3.3.6 Test Results

Configuration 3

Azimuth Angle (Degrees)	Elevation Angle (degrees)									
	10		20		30		40		50	
	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)
0	36.5	-1.7	40.7	2.6	41.9	3.8	37.7	-0.5	35.0	-3.1
30	36.3	-1.8	40.8	2.7	42.0	3.9	37.7	-0.5	34.8	-3.4
60	36.5	-1.6	40.8	2.7	41.9	3.8	37.8	-0.4	34.9	-3.3
90	36.3	-1.9	40.7	2.6	41.9	3.8	37.9	-0.3	34.7	-3.4
120	36.3	-1.8	40.7	2.6	42.0	3.9	37.9	-0.3	34.7	-3.5
150	36.4	-1.7	40.7	2.6	41.7	3.6	38.1	-0.1	35.0	-3.2
180	36.7	-1.5	40.6	2.5	41.9	3.8	38.0	-0.1	35.1	-3.0
210	36.5	-1.6	40.6	2.4	41.8	3.7	37.9	-0.2	35.6	-2.5
240	36.6	-1.5	40.8	2.6	41.7	3.6	37.8	-0.4	35.7	-2.4
270	36.3	-1.8	40.6	2.5	41.8	3.7	37.7	-0.5	35.9	-2.3
300	36.3	-1.8	40.5	2.4	42.0	3.9	37.4	-0.8	35.6	-2.6
330	36.5	-1.6	40.6	2.5	42.0	3.9	39.6	1.4	35.4	-2.7

Azimuth Angle (Degrees)	Elevation Angle (degrees)									
	10		20		30		40		50	
	Vv	Vh	Vv	Vh	Vv	Vh	Vv	Vh	Vv	Vh
0	108.6	92.1	112.5	86.8	113.0	92.2	107.7	78.3	103.5	81.9
30	108.4	92.8	112.6	88.7	113.1	91.5	107.7	84.8	103.1	89.2
60	108.6	93.4	112.6	89.5	113.0	90.3	107.8	79.2	103.2	89.6
90	108.4	92.7	112.5	89.9	113.0	90.1	107.9	80.1	102.9	92.2
120	108.4	92.9	112.5	90.2	113.1	88.3	107.9	82.4	102.9	91.1
150	108.5	94.1	112.5	89.7	112.8	89.1	108.1	84.7	103.0	93.9
180	108.7	95.7	112.4	88.9	113.0	90.3	108.0	87.1	103.4	91.3
210	108.6	94.3	112.4	85.0	112.9	90.1	107.9	86.9	103.6	94.7
240	108.4	98.9	112.4	98.8	112.8	90.5	107.8	85.9	103.8	94.0
270	108.4	92.8	112.3	97.4	112.9	91.3	107.7	82.3	103.9	94.7
300	108.4	93.5	112.3	85.6	113.1	91.4	107.4	80.5	103.7	93.6
330	108.6	92.9	112.4	86.5	113.1	93.0	109.6	80.0	103.7	91.2
Min (Vv-Vh)	9.5		13.6		20.1		21.0		8.9	

$EIRP_{LOSS} = Pt_{ambient} - Pt_{EOL} =$ 38.15- 36.83 = 1.32 dB *

$EIRP_{maxEOL} = Max[EIRP_{max}, (EIRP_{max} - EIRP_{LOSS})] =$ Max[42.0, 40.7]= 42.0 dBm

$EIRP_{minEOL} = Min[EIRP_{min}, (EIRP_{min} - EIRP_{LOSS})] =$ Min[34.7, 33.3]= 33.3 dBm

* $EIRP_{LOSS}$ was calculated using figures from the ACRTreuse-in-colour samples (Section 2)

Legend: ~~**Strikeout**~~ **Under-range** **Over-range** Vv-Vh < 10 dB

Configuration 4

Azimuth Angle (Degrees)	Elevation Angle (degrees)									
	10		20		30		40		50	
	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)	EIRP (dBm)	Gain (dBi)
0	34.2	-3.9	35.8	-2.3	36.8	-1.3	34.4	-3.7	31.9	-6.3
90	34.0	-4.2	35.4	-2.7	36.5	-1.6	34.1	-4.0	~~**29.6**~~	-8.6
180	34.0	-4.2	35.5	-2.6	36.4	-1.7	34.5	-3.7	~~**31.2**~~	-7.0
270	33.8	-4.3	35.8	-2.3	36.8	-1.3	34.2	-4.0	31.5	-6.7

$EIRP_{LOSS} = Pt_{ambient} - Pt_{EOL} =$ 38.15- 36.83 = 1.32 dB *

$EIRP_{maxEOL} = Max[EIRP_{max}, (EIRP_{max} - EIRP_{LOSS})] =$ Max[36.8, 35.5]= 36.8 dBm

$EIRP_{minEOL} = Min[EIRP_{max}, (EIRP_{max} - EIRP_{LOSS})] =$ Min[31.5, 30.2]= 30.2 dBm

* $EIRP_{LOSS}$ was calculated using figures from the ACRTreuse-in-colour samples (Section 2)

Legend: ~~**Strikeout**~~ **Under-range** **Over-range** Vv-Vh < 10 dB

3.4 NAVIGATION SYSTEM TEST

3.4.1 Specification

Cospas-Sarsat T.007, Clause A.3.8

3.4.2 Equipment Under Test and Modification State

SOS-300 (black enclosure) S/N: 300434061224090 - Modification State 0

3.4.3 Date of Test

01 October 2016

3.4.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 4.1.

3.4.5 Environmental Conditions

Ambient Temperature 13.1 - 16.7 °C
Relative Humidity 75.4 - 92.9 %

3.4.6 Test Results

Standard Location Protocol

Position Acquisition Time and Position Accuracy (C/S T.007 A.3.8.2)

Locations:

A.3.8.2.1:	50° 52.131 N	1° -14.694 W	①
A.3.8.2.2:	50° 48.86 N	1° -12.104 W	①

The appropriate position was applied, the EUT activated and time to first message containing valid position data timed.

Configuration as per C/S T.007	C/S T.007 Section A.3.8.2.1		C/S T.007 Section A.3.8.2.2	
	Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres
Configuration 7	62	32.8	62	36.1
Configuration 8	62	32.8	62	45.8

Positional accuracy was calculated using the Haversine Formula, The Earth's radius was taken as 6367 km.

① GPS Site Survey – Live Location

SECTION 4

TEST EQUIPMENT USED

4.1 TEST EQUIPMENT (SECTION 2)

List of absolute measuring and other principal items of test equipment.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.1, 2.2, 2.4, 2.5 Beacons - Constant Temperature Tests					
Power Meter	Hewlett Packard	436A	47	12	14-Jul-2016
Climatic Chamber	Heraeus Votsch	VM 04/100	85	-	O/P Mon
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	18-Feb-2017
Time Interval Analyser	Yokogawa	TA720	181	12	24-Apr-2016
Termination (50ohm)	Diamond Antenna	DL-30N	391	12	16-Feb-2017
Digital Temperature Indicator + T/C	Fluke	51	412	12	2-Mar-2017
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	22-Jun-2016
3dB/10W Attenuator	Texscan	HFP-50N	475	12	4-Apr-2017
Power Divider	Weinschel	1506A	604	12	2-Jun-2016
Signal Generator (100kHz to 2.6GHz)	Hewlett Packard	8663A	1063	12	9-Apr-2016
Attenuator (10dB, 10W)	Trilithic	HFP-50N	1377	12	23-Oct-2016
Hygromer	Rotronic	I-1000	2829	12	4-Nov-2016
Beacon RF Unit	TUV SUD Product Service	N/A	3066	-	TU
Termination (50ohm, 15W)	Diamond Antenna	DL-30N	3098	12	29-Mar-2017
Bandpass filter	Trilithic	5BE406/35-1-AA	3206	12	14-Sep-2016
Beacon Tester	WS Technologies	BT100S	3263	-	TU
Power Sensor	Agilent Technologies	8482A	3290	12	18-Jan-2017
ESA-E Series Spectrum Analyser	Agilent Technologies	E4402B	3348	12	7-Sep-2016
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3358	12	9-Dec-2016
ScopeCorder	Yokogawa	DL750	4175	12	21-Jan-2017
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4508	12	2-Mar-2017
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4510	12	21-May-2016
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4622	12	12-Aug-2016
Section 2.3 Beacons - Spurious Emissions					
Climatic Chamber	Heraeus Votsch	VM 04/100	85	-	O/P Mon
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	22-Jun-2016
3dB/10W Attenuator	Texscan	HFP-50N	475	12	4-Apr-2017
Power Divider	Weinschel	1506A	604	12	2-Jun-2016
Attenuator (10dB, 10W)	Trilithic	HFP-50N	1377	12	23-Oct-2016
Hygromer	Rotronic	I-1000	2829	12	4-Nov-2016
Beacon RF Unit	TUV SUD Product Service	N/A	3066	-	TU
Bandpass filter	Trilithic	5BE406/35-1-AA	3206	12	14-Sep-2016
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3358	12	9-Dec-2016
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4508	12	2-Mar-2017
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4510	12	21-May-2016
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4622	12	12-Aug-2016
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	8-Oct-2016

