

---

# **COSPAS-SARSAT SYSTEM BEACON SPECIFICATION AND DESIGN GUIDELINES**

C/S T.022  
Issue 2, Revision 1  
October 2023

---

This document is provided as a complement to the final clean version of the document. In case of discrepancy between this marked-up version and the clean final version, the information in the clean final version shall prevail.



**COSPAS-SARSAT SYSTEM BEACON**  
**SPECIFICATION AND DESIGN GUIDELINES**

**HISTORY**

| <u>Issue</u> | <u>Revision</u> | <u>Date</u>   | <u>Comments</u>                                |
|--------------|-----------------|---------------|--|
| 1            | -               | February 2018 | Approved by the Cospas-Sarsat Council (CSC-59) |
| 1            | 1               | November 2019 | Approved by the Cospas-Sarsat Council (CSC-62) |
| 1            | 2               | March 2021    | Approved by the Cospas-Sarsat Council (CSC-64) |
| 2            | -               | March 2022    | Approved by the Cospas-Sarsat Council (CSC-66) |
| 2            | 1               | October 2023  | Approved by the Cospas-Sarsat Council (CSC-69) |

## **TABLE OF CONTENTS**

|           |   |            |
|-----------|---|------------|
| <b>1.</b> | <b>INTRODUCTION.....</b>  | <b>1-1</b> |
| 1.1       | Overview .....  | 1-1        |
| 1.2       | Scope .....   | 1-1        |
| 1.3       | Reference Documents.....  | 1-1        |
| <b>2.</b> | <b>PERFORMANCE SPECIFICATION AND DESIGN GUIDELINES FOR<br/>REFERENCE BEACONS.....</b> | <b>2-1</b> |
| 2.1       | Purpose .....   | 2-1        |
| 2.2       | Requirements Common to all Reference Beacons .....                                    | 2-1        |
| 2.3       | Requirements for Designated QMS Reference Beacons.....                                | 2-2        |
| 2.3.1     | Designated LEOSAR QMS Reference Beacons.....  | 2-2        |
| 2.3.2     | Designated GEOSAR QMS Reference Beacons .....   | 2-2        |
| 2.3.3     | Designated MEOSAR QMS Reference Beacons .....   | 2-2        |
| 2.4       | Guidelines for Defining Reference Beacons Requirements.....                           | 2-3        |
| 2.4.1     | Guidelines for Supplying a MEOSAR Reference Beacon .....                              | 2-3        |
| 2.4.2     | Other Guidelines for MEOSAR Reference Beacons .....                                   | 2-4        |
| 2.5       | List of Reference Beacons in the System.....  | 2-6        |
| <b>3.</b> | <b>GUIDELINES FOR DEFINING CALIBRATION BEACON REQUIREMENTS.....</b>                   | <b>3-1</b> |
| 3.1       | Guidelines for Supplying a MEOSAR Calibration Beacon .....                            | 3-1        |
| 3.2       | Other guidelines for MEOSAR Calibration Beacons.....                                  | 3-1        |
| <b>4.</b> | <b>GUIDELINES FOR BEACON SIMULATOR REQUIREMENTS AND<br/>SPECIFICATIONS.....</b>       | <b>4-1</b> |
| 4.1       | Guidelines for Supplying a Beacon Simulator .....                                     | 4-1        |
| 4.2       | Guidelines Unique to a Beacon Simulator .....   | 4-1        |

## **LIST OF ANNEXES**

### **ANNEX A COMMITMENT OF THE MEOSAR REFERENCE BEACON OR CALIBRATION BEACON PROVIDER**

## 1. INTRODUCTION

---

### 1.1 Overview

The purpose of the Cospas-Sarsat System is to provide distress alert and location data for search and rescue (SAR), by using spacecraft and ground facilities to detect and locate distress signals and transmit the computed position and other related information to appropriate SAR authorities.

This document contains both guidelines for administrations to implement various types of System beacons, as well as specifications that explicitly define requirements that must be met (shall), or are recommended to be achieved (should).

### 1.2 Scope

This document describes the performance specification and design guidelines of the different types of beacons that are used for System purpose:

- reference beacons including designated QMS reference beacons,
- calibration beacons,
- beacon simulators.

The specifications for orbitography beacons used by the LEOSAR system are provided in document C/S T.006.

