



## Second Generation Beacon Updates to Cospas-Sarsat Documentation

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Chris Hoffman  
ACR Electronics, Inc. / RTCM



## Topics

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- Transmission Schedule
- DSSS Signal and OQPSK Modulation
- EIRP and Antenna Characteristics
- Digital Message
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- Encoded Position Data and RLS
- Summary



# Overview





## Overview – 1

- Since the last BMW meeting a year ago much time and effort has been put into completing C/S T.018 by the T.018/T.021 CWG, various C/S Participants, RTCM, JC-30 and TG-1/2017
- C/S T.018 the Specification for Second Generation Cospas-Sarsat 406 MHz Beacons was approved and released at Issue 1 by the Council at CSC-57 in December 2016
- Minor technical changes (but fairly large editorial ones) were proposed to C/S T.018 at the recent TG-1/2017 meeting and an updated Issue 1 Revision 1 version of the specification was recommended to be approved by Council at CSC-58 later this month
- It seems likely that further ‘minor’ changes to C/S T.018 will be proposed at JC-31 and will presumably be recommended to the Council for approval as Issue 1 Revision 2 at CSC-59 in February 2018



## Overview – 2

- Second Generation Beacon (SGB) Proof of Concept (POC) testing is still in progress and SGB Demonstration and Evaluation (D&E) testing has yet to commence
- It is thus potentially possible that results from this work MAY impact the SGB specification either positively or negatively (e.g. vary the SGB minimum EIRP limit)
- C/S T.021 the Cospas-Sarsat Second Generation 406 MHz Distress Beacon Type Approval Standard is still in draft form, and is covered in the next presentation
- Likewise requirements for the acceptance of SGB Test Facilities (C/S T.008) is still an unknown, a status update will be provided in the next presentation



# C/S T.018

## Main Additions and Changes





## C/S T.018 – Main Additions and Changes

- Added requirements for Distress Tracking ELTs – ELT(DT)s
- NOTE Requirements for ELT(DT)s often differ to those for all other types of beacons and will be covered in a later presentation
- Added an extra operating temperature range – Class 0 -55C to +70C for all beacons
- Almost completely rewritten sections 2.2 and 2.3 defining the DSSS-OQPSK signal
- Revised the EIRP and Antenna Characteristics requirements
- Restructured the Encoded Position Data requirements
- The Narrowband System Specification that was in Appendix 1 has been removed from the specification and archived, in case it might be needed at some point in the future
- Two new Appendices were added to the specification providing supporting details on the Coding of the Beacon Digital Message, especially on how to encode the position



# Transmission Schedule







## C/S T.018 – Transmission Schedule

- Finalised the transmission schedule as follows:

Time from Activation	Transmission Repetition Interval	Randomisation
0 to 30 seconds	5 seconds +/- 0.1 seconds	None
30 seconds to 30 minutes	30 seconds	+/- 5 seconds
30 minutes +	120 seconds	+/- 5 seconds

- What does this mean from a beacon battery perspective?
- T.001 406 Transmissions last for 899 secs (over 24 hrs)
- T.018 406 Transmissions last for 770 secs (over 24 hrs) – a 15% saving



# Direct Sequence Spread Spectrum Signal and OQPSK Modulation





## C/S T.018 – Direct Sequence Spread Spectrum Signal and OQPSK Modulation – 1

- Added a new section to better explain the concept of the DSSS-OQPSK signal, by way of a functional block diagram and associated description
- Finalised the requirements for the Direct Sequence Spread Spectrum Signal including rewriting these to make them clearer
- Finalised the PRN sequence for both Normal and Self-Test transmissions and added text to clarify the relationship between the chip logic levels and the signal levels
- Confirmed the Carrier Frequency to be 406.050 MHz and restated the tolerance to be +/- 1200 Hz instead of 3ppm



## C/S T.018 – Direct Sequence Spread Spectrum Signal and OQPSK Modulation – 2

- Defined the Long Term Frequency Stability requirement to apply over a period of 5 years or the manufacturers declared beacon maintenance interval
- Set the Short Term Frequency Stability requirement to less than 7.4ppb for averaging times of 166.7 msec (which equates to an Allan Deviation of 1.2ppb) [Note need for both requirements being reviewed]
- Revised the Chip Rate tolerance to be defined as +/- 0.6 chips/s instead of 7.8ppm over the entire burst
- Clarified the OQPSK Modulation requirements and set a limit for the peak to peak amplitude variation between the I and Q components of 15% and finalised the Error Vector Magnitude (EVM) variation away from ideal to be less than 15% when measured over any 150 msec portion of the burst



# EIRP and Antenna Characteristics





## C/S T.018 – EIRP and Antenna Characteristics – 1

- Finalised the beacon EIRP requirement over elevation (Note that unlike in C/S T.001 there are no separate requirements for Power Output into 50 Ohms or for Antenna Gain)
- Defined the EIRP Elevation measurement points to be from 10 degrees to 85 degrees in 5 degree steps
- Set the minimum EIRP level to 34 dBm between 10 and 60 degrees and 33 dBm from 65 to 85 degrees (Note that this is 2 dBm more than for C/S T.001 beacons) [Note the minimum EIRP is still a subject of discussion and may possibly change]
- Set the maximum EIRP level to be 11 dB more than the minimum at each elevation (i.e. 45 dBm and 44 dBm) (Note that this is also 2 dBm more than for C/S T.001 beacons)