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.6 Beacons - Thermal Shock					
Climatic Chamber	Heraeus Votsch	VMT 04/30	40	-	O/P Mon
Power Meter	Hewlett Packard	436A	47	12	14-Jul-2016
Climatic Chamber	Heraeus Votsch	VM 04/100	85	-	O/P Mon
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	18-Feb-2017
Signal Generator	Hewlett Packard	8644A	96	12	23-Apr-2016
Time Interval Analyser	Yokogawa	TA720	181	12	24-Apr-2016
Digital Temperature Indicator + T/C	Fluke	51	412	12	2-Mar-2017
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	22-Jun-2016
3dB/10W Attenuator	Texscan	HFP-50N	475	12	4-Apr-2017
Power Divider	Weinschel	1506A	604	12	2-Jun-2016
Attenuator (10dB, 10W)	Trilithic	HFP-50N	1377	12	23-Oct-2016
Stop Clock	R.S Components	RS328 061	2674	12	2-Jul-2016
Hygromer	Rotronic	I-1000	2829	12	4-Nov-2016
Beacon RF Unit	TUV SUD Product Service	N/A	3066	-	TU
Bandpass filter	Trilithic	5BE406/35-1-AA	3206	12	14-Sep-2016
Beacon Tester	WS Technologies	BT100S	3263	-	TU
ESA-E Series Spectrum Analyser	Agilent Technologies	E4402B	3348	12	7-Sep-2016
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3358	12	9-Dec-2016
ScopeCorder	Yokogawa	DL750	4175	12	21-Jan-2017
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4508	12	2-Mar-2017
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4510	12	21-May-2016
Section 2.7 Beacons - Battery Current Measurements					
Hygromer	Rotronic	I-1000	2829	12	4-Nov-2016
8 Channel Datalogger + Terminal Board	Pico Technology Ltd	ADC-16	3287	12	15-Dec-2016
Resistor (Nominal 0.25ohm)	TUV SUD Product Service	2x RS Components 188-071 R5/100W Resistors	3343	-	TU
Section 2.7 Beacons - Operating Lifetime					
Power Meter	Hewlett Packard	436A	83	12	7-Sep-2016
Climatic Chamber	Heraeus Votsch	VM 04/100	85	-	O/P Mon
Time Interval Analyser	Yokogawa	TA720	181	12	26-Apr-2017
Signal Generator	Hewlett Packard	8644A	199	12	21-Apr-2017
Hygromer	Rotronic	I-1000	2829	12	4-Nov-2016
Beacon RF Unit	TUV SUD Product Service	N/A	3066	-	TU
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3160	12	9-Jun-2016
Attenuator (3dB, 20W)	Aeroflex / Weinschel	23-03-34	3162	12	24-Nov-2016
Bandpass Filter	Trilithic	5BE406/35-1-AA	3205	12	7-Jan-2017
Power Sensor	Agilent Technologies	8482A	3289	12	18-Jan-2017
Rubidium Frequency Standard	Symmetricom	8040C	3490	12	22-Apr-2017
ScopeCorder	Yokogawa	DL750	4175	12	21-Jan-2017
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4508	12	2-Mar-2017
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4509	12	20-May-2016
Bandpass Filter (1MHz)	KR Electronics	3219-SMA	4600	12	10-Jul-2016

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.8 Beacons - Temperature Gradient Down Ramp					
Power Meter	Hewlett Packard	436A	47	12	14-Jul-2016
Climatic Chamber	Heraeus Votsch	VM 04/100	85	-	O/P Mon
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	18-Feb-2017
Signal Generator	Hewlett Packard	8644A	96	12	23-Apr-2016
Time Interval Analyser	Yokogawa	TA720	181	12	24-Apr-2016
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	22-Jun-2016
3dB/10W Attenuator	Texscan	HFP-50N	475	12	4-Apr-2017
Attenuator (10dB, 10W)	Trilithic	HFP-50N	1377	12	23-Oct-2016
Hygromer	Rotronic	I-1000	2829	12	4-Nov-2016
Beacon RF Unit	TUV SUD Product Service	N/A	3066	-	TU
Bandpass filter	Trilithic	5BE406/35-1-AA	3206	12	14-Sep-2016
Beacon Tester	WS Technologies	BT100S	3263	-	TU
Power Sensor	Agilent Technologies	8482A	3290	12	18-Jan-2017
ESA-E Series Spectrum Analyser	Agilent Technologies	E4402B	3348	12	7-Sep-2016
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3358	12	9-Dec-2016
ScopeCorder	Yokogawa	DL750	4175	12	21-Jan-2017
Humidity & Temperature Meter	Radio Spares	1361C	4420	12	20-May-2016
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4508	12	2-Mar-2017
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4510	12	21-May-2016
Section 2.8 Beacons - Temperature Gradient Up Ramp					
Power Meter	Hewlett Packard	436A	47	12	14-Jul-2016
Climatic Chamber	Heraeus Votsch	VM 04/100	85	-	O/P Mon
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	18-Feb-2017
Signal Generator	Hewlett Packard	8644A	96	12	23-Apr-2016
Time Interval Analyser	Yokogawa	TA720	181	12	24-Apr-2016
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	22-Jun-2016
3dB/10W Attenuator	Texscan	HFP-50N	475	12	4-Apr-2017
Attenuator (10dB, 10W)	Trilithic	HFP-50N	1377	12	23-Oct-2016
Hygromer	Rotronic	I-1000	2829	12	4-Nov-2016
Beacon RF Unit	TUV SUD Product Service	N/A	3066	-	TU
Bandpass filter	Trilithic	5BE406/35-1-AA	3206	12	14-Sep-2016
Beacon Tester	WS Technologies	BT100S	3263	-	TU
Power Sensor	Agilent Technologies	8482A	3290	12	18-Jan-2017
ESA-E Series Spectrum Analyser	Agilent Technologies	E4402B	3348	12	7-Sep-2016
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3358	12	9-Dec-2016
ScopeCorder	Yokogawa	DL750	4175	12	21-Jan-2017
Humidity & Temperature Meter	Radio Spares	1361C	4420	12	20-May-2016
2 metre N-Type Cable	Florida Labs	NMS-235SP-78.8-NMS	4508	12	2-Mar-2017
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4510	12	21-May-2016
Section 2.9 Beacons - Satellite Qualitative Test					
Beacon Tester	WS Technologies	BT100S	3263	-	TU
Copper GRP	TUV SUD Product Service	27cm Diameter	3538	-	TU
Humidity & Temperature Meter	Radio Spares	1361C	4420	12	20-May-2016

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.10 Beacons - Antenna Characteristics					
Beacon Tester	WS Technologies	BT 100S	87	-	TU
Spectrum Analyser	Agilent Technologies	E4407B	1154	12	14-Aug-2016
Roberts Antenna 406MHz	Compliance Design		1860	24	12-Apr-2018
Humidity & Temperature Meter	Radio Spares	1361C	4420	12	26-May-2017
Inclinometer, Digital	Radio Spares	01-900-020003 (RS 667-3916)	4125	12	14-Jan-2017
Power Meter	Hewlett Packard	436A	83	12	7-Sep-2016
Power Sensor	Agilent Technologies	8482A	3289	12	18-Jan-2017
Signal Generator	Rohde & Schwarz	SMY 01	118	12	23-Oct-2016

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 2.11 Beacons - Navigation System					
Antenna (Double Ridge Guide)	EMCO	3115	34	12	27-Nov-2016
Attenuator (10dB, 10W)	Texscan	HFP-50N	468	12	22-Jun-2016
Attenuator: 10dB/20W	Narda	766-10	480	12	7-Dec-2016
Spectrum Analyser	Agilent Technologies	E4407B	1154	12	14-Aug-2016
Screened Room (8)	Rainford	Rainford	1548	-	TU
Hygrometer	Rotronic	I-1000	2882	12	4-Nov-2016
GPS/SBAS Simulator	Spirent	STR4500	3056	-	TU
Beacon Tester	WS Technologies	BT100S	3263	-	TU
Copper GRP	TUV SUD Product Service	27cm Diameter	3538	-	TU
0.92 to 2.2 GHz Coupler	Narda	3042B	4472	12	4-Dec-2016

Note: some tests took place over one or more days and consequently it may appear that some of the test equipment could have been outside of the valid calibration period at the time of testing. However, we confirm that all equipment held a valid and in-date calibration when used, and we hold this information on record

TU – Traceability Unscheduled
OP MON – Output Monitored with Calibrated Equipment

4.2 TEST EQUIPMENT (SECTION 3)

List of absolute measuring and other principal items of test equipment.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section 3.1 Beacons - Spurious Emissions					
Climatic Chamber	Heraeus Votsch	VMT 04/30	40	-	O/P Mon
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	29-Jan-2017
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3158	12	29-Jun-2016
Attenuator (3dB, 20W)	Aeroflex / Weinschel	23-03-34	3162	12	24-Nov-2016
Section 3.2 Beacons - Satellite Qualitative Test					
Beacon Tester	WS Technologies	BT 100S	87	-	TU
Copper GRP	TUV SUD Product Service	27cm Diameter	3538	-	TU
Humidity & Temperature Meter	Radio Spares	1361C	4420	12	26-May-2017
Section 3.1 Beacons - Antenna Characteristics					
Power Meter	Hewlett Packard	436A	83	12	7-Sep-2016
Beacon Tester	WS Technologies	BT 100S	87	-	TU
Signal Generator	Rohde & Schwarz	SMY 01	118	12	23-Oct-2016
Spectrum Analyser	Agilent Technologies	E4407B	1154	12	14-Aug-2016
Roberts Antenna 406MHz	Compliance Design		1860	24	12-Apr-2018
Power Sensor	Agilent Technologies	8482A	3289	12	18-Jan-2017
Inclinometer, Digital	Radio Spares	01-900-020003 (RS 667-3916)	4125	12	14-Jan-2017
Humidity & Temperature Meter	Radio Spares	1361C	4420	12	26-May-2017

TU – Traceability Unscheduled
OP MON – Output Monitored with Calibrated Equipment

SECTION 4

PHOTOGRAPHS

5.1 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (SECTION 2)