### 1.3 Reference Documents

| Reference        | Title  |
|------------------|--|
| C/S A.002        | Cospas-Sarsat Mission Control Centres Standard Interface Description (SID)         |
| C/S A.003        | Cospas-Sarsat System Monitoring and Reporting                                      |
| C/S G.003        | Introduction to the Cospas-Sarsat System   |
| C/S T.001        | Specification for Cospas-Sarsat 406 MHz Distress Beacons                           |
| <i>C/S T.003</i> | <i>Description of the 406-MHz Payloads Used in the Cospas-Sarsat LEOSAR System</i> |
| C/S T.006        | Cospas-Sarsat Orbitography Network Specification                                   |
| C/S T.016        | Description of the 406 MHz Payloads Used in the Cospas-Sarsat MEOSAR System        |
| C/S T.018        | Specification for Second-Generation Cospas-Sarsat 406-MHz Distress Beacons         |
| C/S T.019        | Cospas-Sarsat MEOLUT Performance Specification and Design Guidelines               |

## **2. PERFORMANCE SPECIFICATION AND DESIGN GUIDELINES FOR REFERENCE BEACONS**

---

### **2.1 Purpose**

The Cospas-Sarsat MEOSAR system is designed to provide global coverage. All MEOLUTs have the capability to detect and locate 406-MHz distress beacons within, at a minimum, their Declared Coverage Area. The location accuracy achieved is dependent on various parameters, including the accuracy of TOA and FOA measurements.

MEOSAR reference beacons are deployed with characteristics particularly suited to benefit MEOLUTs with a view towards being used for the monitoring of MEOSAR performance and the QMS of the MEOSAR system. The monitoring may include the continuous oversight of one or more of the following MEOLUT parameters:

- system detection rate,
- system localisation performance (probability and accuracy),
- MEOLUT throughput and single satellite-MEOLUT channel throughput,
- TOA and FOA estimation accuracy of a MEOLUT.

These beacons also provide a resource to complete the Quality Management System (QMS) objectives stated in section 7 of document C/S P.015 “Cospas-Sarsat Quality Manual”.

### **2.2 Requirements Common to all Reference Beacons**

The MEOSAR reference beacon network has been developed with the view that each MEOSAR satellite has at least one MEOSAR reference beacon in its field of view, thus allowing the monitoring of the performance of each MEOLUT channel (satellite/MEOLUT-antenna pair), to contribute to the overall MEOSAR QMS.

To limit adverse impact on the System, including the avoidance of unnecessary channel congestion, Participants should coordinate at a regional level the location and installation timeline of their MEOSAR reference beacon(s), and shall coordinate at a Programme level through the Secretariat its transmission characteristics, with a view towards limiting the number of beacon bursts to the minimum required to ensure defined MEOSAR performance.

Reference beacon providers shall provide technical characteristics of their beacons to the Secretariat, to allow this information to be published and made available on the Cospas-Sarsat website, including frequency and time characteristics, hex ID, transmission timing and schedule and, for SGBs, output filter types (i.e., transmission waveforms).

## 2.3 Requirements for Designated QMS Reference Beacons

This section provides technical requirements for reference beacons to be used for the purpose of the QMS defined in document C/S A.003.

### 2.3.1 Designated LEOSAR QMS Reference Beacons

Text to be developed, noting the definition provided in document C/S A.003.

### 2.3.2 Designated GEOSAR QMS Reference Beacons

Text to be developed, noting the definition provided in document C/S A.003.

### 2.3.3 Designated MEOSAR QMS Reference Beacons

Each designated reference beacon used for QMS shall:

- be listed on the Cospas-Sarsat website for QMS, along with its geographic location, transmission frequency, transmission schedule and, for SGBs, output filter types (i.e., transmission waveforms); and
- be committed for use to ensure that it can reliably be used to produce relevant QMS metrics; however, a designated QMS reference beacon may be used for complementary purposes.

#### 2.3.3.1 C/S T.001 Transmissions

Designated C/S T.001 QMS reference beacons shall transmit a burst every 50 seconds ( $\pm 0.1$  seconds) for a total of 12 successive bursts (i.e., for 10 minutes of beacon activation), followed by a transmission gap of at least 10 minutes, to ensure that the MEOLUT resets the beacon activation status, per document C/S T.019 section entitled “Independent Location Processing”. 30 minutes is the preferred duration for transmission repetition periods (TRP) (i.e., 10-minute slots of transmission followed by a 20-minute gap in transmission), as depicted in Figure 2.1. The TRP shall be set to provide an integer number of transmissions per day (e.g., a 30-minute repetition period results in 48 transmission periods per day, a 20-minute repetition period results in 72 transmission periods per day).



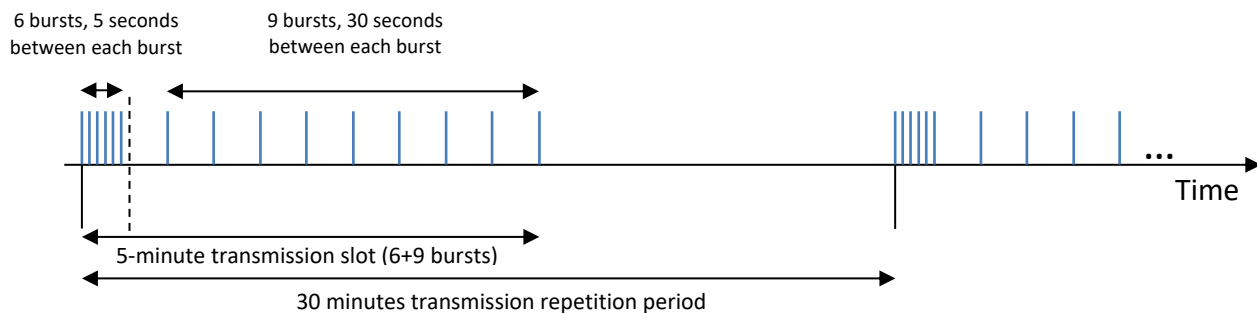
**Figure 2.1: Definition of the Transmission Repetition Periods**

