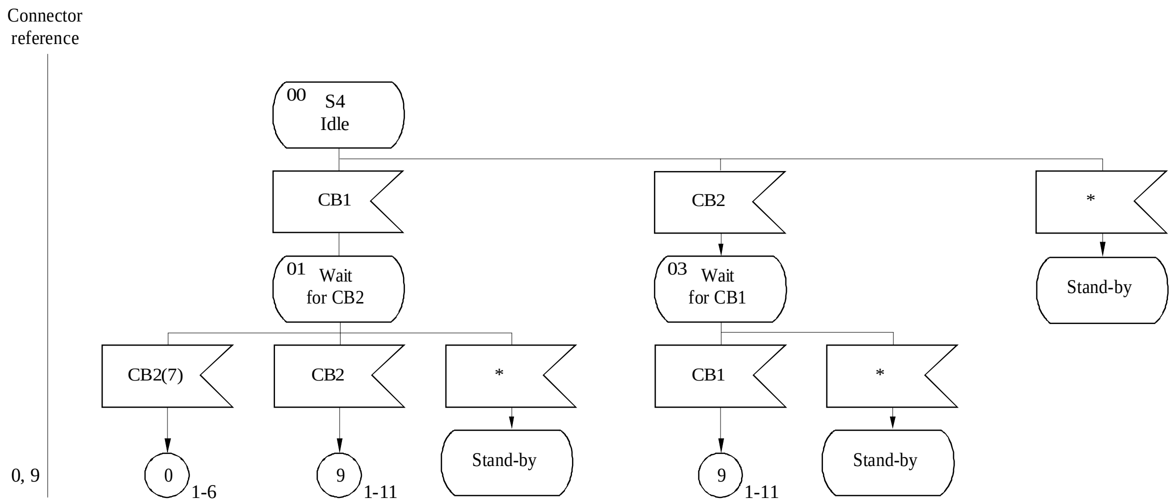
* Detected error, invalid signal or no signal at all

D31

APPENDIX 8

Phasing procedure without automatic identification in the case of a 4-signal call identity (called station)

Sheet 1 (of 1)

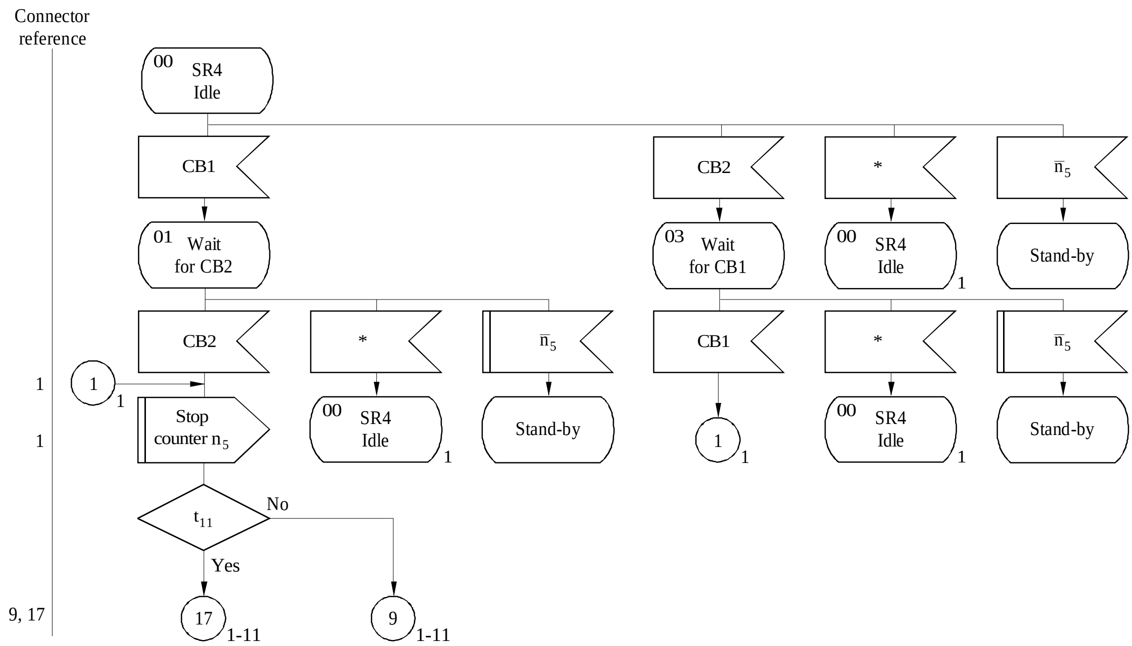


* Detected error, invalid signal or no signal at all

APPENDIX 9

Rephasing procedure with automatic identification in the case of a 4-signal call identity (called station)

Sheet 1 (of 1)



t_{11}: block 2 was the last received block at the moment the interruption occurred?

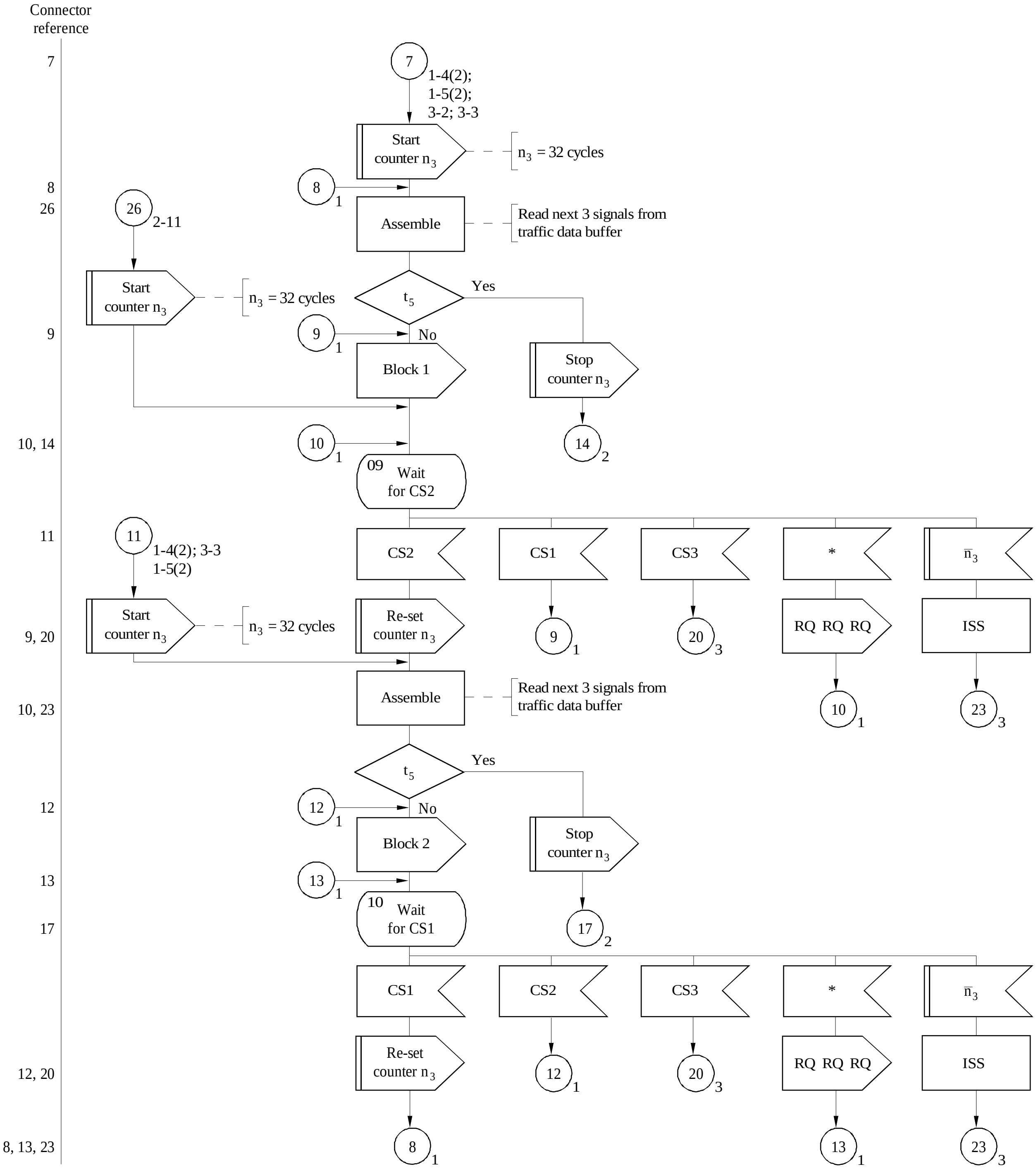
* Detected error, invalid signal or no signal at all

D33

APPENDIX 10

Traffic flow in the case of a 4-signal call identity and in the case of a 7-signal call identity (station is in the ISS position)

Sheet 1 (of 3)



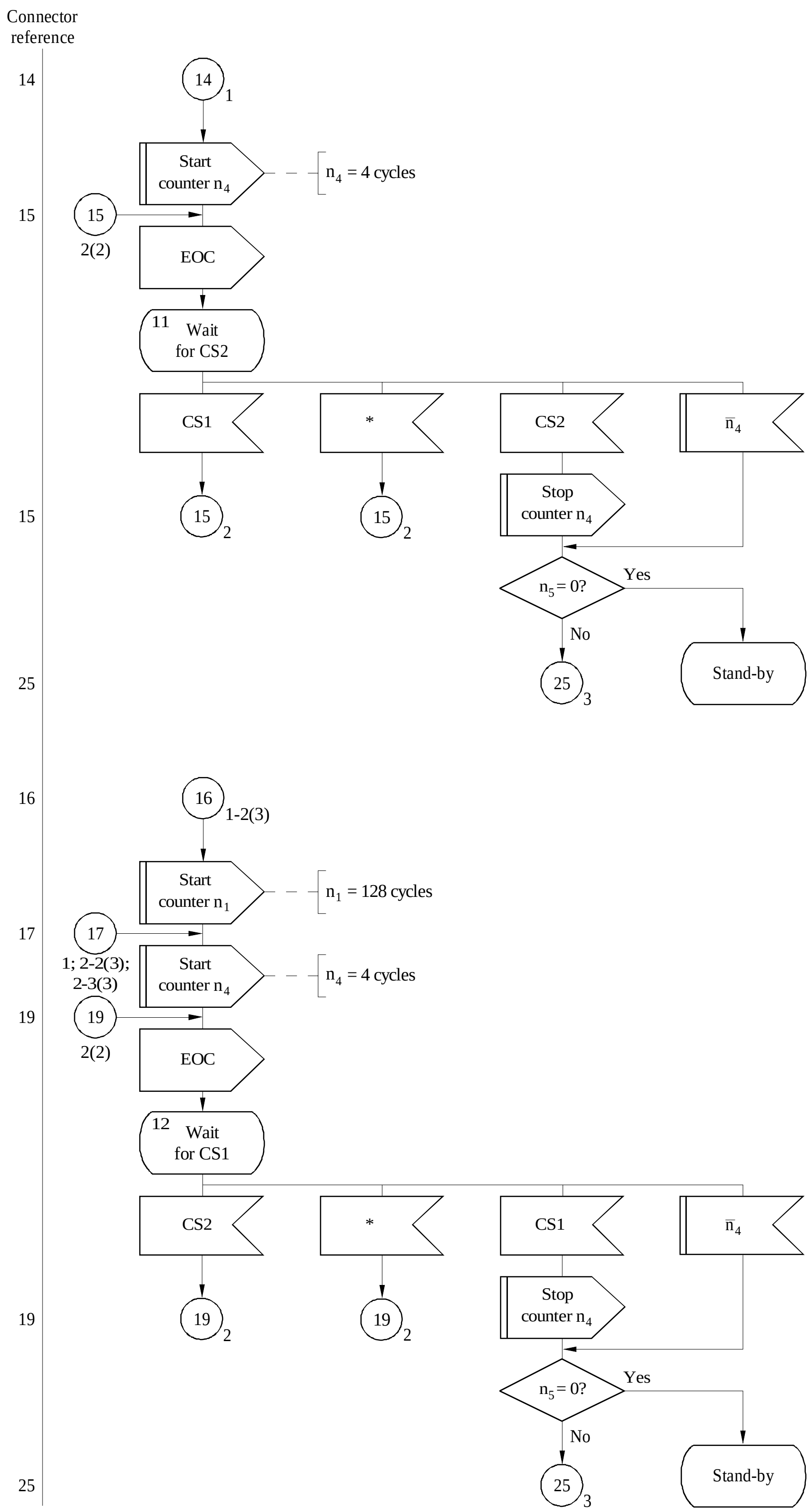
t_5 : data block contains message "end-of-communication"?

ISS: notice: station is ISS at the moment the interruption occurred

* Detected error, invalid signal or no signal at all

APPENDIX 10

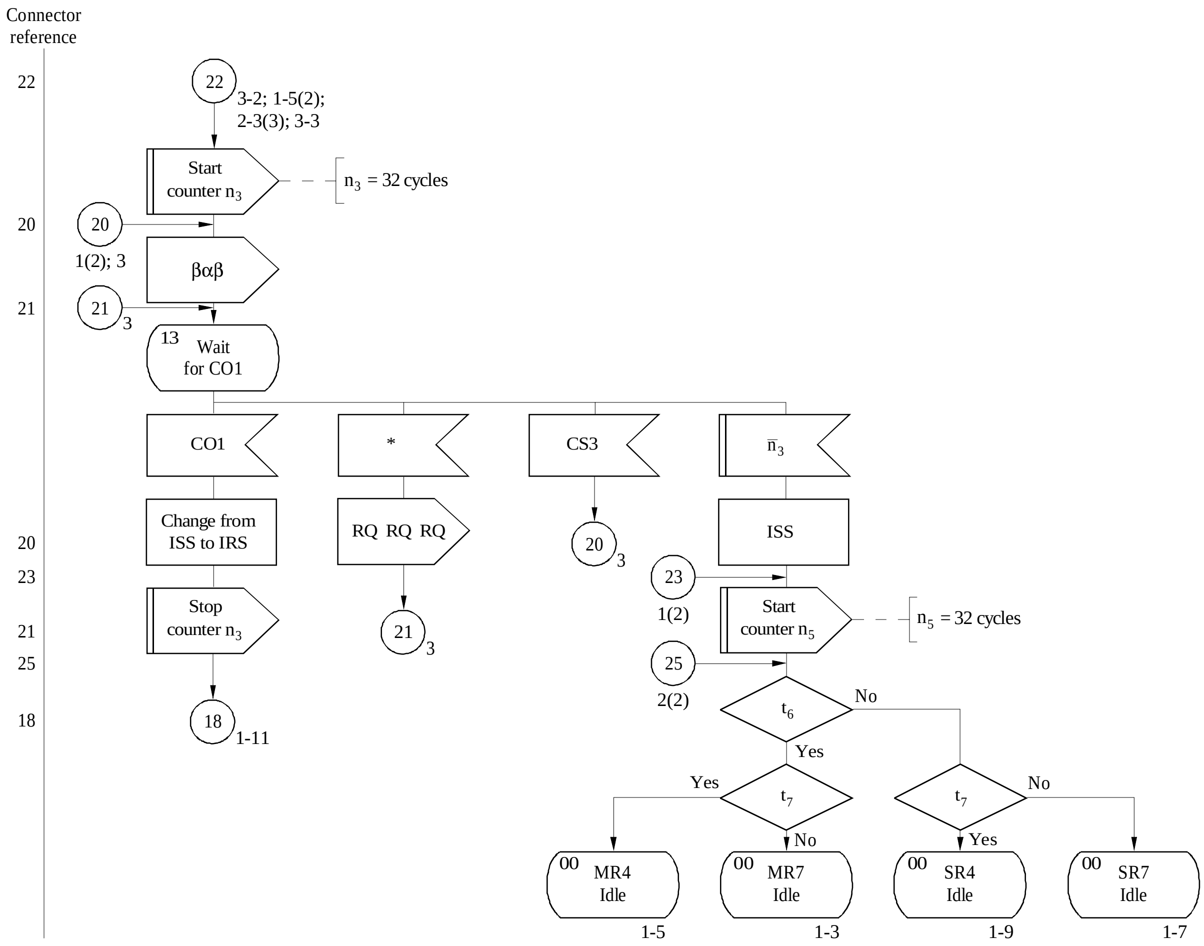
Sheet 2 (of 3)



* Detected error, invalid signal or no signal at all

APPENDIX 10

Sheet 3 (of 3)



t_6 : station is master station?

t_7 : station working in the case of a 4-position call identity?

ISS : notice: station is ISS at the moment the interruption occurred

CO1: if ISS is:
– master then "RQ RQ RQ"
– slave then "RQ"

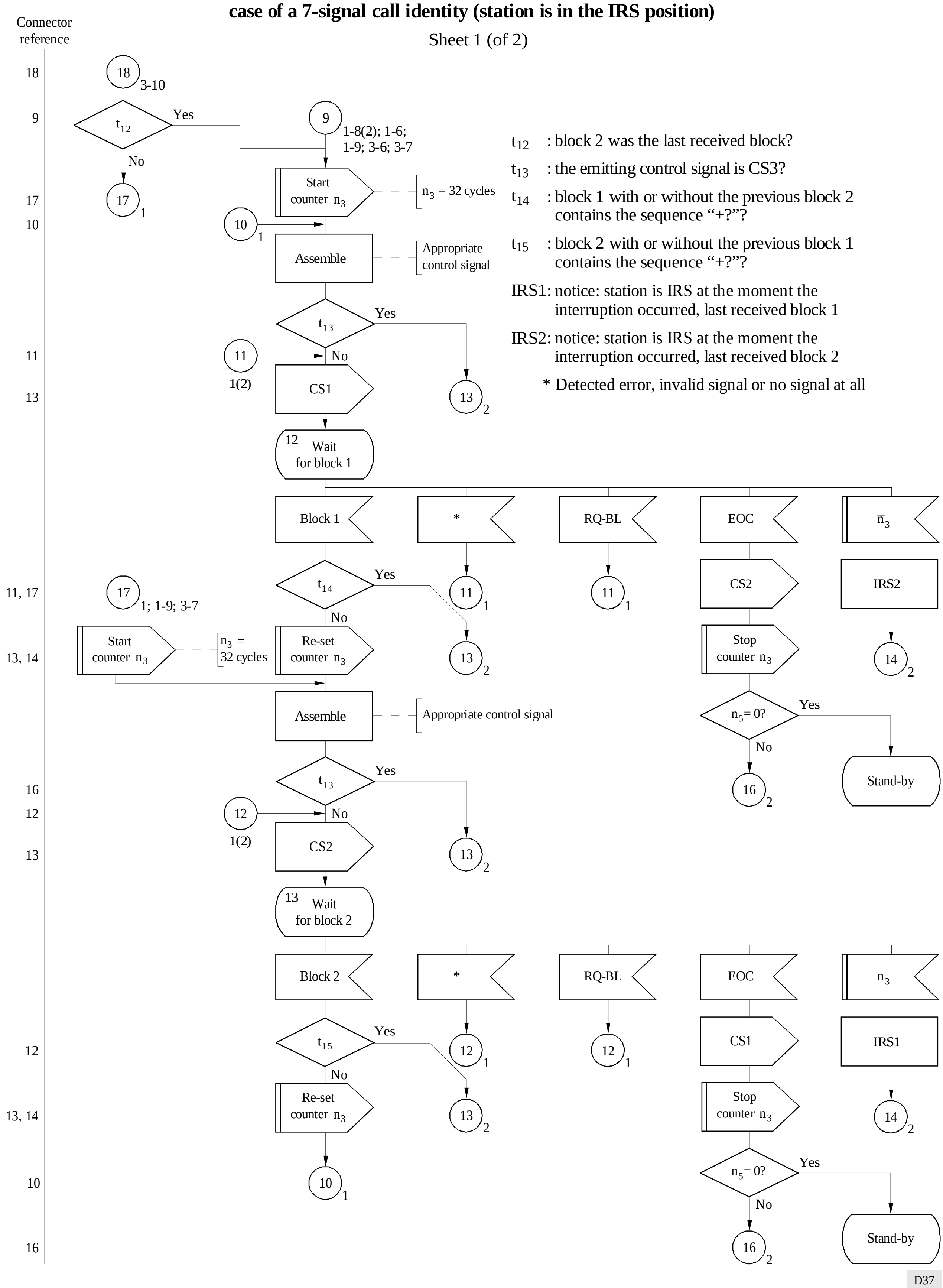
* Detected error, invalid signal or no signal at all

D36

APPENDIX 11

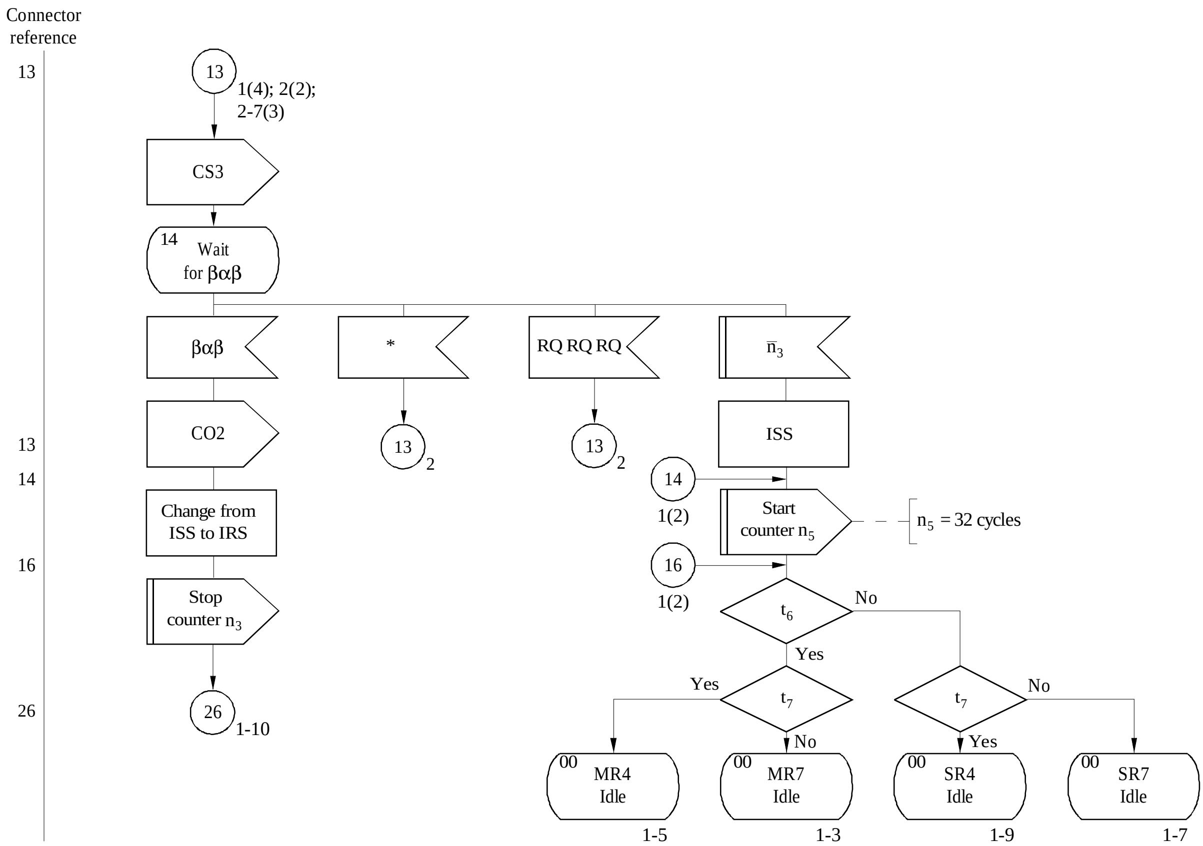
Traffic flow in the case of a 4-signal call identity and in the case of a 7-signal call identity (station is in the IRS position)

Sheet 1 (of 2)



APPENDIX 11

Sheet 2 (of 2)



t_6 : station is master station?

t_7 : station working in the case of a 4-signal call identity?

CO2: if IRS is:
- master then "RQ"
- slave then "RQ RQ RQ"

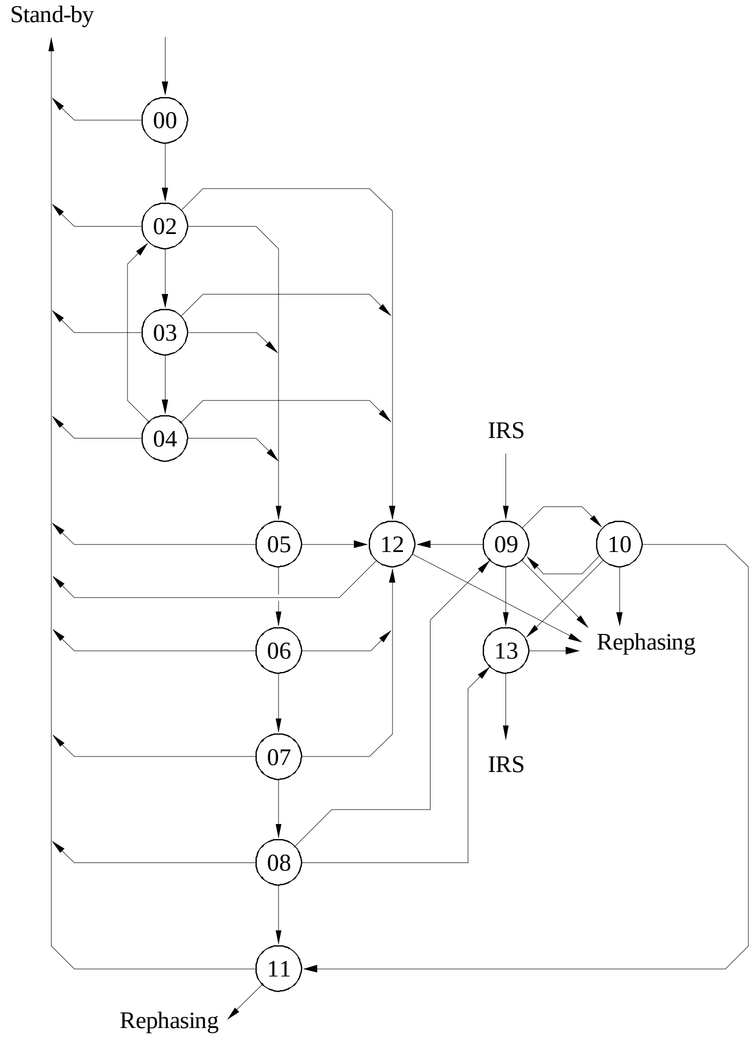
* Detected error, invalid signal or no signal at all

D38

APPENDIX 12

Phasing procedure with automatic identification in the case of a 7-signal call identity (calling station) and traffic flow if the station is in the ISS position (state overview diagram)

Sheet 1 (of 8)



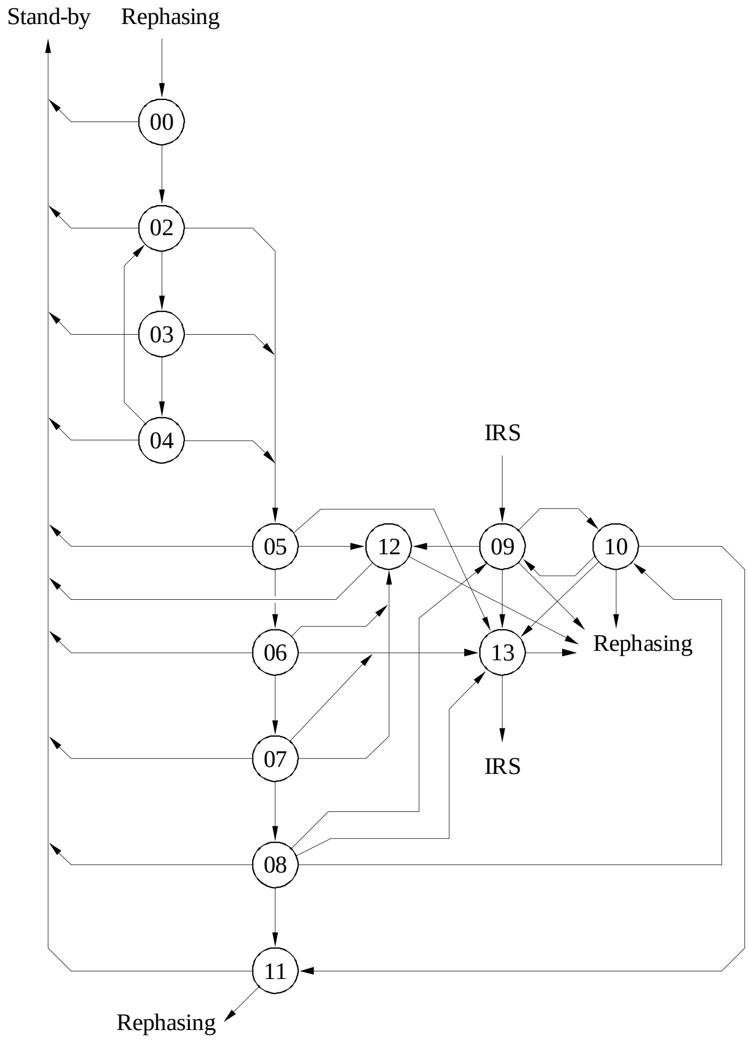
State number	State description	Sheet reference	Counters running	Supervisory counters
00	M7 idle	1-2	n_1	n_0 = 128 cycles
02	Wait for CS4	1-2	n_0	n_1 = 128 cycles
03	Wait for CS4	1-2	n_0	n_2 = 32 cycles
04	Wait for CS4	1-2	n_0	n_3 = 32 cycles
05	Wait for CK1	2-2	n_2	n_4 = 4 cycles
06	Wait for CK2	2-2	n_2	
07	Wait for CK3	2-2	n_2	
08	Wait for CS1	3-2	n_2	
09	Wait for CS2	1-10	n_3	
10	Wait for CS1	1-10	n_3	
11	Wait for CS2	2-10	n_4	
12	Wait for CS1	2-10	n_1,n_4	
13	Wait for change-over	3-10	n_3	

D39

APPENDIX 12

Rephasing procedure with automatic identification in the case of a 7-signal call identity (calling station) and traffic flow if the station is in the ISS position (state overview diagram)

Sheet 2 (of 8)



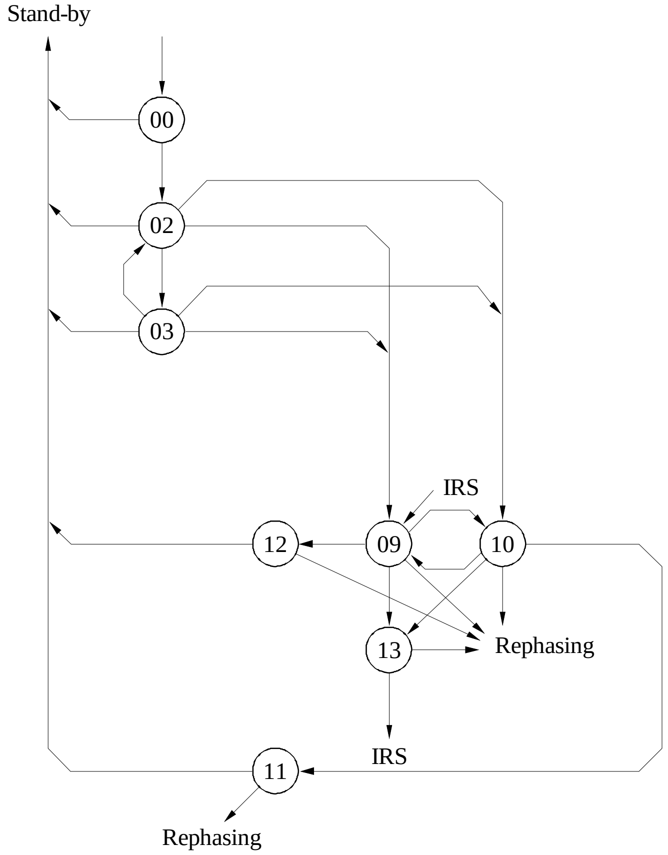
State number	State description	Sheet reference	Counters running	Supervisory counters
00	MR7 idle	1-3	n_5	n_1 = 128 cycles
02	Wait for CS5	1-3	n_5	n_2 = 32 cycles
03	Wait for CS5	1-3	n_5	n_3 = 32 cycles
04	Wait for CS5	1-3	n_5	n_4 = 4 cycles
05	Wait for CK1	2-3	n_2,n_5	n_5 = 32 cycles
06	Wait for CK2	2-3	n_2,n_5	
07	Wait for CK3	2-3	n_2,n_5	
08	Wait for CS1	3-3	n_2,n_5	
09	Wait for CS2	1-10	n_3,n_5	
10	Wait for CS1	1-10	n_3,n_5	
11	Wait for CS2	2-10	n_4,n_5	
12	Wait for CS1	2-10	n_1,n_4,n_5	
13	Wait for change-over	3-10	n_3,n_5	

D40

APPENDIX 12

Phasing procedure without automatic identification in the case of a 4-signal call identity (calling station) and traffic flow if the station is in the ISS position (state overview diagram)

Sheet 3 (of 8)



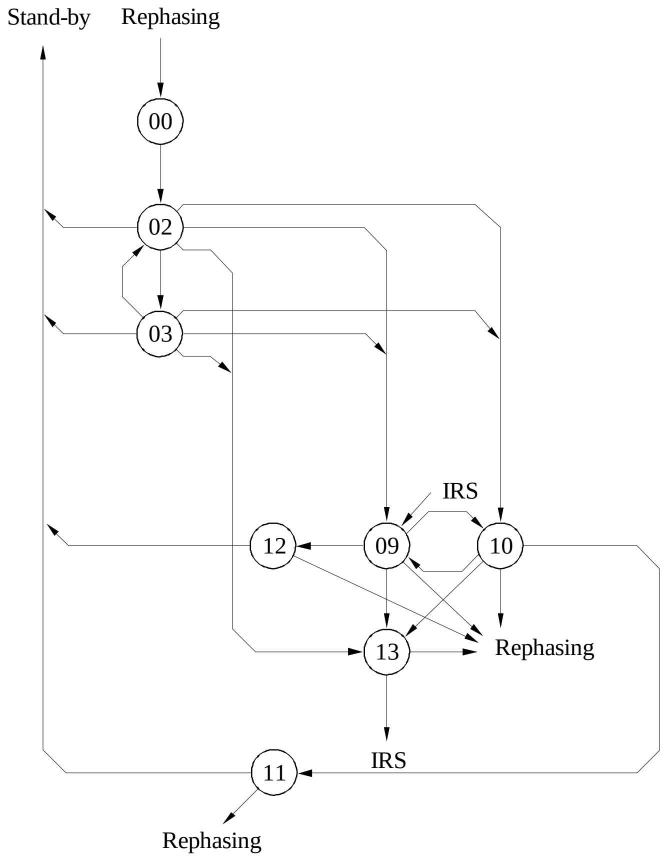
State number	State description	Sheet reference	Counters running	Supervisory counters
00	M4 idle	1- 4	n_1	n_0 = 128 cycles
02	Wait for CS1	1- 4	n_0	n_1 = 128 cycles
03	Wait for CS1	1- 4	n_0	n_3 = 32 cycles
09	Wait for CS2	1-10	n_3	n_4 = 4 cycles
10	Wait for CS1	1-10	n_3	
11	Wait for CS2	2-10	n_4	
12	Wait for CS1	2-10	n_1, n_4	
13	Wait for change-over	3-10	n_3	

D41

APPENDIX 12

Rephasing procedure without automatic identification in the case of a 4-signal call identity (calling station) and traffic flow if the station is in the ISS position (state overview diagram)

Sheet 4 (of 8)



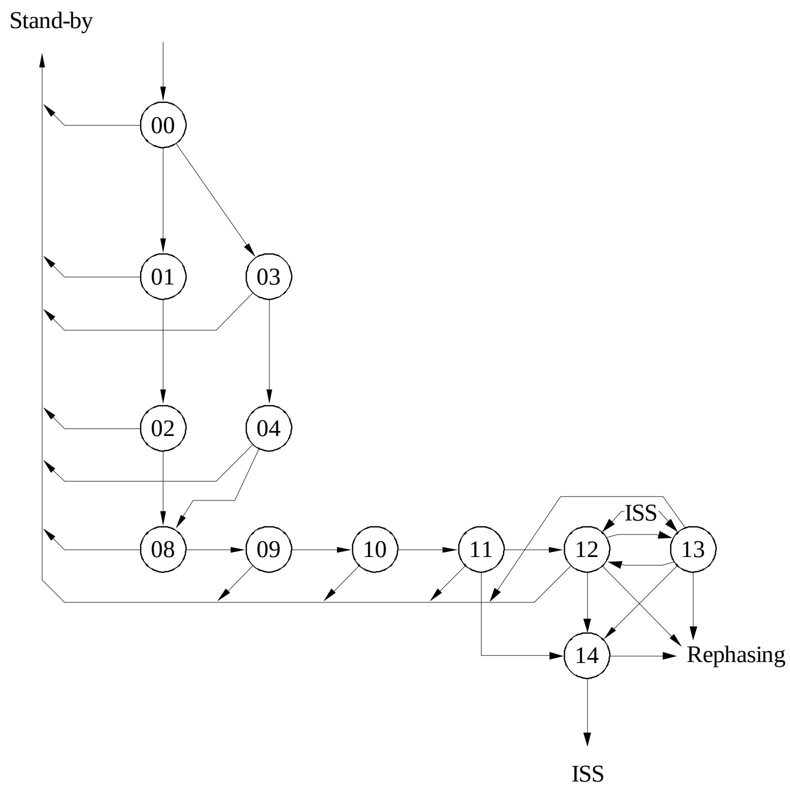
State number	State description	Sheet reference	Counters running	Supervisory counters
00	M4 idle	1-5	n_5	n_1 = 128 cycles
02	Wait for CS1	1-5	n_5	n_3 = 32 cycles
03	Wait for CS1	1-5	n_5	n_4 = 4 cycles
09	Wait for CS2	1-10	n_3	n_5 = 32 cycles
10	Wait for CS1	1-10	n_3	
11	Wait for CS2	2-10	n_4	
12	Wait for CS1	2-10	n_1, n_4	
13	Wait for change-over	3-10	n_3	

D42

APPENDIX 12

Phasing procedure with automatic identification in the case of a 7-signal call identity (called station) and traffic flow if the station is in the IRS position (state overview diagram)

Sheet 5 (of 8)



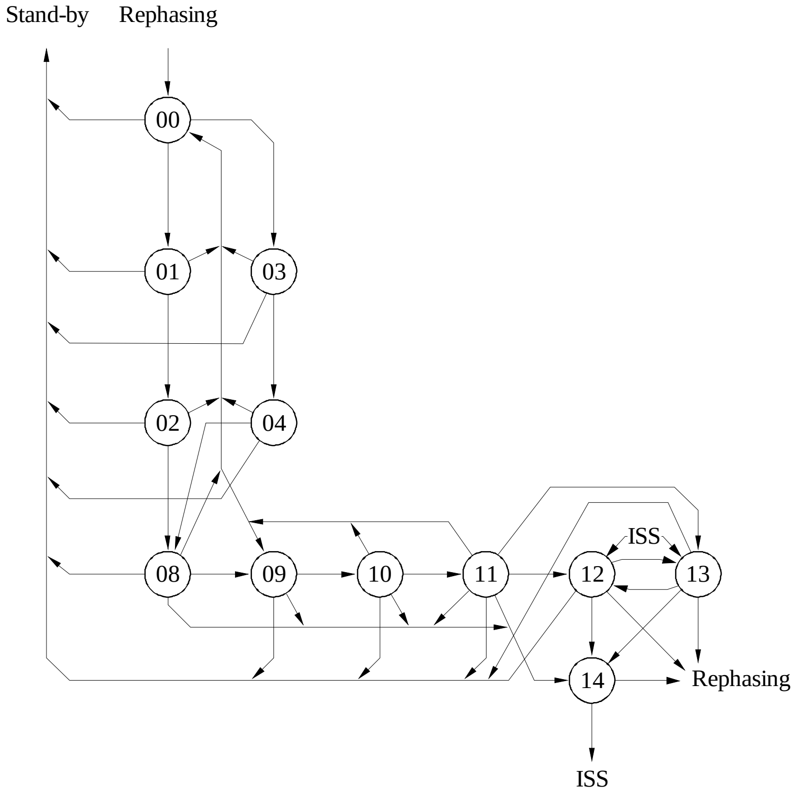
State number	State description	Sheet reference	Counters running	Supervisory counters
00	S7 idle	1-6		n_2 = 32 cycles
01	Wait for CB2	1-6		n_3 = 32 cycles
02	Wait for CB3	1-6		
03	Wait for CB3	1-6		
04	Wait for CB1	1-6		
08	Wait for ID1	2-6	n_2	
09	Wait for ID2	2-6	n_2	
10	Wait for ID3	2-6	n_2	
11	Wait for EOI	3-6	n_2	
12	Wait for block 1	1-11	n_3	
13	Wait for block 2	1-11	n_3	
14	Wait for $\beta\alpha\beta$	2-11	n_3	

D43

APPENDIX 12

Rephasing procedure with automatic identification in the case of a 7-signal call identity (called station) and traffic flow if the station is in the IRS position (state overview diagram)

Sheet 6 (of 8)



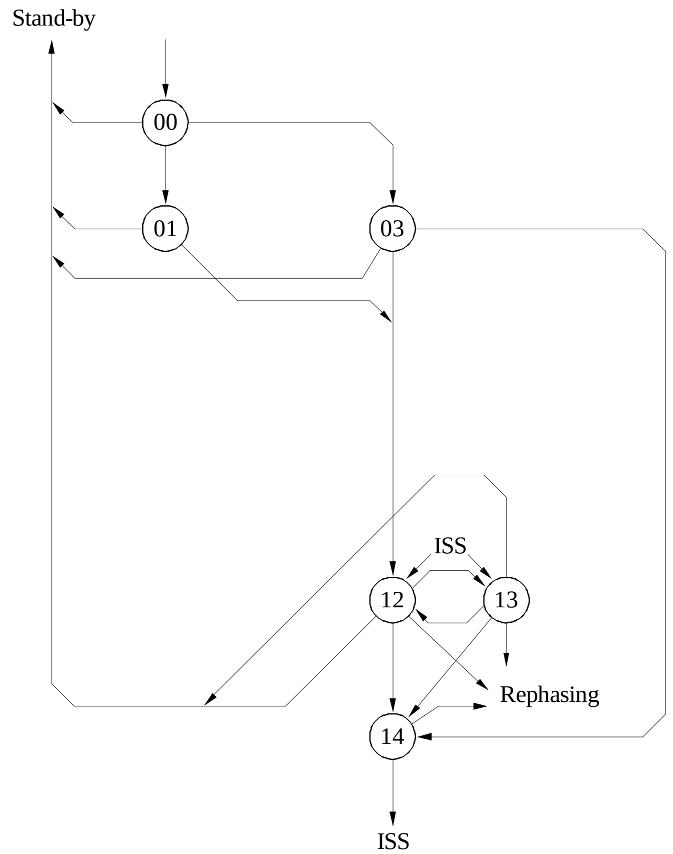
State number	State description	Sheet reference	Counters running	Supervisory counters
00	SR7 idle	1-7	n_5	n_2 = 32 cycles
01	Wait for CB2	1-7	n_5	n_3 = 32 cycles
02	Wait for CB3	1-7	n_5	n_5 = 32 cycles
03	Wait for CB3	1-7	n_5	
04	Wait for CB1	1-7	n_5	
08	Wait for ID1	2-7	n_2, n_5	
09	Wait for ID2	2-7	n_2, n_5	
10	Wait for ID3	2-7	n_2, n_5	
11	Wait for EOI	3-7	n_2, n_5	
12	Wait for block 1	1-11	n_3, n_5	
13	Wait for block 2	1-11	n_3, n_5	
14	Wait for $\beta\alpha\beta$	2-11	n_3, n_5	

D44

APPENDIX 12

Phasing procedure without automatic identification in the case of a 4-signal call identity (called station) and traffic flow if the station is in the IRS position (state overview diagram)

Sheet 7 (of 8)



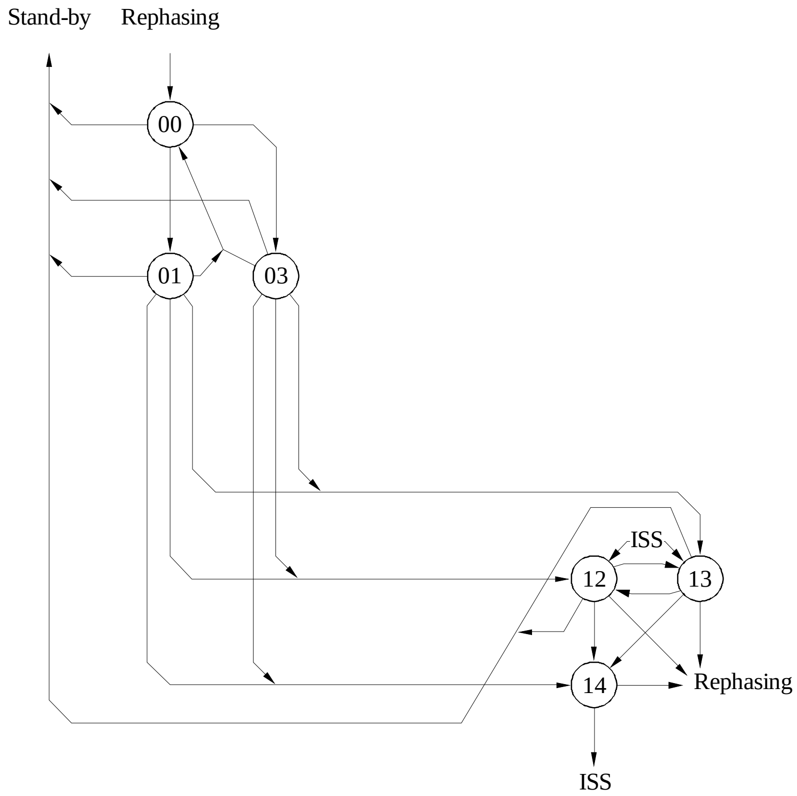
State number	State description	Sheet reference	Counters running	Supervisory counters
00	S4 idle	1-8		n_3 = 32 cycles
01	Wait for CB2	1-8		
03	Wait for CB1	1-8		
12	Wait for block 1	1-11	n_3	
13	Wait for block 2	1-11	n_3	
14	Wait for $\beta\alpha\beta$	2-11	n_3	

D45

APPENDIX 12

Rephasing procedure without automatic identification in the case of a 4-signal call identity (called station) and traffic flow if the station is in the IRS position (state overview diagram)

Sheet 8 (of 8)



State number	State description	Sheet reference	Counters running	Supervisory counters
00	SR4 idle	1-9	n_5	n_2 = 32 cycles
01	Wait for CB2	1-9	n_5	n_3 = 32 cycles
03	Wait for CB1	1-9	n_5	n_5 = 32 cycles
12	Wait for block 1	1-11	n_3, n_5	
13	Wait for block 2	1-11	n_3, n_5	
14	Wait for $\beta\alpha\beta$	2-11	n_3, n_5	

D46

RECOMMENDATION ITU-R M.627-1*

TECHNICAL CHARACTERISTICS FOR HF MARITIME RADIO EQUIPMENT USING NARROW-BAND PHASE-SHIFT KEYING (NBPSK) TELEGRAPHY

(Question ITU-R 54/8)

(1986-1995)

Summary

The Recommendation provides in Annex 1 technical characteristics for narrow-band phase-shift keying (NBPSK) telegraphy equipment used in the HF bands of the maritime-mobile service.

The ITU Radiocommunication Assembly,

considering

a) the fact that direct printing communication modes are currently being widely introduced in the maritime mobile service;

b) that the frequency stability of ship radio receivers and transmitters has considerably improved;

c) that synchronous 7-unit signal codes with error detection are widely used in direct-printing links;

d) that the load on direct-printing channels in the HF maritime mobile service has increased;

e) that NBPSK signals are received with better noise immunity than FSK signals at the same transmitter power;

f) that the use of NBPSK telegraphy allows two PSK channels to be accommodated in one standard channel of narrow-band telegraphy in the maritime mobile service at a modulation rate in each channel of 100 Bd or one PSK channel at a modulation rate of 200 Bd;

g) that the level of mutual channel interference in PSK mode does not exceed that of FSK mode,

recommends

1 that when NBPSK telegraphy equipment is used in the HF maritime mobile service, the equipment characteristics should meet the requirements indicated in Annex 1.

ANNEX 1

1 The modulation rate on the radio link should be 100 or 200 Bd.

2 The carrier wave phase modulation rule should be the following:

In the transmission of signal element *Y*, the carrier wave phase changes by 180° relative to the phase of the preceding bit: but in the transmission of signal element *B*, the carrier wave phase remains the same as for the preceding bit.

NOTE 1 – Signal elements *B* and *Y* are defined in Recommendations ITU-R M.625 and ITU-R M.490.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO) and the Telecommunication Standardization Sector (ITU-T).