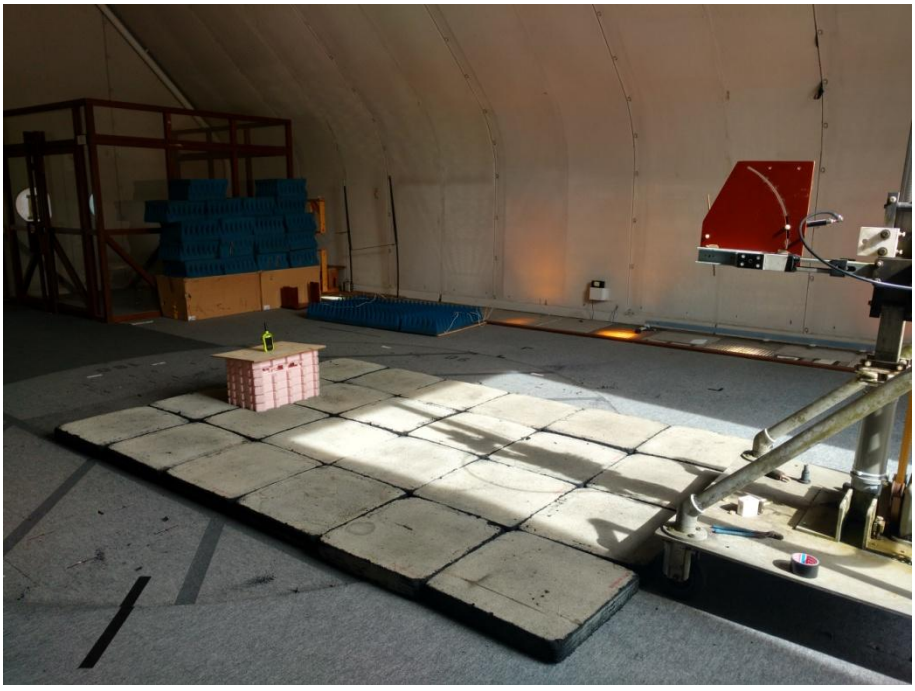
Front View


DEVICE DOES NOT
INCLUDE A
121.5 MHz HOMER
Primary
#1762
EMERGENCY ACTIVATION
CENTIMETRES

Rear View

5.2 TEST SET UP PHOTOGRAPHS (SECTION 2)

Antenna Characteristics - Configuration 3



Antenna Characteristics - Configuration 4

Satellite Qualitative/A.3.8.2 - Configuration 7

Satellite Qualitative/A.3.8.2 - Configuration 8

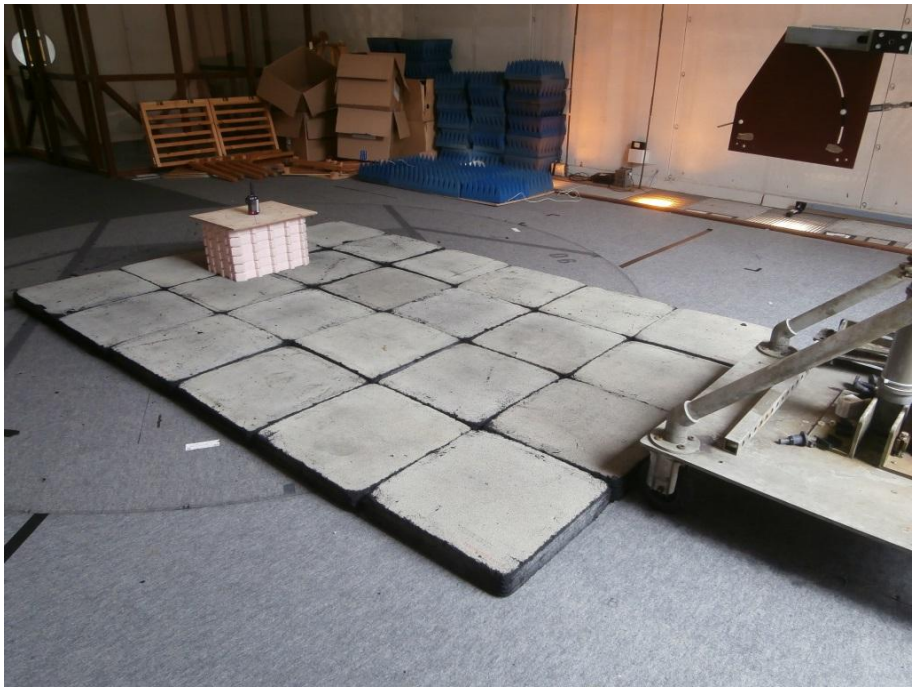
5.3 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (SECTION 3)

Front View

Rear View

5.4 TEST SET UP PHOTOGRAPHS (SECTION 3)

Antenna Characteristics - Configuration 3



Antenna Characteristics - Configuration 4

Satellite Qualitative - Configuration 7

Satellite Qualitative - Configuration 8

Position Acquisition Time and Position Accuracy - Configuration 7 (black enclosure)

SECTION 6

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

6.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

ANNEX A

MANUFACTURER SUPPLIED INFORMATION

Product Service

3/23/2016

ACR Electronics, Inc.
5757 Ravenswood Road
Fort Lauderdale, FL 33312-6645 USA

Report on:
Beacon Coding Software (BCS) and Position Data Encoding (PDE) of the ACR Electronics, Inc. SOS-300

Document Number: Y1-13-0233

Revision: B

ACR Electronics, Inc.

5757 Ravenswood Road
Fort Lauderdale, FL 33312-6645 USA

REPORT ON Emergency Beacons Testing of the
ACR Electronics, Inc.
SOS-300
Document Y1-13-0233 Revision B
3/23/2016

PREPARED AND APPROVED BY

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ACR Electronics, Inc., 5757 Ravenswood Road,
Fort Lauderdale, FL 33312, USA

DATED 3/23/2016

Table of Contents

SECTION 1

REPORT SUMMARY

Emergency Beacons Testing of the
ACR Electronics, Inc.
SOS-300

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Emergency Beacon Testing of the ACR Electronics, Inc SOS-300 to the requirements of T.007 Issue 4 – Rev 10 December 2015, Beacon Coding Software (§ A.2.8) and Position Data Encoding (§ A.3.8.7).

Objective — To perform Emergency Beacon Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.

Specification	Cospas-Sarsat T.007 Issue 4 - Rev 10 December 2015
Manufacturer	ACR Electronics, Inc.
Beacon Model Number(s)	SOS-300
SOS-300 Assembly Model Part Number and Version	A3-06-2918 Rev E (SOS-300)
SOS-300 Printed circuit board P/N and version	A3-07-0434 Rev D
SOS-300 Firmware Part Number and Version	K3-01-0110 Rev C (Ver 2.6), 02/10/2016
Beacon Serial Number(s)	SOS-300 Unit #2396, Unit #2397
EUT Modification State	0
Number of Samples Tested	Two
Measurement Equipment	The major items of test equipment used for this test are identified below.
Environmental Conditions	Ambient Temperature 22 - 25°C Relative Humidity 40 - 50%
Deviations from standard test procedures	None
Non-compliances noticed	None
Start of Test	03/10/2016
Finish of Test	03/17/2016
Performed by	Qingchuan Yao, Celia Miguez
Verified by	Qingchuan Yao, Celia Miguez, Barry Du, Jose Korneluk, Dan Stankovic

1.2 BEACON MANUFACTURER AND BEACON MODEL

Beacon Manufacturer	ACR Electronics, Inc.
Beacon Model	SOS-300
Other Model Names	

1.2.1 Information Provided by the Manufacturer

Name and Location of Beacon Test Facility: ACR Electronics, Inc.
5757 Ravenswood Road,
Fort Lauderdale, FL 33312

1.2.2 Applicable C/S Standards:

Document	Issue	Revision
C/S T.001	3	16
C/S T.007	4	10

1.3 REFERENCES

1.3.1 External Documents

[1] Introduction to the COSPAS-SARSAT System, C/S G.003 (Issue 6 – October 2009)

[2] Specification for COSPAS-SARSAT 406 MHz Distress Beacons, C/S T.001 (Issue 3 – Revision 16, December 2015)

[3] COSPAS-SARSAT 406 MHz Distress Beacon Type Approval Standard, C/S T.007 (Issue 4 - Revision 10, December 2015)

1.3.2 Internal Documents

[1] Y1-10-0096, "SARLink PLB Software Requirements Specification, ACR Electronics, Inc."

[2] Y1-10-0098, "SARLink PLB Software Test Plan, ACR Electronics, Inc."

[3] Y1-10-0099, "SARLink PLB Software Verification Results and Requirements Traceability Matrix, ACR Electronics, Inc."

[4] Y1-10-0098-01, "SARLink PLB Software Test Plan Results, ACR Electronics, Inc. "

[5] Y1-10-0099-01, "SARLink PLB Software Verification Results and Requirements Traceability Matrix Report, ACR Electronics, Inc."

1.4 PRODUCT INFORMATION

1.4.1 Technical Description

The Equipment Under Test (EUT) was a ACR Electronics, Inc SOS-300 as shown in the photograph below. A full technical description can be found in the manufacturer's documentation.

1.4.2 Test Setup Procedure

For final testing, beacons should be configured such that the power output for the 406 MHz signal is set for their final configuration.

Test results shall be recorded on ACR forms and/or the forms shown in C/S T.007 Annex F where indicated.

All measurements shall be performed with equipment and instrumentation which is in a known state of calibration.

Unless otherwise noted the SatTerm application software will be used for beacon communications including beacon serialization.

Figure 1. SOS-300 shown

1.5 MODIFICATIONS

The table below details modifications, if any, made to the EUT during the test performed.

Modification State	Description of Modification	Modified By	Date Modification Fitted
0	None		

1.6 REPORT MODIFICATION RECORD

Revision A- First Issue on 3/23/2016.

SECTION 2

TEST DETAILS

Emergency Beacons Testing of the
ACR Electronics, Inc
SOS-300

TEST RESULTS TABLE

Parameters to be Measured	Range of Specification	Units	Test Results:	Comments
Beacon Coding Software				
Model: SOS-300, S/Ns: 2396				
Sample message for each coding option of the applicable coding types	Correct	P / F	P	Test data in Section 2.1
Sample of self-test message for each coding option of the applicable coding types	Correct	P / F	P	Test data in Section 2.1
Navigation System				
Model: SOS-300, S/Ns: 2396, 2397				
Position Data Encoding	Correct	P / F	P	Test data in Section 2.2

2.1 BEACON CODING SOFTWARE

2.1.1 Equipment Under Test

SOS-300, Serial Numbers: 2396

2.1.2 Date of Test and Modification State

Modification State 0 (SOS-300)

EUT system configuration during the test, including antenna, external ancillary devices, and modes of their operation.	The SOS-300 was configured as a conductive unit with 406 output going to an ACR FPR-300 to receive and decode the data.
Navigation device details	Input data from computer PC using TeraTerm script and PC serial port.