Designated QMS reference beacons shall use linear polarization, to be suitable for both L-band and S-band satellites. The reference beacon shall transmit nominally, but with a transmit power of  $35.0 \pm 0.5$  dB<sub>m</sub> (measured at the antenna input).

Designated QMS reference beacons shall transmit in self-test mode, to minimize impact on the LEOSAR *Sarsat* SARP. The associated beacon message shall be coded so that no more than 18 bits within any sequence of 24 fixed bits match the 24 bit frame pattern for an operational beacon (i.e., 1111 1111 1111 1110 0010 1111), to minimize impact on the LEOSAR *Sarsat* SARP-3. *Also to reduce unintended impact on Sarsat SARP-3 processors, the beacon message should not contain anywhere in bits 1 to 61 more than seven bits in the pattern of the word used for message synchronization by the Sarsat SARP-3 (i.e., 111000101)<sup>1</sup>.*

### 2.3.3.2 C/S T.018 Transmissions

Designated C/S T.018 QMS reference beacons shall transmit a burst every 5 seconds for the first 30 seconds (6 bursts) and one burst every 30 seconds up to 5 minutes of transmission (9 bursts, for a total of 15 bursts in 5 minutes), followed by a transmission gap of at least 10 minutes, to ensure that the MEOLUT resets the beacon activation status, per document C/S T.019 section entitled “Independent Location Processing”. 30 minutes is the preferred duration for transmission repetition periods (TRP) (i.e., 5 minutes slots of transmission followed by a 25-minute gap in transmission), as depicted in Figure 2.2.



**Figure 2.2: Definition of the Transmission Repetition Periods SGB QMS**

Designated QMS reference beacons shall use linear polarization, to be suitable for both L-band and S-band satellites. The SGB QMS messages shall be transmitted in self-test mode with a transmitted power of  $35 \pm 0.5 \text{ dB}_m$  (measured at the antenna input)<sup>2</sup>.

## 2.4 Guidelines for Defining Reference Beacons Requirements

### 2.4.1 Guidelines for Supplying a MEOSAR Reference Beacon

#### Supplying a MEOSAR Reference Beacon

A MEOSAR reference beacon is supplied by a country accepting the commitment stated in Annex A and noting the operational requirements in document C/S A.003.

<sup>1</sup> Nonetheless, if no beacon message can be defined to avoid matching 8 or 9 bits of the Sarsat SARP-3 synchronisation word (e.g., no country code is available that does not match the synchronization word pattern), the reference beacon might transmit in normal mode on an exceptional basis, with due notice of this exception to the System.

<sup>2</sup> The transmit power of the QMS reference beacon shall be configurable in the range 30 to 37 dB<sub>m</sub> with 1 dB steps.

#### Availability

Once a MEOSAR reference beacon has been installed, its availability should be greater than 95%.

#### Antenna Blockage

The MEOSAR reference beacon antenna should provide the widest possible horizon.

#### Location Data

The beacon antenna location (longitude, latitude, altitude) should be provided with a three dimensional accuracy better than 1 m. This location should be given with respect to the Bureau International de l'Heure (BIH) Conventional Terrestrial System, having a reference ellipsoid defined as follows [or expressed in WGS84]:

Semi-major axis = 6,378,137 m

Flattening (ellipticity) = 1/298.2572

The location of all MEOSAR reference beacons is given on the Cospas-Sarsat website [www.cospas-sarsat.int](http://www.cospas-sarsat.int).

### **2.4.2 Other Guidelines for MEOSAR Reference Beacons**

MEOSAR reference beacons should conform to the signal specifications defined in document C/S T.001 (FGB) or C/S T.018 (SGB), except for the following.

#### Repetition period

- FGB bursts, with a repetition period of 50 seconds, transmitting per 10-minute slots,
- SGB bursts, with a repetition period of 30 seconds, transmitting per 5-minute slots.

Beacon activation should be co-ordinated with other providers of MEOSAR reference beacons to prevent repeated transmission collisions.

It should be possible to interrupt the beacon activation for some periods of time to meet the need for coordination of transmissions with other reference beacons or calibration beacons.

#### Transmitted Frequency

Initial frequency:

For FGB:

The transmitted frequency can be  $406.034 \text{ MHz} \pm [10 \text{ Hz}]$  or one of the frequency channels designated as “Reserved, not to be assigned” in Table H.2 of document C/S T.012 up to channel K (406.052 MHz) (note that channels L (406.055 MHz) and above should not be used).