3 The deviation of the information sequence transmission rate from the nominal value must not exceed ± 0.01 bit/s.

4 The necessary transmission bandwidth should be:

4.1 not more than 110 Hz for a rate of 100 Bd;

4.2 not more than 210 Hz for a rate of 200 Bd.

5 The reduction of the mean transmitter output power at the maximum modulation rate compared with that of the unmodulated carrier should not exceed 4 dB.

6 The levels of the out-of-band emission at the transmitter output at a modulation rate of 100 Bd should be:

6.1 –30 dB referred to unmodulated carrier for a bandwidth of not more than 260 Hz;

6.2 – 40 dB referred to unmodulated carrier for a bandwidth of not more than 500 Hz;

6.3 –50 dB referred to unmodulated carrier for a bandwidth of not more than 700 Hz;

6.4 – 60 dB referred to unmodulated carrier for a bandwidth of not more than 900 Hz.

7 The levels of the out-of-band emission at the transmitter output at a modulation rate of 200 Bd should be:

7.1 –30 dB referred to unmodulated carrier for a bandwidth of not more than 520 Hz;

7.2 – 40 dB referred to unmodulated carrier for a bandwidth of not more than 1 000 Hz;

7.3 –50 dB referred to unmodulated carrier for a bandwidth of not more than 1 400 Hz;

7.4 – 60 dB referred to unmodulated carrier for a bandwidth of not more than 1 800 Hz.

8 The standard maritime mobile service narrow-band telegraphy channel may accommodate two PSK sub-channels at a maximum modulation rate of 100 Bd in each PSK sub-channel.

The frequency of one PSK sub-channel should be 130 Hz lower than the assigned frequency of a standard narrow-band telegraphy channel, and the frequency of the second sub-channel should be 130 Hz higher than the assigned frequency.

9 The transmitter should use class of emission G1B or G7B or single-sideband classes J2B or J7B.

10 If class J2B is used, the frequency of the sub-carrier signal to the audio frequency input of the transmitter should be 1 570, 1 700 or 1 830 Hz, while the frequency tolerance of the sub-carrier from the nominal value should not exceed ± 0.5 Hz.

11 If class J7B is used, the frequencies of the sub-carrier signals to the audio frequency input of the transmitter must be 1 570 and 1 830 Hz, while the tolerance of the sub-carrier frequency from the nominal value should not exceed ± 0.5 Hz.

12 The maximum transmitter frequency tolerance from the nominal value should not exceed ± 5 Hz.

13 The linearity of the amplitude characteristics of the transmitter information signal amplification channel should be such that the level of intermodulation components does not exceed –31 dB for the third order, –38 dB for the fifth order, and – 43 dB for the seventh order.

14 The maximum frequency tolerance of the receiver tuning from the nominal value should not exceed ± 5 Hz.

RECOMMENDATION ITU-R M.690-1*

TECHNICAL CHARACTERISTICS OF EMERGENCY POSITION-INDICATING RADIO BEACONS (EPIRBs) OPERATING ON THE CARRIER FREQUENCIES OF 121.5 MHz AND 243 MHz

(Question ITU-R 31/8)

(1990-1995)

Summary

This Recommendation contains technical characteristics to which emergency position-indicating radio beacons (EPIRBs) intended to operate on the carrier frequency of 121.5 MHz and 243 MHz should conform.

Additional characteristics for EPIRBs intended for carriage on aircraft are specified in relevant annexes to the Convention on International Civil Aviation.

The ITU Radiocommunication Assembly,

considering

a) that the Radio Regulations define the purpose of emergency position-indicating radio beacon (EPIRB) signals;

b) that administrations authorizing the use of EPIRBs operating on carrier frequencies of 121.5 MHz and 243 MHz should ensure that such EPIRBs comply with relevant ITU-R Recommendations and the standards and recommended practices of ICAO,

recommends

1 that the technical characteristics of EPIRBs operating on the carrier frequencies of 121.5 MHz and 243 MHz should be in accordance with Annex 1.

ANNEX 1

Technical characteristics of emergency position-indicating radio beacons (EPIRBs) operating on the carrier frequencies of 121.5 MHz and 243 MHz

EPIRBs operating on the carrier frequencies of 121.5 MHz and 243 MHz should fulfil the following conditions (see Note 1):

a) emission in normal antenna conditions and positions should be vertically polarized and be essentially omnidirectional in the horizontal plane;

b) carrier frequencies should be amplitude-modulated (minimum duty cycle of 33%), with a minimum depth of modulation of 0.85;

c) the emission should consist of a characteristic audio-frequency signal obtained by amplitude modulation of the carrier frequencies with a downward audio-frequency sweep within a range of not less than 700 between 1 600 Hz and 300 Hz and with a sweep repetition rate of two to four times per second;

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* This Recommendation should be brought to the attention of the International Civil Aviation Organization (ICAO) and the COSPAS-SARSAT Secretariat.

d) the emission should include a clearly defined carrier frequency distinct from the modulation sideband components; in particular, at least 30% of the power should be contained at all times within:

± 30 Hz of the carrier frequency on 121.5 MHz;

± 60 Hz of the carrier frequency on 243 MHz;

e) the class of emission should be A3X; however, any type of modulation which satisfies the requirements laid down in b), c) and d) above may be used, provided it does not impair the precise locating of the radio beacon.

NOTE 1 – Additional characteristics for EPIRBs aboard aircraft are specified in the relevant annexes to the Convention on International Civil Aviation.

RECOMMENDATION ITU-R RA.769-1

PROTECTION CRITERIA USED FOR RADIOASTRONOMICAL MEASUREMENTS

(Question ITU-R 145/7)

(1992-1995)

The ITU Radiocommunication Assembly,

considering

a) that the development of radioastronomy has led to major technological advances, particularly in receiving techniques, and to improved knowledge of fundamental radio-noise limitations of great importance to radiocommunication, and promises further important results;

b) that radioastronomers have made useful astronomical observations from the Earth's surface at frequencies as low as 2 MHz, as high as 800 GHz, and from space platforms at frequencies which extend down to lower than 10 kHz;

c) that protection from interference is essential to the advancement of radioastronomy and the associated measurements;

d) that the sensitivity of radioastronomical receiving equipment, which is still steadily improving, greatly exceeds the sensitivity of communications and radar equipment;

e) that propagation conditions at frequencies below about 40 MHz are such that a transmitter operating anywhere on the Earth might cause interference detrimental to radioastronomy;

f) that some transmissions from spacecraft introduce problems of interference to radioastronomy and that these cannot be avoided by choice of site for an observatory or by local protection;

g) that certain types of radioastronomical observation require long periods of uninterrupted recording, sometimes up to several days;

h) that interference to radioastronomy can be caused by terrestrial transmissions reflected by the Moon, by aircraft, and possibly by artificial satellites;

j) that some types of high-resolution interferometric observations require simultaneous reception, at the same radio frequency, by receiving systems located in different countries or on different continents;

k) that some degree of protection can be achieved by appropriate frequency assignments on a national rather than an international basis;

l) that the World Radiocommunication Conferences have made improved allocations for radioastronomy, but that protection in many bands, particularly those shared with other radio services, will need careful planning;

m) that technical criteria concerning interference detrimental to the radioastronomy service have been developed, which are those set out in Tables 1, 2, 3 and 4,

recommends

1 that radioastronomers should be encouraged to choose sites as free as possible from interference;

2 that administrations should afford all practicable protection to the frequencies used by radioastronomers in their own and neighbouring countries, taking due account of the levels of interference given in Annex 1;

3 that administrations, in seeking to afford protection to particular radioastronomical observations, should take all practical steps to reduce to the absolute minimum, all unwanted emissions falling within the band of the frequencies to be protected for radioastronomy, particularly those emissions from aircraft, spacecraft and balloons;

4 that when proposing frequency allocations, administrations take into account that it is very difficult for the radioastronomy service to share frequencies with any other service in which direct line-of-sight paths from the transmitters to the observatories are involved. Above about 40 MHz sharing may be practicable with services in which the transmitters are not in direct line-of-sight of the observatories, but coordination may be necessary, particularly if the transmitters are of high power.

ANNEX 1

Sensitivity of radioastronomy systems

1 General considerations

The simplest way to define the sensitivity of an observation in radioastronomy is to state the smallest power level change ΔP at the radiometer input which can, with high certainty, be detected and measured by the radiometer. The sensitivity equation is:

$$\frac{\Delta P}{P} = \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{\Delta f_0 \, t}} \tag{1}$$

where P and ΔP refer to noise powers, Δf_0 stands for the bandwidth and t is the integration time. Equation (1) also holds if P and ΔP are power spectral densities. Thus ΔP, the noise fluctuation in power spectral density in the sensitivity equation (1), is related to the total system sensitivity (noise fluctuations) expressed in temperature units through the Boltzmann constant, k, as shown in equation (2):

$$\Delta P = k \ \Delta T; \quad \text{also} \quad P = k \ T \tag{2}$$

and we may express the sensitivity equation as:

$$\Delta T = \frac{T}{\sqrt{2 \Delta f_0 \, t}} \tag{3}$$

where:

$$T = T_A + T_R$$

and represents the sum of T_A (the antenna noise temperature contribution from the cosmic background, the Earth's atmosphere and radiation from the Earth) and T_R, the receiver noise temperature. Equations (1) or (3) can be used to estimate the sensitivities and interference levels for radioastronomical observations. The results are listed in Tables 1 and 2: an observing (or integration) time t of 2 000 s is assumed. In Table 1 (continuum observations), Δf is assumed to be the bandwidth of the allocated radioastronomy bands. In Table 2 (spectral line observations) Δf is the channel bandwidth (corresponding to a velocity of 3 km/s) typical of a spectral line system.

The interference threshold levels given in Tables 1 and 2 are expressed as the interference level which introduces an error of 10% in the measurement of ΔP (or ΔT), i.e.:

$$\Delta P_H = 0.1 \, \Delta P \ \Delta f \tag{4}$$

In summary, the appropriate columns in Tables 1 and 2 may be calculated using the following methods:

– ΔT, using equation (3),

– ΔP, using equation (2),

– ΔP_H, using equation (4).

The interference can also be expressed in terms of the power flux-density incident at the antenna, either in the total bandwidth or as a spectral power flux-density S_H per 1 Hz of bandwidth. For convenience, the values are given for an antenna having a gain, in the direction of arrival of the interference, equal to that of an isotropic antenna (which has an effective area of $c^2/4\pi f^2$, where c is the speed of the light and f the frequency).

Values of $S_H \Delta f$ (dB(W/m^2)), are derived from P_H by adding:

$$20 \log f - 38.6 \qquad \text{dB} \tag{5}$$

where f (MHz). S_H is then derived by subtracting 10 log Δf to allow for the bandwidth.

The calculated sensitivities and interference levels presented in Tables 1 and 2 are based on assumed integration times of 2 000 s. Integration times actually used in astronomical observations cover a wide range of values. Continuum observations made with telescopes operating singly (rather than in interferometric arrays) are reasonably well represented by the integration time of 2 000 s. It is representative of good quality observations. There are many occasions when this time is exceeded by an order of magnitude. There are also certain types of observations, such as observations of solar bursts, for which the greatest attainable sensitivity may not be required. On the other hand 2 000 s is less representative of spectral line observations. Improvements in receiver stability and the increased use of correlation spectrometers have resulted in the more frequent use of longer integration times. Spectral line observations lasting several hours are quite common. A more representative value would be 10 h with a consequent improvement in sensitivity of 6 dB over those values in Table 2.

Changes in receiving systems can be expected to give improved performance in the future. At the high frequency end of the spectrum now being used by radioastronomers, improvements in receiver technology are likely to have their largest effect. If receiver temperatures of 10 K can be achieved at frequencies in excess of 30 GHz then improvements in sensitivity of approximately 6 dB will result.

The levels given in Tables 1 and 2 are applicable to terrestrial sources of interfering signals, and are valid for intentional as well as unwanted emissions. The harmful power flux-density and spectral power flux-density shown in Tables 1 and 2 are based on the 0 dBi side-lobe case and should be regarded as the general interference criteria for high sensitivity radioastronomy observations, when the interference does not enter the near side lobes.

To simplify the task of finding the interference threshold levels for any band, the results from Tables 1 and 2 have been extracted as appropriate in Table 3.

A model of the typical side-lobe levels for large paraboloid antennas in the frequency range 2 to 10 GHz is given in Recommendation ITU-R SA.509. In this model, the side-lobe level decreases with angular distance (degrees) from the main beam axis, and is equal to $32 - 25 \log \varphi$ (dBi) for $1° < \varphi < 48°$. A level of 0 dBi occurs at 19° from the main beam axis. A source of interference of power flux-density equal to the threshold values given in Table 1 would be harmful if such an antenna was pointed within 19° of it. Thus, in some situations, interference below the harmful thresholds in Table 1 can be a problem to radioastronomers.

2 Special cases

2.1 Interference from geostationary satellites

Interference from geostationary satellites is a case of particular importance. Because the power levels in Tables 1 and 2 were calculated assuming 0 dBi antenna gain, interference detrimental to radioastronomy will be encountered when a reference antenna, such as described in Recommendation ITU-R SA.509, is pointed within 19° of a satellite radiating at levels in accordance with those listed in the tables. A series of similar transmitters located at intervals of 30° around the geostationary-satellite orbit (GSO) would preclude radioastronomy observations with high sensitivity from a band of sky 38° wide and centred on the orbit. The loss of such a large area of sky would impose severe restrictions on radioastronomy observations.

In general, it would not be practical to suppress the unwanted emissions from satellites to below the harmful level when the main beam of a radio telescope is pointed directly towards the satellite. A workable solution is suggested by observing the projection of the GSO in celestial coordinates as viewed from the latitudes of a number of major radioastronomy observations (see Recommendation ITU-R RA.517). If it were possible to point a radio telescope to within 5° of the orbit without encountering detrimental interference, then for that telescope a band of sky 10° wide would be unavailable for high-sensitivity observations. For a given observatory this would be a serious loss. However, for a combination of existing radio telescopes located at northern and southern latitudes, operating at the same frequencies, the entire sky would be accessible. A value of 5° should therefore be regarded as the requirement for minimum angular spacing between the main beam of a radioastronomy antenna and the GSO.

In the model antenna response of Recommendation ITU-R SA.509, the side-lobe level at an angle of 5° from the main beam is 15 dBi. Thus, to avoid interference detrimental to a radio telescope pointed to within 5° of the transmitter, the satellite emissions must be reduced 15 dB below the power flux-densities given in Tables 1 and 2. When satellites are spaced at intervals of only a few degrees along the GSO, the emission levels associated with the individual transmitters must be even lower to meet the requirement that the sum of the powers of all the interfering signals received should be 15 dB below ΔP_H in Tables 1 and 2.

It is recognized that the emission limitations discussed above cannot, in practice, be achieved so as to enable sharing of the same frequency band between radioastronomy and down-link transmissions from satellites to take place. The limitations are, however, applicable to unwanted emission from the satellite transmitters which fall within the radioastronomy bands listed in Tables 1 and 2. These emission limitations have implications for the space services responsible for the interference, which require careful evaluation. Furthermore, the design of new radioastronomy antennas should strive to minimize the level of side-lobe gain near the main beam as an important means of reducing interference from transmitters in the GSO.

2.2 The response of interferometers and arrays to radio interference

Two effects reduce the response to interference. These are related to the frequency of the fringe oscillations that are observed when the outputs of two antennas are combined, and to the fact that the components of the interfering signal received by different and widely-spaced antennas will suffer different relative time delays before they are recombined. The treatment of these effects is more complicated than that for single antennas in § 1. Broadly speaking the major effect is that the effective integration time over which interference affects the measurement is reduced from the total time of observation to the mean time of one natural fringe oscillation. This typically ranges from some seconds for a compact array with the longest projected spacing $L' \sim 10^3\ \lambda$, where λ is the wavelength, to less than 1 ms for intercontinental arrays with $L' \sim 10^7\ \lambda$. Thus, compared to a single radio telescope, the interferometer has a degree of immunity to interference which, under reasonable assumptions increases with the array size expressed in wavelengths.

The greatest immunity from interference occurs for interferometers and arrays in which the separation of the antennas is sufficiently great that the chance of occurrence of correlated interference is very small (e.g. for very long baseline interferometry (VLBI)). In this case, the above considerations do not apply. The tolerable interference level is determined by the requirement that the power level of the interfering signal should be no more than 1% of the receiver noise power to prevent serious errors in the measurement of the amplitude of the cosmic signals. The interference levels for typical VLBI observations are given in Table 4.

It must be emphasized that the use of large interferometers and arrays is generally confined to studies of discrete high brightness sources, with angular dimensions no more than a few tenths of a second of arc for VLBI. For more general studies of radio sources, the results in Tables 1 and 2 apply and are thus appropriate for the general protection of radioastronomy.

TABLE 1

Threshold levels of interference detrimental to radioastronomy continuum observations

				System sensitivity[2] (noise fluctuations)		Harmful interference levels[2] [3]		
Centre frequency[1] f_c (MHz)	Assumed bandwidth Δf_A (MHz)	Minimum antenna noise temperature T_A (K)	Receiver noise temperature T_R (K)	Temperature ΔT (mK)	Power spectral density ΔP (dB(W/Hz))	Input power ΔP_H (dBW)	Power flux-density $S_H \Delta f_A$ (dB(W/m^2))	Spectral power flux-density S_H (dB(W/(m$^2 \cdot$ Hz)))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13.385	0.05	60 000	100	4 250	– 222	– 185	– 201	– 248
25.610	0.120	20 000	100	917	– 229	– 188	– 199	– 249
73.8	1.6	1 000	100	14	– 247	– 195	– 196	– 258
151.525	2.95	200	100	2.76	– 254	– 199	– 194	– 259
325.3	6.6	40	100	0.86	– 259	– 201	– 189	– 258
408.05	3.9	25	100	1.00	– 259	– 203	– 189	– 255
611	6.0	15	100	0.74	– 260	– 202	– 185	– 253
1 413.5	27	10	20	0.091	– 269	– 205	– 180	– 255
1 665	10	10	20	0.15	– 267	– 207	– 181	– 251
2 695	10	10	20	0.15	– 267	– 207	– 177	– 247
4 995	10	10	20	0.15	– 267	– 207	– 171	– 241
10 650	100	12	20	0.05	– 272	– 202	– 160	– 240
15 375	50	15	30	0.10	– 269	– 202	– 156	– 233
23 800	400	15	50	0.051	– 271	– 195	– 147	– 233
31 550	500	18	100	0.083	– 269	– 192	– 141	– 228
43 000	1 000	25	100	0.063	– 271	– 191	– 137	– 227
89 000	6 000	30	150	0.037	– 273	– 185	– 125	– 222
110 500	11 000	40	150	0.029	– 274	– 184	– 121	– 222
166 000	4 000	40	150	0.048	– 272	– 186	– 120	– 216
224 000	14 000	40	200	0.032	– 274	– 182	– 114	– 215
270 000	10 000	40	200	0.038	– 273	– 183	– 113	– 213

(1) Calculation of interference levels is based on the centre frequency shown in this column although not all regions have the same allocations.

(2) An integration time of 2 000 s has been assumed; if integration times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the table should be adjusted by + 1.7, – 1.3, – 2.8, – 4.8 or – 6.3 dB respectively.

(3) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the geostationary orbit, the levels need to be adjusted by –15 dB, as explained in § 2.1.

TABLE 2*

Threshold levels of interference detrimental to radioastronomy spectral-line observations

Frequency f (MHz)	Assumed spectral line channel bandwidth Δf_c (kHz)	Minimum antenna noise temperature T_A (K)	Receiver noise temperature T_R (K)	System sensitivity(1) (noise fluctuations)		Threshold interference levels (1) (2)		
				Temperature ΔT (mK)	Power spectral density ΔP (dB(W/Hz))	Input power ΔP_H (dBW)	Power flux-density $S_H \Delta f_c$ (dB(W/m^2))	Spectral power flux-density S_H (dB(W/(m^2 · Hz)))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
327	10	40	100	22.1	– 245	– 215	– 204	– 244
1 420	20	10	20	3.35	– 253	– 220	– 196	– 239
1 612	20	10	20	3.35	– 253	– 220	– 194	– 238
1 665	20	10	20	3.35	– 253	– 220	– 194	– 237
4 830	50	10	20	2.12	– 255	– 218	– 183	– 230
14 500	50	15	30	1.84	– 256	– 214	– 169	– 221
22 200	250	40	50	2.85	– 254	– 210	– 162	– 216
23 700	250	40	50	2.85	– 254	– 210	– 161	– 215
43 000	500	25	100	2.80	– 254	– 207	– 153	– 210
48 000	500	30	100	2.91	– 254	– 207	– 152	– 209
88 600	1 000	30	150	2.85	– 254	– 204	– 144	– 204
98 000	1 000	40	150	3.00	– 254	– 204	– 143	– 203
115 000	1 000	50	150	3.16	– 254	– 204	– 141	– 201
140 000	1 500	40	150	2.45	– 255	– 203	– 139	– 200
178 000	1 500	40	150	2.45	– 255	– 203	– 136	– 198
220 000	2 500	40	200	2.40	– 255	– 201	– 133	– 197
265 000	2 500	40	200	2.40	– 255	– 201	– 131	– 195

* This table is not intended to give a complete list of spectral-line bands, but only representative examples throughout the spectrum.

(1) An integration time of 2 000 s has been assumed; if assignation times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the table should be adjusted by + 1.7, – 1.3, – 2.8, – 4.8 or – 6.3 dB respectively.

(2) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the geostationary orbit, the levels need to be adjusted by – 15 dB, as explained in § 2.1.

COLUMN DESCRIPTIONS FOR TABLES 1 AND 2

Column

(1) Centre frequency of the allocated radioastronomy band (Table 1) or nominal spectral line frequency (Table 2).

(2) Assumed or allocated bandwidth (Table 1) or assumed typical channel widths used for spectral line observations (Table 2).

(3) Minimum antenna noise temperature includes contributions from the ionosphere, the Earth's atmosphere and radiation from the Earth.

(4) Receiver noise temperature representative of a good radiometer system intended for use in high sensitivity radioastronomy observations.

(5) Total system sensitivity in millikelvins as calculated from equation (1) using the combined antenna and receiver noise temperatures, the listed bandwidth and an integration time of 2 000 s.

(6) Same as (5) above, but expressed in noise power spectral density using the equation $\Delta P = k \, \Delta T$, where $k = 1.38 \times 10^{-23}$ (J/K) (Boltzmann's constant). The actual numbers in the table are the logarithmic expression of ΔP.

(7) Power level at the input of the receiver considered harmful to high sensitivity observations (ΔP_H). This is expressed as the interference level which introduces an error of not more than 10% in the measurement of ΔP; $\Delta P_H = 0.1 \, \Delta P \, \Delta f$. The numbers in the table are the logarithmic expression of ΔP_H.

(8) Power flux-density in a spectral line channel needed to produce a power level of ΔP_H in the receiving system with an isotropic receiving antenna. The numbers in the table are the logarithmic expression of $S_H \, \Delta f$.

(9) Spectral power flux-density in a spectral line channel needed to produce a power level ΔP_H in the receiving system with an isotropic receiving antenna. The numbers in the table are the logarithmic expression of S_H.

TABLE 3

Simplified table of interference threshold levels extracted from Tables 1 and 2

Radioastronomy band	Power flux-density (dB(W/m^2))	Spectral power flux-density (dB(W/(m$^2 \cdot$ Hz)))
13.36-13.41 MHz	–201	–248
25.55-26.70 MHz	–199	–249
73.0-74.6 MHz	–196	–258
150.05-153.0 MHz	–194	–259
322.0-328.6 MHz	–204	–258
406.1-410.0 MHz	–189	–255
608-614 MHz	–185	–253
1 400-1 427 MHz	–196	–255
1 610.6-1 613.8 MHz	–194	–238
1 660-1 670 MHz	–194	–251
2 690-2 700 MHz	–177	–247
4 990-5 000 MHz	–171	–241
10.6-10.7 GHz	–160	–240
15.35-15.4 MHz	–156	–233
22.1-22.5 GHz	–162	–233
23.6-24.0 GHz	–161	–233
31.3-31.8 GHz	–141	–228
42.5-43.5 GHz	–153	–227
86-92 GHz	–144	–222
105-116 GHz	–141	–222
164-168 GHz	–136	–216
182-185 GHz	–135	–216
217-231 GHz	–133	–215
265-275 GHz	–131	–213

TABLE 4

Threshold interference levels for VLBI observations

Centre frequency, f_c[1] (MHz)	Interference level, S_H (dB(W/(m^2 · Hz)))
325.3	–215
611	–211
1 413.5	–209
2 695	–204
4 995	–198
10 650	–192
15 375	–187
23 800	–182
43 000	–173
86 000	–166

(1) Interference levels at other frequencies used for VLBI may be obtained by interpolation.

RECOMMENDATION ITU-R IS.847-1

DETERMINATION OF THE COORDINATION AREA OF AN EARTH STATION OPERATING WITH A GEOSTATIONARY SPACE STATION AND USING THE SAME FREQUENCY BAND AS A SYSTEM IN A TERRESTRIAL SERVICE*

(Question ITU-R 6/12)

(1992-1993)

The ITU Radiocommunication Assembly,

considering

a) that, where earth stations and terrestrial stations share the same frequency bands, there is a possibility of interference, either the earth-station transmission interfering with reception at terrestrial stations, or terrestrial-station transmissions interfering with reception at earth stations, or both;

b) that, to avoid such interference, it will be desirable for the transmitting and receiving frequencies used by earth stations to be coordinated with the frequencies used by terrestrial services, which might either receive interference from earth-station transmissions or cause interference to reception at earth stations;

c) that this coordination will need to be undertaken within an area surrounding the earth station and extending to distances beyond which the possibility of mutual interference may be considered to be negligible;

d) that this area may extend into territory under the jurisdiction of another administration;

e) that such mutual interference will depend upon several factors, including transmitter powers, type of modulation, antenna gains in the direction of the unwanted signals, the permissible interference levels at the receivers, mechanisms of radio-wave propagation, radio-climatology, the distance between stations and the terrain profile;

f) that the possibility of interference will need to be examined in detail in each case, taking all factors into account;

g) that, as a preliminary to this detailed examination, it is desirable to establish a method of determining, on the basis of broad assumptions, a coordination area around an earth station in such a way that the possibility of mutual interference with terrestrial stations situated outside this area may be regarded as negligible, mutual coordination between administrations only being required when the coordination area of the earth station overlaps territory under the jurisdiction of another administration;

h) that the World Administrative Radio Conference, Geneva, 1979, adopted the method of determining the coordination area set out in Appendix 28 of the Radio Regulations (RR) and invited the ex-CCIR to continue its studies on the subject (see Recommendation No. 711 of the WARC-79);

j) that the Conference also adopted Resolution No. 60 inviting the ex-CCIR to maintain the relevant texts as a result of these studies in a format which would permit direct insertion into Appendix 28 of the RR in place of existing § 3, 4, 6 or Annex 3 when it is concluded by the ex-CCIR Plenary Assembly that such an insertion is warranted;

k) that it is necessary to develop Recommendations suitable to serve as source texts for the updating of Appendix 28 of the RR,

recommends

1. that the methods for determining coordination areas of transmitting and receiving earth stations described in Annex 1 should be used for the complete or partial updating of the procedures currently set forth in Appendix 28 of the RR;

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* The procedure described in this Recommendation applies only to radiocommunications stations on the surface of the Earth.

2. that any updating of Appendix 28 of the RR be accompanied by the adoption of a Resolution, similar to Resolution No. 60 of WARC-79, but with wider scope to allow Appendix 28 to be amended in light of technical development and newly acquired knowledge that would suggest such amendments.

Note 1 – The procedure described in Annex 1 to this Recommendation applies to situations where the coordination area is to be determined from specified values of permissible interference. The procedure is appropriate for the determination of the coordination area in frequency bands in which the space service operates with a space station in geostationary or slightly inclined geostationary orbit, and has a unidirectional (Earth-to-space or space-to-Earth) allocation.

The procedure to be followed in frequency bands which are bidirectionally (i.e., Earth-to-space and space-to-Earth) allocated to space services is set forth in Recommendation ITU-R IS.848.

The procedure to be followed for earth stations of space services using non-geostationary (e.g. low earth-orbiting) space stations is set forth in Recommendation ITU-R IS.849.

For cases where the coordination area is based on a predetermined coordination distance with respect to the location of an earth station or with respect to the area within which the earth station may operate, Recommendation ITU-R IS.850 applies. Recommendation ITU-R IS.850 is appropriate for use by an earth station operating with both geostationary and non-geostationary space stations, where the use of a predetermined coordination distance is needed, e.g., when the coordination distance cannot be determined by the procedures in Recommendation ITU-R IS.847 or ITU-R IS.849, respectively.

Note that the coordination distances mentioned in Resolution No. 46 of WARC-92 may take precedence over those determined by the above methods in bands where Resolution No. 46 applies.

The maps in Figs. 4, 5 and 6 have been taken from Recommendation ITU-R PN.837. As more statistics on rainfall are collected, this Recommendation will be updated, in which case the new version may be used instead.

Note 2 – The methods of this Recommendation and of Recommendation ITU-R IS.848 for the determination of the coordination area differ from those of Appendix 30A of the RR in several important details. Also, the maps depicting rain climates in RR Appendices 30 and 30A are different from those in this Recommendation. It is considered desirable that, in future revisions of the RR, Appendices 30 and 30A be aligned with the most recent texts of the ITU-R.

ANNEX 1

Determination of the coordination area for an earth station operating with a geostationary space station

1. Introduction

A procedure is given for determining the coordination area around an earth station which transmits radio frequency signals to, or receives such signals from, a geostationary space station in frequency bands between 1 and 60 GHz shared between space and terrestrial radiocommunication services.

This procedure is appropriate for the determination of the coordination area in frequency bands in which the space service has a unidirectional (Earth-to-space or space-to-Earth) allocation. The procedure to be followed in frequency bands which are bidirectionally (i.e., Earth-to-space and space-to-Earth) allocated to space services is set forth in Recommendation ITU-R IS.848. The procedure to be followed for earth stations of space services using non-geostationary (e.g. low earth-orbiting) space stations is set forth in Recommendation ITU-R IS.849.

The operation of transmitting and receiving earth and terrestrial stations in shared frequency bands between 1 and 60 GHz may give rise to interference between stations of the two services. The magnitude of such interference is dependent on the transmission loss along the interfering path which, in turn, depends on such factors as length and general geometry of the interfering path (e.g., site shielding), antenna directivity, radio climatic conditions, and the percentage of the time during which the transmission loss should be exceeded.

The described procedure allows the determination, in all azimuth directions from a transmitting or receiving earth station, of a distance beyond which the transmission loss would be expected to exceed a specified value for all but a specified percentage of the time. A distance so determined is called the coordination distance and the end points of coordination distances determined for all azimuths define a distance contour around the earth station – the coordination contour – which contains the coordination area. For terrestrial stations located outside the coordination area the probability of causing or experiencing significant interference is considered to be negligible.

The coordination area is obtained by determining, in all azimuth directions from an earth station, the coordination distances, and drawing to scale on an appropriate map the coordination contour which is the boundary of the coordination area.

Although based on technical data, the coordination area is an administrative concept. Since the coordination area is determined before any specific cases of potential interference are examined in detail, it must perforce rely on assumed parameters of the terrestrial systems, while the pertinent parameters of the earth stations are known. So as not to inhibit the technical development of terrestrial systems, the parameters assumed for them need to lie somewhat beyond those presently employed.

It should be emphasized that the presence or installation of a terrestrial station within the coordination area of an earth station may, but does not generally, affect the successful operation of either the earth station or the terrestrial station, since the procedure for the determination of the coordination area is based on unfavourable assumptions as regards mutual interference.

It is also emphasized that the operation of a terrestrial station inside a coordination area is not affected if that station has been coordinated. There is, thus, no need for administrations to avoid the installation or deployment of new terrestrial facilities within a coordination area.

For the determination of the coordination area two cases may have to be considered:

– for the earth station when it is transmitting (and hence capable of interfering with reception at terrestrial stations);

– for the earth station when it is receiving (and hence capable of being interfered with by emissions from terrestrial stations).

When an earth station is intended to transmit or to receive a variety of classes of emissions, the earth station parameters to be used in the determination of the coordination contour shall be those which lead to the greatest coordination distances, for each earth station antenna beam and in each allocated frequency band which the earth station proposes to share with the terrestrial service.

Together with the coordination contour, auxiliary contours should be drawn which are based on less unfavourable assumptions than those chosen for the determination of the coordination contour. These auxiliary contours may be used to eliminate, without more precise calculations, certain existing or planned terrestrial stations located within the coordination area from further consideration.

In addition, supplementary coordination contours should be prepared where possible to define a smaller coordination area for a different type of terrestrial service where the technical assumptions would apply to all potential conditions for the two affected services. These supplementary contours are particularly important in cases where stations in the fixed service using tropospheric scatter have been assumed yet other stations operating in a line-of-sight configuration may have to be addressed, or where stations in the fixed service are assumed yet stations in the mobile (except aeronautical mobile) service may have to be addressed. Auxiliary contours may also be drawn with respect to a supplementary contour, and should be presented on a map separate from the coordination contour.

The coordination area of an earth station operating with a geostationary space station in a slightly inclined geosynchronous orbit should be determined for the minimum angle of elevation and the associated azimuth at which the space station is visible to the earth station.

2. General considerations

2.1 Concept of minimum permissible transmission loss

The determination of coordination distance, as the distance from an earth station beyond which harmful interference from or to a terrestrial station may be considered to be negligible, is based on the premise that the attenuation of an unwanted signal is, or can be represented by, a monotonically increasing function of distance.

The amount of attenuation required between an interfering transmitter and an interfered-with receiver is given by the "minimum permissible transmission loss for *p*% of the time", a value of transmission loss which should be exceeded by the actual or predicted transmission loss for all but *p*% of the time:*

$$L(p) = P_{t'} - P_r(p) \quad \text{dB} \qquad (1)$$

where:

$P_{t'}$**: the maximum available transmitting power level (dBW) in the reference bandwidth at the input to the antenna of an interfering station

$P_r(p)$: threshold interference level of an interfering emission (dBW) in the reference bandwidth to be exceeded for no more than *p*% of the time at the terminals of the receiving antenna of an interfered-with station, the interfering emission originating from a single source.

$P_{t'}$ and $P_r(p)$ are defined for the same radio-frequency bandwidth (the reference bandwidth) and $L(p)$ and $P_r(p)$ for the same percentage of the time, as dictated by the performance criteria of the interfered-with system.

Only small percentages of the time are of interest here, and it is necessary to distinguish between two significantly different mechanisms of propagation for an interfering emission:

– propagation of signals in the troposphere via near-great circle paths; mode (1) see § 3;

– propagation of signals by scattering from hydrometeors; mode (2), see § 4.

2.2 The concept of minimum permissible basic transmission loss

In the case of propagation mode (1) the transmission loss is defined in terms of separable parameters, viz.: a basic transmission loss (i.e. attenuation between isotropic antennas) and the effective antenna gains at both ends of an interference path. The minimum permissible basic transmission loss may then be expressed as:

$$L_b(p) = P_{t'} + G_{t'} + G_r - P_r(p) \quad \text{dB} \qquad (2)$$

where:

$L_b(p)$: minimum permissible basic transmission loss (dB) for *p*% of the time; this value must be exceeded by the actual or predicted basic transmission loss for all but *p*% of the time

$G_{t'}$: gain (dB relative to isotropic) of the transmitting antenna of the interfering station. If the interfering station is an earth station, this is the antenna gain towards the physical horizon on a given azimuth; in the case of a terrestrial station, the maximum expected antenna gain is to be used

G_r: gain (dB relative to isotropic) of the receiving antenna of the interfered-with station. If the interfered-with station is an earth station, this is the gain towards the physical horizon on a given azimuth; in the case of a terrestrial station, the maximum expected antenna gain is to be used.

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* When *p* is a small percentage of the time, in the range 0.001% to 1.0%, it is referred to as "short-term"; if $p \geq 20\%$, it is referred to as "long-term".

** Primes refer to the parameters associated with the interfering station.

Appendix 1 provides the numerical method for determining the minimum angle between the earth-station antenna main beam axis and the physical horizon as a function of azimuth, as well as the corresponding antenna gains. In the case of space stations in slightly inclined geostationary orbits, the minimum angles and corresponding antenna gains will depend on the maximum inclination angle to be coordinated.

2.3 Derivation and tabulation of interference parameters

2.3.1 The threshold interference level of an interfering emission

The threshold interference level of the interfering emission (dBW) in the reference bandwidth, to be exceeded for no more than *p*% of the time at the receiving antenna terminal of a station subject to interference, from each source of interference, is given by the general formula below:

$$P_r(p) = 10 \log (k\, T_e B) + N_L + 10 \log (10^{M_s/10} - 1) - W \qquad \text{dBW} \qquad (3)$$

where:

k : Boltzmann's constant, 1.38×10^{-23} J/K

T_e : the thermal noise temperature of the receiving system (K), at the terminal of the receiving antenna (see Note 1)

N_L : link noise contribution (see Note 2)

B : the reference bandwidth (Hz), i.e., the bandwidth in the interfered-with system over which the power of the interfering emission can be averaged

p : the percentage of the time during which the interference from one source may exceed the threshold value; since the entries of interference are not likely to occur simultaneously: $p = p_0/n$

p_0 : the percentage of the time during which the interference from all sources may exceed the threshold value

n : the number of equivalent equal level, equal probability entries of interference, assumed to be uncorrelated for small percentages of the time

M_s : link performance margin (dB) (see Note 3)

W : an equivalence factor (dB) relating interference from interfering emissions to that caused, alternatively, by the introduction of additional thermal noise of equal power in the reference bandwidth. It is positive when the interfering emissions would cause more degradation than thermal noise (see Note 4).

Tables 1 and 2 list values for the above parameters.

In certain cases, an administration may have reason to believe that, for its receiving earth station, a departure from the values associated with the earth station, as listed in Table 2, may be justified. Attention is drawn to the fact that for specific systems the bandwidths B or, as for instance in the case of demand assignment systems, the percentages of the time p and p_0 may have to be changed from the values given in Table 2.

Note 1 – The noise temperature (K) of the receiving system, referred to the output terminals of the receiving antenna, may be determined from:

$$T_e = T_a + (e - 1)\, 290 + eT_r \qquad \text{K} \qquad (4)$$

where:

T_a : noise temperature (K) contributed by the receiving antenna

e : numerical loss in the transmission line (e.g. a waveguide) between the antenna terminal and the receiver front end

T_r : noise temperature (K) of the receiver front end, including all successive stages at the front end input.

For radio-relay receivers and where the waveguide loss of a receiving earth station is not known, a value of $e = 1.0$ should be used.

Note 2 – The factor N_L is the noise contribution to the link. In the case of a satellite transponder, it includes the up-link noise, intermodulation, etc. For example, generally:

$N_L = 1$ dB for fixed satellite links

$N_L = 0$ dB for terrestrial links.

Note 3 – M_s is the factor by which the link noise under clear-sky conditions would have to be raised to produce the specified minimum performance. It is the dB sum of two margins M_0 (the natural performance margin) and ΔM (the operational excess margin). The natural performance margin M_0 is the dB difference between the two C/N values that would just produce the specified nominal ("long term") and the specified minimum ("short term") performances, respectively. The excess margin ΔM is the dB difference between the actual clear-sky C/N and that which would produce the nominal specified performance; it may be equal to 0 dB. Thus, M_s is the real fade margin but it is also the margin by which the clear-sky noise floor could be raised (e.g., as the result of interfering emissions) to produce minimum performance conditions.

The performance of analogue terrestrial radio-relay systems is specified for the 2 500 km long hypothetical reference circuit (HRC) by Recommendation ITU-R F.393. A single hop (of 50 km length) of 50 hops is permitted to degrade from a nominal 150 pW0p of voice channel noise (3 pW0p/km) to the maximum 47 500 pW0p for the entire HRC (minimum specified performance). Since predemodulation noise and post-demodulation channel performance are proportional, $M_0 = 10 \log (47\,500/150) = 25$ dB. However, fading behaviour on each hop requires that sufficient margin be provided to satisfy minimum performance specifications; hence, the average hop operates under unfaded conditions with 25 pW0p of noise. From this, $\Delta M = 10 \log (150/25) = 7.8$ dB, and $M_S = 25 + 7.8 \cong 33$ dB.

For digital terrestrial systems, the short-term performance is protected by the provision of a fade margin, M_s, of 25 to 40 dB. Since the probability of short-term enhanced interference occurring simultaneously with carrier fades is negligible, the entire fade margin may be used by this interference.

In analogue systems of the fixed-satellite service, M_0 is given, according to Recommendation ITU-R S.353, by $M_0 = 10 \log (50\,000/10\,000) = 7$ dB. Since this is sufficient to deal with fading at least below about 17 GHz, ΔM is taken as 0 dB, and $M_S = 7$ dB. For frequencies above about 17 GHz, ΔM may have to assume some value greater than 0 dB.

In digital systems of the fixed-satellite service, M_0 can be as little as 1 dB for practical satellite circuits. In real satellite circuits, due to the presence of forward error correction (FEC) codes, the BER versus C/N curve is very steep. In addition, at BERs as low as 10^{-5}, the modem's decoder can lose synchronization to the incoming bit stream as the modem FEC algorithm begins to break down. Especially for very low bit rates, the recovery time could be significantly large. Thus, a degradation in C/N as small as 1.0 dB, when the BER is 10^{-7}, could result in degraded performance and/or downtime to the end-user anywhere from a few seconds to several minutes. The low value of M_0, i.e. 1 dB, is not likely to be sufficient to deal with fading on real links, hence, M_s is to be estimated directly from the expected fading depth for the real percentages of the time of concern. Practical values for M_s are therefore:

f (GHz)	M_s (dB)
< 10	2
10 to 17	4
> 17	6

TABLE 1

Parameters required for the determination of coordination distance for a transmitting earth station

Space radiocommunication service designation		Space operation		Mobile-satellite Land mobile-satellite Maritime mobile-satellite		Mobile-satellite	Space research Space operation Earth exploration-satellite	Fixed-satellite Mobile-satellite	Fixed-satellite		Space research		Fixed-satellite Mobile-satellite Meteorological-satellite		Fixed-satellite		Fixed-satellite		Fixed-satellite	Fixed-satellite	Fixed-satellite
Frequency bands (GHz)		1.427-1.429		1.6100-1.6455 1.6565-1.6600 1.675-1.710		1.970-2.010	2.025-2.110 2.110-2.120 (Deep space)	2.655-2.690	5.725-7.075		7.145-7.235		7.900-8.400		10.7-11.7		12.5-13.25 13.75-14.8		17.7-18.1	24.75-25.25 27-29.5	42.5-51.4
Modulation at terrestrial station (1)		A	N	A	N	A	A	A	A	N	A	N	A	N	A	N	A	N	N	N	N
Terrestrial station interference parameters and criteria	p_0(%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.005	0.001	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.005	0.005	0.005
	n	2	2	2	2	2	2	1	2	3	2	2	2	2	2	3	2	2	2	1	1
	p(%)	0.005	0.005	0.005	0.005	0.005	0.005	0.01	0.005	0.002	0.005	0.002	0.005	0.002	0.005	0.002	0.005	0.002	0.002	0.005	0.005
	N_L (dB)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M_s (dB)	33	33	33	33	26(2)	26(2)	26(3)	33	37	33	37	33	37	33	37	33	40	25	25	25
	W (dB)	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
Terrestrial station parameters	G_r (dB) (4)	35	35	35	35	52(2)	52(2)	52(3)	45	45	47	47	47	47	50	50	50	50	50	50	50
	ΔG (dB)	–7	–7	–7	–7	10(2)	10(2)	10(3)	3	3	5	5	5	5	8	8	8	8	8	8	8
	T_r (K)	750	750	750	750	500(2)	500(2)	500(3)	750	750	750	750	750	750	1 500	1 500	1 500	1 500	3 200	3 200	3 200
Reference bandwidth	B (Hz)	4×10^3	10^6	4×10^3	10^6	4×10^3	4×10^3	4×10^3	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	1×10^6	1×10^6	10^6
Threshold interference level	$P_r(p)$ (dBW) in B	–131	–107	–131	–107	–140	–140	–140	–131	–103	–131	–103	–131	–103	–128	–100	–128	–97	–109	–109	–109

(1) A: analogue modulation; N: digital modulation.

(2) The parameters for the terrestrial station associated with trans-horizon systems have been used. Line-of-sight radio-relay parameters associated with the frequency band 1.675-1.710 GHz may also be used to determine a coordination area in accordance with § 2.3.1.

(3) The parameters for the terrestrial station associated with trans-horizon systems have been used. Line-of-sight radio-relay parameters associated with the frequency band 5.725-7.075 GHz may also be used to determine a coordination area in accordance with § 2.3.1 with the exception that G_r = 37 dB and ΔG = –5 dB.

(4) Feeder losses are not included.

TABLE 2

Parameters required for the determination of coordination distance for a receiving earth station

Space radiocommunication service designation			Mobile-satellite Land mobile-satellite Maritime mobile-satellite	Space operation	Meteorological-satellite	Space research		Space operation	Earth exploration-satellite	Fixed-satellite		Fixed-satellite		Fixed-satellite		Fixed-satellite meteorological-satellite		Earth exploration-satellite	Space research		Fixed-satellite		Meteorological-satellite	Fixed-satellite	Mobile-satellite
																			Near Earth	Deep space					
Frequency band (GHz)			1.492-1.530 1.555-1.559 2.160-2.200 2.4835-2.5200 (1)	1.525-1.530	1.670-1.710 (2)	1.700-1.710 2.200-2.290	2.290-2.300 (Deep space)	2.200-2.290	2.200-2.290	2.500-2.690		3.400-4.200		4.500-4.800		7.250-7.750		8.025-8.400	8.400-8.500		10.7-12.75		17.7-47.0		
Modulation at earth station (3)			N	N		N	N	N	N	A	N	A	N	A	N	A	N	–	–	–	A	N		N	
Earth station interference parameters and criteria	p_0 (%)		10	1.0		0.1	0.001	1	1	0.03	0.003	0.03	0.005	0.03	0.005	0.03	0.005	1.0	0.1	0.001	0.03	0.003		0.003	
	n		1	1		2	1	2	2	3	3	3	3	3	3	3	3		2	1	2	2		2	
	p (%)		10	1.0		0.05	0.001	0.5	0.5	0.01	0.001	0.01	0.002	0.01	0.002	0.01	0.002		0.05	0.001	0.015	0.002		0.002	
	N_L (dB)		0			–	–	–	–	1	1	1	1	1	1	1	1		–	–	1	1		1	
	M_s (dB)		1(4)			–	–	–	–	7	2	7	2	7	2	7	2		–	–	7	4		6	
	W (dB)		0	0		–	–	–	–	4	0	4	0	4	0	4	0		–	–	4	0		0	
Terrestrial station parameters	E (dBW) in B (5)	A	37(6)	50	92(7)	62(7)(8)	62(7)(8)	62(7)	92(7)	92(7)	92(7)	55	55	92(9)	92(9)	55	55	55	25(8)	25(8)	55	55		–	
		N	37	37								42	42	42(10)	42(10)	45	45	42	–18	–18	42	42		40	
	P_t (dBW) in B	A	0	13	40(7)	10(7)(8)	10(7)(8)	10(7)	40(7)	40(7)	40(7)	13	13	40(9)	40(9)	13	13	13	–17(8)	–17(8)	10	10		–	
		N	0	0								0	0	0	0	3	3	0	–60	–60	–3	–3		–7	
	ΔG (dB)		–5	–5	10(7)	10(7)	10(7)	10(7)	10(7)	10(7)	10(7)	0	0	10(9)(10)	10(9)(10)	0	0	0	0	0	3	3		5	
Reference bandwidth(11)	B (Hz)		4×10^3	10^3	10^6	1	1	10^3	10^6	10^6	10^6	10^6	10^6	10^6	10^6	10^6	10^6	10^6	1	1	10^6	10^6		10^6	
Threshold interference level	P_r (p) (dBW) in B		–176	–184		–216	–222	–184	–154	–	–	–	–	–	–	–	–	–154	–220	–220	–	–		–	

Notes to Table 2:

(1) In these bands the terrestrial station parameters of line-of-sight radio-relay systems have been used. If an administration believes that, in the bands 2.160-2.200 GHz and 2.4835-2.5200 GHz, trans-horizon systems need to be considered, the parameters associated with the frequency band 2.500-2.690 GHz may be used to determine the coordination area in accordance with § 2.3.1.

(2) In the band 1.670-1.700 GHz an additional contour for coordination with the meteorological aids service is required. See Table 2 of Recommendation ITU-R IS.850 for details of the calculation.

(3) A: analogue modulation; N: digital modulation.

(4) This value is based on an interference contribution of 25%. See Note 3 of § 2.3.1.

(5) E is defined as the equivalent isotropically radiated power of the interfering terrestrial station in the reference bandwidth.

(6) This value is reduced from the nominal value of 50 dBW for the purposes of determination of coordination area, recognizing the low probability of high power emissions falling fully within the relatively narrow bandwidth of the earth station.

