RECOMMENDATION ITU-R M.632-3*

TRANSMISSION CHARACTERISTICS OF A SATELLITE EMERGENCY POSITION-INDICATING RADIO BEACON (SATELLITE EPIRB) SYSTEM OPERATING THROUGH GEOSTATIONARY SATELLITES IN THE 1.6 GHz BAND

(Question ITU-R 90/8)

(1986-1990-1994-1997)

Summary

This Recommendation contains the transmission characteristics of a satellite EPIRB system operating through geostationary satellites in the 1.6 GHz band. This Recommendation is intended to facilitate the popularization of satellite EPIRB systems practically without sacrificing the system performance.

The ITU Radiocommunication Assembly,

considering

a) that satellite EPIRBs are one of the prime alerting means in the Global Maritime Distress and Safety System (GMDSS) adopted by the International Maritime Organization (IMO);

b) that the satellite EPIRB system operating through geostationary satellites in the 1.6 GHz band is one of two satellite-based distress alerting systems developed for use in the GMDSS;

c) that all ships to which Chapter IV of the International Convention for the Safety of Life at Sea (SOLAS) 1974, as amended in 1988, applies are required by Regulation IV/7.1.6 to carry a satellite EPIRB from 1 August 1993;

d) that SOLAS Regulation IV/7.1.6 permits the carriage of a satellite EPIRB operating through the Inmarsat geostationary-satellite system, subject to the availability of appropriate receiving and processing ground facilities for each ocean region covered by Inmarsat;

e) that pre-operational demonstrations have been satisfactorily completed;

f) that the IMO has adopted Resolution A.661(16) – Performance standards for float-free satellite EPIRBs operating through the geostationary Inmarsat satellite system on 1.6 GHz;

g) that ships to which the 1974 SOLAS Convention does not apply will use elements of the GMDSS, including satellite EPIRBs, some of which may not meet all of the requirements established by the IMO in Resolution A.661(16);

h) the necessity to make available satellite EPIRB production units, and to gain operational experience within the remaining time-frame;

j) that the frequency band for satellite EPIRBs available through the first generation Inmarsat space segment is 1 644.3-1 644.5 MHz;

k) that the second generation Inmarsat space segment, which is planned to commence operation from 1990 onwards, will cover both the band 1 644.3-1 644.5 MHz and the band 1 645.5-1 646.5 MHz;

l) that the number of potential users, including non-Convention ships, cannot yet be estimated;

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* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), and the International Mobile Satellite Organization (Inmarsat).

Note by the Secretariat: The current version of this Recommendation has been incorporated by reference in the Radio Regulations (RR) as revised by the World Radiocommunication Conference, 1995 (WRC-95). According to *resolves 1* of Resolution 28 (WRC-95), the next Radiocommunication Assembly shall communicate to the WRC-97 the list of the ITU-R Recommendations incorporated by reference in the RR which have been revised and approved.

m) that the amount of spectrum for the 1.6 GHz satellite EPIRB system necessary to meet the presently foreseen operational capacity requirements is probably not greater than 200 kHz,

recommends

1 that the transmission characteristics of all types of satellite EPIRBs operating through geostationary satellites at 1.6 GHz should be in accordance with Annex 1;

2 that the transmission frequencies of satellite EPIRBs be distributed uniformly across the frequency band appropriate to the space segment in use;

3 that the operational implementation of the 1.6 GHz satellite EPIRB system as it applies to the second and subsequent generations of the Inmarsat space segment be initiated in the spectrum between 1 645.6 and 1 645.8 MHz;

4 that until all satellites of the Inmarsat first generation space segment (spare and operational) are completely replaced, all types of satellite EPIRBs in the 1.6 GHz band will transmit sequentially on both 1 645.6-1 645.8 MHz and 1 644.3-1 644.5 MHz.

ANNEX 1

Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) system operating through geostationary satellites in the 1.6 GHz band

Modulation:	non-coherent binary frequency shift keying (FSK)
Transmit frequency:*	within the bands 1 644.3-1 644.5 MHz (Inmarsat first generation space segment) and 1 645.5-1 646.5 MHz (Inmarsat second generation space segment)
Deviation:	−120 Hz (0) + 120 Hz (1) tolerance ± 1%
Accuracy of clock frequency:	$\pm 2 \times 10^{-6}$/year (This requires a clock accuracy of $\pm 2 \times 10^{-7}$/year in the receiver processor)
Transmit frequency:	
– long-term accuracy (for 1 year):	better than $\pm 3 \times 10^{-6}$
– short-term stability:	2×10^{-8} for 1 min
FSK switching time:	80% transmit power within 1.5 ms
Transmit power (e.i.r.p.):	0 dBW with tolerance + 2 to −3 dB
Antenna:	Hemispherical in pattern
Antenna axial ratio:	≤ 5 dB for ± 90° from zenith
Polarization:	right-hand circular
Frame length:	
– data:	100 bits (see Appendix 1)
– synchronization:	20 bits (see Appendix 1)
– parity bits:	40 bits (see Appendix 2)

* Until all satellites of the Inmarsat first generation space segment (spare and operational) are completely replaced, all types of satellite EPIRBs will transmit sequentially on both frequency bands of the Inmarsat first and subsequent generation space segments.