The transmitted frequency might be configurable to any frequency channel identified in Table H.2 of document C/S T.012 (i.e., including operational and “Reserved, not to be assigned” channels), in order to accommodate future evolution.



For SGB:

The transmitted frequency should be  $406.049 \text{ MHz} \pm [10 \text{ Hz}]$  or  $406.051 \text{ MHz} \pm [10 \text{ Hz}]$ .

The exact transmitted frequency should be provided to the Secretariat by the reference beacon operator for publication.

Output power (except for designated QMS beacons which shall comply with specifications in section 2.3)

$37 \text{ dB}_m \pm 1 \text{ dB}$

The transmitted power should be configurable from  $25 \text{ dB}_m$  to  $37 \text{ dB}_m$  with 1 dB steps (note: this requirement is needed for possible mitigation of interference in the future, as deemed necessary).

Antenna Characteristics (except for QMS beacons which shall comply with specifications in section 2.3)

The beacon antenna should be located to provide visibility to the lowest possible elevation angles at all azimuths (i.e., least obstructed horizon).

The antenna polarization should be either right-hand circular polarization (RHCP), left-hand circular polarization (LHCP) or linear polarisation (note: RHCP polarization is most suitable for L-band MEOSAR satellites, LHCP polarization for DASS S-band satellites, and linear polarization for both S-band and L-band satellites, although with attendant polarization losses). For LHCP and RHCP antennas, the radiation pattern should be omnidirectional in azimuth and elevation. If selected, linear-polarized antennas should offer the widest coverage (radiation pattern) possible, in particular for high elevation angles.

Wideband Interference

If collocated with a MEOLUT, a MEOSAR reference beacon should not produce a power flux spectral density above  $-211 \text{ dB (W/m}^2\text{Hz)}$  in the  $1544.0 \text{ MHz} - 1545.0 \text{ MHz}$  frequency band.

Narrowband Interference

If collocated with a MEOLUT, a MEOSAR reference beacon should not produce a power flux density above  $-168 \text{ dBw/m}^2$  within 1 Hz of the  $1544.0 \text{ MHz} - 1545.0 \text{ MHz}$  frequency band.

Environmental and Operational Requirements

The MEOSAR reference beacon is designed to be operated within a controlled environment consistent with the ranges below and, therefore, is not subject to the stricter thermal or other operational requirements specified in document C/S T.001 or C/S T.018 for distress beacons.

Temperature requirements

Operating temperature range:  $+15^\circ \text{ C}$  to  $+40^\circ \text{ C}$

Storage temperature range:  $-20^\circ \text{ C}$  to  $+60^\circ \text{ C}$

Built in GNSS Receiver

A MEOSAR reference beacon may incorporate a GNSS receiver to receive return link messages (RLM).

SGB Message Definition

Using the SGB message definition from document C/S T.018, the following message parameters should be used:

| Bits      | Usage   |
|-----------|---|
| 1 - 16    | specific TAC number indicating a System beacon as follows: <ul style="list-style-type: none"> <li>• 65,535 for calibration beacons,</li> <li>• 65,534 for QMS beacons,</li> <li>• 65,533 for reference beacons (other than QMS beacons),</li> <li>• 65,532 for beacon simulators.</li> </ul> If a system beacon has multiple uses, it should be coded with the highest applicable TAC number. |
| 17 - 30   | pre-assign serial number  |
| 31 - 40   | country code  |
| 41        | status of homing device: shall be set to "0" (no homing device or homing device disabled)   |
| 42        | RLS function: shall be set to "0" if RLS is not enabled and set to "1" if RLS is enabled (e.g., RLS system testing)   |
| 43        | test protocol: shall be set to "1" (test protocol)  |
| 44 - 90   | encoded GNSS location   |
| 91 - 93   | vessel ID protocol identifier: shall be set to "111" (reserved for System testing)  |
| 94 - 137  | vessel ID: all bits defaulted to "0" or user defined (fixed)  |
| 138 - 140 | beacon type: "111" for System beacons   |
| 141 - 154 | spare bits: all bits set to "1"   |

And use Rotating Field #0 with all fields with valid values

Lifetime

MEOSAR reference beacons should be designed for a lifetime of at least 20 years.

**2.5 List of Reference Beacons in the System**

The complete list of beacons, including the identification, location of each, technical characteristics and status is provided on the Cospas-Sarsat website.

### **3. GUIDELINES FOR DEFINING CALIBRATION BEACON REQUIREMENTS**

---

#### **3.1 Guidelines for Supplying a MEOSAR Calibration Beacon**

##### Supplying a MEOSAR Calibration Beacon

A MEOSAR calibration beacon is supplied by a country accepting the commitment stated in Annex A.

No more than one MEOSAR calibration beacon should be installed per MEOLUT.