(7) As in footnote (9) with the exception that $E = 50$ dBW for analogue terrestrial stations; and $\Delta G = -5$ dB. However, for the space research service only, noting footnote (8) when trans-horizon systems are not considered, $E = 20$ dBW and $P_t = -17$ dBW for analogue terrestrial stations, $E = -23$ dBW and $P_t = -60$ dBW for digital terrestrial stations; and $\Delta G = -5$ dB.

(8) These values are estimated for 1 Hz bandwidth and are 30 dB below the total power assumed for emission.

(9) In this band, the parameters for the terrestrial stations associated with trans-horizon systems have been used. If an administration believes that trans-horizon systems do not need to be considered, the line-of-sight radio-relay parameters associated with the frequency band 3.4-4.2 GHz may be used to determine the coordination area in accordance with § 2.3.1.

(10) Digital systems assumed to be non-trans-horizon. Therefore, $\Delta G = 0$. For digital trans-horizon systems, parameters for analogue trans-horizon systems above may be used.

(11) In certain systems in the fixed-satellite service it may be desirable to choose a greater reference bandwidth B when the system requirements indicate that this may be done. However, a greater bandwidth will result in smaller coordination distances and a later decision to reduce the reference bandwidth may require re-coordination of the earth station.

Signals to be received at a mobile earth station may not be amenable to this type of specification of performance criteria. In particular, it may not be possible to quantify the margin components M_0 and ΔM directly. To provide some measure of protection against interference of such earth stations it is only possible to preserve their operating margin by limiting the amount of interfering noise power that may be added to their receiving system noise. The criterion to be used is then given as a permissible receiving system noise power increase ΔN (e.g. 25%) expressed as a percentage not to be exceeded for more than p% (e.g. 10 – 50%) of the time, so that for each station:

$$P_r(p) = 10 \log k\,T\,B + 10 \log (\Delta N/100)$$

This leads to a link performance margin of:

$$M_s = 10 \log (\Delta N/100 + 1)$$

Note 4 – The factor W (dB) is the level of the radio-frequency thermal noise power relative to the received power of an interfering emission which, in the place of the former and contained in the same (reference) bandwidth, would produce the same interference (e.g., an increase in the voice or video channel noise power, or in the bit error ratio). The factor W generally depends on the characteristics of both the wanted and the interfering signals.

For interference between FDM-FM telephony transmissions, W may be calculated from:

$$W = 10 \log \left[f_m (1 + r\,m)\, D(f_m, 0) \right] \quad \text{dB} \qquad (5)$$

where:

m : r.m.s. modulation index of the interfered-with signal

r : multi-channel peak-to-r.m.s. voltage ratio in the interfered-with signal.

Note that the term $f_m(1 + r\,m)$ is equal to one-half of the Carson's rule bandwidth of the interfered-with signal.

The term $D(f_m, 0)$ is a convolution term contained in the interference reduction factor B of equation (3) of Recommendation ITU-R SF.766.

When the r.m.s. modulation index of the wanted signal is greater than about 0.8, W will not exceed a value of about 4 dB when the reference bandwidth is chosen as the radio-frequency "noise" bandwidth of the wanted signal.

For very low r.m.s. modulation indices of the wanted signal, W may assume a large range of values, increasing with decreasing modulation indices of both the wanted and the unwanted signals. For such cases it has proven useful to choose as the reference bandwidth the nominal voice channel bandwidth of 4 kHz, and in this case $W \leq 0$ dB.

When the wanted signal is digital, W is usually equal to or less than 0 dB, regardless of the characteristics of the interfering signal.

Recommendation ITU-R SF.766 contains information which permits W to be determined more precisely.

2.3.2 Auxiliary contours

The coordination contours and the supplementary coordination contours are based upon the most unfavourable assumptions regarding interference possibilities. Such unfavourable assumptions rarely apply in practice, and so auxiliary contours should be drawn to facilitate the elimination from further consideration of stations for which the extreme assumptions do not apply.

For the great-circle propagation mode (1) the use of auxiliary contours is of administrative benefit because the administration of the territory into which a coordination area extends may, without recourse to more detailed analysis or inter-administration dialogue, use the auxiliary contours to eliminate terrestrial stations or station classes from being considered to be affected in cases where the terrestrial service station antenna gain or e.i.r.p. in the direction of the earth station is less than that assumed in Tables 1 and 2.

The application of the auxiliary contours applies equally to the cases of transmitting and receiving earth stations.

The auxiliary contours should be drawn appropriate for a 5, 10, 15, 20 dB etc. reduction in required transmission loss, down to a minimum coordination distance of 100 km.

2.3.3 Supplementary coordination contours

The coordination contour is based on the type of terrestrial station that would yield the largest coordination distances. Hence, insofar as all bands of concern are allocated to the fixed service, fixed stations using tropospheric scatter have been assumed in bands that may typically be used by such systems, and fixed stations operating in line-of-sight configurations and using analogue modulation have been assumed for other bands. However, other terrestrial systems have typically lower antenna gains or otherwise less stringent characteristics than those on which the maximum coordination areas are based. It is possible for the notifying administration to identify a supplementary coordination contour which assumes the role of the coordination contour for such systems. In such cases, for example digital fixed systems, the necessary parameters are provided in Tables 1 and 2. The supplementary coordination contour may be depicted with its auxiliary contours identified separately from the coordination contour.

In the case of bands shared by the fixed and mobile services, such supplementary contours may also be drawn. Parameters for this purpose are not currently included in Tables 1 and 2.

3. Determination of coordination distance for propagation mode (1) – great-circle propagation mechanisms

3.1 Radio-climatic zones

In the calculation of coordination distance for propagation mode (1), the world is divided into four basic radio-climatic zones. These zones are defined as follows:

– Zone A1: coastal land and shore areas, i.e. land adjacent to a Zone B or Zone C area (see below), up to an altitude of 100 m relative to mean sea or water level, but limited to a maximum distance of 50 km from the nearest Zone B or Zone C area as the case may be; in the absence of precise information on the 100 m contour, an approximation (e.g. 300 feet) may be used;

– Zone A2: all land, other than coastal land and shore defined as Zone A1 above;

– Zone B: "cold" seas, oceans and large bodies of inland water situated at latitudes above 30°, with the exception of the Mediterranean and the Black Sea;

– Zone C: "warm" seas, oceans and large bodies of inland water situated at latitudes below 30°, as well as the Mediterranean and the Black Sea.

Large bodies of inland water

A "large" body of inland water, to be considered as lying in Zone B or C as appropriate, is defined for the administrative purpose of coordination as one having an area of at least 7 800 km^2, but excluding the area of rivers. Islands within such bodies of water are to be included as water within the calculation of this area if they have elevations lower than 100 m above the mean water level for more than 90% of their area. Islands that do not meet these criteria should be classified as land for the purposes of this area calculation.

Large inland lake or wetland areas

Large inland areas of greater than 7 800 km^2 which contain many small lakes or a river can present difficulties. Such areas can be declared as "coastal" Zone A1 by administrations if the areas contain more than 50% water, and more than 90% of the land elevation is less than 100 m above the mean water level.

Climatic regions pertaining to Zone A1, large inland bodies of water and large inland lake and wetland regions are difficult to determine unambiguously. Therefore, administrations are requested to register with the Radiocommunication Bureau (BR) regions within their territorial boundaries that they wish identified as belonging to one of these categories. In the absence of registered information to the contrary, all land areas will be considered to pertain to climatic Zone A2.

For maximum consistency of results between administrations it is highly recommended that the calculations of this procedure be based on the ITU-R Digitized World Map (IDWM), which is available for mainframe or personal computer environments.

3.2 Procedure for the calculation of mode (1) coordination distance

The coordination distance for propagation mode (1) is that distance d_1 (km), which will result in a value of available basic transmission loss which is equal to the minimum permissible basic transmission loss, $L_b(p)$ dB, as defined in § 2.2.

$$L_b(p) = P_{t'} + G_e + 42 + \Delta G - P_r(p) \qquad \text{dB} \qquad (6)$$

where:

$P_{t'}$ and $P_r(p)$ are as defined in § 2.1

G_e : gain of the earth station antenna (dBi) appropriate towards the horizon at the horizon elevation angle and azimuth of the radial path under consideration

ΔG : difference (dB) between the maximum antenna gain assumed for the terrestrial station and the value of 42 dB. Tables 1 and 2 give values for ΔG for the various frequency bands.

Let:

$$L_1 = L_b(p) - A_1 \qquad \text{dB} \qquad (7)$$

in which:

$$A_1 = 120 + 20 \log f + \log p + 5\, p^{0.5} + A_h \qquad \text{dB} \qquad (8)$$

where:

f : frequency (GHz)

A_h : correction for the earth-station horizon elevation angle $\theta°$* given by the expression:

$$A_h = \begin{cases} 20 \log \left[1 + 4.5\, \theta f^{0.5} \right] + \theta f^{0.33} & \text{dB} \quad \text{for} \quad \theta \geq 0° \quad (9a) \\ 8\, \theta & \text{dB} \quad \text{for} \quad 0° > \theta \geq -0.5° \quad (9b) \\ -4 & \text{dB} \quad \text{for} \quad \theta < -0.5° \quad (9c) \end{cases}$$

Note 1 – The maximum value for A_h is 30 dB; the use of larger values may not result in the protection being realized in practical situations.

Having determined L_1, the required distance may be determined on the basis of:

$$L_1 = \sum_{i=1}^{n} \beta_i(p)\, d_i \qquad \text{dB} \qquad (10)$$

where i = 1 to n refers to the individual path sections, each being of Zone Type A1, A2, B or C as defined in § 3.1. Several sections of each type are possible along each radial path.

d_i : traversed distance (km) of the ith section of the path

$\beta_i(p)$: total specific attenuation (dB/km) for the ith path section, viz:

$$\beta_i(p) = 0.01 + \beta_{dz}(p) + \beta_o + \beta_{vz} \qquad \text{dB/km} \qquad (11)$$

* The horizon elevation angle is defined here as the angle viewed from the centre of the earth-station antenna, between the horizontal plane and a ray that grazes the visible physical horizon in the direction concerned. It is necessary to determine horizon angles for all azimuths around an earth station. In practice it will generally suffice to do this in azimuth increments of 5°. However, every attempt should be made to identify and take into consideration minimum horizon elevation angles that may occur between those azimuths examined in 5° increments.

$\beta_{dz}(p)$: (zone specific) attenuation coefficient exceeded for all but p% of time due to the anomalous propagation phenomena

$$\beta_{dz}(p) = C_1 + C_2 \log f + C_3 \, p^{C_4} \qquad \text{dB/km} \qquad (12)$$

Values for C_1, C_2, C_3 and C_4 for the four climatic zones are given in Table 3.

TABLE 3

Values for C_1, C_2, C_3, C_4 and ρ

Zone	C_1	C_2	C_3	C_4	ρ (g/m^3)
A1	0.03	0.03	0.15	0.2	10.0
A2	0.04	0.05	0.16	0.1	7.5
B	0.015	0.015	0.05	0.15	10.0
C	0	0.015	0.04	0.15	10.0

β_o and β_{vz} : specific attenuations due to oxygen and water vapour respectively.

$$\beta_o = \begin{cases} \left[7.19 \times 10^{-3} + \dfrac{6.09}{f^2 + 0.227} + \dfrac{4.81}{(f - 57)^2 + 1.50} \right] f^2 \times 10^{-3} & \text{dB/km for } f < 57 \text{ GHz} \quad (13a) \\ \beta_o = \beta_{o(57)} + 1.5(f - 57) & \text{dB/km for } 57 \le f \le 60 \text{ GHz} \quad (13b) \end{cases}$$

where:

$\beta_{o(57)}$: value of β_o found using equation (13a) and a frequency of 57 GHz.

$$\beta_{vz} = \left\{ 0.050 + 0.0021\,\rho + \frac{3.6}{(f - 22.2)^2 + 8.5} + \frac{10.6}{(f - 183.3)^2 + 9.0} + \frac{8.9}{(f - 325.4)^2 + 26.3} \right\} f^2 \rho \, 10^{-4} \qquad \text{dB/km} \qquad \text{for } f < 350 \text{ GHz} \qquad (14)$$

Values of β_{vz} depend upon the climatic zone, and must be calculated using the appropriate values of water vapour density ρ (g/m^3) as shown in Table 3 above.

Equation (10) shows that the overall mode (1) distance may have to be found via an interactive calculation. Using pre-determined path section lengths, D_i, for each radial path from the earth-station location, calculate and add, in dB, the values of the products $\beta_i(p)D_i$ for successive path sections until the sum is greater than L_1 dB; this will yield the value of n. However, the inclusion of the whole length of the nth-section, particularly if it is over the sea, will generally result in a total distance which significantly exceeds that necessary to achieve L_1 dB. Therefore, where:

$$\sum_{i=1}^{n} \beta_i(p) \, D_i > L_1 \qquad \text{dB} \qquad (15)$$

the required partial penetration, d_n, into the nth-zone is determined by linear interpolation:

$$d_n = \left[L_1 - \sum_{i=1}^{n-1} \beta_i(p) \, D_i \right] \Big/ \beta_n \qquad \text{km} \qquad (16)$$

The coordination distance for mode (1), d_1, is then given by:

$$d_1 = \begin{cases} d_n + \sum_{i=1}^{n-1} D_i & \text{km} \quad \text{for } n > 1 \\ L_1 / \beta_1 & \text{km} \quad \text{for } n = 1 \end{cases} \tag{17}$$

However, this value of d_1 is subject to the limits set out in § 3.3.

3.3 Maximum coordination distances for propagation mode (1)

For paths entirely within a single zone, the distance shall not exceed the value given in Table 4 for that zone.

For mixed paths, the coordination distance can comprise contributions from Zones A1, A2, B and C. The aggregate distance for any one zone shall not exceed the value given in Table 4, the combination of distances in Zones A1 and A2 shall not exceed 500 km. The overall coordination distance shall not exceed the value in Table 4 for the zone in the mixed path having the largest Table 4 value.

TABLE 4

Mode (1) maximum coordination distances

Zone	d_{m1} (km)
A1	500
A2	350
B	900
C	1 200

4. Determination of coordination contour for propagation mode (2) – Scattering from hydrometeors

The hydrometeor scatter coordination distance is that distance that will result in an available transmission loss, L_2, equal to the minimum permissible transmission loss $L(p)$ as defined in § 2.1.

$$L(p) = P_{t'} - P_r(p) \qquad \text{dB} \tag{18}$$

As noted in § 2, the minimum coordination distance is 100 km. For the general case of interference from hydrometeor scatter this is considered to provide adequate protection, and specific cases need only be evaluated within this distance from the earth station. However, there may be particular combinations of system parameters, i.e. high interfering transmitter powers and/or a low permissible interfering power at the interfered-with receiver, which result in the latter station requiring additional protection from hydrometeor-scatter interference.

Therefore, where the required transmission loss, $L(p)$, exceeds by more than ΔG dB the applicable value in Table 5 for the frequency band and rain climate zone (see Appendix 3) appropriate to the earth station, the procedure given in Appendix 2 should be used to create the appropriately-extended mode (2) contour.

TABLE 5

Transmission loss thresholds (dB) for Mode (2) extended contour calculations

Frequency band (GHz)	Rain climate				
	A, B	C, D, E	F, G, H, J, K	L, M	N, P, Q
1	152	148	144	141	136
4	140	136	132	129	125
6	138	134	130	127	124
8	136	132	129	126	124
10	135	131	129	127	126
12	134	131	129	127	126
14	135	132	130	128	127
18	138	136	134	132	131
20	144	142	140	139	137
22.4	153	151	149	148	146
25	149	147	145	144	142
28	147	145	143	141	139
30	147	145	143	141	140
35	151	149	147	145	143
40-60	157	155	153	151	149

5. Minimum value of coordination distance

If the method for determining d_1, the coordination distance for propagation mode (1), leads to a result less than 100 km, d_1 shall be taken equal to 100 km. Similarly, 100 km shall also be the minimum coordination distance for propagation mode (2), measured from the earth station on any azimuth on which the method for determining the hydrometeor scatter distance identifies a point that lies closer to the earth station than 100 km.

6. The coordination contour

On any azimuth, the greater of the coordination distances d_1 or d_2 is the coordination distance to be used for the construction of the coordination contour. However, in order to facilitate the decision whether either mode of propagation might be ignored in determining if a given terrestrial station class needs to be considered to be affected, that part of the contour of propagation mode (1) lying within the propagation mode (2) area, and that part of the propagation mode (2) contour lying within the propagation mode (1) area may be shown as dashed contours.

An example of a coordination contour is shown in Fig. 1.

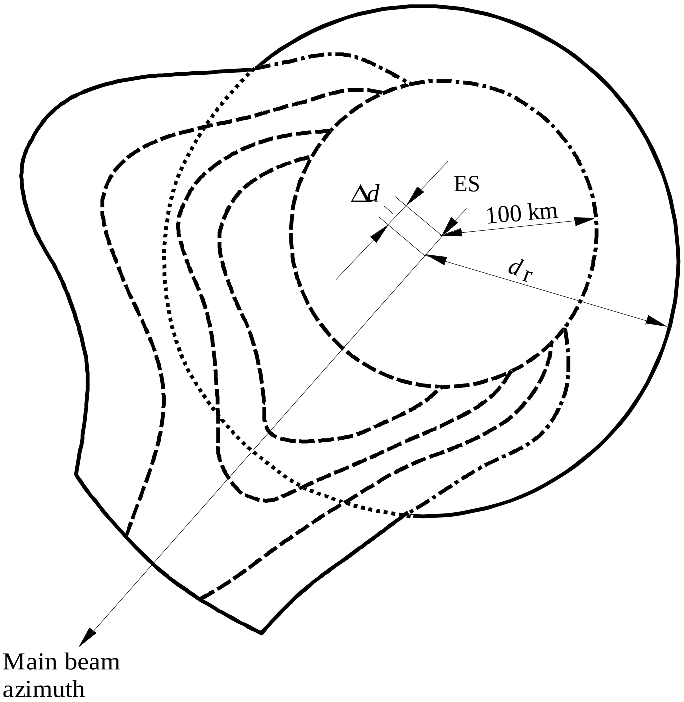
7. Use of computer

Based on the process described above, the coordination contour and auxiliary or supplementary contours could be generated and, where desirable, directly plotted on a map by computer.

The ITU-R Digitized World Map (IDWM) and the software to extract information from it as well as the software to calculate coordination areas according to the Radio Regulations, the Technical Standards and the Rules of Procedure of the ITU-R, are available to administrations. Under the provisions of Article 11 of the Radio Regulations, an administration, and in particular an administration of a country in need of special assistance, can request the BR to calculate and document the coordination area. In addition, a few administrations have submitted to the ITU computer programs which, besides calculating the coordination area and the auxiliary or supplementary contours, also perform some post-processing, such as culling of a set of fixed stations against the contour.

FIGURE 1

Example of a coordination contour for an earth station operating with a geostationary satellite



ES: earth station

Δd: see Appendix 2 to Annex 1, equation (48)

Coordination contour

Contour for propagation mode (1)

Contour for propagation mode (2)

Auxiliary contours for propagation mode (1)

Note 1 – If by using the auxiliary contours it is seen that a terrestrial station can be eliminated with respect to propagation mode (1) then:

– if that terrestrial station is outside the contour for propagation mode (2) it may be eliminated from any further consideration;

– if that terrestrial station is within the contour for propagation mode (2) it must still be considered, but for this mode only;

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8. Operational considerations at frequencies above 10 GHz

At frequencies above 10 GHz rain attenuation will weaken the received signals at earth or space stations for small percentages of the time, increasingly so with increasing frequencies.

Where power margins in the up or down links are insufficient to maintain the required continuity of service, it may be necessary to use site diversity or power control, or both.

When power control is used in the up link to combat rain attenuation on the Earth-to-space path, the increased power will tend to produce greater potential interference to terrestrial systems towards which the attenuation may not have increased. It may therefore be necessary to determine coordination contours taking into account the maximum powers that may be radiated and the percentages of the time during which given levels of power control may have to be exercised. It is understood that the maximum power which may be emitted by a transmitting earth station should be used to determine the coordination area. However, the transmit power will be increased only when rain attenuation exceeds a specified value. Thus, the increased power will not contribute to the interference due to ducting which is a clear sky phenomenon. Therefore, the maximum available transmitting power used to determine the coordination area for propagation mode (1) should be different from that for propagation mode (2). In fact, for propagation mode (1), it seems appropriate to use the maximum transmitting power emitted under clear sky conditions as the maximum available transmitting power.

When site diversity is used to combat attenuation, coordination contours will have to be determined for both sites. Since precipitation is the mechanism largely responsible for attenuation, each of the two sites will be operated, generally, only up to a given attenuation, i.e., to a given rainfall rate, after which the operation is transferred to the other site. As a consequence, rain-scatter coordination distances need to be determined only for those rain rates at which switching to the other site is undertaken. Since the switching rain rates will be substantially lower than the maximum rain rates for the percentage of the time for which continuity of service must be maintained, the rain-scatter coordination areas for the two sites may be significantly smaller than that for a single non-diversity site. It is worth noting that this advantage may accrue to both a transmitting and a receiving earth station.

9. Mobile (except aeronautical mobile) earth stations

For the purpose of establishing whether coordination for a mobile (except an aeronautical mobile) earth station is required, it is necessary to determine the coordination area which would encompass all coordination areas determined for each location within the service area within which operation of the mobile earth stations is proposed.

The preceding method may be used for this purpose by determining the appropriate individual coordination contours for a sufficiently large number of locations within and on the periphery of the proposed service area and by determining from those a composite coordination area which contains all possible individual coordination areas.

In the determination of the coordination area for a geographic area that is to contain mobile earth stations, it is generally only necessary to select a few points on the periphery of the geographical area and construct an envelope of the resulting point coordination contours by straight lines on the map used. The straight line envelope constitutes the effective coordination contour.

10. Transportable earth stations

If a transportable earth station is to be operated on an area basis, the method for mobile (except aeronautical mobile) earth stations described above applies for the determination of the coordination area of the transportable earth station.

11. Revision of propagation data

The material contained in this Annex is based, directly or indirectly, on propagation data compiled, interpreted and documented in other ITU-R texts. This material is given in a form similar to Appendix 28 to the Radio Regulations which is subject to revision pursuant to Resolution No. 60 of the WARC-79. Knowledge regarding propagation is subject to change as new and more reliable data become available, and such change may require or strongly suggest corresponding amendments to the propagation-related material in this Annex based on the findings of the ITU-R.

APPENDIX 1

TO ANNEX 1

Antenna gain in the direction of the earth-station horizon for geostationary satellites

1. General

The gain component of the earth-station antenna in the direction of the physical horizon around an earth station is a function of the angular separation between the antenna main beam axis and the horizon in the direction under consideration. When the earth station is used to transmit to more than one space station along the geostationary orbit, or to one or more space stations in slightly inclined orbits, all possible pointing directions of the antenna main beam axis must be considered. For earth-station coordination, knowledge of $\varphi(\alpha)$, the minimum possible value of the angular separation that will occur during the operation of the space station, is required for each azimuth.

When a geostationary satellite maintains its location close to its nominal orbital position, its elevation ε, and azimuth α, as seen from an earth station at a latitude ζ are uniquely related. Figure 2 shows the possible location arcs of positions on the geostationary orbit in a rectangular azimuth/elevation plot. It shows arcs corresponding to a set of earth-station latitudes and the intersecting arcs correspond to points on the orbit with a fixed difference in longitude East or West of the earth station. Figure 2 also shows a portion of the horizon profile $\varepsilon(\alpha)$. The off-beam angle $\varphi(\alpha)$ between the horizon profile at an azimuth of 190° and a space station located 28° W of an earth station at 43° N latitude is indicated by the great-circle arc shown dashed on Fig. 2.

When the North-South station-keeping of a geostationary satellite is relaxed, the orbit of the satellite becomes inclined with an inclination that increases gradually with time. As viewed from the Earth, the position of the satellite traces a figure eight during each 24-hour period. Figure 3 shows the trajectories of a set of satellites, each with 10° inclination, spaced by 3° along the geostationary orbit from 28° W to 44° E of an earth station at 43° N longitude. For purposes of coordination area determination, only a bounding envelope of these trajectories needs to be considered. A simple bounding envelope based on the maximum excursions in latitude and longitude of the sub-satellite points of satellites at all possible positions along the arc, as shown in Fig. 3, may be used. Figure 3 also shows, with a dashed curve, the great-circle arc corresponding to the minimum off-beam angle $\varphi(\alpha)$ between this envelope and the horizon profile at an azimuth of 110°.

The bounding curve used to determine the minimum off-beam angle should be based on the maximum orbital inclination which will be allowed during the operational life of the space stations on this portion of the geostationary orbit. The use of the bounding envelope simplifies the calculation of the minimum off-beam angle. It does not require the specific values of the space station locations on the arc. Not all of these may be known beforehand, and some space stations may require repositioning at a later time.

2. Determination of $\varphi(\alpha)$

For the determination of $\varphi(\alpha)$, four cases may be distinguished. These depend on whether a single space station or a portion of the geostationary orbit is to be considered, and whether or not the earth station will operate with space stations in slightly inclined orbits. The following equations may be used in all of these cases:

$$\psi_s(i, \delta) = \arccos(\sin\zeta \sin i + \cos\zeta \cos i \cos\delta) \tag{19}$$

$$\varepsilon_s(i, \delta) = \arcsin\left[\frac{K\cos\psi_s(i, \delta) - 1}{(1 + K^2 - 2K\cos\psi_s(i, \delta))^{1/2}}\right] \tag{20}$$

$$\alpha'_s(i, \delta) = \arccos\left[\frac{\sin i - \cos\psi_s \sin\zeta}{\sin\psi_s \cos\zeta}\right] \tag{21}$$

$$\alpha_s(i, \delta) = \alpha'_s(i, \delta) \qquad \text{for space stations located East of the earth station } (\delta \geq 0) \tag{22}$$

$$\alpha_s(i, \delta) = 360° - \alpha'_s(i, \delta) \qquad \text{for space stations located West of the earth station } (\delta \leq 0) \tag{23}$$

$$\varphi(\alpha, i, \delta) = \text{arc cos} \left[\cos \varepsilon(\alpha) \cos \varepsilon_s(i, \delta) \cos (\alpha - \alpha_s(i, \delta)) + \sin \varepsilon(\alpha) \sin \varepsilon_s(i, \delta)\right] \tag{24}$$

where:

- ζ : latitude of the earth station (positive for North; negative for South)
- δ : difference in longitude from the earth station to the space station
- i : latitude of the sub-satellite point (positive for North; negative for South)
- $\psi_s(i, \delta)$: great-circle arc between the earth station and the sub-satellite point
- $\alpha_s(i, \delta)$: space station azimuth as seen from the earth station
- $\varepsilon_s(i, \delta)$: space station elevation angle as seen from the earth station
- $\varphi(\alpha, i, \delta)$: angle between the main beam and the horizon direction corresponding to the pertinent angle, α, when the main beam is steered towards a space station with a sub-satellite point at latitude i and longitude difference δ
- α : azimuth of the pertinent direction
- ε : elevation angle of the horizon in the pertinent azimuth, α
- $\varphi(\alpha)$: angle to be used for horizon gain calculation at the pertinent azimuth, α
- K : orbit radius/Earth radius, assumed to be 6.62.

All arcs mentioned above are in degrees.

Case 1: Single space station, no orbital inclination

For a single space station operating with no orbital inclination at an orbital position with difference in longitude δ_0, equations (19) to (24) may be applied directly, using $i = 0$, to determine $\varphi(\alpha)$ for each azimuth α. Thus:

$$\varphi(\alpha) = \varphi(\alpha, 0, \delta_0) \tag{25}$$

where:

- δ_0 : longitude difference from the earth station to the space station.

Case 2: Space stations on a portion of the geostationary orbital arc, no orbital inclination

For space stations operating with no orbital inclination on a portion of the geostationary orbital arc, equations (19) to (24) may be applied directly, using $i = 0$ to develop the minimum value of off-axis angle. For each azimuth α, the angle $\varphi(\alpha)$ is the minimum value of $\varphi(\alpha, 0, \delta)$ for any position along the arc. Thus:

$$\varphi(\alpha) = \min_{\delta_w \leq \delta \leq \delta_e} \varphi(\alpha, 0, \delta) \tag{26}$$

where:

- δ_e : difference in longitude at the eastern extreme of the operational portion of the orbital arc
- δ_w : difference in longitude at the western extreme of the operational portion of the orbital arc.

FIGURE 2

Position arcs of geostationary satellites with horizon and the arc from the horizon at azimuth 190° to a satellite 28° W of an earth station at 43° N latitude

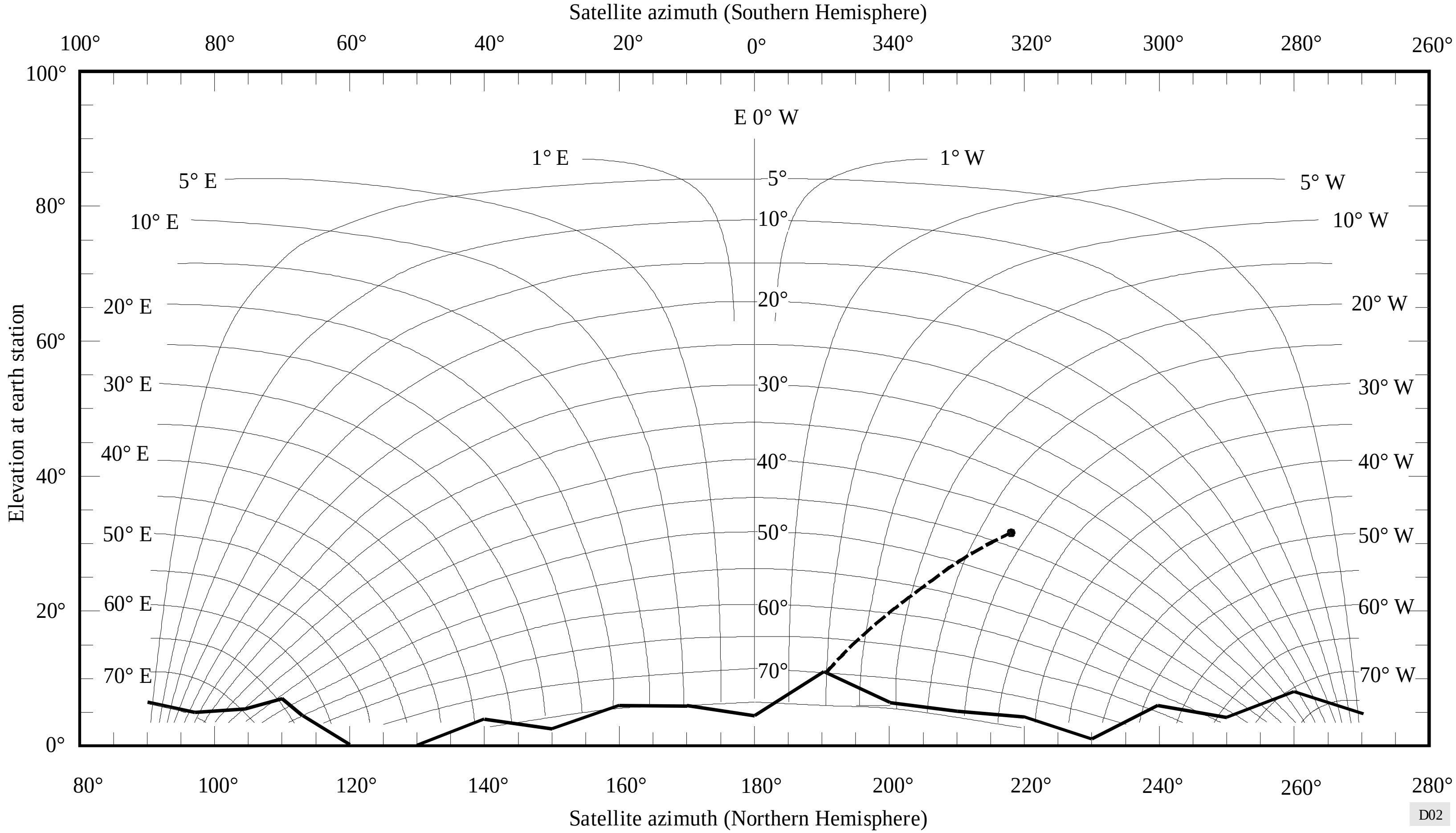
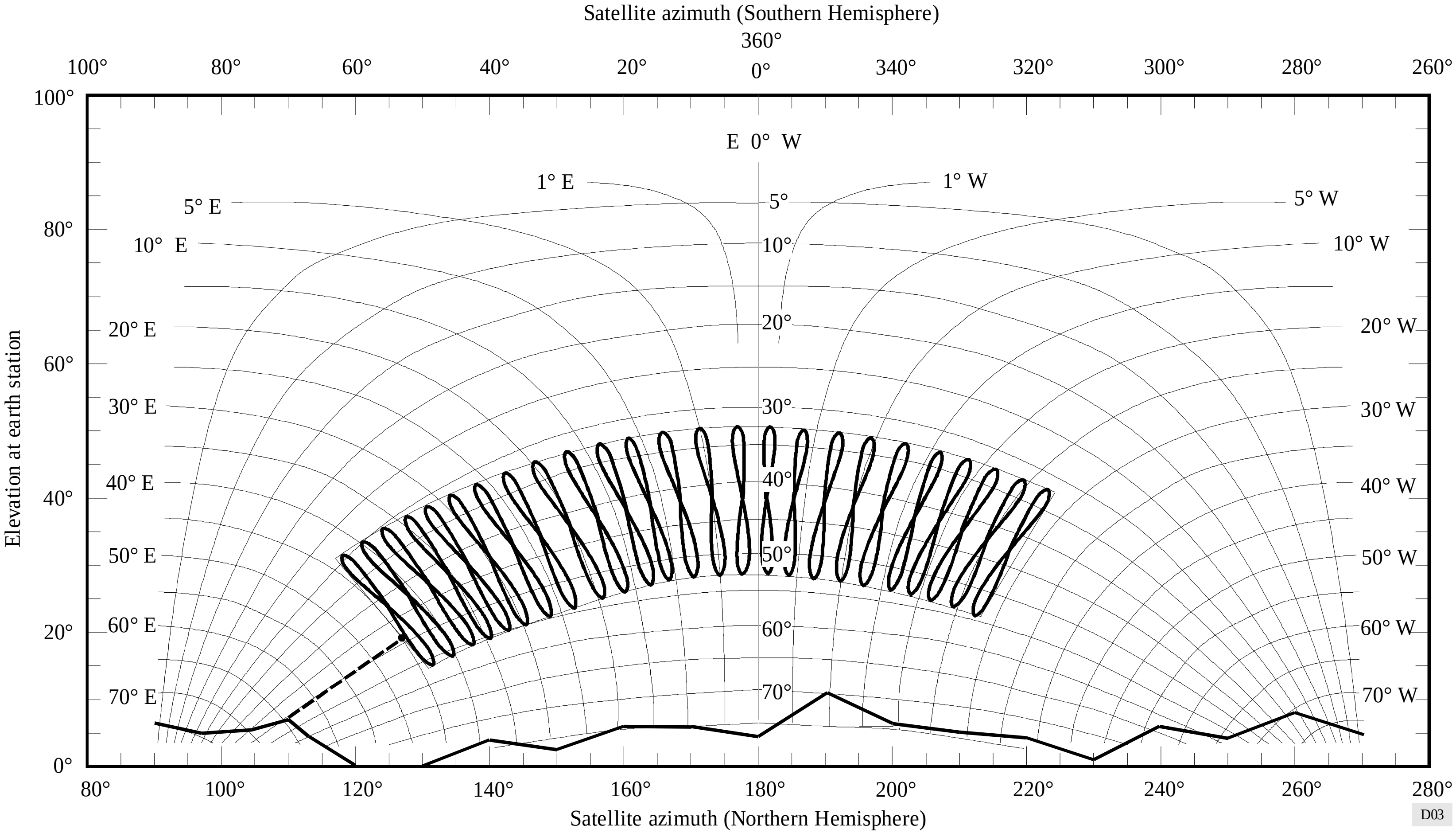


FIGURE 3

Position arcs of geostationary satellites with horizon and the arc from the horizon at azimuth 110° to the envelope of satellites with 10° inclination on the geostationary orbital arc from 28° W to 44° E of an earth station at 43° N latitude



Case 3: Space stations on a portion of the geostationary orbital arc, with orbital inclination

For space stations operating in slightly inclined orbits on a portion of the geostationary arc with nominal longitude difference between δ_e, and δ_w, the maximum orbital inclination over their lifetimes, i_s, must be considered. Equations (19) to (24) may be applied to develop the minimum off-axis angle to each of four arcs in azimuth/elevation space that bound the trajectory of the space station in angle and elevation. The bounding arcs correspond to the maximum and minimum latitudes of the sub-satellite points and the extremes of the difference in longitude between the earth and space stations when the space station is operating at its maximum inclination. Thus:

$$\varphi(\alpha) = \min_{n = 1 \text{ to } 4} \varphi_n(\alpha) \tag{27}$$

with:

$$\varphi_1(\alpha) = \min_{\delta_w - \delta_s \le \delta \le \delta_e + \delta_s} \varphi(\alpha, -i_s, \delta) \tag{28}$$

$$\varphi_2(\alpha) = \min_{\delta_w - \delta_s \le \delta \le \delta_e + \delta_s} \varphi(\alpha, i_s, \delta) \tag{29}$$

$$\varphi_3(\alpha) = \min_{-i_s \le i \le i_s} \varphi(\alpha, i, \delta_w - \delta_s) \tag{30}$$

$$\varphi_4(\alpha) = \min_{-i_s \le i \le i_s} \varphi(\alpha, i, \delta_e + \delta_s) \tag{31}$$

$$\delta_s = (i_s / 15)^2 \tag{32}$$

where:

i_s : maximum operational inclination angle of the satellite orbit

δ_s : maximum longitude change from nominal value of the sub-satellite point of a satellite with orbital inclination i_s.

Case 4: Single space station, with inclined orbits

For a single space station, operating at a nominal longitude difference of δ_0, with a maximum orbital inclination of i_s over its lifetime, the determination of $\varphi(\alpha)$ is the same as for Case 3, except that here $\delta_e = \delta_w = \delta_0$.

It should be noted that the determination of the minimum off-axis angles in equations (26), (28), (29), (30) and (31) may be made by taking increments along a bounding contour. The step size in i or δ should be between 0.5° and 1.0° and the end points of the respective ranges should be included in the determination.

Note that the horizon profile $\varepsilon(\alpha)$ used in the determination of $\varphi(\alpha)$ should be specified at increments in azimuth α that should not exceed 5°.

3. Determination of antenna gain

The relationship $\varphi(\alpha)$ may be used to derive a function for the horizon antenna gain, G(dB) as a function of the azimuth α, by using the actual earth-station antenna pattern, or a formula giving a good approximation. For example, in cases where the ratio between the antenna diameter and the wavelength is not less than 35, the following equation should be used:

$$G(\varphi) = \begin{cases} G_{max} - 2.5 \times 10^{-3} \left(\dfrac{D}{\lambda}\varphi\right)^2 & \text{for } 0 < \varphi < \varphi_m \\ G_1 & \text{for } \varphi_m \le \varphi < \varphi_r \\ 29 - 25 \log \varphi & \text{for } \varphi_r \le \varphi < 36° \\ -10 & \text{for } 36° \le \varphi \le 180° \end{cases} \tag{33}$$

where:

D : antenna diameter
λ : wavelength } expressed in the same unit

G_1 : gain of the first side lobe

$$G_1 = \begin{cases} -1 + 15 \log (D/\lambda) & \text{dBi} \quad \text{for } D/\lambda \geq 100 \\ -21 + 25 \log (D/\lambda) & \text{dBi} \quad \text{for } D/\lambda < 100 \end{cases}$$

$$\varphi_m = \frac{20\,\lambda}{D} \sqrt{G_{max} - G_1} \qquad \text{degrees}$$

$$\varphi_r = \begin{cases} 15.85\,(D/\lambda)^{-0.6} & \text{degrees} \quad \text{for } D/\lambda \geq 100 \\ 100\,(\lambda/D) & \text{degrees} \quad \text{for } D/\lambda < 100 \end{cases}$$

The above patterns may be modified as appropriate to achieve a better representation of the actual antenna pattern.

In cases where D/λ is not given, it may be estimated from the expression:

$$20 \log \frac{D}{\lambda} \approx G_{max} - 7.7$$

where:

G_{max}: main lobe antenna gain (dB).

It should be noted that the above equations may be different from those given in Recommendation ITU-R S.465.

APPENDIX 2

TO ANNEX 1

Calculation of contours for propagation mode (2)

The value of d_r, the distance between the region of maximum scattering and the location of a terrestrial station on the coordination contour for this propagation mode, can be found by an iterative calculation using the algorithm in this Appendix.

The basic equation for transmission loss due to hydrometeor scatter is:

$$L_2 = 168 + 20 \log d_r - 20 \log f - 13.2 \log R - G_T + 10 \log A_b - 10 \log C + \Gamma + H + \beta_o\, d_o + \beta_v\, d_v \qquad \text{dB} \tag{34}$$

Determine the appropriate values for the following parameters:

– R : surface rainfall rate (mm/h) for the time percentage p, given in Appendix 3 for various rain-climatic zones

– k and α, for the appropriate frequency, from Table 6 (for values of k between the frequencies shown use logarithmic interpolation, and for values of α use linear interpolation).

Set:

$G_T = 42 + \Delta G$ dBi (assumed antenna gain for the terrestrial station)

and calculate:

$$\gamma_R = k\, R^{\alpha} \qquad \text{dB} \tag{35}$$

$$d_s = 3.5\, R^{-0.08} \qquad \text{km} \tag{36}$$

$$C = \begin{cases} \dfrac{2.17}{\gamma_R\, d_s}\left(1 - 10^{-\gamma_R\, d_s / 5}\right) & \text{dB} \quad \text{for } f > 4 \text{ GHz} \\ 1 & \text{dB} \quad \text{for } f \leq 4 \text{ GHz} \end{cases} \tag{37}$$

$$\Gamma = \frac{631\, \gamma_R}{\sqrt{R}}\, 10^{-(R+1)^{0.19}} \qquad \text{dB} \tag{38}$$

$$h_{FR} = \begin{cases} 5 - 0.075\,(\zeta - 23) & \text{km} \quad \text{for} \quad \zeta > 23° & \text{Northern Hemisphere} & (39a) \\ 5 & \text{km} \quad \text{for} \quad 0° \leq \zeta \leq 23° & \text{Northern Hemisphere} & (39b) \\ 5 & \text{km} \quad \text{for} \quad 0° \geq \zeta \geq -21° & \text{Southern Hemisphere} & (39c) \\ 5 + 0.1\,(\zeta + 21) & \text{km} \quad \text{for} \quad -71° < \zeta \leq -21° & \text{Southern Hemisphere} & (39d) \\ 0 & \text{km} \quad \text{for} \quad \zeta \leq -71° & \text{Southern Hemisphere} & (39e) \end{cases}$$

where h_{FR} is in km and ζ is the latitude in degrees.

Set:

$$x = 168 - 20 \log f - 13.2 \log R - G_T - 10 \log C + \Gamma - L_2 \tag{40}$$

where:

L_2: available transmission loss (see Annex 1, § 4).

The equation for gaseous specific attenuation, β_o (for oxygen) and β_v (for water vapour), is given in equations (13) and (14). The water vapour specific attenuation β_v is to be calculated for an assumed water vapour density of $\rho = 7.5$ g/m^3.

The maximum hydrometeor scatter distance, d_{m2}, is given by:

$$d_{m2} = \sqrt{17\,000\,(h_{FR} + 3)} \qquad \text{km} \tag{41}$$

The following formulae should then be evaluated to give the basis for the iterative procedure:

$$h_{cv} = \frac{(d_r - 40)^2}{17\,000} \qquad \text{km} \tag{42}$$

$$H = \begin{cases} 6.5(h_{cv} - h_{FR}) & \text{dB} \quad \text{for } h_{cv} > h_{FR} \\ 0 & \text{dB} \quad \text{for } h_{cv} \leq h_{FR} \end{cases} \tag{43}$$

$$10 \log A_b = \begin{cases} 0.005\,(f - 10)^{1.7}\, R^{0.4} & \text{dB} \quad \text{for} \begin{Bmatrix} 10 \text{ GHz} < f \leq 60 \text{ GHz} \\ \text{and } h_{cv} < h_{FR} \end{Bmatrix} \\ 0 & \text{dB} \quad \text{for} \begin{Bmatrix} f \leq 10 \text{ GHz} \\ \text{or } h_{cv} \geq h_{FR} \end{Bmatrix} \end{cases} \tag{44}$$

$$d_o = \begin{cases} 0.7\, d_r + 32 & \text{km} \quad \text{for } d_r < 340 \text{ km} \\ 270 & \text{km} \quad \text{for } d_r \geq 340 \text{ km} \end{cases} \tag{45}$$

$$d_v = \begin{cases} 0.7\, d_r + 32 & \text{km} \quad \text{for } d_r < 240 \text{ km} \\ 200 & \text{km} \quad \text{for } d_r \geq 240 \text{ km} \end{cases} \tag{46}$$

$$Y = x + 20 \log d_r + 10 \log A_b + H + \beta_o\, d_o + \beta_v\, d_v \qquad \text{dB} \tag{47}$$

The required value of d_r is that which gives $Y = 0$.

TABLE 6

Values of *k* and α as a function of the frequency

Frequency (GHz)	*k*	α
1	0.000 0352	0.880
2	0.000 138	0.923
4	0.000 591	1.075
6	0.001 55	1.265
7	0.002 65	1.312
8	0.003 95	1.31
10	0.008 87	1.264
12	0.016 8	1.20
14	0.029	1.15
18	0.055	1.09
20	0.069 1	1.065
22.4	0.090	1.05
25	0.113	1.03
28	0.150	1.01
30	0.167	1.00
35	0.233	0.963
40	0.310	0.929
45	0.393	0.897
50	0.479	0.868
60	0.642	0.824

Note 1 – Y is a monotonically increasing function of d_r. It is therefore possible to use a simple method of iteration, e.g. bisection.

In summary, the value of d_r may be found as follows:

Calculate Y for $d_r = 100$ km, $Y(100 \text{ km})$

If $Y(100 \text{ km}) \geq 0$ then use $d_r = 100$ km for coordination

Or else, calculate Y for $d_r = d_{m2}$, $Y(d_{m2})$

If $Y(d_{m2}) \leq 0$ then use $d_r = d_{m2}$ for coordination

If neither of these values of d_r can be used for coordination then find the appropriate value of d_r using equations (42) to (47) in an iterative process. Initial boundary values are $d_r = 100$ km and $d_r = d_{m2}$.

The rain-scatter coordination contour is determined as a circle having as radius the smaller of the two distances d_r and d_{m2}, designated Min[d_r, d_{m2}], and centred on a point which is offset from the earth station along the main beam azimuth to the satellite by the distance Δd (km) to be obtained from:

$$\Delta d = \frac{\left(\text{Min}\,[d_r, d_{m2}] - 40\right)^2 \cot \varepsilon_s}{17\,000} \qquad \text{km}^* \qquad (48)$$

where ε_s is the elevation angle to the satellite (degrees).

The distance from the earth station to this circle or 100 km, also measured from the earth station, whichever is the greater, is the rain-scatter coordination distance d_2.

For an earth station operating with a geostationary satellite having a slightly inclined orbit, the rain-scatter coordination contour for each of the satellite's two most inclined orbit positions should be determined individually, using the relevant elevation angles and their associated azimuths to the satellite. The rain scatter area is then the total area contained within the two resulting overlapping coordination contours.

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* Where, exceptionally, operating elevation angles to a satellite are smaller than 3°, Δd should be determined from:

$$\Delta d = \text{Min}\,[d_r - 40, (d_r - 40)^2 \cot \varepsilon_s / 17\,000].$$

For an earth station intended to operate with satellites at various orbit locations, the rain-scatter coordination contours for the easternmost and for the westernmost orbit location should be determined individually. The rain-scatter area is then the total area contained within the two resulting overlapping coordination contours.

APPENDIX 3

TO ANNEX 1

Classification of rain climates

As shown in Figs. 4, 5 and 6, the world has been divided into a number of rain climatic zones which show different precipitation characteristics. The curves shown in Fig. 7 represent consolidated rain-rate distributions, each applicable to several of the rain climates of Figs. 4 to 6. The distribution of Fig. 7 should be extended beyond 0.3% to such greater percentages of the time p_c at which the rainfall rate is assumed to approach zero, using the expression:

$$R(p) = R(0.3\%)\left[\frac{\log(p_c / p)}{\log(p_c / 0.3)}\right]^2 \quad \text{mm/h} \qquad (49)$$

and using, for $R(0.3\%)$ and p_c, the following values:

Rain climatic zone	$R(0.3\%)$ (mm/h)	p_c (%)
A, B	1.5	2
C, D, E	3.5	3
F, G, H, J, K	7.0	5
L, M	9.0	7.5
N, P, Q	25.0	10

This approach is appropriate for the numerical evaluation of the rain-scatter distance.