Test Start: March 17 2016, 8:00
Test End: March 17 2016, 18:00

Environmental Conditions: Ambient Temperature 22 - 25°C
Relative Humidity: 40 - 50%

2.1.3 TEST RESULTS

APPENDIX D TO ANNEX F
BEACON CODING SOFTWARE RESULTS
ACR Electronics, Inc. SOS-300

C/S T.007 Table F-D.2: Examples of Standard and National Location Protocol Beacon Messages

Protocol	Operational Message (in hexadecimal including bit and frame synchronisation bits)		Self-Test Message (in hexadecimal including bit and frame synchronisation bits)	GNSS Self Test Message (if applicable, in hexadecimal, including bit and frame synchronisation bits)
	Location "A"[1]	Location "B"[1]		Location "A"
	Lat: 26.051111° North Lon: 80.168888° West	Lat: 26.226666° North Lon: 80.188888° West		Lat: 26.051111° North Lon: 80.168888° West
Standard Location: EPIRB with MMSI	FFFE2F8C92F423F01A2A0B81CCF68C44DC73	FFFE2F8C92F423F01A6A0A615E360583A2F9	FFFED08C92F423F07FDFFB2BF036	
Standard Location: EPIRB with Serial Number	FFFE2F8C96F9C0631A2A0938D3F68C44DC73	FFFE2F8C96F9C0631A6A08D841360583A2F9	FFFED08C96F9C0637FDFF992EF36	
Standard Location: ELT with 24-bit Address	FFFE2F8C93AF0F0F1A2A088356B68C44DC73	FFFE2F8C93AF0F0F1A6A0963C4760583A2F9	FFFED08C93AF0F0F7FDFF8296A76	
Standard Location: ELT with Serial Number	FFFE2F8C94F9C0631A2A0D8811368C44DC73	FFFE2F8C94F9C0631A6A0C6883F60583A2F9	FFFED08C94F9C0637FDFFD222DF6	
Standard Location: ELT with Aircraft Operator Designator	FFFE2F8C95C631F41A2A09D7D3368C44DC73	FFFE2F8C95C631F41A6A083741F60583A2F9	FFFED08C95C631F47FDFF97DEFF6	
Standard Location: PLB with Serial Number	FFFE2F8C97F9C0631A2A0FBB8EF68C44DC73	FFFE2F8C97F9C0631A6A0E5B1C360583A2F9	FFFED08C97F9C0637FDFFF11B236	
Standard Location: Test	FFFE2F8C9EF9C0631A2A089729768C44DC73	FFFE2F8C9EF9C0631A6A0977BBB60583A2F9	FFFED08C9EF9C0637FDFF83D15B6	
National Location: EPIRB	FFFE2F8C9A704646855028E149B61D080016	FFFE2F8C9A7046468F5034981C760C280FA1	FFFED08C9A70465FC0FF07A3F436	
National Location: ELT	FFFE2F8C9870464685502C518B761D080016	FFFE2F8C987046468F503028DEB60C280FA1	FFFED08C9870465FC0FF031336F6	
National Location: PLB	FFFE2F8C9B70464685502E6214B61D080016	FFFE2F8C9B7046468F50321B41760C280FA1	FFFED08C9B70465FC0FF0120A936	

[1]Location "A" and location "B" must be separated by at least 500 meters for the Standard, National and RLS location protocols.

National Location: Test	FFFE2F8C9F70464685502EB5E9F61D080016	FFFE2F8C9F7046468F5032CCBC360C280FA1	FFFED08C9F70465FC0FF01F75476	
RLS Location: (ELT,EPIRB or PLB) [2]				

ACR Electronics, Inc. SOS-300

C/S T.007 Table F-D.3: Examples of User-Location Protocol Beacon Messages

Protocol	Operational Message (in hexadecimal including bit and frame synchronisation bits)		Self-Test Message (in hexadecimal including bit and frame synchronisation bits)	GNSS Self Test Message (if applicable, in hexadecimal, including bit and frame synchronisation bits)
	Location "A"[3]	Location "B"3		Location "A"
	Lat: 26.051111° North Lon: 80.168888° West	Lat: 26.226666° North Lon: 80.188888° West		Lat: 26.051111° North Lon: 80.168888° West
Maritime Protocol with MMSI	FFFE2FCC94186186186680682A6343503D2E	FFFE2FCC94186186186680682A63475038D0	FFFED0CC94186186186680682A6F	
Maritime Protocol with Radio Call Sign	FFFE2FCC9526F6F06B2686294AE343503D2E	FFFE2FCC9526F6F06B2686294AE3475038D0	FFFED0CC9526F6F06B2686294AEF	
Radio Call Sign	FFFE2FCC9DBDBC1A5546876F8EE343503D2E	FFFE2FCC9DBDBC1A5546876F8EE3475038D0	FFFED0CC9DBDBC1A5546876F8EEF	
Serial User-Location: Float-Free EPIRB	FFFE2FCC96A000C6007CE70B3A2343503D2E	FFFE2FCC96A000C6007CE70B3A23475038D0	FFFED0CC96A000C6007CE70B3A2F	
Serial User-Location: Non Float-Free EPIRB	FFFE2FCC972000C6007CE2C9C9A343503D2E	FFFE2FCC972000C6007CE2C9C9A3475038D0	FFFED0CC972000C6007CE2C9C9AF	
Aviation	FFFE2FCC932497380BA6050986A343503D2E	FFFE2FCC932497380BA6050986A3475038D0	FFFED0CC932497380BA6050986AF	
Serial User-Location: ELT	FFFE2FCC962000C6007CE44A94A343503D2E	FFFE2FCC962000C6007CE44A94A3475038D0	FFFED0CC962000C6007CE44A94AF	
Serial User-Location: ELT with Aircraft Operator Designator & Serial Number	FFFE2FCC967C71C0FA7CE43DC7E343503D2E	FFFE2FCC967C71C0FA7CE43DC7E3475038D0	FFFED0CC967C71C0FA7CE43DC7EF	

[2]RLS protocols will be effective as of 1 January 2017. as a target, subject to further review and consideration. The use of RLS-enabled beacons will be regulated by national administrations..
[3]Location "A" and location "B" must be separated by at least 10 km for the User-Location protocol.

Serial User-Location: ELT with Aircraft 24-bit address	FFFE2FCC96F5E1E1E07CE3BB46A343503D2E	FFFE2FCC96F5E1E1E07CE3BB46A3475038D0	FFFED0CC96F5E1E1E07CE3BB46AF	
Serial User-Location: PLB	FFFE2FCC97A000C6007CE188672343503D2E	FFFE2FCC97A000C6007CE1886723475038D0	FFFED0CC97A000C6007CE188672F	
User-Location: Test	FFFE2FCC9E2000C6007CE5E56E2343503D2E	FFFE2FCC9E2000C6007CE5E56E23475038D0	FFFED0CC9E2000C6007CE5E56E2F	

2.2 NAVIGATION SYSTEM

2.2.1 Equipment Under Test

SOS-300, Serial Numbers: 2396, 2397

2.2.2 Date of Test and Modification State

Modification State 0 (SOS-300)

EUT system configuration during the test, including antenna, external ancillary devices, and modes of their operation.	The SOS-300 was configured as a conductive unit with 406 output going to an ACR FPR-300 to receive and decode the data.
Navigation device details	Input data from computer PC using TeraTerm script and PC serial port.

Test Start: March 10 2016, 8:00
Test End: March 17 2016, 19:00

Environmental Conditions: Ambient Temperature 22 - 25°C
Relative Humidity: 40 - 50%

APPENDIX C TO ANNEX F
NAVIGATION SYSTEM TEST RESULTS
ACR Electronics, Inc. SOS-300, PUBX from GPS module

C/S T.007 Table F-C.1: Position Data Encoding Results User-Location Protocol

Script Reference (Table D.1 C/S T.007 - Issue 4 - Revision 10 December 2015)	Value of Encoded Location Bits Transmitted by Beacon	Confirmation that BCH is Correct (√)
1	Bits 108-132= 0FE0FF0	✓
2	Bits 108 – 132= 1001000 Number of seconds after providing navigation data that beacon transmitted the above encoded location information: 27 seconds	✓
3	Bits 108-132= 0000000	✓
4	Bits 108-132= 0006B3C	✓
5	Bits 108-132= 1007B3C	✓
6	Bits 108-132= 1B28590	✓
7	Bits 108-132= 1B29590	✓
8	Bits 108-132= 0B41B40	✓
9	Bits 108-132= 0B3CB40	✓
10	Bits 108-132= 14918A7	✓
Self-Test Navigation Test Scripts		
11	Bits 108-132= 0F00000 (all zeroes for Bits 113 – 132)	✓
12	Bits 108-132= 0F00000 (all zeroes for Bits 113 – 132)	✓

ACR Electronics, Inc. SOS-300, PUBX from GPS module

C/S T.007 Table F-C.2: Position Data Encoding Results Standard Location Protocol

Script Reference (Table D.2 C/S T.007 - Issue 4 - Revision 10 December 2015)	Value of Encoded Location Bits Transmitted by Beacon	Confirmation that BCH is Correct (√)
1	Bits 65 - 85 = 0FFBFF Bits 113 - 132 = 83E0F	✓
2	Bits 65 - 85 = 100400 Bits 113 - 132 = 8420E Number of seconds after providing navigation data that beacon transmitted the above encoded location information: 21 seconds	✓
3	Bits 65 - 85 = 000000 Bits 113 - 132 = 8360D	✓
4	Bits 65 - 85 = 000ACF Bits 113 - 132 = 0F222	✓
5	Bits 65 - 85 = 0012CE Bits 113 - 132 = 93A60	✓
6	Bits 65 - 85 = 100ECF Bits 113 - 132 = 0FA10	✓
7	Bits 65 - 85 = 1B2964 Bits 113 - 132 = 80A00	✓
8	Bits 65 - 85 = 1B2D64 Bits 113 - 132 = 84E00	✓
9	Bits 65 - 85 = 0B46D0 Bits 113 - 132 = 03801	✓
10	Bits 65 - 85 = 0B42D0 Bits 113 - 132 = 08009	✓
11	Bits 65 - 85 = 14962A Bits 113 - 132 = 80200	✓
Self-Test Navigation Test Scripts		
12	Bits 65 - 85 = 0FFBFF Bits 113 - 132 = 00000 (all zeroes for Bits 113 – 132)	✓
13	Bits 65 - 85 = 0FFBFF Bits 113 - 132 = 00000 (all zeroes for Bits 113 – 132)	✓