##### Availability

Once a MEOSAR calibration beacon has been installed, its availability should be greater than 95%.

##### Antenna Blockage

The MEOSAR calibration beacon antenna should provide the widest possible horizon.

##### Location Data

The beacon antenna location (longitude, latitude, altitude) should be provided with a three dimensional accuracy better than 1 m. This location should be given with respect to the Bureau International de l'Heure (BIH) Conventional Terrestrial System, having a reference ellipsoid defined as follows [or expressed in WGS84]:

Semi-major axis = 6,378,137 m

Flattening (ellipticity) = 1/298.2572

The location of all MEOSAR calibration beacons is given on the Cospas-Sarsat website.

#### **3.2 Other Guidelines for MEOSAR Calibration Beacons**

MEOSAR calibration beacons should conform to the signal specifications defined in document C/S T.001 (FGB) or C/S T.018 (SGB), except for the following.

##### Repetition period

- FGB bursts, with a period between burst transmissions of 150 seconds continuously transmitting,
- SGB bursts, with a period between burst transmissions of 150 seconds continuously transmitting,

Beacon activation should be co-ordinated with other providers of MEOSAR reference and calibration beacons to prevent repeated transmission collisions.

It should be possible to interrupt the beacon activation for some periods of time to meet the need for coordination of transmissions with other calibration beacons or reference beacons.

### Transmitted Frequency

Initial frequency:

For FGB:

The transmitted frequency can be  $406.034 \text{ MHz} \pm [10 \text{ Hz}]$  or one of the frequency channels designated as “Reserved, not to be assigned” in Table H.2 of document C/S T.012 up to channel K (406.052 MHz) (note that channels L (406.055 MHz) and above should not be used).

The transmitted frequency might be configurable to any frequency channel identified in Table H.2 of document C/S T.012 (i.e., including operational and “Reserved, not to be assigned” channels), in order to accommodate future evolution.

For SGB:

The transmitted frequency should be  $406.049 \text{ MHz} \pm [10 \text{ Hz}]$  or  $406.051 \text{ MHz} \pm [10 \text{ Hz}]$ .

The exact transmitted frequency should be provided to the Secretariat by the reference beacon operator for publication.

Short term frequency stability:

The transmitted frequency should not vary more than 1 part in  $10^{10}$  in 100 ms.

Frequency accuracy<sup>3</sup>:

For FGB, the frequency of transmission of each burst should be between  $[-0.014] \text{ Hz}$  and  $[+0.014] \text{ Hz}$  from the declared transmission frequency.

For SGB, the frequency of transmission of each burst should be between  $[-0.014] \text{ Hz}$  and  $[+0.014] \text{ Hz}$  from the declared transmission frequency.

### Modulation symmetry

For FGB, the modulation symmetry, as defined in document C/S T.001, should be less than 0.02.

### Rise and fall times of the modulated waveform

For FGB, the modulation rise and fall times should be in the range 50-150  $\mu\text{s}$  and maintained within  $\pm 1 \mu\text{s}$  of the selected value.

The modulation rise and fall times should be provided by the calibration beacon operator.

### Digital Message

For FGB, the final  $360 \text{ ms} \pm 1 \text{ percent}$  of the transmitted signal should contain a 144-bit message at a bit rate of  $400 \text{ bps} \pm 0.1\%$ .

---

<sup>3</sup> The frequency accuracy values were derived from section 5.8.1 in document C/S T.019. Considering that a MEOLUT may use two calibration beacons to calibrate its FOA measurements, and that the FOA measurement bias is required to be below 0.02 Hz, a maximum value of  $0.02/\sqrt{2} = 0.014 \text{ Hz}$  is proposed.

#### Timing accuracy of transmitted beacon bursts<sup>4</sup>

For FGB, the time of transmission of each burst should be between  $[-1.77] \mu\text{s}$  and  $[+1.77] \mu\text{s}$  from the declared transmission time.

For SGB, the time of transmission of each burst should be between  $[-0.14] \mu\text{s}$  and  $[+0.14] \mu\text{s}$  from the declared transmission time.

The definition of the time reference point (anchor) of the transmitted bursts is identical to the uplink TOA time reference, as defined for MF#67 in document C/S A.002.

The time reference point should be provided by the calibration beacon operator.

A round second is preferred for the time reference point of calibration beacons.

#### Output power

$37 \text{ dB}_m \pm 1 \text{ dB}$

The transmitted power should be configurable from  $25 \text{ dB}_m$  to  $37 \text{ dB}_m$  with 1 dB steps (note: this requirement is needed for possible mitigation of interference in the future, as deemed necessary).

#### Antenna Characteristics

The beacon antenna should be located to provide visibility to the lowest possible elevation angles at all azimuths (i.e., least obstructed horizon).