The rain-rate distributions of Fig. 7 are approximated numerically by the following expressions:

Climates A, B

$$R = 1.1\,p^{-0.465} + 0.25\left[\log(p / 0.001)\log^3(0.3 / p)\right] - \left[\,\left|\log(p / 0.1)\right| + 1.1\right]^{-2} \quad \text{mm/h} \qquad (50)$$

Climates C, D, E

$$R = 2\,p^{-0.466} + 0.5\left[\log(p / 0.001)\log^3(0.3 / p)\right] \quad \text{mm/h} \qquad (51)$$

Climates F, G, H, J, K

$$R = 4.17\,p^{-0.418} + 1.6\left[\log(p / 0.001)\log^3(0.3 / p)\right] \quad \text{mm/h} \qquad (52)$$

Climates L, M

$$R = 4.9\,p^{-0.48} + 6.5\left[\log(p / 0.001)\log^2(0.3 / p)\right] \quad \text{mm/h} \qquad (53)$$

Climates N, P, Q

$$R = 15.6\left(p^{-0.383} + \left[\log(p / 0.001)\log^{1.5}(0.3 / p)\right]\right) \quad \text{mm/h} \qquad (54)$$

for the range $0.001 \le p \le 0.3\%$.

FIGURE 4

Rain climatic zones (see Table 7)

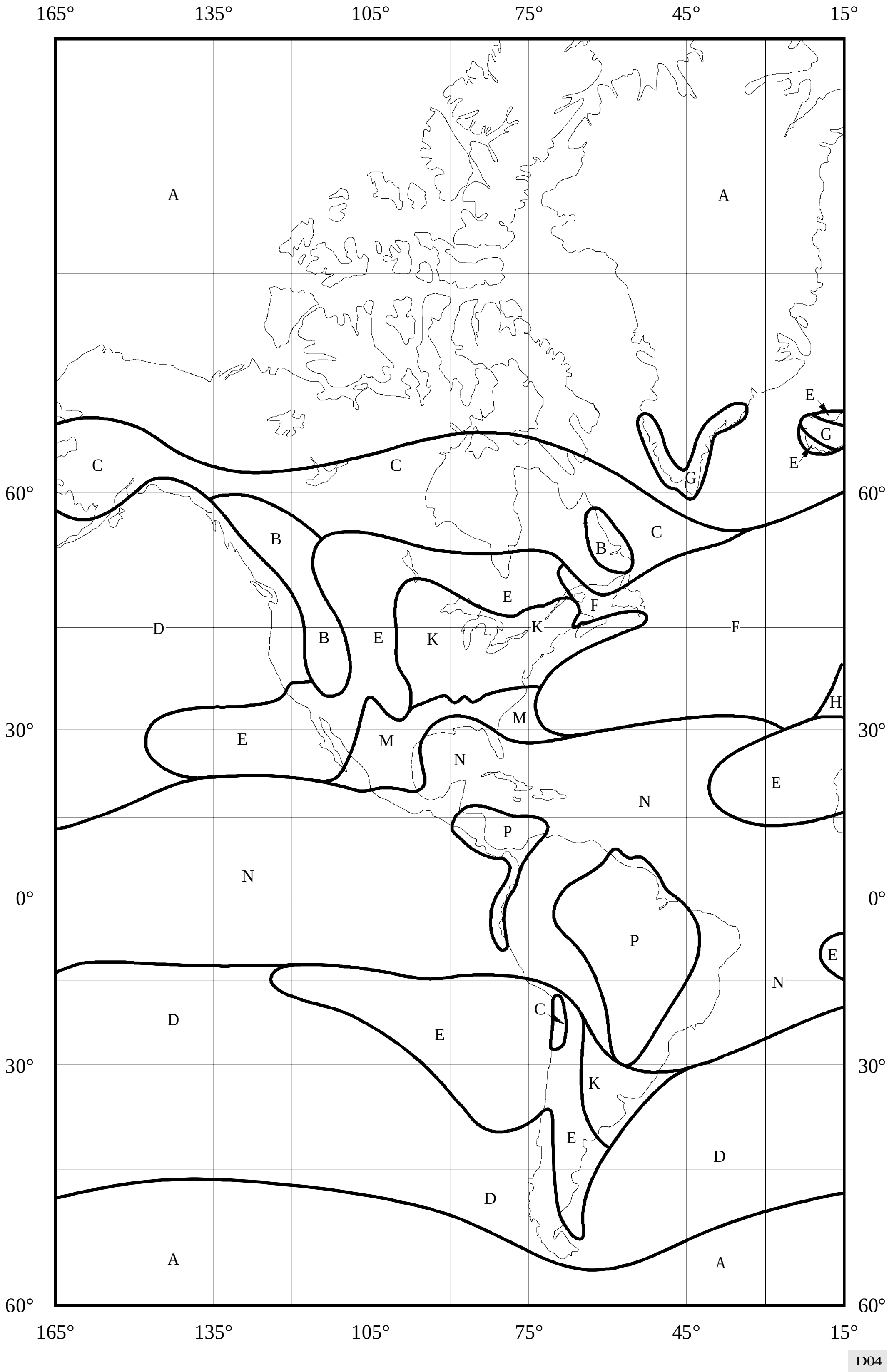


FIGURE 5

Rain climatic zones (see Table 7)

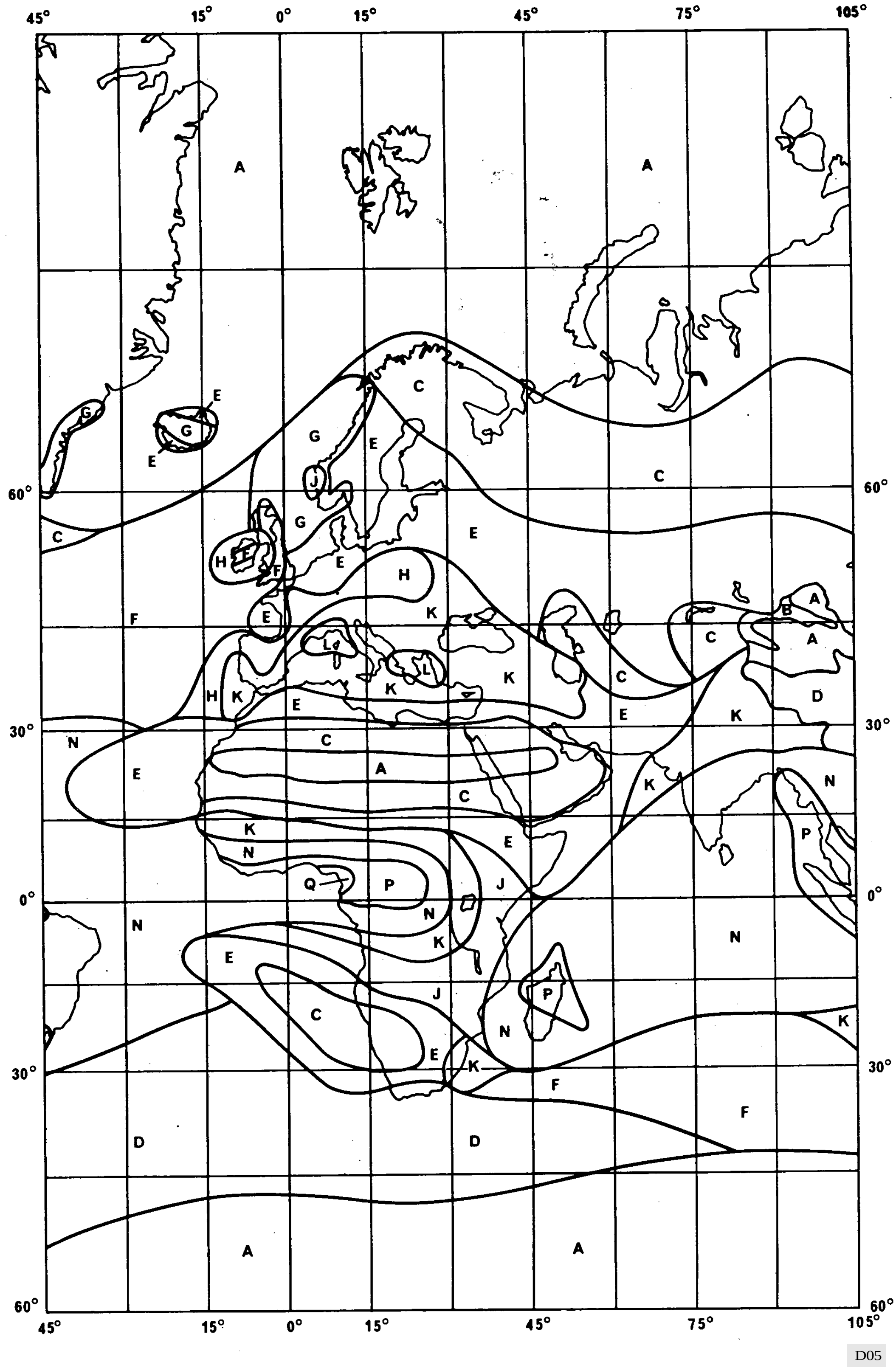


FIGURE 6

Rain climatic zones (see Table 7)

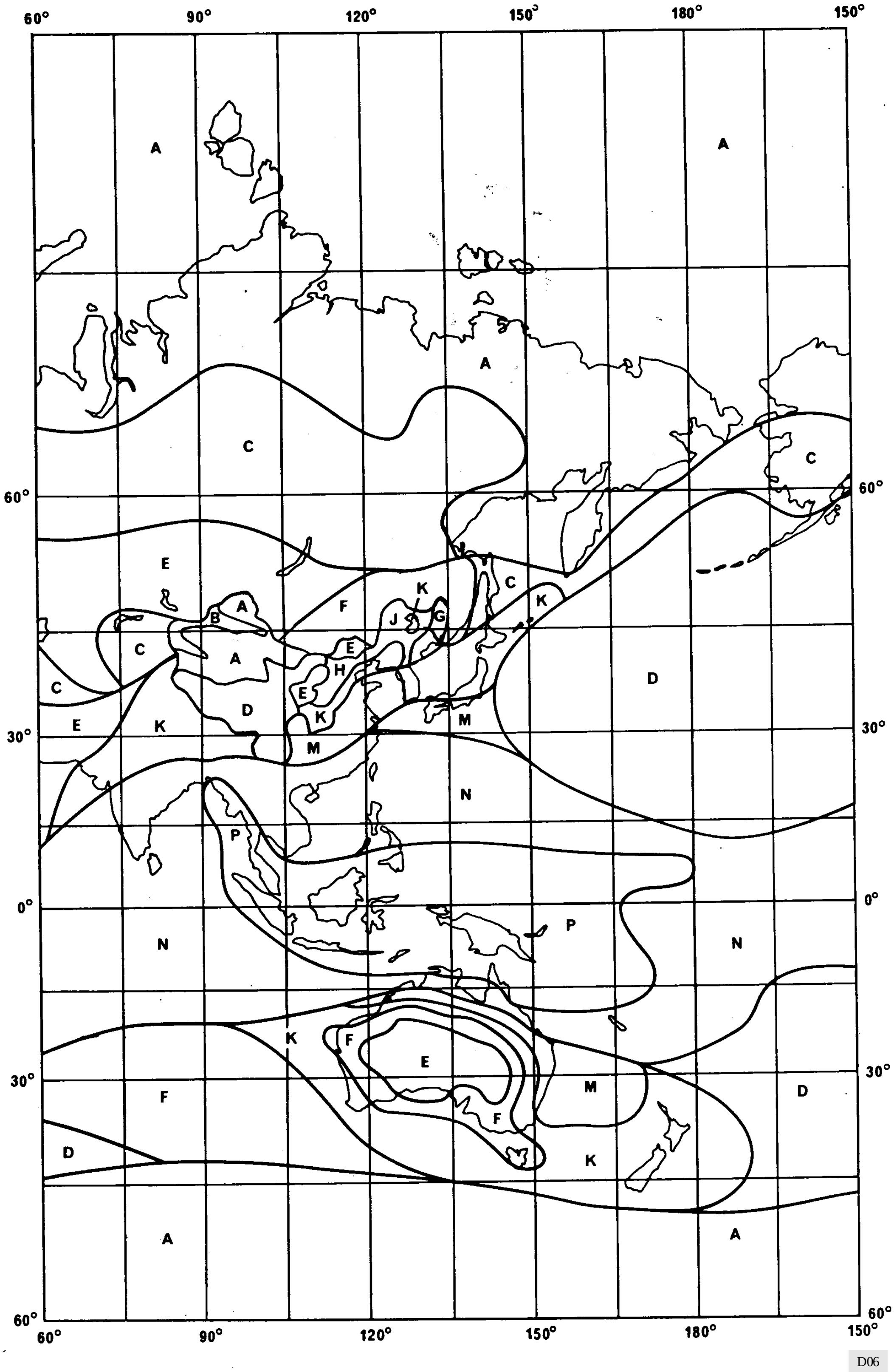


TABLE 7

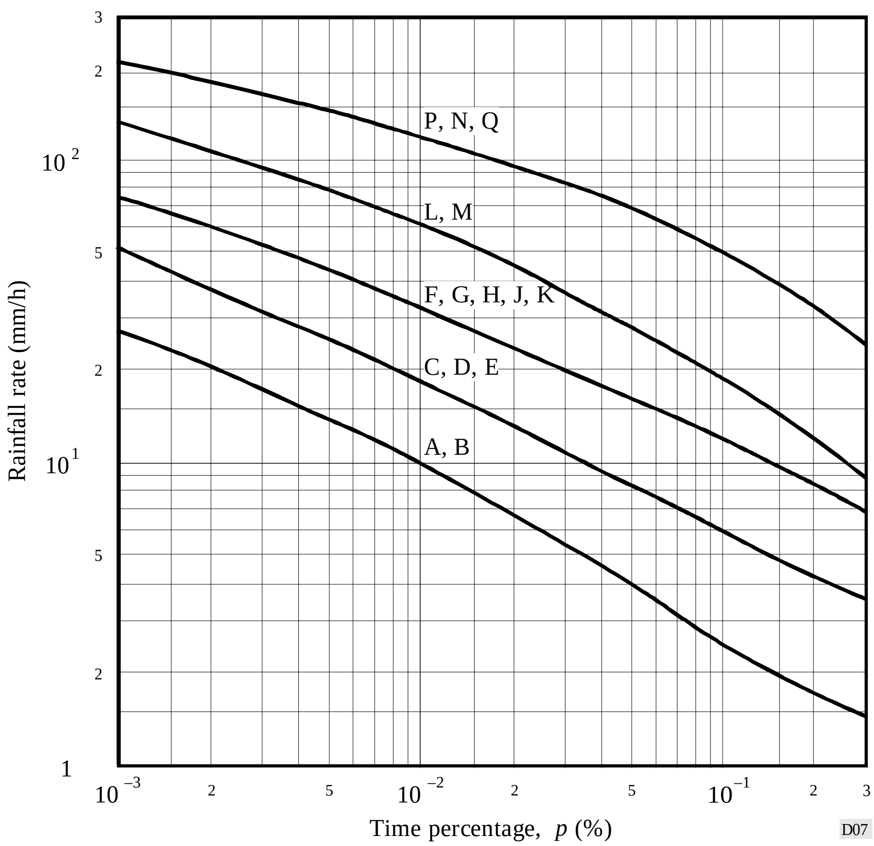
Rain climatic zones

Rainfall intensity exceeded (mm/h) (Reference to Figs. 4 to 6)

Percentage of time (%)	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
1.0	< 0.1	0.5	0.7	2.1	0.6	1.7	3	2	8	1.5	2	4	5	12	24
0.3	0.5	2.0	2.8	4.5	2.4	4.5	7	4	13	4.2	7	11	15	34	49
0.1	2	3	5	8	6	8	12	10	20	13	15	22	35	65	72
0.03	5	6	9	13	12	15	20	18	23	23	33	40	65	105	96
0.01	8	12	15	19	23	28	30	32	35	42	60	63	95	145	115
0.003	14	21	26	29	41	54	45	55	45	70	105	95	140	200	142
0.001	22	32	42	42	70	78	65	83	55	100	150	120	180	250	170

FIGURE 7

Consolidated cumulative distributions of rainfall rate for the rain climatic zones of Figs. 4 to 6



RECOMMENDATION ITU-R IS.848-1*

DETERMINATION OF THE COORDINATION AREA OF A TRANSMITTING EARTH STATION USING THE SAME FREQUENCY BAND AS RECEIVING EARTH STATIONS IN BIDIRECTIONALLY ALLOCATED FREQUENCY BANDS

(Questions ITU-R 3/12, ITU-R 4/12, ITU-R 5/12 and ITU-R 6/12)

(1992-1993)

The ITU Radiocommunication Assembly,

considering

a) that some frequency bands are allocated to space services in both the Earth-to-space and the space-to-Earth direction of transmission;

b) that, therefore, there is a possibility of interference from a transmitting earth station to a receiving earth station;

c) that such potential interference may be alleviated or avoided through the coordination of the two types of earth station;

d) that it is desirable to limit the number of coordinations that may have to be undertaken;

e) that it is possible to define an area around a transmitting earth station outside of which a receiving earth station would be subject to only negligible interference;

f) that the general methodology of Recommendation ITU-R IS.847 lends itself to the determination of such an area which would be known as the bidirectional coordination area;

g) that, to apply the methodology of Recommendation ITU-R IS.847 to the determination of the bidirectional coordination area, certain elements in the Recommendation ITU-R IS.847 methodology would have to be changed,

recommends

1. that, in frequency bands allocated to space services in both the space-to-Earth and the Earth-to-space direction of transmission, a bidirectional coordination area be determined for each transmitting earth station;

2. that, for that purpose, the methodology of Recommendation ITU-R IS.847 be used except for the specific modifications to this methodology set forth in Annex 1.

Note 1 – The reliance of the determination of the bidirectional coordination area on the methodology of Recommendation ITU-R IS.847 suggests that revisions of this Recommendation or of Recommendation ITU-R IS.847 be undertaken concurrently so as to maintain compatibility between the Recommendations.

ANNEX 1

Determination of the bidirectional coordination area for a transmitting earth station operating with a geostationary space station

1. Introduction

The following describes a procedure for the determination of the bidirectional coordination area for an earth station transmitting in a frequency band allocated to space services in both the Earth-to-space and space-to-Earth direction, to be used for the purpose of establishing whether or not coordination between the transmitting and receiving earth stations is required.

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* Pending completion of appropriate studies, this Recommendation does not apply to the radiodetermination satellite and radionavigation-satellite services operating in the 1 610-1 626.5 MHz band.

The procedure applies to earth stations operating with geostationary satellites and uses the same basic concepts for determining the coordination area as that of Recommendation ITU-R IS.847. However, the method is different in a number of respects, and these differences are discussed in this Annex.

This Annex should be used in connection with Annex 1 to Recommendation ITU-R IS.847 which it modifies in certain areas.

2. Determination of the threshold interference level $P_r(p)$

The threshold interference level at a receiving earth station is calculated in the same way as set forth in Annex 1 to Recommendation ITU-R IS.847 except that the following earth station receiving system noise temperatures should be used:

Frequency range (GHz)	T_e (K)
1-10	75
10-17	150
> 17	300

This assumption is necessary because the receiving earth station takes the place of a receiving terrestrial station in Recommendation ITU-R IS.847; in both cases the location and precise characteristics of the station are unknown.

3. Determination of G_r for propagation mode (1)

Since not only the precise characteristics of the receiving earth station are unknown but also its precise location, use is made of the fact that the receiving earth station must be assumed to lie anywhere on the boundary of the bidirectional coordination area, and that this places it relatively close, in global geometric terms, to the transmitting earth station. Hence the simplifying assumptions are made that plane rather than spherical geometry between the two earth stations can be used, and that the receiving earth station site has the same latitude as the transmitting earth station around which the coordination area is to be determined.

As prescribed by equations (2) and (6) of Recommendation ITU-R IS.847, the horizon antenna gains of the transmitting and receiving antennas must be added for each azimuth on a common azimuth plot which is referred to the transmitting antenna. This allows the transmitting antenna gain to be directly plotted versus its azimuth, but a given azimuth at the transmitting antenna's locations is the opposite or "back" azimuth at the receiving antenna's location. Therefore to a value of G_t' found for each azimuth α at the transmitting earth station must be added a value of G_r which is found for the azimuth $\alpha' = (\alpha + 180°)$.

The determination of the antenna gain G_r of the receiving earth station which in this Annex takes the place of the receiving terrestrial station of Annex 1 to Recommendation ITU-R IS.847 recognizes that:

– the main beam is not directed towards the physical horizon but towards a satellite at some, perhaps a large, elevation angle;

– its direction is constrained by the possible locations of geostationary satellites.

Hence, to determine G_r, in the absence of any knowledge regarding the location of a receiving earth station, the procedure described in Appendix 1 to Annex 1 of Recommendation ITU-R IS.847 is used, noting that, in equation (6), $G_e = 42 + \Delta G$.

Since it is not known beforehand towards which orbit location a receiving earth-station antenna beam is directed, the horizon antenna gain must be determined for all geostationary-orbit locations. Also, since the horizon elevation is not known, 0° is used for all azimuths. Finally, the assumption that the latitude of the receiving earth station is the same as that of the transmitting earth station for which the coordination area is being determined, is a simplifying assumption which introduces generally negligible errors which, in any case, will not exceed 2 dB.

Thus the procedure given in Case 2 in Appendix 1 to Annex 1 of Recommendation ITU-R IS.847 for calculating the antenna gain in the direction of the earth-station horizon has to be carried out for each counter-azimuth α':

– for all orbital locations having elevation angles greater than 3°, using the latitude of the transmitting earth station as an approximation for the receiving earth station latitude;

– with a 0° horizon elevation angle.

Figure 1 shows an example set of curves of the minimum angular distance between points on the geostationary-satellite orbit and the horizontal plane as functions of azimuth (α) and counter-azimuth (α') with the station latitude (ζ) as a parameter. Using the earth-station antenna reference pattern of Appendix 1 to Annex 1 of Recommendation ITU-R IS.847, a plot of horizon antenna gain as a function of (α) and (α') can then be constructed. Figure 2 gives an example of such a plot.

The assumption of 0° horizon elevation angle is conservative since the increase in antenna gain due to a raised horizon would, in practice, be more than offset by any real site shielding which, for the receiving antenna site, must be assumed to be zero. It should be noted that while no site shielding can be assumed for the receiving earth station, any site shielding that may exist at the transmitting earth station is considered in the normal fashion.

An example of how the antenna gains $G_{t'}$ and G_r are to be added on a common azimuth plot is given below:

$$\alpha = 192°$$
$$\alpha + 180° = 372° \; (= 360° + 12°)$$
$$\alpha' = 12°$$

One obtains $G_{t'} + G_r$ from:

$$G_{t'} + G_r = G_{t'}(\alpha) + G_r(\alpha') \quad \text{dB} \tag{1}$$

for each azimuth α at a transmitting earth station to be used in equations (2) and (6) of Recommendation ITU-R IS.847. When determining G_r (α') using equation (33) of Recommendation ITU-R IS.847 and the equations following it, G_{max} shall be taken to be 42 dBi. (Based on information from the ITU, this is the 1σ (one standard deviation) antenna gain of a large statistical sample of notified earth station antennas, the average main beam gain of which was found to be 50 dBi.)

Figure 3 gives a more elaborate example of a coordination area determined by this method. Figure 4 shows the sum of the antenna gains $G_{t'} + G_r$ for the example of Fig. 3 on a transmitting earth station's azimuth plot.

FIGURE 1

Illustration of minimum angular distance between points on the geostationary-satellite orbit (GSO) and the horizontal plane

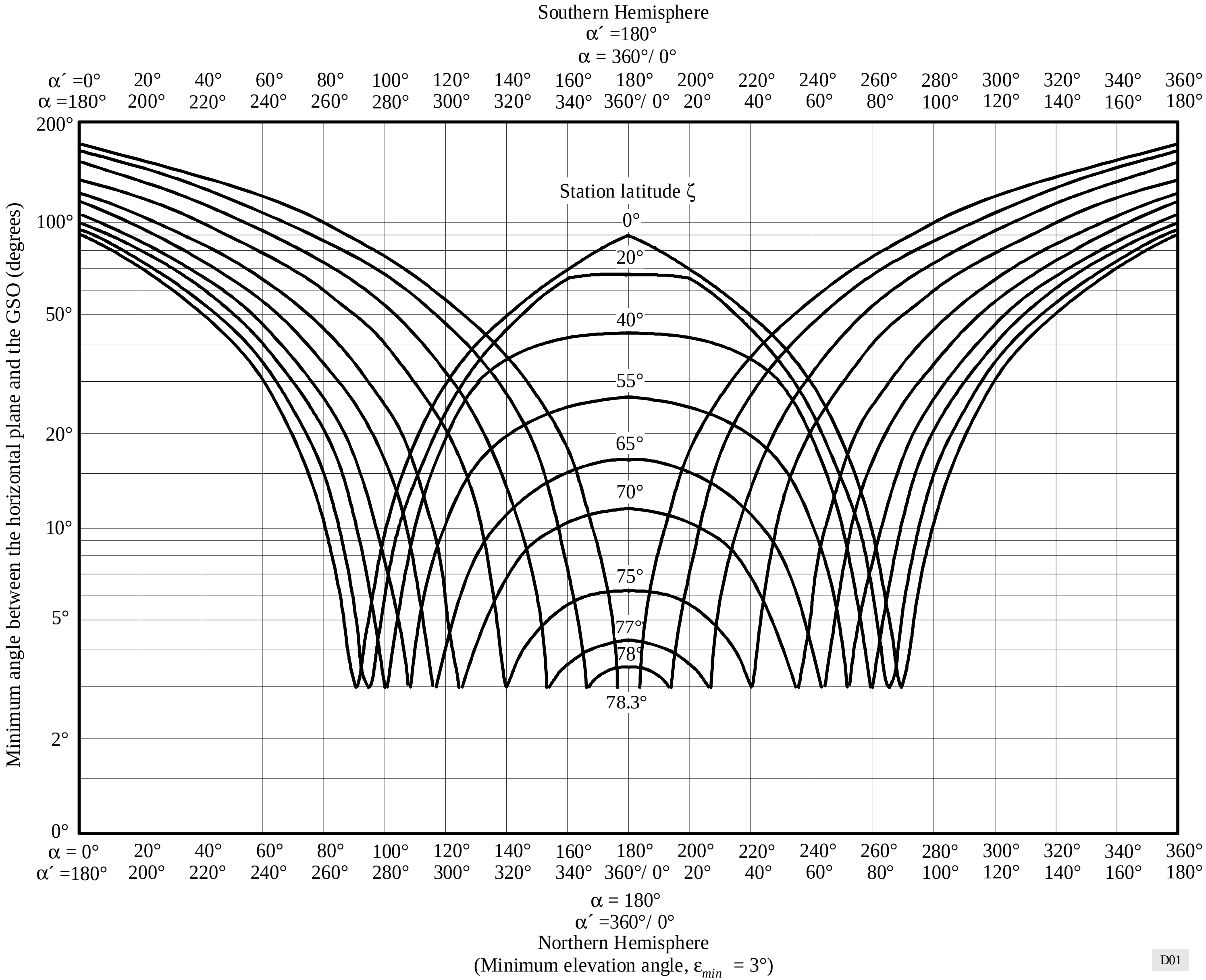
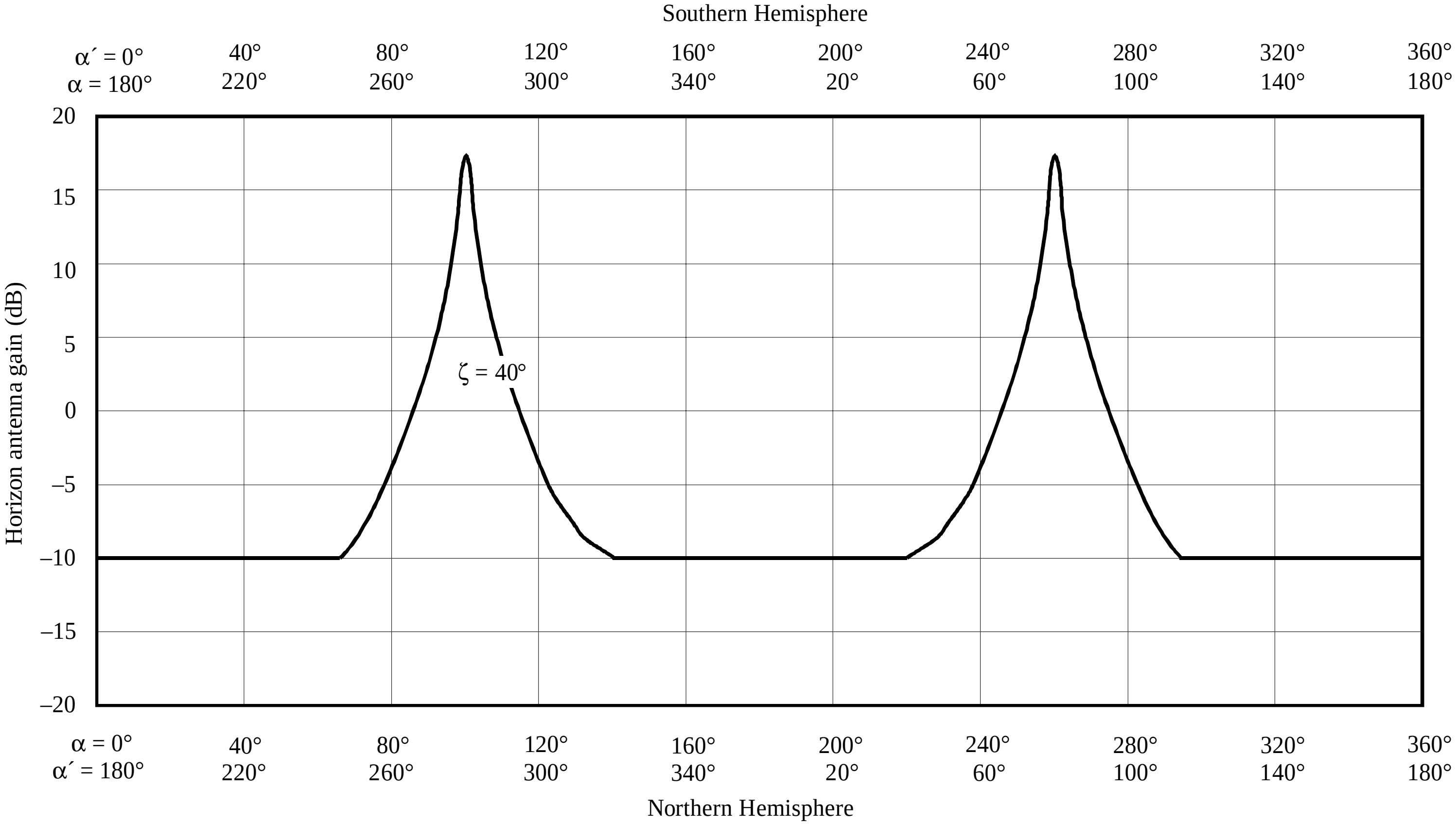


FIGURE 2

Example of full-arc horizon antenna gain for 0° horizon elevation angle at 40° latitude



(Minimum main beam elevation angle = 3°)

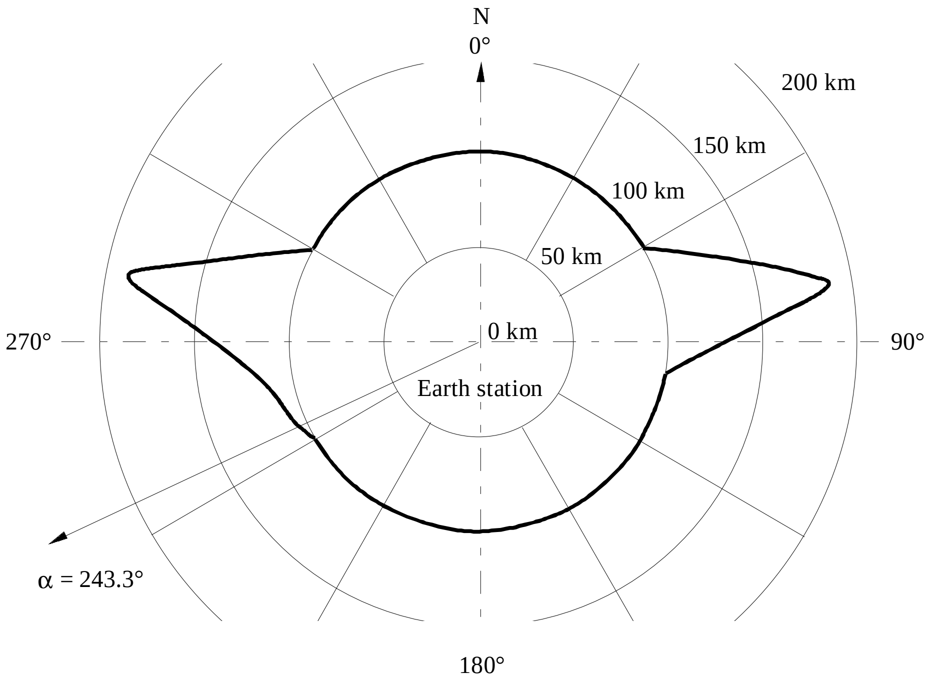
Assumed earth station reference radiation diagram $G(\theta) = 29 - 25 \log \theta$ (dB)

$\alpha' = (\alpha + 180°)$ modulo (360°)

D02

FIGURE 3

Example of a bidirectional great-circle coordination area



Assumptions for the transmitting earth station:

f = 17 GHz
$P_{t'}$ = 40 dB(W/MHz)
ζ = 40° N
Elevation angle to satellite = 20°
Azimuth to satellite = 243.3°
Radio climatic zone = A2
Horizon elevation angle = 0°

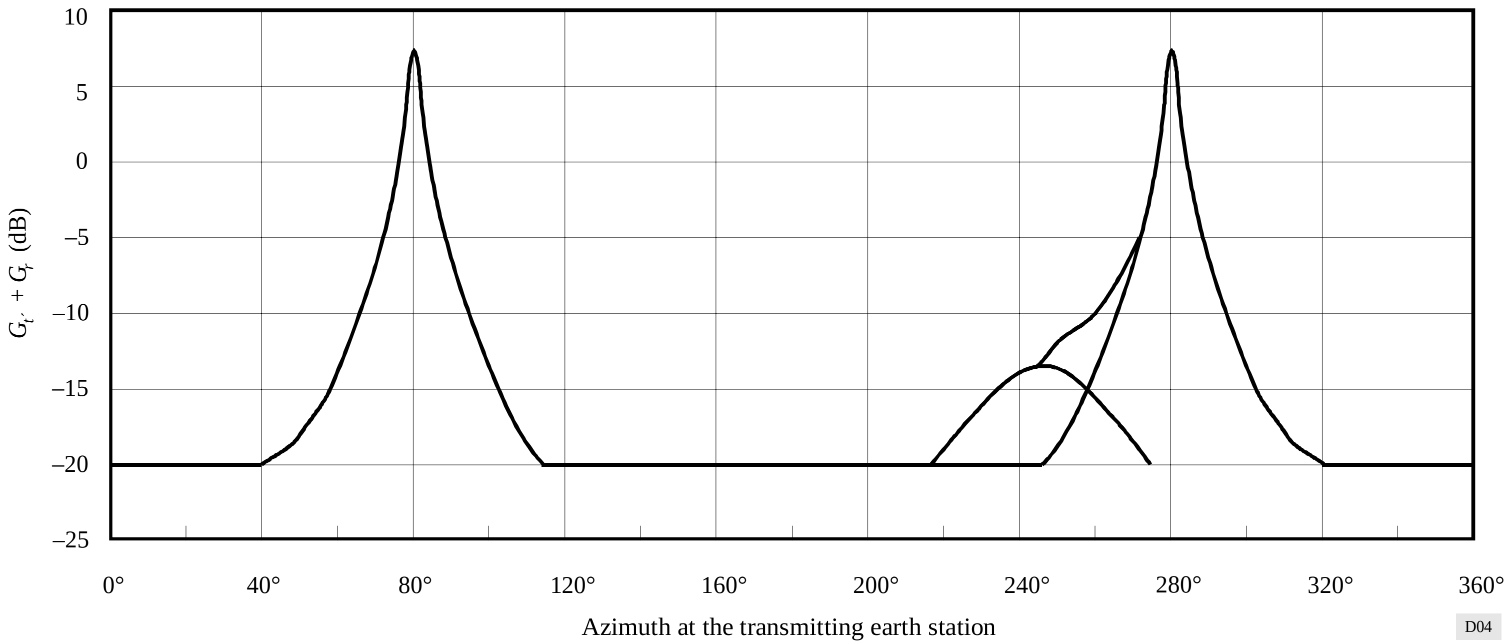
Calculation result:

$P_r\ (p)$	= –141.1 dB(W/MHz)	Equation (3) of Recommendation ITU-R IS.847
p	= 0.003%	Table 2 of Recommendation ITU-R IS.847
L_1	= 38.7 = $G_{t'} + G_r$	Equations (6) and (7) of Recommendation ITU-R IS.847
$G_{t'} + G_r$	= see Fig. 4	For $G_e = 42 + \Delta G$ of equation (6) of Recommendation ITU-R IS.847
β_{dz}	= 0.19102 dB/km	Equation (12) of Recommendation ITU-R IS.847
β_o	= 0.00903 dB/km	Equation (13) of Recommendation ITU-R IS.847
β_{vz}	= 0.03631 dB/km	Equation (14) of Recommendation ITU-R IS.847
d_1	= L_1/0.24636	From equation (10) of Recommendation ITU-R IS.847

D03

FIGURE 4

Composite horizon antenna gain $G_{t'} + G_r$ for the example of Fig. 3



4. Determination of the bidirectional rain scatter area

The bidirectional rain scatter area for a transmitting earth station is determined as follows:

Step 1: Determine the elevation angle ε_s and the azimuth α_s to the satellite with which the earth station is to operate. For an earth station operating with an inclined-orbit satellite, use the lowest expected operational antenna elevation angle and the associated azimuth.

Step 2: Determine the "beam intersection distance" d_s (km) from the earth station to the point at which the beam axis attains the 0° isotherm altitude h_{FR} from:

$$d_s = 8\,500 \left(\sqrt{\tan^2 \varepsilon_s + h_{FR} / 4\,250} - \tan \varepsilon_s \right) \quad \text{km} \tag{2}$$

$$h_{FR} = \begin{cases} 5 - 0.075(\zeta - 23) & \text{km} \quad \text{for} \quad \zeta > 23° \\ 5 & \text{km} \quad \text{for} \quad 0° \le \zeta \le 23° \end{cases} \text{Northern Hemisphere}$$

$$h_{FR} = \begin{cases} 5 & \text{km} \quad \text{for} \quad 0° \ge \zeta \ge -21° \\ 5 + 0.1(\zeta + 21) & \text{km} \quad \text{for} \quad -71° < \zeta \le -21° \\ 0 & \text{km} \quad \text{for} \quad \zeta \le -71° \end{cases} \text{Southern Hemisphere} \tag{3}$$

Step 3: Mark the distance d_s on the azimuth α_s from the earth station location, on a map of appropriate scale. This point is the geographic location of the beam intersection point and is the reference point around which the bidirectional rain scatter contour is constructed.

Step 4: Determine the maximum visibility distance d_{max} for the beam intersection point from:

$$d_{max} = 130.4 \sqrt{h_{FR}} \text{ km or 100 km} \tag{4}$$

whichever is the greater,

and the reference azimuth α_r from:

$$\alpha_r = \cos^{-1} (0.2069 \tan \zeta) \tag{5}$$

where ζ is the latitude of the beam intersection point (also assumed to be equal to that of the transmitting earth station).

For North latitudes above 78.3° and for South latitudes below –71°, the rain scatter contour is a circle of radius 100 km (d_{max} = 100 km).

Step 5: From the beam intersection point, mark on the map the distance d_{max} in the two azimuths α_r and 360° – α_r.

Step 6: Draw on the map from both of the two maximum distance marks of Step 5 equal distance arcs of width 3° clockwise and counter-clockwise with the location of the beam penetration point as centre. These two arcs, each having a total width of 6°, are the first boundary elements of the bidirectional rain scatter area.

Step 7: Mark a circle of 100 km radius around the earth station location and draw straight lines from the northern edges of the two arc segments tangential to the northern rim of the 100 km radius circle, and from the southern edges of the two arc segments tangential to the southern rim of the 100 km radius circle.

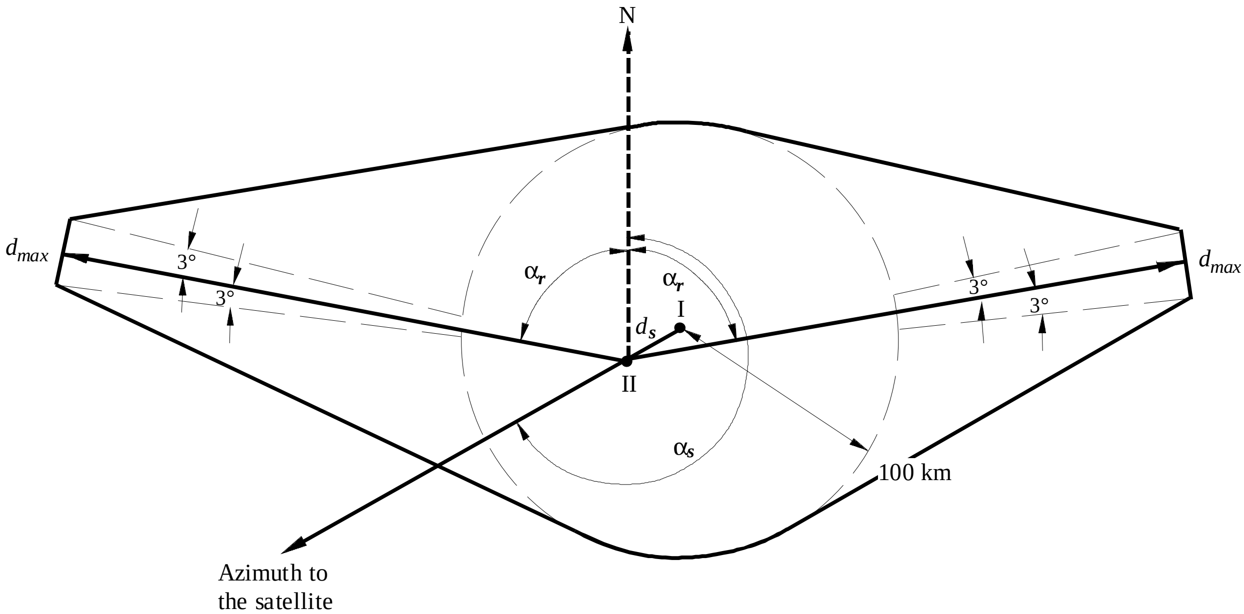
The area bounded by the two 6° wide arcs, the four straight lines, and the 100 km radius circle sections (of which there is always at least one) between the two northern and the two southern tangent points with the straight lines, constitutes the bidirectional rain scatter area.

Figure 5 illustrates the construction of the bidirectional rain scatter area. (The resulting rain scatter area contains the loci of all receiving earth station locations for which directions towards the geostationary-satellite orbit intersect the beam axis of the transmitting earth station antenna. The boundaries of the area are established by stipulating a minimum beam intersection avoidance angle of 3°.)

FIGURE 5

Example of the bidirectional rain scatter area

(Not to scale)



I: location of the transmitting earth station

II: point where the earth station antenna beam axis penetrates the altitude h_{FR}

Assumptions:

ζ = 40° N

ε_s = 8°

α_s = 253.6

Results:

d_s = 26.2 km from equation (2)

h_{FR} = 3.725 km from equation (3)

d_{max} = 251.7 km from equation (4)

α_r = 80.0° from equation (5)

D05

RECOMMENDATION ITU-R IS.849-1

DETERMINATION OF THE COORDINATION AREA FOR EARTH STATIONS OPERATING WITH NON-GEOSTATIONARY SPACECRAFT IN BANDS SHARED WITH TERRESTRIAL SERVICES*

(Questions ITU-R 3/12, ITU-R 4/12, ITU-R 5/12 and ITU-R 6/12)

(1992-1993)

The ITU Radiocommunication Assembly,

considering

a) that in certain space systems using non-geostationary space stations, the gain of earth station antennas towards the horizon may vary substantially over time in a consistent and predictable manner;

b) that in cases where earth station antenna gain towards the horizon varies significantly over time, the occurrences of relatively high gain towards the horizon and relatively low basic transmission loss in the same azimuth can be treated as independent statistical events that will occur simultaneously for only small percentages of time;

c) that the limits on the minimum elevation angle of an antenna main beam and the maximum equivalent isotropically radiated power (e.i.r.p.) towards the horizon prescribed for earth stations in Article 28 of the Radio Regulations (RR) help limit the maximum extent of coordination distances;

d) that the method of Recommendation ITU-R IS.847 for determining coordination distances assumes a constant earth station antenna gain towards the horizon,

recommends

1. that earth stations using antennas that track non-geostationary space stations be operated with the highest practical values of minimum antenna elevation angles consistent with operational requirements and the elevation angle and e.i.r.p. limits specified in RR Article 28;

2. that coordination areas for earth stations operating with non-geostationary space stations be determined using one of the following methods, whichever results in the smaller coordination distance (Note 1). These methods should be applied using the receiving earth station parameters specified in Table 1, where appropriate, in place of those specified in Table 2 of Annex 1 to Recommendation ITU-R IS.847 (Note 2);

2.1 Statistical methods

The 3% method – Where the statistics of horizon antenna gain can be determined in accordance with Annex 1, the value of horizon antenna gain (i.e. $G_{t'}$ or G_r as appropriate) exceeded for 3% of the time, as determined for each azimuth by the method in Annex 1, should be used in conjunction with the method of Annex 1 to Recommendation ITU-R IS.847 for propagation Mode 1 distances.

The composite method – When a potentially affected terrestrial station of another administration is identified within the coordination area that has been determined in accordance with the 3% method, upon agreement between administrations this coordination contour may be replaced by the coordination contour determined in accordance with the composite method of Annex 2. The composite method accounts for the joint statistics of propagation loss and antenna gain by convolving their probability density functions (Note 3).

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* The procedure described in this Recommendation applies to situations where the coordination area is to be determined from specified threshold levels of interference power. For cases where the coordination distances are predetermined refer to Recommendation ITU-R IS.850. Recommendation ITU-R IS.850 should, in any case, be consulted prior to application of this Recommendation.

2.2 Time-invariant gain (TIG) method

Where the statistics of horizon antenna gain cannot be reliably determined, the values of horizon antenna gain defined below for each azimuth should be used with the method of Annex 1 to Recommendation ITU-R IS.847 for propagation Mode 1 distances (Note 4):

$$G_e = G_{max} \quad \text{for} \quad (G_{max} - G_{min}) \leq 20 \text{ dB}$$

$$G_e = G_{min} + 20 \quad \text{for } 20 \text{ dB} < (G_{max} - G_{min}) < 30 \text{ dB}$$

$$G_e = G_{max} - 10 \quad \text{for} \quad (G_{max} - G_{min}) \geq 30 \text{ dB}$$

where:

G_e : horizon antenna gain of the earth station (dBi) for a particular azimuth for use as $G_{t'}$ or G_r in equation (2) of Annex 1 to Recommendation ITU-R IS.847

G_{max}, G_{min} : maximum and minimum values of horizon antenna gain (dBi), respectively, on the azimuth under consideration;

3. that in the event an earth station is intended to operate at times with satellites in geostationary orbit and at other times with non-geostationary satellites, the coordination distance for each azimuth is the greater of the coordination distances determined for each type of operation in accordance with all applicable provisions of this Recommendation and Recommendation ITU-R IS.847 (Note 5);

4. that published coordination contours for earth stations that operate with non-geostationary space stations be supplemented with the following data:

– an indication of which of the methods in § 2 or 3 was used to determine the coordination area;

– a diagram or table furnishing for each azimuth the minimum operational elevation angles; and

– a list of antenna horizon gain values used in the calculation of coordination distances.

5. that the following Notes should be considered to be part of this Recommendation:

Note 1 – Both the statistical and time-invariant gain (TIG) methods of § 2 have been found to provide coordination distances that are consistent with the purpose of coordination areas. In the practical cases considered in developing this Recommendation, the statistical method has been found to result generally in smaller coordination distances than the TIG method. Thus, the coordination distance will be the value determined by the statistical method unless the values determined by the TIG method are smaller for all azimuths, in which case the values from the TIG method should be used. Annex 3 provides example calculations of coordination distances using both methods.

Note 2 – Propagation Mode 2 (hydrometeor scatter) is not considered in § 2 because the probability of not exceeding the required level of transmission loss is greatly reduced by antenna motion in the case of earth-station antennas with relatively high gain or by the relatively high transmission losses associated with earth-station antennas having relatively low gain. In all cases, the propagation Mode 2 distances would be less than the propagation Mode 1 (great-circle) distances. However, the Mode 2 mechanism may produce significant interference at shorter separation distances than the Mode 1 coordination distance; thus, during coordination, it is necessary to consider the potential for interference via propagation Mode 2.