Code:	NRZ-L
Modulation rate:	32 Bd
Total transmission duration:	40 min (150 min) (see § 7 of Appendix 3)
Number of transmissions:	4 (see Appendix 3)

NOTE 1 – The total transmission duration will be reduced to 20 min (75 min) (see § 7 of Appendix 3) (see also § 5 of Appendix 3) when all first generation satellites have been replaced.

APPENDIX 1

TO ANNEX 1

1 The following items, listed in the preferred priority order for entry and read-out, should be included in distress messages to the extent practicable and necessary:

TABLE 1

Content of distress message

Item	Content of distress message	Number of bits
1	Ship station identity	30
2	Position coordinates and information in the following order:	
2.1	Latitude in degrees and minutes(1)	14
2.2	Longitude in degrees and minutes(1)	15
2.3	Time of position up-date(2)	11
3	Nature of distress	4
4	Course	9
5	Speed	6
6	Time of activation(3)	11
7	Assistance desired and any other information which might facilitate the rescue(4)	

(1) For implementation reasons the order in which items 2.1 and 2.2 are transmitted on the radio path is given in Tables 2 and 4 and Fig. 1.

(2) The time of receipt of an alert is added by the digital receiver processor.

(3) Where a GPS receiver is built in as an integral part of the EPIRB, this field may be omitted. The 11 bits thereby released may be used to enhance the accuracy of reported position as given in Table 4.

(4) Item 7 may be included with the data sent in item 3, if necessary.

2 The format of the transmitted message and string is shown in Table 2 and Fig. 1.

TABLE 2

Format of the transmitted message (see (1) Table 1)

Synchronization bits	20 bits	Hex EDE20
Distress message	30 bits	Ship station identity range: 0-999.999.999
	1 bit	Longitude hemispherical symbol 0: East; 1: West
	1 bit	Latitude hemispherical symbol 0: North; 1: South
	8 bits	Degrees of longitude range: 0-180
	6 bits	Minutes of longitude range: 0-60
	7 bits	Degrees of latitude range: 0-90
	6 bits	Minutes of latitude range: 0-60
	9 bits	Course: degrees (true) range: 0-360
	5 bits	Time of position update: h (UTC) range: 0-24
	6 bits	Time of position update: min range: 0-60
	5 bits	Time of activation: h (UTC) range: 0-24
	6 bits	Time of activation: min range: 0-60
	6 bits	Speed: knots range: 0-63
	4 bits	Nature of distress (see Table 3)
Parity bits	40 bits	See Appendix 2 for composition

In those systems where it is desirable to provide, on activation, a specific indication of the nature of distress, the indications of Table 3 should be used.

TABLE 3

Nature of distress indications

IMO indicator	Binary code	Nature of distress
1	0001	Fire/explosion
2	0010	Flooding
3	0011	Collision
4	0100	Grounding
5	0101	Listing, in danger of capsizing
6	0110	Sinking
7	0111	Disabled and adrift
8	0000	Undesignated (unspecified distress)
9	1000	Abandoning ship
10	1111	Test(1)

(1) Use of this indicator should be restricted to those applications where transmission of the distress alert (or call) is required to ascertain that the system is operating properly. Provisions may be required to confirm that the complete system is functioning.

Additional capacity should be provided if practical.

TABLE 4

Format of the transmitted message for "high resolution" mode*

Synchronization bits	20 bits	Hex EDE20
Distress message	30 bits	System code range: 0-999.999.999
	1 bit	Longitude hemispherical symbol 0: East; 1: West
	1 bit	Latitude hemispherical symbol 0: North; 1: South
	8 bits	Degrees of longitude range: 0-180
	6 bits	Minutes of longitude range: 0-60
	7 bits	Degrees of latitude range: 0-90
	6 bits	Minutes of latitude range: 0-60
	9 bits	Course: degrees (true) range: 0-360
	5 bits	Time of position update: h (UTC) range: 0-24
	6 bits	Time of position update: min range: 0-60
	3 bits	Mode selection (normal mode/high resolution) (see NOTE 1)
	4 bits	Latitude position enhancement (see Table 5)
	4 bits	Longitude position enhancement (see Table 5)
	6 bits	Speed: knots range: 0-63
	4 bits	Nature of distress (see Table 3)
Parity bits	40 bits	See Appendix 2 for composition

* For EPIRBs having an integral GPS receiver if a valid position fix has been provided, these 3 bits will be set to all ones to enable the digital receiver processor to recognize this and switch to "high resolution" mode.