The antenna polarization should be either right-hand circular polarization (RHCP), left-hand circular polarization (LHCP) or linear polarisation (note: RHCP polarization is most suitable for L-band MEOSAR satellites, LHCP polarization for DASS S-band satellites, and linear polarization for both S-band and L-band satellites, although with attendant polarization losses). For LHCP and RHCP antennas, the radiation pattern should be omnidirectional in azimuth and elevation. If selected, linear-polarized antennas should offer the widest coverage (radiation pattern) possible, in particular for high elevation angles.

#### Wideband Interference

If collocated with a MEOLUT, a MEOSAR calibration beacon should not produce a power flux spectral density above  $-211 \text{ dB (W/m}^2\text{Hz)}$  in the  $1544.0 \text{ MHz} - 1545.0 \text{ MHz}$  frequency band.

---

<sup>4</sup> The time accuracy values were derived from section 5.8.1 in document C/S T.019. Considering that a MEOLUT may use two calibration beacons to calibrate its TOA measurements, and that the TOA measurement bias is required to be below  $2.5 \mu\text{s}$  for C/S T.001 beacons and  $[0.2] \mu\text{s}$  for C/S T.018 beacons,  $2.5/\sqrt{2} = 1.77 \mu\text{s}$  is proposed for C/S T.001 beacons measurements and a maximum value of  $0.2/\sqrt{2} = 0.14 \mu\text{s}$  is proposed for C/S T.018 beacons measurements.

Narrowband Interference

If collocated with a MEOLUT, a MEOSAR calibration beacon should not produce a power flux density above  $-168 \text{ dBw/m}^2$  within 1 Hz of the 1544.0 MHz – 1545.0 MHz frequency band.

Environmental and Operational Requirements

The MEOSAR calibration beacon is designed to be operated within a controlled environment consistent with the ranges below and, therefore, is not subject to the stricter thermal or other operational requirements specified in document C/S T.001 or C/S T.018 for distress beacons.

Temperature requirements

Operating temperature range:  $+15^\circ \text{C}$  to  $+40^\circ \text{C}$

Storage temperature range:  $-20^\circ \text{C}$  to  $+60^\circ \text{C}$

Built in GNSS Receiver

A MEOSAR calibration beacon may incorporate a GNSS receiver to receive return link messages (RLM) and for UTC time and frequency synchronization of calibration bursts.

Calibration Protocol (for FGB calibration bursts)

The orbitography user protocol should be used. This protocol, defined in document C/S T.001, is as follows:

| Bits    | Usage  |
|---------|--|
| 1-15    | bit synchronization  |
| 16-24   | frame synchronization  |
| 25      | format flag ("0" for short message and "1" for long message)   |
| 26      | protocol flag (set bit to "1")   |
| 27-36   | country code (MID)   |
| 37-39   | orbitography protocol ("000")  |
| 40-81   | seven character orbitography beacon clear text identifier using the modified Baudot code (see document C/S T.001). The seven characters shall be right justified. Characters not used shall be filled with the "space" character (100100). |
| 82-85   | four binary zeros ("0000")   |
| 107     | national use (set bit to "0")  |
| 108-112 | national use   |
| 113-144 | optional long message. National use.   |

The 15 hexadecimal character identification used by the MCCs describes bits 26 through 85 (i.e., 60 bits).

[A protected PDF2 field might be used.]

*If the calibration beacon transmits in self-test mode, to reduce unintended impact on LEOSAR Sarsat SARP-3 processors, the beacon message should not contain anywhere in bits 1 to 61 more than seven bits in the pattern of the word used for message synchronization by the Sarsat SARP-3 (i.e., 111000101).*

SGB Message Definition

Using the SGB message definition from document C/S T.018, the following message parameters should be used:

| Bits  | Usage   |
|---|---|
| 1 - 16  | specific TAC number indicating a System beacon as follows: <ul style="list-style-type: none"> <li>• 65,535 for calibration beacons,</li> <li>• 65,534 for QMS beacons,</li> <li>• 65,533 for reference beacons (other than QMS beacons),</li> <li>• 65,532 for beacon simulators.</li> </ul> If a system beacon has multiple uses, it should be coded with the highest applicable TAC number. |
| 17 - 30   | pre-assign serial number  |
| 31 - 40   | country code  |
| 41  | status of homing device: shall be set to "0" (no homing device or homing device disabled)   |
| 42  | RLS function: shall be set to "0" if RLS is not enabled and set to "1" if RLS is enabled (e.g., RLS system testing)   |
| 43  | test protocol: shall be set to "1" (test protocol)  |
| 44 - 90   | encoded GNSS location   |
| 91 - 93   | vessel ID protocol identifier: shall be set to "111" (reserved for System testing)  |
| 94 - 137  | vessel ID: all bits defaulted to "0" or user defined (fixed)  |
| 138 - 140   | beacon type: "111" for System beacons   |
| 141 - 154   | spare bits: all bits set to "1"   |
| And use Rotating Field #0 with all fields with valid values |   |

Lifetime

MEOSAR calibration beacons should be designed for a lifetime of at least 20 years.