Note 3 – The composite method described in Annex 2 is a new procedure that administrations are encouraged to use. Tests of this procedure so far have indicated that it produces a coordination area that is sufficiently large, but smaller than that produced by either the statistical (3%) method or the TIG method in § 2.

Note 4 – The provisions of the TIG method allow some advantage to be taken of the time varying nature of the horizon antenna gain for earth stations using antennas that track non-geostationary space stations. However, no advantage can be applied reliably under this method for earth stations using low-gain antennas (i.e. antennas having a maximum gain less than about 23 dBi generally cannot produce 20 dB or greater differences between the minimum and maximum values of horizon antenna gain).

TABLE 1

Parameters for determination of coordination distance for receiving earth stations operating with non-geostationary space stations

Space radiocommunications service designations		Space research			Space operation		Earth exploration-satellite		Meteorological satellite		
		Near-Earth		Deep space							
		Unmanned	Manned								
Frequency bands (MHz) (1)		1 700-1 710 2 200-2 290		2 290-2 300	1 525-1 530	2 200-2 290	8 025-8 400		1 670-1 710 (14)		7 450-7 550
Modulation at earth station (2)		–	–	–	–	–	N	N	N	N	N
Earth station interference parameters and criteria	p_0 (%)	0.1	0.001	0.001	1.0	1.0	0.02	0.022	0.012	0.012	0.006
	n	2	1	1	1	2	2	2	2	2	2
	p (%)	0.05	0.001	0.001	1.0	0.5	0.01	0.011	0.006	0.006	0.003
	N_L (dB) (3)	–	–	–	–	–	–	–	–	–	1
	M_s (dB) (4)	–	–	–	–	–	–	–	–	–	24
	W (dB) (5)	–	–	–	0	0	0	0	0	0	0
Terrestrial station parameters	E (dBW) A	62 (6)	62 (6)	62 (6)	50	62 (7)	55	55	92 (7)	92 (7)	55
	E (dBW) N	–	–	–	37	–	42	42	–	–	–
	P_t (dBW) A	10 (6)	10 (6)	10 (6)	13	10 (7)	13	13	40 (7)	40 (7)	13
	P_t (dBW) N	–	–	–	0	–	0	0	–	–	–
	ΔG (dB)	10 (6)	10 (6)	10 (6)	–5	10 (7)	0	0	10 (7)	10 (7)	0
Reference bandwidth(8)	B (Hz)	1	1	1	10^3	10^3	100×10^6 (9)	40×10^6 (9)	5.33×10^6	1.334×10^6	10^6
Threshold interference level	$P_r(p)$ (dBW) in B	–216	–216	–222	–184	–184	–118 (10)	–126 (11)	–124 (12)	–144 (13)	–142

Notes to Table 1:

([1]) The allocated frequency bands are given in RR Article 8.

([2]) A: analogue modulation; N: digital modulation .

([3]) ([4]) ([5]) See Notes 2, 3 and 4 in § 2.3.1 of Annex 1 to Recommendation ITU-R IS.847.

([6]) In these bands, the parameters for the terrestrial stations associated with trans-horizon systems have been used.

For the space research service only, when trans-horizon systems are not considered, assuming that they are estimated for 1 Hz bandwidth and are 30 dB below the total power assumed for emission, the following values may be used:

E = 20 dB, P_t = –17 dBW, ΔG = –5 dB for analogue terrestrial stations

E = –23 dB, P_t = –60 dBW, ΔG = –5 dB for digital terrestrial stations.

([7]) In these bands, the parameters for the terrestrial stations associated with trans-horizon systems have been used. If an administration believes that trans-horizon systems do not need to be considered, the line-of-sight radio relay parameters associated with the frequency band (1 525-1 530) MHz may be used to determine the coordination area.

([8]) In certain systems it may be desirable to choose a reference bandwidth B that differs from the table entry when the system requirements indicate that this may be done. However, because the values of E and P_t should not be changed, a greater bandwidth will result in smaller coordination distances, and a later decision to reduce the reference bandwidth may require re-coordination of the earth station. It may also be desirable to decrease the value of the reference bandwidth; for example, for narrow-band transmissions the reference bandwidth B might be assumed to be equal to the narrower bandwidth occupied by the wanted transmissions.

([9]) In certain cases it is necessary to consider a smaller reference bandwidth B due to the characteristics of the systems. For these cases, the reference bandwidth B should be assumed to be equal to the real bandwidth occupied or 1 MHz, whichever is greater, and the threshold interference criteria would be adopted proportionally (for example, if $P_r(p)$ is –118 dBW in 100 MHz, then $P_r(p)$ can be taken as –138 dBW in 1 MHz).

([10]) This value applies for an earth station used for recorded data acquisition and with an antenna gain of 55.2 dBi (9 m diameter). For other antenna gains, the level of total permissible interference changes in direct proportion to the change in antenna gain.

([11]) This value applies for an earth station used for direct data readout and with an antenna gain of 36.4 dBi (1 m diameter). For other antenna gains, the level of total permissible interference changes in direct proportion to the change in antenna gain.

([12]) This value applies for an earth station with an antenna gain of 46.8 dBi (15.9 m diameter). For other antennas, in the range 39 dBi (6.5 m diameter) < σ < 46.8, $P_r(p) = \sigma - 170.8$ dBW.

([13]) This value applies for an earth station with an antenna gain of 29.8 dBi (2.2 m diameter). For antennas having other gain values of σ ($\sigma \leq 38$ dBi), the appropriate values of $P_r(p)$ are as follows:

$P_r(p) = -144$	dBW	for	$\sigma \leq 30$ dBi (2.3 m diameter)
$P_r(p) = 2(\sigma - 30) - 144$	dBW	for 30 dBi	$< \sigma \leq 34$ dBi (3.6 m diameter)
$P_r(p) = \sigma - 170$	dBW	for 34 dBi	$< \sigma < 38$ dBi (5.8 m diameter)

([14]) In the band 1 670-1 700 MHz, an additional contour for coordination with the meteorological aids service is required. See Table 2 of Recommendation ITU-R IS.850 for details of the calculation.

Note 5 – In cases where § 3 is applicable, propagation Mode 2 distances should be determined and applied for the geostationary-satellite operations as described in Recommendation ITU-R IS.847. In these cases, the coordination distance on any particular azimuth is the greater of the distances determined for geostationary-satellite operation (propagation Modes 1 and 2) and non-geostationary space station operation (propagation Mode 1 only).

ANNEX 1

Applicable statistics of horizon antenna gain

Cumulative distributions of horizon antenna gain are needed for each azimuth in order to determine:

– the horizon antenna gain exceeded for 3% of the time, and

– the probability densities of horizon antenna gain in cases where the coordination contour is to be calculated by the composite method.

These distributions are determined as indicated below. Space station flight simulation software, or other means, can be used to determine the statistics of earth station antenna pointing and, hence, the statistics of horizon antenna gain on particular azimuths. Reference or measured antenna radiation patterns may be used as described in Appendix 1 to Annex 1 of Recommendation ITU-R IS.847. Consistent with the purpose of this Recommendation, it is essential that the applied statistics of horizon antenna gain do not underestimate the actual statistical values.

In the case where the earth station is receiving, the applicable interference threshold $P_r(p)$ is specified with respect to the percentage of time during reception. Thus, the horizon antenna gain statistics are to be specified with respect to the total time that the receiver is in operation rather than the total elapsed time. The statistics pertain to all anticipated earth station operation for reception except that involving geostationary satellites. Thus, in considering earth station operations with space stations in various orbits or trajectories, the percentage of time during which a given horizon antenna gain is exceeded is the maximum of the percentages of time that the gain level is exceeded when operating with each space station. Because the temporal probabilities are normalized by total time of reception for each type of operation, there is some tolerance for overlooking certain earth station operations that may lead to higher values of horizon antenna gain exceeded for a given percentage of time. These omissions generally lead to at most a small underestimation of horizon antenna gain exceeded for 3% of the time (e.g. 1 dB error) and consequently the coordination contour remains reliable. Furthermore, in cases where a coordination contour is being calculated by the composite method, the effective error in the resulting coordination distance will be reduced by virtue of the convolution process (which applies conservatively low values of basic transmission loss).

In the case of a transmitting earth station, the antenna gain statistics are specified with respect to total elapsed time regardless of whether the earth station is being operated over all the elapsed time. This is necessary for consistency with the interference thresholds specified for terrestrial services.

Thus, it is essential that all envisaged earth station operations corresponding with the busiest foreseen operating schedule be carefully considered in a manner that yields worst-month statistics for horizon antenna gain. (Worst-month statistics of horizon antenna gain are the statistics associated with the 30 contiguous days of earth station operation that yield the highest level of horizon antenna gain exceeded for 3% of the time. In many cases, the most intensive possible earth station operational schedule and the types of associated space station orbits/trajectories can be defined to serve as a basis for calculating the worst-month statistics.)

ANNEX 2

Coordination area for earth stations with tracking antennas
Determination by the composite method

1. Introduction

This Annex modifies the methodology of Annex 1 to Recommendation ITU-R IS.847 in order to obtain coordination distances that are consistent with the relatively low horizon antenna gain levels that occur for large percentages of the time in certain earth stations that operate with non-geostationary space stations.

Under the composite method, the coordination contour is determined using calculations that precisely apply the temporal statistics associated with the basic transmission loss and the horizon antenna gain of an earth station. Consequently, the distances determined with this approach are smaller than the coordination distances determined by the statistical (3%) method, which necessarily makes conservative assumptions for the purposes of simplification. In cases where horizon antenna gain statistics are predictable with high confidence, the coordination contour determined by means of the composite method will assure that no terrestrial stations located outside it will cause or suffer unacceptable interference with respect to the earth station.

The composite method requires use of relatively complex calculations which should only be applied by agreement with affected administrations. All terminology and parameter symbols used herein are defined in Recommendation ITU-R IS.847 except where definitions are included in this Annex.

The coordination contour determined by the composite method uses an alternative form of equation (2) of Recommendation ITU-R IS.847, which involves an iterative calculation that converges to the coordination distance. The equation upon which the iterations are based is expressed as:

$$I(p) = P_{t'} + G_{terr} + [G_{es} - L_b(d')](p) \tag{1a}$$

$$e = P_r(p) - I(p) \tag{1b}$$

$$d_{m1} = d', \text{ when } 0 < e < 0.5 \text{ dB} \tag{1c}$$

where:

$I(p)$: interference power level (dBW) in the reference bandwidth predicted to occur for no more than p% of the time at the receiver antenna port

$P_{t'}$: transmitter power (dBW) in the reference bandwidth at the input to the antenna of the potentially interfering station (see more complete definition in Recommendation ITU-R IS.847)

G_{terr} : antenna gain (dBi) of the terrestrial station

G_{es} : antenna gain (dBi) of the earth station towards the physical horizon (i.e., the horizon antenna gain)

$L_b(d')$: basic transmission loss (dB) on a path of length d'

d' : estimated coordination distance (km)

e : amount (dB) by which the coordination threshold level of interfering signal power exceeds the level of interfering signal power predicted to occur at the estimated coordination distance

$P_r(p)$: coordination threshold level (dBW) of interfering signal power in the reference bandwidth

d_{m1} : coordination distance (km), which results from iterative application of equations (1a) and (1b).

2. Determination of values of the function $[G_{es} - L_b(d')](p)$

A value for the function $[G_{es} - L_b(d')](p)$ is determined from a cumulative distribution that is calculated from the convolution of the temporal probability densities of G_{es} and $L_b(d')$. These probability densities, in turn, are determined from the cumulative distributions of G_{es} and $L_b(d')$. The cumulative distribution of earth station antenna gain is determined in accordance with Annex 1.

The cumulative distribution of $L_b(d')$ is constructed from statistics calculated using the method of § 3 of Annex 1 to Recommendation ITU-R IS.847, as supplemented in § 4 of this Annex. Logarithmic interpolation is used to fashion a continuous cumulative distribution from the statistics calculated as follows.

$p \leq 0.0001$: $L_b(d') = L_b(0.001) - 10$ dB

$p = 0.001$, $p = 0.01$, $p = 0.1$, $p = 1.0$, $p = 10.0$: Values are calculated using § 3 of Annex 1 to Recommendation ITU-R IS.847

$p = 50.0$: $L_b(d')$ = calculated in accordance with § 4

$p = 90.0$: $L_b(d') = (2 \times L_b(50)) - L_b(10.0)$

$p = 99.0$: $L_b(d') = (2 \times L_b(50)) - L_b(1.0)$

$p = 99.9$: $L_b(d') = (2 \times L_b(50)) - L_b(0.1)$

$p \geq 99.99$ $L_b(d') = L_b(99.9) + 20$ dB

3. Iterative convergence on coordination distance under the composite method

The initial estimate of coordination distance d' should be taken as 95% of the coordination distance resulting from the statistical (3%) method of *recommends* 2. The initial and all successive coordination distance estimates d' are used in equations (1a) and (1b) to determine values for the parameter e, which, in turn, are used to determine the amount by which d' should be incremented. Because all variables and equations in these iterations behave monotonically, a variety of methods can be used to determine successive estimates of d' in order to converge on the coordination distance in accordance with equation (1c). With reference to the parameters distance d_n and specific attenuation β_n defined in § 3 of Annex 1 to Recommendation ITU-R IS.847, equations (15) and (16), one such method for making successive distance estimates is as follows:

$$L_n = d_n \beta_n \quad (2a)$$

$$d' = \frac{L_1 - 0.8\,e}{\beta_1} \qquad \text{for } n = 1 \quad (2b)$$

$$d' = \frac{L_n \text{ (from previous } d' \text{ value)}}{\beta_n \text{ (from previous } d' \text{ value)}} + \sum_{i=1}^{n-1} D_i \quad \text{km} \qquad \text{for } n > 1 \quad (2c)$$

where:

L_n: basic transmission loss component (dB) available from the nth section of the interfering signal path

d': next value of estimated coordination distance (km) to be applied in equations (1a) to (1c).

4. Propagation loss exceeded for all but 50% of the time

The basic transmission loss exceeded for all but 50% of the time is calculated using:

$$L_b(50) = 137 + k(f) + 20 \log d' + 0.09\, d' + 0.075\,|\zeta| + A_g \qquad (3)$$

where:

L_b (50): basic transmission loss (dB) exceeded for all but 50% of the time

$$k(f) = \begin{cases} 30 \log (f) & \text{for } f \leq 2 \text{ GHz} \\ 3 + 20 \log (f) & \text{for } f > 2 \text{ GHz} \end{cases}$$

f : frequency (GHz)

d' : estimated coordination distance (km)

ζ : latitude of earth station (degrees)

A_g : gaseous attenuation (dB)

A_g = $(\beta_o + \beta_v) d'$

β_o, β_v are as defined in Recommendation ITU-R IS.847.

ANNEX 3

Example calculations of coordination distance for an earth station operating with satellites in low earth orbit

1. Introduction

This Annex presents example calculations of coordination distance for one azimuth using the methods of *recommends* 2. The parameters used in this example are provided in Table 2.

The cumulative distribution of horizon antenna gain generated for the azimuth under consideration in this example as required for the statistical method, is provided in Table 3.

2. Time-invariant gain (TIG) method

From the antenna pattern, minimum antenna elevation angle, and physical horizon angle specified for the earth station in Table 2, the difference between the maximum and minimum values for horizon antenna gain is found to be 30.6 – (–1.4) dB or 32 dB. Thus, the horizon antenna gain to be used in equation (2) of Recommendation ITU-R IS.847 is 20.6 dBi (30.6 dBi – 10 dB).

From equation (2) of Recommendation ITU-R IS.847 and the parameters in Table 2, above:

$$L_b(0.006) = 37 + 20.6 - (-144)$$

$$= 201.6 \text{ dB}$$

From § 3.2 of Annex 1 to Recommendation ITU-R IS.847:

$$L_1 = 201.6 - 120 - 20 \log 1.7 - \log 0.006 - 5(0.006)^{0.5} - \left(20 \log \left[1 + (4.5)(3)(1.72)^{0.5}\right] + 3(1.7)^{0.33}\right)$$

$$= 49.9 \text{ dB}$$

$$\beta_i (0.006) = 0.01 + \left[0.04 + 0.05 \log 1.7 + 0.16(0.006)^{0.1}\right] + 0.0 + 0.0$$

$$= 0.157 \text{ dB/km}$$

$$d_1 = 318 \text{ km.}$$

TABLE 2

Receiving earth station and satellite orbit parameters used to determine coordination distance with respect to a digital terrestrial station

Earth station type	Meteorological, receiving
Latitude (degrees)	37.5
Frequency (GHz)	1.70
Antenna diameter (m)	2.46
Minimum operating elevation angle (degrees)	3
Gain pattern (dBi):	
$G(\varphi) = \begin{cases} 30.6 - (2.5 \times 10^{-3})(14\,\varphi)^2 & \text{for } \varphi < 5.4° \\ 16.2 & \text{for } 5.4° \leq \varphi < 9.4° \\ 40.5 - 25 \log \varphi & \text{for } 9.4° \leq \varphi < 48° \\ -1.4 & \text{for } \varphi \geq 48° \end{cases}$	
Orbit parameters	
Multiple satellites with similar ephemerides	
Inclination (degrees)	98.89
Altitude (km)	825
Receiver parameters	
$P_r(p)$ (dBW)	–144
Percentage of time (p)	0.006
Terrestrial station	
Transmit power ($P_{t'}$) (dBW)	0
Mainbeam gain (G_{terr}) (dBi)	37
Gain adjustment (G) (dB)	–5
Analysis parameters	
Interferer azimuth (degrees)	90
Radio climatic zone	A2
Physical horizon (degrees)	3

TABLE 3

Statistics of horizon antenna gain for example receiving earth station

Earth station horizon antenna gain (dBi)	Percentage of reception time gain is exceeded (four significant digits)
30.6	0.0000
24.0	0.0195
23.0	0.0585
22.0	0.0975
21.0	0.0976
20.0	0.1365
19.0	0.6632
18.0	0.8192
17.0	1.1313
16.0	1.3068
15.0	1.6189
14.0	2.0285
13.0	2.4966
12.0	2.9647
11.0	3.5303
10.0	4.1935
9.0	5.0322
8.0	5.9294
7.0	6.8851
6.0	8.0164
5.0	9.3037
4.0	10.8250
3.0	12.4144
2.0	14.2383
1.0	16.2863
0.0	18.4708
–1.0	20.9674
–1.4	22.2157

3. Statistical method

From interpolation of the statistics of antenna horizon gain given in Table 3, the horizon antenna gain exceeded for 3% of the time is 11.9 dBi. This yields:

$$L_b(0.006) = 192.9 \text{ dB}$$

$$L_1 = 41.1 \text{ dB}$$

$$\beta_i(0.006) = 0.157 \text{ dB/km}$$ (as determined in § 2 above)

$$d_1 = 262 \text{ km}.$$

4. Resulting coordination distance for example problem

Because the 262 km coordination distance determined by the statistical method is smaller than that determined by the time-invariant gain (TIG) method (318 km), the coordination distance in the azimuth under consideration is 262 km and the statistical method is to be used to determine coordination distances for all azimuths.

RECOMMENDATION ITU-R SM.1138*

DETERMINATION OF NECESSARY BANDWIDTHS INCLUDING EXAMPLES FOR THEIR CALCULATION AND ASSOCIATED EXAMPLES FOR THE DESIGNATION OF EMISSIONS

(1995)

The ITU Radiocommunication Assembly,

considering

a) the Final Report and recommendations of the Voluntary Group of Experts (VGE) to study allocation and improved use of the radio-frequency spectrum and simplification of the Radio Regulations (RR) was established in accordance with Resolution No. 8 of the Plenipotentiary Conference (Nice, 1989) and continued its work in accordance with Resolution No. 8 of the Additional Plenipotentiary Conference (Geneva, 1992);

b) that the 1995 World Radiocommunication Conference (WRC-95) will consider and adopt, as appropriate, proposals for the Simplified RR,

recommends

1 that the formulae given in Annex 1 shall be used to calculate the necessary bandwidth when required by the RR.

ANNEX 1

Determination of necessary bandwidths including examples for their calculation and associated examples for the designation of emissions

1 The necessary bandwidth is not the only characteristic of an emission to be considered in evaluating the interference that may be caused by that emission.

2 In the formulation of the table, the following terms have been employed:

B_n: necessary bandwidth (Hz)

B: modulation rate (Bd)

N: maximum possible number of black plus white elements to be transmitted per second, in facsimile

M: maximum modulation frequency (Hz)

C: sub-carrier frequency (Hz)

D: peak deviation, i.e., half the difference between the maximum and minimum values of the instantaneous frequency. The instantaneous frequency (Hz) is the time rate of change in phase (rad) divided by 2π

t: pulse duration (s) at half-amplitude

t_r: pulse rise time (s) between 10% and 90% amplitude

K: an overall numerical factor which varies according to the emission and which depends upon the allowable signal distortion

N_c: number of baseband channels in radio systems employing multichannel multiplexing

f_p: continuity pilot sub-carrier frequency (Hz) (continuous signal utilized to verify performance of frequency-division multiplex systems).

* Reference has been made to this Recommendation in the Radio Regulations (RR) as revised by the World Radiocommunication Conference 1995 (WRC-95). This will come into force on 1 June 1998.

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
I. NO MODULATING SIGNAL			
Continuous wave emission	–	–	NONE
II. AMPLITUDE MODULATION			
1. Signal with quantized or digital information			
Continuous wave telegraphy, Morse code	$B_n = BK$ $K = 5$ for fading circuits $K = 3$ for non-fading circuits	25 words per minute $B = 20$, $K = 5$ Bandwidth: 100 Hz	100HA1AAN
Telegraphy by on-off keying of a tone modulated carrier, Morse code	$B_n = BK + 2M$ $K = 5$ for fading circuits $K = 3$ for non-fading circuits	25 words per minute $B = 20$, $M = 1\,000$, $K = 5$ Bandwidth: 2 100 Hz = 2.1 kHz	2K10A2AAN
Selective calling signal using sequential single frequency code, single-sideband full carrier	$B_n = M$	Maximum code frequency is: 2 110 Hz $M = 2\,110$ Bandwidth: 2 110 Hz = 2.11 kHz	2K11H2BFN
Direct-printing telegraphy using a frequency shifted modulating sub-carrier, with error-correction, single-sideband, suppressed carrier (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$	$B = 50$ $D = 35$ Hz (70 Hz shift) $K = 1.2$ Bandwidth: 134 Hz	134HJ2BCN
Telegraphy, multichannel with voice frequency, error-correction, some channels are time-division multiplexed, single-sideband, reduced carrier	B_n = highest central frequency + M + DK $M = \frac{B}{2}$	15 channels; highest central frequency is: 2 805 Hz $B = 100$ $D = 42.5$ Hz (85 Hz shift) $K = 0.7$ Bandwidth: 2 885 Hz = 2.885 kHz	2K89R7BCW
2. Telephony (commercial quality)			
Telephony, double-sideband (single channel)	$B_n = 2M$	$M = 3\,000$ Bandwidth: 6 000 Hz = 6 kHz	6K00A3EJN
Telephony, single-sideband, full carrier (single channel)	$B_n = M$	$M = 3\,000$ Bandwidth: 3 000 Hz = 3 kHz	3K00H3EJN
Telephony, single-sideband, suppressed carrier (single channel)	$B_n = M -$ lowest modulation frequency	$M = 3\,000$ lowest modulation frequency = 300 Hz Bandwidth: 2 700 Hz = 2.7 kHz	2K70J3EJN
Telephony with separate frequency modulated signal to control the level of demodulated speech signal, single-sideband, reduced carrier (Lincompex) (single channel)	$B_n = M$	Maximum control frequency = 2 990 Hz $M = 2\,990$ Bandwidth: 2 990 Hz = 2.99 kHz	2K99R3ELN

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
2. Telephony (commercial quality) *(cont.)*			
Telephony with privacy, single-sideband, suppressed carrier (two or more channels)	$B_n = N_c M -$ lowest modulation frequency in the lowest channel	$N_c = 2$ $M = 3\,000$ lowest modulation frequency = 250 Hz Bandwidth: 5 750 Hz = 5.75 kHz	5K75J8EKF
Telephony, independent sideband (two or more channels)	B_n = sum of M for each sideband	2 channels $M = 3\,000$ Bandwidth: 6 000 Hz = 6 kHz	6K00B8EJN
3. Sound broadcasting			
Sound broadcasting, double-sideband	$B_n = 2M$ M may vary between 4 000 and 10 000 depending on the quality desired	Speech and music $M = 4\,000$ Bandwidth: 8 000 Hz = 8 kHz	8K00A3EGN
Sound broadcasting, single-sideband, reduced carrier (single channel)	$B_n = M$ M may vary between 4 000 and 10 000 depending on the quality desired	Speech and music $M = 4\,000$ Bandwidth: 4 000 Hz = 4 kHz	4K00R3EGN
Sound broadcasting, single-sideband, suppressed carrier	$B_n = M -$ lowest modulation frequency	Speech and music $M = 4\,500$ lowest modulation frequency = 50 Hz Bandwidth: 4 450 Hz = 4.45 kHz	4K45J3EGN
4. Television			
Television, vision and sound	Refer to relevant ITU-R documents for the bandwidths of the commonly used television systems	Number of lines: 625 Nominal video bandwidth = 5 MHz Sound carrier relative to video carrier: 5.5 MHz Total vision Bandwidth: 6.25 MHz FM sound bandwidth including guardbands: 750 kHz RF channel Bandwidth: 7 MHz	6M25C3F -- 750KF3EGN
5. Facsimile			
Analogue facsimile by sub-carrier frequency modulation of a single-sideband emission with reduced carrier, monochrome	$B_n = C + \frac{N}{2} + DK$ $K = 1.1$ (typically)	$N = 1\,100$ corresponding to an index of cooperation of 352 and a cycler rotation speed of 60 rpm. Index of cooperation is the product of the drum diameter and number of lines per unit length. $C = 1\,900$ $D = 400$ Hz Bandwidth: 2 890 Hz = 2.89 kHz	2K89R3CMN
Analogue facsimile; frequency modulation of an audio frequency sub-carrier which modulates the main carrier, single-sideband suppressed carrier	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	$N = 1\,100$ $D = 400$ Hz Bandwidth: 1 980 Hz = 1.98 kHz	1K98J3C --

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
6. Composite emissions			
Double-sideband, television relay	$B_n = 2C + 2M + 2D$	Video limited to 5 MHz, audio on 6.5 MHz, frequency modulated sub-carrier, sub-carrier deviation = 50 kHz: $C = 6.5 \times 10^6$ $D = 50 \times 10^3$ Hz $M = 15\,000$ Bandwidth: 13.13×10^6 Hz = 13.13 MHz	13M1A8W --
Double-sideband radio-relay system, frequency division multiplex	$B_n = 2M$	10 voice channels occupying baseband between 1 kHz and 164 kHz $M = 164\,000$ Bandwidth: 328 000 Hz = 328 kHz	328KA8E --
Double-sideband emission of VOR with voice (VOR: VHF omnidirectional radio range)	$B_n = 2C_{max} + 2M + 2DK$ $K = 1$ (typically)	The main carrier is modulated by: – a 30 Hz sub-carrier – a carrier resulting from a 9 960 Hz tone frequency modulated by a 30 Hz tone – a telephone channel – a 1 020 Hz keyed tone for continual Morse identification $C_{max} = 9\,960$ $M = 30$ $D = 480$ Hz Bandwidth: 20 940 Hz = 20.94 kHz	20K9A9WWF
Independent sidebands; several telegraph channels with error-correction together with several telephone channels with privacy; frequency division multiplex	B_n = sum of M for each sideband	Normally composite systems are operated in accordance with standardized channel arrangements (e.g. Rec. ITU-R F.348). 3 telephone channels and 15 telegraphy channels require the bandwidth: 12 000 Hz = 12 kHz	12K0B9WWF
III-A. FREQUENCY MODULATION			
1. Signal with quantized or digital information			
Telegraphy without error-correction (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$ $D = 85$ Hz (170 Hz shift) Bandwidth: 304 Hz	304HF1BBN
Telegraphy, narrow-band direct-printing with error-correction (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$ $D = 85$ Hz (170 Hz shift) Bandwidth: 304 Hz	304HF1BCN
Selective calling signal	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$ $D = 85$ Hz (170 Hz shift) Bandwidth: 304 Hz	304HF1BCN

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
1. Signal with quantized or digital information *(cont.)*			
Four-frequency duplex telegraphy	$B_n = 2M + 2DK$ B: modulation rate (Bd) of the faster channel. If the channels are synchronized: $M = \frac{B}{2}$ (otherwise, $M = 2B$) $K = 1.1$ (typically)	Spacing between adjacent frequencies = 400 Hz Synchronized channels $B = 100$ $M = 50$ $D = 600$ Hz Bandwidth: 1 420 Hz = 1.42 kHz	1K42F7BDX
2. Telephony (commercial quality)			
Commercial telephony	$B_n = 2M + 2DK$ $K = 1$ (typically, but under certain conditions a higher value of K may be necessary)	For an average case of commercial telephony, $D = 5\,000$ Hz $M = 3\,000$ Bandwidth: 16 000 Hz = 16 kHz	16K0F3EJN
3. Sound broadcasting			
Sound broadcasting	$B_n = 2M + 2DK$ $K = 1$ (typically)	Monaural $D = 75\,000$ Hz $M = 15\,000$ Bandwidth: 180 000 Hz = 180 kHz	180KF3EGN
4. Facsimile			
Facsimile by direct frequency modulation of the carrier; black and white	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	$N = 1\,100$ elements/s $D = 400$ Hz Bandwidth: 1 980 Hz = 1.98 kHz	1K98F1C --
Analogue facsimile	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	$N = 1\,100$ elements/s $D = 400$ Hz Bandwidth: 1 980 Hz = 1.98 kHz	1K98F3C --
5. Composite emissions (see Table III-B)			
Radio-relay system, frequency division multiplex	$B_n = 2f_p + 2DK$ $K = 1$ (typically)	60 telephone channels occupying baseband between 60 kHz and 300 kHz; rms per-channel deviation: 200 kHz; continuity pilot at 331 kHz produces 100 kHz rms deviation of main carrier. $D = 200 \times 10^3 \times 3.76 \times 2.02$ $= 1.52 \times 10^6$ Hz $f_p = 0.331 \times 10^6$ Hz Bandwidth: 3.702×10^6 Hz = 3.702 MHz	3M70F8EJF

<table>
<tr><th rowspan="2">Description of emission</th><th colspan="2">Necessary bandwidth</th><th rowspan="2">Designation of emission</th></tr>
<tr><th>Formula</th><th>Sample calculation</th></tr>
<tr><td colspan="4">5. Composite emissions (cont.)</td></tr>
<tr><td>Radio-relay system, frequency division multiplex</td><td>$B_n = 2M + 2DK$
$K = 1$
(typically)</td><td>960 telephone channels occupying baseband between 60 kHz and 4 028 kHz; rms per-channel deviation: 200 kHz; continuity pilot at 4 715 kHz produces 140 kHz rms deviation of main carrier.
$D = 200 \times 10^3 \times 3.76 \times 5.5$
$= 4.13 \times 10^6$ Hz
$M = 4.028 \times 10^6$
$f_p = 4.715 \times 10^6$
$(2M + 2DK) > 2\,f_p$
Bandwidth: 16.32×10^6 Hz
= 16.32 MHz</td><td>16M3F8EJF</td></tr>
<tr><td>Radio-relay system, frequency division multiplex</td><td>$B_n = 2f_p$</td><td>600 telephone channels occupying baseband between 60 kHz and 2 540 kHz; rms per-channel deviation: 200 kHz; continuity pilot at 8 500 kHz produces 140 kHz rms deviation of main carrier.
$D = 200 \times 10^3 \times 3.76 \times 4.36$
$= 3.28 \times 10^6$ Hz
$M = 2.54 \times 10^6$
$K = 1$
$f_p = 8.5 \times 10^6$
$(2M + 2DK) < 2\,f_p$
Bandwidth: 17×10^6 Hz = 17 MHz</td><td>17M0F8EJF</td></tr>
<tr><td>Stereophonic sound broadcasting with multiplexed subsidiary telephony sub-carrier</td><td>$B_n = 2M + 2DK$
$K = 1$
(typically)</td><td>Pilot tone system;
$M = 75\,000$
$D = 75\,000$ Hz
Bandwidth: 300 000 Hz = 300 kHz</td><td>300KF8EHF</td></tr>
</table>

III-B. MULTIPLYING FACTORS FOR USE IN COMPUTING *D*, PEAK FREQUENCY DEVIATION, IN FM FREQUENCY DIVISION MULTIPLEX (FM-FDM) MULTI-CHANNEL EMISSSIONS

For FM-FDM systems the necessary bandwidth is:

$$B_n = 2M + 2DK$$

The value of D, or peak frequency deviation, in these formulae for B_n is calculated by multiplying the rms value of per-channel deviation by the appropriate "multiplying factor" shown below.

In the case where a continuity pilot of frequency f_p exists above the maximum modulation frequency M, the general formula becomes:

$$B_n = 2f_p + 2DK$$

In the case where the modulation index of the main carrier produced by the pilot is less than 0.25, and the rms frequency deviation of the main carrier produced by the pilot is less than or equal to 70% of the rms value of per-channel deviation, the general formula becomes either:

$$B_n = 2f_p \qquad \text{or} \qquad B_n = 2M + 2DK$$

whichever if greater.

Number of telephone channels N_c	Multiplying factor (1): (Peak factor) $\times$ antilog $\left[\dfrac{\text{value in dB above modulation reference level}}{20}\right]$
$3 < N_c < 12$	$4.47 \times \text{antilog}\left[\dfrac{\text{a value in dB specified by the equipment manufacturer or station licensee, subject to administration approval}}{20}\right]$
$12 \le N_c < 60$	$3.76 \times \text{antilog}\left[\dfrac{2.6 + 2\log N_c}{20}\right]$
Number of telephone channels N_c	Multiplying factor (2): (Peak factor) $\times$ antilog $\left[\dfrac{\text{value in dB above modulation reference level}}{20}\right]$
$60 \le N_c < 240$	$3.76 \times \text{antilog}\left[\dfrac{-1 + 4\log N_c}{20}\right]$
$N_c \ge 240$	$3.76 \times \text{antilog}\left[\dfrac{-15 + 10\log N_c}{20}\right]$

(1) In the above chart, the multipliers 3.76 and 4.47 correspond to peak factors of 11.5 and 13.0 dB, respectively.

(2) In the above chart, the multipliers 3.76 correspond to peak factors of 11.5 dB.

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
IV. PULSE MODULATION			
1. Radar			
Unmodulated pulse emission	$B_n = \frac{2K}{t}$ K depends upon the ratio of pulse duration to pulse rise time. Its value usually falls between 1 and 10 and in many cases it does not need to exceed 6	Primary radar range resolution = 150 m K = 1.5 (triangular pulse where $t \simeq t_r$, only components down to 27 dB from the strongest are considered) Then: $t = \frac{2 \times (\text{range resolution})}{\text{velocity of light}}$ $= \frac{2 \times 150}{3 \times 10^8}$ $= 1 \times 10^{-6}$ s Bandwidth: 3×10^6 Hz = 3 MHz	3M00P0NAN
2. Composite emissions			
Radio-relay system	$B_n = \frac{2K}{t}$ K = 1.6	Pulse position modulated by 36 voice channel baseband; pulse width at half amplitude = 0.4 μs Bandwidth: 8×10^6 Hz = 8 MHz (Bandwidth independent of the number of voice channels)	8M00M7EJT

RECOMMENDATION ITU-R M.1169*

HOURS OF SERVICE OF SHIP STATIONS

(1995)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe the working hours of ship stations,

recommends

1 that the hours of service of ship stations should be in accordance with Annexes 1 and 2.

ANNEX 1

§ 1. (1) For the international public correspondence service, ship stations are divided into four categories:

a) stations of the first category: these stations maintain a continuous service;

b) stations of the second category: these stations maintain a service for 16 hours a day;

c) stations of the third category: these stations maintain a service for 8 hours a day;

d) stations of the fourth category: these stations maintain a service the duration of which is either shorter than that of stations of the third category, or is not fixed by these Regulations.

(2) Each administration shall itself determine the rules under which ship stations subject to it are to be placed in one of the above four categories.

§ 2. (1) Ship stations of the second category shall maintain the following hours of service:

0000 - 0400
0800 - 1200
1600 - 1800
2000 - 2200 } ship's time or zone time

and, additionally, four hours of service at times to be decided by the administration, master or responsible person, to meet the essential communication needs of the ship, having regard to propagation conditions and traffic requirements.

(2) Ship stations of the third category shall maintain the following hours of service:

0800 - 1200 ship's time or zone time,

two continuous hours of service between 1800 and 2200 h, ship's time or zone time, at times decided by the administration, master or responsible person and, additionally, two hours of service at times decided by the administration, master or responsible person, to meet the essential communication needs of the ship, having regard to propagation conditions and traffic requirements.

(3) Each administration will determine whether ship's time observed by its ships is to be zone time as shown in Annex 2.

(4) In case of short voyages, these stations shall provide service during the hours fixed by the administrations to which they are subject.

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO).

§ 3. Ship stations of the fourth category are encouraged to provide service from 0830 to 0930 h, ship's time or zone time.

§ 4. (1) Ship stations whose service is not continuous shall not close before:

a) finishing all operations resulting from a distress call or from an urgency or safety signal;

b) exchanging, so far as practicable, all traffic originating in or destined for coast stations situated within their service area and for ship stations which, being within their service area, have indicated their presence before the actual cessation of work.

(2) Any ship station not having fixed working hours shall inform the coast stations with which it is in communication of the time of closing and the time of reopening its service.

§ 5. (1) Any ship station arriving in port, and whose service is therefore about to close, shall:

a) notify accordingly the nearest coast station and, if appropriate, the other coast stations with which it generally communicates;

b) not close until after the disposal of traffic on hand, unless this conflicts with the regulations in force in the country of the port of call.

(2) On departure from port the ship station shall notify the coast station or stations concerned that its service is reopening as soon as such reopening is permitted by the regulations in force in the country of the port of departure. However, a ship station not having hours of service fixed by these Regulations may defer such notification until the station first reopens its service after departure from port.

ANNEX 2

Hours of service for ship stations of the second and third categories

Section I. Table

Hours of service Ship's time or zone time (See § 2.(1) and 2.(2) in Annex 1)	
16 hours (H16)	8 hours (H8)
from to 0000 - 0400 h 0800 - 1200 h 1600 - 1800 h 2000 - 2200 h plus 4 hours (see § 2.(1) in Annex 1)	from to 0800 - 1200 h 1800 - 2200 h [(a)] plus 2 hours (see § 2.(2) in Annex 1)

[(a)] Two continuous hours of service between 1800 and 2200 h, ship's time or zone time, at times decided by the administration, master or responsible person.

Section II. Diagram and Map

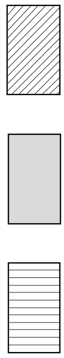
Note a: This diagram indicates the *fixed* and *elected* hours of service maintained by ships of the second and third categories in terms of zone time. (The hours of service shown exclude those which are determined by the administration, master, or responsible person.)

The *fixed* hours of watch are shown thus:

I) for ships of the second category:

II) for ships of the second and third categories:

III) for ships of the third category, period over which two continuous hours of service may be elected:

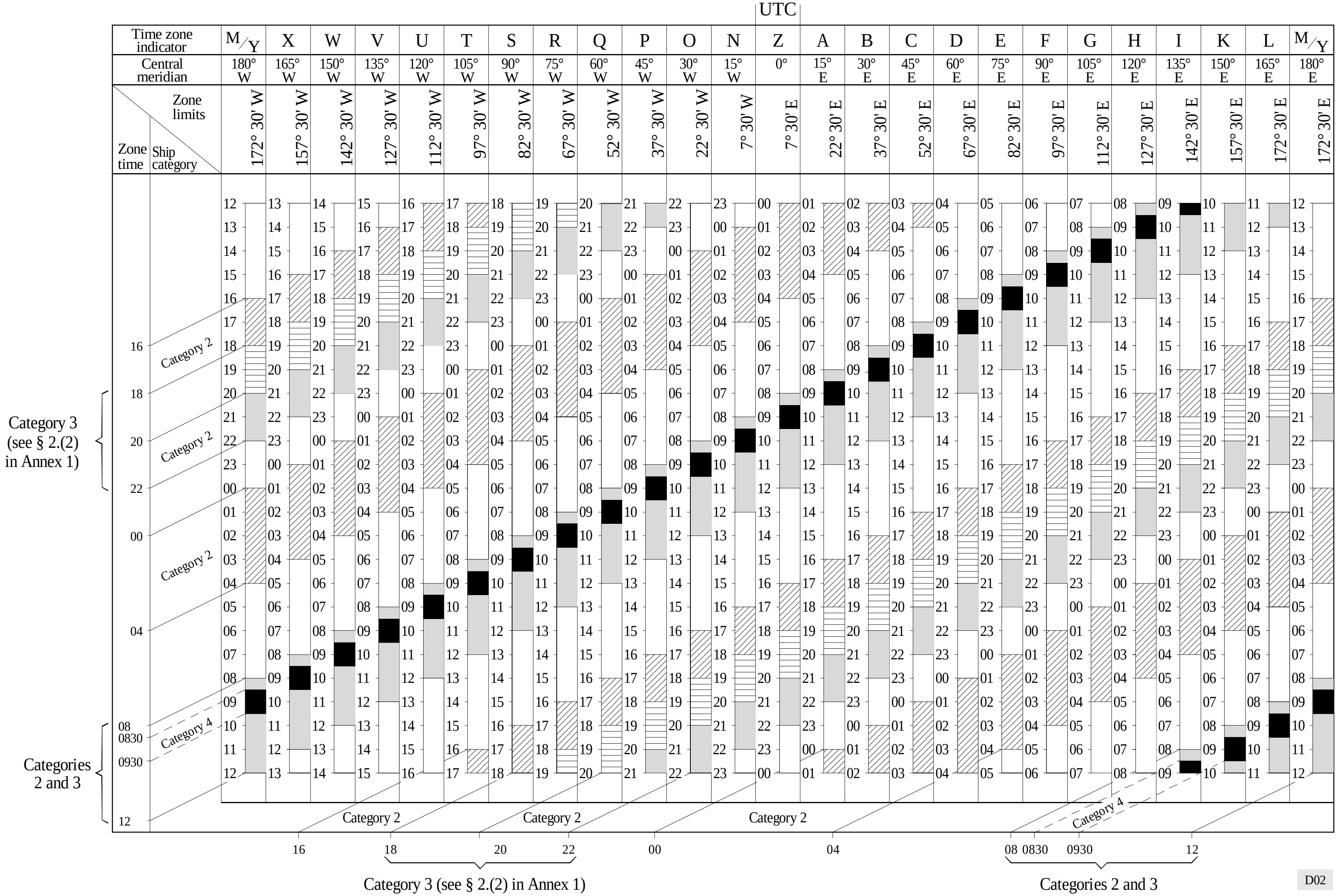


D01

Note b: Also shown (in black) is the specific service 0830-0930 that ships of the fourth category are encouraged to provide (see § 3 in Annex 1).

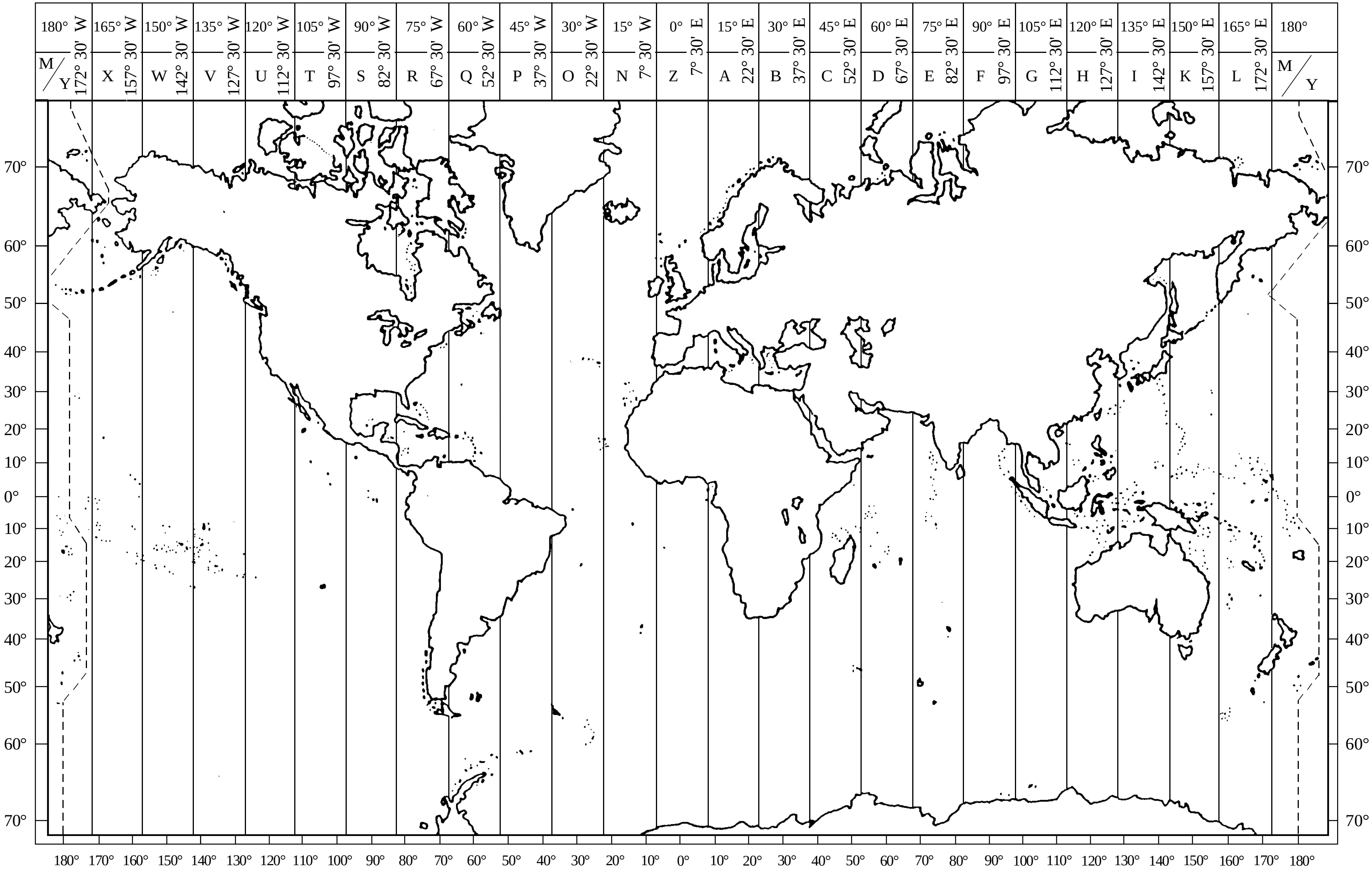
DIAGRAM

Time zones and hours of service of ship stations



MAP

Time zones



RECOMMENDATION ITU-R M.1170*

MORSE TELEGRAPHY PROCEDURES IN THE MARITIME MOBILE SERVICE

(1995)

The ITU Radiocommunication Assembly,

considering

a) that since some administrations may still use Morse telegraphy for the maritime mobile service,

recommends

1 that Morse telegraphy in the maritime mobile service should be performed in accordance with Annex 1.

ANNEX 1

Section I. Introduction

§ 1. The use of the Morse code signals specified in the Instructions for the Operation of the International Public Telegram Service shall be obligatory. However, for radiocommunications of a special character, the use of other signals is not precluded.

§ 2. The service abbreviations given in Recommendation ITU-R M.1172 are to be used.

Section II. Preliminary Operations

§ 3. (1) Before transmitting, a station shall take precautions to ensure that its emissions will not interfere with transmissions already in progress; if such interference is likely, the station shall await an appropriate break in the communications in progress.

(2) If, these precautions having been taken, the emissions of the station should, nevertheless, interfere with a transmission already in progress, the following rules shall be applied:

a) the ship station whose emission causes interference to the communication of a mobile station with a coast station shall cease sending at the first request of the coast station;

b) the ship station whose emission causes interference to communications already in progress between mobile stations shall cease sending at the first request of one of the other stations;

c) the station which requests this cessation shall indicate the approximate waiting time imposed on the station whose emission it suspends.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), and the Telecommunication Standardization Sector (ITU-T).

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

Section III. Calls by Morse Radiotelegraphy

A. General

§ 4. (1) As a general rule, it rests with the ship station to establish communication with the coast station. For this purpose, the ship station may call the coast station only when it comes within the service area of the latter, that is to say, that area within which, by using an appropriate frequency, the ship station can be heard by the coast station.

(2) However, a coast station having traffic for a ship station may call this station if it has reason to believe that the ship station is keeping watch and is within the service area of the coast station.