ACR Electronics, Inc. SOS-300, PUBX from GPS module

Table F-C.3: Position Data Encoding Results National Location Protocol

Script Reference (See Table D.3 C/S T.007 - Issue 4 - Revision 10 December 2015)	Value of Encoded Location Bits Transmitted by Beacon	Confirmation that BCH is Correct (√)
1	Bits 59 - 85 = 3F81FE0 Bits 113 - 126 = 27CF	✓
2	Bits 59 - 85 = 4002000 Bits 113 - 126 = 284E Number of seconds after providing navigation data that beacon transmitted the above encoded location information: 31 seconds	✓
3	Bits 59 - 85 = 0000000 Bits 113 - 126 = 26CD	✓
4	Bits 59 - 85 = 0019678 Bits 113 - 126 = 060D	✓
5	Bits 59 - 85 = 001567A Bits 113 - 126 = 2710	✓
6	Bits 59 - 85 = 401B677 Bits 113 - 126 = 0740	✓
7	Bits 59 - 85 = 6CA0B20 Bits 113 - 126 = 06C0	✓
8	Bits 59 - 85 = 6CA2B20 Bits 113 - 126 = 21C0	✓
9	Bits 59 - 85 = 2D03680 Bits 113 - 126 = 0701	✓
10	Bits 59 - 85 = 2CF5680 Bits 113 - 126 = 2009	✓
11	Bits 59 - 85 = 523F14F Bits 113 - 126 = 2040	✓
Self-Test Navigation Test Scripts		
12	Bits 59 - 85 = 3F81FE0 Bits 113 - 126 = 0000 (all zeroes for Bits 113 – 126)	✓
13	Bits 59 - 85 = 3F81FE0 Bits 113 - 126 = 0000 (all zeroes for Bits 113 – 126)	✓

2.3 TEST EQUIPMENT USED

	Description	ACR P/N
Hardware	PC-compatible	Purchased Commercial Hardware
Operating System	Windows XP SP3 / Windows 7	
Flash Device	Texas Instruments MSP-FET430UIF OR Elprotronic FlashPro430	Purchased Commercial Hardware
Software Verification and Validation Environment and Equipment	• PC	Purchased Commercial Hardware
	• Windows XP SP3 / Windows 7	N/A
	• TI Code Composer v4.34	K1-02-0027
	• TeraTerm V4.71or better	K1-02-0047
	• USB Cable	A3-06-2599
	• FPR-300 ACR Electronics Field Programmer/Reader v1.12.11 or other (406 message decoder)	A3-06-2619
	• FPR-30 v1.12.11	A3-06-2596
	• SatTerm 8.8.1	NAL Research Corporation tool from web site: http://www.nalresearch.com/
	• Power Supply	Purchased Commercial Hardware
	• TeraTerm Navigation Scripts	
	• Java Automation Scripts	

Product Service

ACR PLB Models:
SOS-300
Description of Modes of Operation

Per C/S T.007 5(d)

Off Mode:

All circuitry including the microcontroller is not powered during off mode. There is no microcontroller activity and no battery power consumption.

Self-Test Mode:

Self-test of the beacon is initiated by pushing the 406 √ (self-test) button and holding it for at least 1 second before releasing it. The 406 √ (self-test) button will flash green briefly to indicate that self-test has begun. During self-test the beacon is powered by the primary non-rechargeable batteries. Iridium portion of the unit does not perform self-test in this case. Iridium portion of the unit has a separate self-test function, that is physically independent of the beacon.

During self-test the following occurs:

- Battery Life Test:
  - Total time the beacon has been on is checked and
  - The number of emergency activations is checked to see if an emergency activation has occurred and
  - The number of read-write errors to the battery pack memory is checked
  - The serial number in the battery pack is validated.
- RF Test:
  - One 406 MHz self-test message is transmitted with inverted frame sync and default location data and
    - PLL lock detect is checked and
    - 406 MHz RF power is checked
    - Distinct indication that 406 MHz RF power is emitted is confirmed by observing that the third in sequence local LED pulse is GREEN. If the third in sequence local LED pulse is RED, 406 MHz RF power was NOT emitted.
- Board Test:
  - Nonvolatile memory is checked and
  - Internal GPS receiver module is checked by looking for incoming data with the correct GPS header information

Upon completion of the self-test, the time it took to run the self-test is added to the total ON time and the total ON time is saved in beacon nonvolatile memory and Iridium nonvolatile memory. When using the Iridium functions on the unit, the user can review the results of the last completed beacon self-test. In doing so, the unit accesses the Iridium nonvolatile memory, powered only by the rechargeable battery.

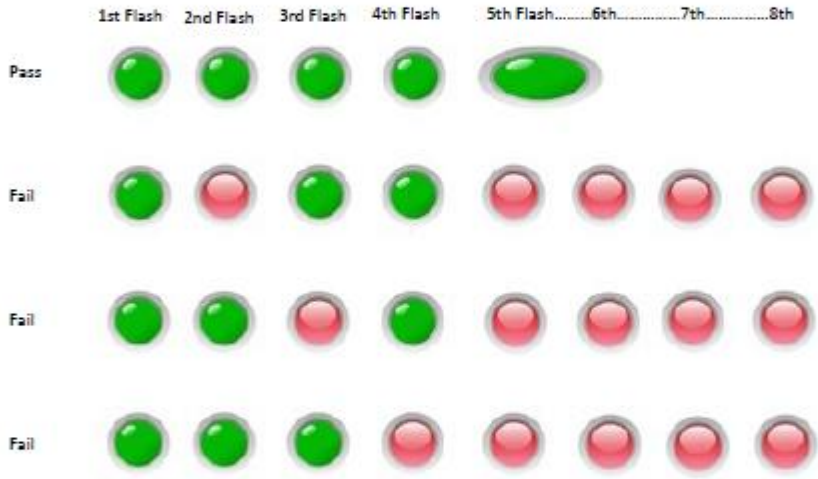
As each individual test passes, 406 √ (self-test) button will flash green. If an individual test fails, 406 √ (self-test) button will flash red.

If all individual tests pass, then self-test passes and the 406 √ (self-test) button will illuminate green for three (3) seconds at the completion of self-test.

If any individual test fails self-test fails, the 406 √ (self-test) button will flash red four (4) times at the completion of self-test.

The following is the explanation of the meaning of each 406 v (self-test) button flash:

1st flash - A brief GREEN LED flash indicates that that the self-test button has been pressed for 1 second and the button can be released.
2nd flash - GREEN/RED LED flash to indicate for electronic witness, battery pack serial number, battery communication (Green LED = pass, Red LED = fail).
3rd flash - GREEN/RED LED flash to indicate for 406 PLL lock, 406 transmit, battery voltage during 406 transmit (Green LED = pass, Red LED = fail). Green LED is a distinct indication that 406 MHz RF power emitted (reference Diagram 1).
4th flash- GREEN/RED LED flash to indicate for non-volatile memory, code checksum, missing beacon ID, GPS communication (Green LED = pass, Red LED = fail).
5th flash– 3 second green pulse indicates a pass and 4 short LED flashes indicate a fail. SOS-300 should be sent back to ACR Electronics in the event of a self-test fail.



Self-test takes approximately 10 seconds to complete. When self-test is complete, including the display of the self-test results, the beacon turns off.
If the SOS (activation) button is pressed during the self-test, the beacon will be activated and enter normal operating mode and the Self-test will be terminated without being completed.

Although the number of self-tests is not hard limited by the beacon design, the total ON time is checked as described above. If the total ON time exceeds 1 hour, the beacon fails the battery test; additional self-tests can continue to be run after the total ON time exceeds 1 hour.

SOS-300
Self-Test Timing Diagram showing distinct indication of RF emission

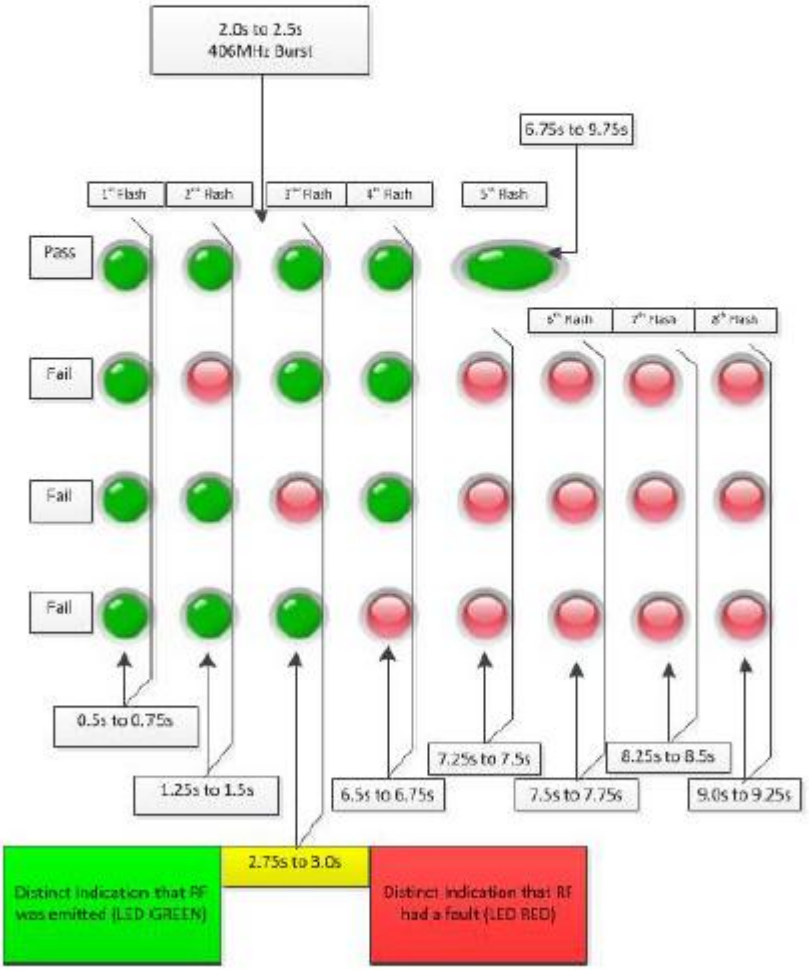


Diagram 1, Self-Test timing with Distinct Indication of RF being emitted

GNSS Self-Test Mode:

This beacon does not have GNSS Self-test ability. GNSS self-test can only be performed from the Iridium portion of the unit, totally independent from the beacon.