- END OF SECTION 3 -

## **4. GUIDELINES FOR BEACON SIMULATOR REQUIREMENTS AND SPECIFICATIONS**

---

### **4.1 Guidelines for Supplying a Beacon Simulator**

#### Antenna Blockage

The beacon simulator antenna should provide the widest possible horizon.

#### Location Data

The beacon antenna location (longitude, latitude, altitude) should be provided with a three-dimensional accuracy better than 1 m. This location should be given with respect to the Bureau International de l'Heure (BIH) Conventional Terrestrial System, having a reference ellipsoid defined as follows [or expressed in WGS84]:

Semi-major axis = 6,378,137 m

Flattening (ellipticity) = 1/298.2572

### **4.2 Guidelines Unique to a Beacon Simulator**

#### Guidelines for Functional Specifications

A beacon simulator should:

- a) Be able to simulate the burst transmissions of both C/S T.001 and C/S T.018 beacons in accordance with those specifications;
- b) Be able to execute all test scripts for both C/S T.001 and C/S T.018 beacons as defined in documents C/S T.005, C/S T.010 and C/S T.020;
- c) Be able to transmit C/S T.001 and C/S T.018 beacon bursts over the average burst power range 25 dB<sub>m</sub> to 39 dB<sub>m</sub> in 1 dB steps by pre-configuration;
- d) Be able to transmit bursts at fixed invariant power and variable power levels per burst following a pre-configured profile over time;
- e) Have transmission antenna patterns with associated EIRP values consistent with C/S T.001 and C/S T.018 beacons for the particular beacon types being simulated;
- f) Be able to implement burst schedules including time randomization as defined in document C/S T.001 and C/S T.018, and also transmit bursts at time-invariant rates as defined by the pre-configuration;
- g) Be able to simultaneously transmit at least [10] beacon bursts of any combination of C/S T.001 and C/S T.018 beacon types, with both partial and complete bursts overlapping in time;
- h) Be able to synchronize burst transmission schedules with UTC time (see timing accuracy specification below);



- i) Be able to simulate up to 200 C/S T.001 and up to 200 C/S T.018 simultaneous active beacons;
- j) Be able to vary message content (e.g., GNSS encoded position) from burst to burst for any given simulated beacon event;
- k) Be configurable in all beacon transmission parameters (e.g., by script or operator interface) within allowed ranges in documents C/S T.001 and C/S T.018 (e.g., modulation index, rise time, bit rate, chip rate, chip rate variation, etc.);
- l) Be able to record, store and export to a file in a standard format (e.g., csv, xml) all beacon transmission parameters for each burst transmission, including transmission time stamps; and
- m) Be able to generate various pulse shapes (i.e., waveform) for C/S T.018 beacons (e.g., half-sine, cosine, rectangular).

These functional requirements are useful for both MEOLUT commissioning tests and system-level tests (e.g., Demonstration and Evaluation (D&E)). Items (a), (b) and (c) are particularly useful for commissioning tests. Item (g) through (i) are particularly useful for system capacity testing. Item (j) could be useful for evaluating message processing of moving beacons.

#### Transmitted Frequency

Initial frequency:

For FGB:

The transmitted frequency can be from 406.0 MHz to 406.1 MHz.

Note that when conducting MEOLUT commissioning, FGB signals should only be transmitted in non-operational frequency channels in the upper part of the 406 MHz band (from channel L (406.055 MHz) and above).

For SGB:

The transmitted frequency should be from 406.048 MHz to 406.052 MHz.

Short term frequency stability:

For simulated bursts, the transmitted frequency should not vary more than 1 part in  $10^{10}$  in 100 ms.

#### Frequency accuracy<sup>5</sup>

For FGB simulator, the frequency of transmission of each burst should be between  $[-0.014]$  Hz and  $[+0.014]$  Hz from the declared transmission frequency.

For SGB simulator, the frequency of transmission of each burst should be between  $[-0.014]$  Hz and  $[+0.014]$  Hz from the declared transmission frequency.

---

<sup>5</sup> The frequency accuracy values were derived from section 5.8.1 in document C/S T.019. Considering that a MEOLUT may use two calibration beacons to calibrate its FOA measurements, and that the FOA measurement bias is required to be below 0.02 Hz, a maximum value of  $0.02/\sqrt{2} = 0.014$  Hz is proposed

Timing Accuracy of Transmitted Beacon Bursts<sup>6</sup>

For FGB simulator, the time of transmission of each burst should be  $[-1.77]$   $\mu\text{s}$  and  $[+1.77]$   $\mu\text{s}$  from the declared transmission time.

For SGB simulator, the time of transmission of each burst should be  $[-0.14]$   $\mu\text{s}$  and  $[+0.14]$   $\mu\text{s}$  from the declared transmission time.