TABLE 5

Use of additional 4 bits to enhance latitude and longitude accuracy

The additional 4 bits enable increased accuracy by subdividing the minutes information into 15 equal steps, i.e. intervals of 3.75 s or 0.0625 min. The binary representation of steps 1 to 15 is shown in Table 5.

Step	Binary number	Equivalent s	Decimal min
1	0001	3.75	0.0625
2	0010	7.5	0.125
3	0011	11.25	0.1875
4	0100	15.00	0.25
5	0101	18.75	0.3125
6	0110	22.50	0.375
7	0111	26.25	0.4375
8	1000	30.00	0.5
9	1001	33.75	0.5625
10	1010	37.50	0.625
11	1011	41.25	0.6875
12	1100	45.00	0.75
13	1101	48.75	0.8125
14	1110	52.5	0.875
15	1111	56.25	0.9375

APPENDIX 2

TO ANNEX 1

Forward error-correction code

40 parity bits for error-correcting purposes. A (140, 100, 5) BCH code is used resulting in a minimum code distance of 11.

The input message

$$\underbrace{C_1, C_2, \cdots, C_{100},}_{\text{Distress message}} \qquad \underbrace{C_{101}, \cdots, C_{140}}_{= 0}$$

MSB*

is divided modulo 2 by the following generator polynomial:

$$\begin{aligned} g(x) = {} & x^{40} + x^{37} + x^{36} + x^{33} + x^{32} \\ & + x^{30} + x^{29} + x^{28} + x^{27} + x^{26} + x^{24} + x^{23} + x^{22} + \\ & + x^{20} + x^{17} + x^{16} + x^{15} + x^{13} + x^{11} \\ & + x^{10} + x^{8} + x^{4} + \\ & + 1 \end{aligned}$$

The remainder of this division represents the parity bits C_{101}, …, C_{140}.

The output message is generated by inserting the parity bits in the output message.

Resultant output message:

$$\underbrace{C_1, C_2, \cdots, C_{100},}_{\text{Distress message}} \qquad \underbrace{C_{101}, \cdots, C_{140}}_{\text{Parity bits}}$$