§ 5. (1) In addition, each coast station shall, so far as practicable, transmit its calls in the form of "traffic lists" consisting of the call signs in alphabetical order of all ship stations for which it has traffic on hand. These calls are made at specified times fixed by agreement between the administrations concerned and at intervals of at least two hours and not more than four hours during the working hours of the coast station.

(2) In the bands between 4 000 kHz and 27 500 kHz, however, traffic lists may be transmitted at intervals of not less than one hour.

(3) Continuous or frequently repeated emissions of its call sign or of the enquiry signal CQ by a coast station should be avoided (see RR No. S15.1 [No.1799]).

(4) However, in the bands between 4 000 kHz and 27 500 kHz, a coast station may transmit its call sign at intervals, using type A1A transmission, to enable ship stations to select the calling band with the most favourable propagation characteristics for reliable communication (see RR No. S52.28 [No. 4261]).

(5) Coast stations shall transmit their traffic lists on their normal working frequencies in the appropriate bands. This transmission shall be preceded by a general call to all stations (CQ).

(6) The call to all stations announcing the traffic list may be sent on a calling frequency in the following form:

– CQ, not more than three times;

– the word DE;

– the call sign of the calling station, not more than three times;

– QSW followed by the indication of the working frequency or frequencies on which the traffic list is about to be sent.

In no case may this preamble be repeated.

(7) The provisions of § 5.(6) above:

a) are obligatory when 500 kHz is used;

b) do not apply when frequencies in the bands between 4 000 kHz and 27 500 kHz are used.

(8) The hours at which coast stations transmit their traffic lists and the frequencies and classes of emission which they use for this purpose shall be stated in the List of Coast Stations.

(9) Ship stations should, as far as possible, listen to the traffic lists transmitted by coast stations. On hearing their call sign in such a list they shall reply as soon as they can do so.

(10) When the traffic cannot be sent immediately, the coast station shall inform each ship station concerned of the probable time at which working can begin, and also, if necessary, the frequency and class of emission which will be used.

§ 6. When a coast station receives calls from several ship stations at practically the same time, it decides the order in which these stations may transmit their traffic. Its decision shall be based on the priority (see RR No. S53.1 [No. 4441]) of the radiotelegrams that ship stations have on hand and on the need for allowing each calling station to clear the greatest possible number of communications.

§ 7. (1) When a station called does not reply to a call sent three times at intervals of two minutes, the calling shall cease and shall not be renewed until after an interval of fifteen minutes.

(2) In the case of a communication between a station of the maritime mobile service and an aircraft station, calling may be renewed after an interval of five minutes, notwithstanding (1) § 7. above.

(3) Before renewing the call, the calling station shall ascertain that the station called is not in communication with another station.

(4) If there is no reason to believe that harmful interference will be caused to other communications in progress, the provisions of RR No. S51.71 [No. 4146] and § 7.(1) are not applicable. In such cases the call, sent three times at intervals of two minutes, may be repeated after an interval of less than fifteen minutes but not less than three minutes.

§ 8. Ship stations shall not radiate a carrier wave between calls.

§ 9. When the name and address of the administration or private operating agency controlling a ship station are not given in the appropriate list of stations or are no longer in agreement with the particulars given therein, it is the duty of the ship station to furnish as a matter of regular procedure, to the coast station to which it transmits traffic, all the necessary information in this respect.

§ 10. (1) The coast station may, by means of the abbreviation TR, ask the ship station to furnish it with the following information:

a) position and, whenever possible, course and speed;

b) next port of call.

(2) The information referred to in § 10.(1) above, preceded by the abbreviation TR, should be furnished by ship stations whenever this seems appropriate, without prior request from the coast station. The provision of this information is authorized only by the master or person responsible for the ship or other vessel carrying the ship station.

B. Calls to Several Stations

§ 11. Two types of calling signal "to all stations" are recognized:

a) call CQ followed by the letter K;

b) call CQ not followed by the letter K.

§ 12. Stations desiring to enter into communication with stations of the maritime mobile service without, however, knowing the names of any such stations within their service area may use the enquiry signal CQ in place of the call sign of the station called in the calling formula, the call being followed by the letter K (general call to all stations in the maritime mobile service with request for reply).

§ 13. In regions where traffic is congested, the use of the call CQ followed by the letter K is forbidden. As an exception it may be used with signals denoting urgency.

§ 14. The call CQ not followed by the letter K (general call to all stations without request for reply) is used before the transmission of information of any kind intended to be read or used by anyone who can intercept it.

§ 15. The call CP followed by two or more call signs or by a code word (call to certain receiving stations without request for reply) is used only for the transmission of information of any nature intended to be read or used by the persons authorized.

Section IV. Method of Calling, Reply to Calls and Signals Preparatory to Traffic

A. Method of Calling – Morse Telegraphy

§ 16. (1) The call consists of:

– the call sign of the station called, not more than twice;

– the word DE;

– the call sign of the calling station, not more than twice;

– the information required by § 18.(1) and, as appropriate, by § 19.(1) and § 19.(2);

– the letter K.

(2) For normal calling, when the requirements of RR No. S52.60 [No. 4261] have been met, the call specified in § 16.(1) above may be transmitted twice at an interval of not less than one minute; thereafter it shall not be repeated until after an interval of three minutes.

B. Frequency to Be Used for Calling and for Preparatory Signals

§ 17. (1) For making the call and for transmitting preparatory signals, the calling station shall use a frequency on which the station called keeps watch.

(2) A ship station calling a coast station in any of the frequency bands between 4 000 kHz and 27 500 kHz shall use a frequency in the calling band specially reserved for this purpose.

C. Indication of the Frequency to Be Used for Traffic

§ 18. (1) The call, as described in § 16.(1), shall contain the service abbreviation indicating the working frequency and, if useful, the class of emission which the calling station proposes to use for the transmission of its traffic.

(2) When the call by a coast station does not contain an indication of the frequency to be used for the traffic, this indicates that the coast station proposes to use for traffic its normal working frequency shown in the List of Coast Stations.

D. Indication of Priority, of the Reason for the Call, and of Transmission of Radiotelegrams in Series

§ 19. (1) The calling station shall transmit the service abbreviation after the above-mentioned preparatory signals to indicate a priority message other than a distress, urgency or safety message (see RR No. S53.1 [No. 4441]) and to indicate the reason for the call.

(2) Moreover, when the calling station wishes to send its radiotelegrams in series, it shall indicate this by adding the service abbreviation for requesting the consent of the station called.

E. Form of Reply to Calls

§ 20. The reply to calls consists of:

– the call sign of the calling station, not more than twice;

– the word DE;

– the call sign of the station called, once only.

F. Frequency for Reply

§ 21. Except as otherwise provided in these Regulations, for transmitting the reply to calls and to preparatory signals, the station called shall use the frequency on which the calling station keeps watch, unless the calling station has specified a frequency for the reply.

G. Agreement on the Frequency to Be Used for Traffic

§ 22. (1) If the station called is in agreement with the calling station, it shall transmit:

a) the reply to the call;

b) the service abbreviation indicating that from that moment onwards it will listen on the working frequency announced by the calling station;

c) if necessary, the indications referred to in § 23.;

d) if useful, the service abbreviation and figure indicating the strength and/or intelligibility of the signals received (see Recommendation ITU-R M.1172);

e) the letter K if the station called is ready to receive the traffic of the calling station.

(2) If the station called is not in agreement with the calling station on the working frequency to be used, it shall transmit:

a) the reply to the call;

b) the service abbreviation indicating the working frequency to be used by the calling station and, if necessary, the class of emission;

c) if necessary, the indications specified in § 23.

(3) When agreement is reached regarding the working frequency which the calling station shall use for its traffic, the station called shall transmit the letter K after the indications contained in its reply.

H. Reply to the Request for Transmission by Series

§ 23. The station called, in replying to a calling station which has proposed to transmit its radiotelegrams by series (see § 19.(2)), shall indicate, by means of the service abbreviation, its acceptance or refusal. In the former case it shall specify, if necessary, the number of radiotelegrams which it is ready to receive in one series.

I. Difficulties in Reception

§ 24. (1) If the station called is unable to accept traffic immediately, it shall reply to the call as indicated in § 22.(1) *a*) to *e*), but it shall replace the letter K by the signal • – • • • (wait), followed by a number indicating in minutes the probable duration of the waiting time. If the probable duration exceeds ten minutes (five minutes in the case of an aircraft station communicating with a station of the maritime mobile service), the reason for the delay shall be given.

(2) When a station receives a call without being certain that such a call is intended for it, it shall not reply until the call has been repeated and understood. When, on the other hand, a station receives a call which is intended for it but is uncertain of the call sign of the calling station, it shall reply immediately using the service abbreviation in place of the call sign of this latter station.

Section V. Forwarding (Routing) of Traffic

A. Traffic Frequency

§ 25. (1) As a general rule, a station of the maritime mobile service shall transmit its traffic on one of its working frequencies in that band in which the call has been made.

(2) In addition to its normal working frequency, printed in heavy type in the List of Coast Stations, a coast station may use one or more supplementary frequencies in the same band, in accordance with the provisions of RR Article S52 [Article 60].

(3) The use of frequencies reserved for calling shall be forbidden for traffic, except distress traffic (see RR Chapter SVII [Chapter IX]).

(4) If the transmission of a radiotelegram is to take place on a frequency and/or with a class of emission other than those used for the call, the transmission of the radiotelegram shall be preceded by:

– the call sign of the station called, not more than twice;

– the word DE;

– the call sign of the calling station, once only.

(5) If the transmission is to be made on the same frequency and with the same class of emission as the call, the transmission of the radiotelegram shall be preceded, if necessary, by:

– the call sign of the station called;

– the word DE;

– the call sign of the calling station.

B. Numbering in Daily Series

§ 26. (1) As a general rule, radiotelegrams of all kinds transmitted by ship stations shall be numbered in a daily series; number 1 shall be given to the first radiotelegram sent each day to each separate station.

(2) A series of numbers which has begun in radiotelegraphy should be continued in radiotelephony and vice versa.

C. Long Radiotelegrams

§ 27. (1) In cases where both stations are able to change from sending to receiving without manual switching, the transmitting station may continue to send until completion of the message or until the receiving station breaks in on the transmission with the service abbreviation BK. Before commencing, both stations normally agree on such a method of working by means of the abbreviation QSK.

(2) If this method of working cannot be employed, long radiotelegrams, whether in plain language or in secret language, shall, as a general rule, be transmitted in sections, each section containing fifty words in the case of plain language and twenty words or groups if secret language is used.

(3) At the end of each section the signal • • – – • • (?) meaning “Have you received the radiotelegram correctly up to this point?” shall be transmitted. If the section has been correctly received, the receiving station shall reply by sending the letter K and the transmission of the radiotelegram shall be continued.

D. Suspension of Traffic

§ 28. When a ship station transmits on a working frequency of a coast station and causes interference with the transmission of such a coast station, it shall suspend working at the first request of the latter.

Section VI. End of Traffic and Work

A. Signal for the End of Transmission

§ 29. (1) The transmission of a radiotelegram shall be terminated by the signal • – • – • (end of transmission), followed by the letter K.

(2) In the case of transmission by series, the end of each radiotelegram shall be indicated by the signal • – • – • (end of transmission) and the end of the series by the letter K.

B. Acknowledgement of Receipt

§ 30. (1) The acknowledgement of receipt of a radiotelegram or a series of radiotelegrams shall be given by the receiving station in the following manner:

– the call sign of the sending station;

– the word DE;

– the call sign of the receiving station;

– the letter R followed by the number of the radiotelegram; *or*

– the letter R followed by the number of the last radiotelegram of a series.

(2) The acknowledgement of receipt shall be transmitted by the receiving station on the traffic frequency (see § 25.(1) and § 25.(2)).

C. End of Work

§ 31. (1) The end of work between two stations shall be indicated by each of them by means of the signal · · · – · – (end of work).

(2) The signal · · · – · – (end of work) shall also be used:

– when the transmission of radiotelegrams of general information, meteorological information and general safety notices is finished;

– when transmission is ended in long-distance radiocommunication services with deferred acknowledgement of receipt or without acknowledgement of receipt.

Section VII. Control of Working

§ 32. The provisions of this Section are not applicable in cases of distress, urgency or safety (see RR No. S55.1 [No. 4710]).

§ 33. In communications between coast stations and ship stations, the ship station shall comply with the instructions given by the coast station, in all questions relating to the order and time of transmission, to the choice of frequency and class of emission, and to the duration and suspension of work.

§ 34. In communications between ship stations, the station called shall control the working in the manner indicated in § 33. above. However, if a coast station finds it necessary to intervene, these stations shall comply with the instructions given by the coast station.

Section VIII. Tests

§ 35. When it is necessary for a ship station to send signals for testing or adjustment which are liable to interfere with the working of neighbouring coast stations, the consent of these stations shall be obtained before such signals are sent.

§ 36. When it is necessary for a station in the maritime mobile service to make test signals, either for the adjustment of a transmitter before making a call or for the adjustment of a receiver, such signals shall not be continued for more than ten seconds and shall be composed of a series of VVV followed by the call sign of the station emitting the test signals.

RECOMMENDATION ITU-R M.1171*

RADIOTELEPHONY PROCEDURES IN THE MARITIME MOBILE SERVICE

(1995)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe standard procedures for radiotelephony in the maritime mobile service,

recommends

1 that radiotelephony in the maritime mobile service should be performed in accordance with Annex 1.

ANNEX 1

Section I. Introduction

§ 1. Radiotelephone stations should, as far as possible, be equipped with devices for instantaneous switching from transmission to reception and vice versa. This equipment is necessary for all stations participating in communication between ships and subscribers of the land telephone system.

§ 2. (1) Stations equipped for radiotelephony may transmit and receive radiotelegrams by means of radiotelephony. Coast stations providing such service and open for public correspondence shall be indicated in the List of Coast Stations.

(2) To facilitate radiocommunications the service abbreviations given in Recommendation ITU-R M.1172 may be used.

Section II. Calls by Radiotelephony

§ 3. The provisions of this Section relating to the intervals between calls are not applicable to a station operating under conditions involving distress, urgency or safety.

§ 4. (1) As a general rule, it rests with the ship station to establish communication with the coast station. For this purpose the ship station may call the coast station only when it comes within the service area of the latter, that is to say, that area within which, by using an appropriate frequency, the ship station can be heard by the coast station.

(2) However, a coast station having traffic for a ship station may call this station if it has reason to believe that the ship station is keeping watch and is within the service area of the coast station.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), and the Telecommunication Standardization Sector (ITU-T)

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

§ 5. (1) In addition, each coast station shall, so far as practicable, transmit its calls in the form of "traffic lists" consisting of the call signs or other identification in alphabetical order of all ship stations for which it has traffic on hand. These calls shall be made at specified times fixed by agreement between the administrations concerned and at intervals of not less than two hours and not more than four hours during the working hours of the coast station.

(2) Coast stations shall transmit their traffic lists on their normal working frequencies in the appropriate bands. The transmission shall be preceded by a general call to all stations.

(3) The general call to all stations announcing the traffic lists may be sent on a calling frequency in the following form:

– "Hello all ships" or CQ (spoken as CHARLIE QUEBEC) not more than three times;

– the words THIS IS (or DE spoken as DELTA ECHO in case of language difficulties);

– " . . . Radio" not more than three times;

– "Listen for my traffic list on . . . kHz".

In no case may this preamble be repeated.

(4) However, in the bands between 156 MHz and 174 MHz when the conditions for establishing contact are good, the call described in § 5.(3) above may be replaced by:

– "Hello all ships" or CQ (spoken as CHARLIE QUEBEC), once;

– the words THIS IS (or DE spoken as DELTA ECHO in case of language difficulties);

– " . . . Radio", twice;

– "Listen for my traffic list on channel . . . ".

In no case may this preamble be repeated.

(5) The provisions of § 5.(3) are obligatory when 2 182 kHz or 156.8 MHz is used.

(6) The hours at which coast stations transmit their traffic lists and the frequencies and classes of emission which they use for this purpose shall be stated in the List of Coast Stations.

(7) Ship stations should as far as possible listen to the traffic lists transmitted by coast stations. On hearing their call sign or other identification in such a list they must reply as soon as they can do so.

(8) When the traffic cannot be sent immediately, the coast station shall inform each ship station concerned of the probable time at which working can begin, and also, if necessary, the frequency and class of emission which will be used.

§ 6. When a coast station receives calls from several ship stations at practically the same time, it decides the order in which these stations may transmit their traffic. Its decision shall be based on the priority (see RR No. S53.1 [No. 4441]) of the radiotelegrams or radiotelephone calls that the ship stations have on hand and on the need for allowing each calling station to clear the greatest possible number of communications.

§ 7. (1) When a station called does not reply to a call sent three times at intervals of two minutes, the calling shall cease.

(2) However, when a station called does not reply, the call may be repeated at three-minute intervals.

(3) In areas where reliable VHF communication with a called coast station is practicable, the calling ship station may repeat the call as soon as it is ascertained that traffic has been terminated at the coast station.

(4) In the case of a communication between a station of the maritime mobile service and an aircraft station, calling may be renewed after an interval of five minutes.

(5) Before renewing the call, the calling station shall ascertain that the station called is not in communication with another station.

(6) If there is no reason to believe that harmful interference will be caused to other communications in progress, the provisions of § 7.(4) above are not applicable. In such cases the call, sent three times at intervals of two minutes, may be repeated after an interval of not less than three minutes.

(7) However, before renewing the call, the calling station shall ascertain that further calling is unlikely to cause interference to other communications in progress and that the station called is not in communication with another station.

(8) Ship stations shall not radiate a carrier wave between calls.

§ 8. When the name and address of the administration or private operating agency controlling a ship station are not given in the appropriate list of stations or are no longer in agreement with the particulars given therein, it is the duty of the ship station to furnish as a matter of regular procedure, to the coast station to which it transmits traffic, all the necessary information in this respect.

§ 9. (1) The coast station may, by means of the abbreviation TR (spoken as TANGO ROMEO), ask the ship station to furnish it with the following information:

a) position and, whenever possible, course and speed;

b) next port of call.

(2) The information referred to in § 9.(1) above, preceded by the abbreviation TR, should be furnished by ship stations, whenever this seems appropriate, without prior request from the coast station. The provision of this information is authorized only by the master or the person responsible for the ship.

Section III. Method of Calling, Reply to Calls and Signals Preparatory to Traffic when Using Calling Methods Other than Digital Selective Calling

A. Method of Calling

§ 10. (1) The call consists of:

– the call sign or other identification of the station called, not more than three times;

– the words THIS IS (or DE spoken as DELTA ECHO in case of language difficulties);

– the call sign or other identification of the calling station, not more than three times.

(2) However, in the bands between 156 MHz and 174 MHz when the conditions for establishing contact are good, the call described in § 10.(1) above may be replaced by:

– the call sign of the station called, once;

– the words THIS IS (or DE spoken as DELTA ECHO in case of language difficulties);

– the call sign or other identification of the calling station, twice.

(3) When calling a VHF coast station operating on more than one channel, a ship station calling on a working channel should include the number of that channel in the call.

(4) When contact is established, the call sign or other identification may thereafter be transmitted once only.

(5) When the coast station is fitted with equipment for selective calling in accordance with Recommendation ITU-R M.541, and the ship station is fitted with equipment for receiving such selective calls, the coast station shall call the ship by transmitting the appropriate code signals. The ship station shall call the coast station by speech in the manner given in § 10.(1) (see also Annex 2 to Recommendation ITU-R M.257).

§ 11. Calls for internal communications on board ship when in territorial waters shall consist of:

a) From the master station:

  – the name of the ship followed by a single letter (ALFA, BRAVO, CHARLIE, etc.) indicating the sub-station not more than three times;

  – the words THIS IS;

  – the name of the ship followed by the word CONTROL;

b) From the sub-station:

– the name of the ship followed by the word CONTROL not more than three times;

– the words THIS IS;

– the name of the ship followed by a single letter (ALFA, BRAVO, CHARLIE, etc.) indicating the sub-station.

B. Frequency to Be Used for Calling and for Preparatory Signals

B1. Bands Between 1 605 kHz and 4 000 kHz

§ 12. (1) A radiotelephone ship station calling a coast station should use for the call, in order of preference:

a) a working frequency on which the coast station is keeping watch;

b) the carrier frequency 2 182 kHz;

c) in Regions 1 and 3 and in Greenland, the carrier frequency 2 191 kHz (assigned frequency 2 192.4 kHz) when a carrier frequency of 2 182 kHz is being used for distress;

d) in Region 2 except for Greenland, the carrier frequency 2 191 kHz as a supplementary calling frequency in those areas of heavy usage of 2 182 kHz.

(2) A radiotelephone ship station calling another ship station should use for the call:

a) the carrier frequency 2 182 kHz;

b) an intership frequency, whenever and wherever traffic density is high and prior arrangements can be made.

(3) Subject to the provisions of § 12.(6), coast stations shall, in accordance with the requirements of their own country, call ship stations of their own nationality either on a working frequency or, when calls to individual ships are made, on the carrier frequency 2 182 kHz.

(4) However, a ship station which keeps watch simultaneously on the carrier frequency 2 182 kHz and a working frequency should be called on the working frequency.

(5) As a general rule, coast stations should call radiotelephone ship stations of another nationality on the carrier frequency 2 182 kHz.

(6) Coast stations may call ship stations equipped to receive selective calls in accordance with Recommendations ITU-R M.257 and ITU-R M.541.

B2. Bands Between 4 000 kHz and 27 500 kHz

§ 13. (1) A ship station calling a coast station by radiotelephony shall use either one of the calling frequencies mentioned in RR No. S52.221 [No. 4375] or the working frequency associated with that of the coast station, in accordance with RR Appendix S17, Part B Section I, [Appendix 16, Section A]

(2) A coast station calling a ship station by radiotelephony shall use one of the calling frequencies mentioned in RR No. S52.222 [No. 4376], one of its working frequencies shown in the List of Coast Stations, or the carrier frequency 4 125 kHz or 6 215 kHz, in accordance with the provisions of RR Nos. S52.221.2 and S52.221.3 [Nos. 4375.2 and 4375.3].

(3) The preliminary operations for the establishment of radiotelephone communications may also be carried out by radiotelegraphy using the procedure appropriate to radiotelegraphy (see Recommendation ITU-R M.1170 § 17).

(4) The provisions of § 13.(1) and § 13.(2) do not apply to communications between ship stations and coast stations using the simplex frequencies specified in RR Appendix S17, Part B, Section I [Appendix 16, Section B].

B3. Bands Between 156 MHz and 174 MHz

§ 14. (1) In the bands between 156 MHz and 174 MHz, intership and coast station to ship calling should, as a general rule, be made on 156.8 MHz. However, coast station to ship calling may be conducted on a working channel or on a two-frequency calling channel which has been implemented in accordance with RR No. S52.236. Except for distress, urgency or safety communications, when 156.8 MHz should be used, ship to coast station calling should, whenever possible, be made on a working channel or on a two-frequency calling channel which has been implemented in accordance with RR No. S52.236 [No. 4391]. Ships wishing to participate in a port operations service or ship movement service should call on a port operations or ship movement working frequency, indicated in heavy type in the List of Coast Stations.

(2) When 156.8 MHz is being used for distress, urgency or safety communications, a ship station desiring to participate in the port operations service may establish contact on 156.6 MHz, or another port operations frequency indicated in heavy type in the List of Coast Stations.

B4. Procedure for Calling a Station Providing Pilot Service

§ 15. A radiotelephone ship station calling a station providing pilot service should use for the call, in order of preference:

a) an appropriate channel in the bands between 156 MHz and 174 MHz;

b) a working frequency in the bands between 1 605 kHz and 4 000 kHz;

c) the carrier frequency 2 182 kHz, and then only to determine the working frequency to be used.

C. Form of Reply to Calls

§ 16. The reply to calls consists of:

– the call sign or other identification of the calling station, not more than three times;

– the words THIS IS (or DE spoken as DELTA ECHO in case of language difficulties);

– the call sign or other identification of the station called, not more than three times.

D. Frequency for Reply

D1. Bands Between 1 605 kHz and 4 000 kHz

§ 17. (1) When a ship station is called on the carrier frequency 2 182 kHz, it should reply on the same carrier frequency unless another frequency is indicated by the calling station.

(2) When a ship station is called by selective calling in accordance with Recommendation ITU-R M.257 it shall reply on a frequency on which the coast station keeps watch.

(3) When a ship station is called on a working frequency by a coast station of the same nationality, it shall reply on the working frequency normally associated with the frequency used by the coast station for the call.

(4) When calling a coast station or another ship station, a ship station shall indicate the frequency on which a reply is required if this frequency is not the normal one associated with the frequency used for the call.

(5) A ship station which frequently exchanges traffic with a coast station of another nationality may use the same procedure for reply as ships of the nationality of the coast station, where this has been agreed by the administrations concerned.

(6) As a general rule a coast station shall reply:

a) on the carrier frequency 2 182 kHz to calls made on the carrier frequency 2 182 kHz, unless another frequency is indicated by the calling station;

b) on a working frequency to calls made on a working frequency;

c) on a working frequency to calls made in Regions 1 and 3 and in Greenland on the carrier frequency 2 191 kHz (assigned frequency 2 192.4 kHz).

D2. Bands Between 4 000 kHz
and 27 500 kHz

§ 18. (1) A ship station called by a coast station shall reply either on one of the calling frequencies mentioned in RR No. S52.221 [No. 4375] or on the working frequency associated with that of the coast station, in accordance with RR Appendix S17, Part B, Section I [Appendix 16, Section A].

(2) A coast station called by a ship station shall reply on one of the calling frequencies mentioned in RR No. S52.222 [No. 4376], or on one of its working frequencies shown in the List of Coast Stations.

(3) When a station is called on the carrier frequency 4 125 kHz it should reply on the same frequency unless another frequency is indicated for that purpose by the calling station.

(4) When a station is called on the carrier frequency 6 215 kHz it should reply on the same frequency unless another frequency is indicated for that purpose by the calling station.

(5) The provisions of § 18.(1) and § 18.(2) do not apply to communication between ship stations and coast stations using the simplex frequencies specified in RR Appendix S17, Part B, Section I [Appendix 16, Section B].

D3. Bands Between 156 MHz and 174 MHz

§ 19. (1) When a station is called on 156.8 MHz it should reply on the same frequency unless another frequency is indicated by the calling station.

(2) When a coast station open to public correspondence calls a ship either by speech or by selective calling in accordance with Annex 2 to Recommendation ITU-R M.257, using a two-frequency channel, the ship station shall reply by speech on the frequency associated with that of the coast station; conversely, a coast station shall reply to a call from a ship station on the frequency associated with that of the ship station.

E. Indication of the Frequency to Be Used for Traffic

E1. Bands Between 1 605 kHz and 4 000 kHz

§ 20. If contact is established on the carrier frequency 2 182 kHz, coast and ship stations shall transfer to working frequencies for the exchange of traffic.

E2. Bands Between 4 000 kHz
and 27 500 kHz

§ 21. After a ship station has established contact with a coast station, or another ship station, on the calling frequency of the band chosen, traffic shall be exchanged on their respective working frequencies.

E3. Bands Between 156 MHz and 174 MHz

§ 22. (1) Whenever contact has been established between a coast station in the public correspondence service and a ship station either on 156.8 MHz or on a two-frequency calling channel (see RR No. S52.237 [No. 4392]), the stations shall transfer to one of their normal pairs of working frequencies for the exchange of traffic. The calling station should indicate the channel to which it is proposed to transfer by reference to the frequency in MHz or, preferably, to its channel designator.

(2) When contact on 156.8 MHz has been established between a coast station in the port operations service and a ship station, the ship station should indicate the particular service required (such as navigational information, docking instructions, etc.) and the coast station shall then indicate the channel to be used for the exchange of traffic by reference to the frequency in MHz, or, preferably, to its channel designator.

(3) When contact on 156.8 MHz has been established between a coast station in the ship movement service and a ship station, the coast station shall then indicate the channel to be used for the exchange of traffic by reference to the frequency in MHz or, preferably, to its channel designator.

(4) A ship station, when it has established contact with another ship station on 156.8 MHz, should indicate the intership channel to which it is proposed to transfer for the exchange of traffic by reference to the frequency in MHz or, preferably, to its channel designator.

(5) However, a brief exchange of traffic not to exceed one minute concerning the safety of navigation need not be transmitted on a working frequency when it is important that all ships within range receive the transmission.

(6) Stations hearing a transmission concerning the safety of navigation shall listen to the message until they are satisfied that the message is of no concern to them. They shall not make any transmission likely to interfere with the message.

F. Agreement on the Frequency to Be Used for Traffic

§ 23. (1) If the station called is in agreement with the calling station, it shall transmit:

a) an indication that from that moment onwards it will listen on the working frequency or channel announced by the calling station;

b) an indication that it is ready to receive the traffic of the calling station.

(2) If the station called is not in agreement with the calling station on the working frequency or channel to be used, it shall transmit an indication of the working frequency or channel proposed.

(3) For communications between a coast station and a ship station, the coast station shall finally decide the frequency or channel to be used.

(4) When agreement is reached regarding the working frequency or channel which the calling station shall use for its traffic, the station called shall indicate that it is ready to receive the traffic.

G. Indication of Traffic

§ 24. When the calling station wishes to exchange more than one radiotelephone call, or to transmit one or more radiotelegrams, it should indicate this when contact is established with the station called.

H. Difficulties in Reception

§ 25. (1) If the station called is unable to accept traffic immediately, it should reply to the call as indicated in § 16 followed by “Wait . . . minutes” (or $\overline{\text{AS}}$ spoken as ALFA SIERRA . . . (minutes) in case of language difficulties), indicating the probable duration of waiting time in minutes. If the probable duration exceeds ten minutes the reason for the delay shall be given. Alternatively the station called may indicate, by any appropriate means, that it is not ready to receive traffic immediately.

(2) When a station receives a call without being certain that such a call is intended for it, it shall not reply until the call has been repeated and understood.

(3) When a station receives a call which is intended for it, but is uncertain of the identification of the calling station, it shall reply immediately asking for a repetition of the call sign or other identification of the calling station.

Section IV. Forwarding (Routing) of Traffic

A. Traffic Frequency

§ 26. (1) Every station should transmit its traffic (radiotelephone calls or radiotelegrams) on one of its working frequencies in the band in which the call has been made.

(2) In addition to its normal working frequency, printed in heavy type in the List of Coast Stations, a coast station may use one or more supplementary frequencies in the same band, in accordance with the provisions of RR Article S52 [Article 60].

(3) The use of frequencies reserved for calling shall be forbidden for traffic, except distress traffic (see RR Appendix S13 [Chapter IX]).

(4) After contact has been established on the frequency to be used for traffic, the transmission of a radiotelegram or radiotelephone call shall be preceded by:

– the call sign or other identification of the station called;

– the words THIS IS (or DE spoken as DELTA ECHO in case of language difficulties);

– the call sign or other identification of the calling station.

(5) The call sign or other identification need not be sent more than once.

B. Establishment of Radiotelephone Calls
and Transmission of Radiotelegrams

B1. Establishment of Radiotelephone Calls

§ 27. (1) In setting up a radiotelephone call, the coast station should establish connection with the telephone network as quickly as possible. In the meantime, the ship station shall maintain watch on the appropriate working frequency as indicated by the coast station.

(2) However, if the connection cannot be quickly established, the coast station shall inform the ship station accordingly. The latter station shall then either:

a) maintain watch on the appropriate frequency until an effective circuit can be established; *or*

b) contact the coast station later at a mutually agreed time.

(3) When a radiotelephone call has been completed, the procedure indicated in § 29.(3) shall be applied unless further calls are on hand at either station.

B2. Transmission of Radiotelegrams

§ 28. (1) The transmission of a radiotelegram should be made as follows:

– radiotelegram begins: from . . . (name of ship or aircraft);

– number . . . (serial number of radiotelegram);

– number of words . . . ;

– date . . . ;

– time . . . (time radiotelegram was handed in aboard ship or aircraft);

– service indicators (if any);

– address . . . ;

– text . . . ;

– signature . . . (if any);

– radiotelegram ends, over.

(2) As a general rule, radiotelegrams of all kinds transmitted by ship stations shall be numbered in a daily series; number 1 shall be given to the first radiotelegram sent each day to each separate station.

(3) A series of numbers which has begun in radiotelegraphy should be continued in radiotelephony and vice versa.

(4) Each radiotelegram should be transmitted once only by the sending station. However, it may, when necessary, be repeated in full or in part by the receiving or the sending station.

(5) In transmitting groups of figures, each figure shall be spoken separately and the transmission of each group or series of groups shall be preceded by the words “in figures”.

(6) Numbers written in letters shall be spoken as they are written, their transmission being preceded by the words “in letters”.

B3. Acknowledgement of Receipt

§ 29. (1) The acknowledgement of receipt of a radiotelegram or a series of radiotelegrams shall be given by the receiving station in the following manner:

– the call sign or other identification of the sending station;

– the words THIS IS (or DE spoken as DELTA ECHO in case of language difficulties);

– the call sign or other identification of the receiving station;

– “Your No. . . . received, over” (or R spoken as ROMEO . . . (number), K spoken as KILO in case of language difficulties); *or*

` – “Your No. . . . to No. . . . received, over” (or R spoken as ROMEO . . . (numbers), K spoken as KILO in case of language difficulties).

(2) The radiotelegram, or series of radiotelegrams, shall not be considered as cleared until this acknowledgement has been received.

(3) The end of work between two stations shall be indicated by each of them by means of the word “Out” (or $\overline{\text{VA}}$ spoken as VICTOR ALFA in case of language difficulties).

Section V. Duration and Control of Working

§ 30. (1) In communications between coast stations and ship stations, the ship station shall comply with the instructions given by the coast station in all questions relating to the order and time of transmission, to the choice of frequency, and to the duration and suspension of work.

(2) In communications between ship stations, the station called controls the working in the manner indicated in § 30.(1) above. However, if a coast station finds it necessary to intervene, the ship stations shall comply with the instructions given by the coast station.

RECOMMENDATION ITU-R M.1172*

MISCELLANEOUS ABBREVIATIONS AND SIGNALS TO BE USED FOR RADIOCOMMUNICATIONS IN THE MARITIME MOBILE SERVICE

(1995)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe miscellaneous abbreviations and signals to be used in the maritime mobile service,

recommends

1 that the use of miscellaneous abbreviations and signals for radiocommunications in the maritime mobile service be in accordance with Annex 1.

ANNEX 1

Miscellaneous abbreviations and signals to be used for radiocommunications in the maritime mobile service

Section I. Q Code

Introduction

1 The series of groups listed in this Annex range from QOA to QUZ.

2 The QOA to QQZ series are reserved for the maritime mobile service.

3 Certain Q code abbreviations may be given an affirmative or negative sense by sending, immediately following the abbreviation, the letter C or the letters NO (in radiotelephony spoken as: CHARLIE or NO).

4 The meanings assigned to Q code abbreviations may be amplified or completed by the appropriate addition of other groups, call signs, place names, figures, numbers, etc. It is optional to fill in the blanks shown in parentheses. Any data which are filled in where blanks appear shall be sent in the same order as shown in the text of the following tables.

5 Q code abbreviations are given the form of a question when followed by a question mark in radiotelegraphy and RQ (ROMEO QUEBEC) in radiotelephony. When an abbreviation is used as a question and is followed by additional or complementary information, the question mark (or RQ) should follow this information.

6 Q code abbreviations with numbered alternative significations shall be followed by the appropriate figure to indicate the exact meaning intended. This figure shall be sent immediately following the abbreviation.

7 All times shall be given in Coordinated Universal Time (UTC) unless otherwise indicated in the question or reply.

8 An asterisk * following a Q code abbreviation means that this signal has a meaning similar to a signal appearing in the International Code of Signals.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO).

Abbreviations Available for the Maritime Mobile Service

A. List of Abbreviations in Alphabetical Order

Abbreviation	Question	Answer or Advice
QOA	Can you communicate by radiotelegraphy (500 kHz)?	I can communicate by radiotelegraphy (500 kHz).
QOB	Can you communicate by radiotelephony (2 182 kHz)?	I can communicate by radiotelephony (2 182 kHz).
QOC	Can you communicate by radiotelephony (channel 16 – frequency 156.80 MHz)?	I can communicate by radiotelephony (channel 16 – frequency 156.80 MHz).
QOD	Can you communicate with me in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish?	I can communicate with you in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish.
QOE	Have you received the safety signal sent by … *(name and/or call sign)*?	I have received the safety signal sent by … *(name and/or call sign)*.
QOF	What is the commercial quality of my signals?	The quality of your signals is … 1. not commercial 2. marginally commercial 3. commercial.
QOG	How many tapes have you to send?	I have … tapes to send.
QOH	Shall I send a phasing signal for … seconds?	Send a phasing signal for … seconds.
QOI	Shall I send my tape?	Send your tape.
QOJ	Will you listen on … kHz (*or* MHz) for signals of emergency position-indicating radiobeacons?	I am listening on … kHz (*or* MHz) for signals of emergency position-indicating radiobeacons.

Abbre-viation	Question	Answer or Advice
QOK	Have you received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz)?	I have received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz).
QOL	Is your vessel fitted for reception of selective calls? If so, what is your selective call number or signal?	My vessel is fitted for the reception of selective calls. My selective call number or signal is …
QOM	On what frequencies can your vessel be reached by a selective call?	My vessel can be reached by a selective call on the following frequency/ies … (periods of time to be added if necessary).
QOO	Can you send on any working frequency?	I can send on any working frequency.
QOT	Do you hear my call; what is the approximate delay in minutes before we may exchange traffic?	I hear your call; the approximate delay is … minutes.
QRA	What is the name of your vessel (*or* station)?	The name of my vessel (*or* station) is …
QRB	How far approximately are you from my station?	The approximate distance between our stations is … nautical miles (*or* kilometres).
QRC	By what private enterprise (*or* state administration) are the accounts for charges for your station settled?	The accounts for charges of my station are settled by the private enterprise … (*or* state administration).
QRD	Where are you bound for and where are you from?	I am bound for … from …
QRE	What is your estimated time of arrival at … (*or* over …) *(place)*?	My estimated time of arrival at … (*or* over …) *(place)* is … hours.
QRF	Are you returning to … *(place)*?	I am returning to … *(place)*. *or* Return to ... (*place*).

Abbre-viation	Question	Answer or Advice
QRG	Will you tell me my exact frequency (*or* that of …)?	Your exact frequency (*or* that of …) is ... kHz (*or* MHz).
QRH	Does my frequency vary?	Your frequency varies.
QRI	How is the tone of my transmission?	The tone of your transmission is … 1. good 2. variable 3. bad.
QRJ	How many radiotelephone calls have you to book?	I have … radiotelephone calls to book.
QRK	What is the intelligibility of my signals (*or* those of … *(name and/or call sign)*)?	The intelligibility of your signals (*or* those of … *(name and/or call sign*)) is … 1. bad 2. poor 3. fair 4. good 5. excellent.
QRL	Are you busy?	I am busy (*or* I am busy with … *(name and/or call sign)*). Please do not interfere.
QRM	Is my transmission being interfered with?	Your transmission is being interfered with … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.
QRN	Are you troubled by static?	I am troubled by static … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.

Abbre-viation	Question	Answer or Advice
QRO	Shall I increase transmitter power?	Increase transmitter power.
QRP	Shall I decrease transmitter power?	Decrease transmitter power.
QRQ	Shall I send faster?	Send faster (… words per minute).
QRR	Are you ready for automatic operation?	I am ready for automatic operation. Send at … words per minute.
QRS	Shall I send more slowly?	Send more slowly (… words per minute).
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready.
QRW	Shall I inform … that you are calling him on … kHz (*or* MHz)?	Please inform … that I am calling him on … kHz (*or* MHz).
QRX	When will you call me again?	I will call you again at … hours on … kHz (*or* MHz).
QRY	What is my turn? *(Relates to communication.)*	Your turn is Number … *(or according to any other indication). (Relates to communication.)*
QRZ	Who is calling me?	You are being called by … (on … kHz(*or* MHz)).
QSA	What is the strength of my signals (*or* those of … *(name and/or call sign)*)?	The strength of your signals (*or* those of … *(name and/or call sign)*) is … 1. scarcely perceptible 2. weak 3. fairly good 4. good 5. very good.

Abbre-viation	Question	Answer or Advice
QSB	Are my signals fading?	Your signals are fading.
QSC	Are you a low traffic ship station?	I am a low traffic ship station.
QSD	Are my signals mutilated?	Your signals are mutilated.
QSE*	What is the estimated drift of the survival craft?	The estimated drift of the survival craft is … *(figures and units)*.
QSF*	Have you effected rescue?	I have effected rescue and am proceeding to … base (with … persons injured requiring ambulance).
QSG	Shall I send … telegrams at a time?	Send … telegrams at a time.
QSH	Are you able to home with your direction-finding equipment?	I am able to home with my direction-finding equipment (on … *(name and/or call sign)*).
QSI		I have been unable to break in on your transmission. *or* Will you inform … *(name and/or call sign)* that I have been unable to break in on his transmission (on … kHz (*or* MHz)).
QSJ	What is the charge to be collected to … including your internal charge?	The charge to be collected to … including my internal charge is … francs.
QSK	Can you hear me between your signals and if so may I break in on your transmission?	I can hear you between my signals; break in on my transmission.
QSL	Can you acknowledge receipt?	I am acknowledging receipt.

Abbre-viation	Question	Answer or Advice
QSM	Shall I repeat the last telegram which I sent you (*or* some previous telegram)?	Repeat the last telegram which you sent me (*or* telegram(s) number(s) …).
QSN	Did you hear me (*or* … *(name and/or call sign)*) on … kHz (*or* MHz)?	I did hear you (*or* … *(name and/or call sign)*) on … kHz (*or* MHz).
QSO	Can you communicate with … *(name and/or call sign)* direct (*or* by relay)?	I can communicate with … *(name and/or call sign)* direct (*or* by relay through …).
QSP	Will you relay to … *(name and/or call sign)* free of charge?	I will relay to … *(name and/or call sign)* free of charge.
QSQ	Have you a doctor on board (*or* is … *(name of person)* on board)?	I have a doctor on board (*or* … *(name of person)* is on board).
QSR	Shall I repeat the call on the calling frequency?	Repeat your call on the calling frequency; did not hear you (*or* have interference).
QSS	What working frequency will you use?	I will use the working frequency … kHz (*or* MHz) *(in the high frequency bands normally only the last three figures of the frequency need be given)*.
QSU	Shall I send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	Send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSV	Shall I send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz))?	Send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz)).

Abbre-viation	Question	Answer or Advice
QSW	Will you send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	I am going to send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSX	Will you listen to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …?	I am listening to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …
QSY	Shall I change to transmission on another frequency?	Change to transmission on another frequency (*or* on … kHz (*or* MHz)).
QSZ	Shall I send each word or group more than once?	Send each word or group twice (*or* … times).
QTA	Shall I cancel telegram (*or* message) number …?	Cancel telegram (*or* message) number …
QTB	Do you agree with my counting of words?	I do not agree with your counting of words; I will repeat the first letter or digit of each word or group.
QTC	How many telegrams have you to send?	I have … telegrams for you (*or* for … *(name and/or call sign)*).
QTD*	What has the rescue vessel or rescue aircraft recovered?	… *(identification)* has recovered… 1. … *(number)* survivors 2. wreckage 3. … *(number)* bodies.
QTE	What is my TRUE bearing from you? *or* What is my TRUE bearing from … *(name and/or call sign)*? *or*	Your TRUE bearing from me is … degrees at … hours. *or* Your TRUE bearing from … *(name and/or call sign)* was … degrees at … hours. *or*

Abbre-viation	Question	Answer or Advice
QTE (cont.)	What is the TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)*?	The TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)* was … degrees at … hours.
QTF	Will you give me my position according to the bearings taken by the direction-finding stations which you control?	Your position according to the bearings taken by the direction-finding stations which I control was … latitude, … longitude *(or other indication of position)*, class … at … hours.
QTG	Will you send two dashes of ten seconds each (*or* carrier) followed by your call sign (*or* name) (repeated … times) on … kHz (or MHz)? *or* Will you request … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign *(and/or name)* (repeated … times) on … kHz (*or* MHz)?	I am going to send two dashes of ten seconds each (*or* carrier) followed by my call sign (*or* name) (repeated … times) on … kHz (*or* MHz). *or* I have requested … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign *(and/or name)* (repeated … times) on ... kHz (*or* MHz).
QTH	What is your position in latitude and longitude *(or according to any other indication)*?	My position is … latitude, … longitude *(or according to any other indication).*
QTI*	What is your TRUE course?	My TRUE course is … degrees.

Abbre-viation	Question	Answer or Advice
QTJ*	What is your speed? *(Requests the speed of a ship or aircraft through the water or air respectively.)*	My speed is … knots (*or* kilometres per hour *or* … statute miles per hour). *(Indicates the speed of a ship or aircraft through the water or air respectively.)*
QTK*	What is the speed of your aircraft in relation to the surface of the Earth?	The speed of my aircraft in relation to the surface of the Earth is … knots (*or* … kilometres per hour *or* … statute miles per hour).
QTL*	What is your TRUE heading?	My TRUE heading is … degrees.
QTM*	What is your MAGNETIC heading?	My MAGNETIC heading is … degrees.
QTN	At what time did you depart from … *(place)*?	I departed from … *(place)* at … hours.
QTO	Have you left dock (*or* port)? *or* Are you airborne?	I have left dock (*or* port). *or* I am airborne.
QTP	Are you going to enter dock (*or* port)? *or* Are you going to alight (*or* land)?	I am going to enter dock (*or* port). *or* I am going to alight (*or* land).
QTQ	Can you communicate with my station by means of the International Code of Signals (INTERCO)?	I am going to communicate with your station by means of the International Code of Signals (INTERCO).
QTR	What is the correct time?	The correct time is … hours.
QTS	Will you send your call sign (*and/or* name) for … seconds?	I will send my call sign (*and/or* name) for … seconds.
QTT		The identification signal which follows is superimposed on another transmission.

Abbre-viation	Question	Answer or Advice
QTU	What are the hours during which your station is open?	My station is open from … to … hours.
QTV	Shall I stand guard for you on the frequency of … kHz (*or* MHz) (from … to … hours)?	Stand guard for me on the frequency of … kHz (*or* MHz) (from … to … hours).
QTW*	What is the condition of survivors?	Survivors are in … condition and urgently need …
QTX	Will you keep your station open for further communication with me until further notice (*or* until … hours)?	I will keep my station open for further communication with you until further notice (*or* until … hours).
QTY*	Are you proceeding to the position of incident and if so when do you expect to arrive?	I am proceeding to the position of incident and expect to arrive at … hours (on ... *(date)*).
QTZ*	Are you continuing the search?	I am continuing the search for … (aircraft, ship, survival craft, survivors or wreckage).
QUA	Have you news of … *(name and/or call sign)*?	Here is news of … *(name and/or call sign)*.
QUB*	Can you give me in the following order information concerning: the direction in degrees TRUE and speed of the surface wind; visibility; present weather; and amount, type and height of base of cloud above surface elevation at … *(place of observation)*?	Here is the information requested: … *(The units used for speed and distances should be indicated.)*

Abbre-viation	Question	Answer or Advice
QUC	What is the number *(or other indication)* of the last message you received from me (*or* from … *(name and/or call sign)*)?	The number *(or other indication)* of the last message I received from you (*or* from … *(name and/or call sign)*) is …
QUD	Have you received the urgency signal sent by … *(name and/or call sign)*?	I have received the urgency signal sent by … *(name and/or call sign)* at … hours.
QUE	Can you speak in … *(language)*, with interpreter if necessary; if so, on what frequencies?	I can speak in … *(language)* on … kHz (*or* MHz).
QUF	Have you received the distress signal sent by … *(name and/or call sign)*?	I have received the distress signal sent by … *(name and/or call sign)* at … hours.
QUH*	Will you give me the present barometric pressure at sea level?	The present barometric pressure at sea level is … *(units)*.
QUM	May I resume normal working?	Normal working may be resumed.
QUN	1. *When directed to all stations:* Will vessels in my immediate vicinity … *or* (in the vicinity of … latitude, … longitude) *or* (in the vicinity of …) please indicate their position, TRUE course and speed? 2. *When directed to a single station:* Please indicate your position, TRUE course and speed.	My position, TRUE course and speed are …

Abbre-viation	Question	Answer or Advice
QUO*	Shall I search for…. 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*?	Please search for … 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*.
QUP*	Will you indicate your position by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights?	My position is indicated by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights.
QUR*	Have survivors … 1. received survival equipment 2. been picked up by rescue vessel 3. been reached by ground rescue party?	Survivors ... 1. are in possession of survival equipment dropped by … 2. have been picked up by rescue vessel 3. have been reached by ground rescue party.
QUS*	Have you sighted survivors or wreckage? If so, in what position?	Have sighted … 1. survivors in water 2. survivors on rafts 3. wreckage in position … latitude, … longitude *(or according to any other indication)*.
QUT*	Is position of incident marked?	Position of incident is marked by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.