The definition of the time reference point (anchor) of the transmitted bursts is identical to the uplink TOA time reference, as defined for MF#67 in document C/S A.002.

Wideband Interference

If collocated with a MEOLUT, a beacon simulator should not produce a power flux spectral density above  $-211$  dB (W/m<sup>2</sup>/Hz) in the 1544.0 MHz – 1545.0 MHz frequency band.

Narrowband Interference

If collocated with a MEOLUT, a beacon simulator should not produce a power flux density above  $-168$  dBw/m<sup>2</sup> within 1 Hz of the 1544.0 MHz – 1545.0 MHz frequency band.

Environmental and Operational Requirements

The beacon simulator should be designed to be operated within a controlled environment and, therefore, is not subject to the stricter thermal or other operational requirements specified in documents C/S T.001 and C/S T.018 for distress beacons.

Built in GNSS Receiver

A beacon simulator should incorporate a GNSS receiver to receive return link messages (RLM) and for UTC time and frequency synchronization of bursts. This GNSS receiver should be compatible with RLS providers.

SGB Message Definition

Using the SGB message definition from document C/S T.018, the following message parameters should be used:

Bits      Usage

1 - 16      specific TAC number indicating a System beacon as follows:

- 65,535 for calibration beacons,
- 65,534 for QMS beacons,
- 65,533 for reference beacons (other than QMS beacons),
- 65,532 for beacon simulators.

If a system beacon has multiple uses, it should be coded with the highest applicable TAC number.

17 - 30      pre-assign serial number

---

<sup>6</sup> The time accuracy values were derived from section 5.8.1 in document C/S T.019. Considering that a MEOLUT may use two calibration beacons to calibrate its TOA measurements, and that the TOA measurement bias is required to be below  $2.5$   $\mu\text{s}$  for C/S T.001 beacons and  $[0.2]$   $\mu\text{s}$  for C/S T.018 beacons,  $2.5/\sqrt{2} = 1.77$   $\mu\text{s}$  is proposed for C/S T.001 beacons measurements and a maximum value of  $0.2/\sqrt{2} = 0.14$   $\mu\text{s}$  is proposed for C/S T.018 beacons measurements.

- 31 - 40 country code
  - 41 status of homing device: shall be set to "0" (no homing device or homing device disabled)
  - 42 RLS function: shall be set to "0" if RLS is not enabled and set to "1" if RLS is enabled (e.g., RLS system testing)
  - 43 test protocol: shall be set to "1" (test protocol)
  - 44 - 90 encoded GNSS location
  - 91 - 93 vessel ID protocol identifier: shall be set to "111" (reserved for System testing)
  - 94 - 137 vessel ID: all bits defaulted to "0" or user defined (fixed)
  - 138 - 140 beacon type: "111" for System beacons
  - 141 - 154 spare bits: all bits set to "1"
- And use Rotating Field #0 with all fields with valid values

- END OF SECTION 4 -

**ANNEX A**  
**COMMITMENT OF THE MEOSAR REFERENCE BEACON OR CALIBRATION**  
**BEACON PROVIDER**

The installation and operation of a MEOSAR reference beacon or calibration beacon is based upon a mutual agreement between Cospas-Sarsat and the country providing such a beacon, whereby the Cospas-Sarsat Council accepts the proposed provision of the MEOSAR reference beacon and the providing country agrees to abide with the following principles:

- the host country will assume all costs of providing, operating and maintaining the beacon in service,
- in taking the decision where to place an orbitography, MEOSAR reference beacon or calibration beacon, both Cospas Sarsat system requirements and the supplying country's requirements should be taken into account,
- the supplying country will inform Cospas-Sarsat of the precise location of the MEOSAR reference or calibration beacon,
- information on the MEOSAR reference beacon or calibration beacon must be provided by the beacon operator as described in document C/S T.022,
- the MEOSAR reference beacon should meet the Cospas-Sarsat specifications defined in document C/S T.022,
- Cospas-Sarsat may request and/or the country supplying the beacon may decide to terminate the operation of the MEOSAR reference beacon or calibration beacon,
- a decision to terminate operation will be subject to coordination among Cospas-Sarsat Participants and will not take effect until 12 months after the request/decision has been made by one of the parties involved,
- in case of a failure of a beacon that would be cost-prohibitive to remedy, the supplying country will not be obliged to supply a new beacon,
- the host country will only code reference beacons using an associated country code, as assigned by the ITU, unless coordinated with another country to transmit a country code assigned to that other country.

- END OF ANNEX A -

- END OF DOCUMENT -

---

Cospas-Sarsat Secretariat  
1250 Boul. René-Lévesque West, Suite 4215, Montreal (Quebec) H3B 4W8 Canada  
Telephone: +1 514 500 7999 / Fax: +1 514 500 7996  
Email: [mail@cospas-sarsat.int](mailto:mail@cospas-sarsat.int)  
Website: [www.cospas-sarsat.int](http://www.cospas-sarsat.int)

---