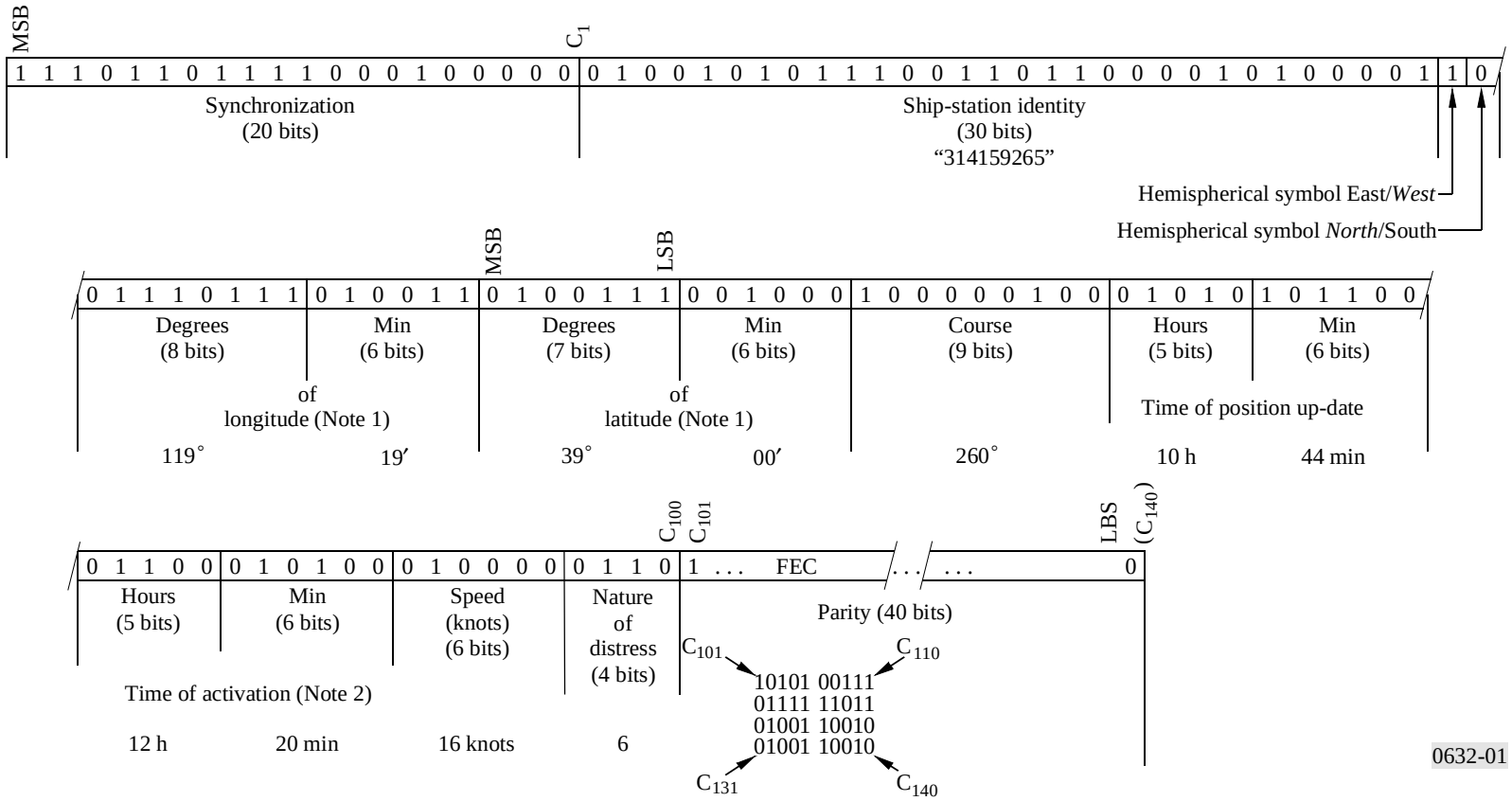
MSB LSB**

* MSB: most significant bit.

** LSB: least significant bit.

FIGURE 1

Transmitted message string (example)
(See (1), Table 1)



MSB: most significant bit
LSB: least significant bit
FEC: forward error-correction code

– The data frame is periodically repeated during the whole operating time.
– The HSD of the data frame is transmitted first.

Note 1 – Where an integral GPS receiver is included in the EPIRB 4 additional bits will be available to provide increased accuracy as shown in Table 5.
Note 2 – As described in Note 1 to Table 4, 3 bits from this field will be used to indicate "high resolution" mode where a valid position fix from the integral GPS receiver is available.

APPENDIX 3

TO ANNEX 1

Duty cycle

1 The duration of each transmission period should initially be 10 min. However, when all satellites of the Inmarsat first generation (spare and operational) have been completely replaced, the minimum overall transmission duration for each burst can be reduced to 5 min in the distress and safety band 1 645.5-1 646.5 MHz.

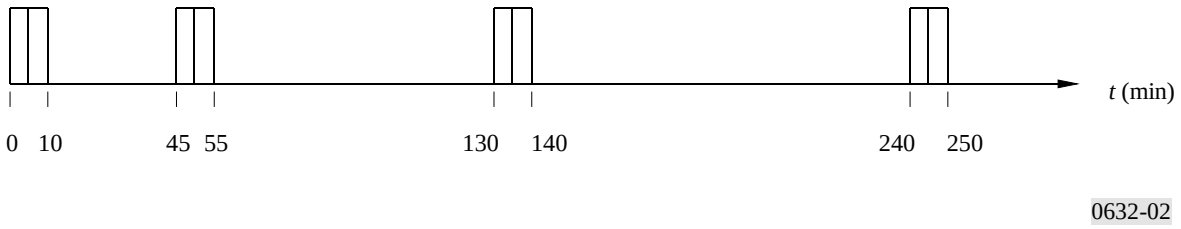
2 Once all first generation satellites have been retired, EPIRBs will only be required to transmit in the distress and safety band (1 645.5-1 646.5 MHz). Until that time satellite EPIRBs shall transmit sequentially for 5 min on each of the frequency bands 1 645.5-1 646.5 MHz and 1 644.3-1 644.5 MHz in that order.

3 The first transmission should be initiated when the distress occurs either by manual activation from on-board the ship or when the satellite EPIRB floats free.

4 The second transmission should begin 45 min after the start of the first to overcome possible interruptions caused by shadowing due to the superstructure of the abandoned ship.

5 To further increase the probability of a successful transfer of the distress alert, two additional transmissions should follow the first two, the third 130 min, and the fourth 240 min, after the start of the first transmission.

6 The transmission repetition rate is illustrated as follows:



Note that each transmission burst initially comprises 2 × 5 min duration. As noted under § 1 above, the duration will eventually be reduced to 5 min per burst.

7 Where an EPIRB contains integral facilities for position updating the total transmission duration may be extended to 150 (75) min by means of a further ten 10 (5) min transmission every four hours resulting in a total operational period of 48 h and 10 (5) min; the first of these additional bursts commencing 480 min after the commencement of transmissions from the EPIRB.