Abbre-viation	Question	Answer or Advice
QUU*	Shall I home ship or aircraft to my position?	Home ship or aircraft … *(name and/or call sign)* … 1. to your position by sending your call sign and long dashes on … kHz (*or* MHz) 2. by sending on … kHz (*or* MHz) TRUE track to reach you.
QUW*	Are you in the search area designated as … *(designator or latitude and longitude)*?	I am in the … *(designation)* search area.
QUX	Do you have any navigational warnings or gale warnings in force?	I have the following navigational warning(s) or gale warning(s) in force: …
QUY*	Is position of survival craft marked?	Position of survival craft was marked at … hours by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.

B. List of Signals According to the Nature of Questions, Answer or Advice

Abbre-viation	Question	Answer or Advice
	Name	
QRA	What is the name of your vessel (*or* station)?	The name of my vessel (*or* station) is …
	Route	
QRD	Where are you bound for and where are you from?	I am bound for … from …
	Position	
QRB	How far approximately are you from my station?	The approximate distance between our stations is … nautical miles (*or* kilometres).
QTH	What is your position in latitude and longitude *(or according to any other indication)*?	My position is … latitude, … longitude *(or according to any other indication)*.
QTN	At what time did you depart from … *(place)*?	I departed from … *(place)* at … hours.
	Quality of Signals	
QOF	What is the commercial quality of my signals?	The quality of your signals is … 1. not commercial 2. marginally commercial 3. commercial.
QRI	How is the tone of my transmission?	The tone of your transmission is… 1. good 2. variable 3. bad.

Abbreviation	Question	Answer or Advice
	Quality of Signals (cont.)	
QRK	What is the intelligibility of my signals (*or* those of … *(name and/or call sign)*)?	The intelligibility of your signals (*or* those of … *(name and/or call sign)*) is … 1. bad 2. poor 3. fair 4. good 5. excellent.
	Strength of Signals	
QRO	Shall I increase transmitter power?	Increase transmitter power.
QRP	Shall I decrease transmitter power?	Decrease transmitter power.
QSA	What is the strength of my signals (*or* those of … *(name and/or call sign)*)?	The strength of your signals (*or* those of … *(name and/or call sign)*) is … 1. scarcely perceptible 2. weak 3. fairly good 4. good 5. very good.
QSB	Are my signals fading?	Your signals are fading.
	Keying	
QRQ	Shall I send faster?	Send faster (… words per minute).
QRR	Are you ready for automatic operation?	I am ready for automatic operation. Send at … words per minute.

Abbre-viation	Question	Answer or Advice
	Keying (cont.)	
QRS	Shall I send more slowly?	Send more slowly (… words per minute).
QSD	Are my signals mutilated?	Your signals are mutilated.
	Interference	
QRM	Is my transmission being interfered with?	Your transmission is being interfered with … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.
QRN	Are you troubled by static?	I am troubled by static … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.
	Adjustment of Frequency	
QRG	Will you tell me my exact frequency (*or* that of …)?	Your exact frequency (*or* that of …) is … kHz (*or* MHz).
QRH	Does my frequency vary?	Your frequency varies.
QTS	Will you send your call sign *(and/or name)* for … seconds?	I will send my call sign *(and/or name)* for … seconds.
	Choice of Frequency and/or Class of Emission	
QOO	Can you send on any working frequency?	I can send on any working frequency.

Abbre-viation	Question	Answer or Advice
	Choice of Frequency and/or Class of Emission (cont.)	
QSN	Did you hear me (*or* … *(name and/or call sign)*) on … kHz (*or* MHz)?	I did hear you (*or* … *(name and/or call sign)*) on … kHz (*or* MHz).
QSS	What working frequency will you use?	I will use the working frequency … kHz (*or* MHz) *(in the high frequency bands normally only the last three figures of the frequency need be given)*.
QSU	Shall I send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	Send or reply on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSV	Shall I send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz))?	Send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (*or* MHz)).
QSW	Will you send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	I am going to send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSX	Will you listen to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …?	I am listening to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/ channels …
	Change of Frequency	
QSY	Shall I change to transmission on another frequency?	Change to transmission on another frequency (*or* on … kHz (*or* MHz)).
	Establishing Communication	
QOA	Can you communicate by radiotelegraphy (500 kHz)?	I can communicate by radiotelegraphy (500 kHz).

Abbreviation	Question	Answer or Advice
	Establishing Communication (cont.)	
QOB	Can you communicate by radiotelephony (2 182 kHz)?	I can communicate by radiotelephony (2 182 kHz).
QOC	Can you communicate by radiotelephony (channel 16 – frequency 156.80 MHz)?	I can communicate by radiotelephony (channel 16 – frequency 156.80 MHz).
QOD	Can you communicate with me in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish?	I can communicate with you in … 0. Dutch 5. Italian 1. English 6. Japanese 2. French 7. Norwegian 3. German 8. Russian 4. Greek 9. Spanish.
QOT	Do you hear my call; what is the approximate delay in minutes before we may exchange traffic?	I hear your call; the approximate delay is … minutes.
QRL	Are you busy?	I am busy (*or* I am busy with … *(name and/or call sign)*). Please do not interfere.
QRV	Are you ready?	I am ready.
QRX	When will you call me again?	I will call you again at … hours on … kHz (*or* MHz).
QRY	What is my turn? *(Relates to communication.)*	Your turn is Number … *(or according to any other indication). (Relates to communication.)*
QRZ	Who is calling me?	You are being called by … (on … kHz (*or* MHz)).
QSC	Are you a low traffic ship station?	I am a low traffic ship station.

Abbre-viation	Question	Answer or Advice
	Establishing Communication (cont.)	
QSR	Shall I repeat the call on the calling frequency?	Repeat your call on the calling frequency; did not hear you (*or* have interference).
QTQ	Can you communicate with my station by means of the International Code of Signals (INTERCO)?	I am going to communicate with your station by means of the International Code of Signals (INTERCO).
QUE	Can you speak in … *(language)*, with interpreter if necessary; if so, on what frequencies?	I can speak in … *(language)* on … kHz (*or* MHz).
	Selective Calls	
QOL	Is your vessel fitted for reception of selective calls? If so, what is your selective call number or signal?	My vessel is fitted for the reception of selective calls. My selective call number or signal is …
QOM	On what frequencies can your vessel be reached by a selective call?	My vessel can be reached by a selective call on the following frequency/ies … (periods of time to be added if necessary).
	Time	
QTR	What is the correct time?	The correct time is ... hours.
QTU	What are the hours during which your station is open?	My station is open from … to … hours.
	Charges	
QRC	By what private enterprise (*or* state administration) are the accounts for charges for your station settled?	The accounts for charges of my station are settled by the private enterprise … (*or* state administration).

Abbre-viation	Question	Answer or Advice
	Charges (cont.)	
QSJ	What is the charge to be collected to … including your internal charge?	The charge to be collected to … including my internal charge is … francs.
	Transit	
QRW	Shall I inform … that you are calling him on … kHz (*or* MHz)?	Please inform … that I am calling him on … kHz (*or* MHz).
QSO	Can you communicate with … *(name and/or call sign)* direct (*or* by relay)?	I can communicate with … *(name and/or call sign)* direct (*or* by relay through …).
QSP	Will you relay to … *(name and/or call sign)* free of charge?	I will relay to … *(name and/or call sign)* free of charge.
QSQ	Have you a doctor on board (*or* is … *(name of person)* on board)?	I have a doctor on board (*or* … *(name of person)* is on board).
QUA	Have you news of … *(name and/or call sign)*?	Here is news of … *(name and/or call sign)*.
QUC	What is the number *(or other indication)* of the last message you received from me (*or* from … *(name and/or call sign)*)?	The number *(or other indication)* of the last message I received from you (*or* from … *(name and/or call sign)*) is ...
	Exchange of Correspondence	
QOG	How many tapes have you to send?	I have … tapes to send.
QOH	Shall I send a phasing signal for … seconds?	Send a phasing signal for … seconds.

Abbre-viation	Question	Answer or Advice
	Exchange of Correspondence (cont.)	
QOI	Shall I send my tape?	Send your tape.
QRJ	How many radiotelephone calls have you to book?	I have … radiotelephone calls to book.
QRU	Have you anything for me?	I have nothing for you.
QSG	Shall I send … telegrams at a time?	Send … telegrams at a time.
QSI		I have been unable to break in on your transmission. *or* Will you inform … *(name and/or call sign)* that I have been unable to break in on his transmission (on … kHz (*or* MHz)).
QSK	Can you hear me between your signals and if so may I break in on your transmission?	I can hear you between my signals; break in on my transmission.
QSL	Can you acknowledge receipt?	I am acknowledging receipt.
QSM	Shall I repeat the last telegram which I sent you (*or* some previous telegram)?	Repeat the last telegram which you sent me (*or* telegram(s) number(s) …).
QSZ	Shall I send each word or group more than once?	Send each word or group twice (*or* … times).
QTA	Shall I cancel telegram (*or* message) number …?	Cancel telegram (*or* message) number …
QTB	Do you agree with my counting of words?	I do not agree with your counting of words; I will repeat the first letter or digit of each word or group.

Abbre-viation	Question	Answer or Advice
	Exchange of Correspondence (cont.)	
QTC	How many telegrams have you to send?	I have … telegrams for you (*or* for … *(name and/or call sign)*).
QTV	Shall I stand guard for you on the frequency of … kHz (*or* MHz) (from … to … hours)?	Stand guard for me on the frequency of … kHz (*or* MHz) (from … to … hours).
QTX	Will you keep your station open for further communication with me until further notice (*or* until … hours)?	I will keep my station open for further communication with you until further notice (*or* until … hours).
	Movement	
QRE	What is your estimated time of arrival at … (*or* over …) *(place)*?	My estimated time of arrival at … (*or* over …) *(place)* is … hours.
QRF	Are you returning to … *(place)*?	I am returning to … *(place)*. *or* Return to … *(place)*.
QSH	Are you able to home with your direction-finding equipment?	I am able to home with my direction-finding equipment (on … *(name and/or call sign)*).
QTI*	What is your TRUE course?	My TRUE course is … degrees.
QTJ*	What is your speed? *(Requests the speed of a ship or aircraft through the water or air respectively.)*	My speed is … knots (*or* kilometres per hour *or* … statute miles per hour). *(Indicates the speed of a ship or aircraft through the water or air respectively.)*

Abbre-viation	Question	Answer or Advice
	Movement (cont.)	
QTK*	What is the speed of your aircraft in relation to the surface of the Earth?	The speed of my aircraft in relation to the surface of the Earth is … knots (*or* … kilometres per hour *or* … statute miles per hour).
QTL*	What is your TRUE heading?	My TRUE heading is … degrees.
QTM*	What is your MAGNETIC heading?	My MAGNETIC heading is … degrees.
QTN	At what time did you depart from … *(place)*?	I departed from … *(place)* at … hours.
QTO	Have you left dock (*or* port)? *or* Are you airborne?	I have left dock (*or* port). *or* I am airborne.
QTP	Are you going to enter dock (*or* port)? *or* Are you going to alight (*or* land)?	I am going to enter dock (*or* port). *or* I am going to alight (*or* land).
QUN	1. *When directed to all stations:* Will vessels in my immediate vicinity … *or* (in the vicinity of … latitude, … longitude) *or* (in the vicinity of …) please indicate their position, TRUE course and speed? 2. *When directed to a single station:* Please indicate your position, TRUE course and speed.	My position, TRUE course and speed are …

Abbre-viation	Question	Answer or Advice
	Meteorology	
QUB*	Can you give me in the following order information concerning: the direction in degrees TRUE and speed of the surface wind; visibility; present weather; and amount, type and height of base of cloud above surface elevation at … *(place of observation)*?	Here is the information requested: … *(The units used for speed and distances should be indicated.)*
QUH*	Will you give me the present barometric pressure at sea level?	The present barometric pressure at sea level is … *(units).*
QUX	Do you have any navigational warnings or gale warnings in force?	I have the following navigational warning(s) or gale warning(s) in force: …
	Radio Direction-Finding	
QTE	What is my TRUE bearing from you?	Your TRUE bearing from me is … degrees at … hours.
	or	*or*
	What is my TRUE bearing from … *(name and/or call sign)*?	Your TRUE bearing from … *(name and/or call sign)* was … degrees at … hours.
	or	*or*
	What is the TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)*?	The TRUE bearing of … *(name and/or call sign)* from … *(name and/or call sign)* was … degrees at … hours.

Abbre-viation	Question	Answer or Advice
	Radio Direction-Finding (cont.)	
QTF	Will you give me my position according to the bearings taken by the direction-finding stations which you control?	Your position according to the bearings taken by the direction-finding stations which I control was … latitude, … longitude *(or other indication of position)*, class … at … hours.
QTG	Will you send two dashes of ten seconds each (*or* carrier) followed by your call sign (*or* name) (repeated … times) on … kHz (*or* MHz)?	I am going to send two dashes of ten seconds each (*or* carrier) followed by my call sign (*or* name) (repeated … times) on … kHz (*or* MHz).
	or	*or*
	Will you request … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign (*and/or* name) (repeated … times) on … kHz (*or* MHz)?	I have requested … *(name and/or call sign)* to send two dashes of ten seconds each (*or* carrier) followed by his call sign (*and/or* name) (repeated … times) on … kHz (*or* MHz).
	Suspension of Work	
QRT	Shall I stop sending?	Stop sending.
QUM	May I resume normal working?	Normal working may be resumed.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.
	Safety	
QOE	Have you received the safety signal sent by … *(name and/or call sign)*?	I have received the safety signal sent by … *(name and/or call sign)*.

Abbre-viation	Question	Answer or Advice
	Safety (cont.)	
QUX	Do you have any navigational warnings or gale warnings in force?	I have the following navigational warning(s) or gale warning(s) in force: …
	Urgency	
QUD	Have you received the urgency signal sent by … *(name and/or call sign)*?	I have received the urgency signal sent by … *(name and/or call sign)* at … hours.
	Distress	
QOJ	Will you listen on … kHz (*or* MHz) for signals of emergency position-indicating radiobeacons?	I am listening on … kHz (*or* MHz) for signals of emergency position-indicating radiobeacons.
QOK	Have you received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz)?	I have received the signals of an emergency position-indicating radiobeacon on … kHz (*or* MHz).
QUF	Have you received the distress signal sent by … *(name and/or call sign)*?	I have received the distress signal sent by … *(name and/or call sign)* at … hours.
QUM	May I resume normal working?	Normal working may be resumed.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.
	Search and Rescue	
QSE*	What is the estimated drift of the survival craft?	The estimated drift of the survival craft is … *(figures and units)*.

Abbre-viation	Question	Answer or Advice
	Search and Rescue (cont.)	
QSF*	Have you effected rescue?	I have effected rescue and am proceeding to … base (with … persons injured requiring ambulance).
QTD*	What has the rescue vessel or rescue aircraft recovered?	… *(identification)* has recovered… 1.…. *(number)* survivors 2. wreckage 3. … *(number)* bodies.
QTW*	What is the condition of survivors?	Survivors are in … condition and urgently need …
QTY*	Are you proceeding to the position of incident and if so when do you expect to arrive?	I am proceeding to the position of incident and expect to arrive at … hours (on … *(date)*).
QTZ*	Are you continuing the search?	I am continuing the search for … (aircraft, ship, survival craft, survivors or wreckage).
QUN	1. *When directed to all stations:* Will vessels in my immediate vicinity … *or* (in the vicinity of … latitude, … longitude) *or* (in the vicinity of …) please indicate their position, TRUE course and speed? 2. *When directed to a single station:* Please indicate your position, TRUE course and speed.	My position, TRUE course and speed are …

Abbre-viation	Question	Answer or Advice
	Search and Rescue (cont.)	
QUO*	Shall I search for … 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*?	Please search for … 1. aircraft 2. ship 3. survival craft in the vicinity of … latitude, … longitude *(or according to any other indication)*.
QUP*	Will you indicate your position by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights?	My position is indicted by … 1. searchlight 2. black smoke trail 3. pyrotechnic lights.
QUR*	Have survivors … 1. received survival equipment 2. been picked up by rescue vessel 3. been reached by ground rescue party?	Survivors … 1. are in possession of survival equipment dropped by … 2. have been picked up by rescue vessel 3. have been reached by ground rescue party.
QUS*	Have you sighted survivors or wreckage? If so, in what position?	Have sighted … 1. survivors in water 2. survivors on rafts 3. wreckage in position … latitude, … longi-tude *(or according to any other indication)*.
QUT*	Is position of incident marked?	Position of incident is marked by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.

Abbre-viation	Question	Answer or Advice
	Search and Rescue (cont.)	
QUU*	Shall I home ship or aircraft to my position?	Home ship or aircraft … *(name and/or call sign)* … 1. to your position by sending your call sign and long dashes on ... kHz (*or* MHz) 2. by sending on … kHz (*or* MHz) TRUE track to reach you.
QUW*	Are you in the search area designated as … *(designator or latitude and longitude)*?	I am in the … *(designation)* search area.
QUY*	Is position of survival craft marked?	Position of survival craft was marked at … hours by … 1. flame or smoke float 2. sea marker 3. sea marker dye 4. … *(specify other marking)*.
QUZ	May I resume restricted working?	Distress phase still in force; restricted working may be resumed.
	Identification	
QTT		The identification signal which follows is superimposed on another transmission.

Section II. Miscellaneous Abbreviations and Signals

Abbre-viation or signal	Definition
AA	All after … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
AB	All before … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
ADS	Address *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
$\overline{\text{AR}}$	End of transmission.
$\overline{\text{AS}}$	Waiting period.
BK	Signal used to interrupt a transmission in progress.
BN	All between … and … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
BQ	A reply to an RQ.
$\overline{\text{BT}}$	Signal to mark the separation between different parts of the same transmission.
C	Yes *or* "The significance of the previous group should be read in the affirmative".
CFM	Confirm (*or* I confirm).
CL	I am closing my station.
COL	Collate (*or* I collate).
CORREC-TION	Cancel my last word *or* group. The correct word *or* group follows *(used in radiotelephony, spoken as KOR-REK-SHUN)*.
CP	General call to two or more specified stations *(see Recommendation ITU-R M.1170)*.
CQ	General call to all stations.
CS	Call sign *(used to request a call sign)*.

Note: When used in radiotelegraphy, a bar over the letters composing a signal denotes that the letters are to be sent as one signal.

Abbre-viation or signal	Definition
DE	"From …" *(used to precede the name or other identification of the calling station)*.
DF	Your bearing at … hours was … degrees, in the doubtful sector of this station, with a possible error of … degrees.
DO	Bearing doubtful. Ask for another bearing later (*or* at … hours).
DSC	Digital selective calling.
E	East (cardinal point).
ETA	Estimated time of arrival.
INTERCO	International Code of Signals groups follow *(used in radiotelephony, spoken as IN-TER-CO)*.
K	Invitation to transmit.
$\overline{\text{KA}}$	Starting signal.
KTS	Nautical miles per hour *(knots)*.
MIN	Minute (*or* Minutes).
MSG	Prefix indicating a message to or from the master of a ship concerning its operation or navigation.
MSI	Maritime safety information.
N	North (cardinal point).
NBDP	Narrow-band direct-printing telegraphy.
NIL	I have nothing to send to you.
NO	No *(negative)*.
NW	Now.
NX	Notice to Mariners (*or* Notice to Mariners follows).
OK	We agree (*or* It is correct).
OL	Ocean letter.
P	Prefix indicating a private radiotelegram.
PBL	Preamble *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
PSE	Please.
R	Received.

Abbre-viation or signal	Definition
RCC	Rescue coordination centre.
REF	Reference to … (*or* Refer to …).
RPT	Repeat (*or* I repeat) (*or* Repeat …).
RQ	Indication of a request.
S	South (cardinal point).
SAR	Search and Rescue.
SIG	Signature *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
SLT	Radiomaritime Letter.
SVC	Prefix indicating a service telegram.
SYS	Refer to your service telegram.
TFC	Traffic.
TR	Used by a land station to request the position and next port of call of a mobile station; used also as a prefix to the reply.
TU	Thank you.
TXT	Text *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
$\overline{\text{VA}}$	End of work.
W	West (cardinal point).
WA	Word after … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
WB	Word before … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
WD	Word(s) *or* Group(s).
WX	Weather report (*or* Weather report follows).
XQ	Prefix used to indicate the transmission of a service note.
YZ	The words which follow are in plain language.

RECOMMENDATION ITU-R M.1173*

TECHNICAL CHARACTERISTICS OF SINGLE-SIDEBAND TRANSMITTERS USED IN THE MARITIME MOBILE SERVICE FOR RADIOTELEPHONY IN THE BANDS BETWEEN 1 606.5 kHz (1 605 kHz REGION 2) AND 4 000 kHz AND BETWEEN 4 000 kHz AND 27 500 kHz

(1995)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe the technical characteristics of single-sideband transmitters for the bands 1 606.5 kHz (1 605 kHz Region 2) to 4 000 kHz and 4 000 kHz to 27 500 kHz,

recommends

1 that single-sideband transmitters used in the maritime mobile service for radiotelephony in the bands between 1 606.5 kHz (1 605 kHz Region 2) and 4 000 kHz and between 4 000 kHz and 27 500 kHz should be designed to meet the technical characteristics shown in Annex 1.

ANNEX 1

Technical characteristics of single-sideband transmitters used in the maritime mobile service for radiotelephony in the bands between 1 606.5 kHz (1 605 kHz Region 2) and 4 000 kHz and between 4 000 kHz and 27 500 kHz

1 Power of the carrier:

For class J3E emissions the power of the carrier shall be at least 40 dB below the peak envelope power.

2 Coast and ship stations shall use only the upper sideband.

3 The transmitter audio-frequency band shall be 350 Hz to 2 700 Hz with a permitted amplitude variation of 6 dB.

4 The carrier frequencies shall be maintained within the tolerances specified in Recommendation ITU-R SM.1137.

5 The unwanted frequency modulation of the carrier shall be sufficiently low to prevent harmful distortion.

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO).

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

6 When class H3E or J3E emissions are used, the power of any unwanted emission supplied to the antenna transmission line on any discrete frequency shall, when the transmitter is driven to full peak envelope power, be in accordance with the following Tables:

a) Transmitters installed before 2 January 1982:

Separation Δ between the frequency of the unwanted emission [1] and the assigned frequency [4] (kHz)	Minimum attenuation below peak envelope power
$1.6 < \Delta \leq 4.8$	28 dB
$4.8 < \Delta \leq 8$	38 dB
$8 < \Delta$	43 dB without the unwanted emission power exceeding the power of 50 mW

Transmitters using suppressed carrier emission may, as far as concerns out-of-band emissions [2] and those spurious emissions [3] which are a result of the modulation process but do not fall in the spectrum of out-of-band emissions [2], be tested for compliance with this regulation by means of a two-tone-audio input signal with a frequency separation between the tones such that all intermodulation products occur at frequencies at least 1.6 kHz removed from the assigned frequency [4].

b) Transmitters installed after 1 January 1982:

Separation Δ between the frequency of the unwanted emission [1] and the assigned frequency [4] (kHz)	Minimum attenuation below peak envelope power
$1.5 < \Delta \leq 4.5$	31 dB
$4.5 < \Delta \leq 7.5$	38 dB
$7.5 < \Delta$	43 dB without the unwanted emission power exceeding the power of 50 mW

Transmitters using suppressed carrier emission may, as far as concerns out-of-band emissions [2] and those spurious emissions [3] which are a result of the modulation process but do not fall in the spectrum of out-of-band emissions [2], be tested for compliance with this regulation by means of a two-tone-audio input signal with a frequency separation between the tones such that all intermodulation products occur at frequencies at least 1.5 kHz removed from the assigned frequency [4].

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1 *Unwanted emission:* see RR No. S1.146 [No. 140].

2 *Out-of-band emission:* see RR No. S1.144 [No. 138].

3 *Spurious emission:* see RR No. S1.145 [No. 139].

4 The assigned frequency is 1 400 Hz higher than the carrier frequency: see RR No. S.52.177 [No. 4325].

RECOMMENDATION ITU-R M.1174

CHARACTERISTICS OF EQUIPMENT USED FOR ON-BOARD COMMUNICATIONS IN THE BANDS BETWEEN 450 AND 470 MHz

(1995)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe the characteristics of equipment used for on-board communications in the bands between 450 and 470 MHz,

recommends

1 that transmitters and receivers used in the maritime mobile service for on-board communications in the bands between 450 and 470 MHz should conform to the technical characteristics shown in Annex 1.

ANNEX 1

Characteristics of equipment used for on-board communication in the bands between 450 and 470 MHz

1 The equipment should be fitted with sufficient channels for satisfactory operation in the area of intended use.

2 The effective radiated power shall be limited to the minimum required for satisfactory operation, but shall in no case exceed 2 W. Wherever practicable the equipment should be fitted with a suitable device to reduce readily the output power by at least 10 dB.

3 In the case of equipment installed at a fixed point on the ship, the height of its antenna shall not be more than 3.5 m above the level of the bridge.

4 Only frequency modulation with a pre-emphasis of 6 dB/octave (phase modulation) shall be used.

5 The frequency deviation shall not exceed ± 5 kHz.

6 The frequency tolerance shall be 5 parts in 10^6.

7 The audio-frequency band shall be limited to 3 000 Hz.

8 Control, telemetry and other non-voice signals shall be coded in such a manner as to minimize the possibility of false response to interfering signals.

9 The frequencies specified in RR No. S5.287 [No. 669] for on-board communications may be used for single-frequency and two-frequency simplex operations.

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

10 For ships using these on-board communication frequencies in survival craft two-way radiotelephone stations, the survival craft equipment shall be capable of transmitting and receiving the frequency 457.525 MHz.

11 If the use of a repeater station is required on board a ship, the following frequency pairs shall be used (see also RR No. S5.288 [No. 670]):

457.525 MHz and 467.525 MHz

457.550 MHz and 467.550 MHz

457.575 MHz and 467.575 MHz

RECOMMENDATION ITU-R M.1175*

AUTOMATIC RECEIVING EQUIPMENT FOR RADIOTELEGRAPH AND RADIOTELEPHONE ALARM SIGNALS

(1995)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to describe the automatic receiving equipment for radiotelegraph and radiotelephone alarm signals,

recommends

1 that automatic receiving equipment for radiotelegraph and radiotelephone alarm signals should fulfil the conditions contained in Annex 1.

ANNEX 1

Automatic receiving equipment for radiotelegraph and radiotelephone alarm signals

1 Automatic devices intended for the reception of the radiotelegraph alarm signal shall fulfil the following conditions:

a) the equipment shall respond to the alarm signal transmitted by the telegraphic emissions of at least class A2B and H2B (see RR No. S52.18 [No. 4216);

b) the equipment shall respond to the alarm signal through interference (provided it is not continuous) caused by atmospherics and powerful signals other than the alarm signal, preferably without any manual adjustment being required during any period of watch maintained by the apparatus;

c) the equipment shall not be actuated by atmospherics or by strong signals other than the alarm signal;

d) the equipment shall possess a minimum sensitivity such that with negligible atmospheric interference, it is capable of being operated by the alarm signal transmitted by the emergency transmitter of a ship station at any distance from this station up to the normal range fixed for this transmitter by the International Convention for the Safety of Life at Sea, and preferably at greater distances;

e) the equipment should, as far as practicable, give warning of any faults that would prevent the apparatus from functioning normally during watch hours.

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO).

Note by the Secretariat: The references made to the Radio Regulations (RR) in this Recommendation refer to the RR as revised by the World Radiocommunication Conference 1995. These elements of the RR will come into force on 1 June 1998. Where applicable, the equivalent references in the current RR are also provided in square brackets.

2 Automatic devices intended for the reception of the radiotelephone alarm signal shall fulfil the following conditions:

a) the equipment shall respond to the alarm signal through intermittent interference caused by atmospherics and powerful signals other than the alarm signal, preferably without any manual adjustment being required during any period of watch maintained by the equipment;

b) the equipment shall not be actuated by atmospherics or by strong signals other than the alarm signal;

c) the equipment shall be effective beyond the range at which speech transmission is satisfactory and it should, as far as practicable, give warning of faults that would prevent the apparatus from performing its normal function during watch hours.

RECOMMENDATION ITU-R M.1185-1

METHOD FOR DETERMINING COORDINATION DISTANCE BETWEEN GROUND BASED MOBILE EARTH STATIONS AND TERRESTRIAL STATIONS OPERATING IN THE 148.0-149.9 MHz BAND

(Question ITU-R 201/8)

(1995-1997)

Summary

This Recommendation provides the calculation method of coordination distances used for procedures in Resolution 46 (Rev.WRC-95) of the World Radio Conference (Geneva, 1995). This method is based on the troposcatter propagation model in Recommendation ITU-R P.452.

The ITU Radiocommunication Assembly,

considering

a) that the use of the 148.0-149.9 MHz frequency band is subject to Radio Regulations No. S5.219;

b) that mobile earth stations (MESs) in the mobile-satellite service (MSS) operating below 1 GHz will, typically, operate with e.i.r.p.s of 10 dBW or less;

c) that the MESs may typically be located anywhere within an administration implementing such a service;

d) that the land earth stations in the MSS operating below 1 GHz will use high-gain steerable antennas at fixed locations which may sometimes radiate nearly continuous signals in any azimuth and various, sometimes low elevations at e.i.r.p.s higher than that of the MES;

e) that some administrations may choose to implement only MESs;

f) that coordination of MESs is inherently different from the coordination of land earth stations;

g) that in the case of MESs transmitting short duration bursts with low duty cycle, coordination with terrestrial stations may be limited inside auxiliary contours based upon more favourable assumptions than the ones used to determine the coordination contours,

recommends

1 that the method described in Annex 1 be used to calculate a coordination distance identifying administrations that may be affected;

2 that the method take account of the actual parameters of terrestrial stations;

3 that the method be used in conjunction with procedures of Resolution 46 (Rev.WRC-95) relating to coordination between grounded based MESs and terrestrial stations;

4 that the method described in Annex 2 be used in order to facilitate the coordination with terrestrial analogue voice services in the case of MESs transmitting short duration bursts with low duty cycle.

ANNEX 1

Method for determining the coordination distance between ground based MESs and terrestrial stations

The method of calculation of a coordination distance between a MES and a terrestrial station is based on determining the distance, on the surface of the Earth, that will provide sufficient isolation between MES transmitter and the terrestrial receiver such that a terrestrial receiver lying beyond the coordination distance will have a very low probability of receiving interference from the MES. The coordination distance calculation is based on a troposcatter propagation model which is slightly more conservative to the one used in the propagation section of Recommendation ITU-R P.452, "Prediction procedure for the evaluation of microwave interference between stations on the surface of the Earth at frequencies above about 0.7 GHz". The troposcatter propagation mechanism provides a relatively large distance in comparison to other propagation mechanisms and, therefore, can be used as a conservative estimate of the coordination distance between the two systems. Specifically, the propagation loss in Fig. 1 is based on an equation 10 dB more conservative than equation (10a) of Recommendation ITU-R P.452. Among the simplifying assumptions used to derive Fig. 1 are:

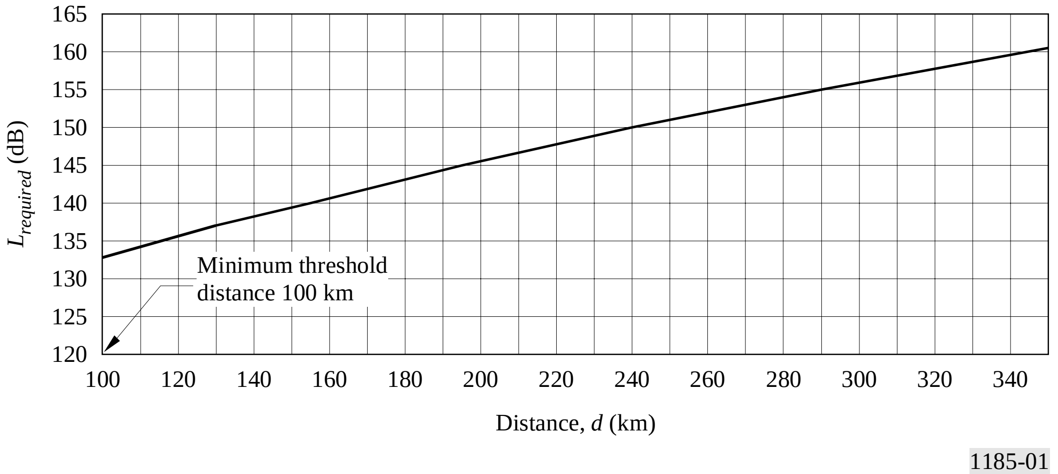
– the frequency is 148 MHz;

– no site shields exist for either transmitter or receiver;

– the propagation loss will be exceeded for 99.9% of the time.

FIGURE 1

MES/terrestrial station coordination distance



The method first calculates the required loss between the MES and a terrestrial receiver as shown in equation (1):

$$L_{required} = (P_t + G_t + 36.0) - (I_r - G_r + L_r) \tag{1}$$

where:

$L_{required}$: required threshold loss between the transmitter and receiver (dB)

I_r: terrestrial receiver permissible interference referenced to a 4 kHz bandwidth (dB(W/4 kHz))

L_r: line losses between the terrestrial receiver and antenna (dB)

G_r: maximum antenna gain of terrestrial receiver (dBi)

P_t: maximum power density of the MES (dB(W/Hz))

G_t: maximum antenna gain of the MES (dBi).

The values of P_t and G_t, for the MES, are available in the information supplied under Section II of Annex 1 to Resolution 46 (Rev.WRC-95). The values for I_r, G_r and L_r will be provided by the administration that may be affected.

Figure 1 is then used to determine the coordination distance by entering $L_{required}$ on the ordinate and reading the corresponding distance (*d* (km)) on the abscissa. A minimum coordination distance of 100 km should be used.

Examples of the application of this method are shown in Appendix 1.

The generating equation for Fig. 1 is:

$$L_{required}(d) = 86 + 20 \log d + 0.0674\, d \qquad \text{dB} \qquad (2)$$

where:

d: distance (km) ($d \geq 100$ km)

$L_{required}$: intersystem loss required (dB) that can be expected to be exceeded for 99.9% of the time.

APPENDIX 1

TO ANNEX 1

Example of determination of coordination distance

Two examples of the use of the coordination distance calculation method are provided in this Appendix. Example 1 represents a narrow-band MSS system and example 2 a wide-band MSS system.

TABLE 1

Coordination distance examples

	Example 1	Example 2
	Narrow-band MSS	Wide-band MSS
MSS system information		
MSS maximum power density[(1)] (dB(W/Hz))	–27.0	–56.3
MSS maximum isotropic gain[(1)] (dBi)	2.0	0.0
Conversion to 4 kHz bandwidth (dB)	36.0	36.0
MSS e.i.r.p. density (dB(W/4 kHz))	11.0	–20.3
Mobile system information		
Example terrestrial receiver permissible interference level (dB(W/4 kHz))	–140.0	–140.0
Example terrestrial line losses (dB)	–1.0	–1.0
Example terrestrial antenna gain (dBi)	5.0	5.0
Terrestrial receiver permissible interference level at antenna (dB(W/4 kHz))	–144.0	–144.0
Required isolation, $L_{required}$ (dB)	155.0	123.7
Coordination distance from Fig. 1 (km)	290	100[(2)]

(1) Information supplied in accordance with Section II of Annex 1 to Resolution 46 (Rev.WRC-95).

(2) Minimum coordination distance is 100 km.

ANNEX 2

Coordination between MESs and terrestrial stations providing analogue voice in the case of MESs transmitting short duration bursts with low duty cycle

In order to reduce the probability of interference to terrestrial stations, MES operating in the 148-149.9 MHz frequency band may have a working mode consisting in transmitting short bursts with low duty cycle, so allowing to use the propagation model (average conditions) contained in Recommendation ITU-R P.529, provided that adequate limits are imposed on the burst duration and the duty cycle.

The use of this model is limited to systems having burst durations which even though short, would still represent interference if received for a percentage of time exceeding 0.1%, and duty cycles less than 0.5% of the time. The recommended use is for establishing auxiliary contour in order to facilitate the coordination with terrestrial stations.

When these conditions are satisfied, the auxiliary contour is computed as follows, using the protection criteria of the affected terrestrial system:

– the required threshold loss between the transmitter and receiver, $L_{required}$, is derived from formula (1) of Annex 1;

– the radius of the auxiliary contour is calculated with the following formula:

$$L_{required} = 100 + 40 \log d \qquad \text{dB} \tag{3}$$

where d is the radius of the auxiliary contour (km).

Note that formula (3) has been established with the product of h_1 and h_2 being 10 m^2, where h_1 and h_2 are the equivalent heights of the transmitting and receiving antennas respectively. The product of h_1 and h_2 being 10 m^2 is considered to be realistic when concluding coordination between a MES and a mobile station. Generalization of formula (3) to different values of h_1 and h_2 leads to the following formula (4):

$$L_{required} = 100 + 40 \log d - 20 \log \left[(h_1 \, h_2) / 10 \right] \qquad \text{dB} \tag{4}$$

where h_1 and h_2 are expressed in metres.

When an ensemble of MESs is present within the auxiliary contour as calculated above, consideration of the transmitting characteristics (i.e., burst length, duty cycle, probability of simultaneous transmission) must be taken into account to determine the total interfering probability to a terrestrial station.

RECOMMENDATION ITU-R M.1187

A METHOD FOR THE CALCULATION OF THE POTENTIALLY AFFECTED REGION FOR A MOBILE-SATELLITE SERVICE (MSS) NETWORK IN THE 1-3 GHz RANGE USING CIRCULAR ORBITS

(Questions ITU-R 83/8 and ITU-R 201/8)

(1995)

Summary

This Recommendation defines the term “active service arc” and provides a method for the calculation of an “affected region” when assigning frequencies to space stations of MSS networks operating between 1 and 3 GHz and for giving assistance in the identification of administrations whose assignments may be included within this “affected region”.

The ITU Radiocommunication Assembly,

considering

a) that the World Administrative Radio Conference for dealing with Frequency Allocations in certain parts of the spectrum (Malaga-Torremolinos, 1992) (WARC-92) adopted Resolution No. 46 as an interim coordination procedure for MSS systems for certain bands within the Table of Frequency Allocations of the Radio Regulations (RR) within the frequency range of 1-3 GHz;

b) that Resolution No. 46 invites the ITU-R to study and develop Recommendations on coordination methods, the necessary orbital data relating to non-geostationary (non-GSO) satellite systems, and sharing criteria;

c) that non-GSO satellite networks implementing these MSS allocations may have different constellations, with different altitudes, and different inclination angles;

d) that the Annex to Resolution No. 46 states that non-GSO satellite networks should provide additional information in addition to that of RR Appendix 3 or Appendix 4, including their “active service arc”;

e) that Resolution No. 46 does not define “active service arc”;

f) that Section II of the Annex to Resolution No. 46 states that a non-GSO satellite network shall effect coordination of the frequency assignment with any administration whose assignment to an earth station of a GSO satellite network, earth station of non-GSO satellite network, terrestrial stations of the fixed service (FS) or mobile service (MS) might be affected;

g) that there is a need to define the area where other services, including MSS, might be affected and where coordination may be performed for which the relevant criteria and methods are not defined in this Recommendation;

h) that there is a need to further define the concept of an “affected region” (which is not to be confused with the “coordination area”) for MSS operating between 1 and 3 GHz;

recommends

1 that “active service arc” in Resolution No. 46 be defined as: the locus of orbital points in an MSS constellation that specifies the location of the networks’ space stations when their transmitters are active to serve a specific geographic area. The location of the active arc shall be provided in geocentric earth fixed coordinates;

2 that when a specific active service arc is published, the methodology in Annex 1 could be used to assist in the identification of administrations whose assignments may be included in the “affected region” (see Note 1).

NOTE 1 – This methodology could be further improved by taking into account more precise technical characteristics of the MSS system.

ANNEX 1

A method for the calculation of the potentially affected region for an MSS network in the 1-3 GHz range using circular orbits

1 Introduction

Section II of the Annex to Resolution No. 46 of WARC-92 outlines the procedures for assignment and coordination of the frequencies of a space station in a MSS network by an individual administration. Paragraphs 2.1 and 2.2 of Section II in the Annex specify that an administration shall effect coordination with earth stations of satellite networks and stations of terrestrial networks “whose assignment ... might be affected”.

This Annex defines a methodology for calculating the “affected region”. This affected region should be used to identify co-frequency MSS and other services with equal or higher status in other administrations that might be affected by operation of the MSS network. First, the locus of points of the satellite’s orbital arc are plotted that correspond to points where the satellite would be active in order to cover its service area. Then, the corresponding sub-satellite locations are plotted on the Earth’s surface. The affected region is then defined to be these areas on the Earth within visibility of the spacecraft and referenced to the perimeter of the sub-satellite locus.

This methodology to calculate the affected region identifies the administrations whose co-frequency assignments might be affected.

It is recognized that another means of determining affected frequency assignments of other administrations with respect to an MSS space station and its associated service area (Section II of Resolution No. 46, § 2.3) could be used and that the incorporation of this methodology into an ITU-R Recommendation would not make its use mandatory.

Use of this methodology for calculating an affected region does not change the status (primary or secondary) of the radio services within that region.

2 Calculation of the affected region

Let the quadrilateral A depicted in Fig. 1 represent the active sub-satellite area needed to serve an administration for a representative MSS system. Note that the sub-satellite area is not necessarily coincident with the borders of the administration. The distance, *D*, depicted in Fig. 1 is the distance from the outer perimeter of A to the field of view (FOV) point from the satellite. The FOV is defined as extending to the limits of the visible horizon as seen from the satellite. The total affected region is then the total area calculated from the edges of the sub-satellite area out to the distance *D*. For circular constellations distance *D* will be a constant great circle distance which increases with increasing satellite altitudes.

2.1 Calculation of width of affected region envelope

This section presents a methodology to calculate the distance that should be used to draw the outer perimeter around the active sub-satellite areas to create the affected region.

Figure 2 illustrates the calculation of the outer perimeter distance *D*, which is the distance from the edge of the sub-satellite area A to the FOV of the satellite at the active area outer edge. The affected region is defined as follows:

Affected region: an area on the Earth’s surface calculated by defining a distance from the perimeter of the active sub-satellite area A, a distance *D* from the perimeter of the active sub-satellite sub-area, corresponding to the maximum field of view from the satellites at the perimeter of the active service arc. The region also includes administrations within the active sub-satellite area.

Additionally, the following definitions are provided:

Active service arc: the locus of orbital points in a MSS constellation that describes where the satellites are transmitting or receiving. The MSS operator calculates the arc utilizing those system specific characteristics such as the constellations orbits, spacecraft antenna characteristics, e.i.r.p., which achieve its service objectives for a particular service area.

Active sub-satellite area: the projection down the nadir from the active service arc to points on the Earth's surface. The perimeter of this area is defined in geocentric coordinates (latitude/longitude).

FIGURE 1

Representation of an active sub-satellite area required to serve an administration and its corresponding affected region

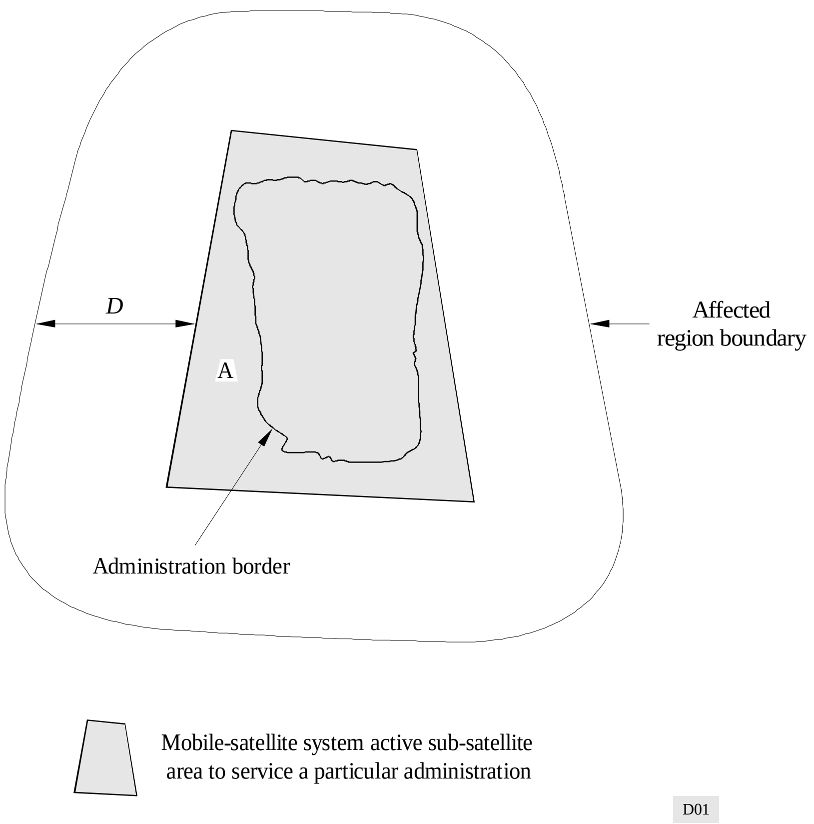
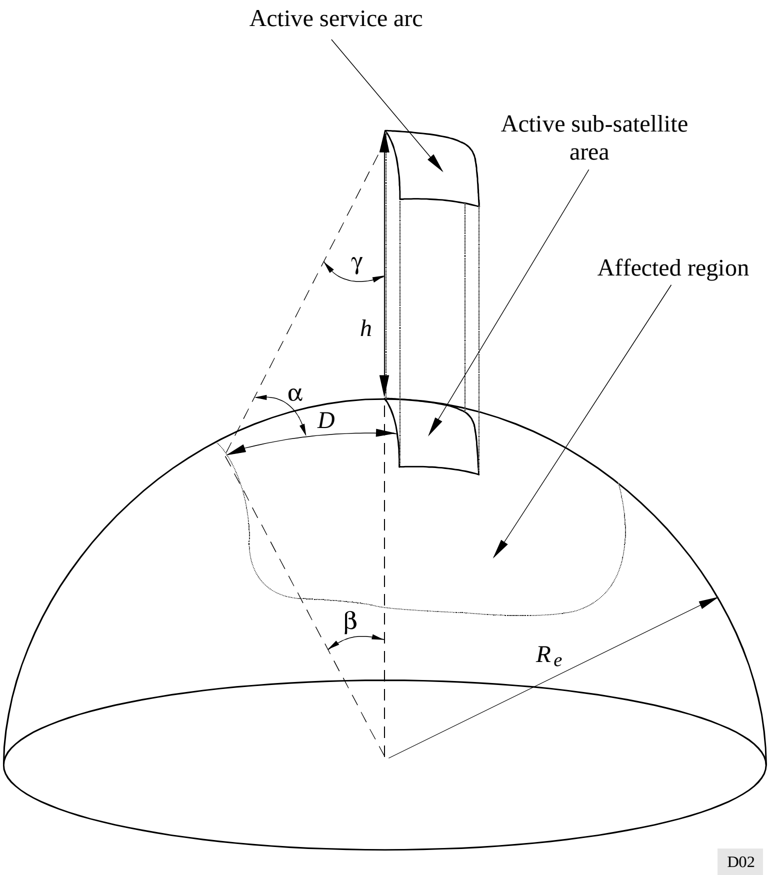


FIGURE 2

Geometry required to calculate *D*, envelope distance around sub-satellite area



Definition of variables:

R_e: Earth radius

h: satellite altitude

γ: nadir angle from satellite at sub-satellite perimeter edge to its field of view distance

β: geocentric angle from sub-satellite area edge to field of view distance

α: elevation angle

D: Earth distance from active sub-satellite area perimeter to 0° elevation angle point (maximum field of view limits).

The necessary formulae to calculate the distance *D*:

$$\beta = \cos^{-1} [R_e/(R_e + h)] \tag{1}$$

$$D = R_e \, \beta \qquad \text{rad} \tag{2}$$

Once *D* has been calculated, it can be used to determine the affected region in conjunction with the sub-satellite area.

2.2 Example calculation of an affected region

This section gives an example of how to calculate the affected region for a mobile-satellite system intending to provide service within the territory of an administration. The example administration is Italy, and Fig. 3 illustrates the sub-satellite area for servicing Italy for the LEO A (see Recommendation ITU-R M.1184) mobile-satellite system.

FIGURE 3

Hypothetical sub-satellite active area for Italy

The necessary parameters to calculate the affected region are:

Satellite altitude:	780 km
Earth radius:	6 367 km
Sub-satellite area width:	1 140 km
Sub-satellite area length:	1 625 km

Note that the sub-satellite active area was chosen assuming the service area was the Italian administration and is only an example. The actual sub-satellite area for Italy of any mobile-satellite system may be quite different depending on the satellite networks system specific characteristics.

Using equations (1) and (2) for this case, $\beta = 27°$ and $D = 3\,000$ km, so the distance D to add around the sub-satellite area is 3 000 km. Therefore, for the example sub-satellite area in Fig. 3, the affected region would extend into North-Western Sudan, Western Russia (including Moscow), Northern Norway and Mauritania.