## C/S T.018 – EIRP and Antenna Characteristics – 2

- The EIRP pass/fail criteria was set such that greater than 65% of the measured EIRP values have to meet the EIRP limits
- An additional criteria was added requiring that 90% of the measured EIRP values below 55 degrees elevation must also meet the EIRP limits (this requirement was added due to the fact that to date only a monopole SGB antenna has been evaluated) [Note this requirement may be further clarified at JC-31]



## C/S T.018 – EIRP and Antenna Characteristics – 3

### What does the current SGB EIRP specification imply?

- Taking data for a typical EPIRB with a monopole antenna measured using the new antenna EIRP test set up as currently proposed by RTCM in C/S T.021, RTCM estimates that such a beacon would need a power output into 50 Ohms of greater than 36 dBm in order to pass the current EIRP limits in C/S T.018.
- There is no allowance for any Measurement Uncertainty in the above number or for variations in antennas (e.g. inclined ELT antennas) or for different types of beacon such as PLBs that may struggle to provide as much antenna gain. So adding say a 2dB safety margin to the above data implies a typical required SGB power output into 50 Ohms of around 38 dBm (6.3 Watts).





## C/S T.018 – EIRP and Antenna Characteristics – 4

Definitions for different types of Antennas were added as follows (to match corresponding proposed test requirements in C/S T.021):

- External Antenna – directly and permanently fixed to the beacon (e.g. an EPIRB)
- Detachable Antenna – directly detachable from the beacon (e.g. an ELT(AP))
- Internal Antenna - inside the beacon casing (usually a special case)
- Remote Antenna – connected to the beacon by a cable
  - without an Integrated Cable (e.g. an ELT(AF))
  - with an Integrated Cable (e.g. a Military Pilots PLB)



# Digital Message





## C/S T.018 – Digital Message

- The use of the Homing Bit in the digital message has been clarified
- A specific Cancellation Message has been defined, this includes the allocation of a Rotating Field in the digital message specially for this purpose and the allocation of bits in the main message
- A definition of when and how often the Cancellation Message is transmitted was added
- The ‘User Cancellation’ bit in the message has been reallocated as a ‘Test Protocol’ bit which was previously missing as an option
- The In Flight Emergency Rotating Field (for ELT(DT)s) and the Return Link Service (RLS) Rotating Field have both been fully defined
- The transmission schedule for each rotating field has been fully defined (i.e. which rotating field is transmitted with the main message field in each circumstance)



# Homing Signals





## C/S T.018 – Homing Signals

- A 406 MHz Homing Signal was confirmed to be optional, but the specification for this still has to be agreed. It is anticipated that this specification should be finalised at JC-31 and is likely to be a short unmodulated CW burst at a similar power level to a 121.5 MHz signal. [Note that concerns over potential interference with the 406 MHz satellite signal and ITU in-band interference requirements still have to be resolved]
- The transmission of other homing signals was also clarified to make it clear that the specification of and requirements for such signals (e.g. 121.5 MHz, AIS, 243 MHz etc) was the responsibility of appropriate national administrations and should be addressed in their relevant standards.
- Finally in this respect a requirement was added to delay the start of any homing signals for at least 30 seconds after beacon activation, but by no more than 5 minutes maximum (except AIS, if applicable, which has a 1 minute maximum delay).



# Encoded Position Data and RLS





## C/S T.018 – Encoded Position Data and RLS

- The encoded position data Section 4.5.5 of the specification has been completely rewritten (without really changing the requirements) to make it much clearer in terms of the requirements for Internal Navigation Devices and / or the External Navigation Input
- Some minor changes were made to the way in which the timing of the GNSS Receiver works during RLS operation
- A requirement for an RLS Indicator was added (previously omitted by mistake)
- A requirement to send an RLS Acknowledgement of Receipt message, upon receiving a Return Link Message (RLM) was added, to in effect close the RLS loop



# Summary







## Second Generation Beacon Documents – Summary

- C/S T.018 is now pretty mature and should be released as Issue 1 Revision 1 early next month (June 2017)
- The only omission in the standard right now is the 406 MHz Homing Signal specification
- Its possible that further minor revisions will be made to T.018 at JC-31
- The main area of concern from a beacon manufacturers perspective going forward, is possible further changes related to the EIRP and Antenna Characteristics requirements
- There is much work to do still on the Type Approval Standard C/S T.021
- Requirements, readiness and acceptance of SGB Test Facilities to type approve SGBs is still unknown



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Questions?

Chris Hoffman  
ACR Electronics, Inc.

[chris.hoffman@acrartex.com](mailto:chris.hoffman@acrartex.com)