Main Operating Mode:

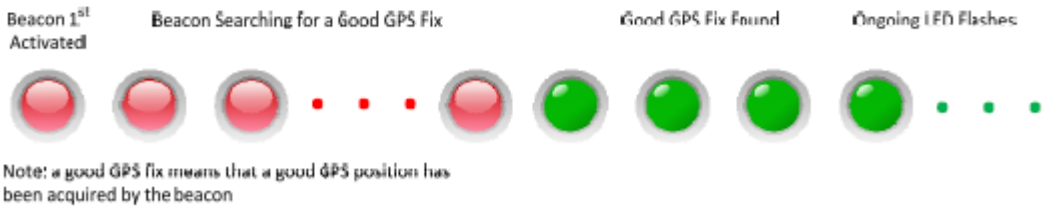
The main operating mode is entered by pressing and holding the SOS (activation) button for at least three (3) seconds. After the beacon has entered normal operating mode if the SOS (activation) button is pressed and held for at least four (4) seconds, the normal beacon operation will stop and the beacon will turn off.

The SOS (activation) button, when pressed, activates internal circuitry and wakes both the beacon and the Iridium processors. When The SOS (activation) button is pressed and held for at least three (3) seconds, both the beacon and the Iridium portions of the unit enter Operation Mode independent of each other.

During SOS (activation) the beacon is powered by the primary non-rechargeable batteries with a possible exception of the GPS module (reference GPS Module section below).

The Iridium portion of the unit, is never powered in any way by the primary non-rechargeable beacon battery.

The 406 ν (self-test) button will continually flash red after the SOS (activation) button has been pressed for two (2) seconds indicating that the beacon has been activated. The 406 ν (self-test) button then flashes red or green at a rate of 20 per minute until the beacon is turned off or battery end-of-life. 406 ν (self-test) button flashing red indicates that a valid GPS location has not been found or that 4 hours have passed without a valid GPS location update. 406 ν (self-test) button flashing green indicates that a valid GPS location has been found.



The first 406 MHz burst is transmitted 60 seconds ± 2.5 after the beacon has been activated. If a valid GPS location has been obtained prior to the first transmission, the location data is encoded in the transmitted message. If a valid GPS location has not been obtained, then the default location will be transmitted.

The time between 406 MHz bursts is 50 seconds ± 2.5 seconds as determined by a random number generator operating in accordance with C/S T.001 Section 2.2.1.

The GPS turns on and off according to the schedule provided below. Location data is encoded into the 406 MHz message as soon as the received GPS location data has been validated as a good fix. GPS location data is validated as follows: the NMEA sentence header is checked to ensure the sentence is parsed correctly, the basic NMEA sentence structure and checksum must be correct, the number of satellites must be 3 or more, the HDOP must be seven (7) or less, the navigation status (good fix indicator) must be a 2D or 3D solution, and the latitude and longitude must be valid locations.

If 4 hours pass from the last valid GPS location update, the default location is encoded in the 406 MHz message.

The time the beacon is ON is periodically added to the total ON time and saved to the nonvolatile memory.

The beacon turns off if the SOS activation button is pressed and held for at least three (3) seconds.

GPS On/Off Cycle:

The schedule is followed until an initial valid GPS location is encoded into the beacon message:

- The first time the GPS is turned on, it remains on for 13 minutes and then off for two minutes.
- For the next 1 hour and 45 minutes, the GPS is turned on for 3½ minutes once every 15 minutes.

As per T.001 Section 4.5.5.4, if a valid location fix is obtained during either of the above GPS on times, the beacon attempts to acquire locations for additional 10 seconds and encode the location with lowest HDOP obtained during this period into the next available beacon message. Following this, the GPS is turned off immediately.

As soon as a valid fix is obtained during the first two hours or if no valid fix is obtained for the entire two hour duration, the GPS is then turned on and off according to the schedule below.

- Until 6 hours from the time the GPS was first turned on the GPS is turned on once every 30 minutes until a valid location fix is obtained or 3½ minutes have elapsed.
- After 6 hours, until the battery end-of-life, the GPS is turned on once every hour until a valid location fix is obtained or 3½ minutes have elapsed.

USB Charging Port:

The USB port on the SOS-300 is only used to charge the Iridium rechargeable battery and to power the Iridium portion of the unit. The user manual instructs the user to remove the charging cable from the unit when SOS (activation) is activated. However, if the user fails to remove the charging cable and activates the beacon, the beacon will function normally and the 406 MHz distress signal will be transmitted.

GPS Module:

The unit GPS module is normally powered by the Iridium rechargeable battery.
In the event that the user activates SOS (activation), the beacon processor will send a cold start command to the GPS module, which clears all GPS buffers. The GPS module will continue to be powered by the rechargeable battery (Figure 1) until this battery reaches a low voltage threshold, after which power to the GPS module will be supplied by the primary non-rechargeable battery (Figure 2).
As long as the GPS module receives power (from either the Iridium rechargeable or primary non- rechargeable batteries, or thru the USB charging cable), the GPS module will try to acquire and process GPS satellite signals and continually provide position data via the serial data bus. This serial data bus is connected to the Iridium and beacon processors (Figure 1).
While the beacon is not activated, the beacon processor ignores the data on the GPS serial data bus.

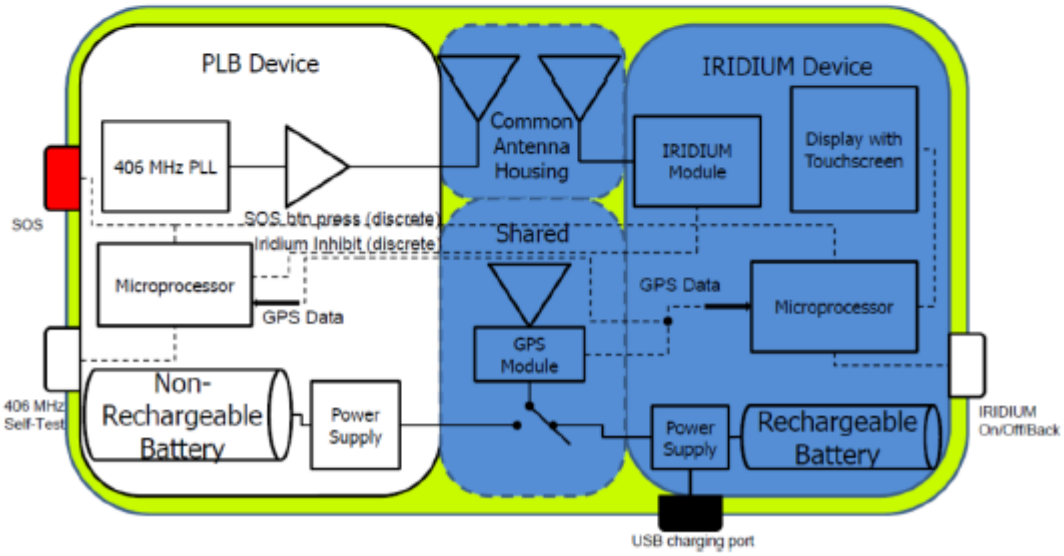


Figure 1, SOS-300 functional diagram with rechargeable battery providing adequate power.

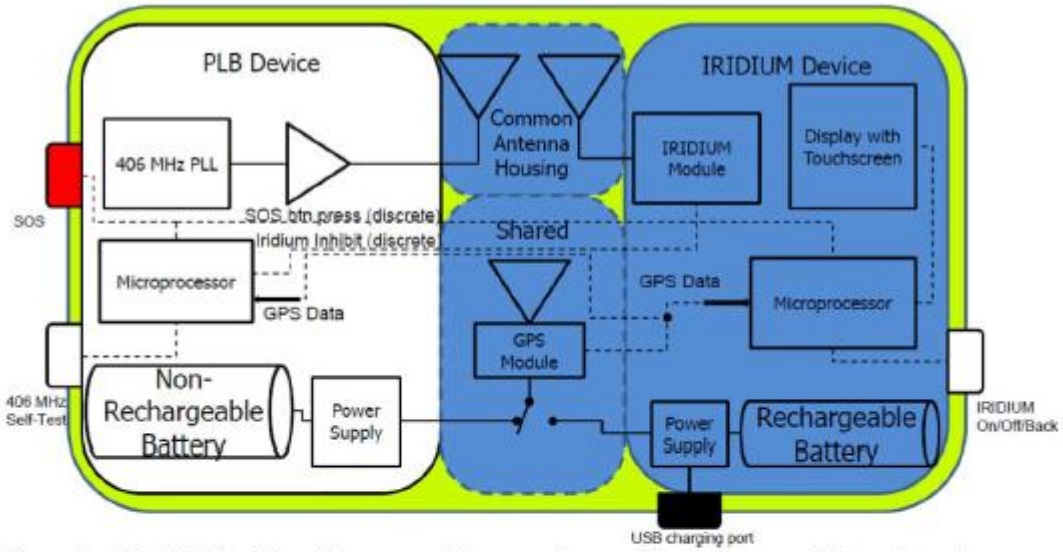


Figure 2, SOS-300 functional diagram with non-rechargeable battery providing adequate power.

Simultaneous Beacon and Iridium operation:

While the beacon is not activated, the Iridium modem transmits and receives data uninterrupted. During SOS (activation) the beacon processor uses the Iridium Inhibit discrete line to control Iridium modem transmit/receive function (High = Iridium Modem Inhibit, Low = Iridium Modem Enable). The beacon processor, 0.5 sec before next 406 MHz burst, disables the Iridium modem transmit/receive function and enables it again at the 406 MHz burst completion. Therefore, simultaneous 406 MHz and Iridium transmission is not possible (Figure 3).