RECOMMENDATION ITU-R BO.1213

REFERENCE RECEIVING EARTH STATION ANTENNA PATTERNS FOR PLANNING PURPOSES TO BE USED IN THE REVISION OF THE WARC BS-77 BROADCASTING-SATELLITE SERVICE PLANS FOR REGIONS 1 AND 3

(Question ITU-R 93/11)

(1995)

The ITU Radiocommunication Assembly,

considering

a) that Resolution No. 524 invites the ITU-R to study the possibilities to improve the efficiency of the World Administrative Radio Conference for the Planning of the Broadcasting-Satellite Service (Geneva, 1977) (WARC BS-77) Plan by taking due account of the technological progress;

b) that for broadcasting-satellite service (BSS) planning purposes a simple receiving antenna reference pattern is necessary;

c) that the existing Radio Regulations (RR) Appendix 30 Region 1 and 3 receiving earth station pattern is no longer appropriate due to technological improvements in TVRO antennas;

d) that the performance of receiving earth station antenna is crucial to the efficient use of the orbit-spectrum resources;

e) that measured data in support of an improved receive antenna reference pattern is available;

f) that the use of antennas with the best achievable radiation pattern will lead to the most efficient use of the radio-spectrum and the geostationary-satellite orbit;

g) that smaller diameter receiving earth station antennas than used in the WARC BS-77 Plan are now in widespread use in the BSS in Regions 1 and 3, with wider beamwidths up to 4°,

recognizing

1 that the adoption of a reference receive earth station antenna patterns for planning purposes will not preclude the use of receive antennas not in accordance with the reference patterns,

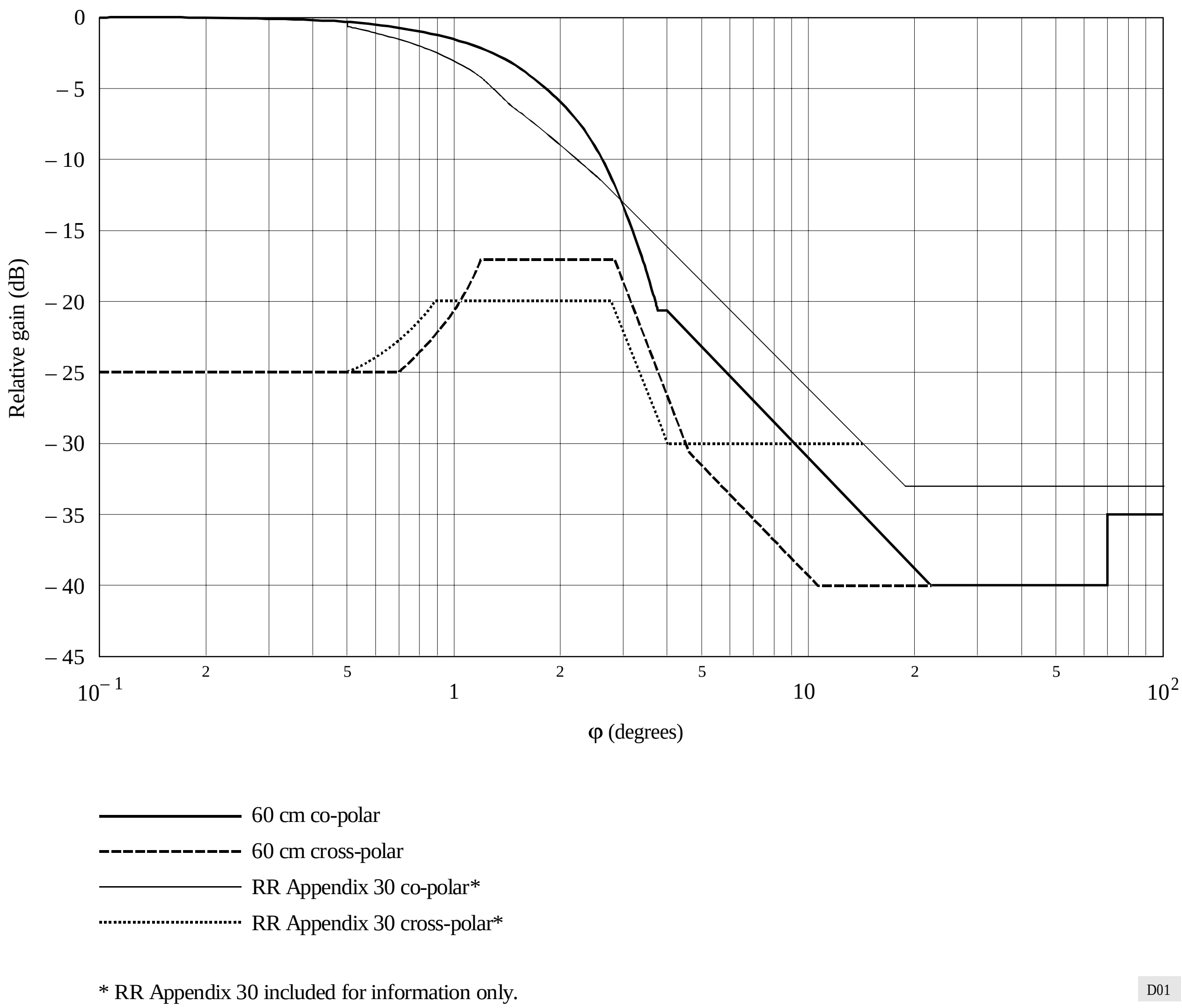
recommends

1 that for replanning purposes of the WARC BS-77 BSS Plans in Regions 1 and 3, the 60 cm antenna co-polar and cross-polar patterns given in Fig. 2 with their associated formulae provided in Annex 1 should be used.

ANNEX 1

FIGURE 1

Reference receiving earth station antenna pattern



Antenna pattern formulae

Co-polar pattern:

$G_{co}(\varphi) = G_{max} - 2.5 \times 10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2$ for $0 \leq \varphi < \varphi_m$ where $\varphi_m = \frac{\lambda}{D}\sqrt{\frac{G_{max} - G_1}{0.0025}}$

$G_{co}(\varphi) = G_1 = 29 - 25 \log \varphi_r$ for $\varphi_m \leq \varphi < \varphi_r$ where $\varphi_r = 95\frac{\lambda}{D}$

$G_{co}(\varphi) = 29 - 25 \log \varphi$ for $\varphi_r \leq \varphi < \varphi_b$ where $\varphi_b = 10^{(34/25)}$

$G_{co}(\varphi) = -5$ dBi for $\varphi_b \leq \varphi < 70°$

$G_{co}(\varphi) = 0$ dBi for $70° \leq \varphi < 180°$

Cross-polar pattern:

$G_{cross}(\varphi) = G_{max} - 25$ for $0 \leq \varphi < 0.25\,\varphi_0$

where $\varphi_0 = 2\frac{\lambda}{D}\sqrt{\frac{3}{0.0025}}$

$= 3$ dB beamwidth

$G_{cross}(\varphi) = G_{max} - 25 + 8\left(\frac{\varphi - 0.25\,\varphi_0}{0.19\,\varphi_0}\right)$ for $0.25\,\varphi_0 \leq \varphi < 0.44\,\varphi_0$

$G_{cross}(\varphi) = G_{max} - 17$ for $0.44\,\varphi_0 \leq \varphi < \varphi_0$

$G_{cross}(\varphi) = G_{max} - 17 - 13.5625\left|\frac{\varphi - \varphi_0}{\varphi_1 - \varphi_0}\right|$ for $\varphi_0 \leq \varphi < \varphi_1$ where $\varphi_1 = \frac{\varphi_0}{2}\sqrt{10.1875}$

$G_{cross}(\varphi) = 21 - 25 \log \varphi$ for $\varphi_1 \leq \varphi < \varphi_2$ where $\varphi_2 = 10^{(26/25)}$

$G_{cross}(\varphi) = -5$ dBi for $\varphi_2 \leq \varphi < 70°$

$G_{cross}(\varphi) = 0$ dBi for $70° \leq \varphi < 180°$

For the 60 cm antenna pattern which is to be used as a reference for replanning, the following parameters apply:

Co-polar:

$G_{max} = 35.5$ dBi

$D/\lambda = 23.4$

$\varphi_m = 3.66°$

$\varphi_r = 4.04°$

$G_1 = 13.84$ dB

$\varphi_b = 10^{(34/25)}$

Cross-polar:

$\varphi_0 = 2.96°$

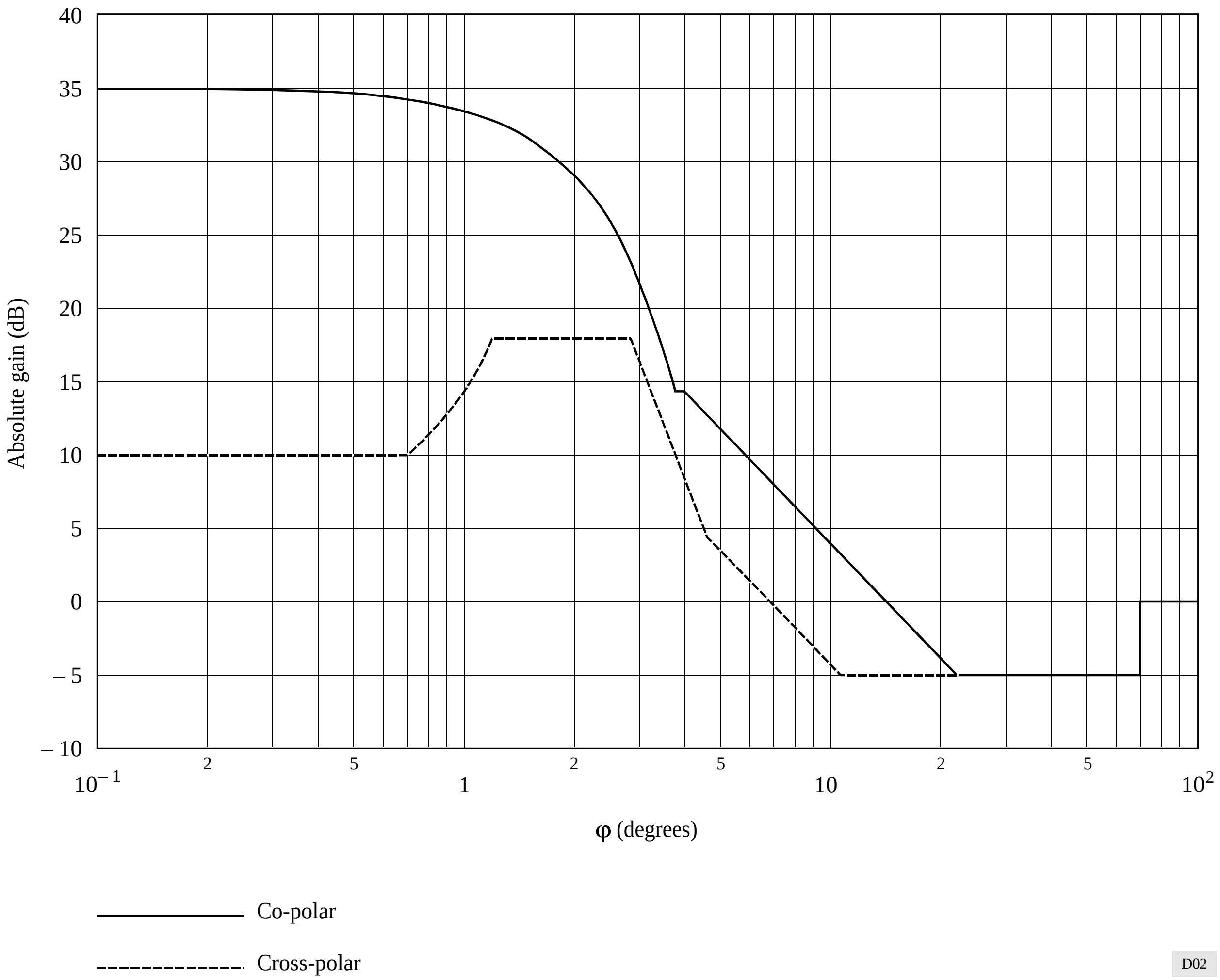
$\varphi_1 = 4.73°$

$\varphi_2 = 10.96°$

The corresponding antenna diagram is given in Fig. 2.

FIGURE 2

Reference receiving earth station antenna patterns



RECOMMENDATION ITU-R BO.1293

PROTECTION MASKS AND ASSOCIATED CALCULATION METHODS FOR INTERFERENCE INTO BROADCAST SATELLITE SYSTEMS INVOLVING DIGITAL EMISSIONS

(Question ITU-R 93/11)

(1997)

The ITU Radiocommunication Assembly,

considering

a) that protection ratios and associated protection masks are essential characteristics for the television signals in the broadcasting-satellite service (BSS) and associated feeder links;

b) that the Radio Regulations (RR) Appendices 30 and 30A Plans have been developed by using values of protection ratio and interference calculation methods based on fixed frequency offsets and given types of signal;

c) that new systems submitted to the Radiocommunication Bureau (BR) for implementation in these plans propose to use new types of signals for which no protection masks and only limited interference calculation methods are available;

d) that the BR has requested radiocommunications Study Group 11 to provide additional methodologies and protection criteria to assess interference from and to these new types of signals;

e) that the definition of protection masks and associated calculation methods are very useful technical information when revising the RR Appendices 30 and 30A Plans for Regions 1 and 3;

f) that several studies have now been carried out by various administrations and organizations that validate the proposed interference calculation method,

recognizing

a) that protection masks extend the usefulness of protection ratios, which are themselves associated with fixed frequency offsets;

b) that appropriate protection masks for interference calculation between digital emissions can be derived by using the methodology provided in Annex 1,

recommends

1 that the calculation method to generate protection masks provided in Annex 1 for different types of digital phase shift keyed emissions, should be applied as needed in compatibility analyses for RR Appendices 30 and 30A.

2 that the associated interference calculation methods provided in Annex 2, should be used as needed to assess the interference situation in RR Appendices 30 and 30A.

NOTE 1 – Further studies are needed to develop masks for interference between other types of emission (i.e. for analogue into analogue, digital into analogue and analogue into digital interference). Until such time as these masks are available, the method described in Annex 3 should be used when calculating interference between emissions when the interference is digital.

NOTE 2 – Although the method proposed in Annex 1 provides an accurate assessment of the protection mask for interference between two digital signals, based on knowledge of the key signal parameters and assuming a linear channel, in practice most BSS satellite transponders operate in a saturated non-linear mode. The proposed model is expected to underestimate the interference when the channel is non-linear. Further studies are required to quantify these non-linear effects. In the meantime, the (more conservative) method described in Annex 3 should be used when calculating interference between digital emissions.

NOTE 3 – The effects of the application of the method proposed in Annex 1 on the notification of new parameters associated with each digital emission are described in Appendix 1 to Annex 1.

ANNEX 1

Calculation of protection masks for interference between various types of digital carriers

1 Method

It is assumed that the interfering digital carrier can, for interference calculation purposes, be modelled as a white noise source followed by a square-root, raised cosine pulse shaping filter. The roll-off factor, α_i, of this filter may be freely specified in the range $0 \le \alpha_i \le 1$ (0% to 100% roll-off). The filter's 3 dB bandwidth is specified by the transmitted symbol rate, R_i, for the interfering digital signal.

The level of digital interference affecting the wanted digital signal is dependent upon the frequency offset between the wanted and interfering signals, δf, and the characteristics of the receiver's filter. It is assumed that this filter is also a square-root, raised cosine filter with a roll-off factor, α_w, where ($0 \le \alpha_w \le 1$), and a 3 dB bandwidth specified by the wanted signal symbol rate R_w.

The parameters R_i and R_w are expressed in Msymbol/s. The total bandwidths of the wanted and interfering signals are given by $R_w(1 + \alpha_w)$ MHz and $R_i(1 + \alpha_i)$ MHz respectively. The frequency difference parameter δf is expressed in MHz. The interference at the output of the receiver filter is assumed to be noise-like.

The level of interference power $I(\delta f)$, measured at the output of the receiver's filter and expressed relative to the wanted carrier power for a reference link C/I of 0 dB (i.e. assuming equal wanted and interfering carrier powers), is calculated as follows (see § 3 for definitions of the terms used below):

Step 1: Calculate the wanted signal power, P_w, at the output of the receiver filter:

a) set the interfering signal parameters equal to the wanted signal parameters and the frequency offset to zero ($R_i = R_w$, $\alpha_i = \alpha_w$, $\delta f = 0$);

b) calculate the nine pairs of limits (U_n, L_n, $n = 1, \ldots, 9$);

c) calculate the five power contribution terms (C_m, $m = 1, \ldots, 5$);

d) Calculate the total received power, P_w:

$$P_w = \sum_{m=1}^{5} C_m$$

Step 2: Calculate the interfering signal power, P_i, at the output of the receiver filter:

a) set the interfering signal parameters and the frequency offset to the appropriate values for the interference scenario under consideration;

b) to d) repeat steps b) to d) above using the revised input parameters, leading to the calculation of the interfering signal power:

$$P_i = \sum_{m=1}^{5} C_m$$

Step 3: Calculate the relative interference power for the given signal parameters and frequency offset:

$$I(\delta f) = 10 \log \left(\frac{P_i}{P_w} \right) \qquad \text{dB}$$

2 Example calculation of a protection mask

As an (arbitrary) example, it is assumed that the wanted and interfering signal parameters are as follows:

Wanted digital signal:

symbol rate, $R_w = 22.7$ Msymbol/s

roll-off factor, $\alpha_w = 0.4$ (40% cosine roll-off).

Interfering digital signal:

symbol rate, $R_i = 22.7$ Msymbol/s

roll-off factor, $\alpha_i = 0.4$ (40% cosine roll-off).

The frequency offset between the wanted and interfering signals, δf, is assumed to be 19.18 MHz. The application of the calculation method described in § 1 of this Annex, and detailed in § 3 of this Annex, gives the following:

Step 1: Calculate the wanted signal power, P_w, at the output of the receiver filter ($\delta f = 0$):

$L_1 = –6.81, \quad L_2 = L_3 = L_4 = L_5 = L_6 = L_7 = L_8 = L_9 = 6.81$

$U_1 = U_2 = U_3 = U_4 = U_5 = 6.81, \quad U_6 = U_7 = 15.89, \quad U_8 = U_9 = –6.81$

$C_1 = 0.8, \quad C_2 = C_3 = 0, \quad C_4 = 0.1, \quad C_5 = 0$

$$P_w = \sum_{m=1}^{5} C_m \qquad\qquad P_w = 0.90$$

Step 2: Calculate the interfering signal power, P_i, at the output of the receiver filter ($\delta f = 19.18$ MHz):

$L_1 = L_3 = L_4 = 12.37, \quad L_2 = L_5 = L_7 = 6.81, \quad L_6 = L_9 = 25.99, \quad L_8 = –12.37$

$U_1 = 6.81, \quad U_2 = U_5 = –12.37, \quad U_3 = U_4 = U_6 = 15.89, \quad U_7 = –3.29, \quad U_8 = U_9 = –6.81$

$C_1 = 0.216, \quad C_2 = C_3 = –0.030, \quad C_4 = 0, \quad C_5 = 0.004$

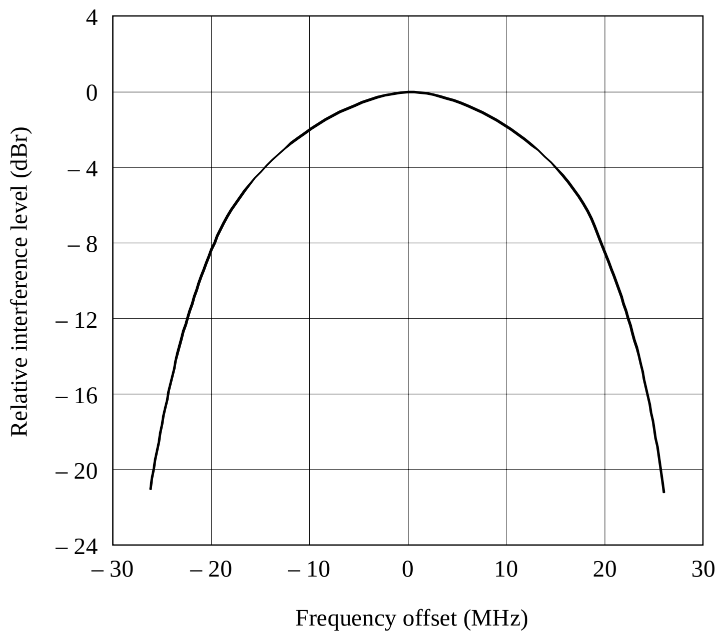
$$P_i = \sum_{m=1}^{5} C_m \qquad\qquad P_i = 0.16$$

Step 3: Calculate the relative interference power for the given signal parameters and frequency offset:

$$I(\delta f) = 10 \log \left(\frac{P_i}{P_w} \right) \qquad \text{dB} \qquad\qquad I(19.18) = –7.5 \, \text{dBr}$$

Following this procedure for a range of frequency offsets results in the example protection mask given in Fig. 1.

FIGURE 1



1293-01

3 Algorithms: Calculation of the received (wanted or interfering) signal power

3.1 Limits

$A = (1 - \alpha_w)\frac{R_w}{2}$ $B = (1 + \alpha_w)\frac{R_w}{2}$ $C = (1 - \alpha_i)\frac{R_i}{2}$ $D = (1 + \alpha_i)\frac{R_i}{2}$

$L_1 = max\,(-A;\, \delta f - C)$ $L_4 = max\,(A;\, \delta f - C)$ $L_7 = max\,(A;\, -\delta f + C)$

$U_1 = min\,(A;\, \delta f + C)$ $U_4 = min\,(B;\, \delta f + C)$ $U_7 = min\,(B;\, -\delta f + D)$

$L_2 = max\,(-A - \delta f;\, C)$ $L_5 = max\,(A;\, -\delta f - C)$ $L_8 = max\,(-B;\, -\delta f + C)$

$U_2 = min\,(A - \delta f;\, D)$ $U_5 = min\,(B;\, -\delta f + C)$ $U_8 = min\,(-A;\, -\delta f + D)$

$L_3 = max\,(-A + \delta f;\, C)$ $L_6 = max\,(A;\, \delta f + C)$ $L_9 = max\,(-B;\, \delta f + C)$

$U_3 = min\,(A + \delta f;\, D)$ $U_6 = min\,(B;\, \delta f + D)$ $U_9 = min\,(-A;\, \delta f + D)$

NOTE 1:

max (a; b): maximum value of a and b

min (a; b): minimum value of a and b

δf = frequency of interfering signal – frequency of wanted signal

3.2 Functions

When $1 \le n \le 3$:

$$p_n(a,b) = f_n(a) - f_n(b) \quad \text{for } a > b$$
$$= 0 \quad \text{for } a \le b$$

When $4 \le n \le 5$:

$$p_n(a,b,\delta f) = f_n(a,\delta f) - f_n(b,\delta f) \quad \text{for } a > b$$
$$= 0 \quad \text{for } a \le b$$

$$f_1(x) = \left(\frac{x}{R_i}\right) \qquad f_2(x) = \frac{\alpha_i}{2\pi}\cos\left(\frac{\pi}{2}\,\frac{2x - R_i}{\alpha_i R_i}\right) \qquad f_3(x) = \frac{\alpha_w R_w}{2\pi R_i}\cos\left(\frac{\pi}{2}\,\frac{2x - R_w}{\alpha_w R_w}\right)$$

$$f_4(x,y) = f_{4a}(x,y) \quad \text{for } \alpha_w R_w = \alpha_i R_i$$
$$= f_{4b}(x,y) \quad \text{for } \alpha_w R_w \ne \alpha_i R_i$$

$$f_5(x,y) = f_{5a}(x,y) \quad \text{for } \alpha_w R_w = \alpha_i R_i$$
$$= f_{5b}(x,y) \quad \text{for } \alpha_w R_w \ne \alpha_i R_i$$

$$f_{4a}(x,y) = \frac{1}{16\pi R_i}\left(2\pi x \cos\left(\frac{\pi}{2}\,\frac{2y + R_i - R_w}{\alpha_i R_i}\right) - \alpha_i R_i \sin\left(\frac{\pi}{2}\,\frac{4x - 2y - R_i - R_w}{\alpha_i R_i}\right)\right)$$

$$f_{4b}(x,y) = \frac{\alpha_i \alpha_w R_w}{4\pi\left(\alpha_i^2 R_i^2 - \alpha_w^2 R_w^2\right)}\left(\alpha_i R_i \cos\left(\frac{\pi}{2}\,\frac{2x - R_w}{\alpha_w R_w}\right)\sin\left(\frac{\pi}{2}\,\frac{2y - 2x + R_i}{\alpha_i R_i}\right) + \alpha_w R_w \sin\left(\frac{\pi}{2}\,\frac{2x - R_w}{\alpha_w R_w}\right)\cos\left(\frac{\pi}{2}\,\frac{2y - 2x + R_i}{\alpha_i R_i}\right)\right)$$

$$f_{5a}(x,y) = \frac{1}{16\pi R_i}\left(\alpha_i R_i \sin\left(\frac{\pi}{2}\,\frac{4x - 2y - R_i + R_w}{\alpha_i R_i}\right) - 2\pi x \cos\left(\frac{\pi}{2}\,\frac{2y + R_i + R_w}{\alpha_i R_i}\right)\right)$$

$$f_{5b}(x,y) = \frac{\alpha_i \alpha_w R_w}{4\pi\left(\alpha_i^2 R_i^2 - \alpha_w^2 R_w^2\right)}\left(\alpha_i R_i \cos\left(\frac{\pi}{2}\,\frac{2x + R_w}{\alpha_w R_w}\right)\sin\left(\frac{\pi}{2}\,\frac{2x + 2y - R_i}{\alpha_i R_i}\right) - \alpha_w R_w \sin\left(\frac{\pi}{2}\,\frac{2x + R_w}{\alpha_w R_w}\right)\cos\left(\frac{\pi}{2}\,\frac{2x - 2y - R_i}{\alpha_i R_i}\right)\right)$$

3.3 Power contributions

$$C_1 = p_1\left(U_1, L_1\right) + \frac{1}{2}\sum_{n=2}^{5} p_1\left(U_n, L_n\right) + \frac{1}{4}\sum_{n=6}^{9} p_1\left(U_n, L_n\right)$$

$$C_2 = p_2\left(U_2, L_2\right) + p_2\left(U_3, L_3\right) + \frac{1}{2}\left[p_2\left(U_6 - \delta f, L_6 - \delta f\right) + p_2\left(U_7 + \delta f, L_7 + \delta f\right) + p_2\left(U_8 + \delta f, L_8 + \delta f\right) + p_2\left(U_9 - \delta f, L_9 - \delta f\right)\right]$$

$$C_3 = p_3\left(U_4, L_4\right) + p_3\left(U_5, L_5\right) + \frac{1}{2}\left[p_3\left(U_6, L_6\right) + p_3\left(U_7, L_7\right) + p_3\left(-L_8, -U_8\right) + p_3\left(-L_9, -U_9\right)\right]$$

$$C_4 = p_4\left(U_6, L_6, \delta f\right) + p_4\left(U_7, L_7, -\delta f\right)$$

$$C_5 = p_5\left(U_8, L_8, -\delta f\right) + p_5\left(U_9, L_9, \delta f\right)$$

3.4 Total received signal power

$$\text{Power} = \sum_{m=1}^{5} C_m$$

APPENDIX 1

TO ANNEX 1

Notification of parameters associated to digital emissions

Application of the method described in Annex 1 for calculation of protection masks for interference between digital emissions requires the notification of new parameters associated with each digital emission. These parameters are:

– the digital modulation type (the method is applicable only to phase shift keyed signals);

– the transmitted symbol rate (Msymbol/s);

– the roll-off factor of the digital pulse shaping filter (assumed to be a cosine roll-off filter or an approximation thereof), a value in the range 0 to 1.

Pending the results of further studies as indicated in this Recommendation, additional parameters may need to be defined (e.g. indication of linear or non-linear channel operation).

The necessary parameters should be submitted explicitly for each digital emission.

It is recommended to update Annex 2 of RR Appendices 30 and 30A accordingly at a competent Radio Conference once the results of the study become available.

ANNEX 2

Interference calculation methods associated with Annexes 1 and 3*

1 Introduction

The purpose of this Annex is to define a generic method to calculate the interference situation in the BSS Plans, taking into account different categories of interference (e.g. co-channel, adjacent-channel, ...).

The generic interference calculation method defined below, associated with the appropriate protection mask calculation methods, should be applied to establish the values necessary to assess the interference situation between different emissions of the BSS Plans.

2 Terminology, symbols and operators

In order to simplify this Annex and to facilitate its understanding, the following terminology, symbols and operators are defined:

Single entry, se:	a single interfering carrier is considered
Aggregate, ag:	all interfering carriers are considered
Equivalent, eq:	combination of co-frequency and frequency offset interference
Overall, ov:	combination of feeder-link, up, and downlink, dn, interference
fo:	frequency offset: difference between the centre frequencies of two carriers
c/i :	carrier to interference ratio
C/I:	carrier to interference ratio (dB)
PR:	protection ratio (dB)

* This method has been developed to carry out the compatibility analysis of assignments, submitted to the BR under the provision of RR Appendices 30 and 30A, with parameters different from those used in the establishment of the Plans (channel bandwidth, centre frequency, type of emission, etc.).

EPM: equivalent protection margin (dB)

OEPM: overall equivalent protection margin (dB)

X: reduction of the overall *C*/*I* due to interference in the feeder link (dB)

Operator ⊕: $A \oplus B = -10 \log \left(10^{-A/10} + 10^{-B/10}\right)$

Operator ©: $A \copyright B = -10 \log \left(10^{-A/10} - 10^{-B/10}\right)$

Operator Σ⊕: $\sum_{n=1}^{N} \oplus A_n = -10 \log \left(10^{-A_1/10} + 10^{-A_2/10} + \ldots + 10^{-A_n/10}\right)$

3 Interference calculation methods

In order to calculate the interference situation of an assignment, two major elements are needed:

– the equivalent aggregate carrier to interference ratio, $C/I_{eq,\,ag}$, on both up and downlinks, $C/I_{eq,\,ag,\,up}$, $C/I_{eq,\,ag,\,dn}$, respectively,

– the overall co-channel (or co-frequency) protection ratios of the wanted carrier, PR_{ov}.

In addition, definitions for the equivalent protection margins (EPM) (see Note 1) and Overall Equivalent Protection Margin (OEPM) are required.

NOTE 1 – EPM is not needed in case of application of this method to the Region 2 BSS Plan.

3.1 The first elements, i.e. the equivalent aggregate carrier to interference ratios, are calculated as follows for both the up and downlinks

$$C/I_{eq,\,ag,\,up} = \sum_{i=1}^{m} \oplus \left(C/I_{i,\,se,\,up} + D_i(fo_i)\right)$$

$$C/I_{eq,\,ag,\,dn} = \sum_{i=1}^{m} \oplus \left(C/I_{i,\,se,\,dn} + D_i(fo_i)\right)$$

where:

m : number of interfering carriers on the feeder-link

n : number of interfering carriers on the downlink

fo : frequency offset between the centre frequencies of the wanted carrier and one interfering carrier; a positive or negative value (MHz)

$D(fo)$: difference (dB) between the appropriate protection mask's value with no frequency offset (i.e. the centre value at 0 MHz) and the protection mask's value with a frequency offset of *fo* MHz.

For the case of a digital wanted carrier and a digital interfering carrier, the value $D(fo) = -I(fo)$, where $I(fo)$ ($\equiv I(\delta f)$) is defined in Annex 1 assuming a linear channel. However, pending further studies to quantify the effects of the non-linear channel, the model given in Annex 3 should be applied to evaluate $D(fo)$.

For other combinations of wanted and interfering carrier types (digital into analogue interference) appropriate masks remain to be defined. Until such time as these masks are available, the model given in Annex 3 should be applied to evaluate $D(fo)$.

From these first elements the overall equivalent aggregate carrier to interference ratio (denoted $C/I_{ov,\,eq,\,ag}$) can be calculated as follows:

$$C/I_{ov,\,eq,\,ag} = C/I_{eq,\,ag,\,up} \oplus C/I_{eq,\,ag,\,dn}$$

3.2 The second major element, i.e. the overall protection ratio, PR_{ov}, is associated to the type of the wanted carriers

In addition to this second element, a feeder-link protection ratio and a downlink protection ratio, PR_{up} and PR_{dn} respectively, can be defined. Assuming a given increase, *X*, in the downlink protection ratio to allow for interference in the feeder-link, PR_{up} and PR_{dn} are defined as follows:

$$PR_{dn}^{2} = PR_{ov} + X$$

$$PR_{up}^{2} = PR_{ov} \copyright PR_{dn}$$

3.3 EPM_{up}, EPM_{dn} and OEPM definitions

$$OEPM = C/I_{ov,\,eq,\,ag} - PR_{ov}$$

$$EPM_{up}^{2} = C/I_{eq,\,ag,\,up} - PR_{up}$$

$$EPM_{dn}^{2} = C/I_{eq,\,ag,\,dn} - PR_{dn}$$

ANNEX 3

Calculation of digital interference in the absence of appropriate protection masks

When applying the calculation method of Annex 2, it is desirable to apply the most appropriate protection mask for the digital interference situation under consideration (i.e. the most appropriate value for $D_i(fo_i)$ in Annex 2). For example, for digital interference into a digital emission, this mask can be derived using the calculation method given in Annex 1, subject to further studies to quantify the effects of channel non-linearities.

Further studies are also required to derive suitable generic protection masks for the case of digital into analogue interference.

Until such time as these masks are available, the method given below should be used to calculate the interference between two emissions, where the interferer is a digital emission.

The value for $D(fo)$ is calculated as follows:

$$D(fo) = 10 \log_{10}\big(B / b(fo)\big) + K$$

where:

- $b(fo)$: overlapping bandwidth between the interfering carrier and the wanted carrier (MHz)
- B: necessary bandwidth of the interfering digital carrier (MHz)
- K: positive weighting coefficient.

In general, a protection mask calculation method such as that given in Annex 1 quantifies the value *K* which may vary depending upon the wanted and interfering signal parameters and the frequency offset between the two signals (in fact, the method of Annex 1 does not explicitly calculate the factor *K* but rather calculates directly the value $-D(fo)$).

In the absence of suitable protection masks which quantify the factor *K*, either directly or indirectly, it should be assumed that $K = 0$ which corresponds to the worst case.

RECOMMENDATION ITU-R BO.1295

REFERENCE TRANSMIT EARTH STATION ANTENNA OFF-AXIS e.i.r.p. PATTERNS FOR PLANNING PURPOSES TO BE USED IN THE REVISION OF THE APPENDIX 30A (Orb-88) PLANS OF THE RADIO REGULATIONS AT 14 GHz and 17 GHz IN REGIONS 1 AND 3

(Question ITU-R 218/11)

(1997)

The ITU Radiocommunication Assembly,

considering

a) that Resolution 531 (WRC-95) of the World Radiocommunication Conference (Geneva, 1995) invites the ITU-R to study the possibilities to improve the efficiency of the Appendix 30A (Orb-88) Plans of the Radio Regulations (RR) by taking due account of the technological progress;

b) that for the feeder link of the broadcasting-satellite service planning purposes a simple transmit earth station antenna reference pattern is necessary;

c) that the existing RR Appendix 30A (Orb-88) Regions 1 and 3 transmit earth station antenna patterns are no longer appropriate due to technological improvements (see also Recommendations ITU-R S.465, ITU-R S.580 and ITU-R S.731);

d) that measured data in support of an improved transmit antenna reference pattern is available;

e) that the use of antennas with the best achievable radiation pattern will lead to the most efficient use of the radio-spectrum and the geostationary-satellite orbit;

f) that the transmit earth station antenna in the feeder-link Plans are operated by professional users,

recognizing

a) that the adoption of improved reference transmit earth station antenna patterns for planning purposes does not prevent the use of other antennas that have been coordinated or will be coordinated in the future on the basis of different patterns;

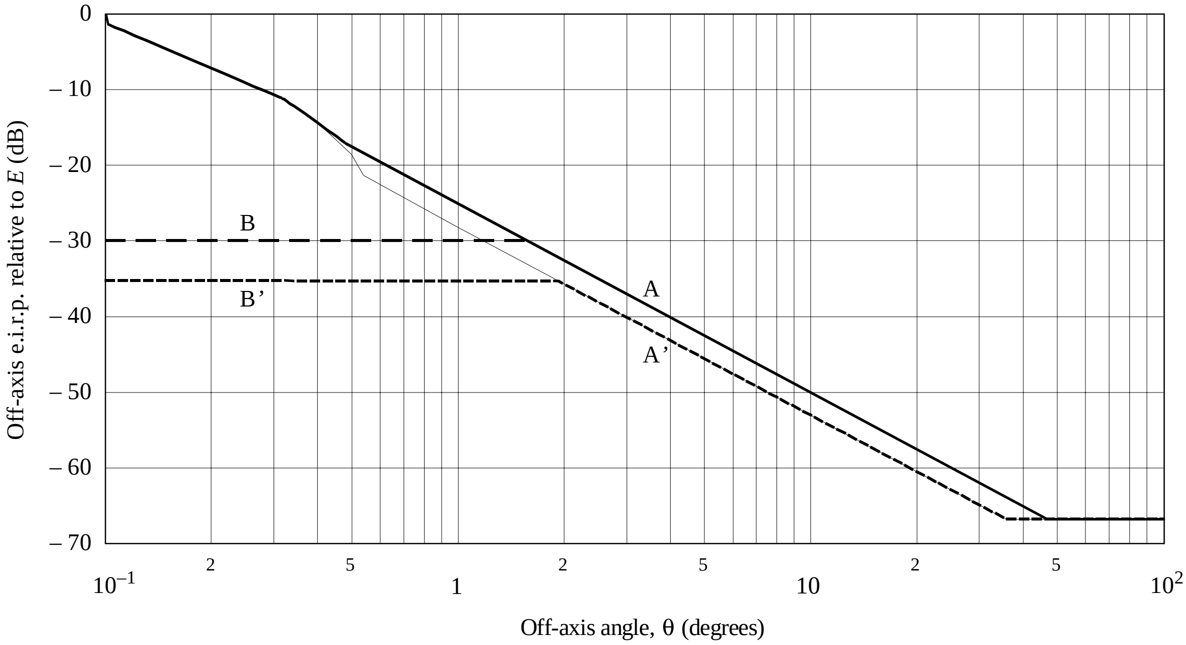
b) that off-axis e.i.r.p. values were used in the development of the RR Appendix 30A (Orb-88) Plans,

recommends

1 the use of co-polar and cross-polar off-axis e.i.r.p. values given in Fig. 1 together with their associated formulae provided in Annex 1 for replanning purposes of the RR Appendix 30A (Orb-88) Plans in Regions 1 and 3.

FIGURE 1

Earth station e.i.r.p. at off-axis antenna angles



Curves A': new transmit earth station co-polar
B': new transmit earth station cross-polar
A: RR Appendix 30A (Orb-88) Regions 1 and 3 co-polar*
B: RR Appendix 30A (Orb-88) Regions 1 and 3 cross-polar*

1295-01

* Curves included for information only.

ANNEX 1

Formulae associated to the curves of Fig. 1

Curve A′: co-polar component (dBW):

E	for	$0° \leq \theta \leq 0.1°$
$E - 21 - 20 \log \theta$	for	$0.1° < \theta \leq 0.32°$
$E - 5.7 - 53.2\ \theta^2$	for	$0.32° < \theta \leq 0.54°$
$E - 28 - 25 \log \theta$	for	$0.54° < \theta \leq 36.31°$
$E - 67$	for	$36.31° < \theta$

Curve B′: cross-polar component (dBW):

$E - 35$	for	$0° \leq \theta \leq 1.91°$
$E - 28 - 25 \log \theta$	for	$1.91° < \theta \leq 36.31°$
$E - 67$	for	$36.31° < \theta$

where:

E: earth station e.i.r.p. on the antenna axis (dBW)

θ: off-axis angle referred to the main lobe axis (degrees).

For replanning purposes, an antenna diameter of 5 m for the band 17.3-18.1 GHz and 6 m for the band 14.5-14.8 GHz are to be assumed.

The on-axis gain for the 5 m antenna at 17.3 - 18.1 GHz and for the 6 m antenna at 14.5-14.8 GHz is taken as 57 dBi.

RECOMMENDATION ITU-R BO.1296

REFERENCE RECEIVE SPACE STATION ANTENNA PATTERNS FOR PLANNING PURPOSES TO BE USED FOR ELLIPTICAL BEAMS IN THE REVISION OF THE APPENDIX 30A (Orb-88) PLANS OF THE RADIO REGULATIONS AT 14 GHz AND 17 GHz IN REGIONS 1 AND 3

(Question ITU-R 218/11)

(1997)

The ITU Radiocommunication Assembly,

considering

a) that Resolution 531 (WRC-95) (World Radiocommunication Conference (Geneva, 1995)) invites the ITU-R to study the possibilities to improve the efficiency of the Appendix 30A (Orb-88) Plans of the Radio Regulations (RR) by taking due account of the technological progress;

b) that for the feeder link of the broadcasting-satellite service planning purposes a simple receive space station antenna reference pattern is necessary;

c) that the existing RR Appendix 30A (Orb-88) Regions 1 and 3 receive space station antenna patterns are no longer appropriate due to technological improvements;

d) that measured data in support of an improved receive antenna reference pattern is available;

e) that the use of antennas with the best achievable radiation pattern will lead to the most efficient use of the radio-spectrum and the geostationary-satellite orbit,

recognizing

1 that the adoption of improved reference receive space station antenna patterns for planning purposes does not prevent the use of other antennas that have been coordinated or will be coordinated in the future on the basis of different patterns;

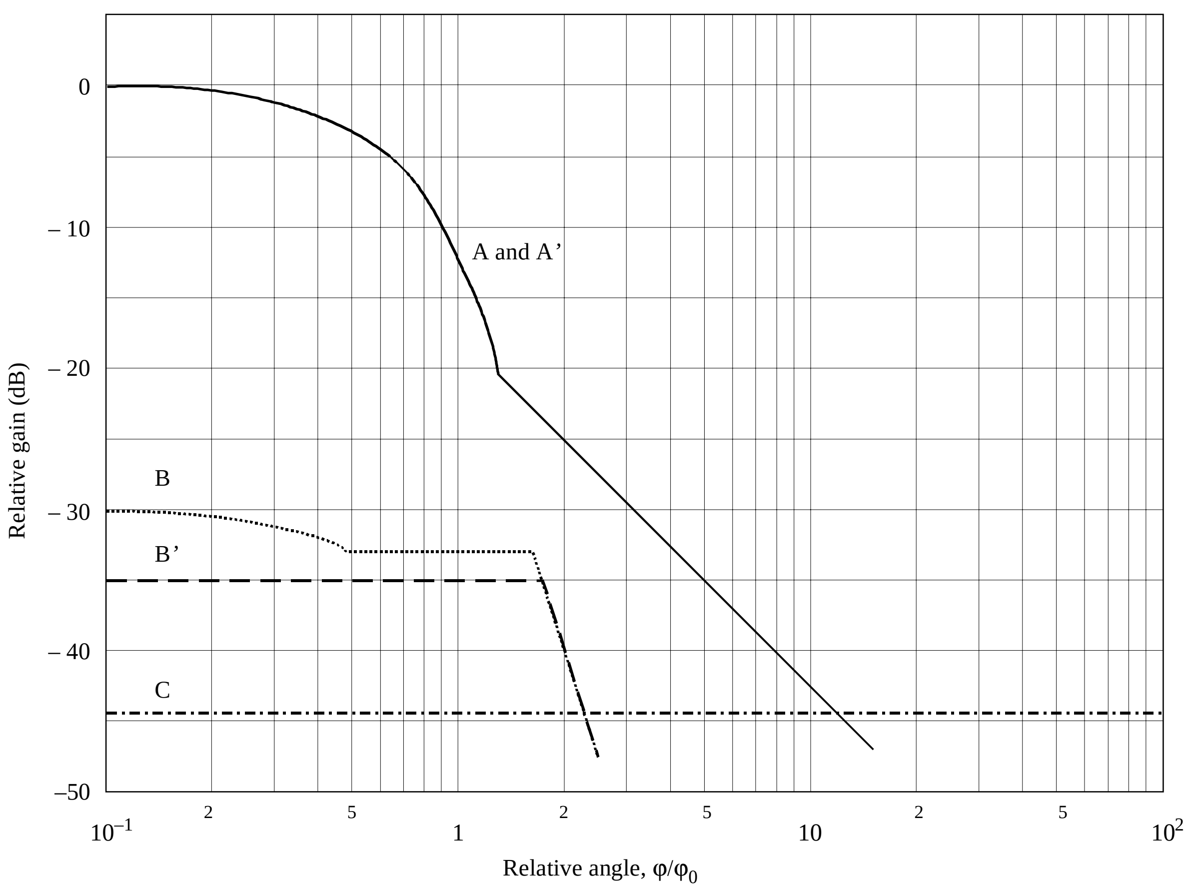
2 that these patterns may become part of the Plan,

recommends

1 the use of the circularly polarized reference antenna co-polar and cross-polar patterns given in Fig. 1 together with their associated formulae provided in Annex 1, for elliptical beams for planning purposes in the revision of the RR Appendix 30A (Orb-88) Plans in Regions 1 and 3.

FIGURE 1

Receiving space station circularly polarized antenna co-polar and cross-polar reference patterns for elliptical beams



Curves A': new receive space station Co-polar (same as Curve A*, Fig.B, RR Appendix 30A (Orb-88) Regions 1 and 3)

B': new receive space station cross-polar

C: curve C (minus the on-axis gain)

B*: Fig.B, RR Appendix 30A (Orb-88), Regions 1 and 3, cross-polar

* Curves included for information only.

1296-01

ANNEX 1

Formulae associated to the curves of Fig. 1

Curve A′: co-polar relative gain (dB):

$G = -12\ (\varphi/\varphi_0)^2$ for $0 \leq \varphi/\varphi_0 < 1.3$

$G = -17.5 - 25 \log (\varphi/\varphi_0)$ for $1.3 \leq \varphi/\varphi_0$

After intersection with Curve C, as Curve C.

Curve B′: cross-polar relative gain (dB):

$G = -35$ for $0 \leq \varphi/\varphi_0 < 1.75$

$G = -40 - 40 \log (\varphi/\varphi_0 - 1)$ for $1.75 \leq \varphi/\varphi_0$

After intersection with Curve C, as Curve C.

Curve C: minus the on-axis gain (Curve C in the above figure illustrates the particular case of an antenna with an on-axis gain of 44.44 dBi),

where:

φ: off-axis angle (degrees)

φ_0: cross-sectional half-power beamwidth in the direction of interest (degrees).

The relationship between the maximum gain of an antenna and the half-power beamwidth can be derived from the expression:

$$G_{max} \text{ (dB)} = 44.44 - 10 \log a - 10 \log b$$

where *a* and *b* are the angles (degrees) subtended at the satellite by the major and minor axes of the elliptical cross-section of the beam.

RECOMMENDATION ITU-R BO.1297*

PROTECTION RATIOS TO BE USED FOR PLANNING PURPOSES IN THE REVISION OF THE APPENDICES 30 (Orb-85) AND 30A (Orb-88) PLANS OF THE RADIO REGULATIONS IN REGIONS 1 AND 3

(Question ITU-R 85/11)

(1997)

The ITU Radiocommunication Assembly,

considering

a) that Resolution 531 (WRC-95) of the World Radiocommunication Conference (Geneva, 1995) invites the ITU-R to study the possibilities to improve the efficiency of the Appendices 30 (Orb-85) and 30A (Orb-88) of the Radio Regulations (RR) Plans by taking due account of the technological progress;

b) that WRC-95 has adopted in Recommendation 521 (WRC-95) overall aggregate protection ratios;

c) that protection ratios are essential characteristics for the planning of the broadcasting-satellite service (BSS) and the associated feeder links;

d) that the RR Appendices 30 (Orb-85) and 30A (Orb-88) Plans have been developed by using values of protection ratio based on fixed frequency offsets of 19.18 MHz and analogue signals;

e) that the existing RR Appendices 30 (Orb-85) and 30A (Orb-88) Regions 1 and 3 protection ratios are no longer appropriate due to technological improvements made in the BSS;

f) that measured data in support of an improvement of the protection ratios are available,

recommends

1 the use of the aggregate protection ratio provided in Annex 1 below, for planning purposes in the revision of RR Appendices 30 (Orb-85) and 30A (Orb-88) Plans in Regions 1 and 3.

ANNEX 1

Aggregate protection ratios to be used for planning purposes in the revision of RR Appendices 30 (Orb-85) and 30A (Orb-88) Plans in Regions 1 and 3

	Co-channel protection ratio (dB)	Adjacent channel protection ratio (dB)
Feeder link path	30	22
Down link path	24	16
Overall path	23	15

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* The Administrations of Saudi Arabia, the Islamic Republic of Iran and Syria reserved their position on the acceptance of this Recommendation until such time as they know precisely what were the reasons for the reduction in the protection ratio from 30 dB to 22 dB and who benefited from that reduction.