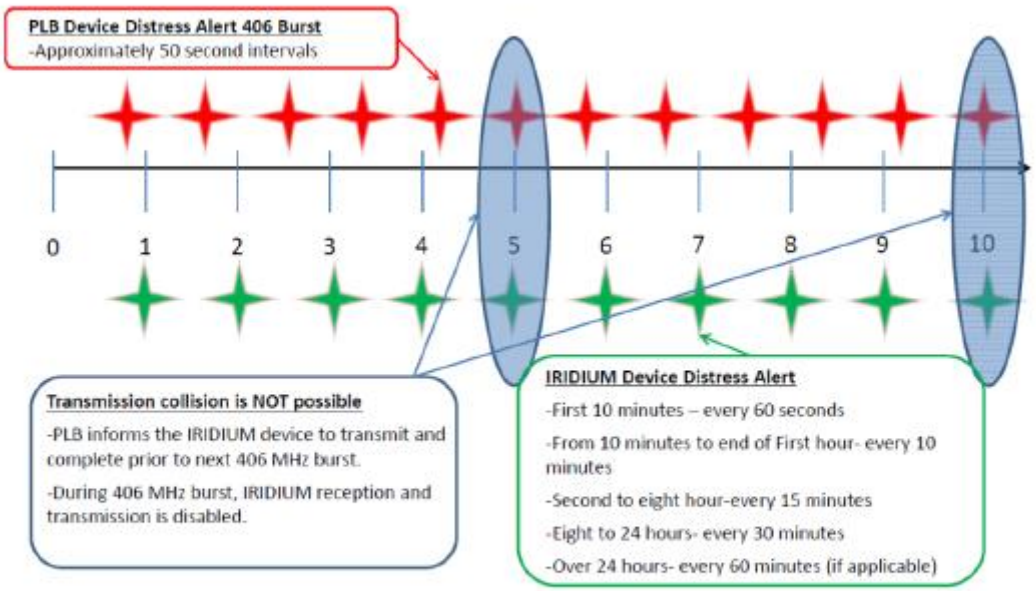


Figure 3, SOS-300 beacon 406 MHz burst and Iridium transmission timing

Statements and Descriptions for SOS-300 COSPAS-SARSAT Application

Protection against Continuous Transmission (Per C/S T.007 5. j. i.)

The protection against continuous transmission of the 406 MHz signal is provided through redundant controlling hardware and software.

Hardware:
SOS-300 is designed to limit any inadvertent 406MHz transmission:

The 406_on signal enables the Dc bias for 406 MHz power amplifier Q201 and Q202 making the power amplifier operational. The 406_on signal also supplies voltage to the gate Q200 thru R204, R206 and C205 with time constant 2.2 sec. If the power amplifier is on longer than 2.2 sec sufficient voltage will developed on C205 to turn Q200 on, thereby disabling the DC bias for Q201 and Q202. Without the DC bias voltage on Q201 and Q202 the 406 MHz transmitter will be disabled.

Software:
The 406 MHz RF Power module is controlled by a single circuit/switch under microprocessor control. The transmission must cease if the microprocessor control line output is not high, putting out current at 3.3 volts. If the microprocessor should fail, the voltage on this line will go low and the transmission must stop. It is fail safe. The entire synthesizer/modulator circuitry is turned on and off for each transmission. Therefore, the transmission can never be continuous.

Additionally, after any system resets the control line to the 406 MHz RF Power Module is set low, terminating transmission. The software enables the microprocessor Watch-Dog Timer (WDT) Reset, so if the software were to execute object code blocking normal code execution, the WDT will reset the processor, terminating 406 MHz RF transmission.

Protection from Repetitive Self-Test Mode Transmissions (Per C/S T.007 5. j. iii.)

The Self-Test algorithm is in-line code with no loops that execute consecutive instructions initiating a self-test. It is possible to either; complete one self-test, enter the ON state, or turn the SOS-300 off. It is not possible to repeat the self-test without a transition on the switch.

Confirmation that the Self-Test Messages Have Default Values at All Times (Per C/S T.007 5. j. iv.)

Initiation of a self-test will:

1. Initialize the 406 MHz message payload with inverted frame synchronization and default location data. No interleaving code execution will reset the frame synchronization or location data.
2. Start the self-test sequence, which will perform the 406 MHz burst shortly after self-test initialization.
3. Complete the self-test sequence.

Protection against Erroneous Position Encoding (Per C/S T.007 5. j. v.)

For GPS data, a GPS location fix is only considered valid if all of the following are acceptable:

1. The "$PUBX" header data is verified.
2. The NMEA checksum is correct.
3. The navigation status (good fix indicator) is a 2D or 3D solution.
4. The number of satellites in-range is 3 or more.
5. The HDOP is 7 or less
6. The GPS coordinates are in range.
   i.e. the latitude must be ≤90° and the longitude must be ≤180°.

A location fix is only considered valid and encoded into a 406 MHz message if all of the above are valid. If not, the encoded location in the 406 MHz message is left as default location if it was default or retains previous location values according to the time-out rules. Therefore, it is not possible for 406 MHz transmissions to contain erroneous position data caused by invalid or malfunctioning navigation data input.

Protection against Failure of the GPS Receiver (Per C/S T.007 5. j. v.)

The GPS module has its own dedicated voltage regulator that has built in current limiter fold back circuit that operates as a short circuit protection and an output current limiter at the output of the voltage regulator. This protects the 406 side of the beacon from any hardware malfunctions with the GPS.

Product Service

Protection Against Faulty Operation of the GPS Receiver (Per C/S T.007 5. j. v.)

Any invalid data and/or hardware faults, between the output of the GPS receiver and the input to the beacon processor, will be ignored by the beacon firmware and the beacon will continue to operate as if there was no GPS data present.

Product Service

ACR PLB Models:
SARLink
External Ancillary Devices, Technical Data

Per C/S T.007 5(p-i)

Please note that in case of SOS (activation) the user is instructed to disconnect the USB charging cable from the unit. However, it is referenced in this document for the purpose of explaining its functionality as it relates to this unit.
The entire Iridium portion of the device is treated as an ancillary device. However, the connections between the beacon and the Iridium portion of the device are explained individually in this document. It is important to note that the beacon portion of the unit, only provides data and discretes to the Iridium device, it does not receive. The beacon is electrically protected from all failure events possible on the Iridium side, and the presence or absence of the Iridium portion of the unit, has absolutely no effect on the functionality or performance of the beacon.

GPS Module:

The GPS module is part of the beacon, however it is normally powered by the Iridium rechargeable battery or by USB charging cable (when connected).

In the event that the user activates SOS (activation), the user is instructed to disconnect the USB charging cable from the unit. The GPS module will continue to be powered by the rechargeable battery (Figure 1) until the battery reaches a low voltage threshold, after which power to the GPS module will be supplied by the primary non-rechargeable battery (Figure 2).

As long as the GPS module receives power, the GPS module will try to acquire and process GPS satellite signals and continually provide position data via the serial data bus. This serial data bus is connected to the Iridium and beacon processors (Figure 1 or Figure 2).

While the beacon is not activated, the beacon processor ignores the data on the GPS serial data bus.

Beacon is protected from all possible fault conditions on the GPS data line as explained in file "5(j-i, ii, iii, iv & v) Design Protection\SARLink C-S Desc CS T007Sec5j(i)(iii)(iv)(v).pdf"

Iridium Inhibit discrete:

The beacon processor uses a single buffered discrete line to control the Iridium modem's transmit/receive function. (Figure 3). The beacon processor is protected by the buffer from any possible fault on this discrete line, i.e. short circuit, over-voltage or open circuit.

While the beacon is not activated, the Iridium modem transmits and receives data uninterrupted. During SOS (activation) the beacon processor uses the Iridium Inhibit discrete line to control the Iridium modem transmit/receive function (High = Iridium Modem Inhibit, Low = Iridium Modem Enable). The beacon processor, 0.5 sec before the next 406 MHz burst, disables the Iridium modem transmit/receive function and enables it again at the 406 MHz burst completion (Figure 4). Therefore, simultaneous 406 MHz and Iridium transmission is not possible.

SOS Button:

The "SOS" button when pressed provides a ground on the "SOS btn press (discrete)" line (Figure 5). This line initiates SOS (activation) for both the Iridium portion of the unit and the beacon portion of the unit. A detailed description of the activation function is contained in file "5(d) Operating mode list\SARLink Descr of Op Modes CS T007Sec5d.pdf"

The beacon processor is protected by the buffering diode from any possible fault coming from the Iridium processor, i.e. short circuit, over-voltage or open circuit.

Once the user presses the SOS (activation) button, regardless of the Iridium processor's condition, the beacon circuitry will detect a Low on the SOS btn press line and initiate activation.

Self-Test Button:

"406 √" (self-test) button, when pressed provides a ground on the Self-Test discrete line to the beacon processor. After being pressed for more than 1 second, the beacon will perform a Self-Test. A detailed description of the Self-Test function is contained in file "5(d) Operating mode list\SARLink Descr of Op Modes CS T007Sec5d.pdf"

Upon completion of the self-test, the time it took to run the self-test is added to the total ON time and the total ON time is saved in beacon nonvolatile memory and Iridium nonvolatile memory (Figure 6). When using the Iridium functions in the unit, the user can review the results of the last completed beacon self-test. In doing so, the unit accesses the Iridium nonvolatile memory, powered only by the rechargeable battery.

The Beacon is protected from all possible fault conditions on the Iridium portion of the unit self-test serial serial data line, via a buffer. The Iridium portion of the self-test serial data line could have a short, over-voltage condition, or erroneous data, without affecting the beacon functionality.

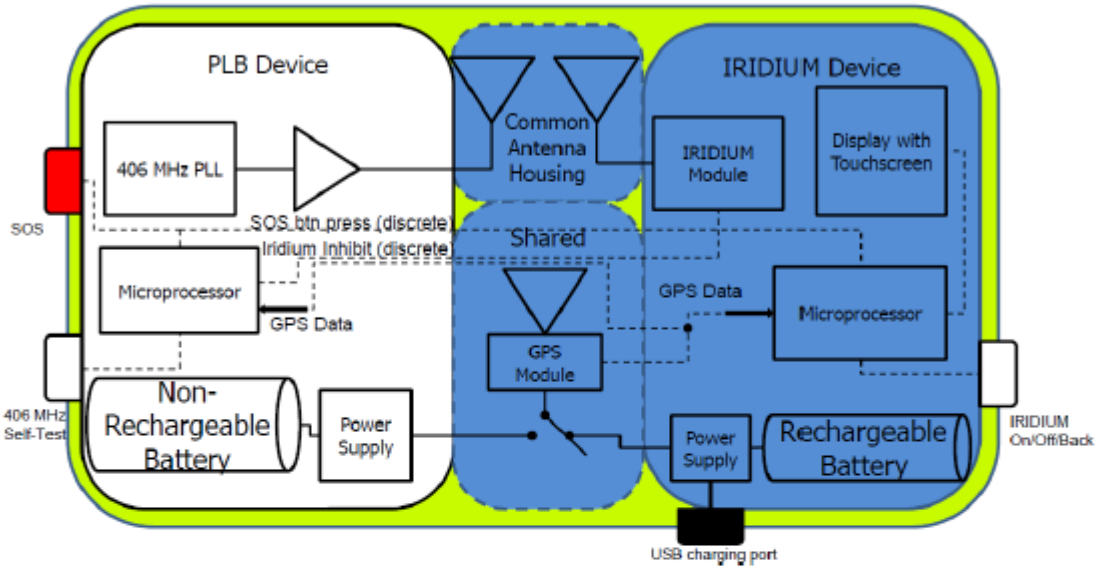


Figure 1, SARLink functional diagram with rechargeable battery providing adequate power.

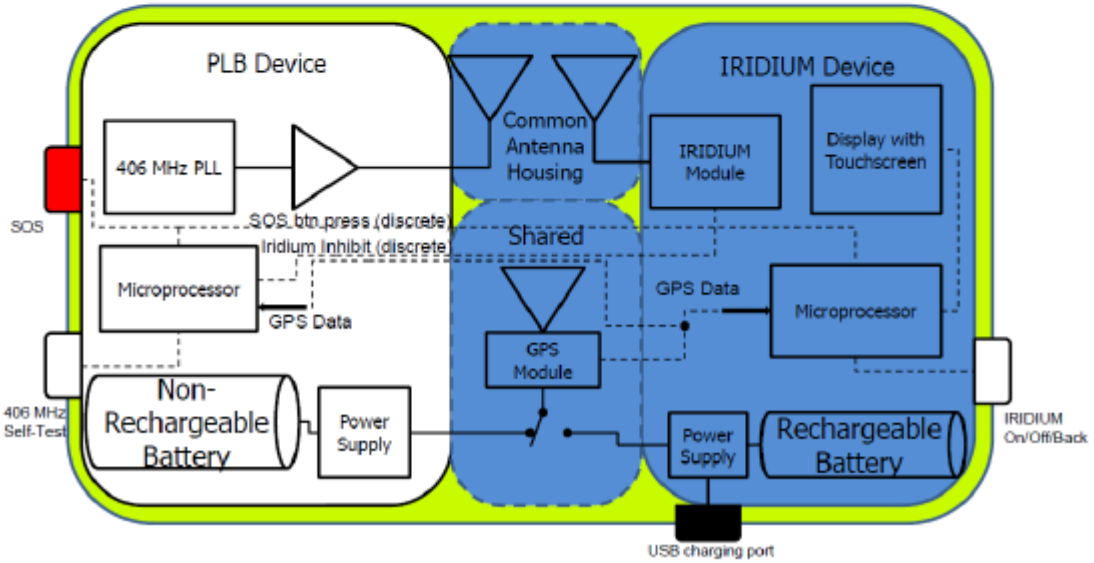


Figure 2, SARLink functional diagram with non-rechargeable battery providing adequate power.

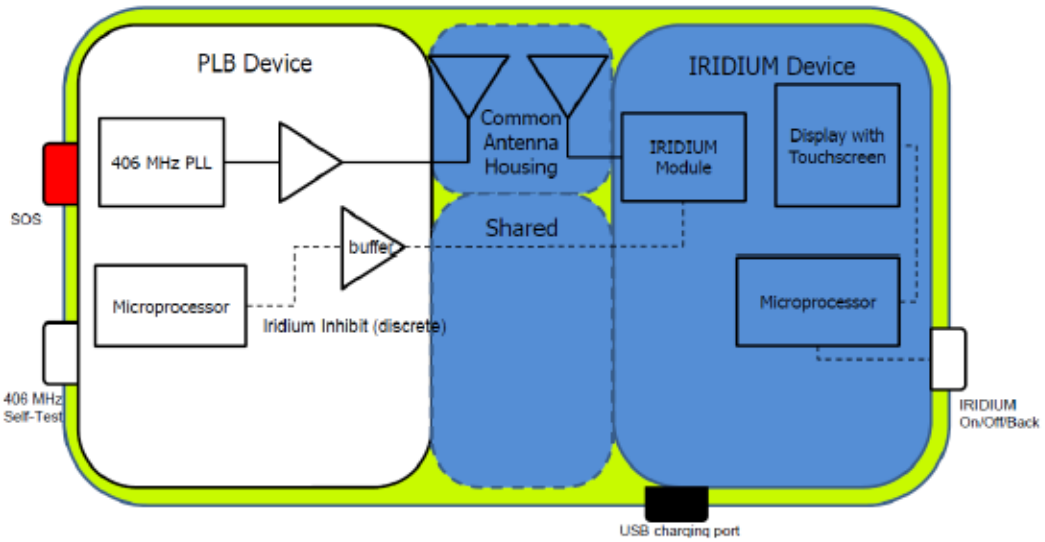


Figure 3, Iridium Inhibit discrete logic

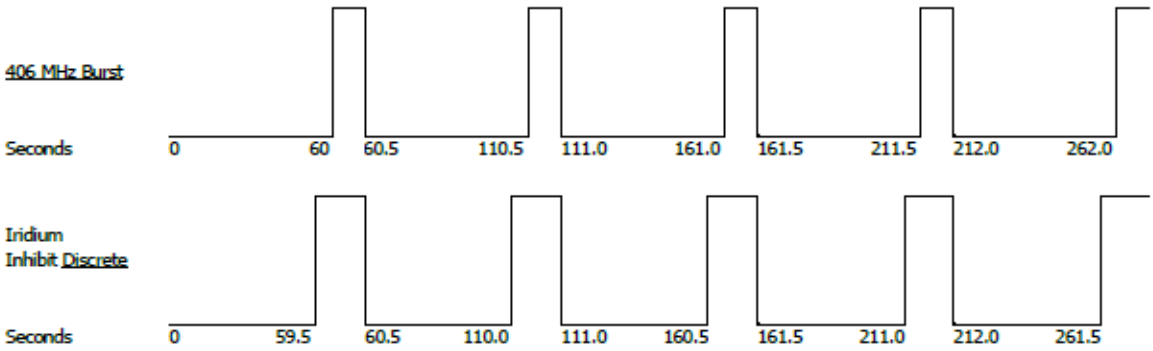


Figure 4, Iridium Inhibit discrete, timing.
Showing the state of the Iridium Inhibit Discrete going High 0.5 seconds before the 406 MHz burst, and Low as soon as the 406 MHz burst completes.

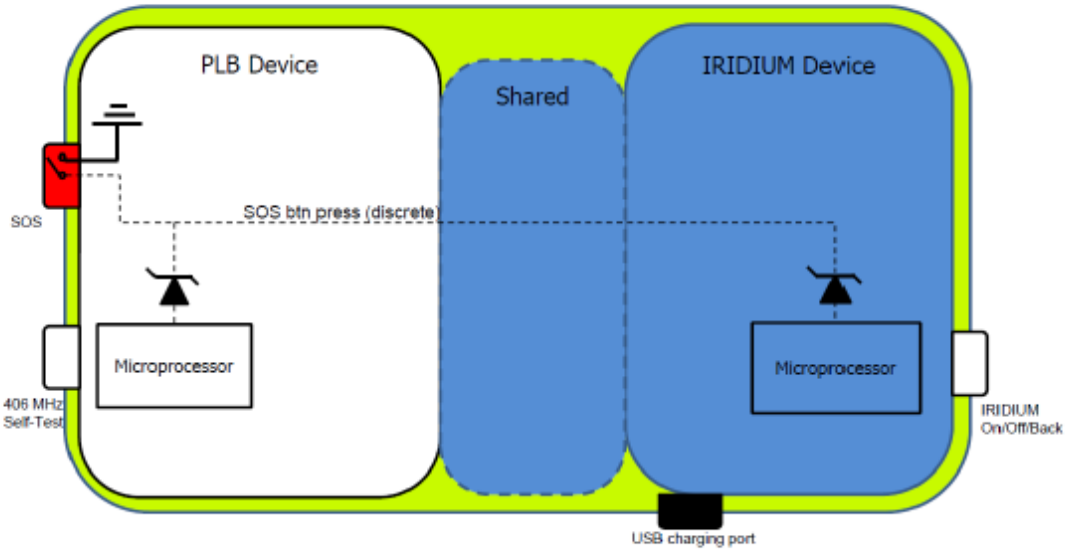


Figure 5, SOS button press discrete line

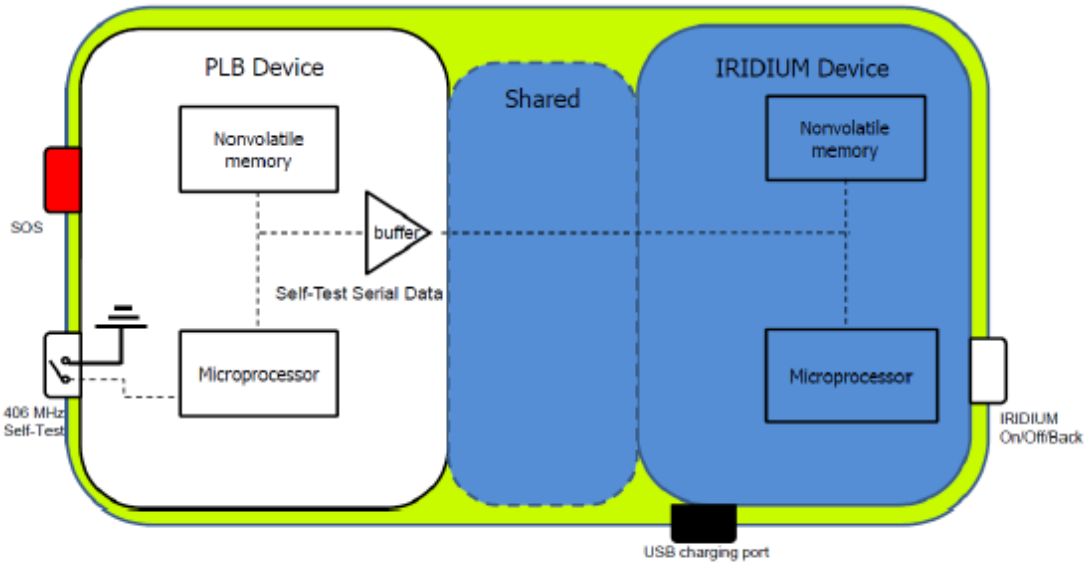


Figure 6, Self-Test Storage

Product Service

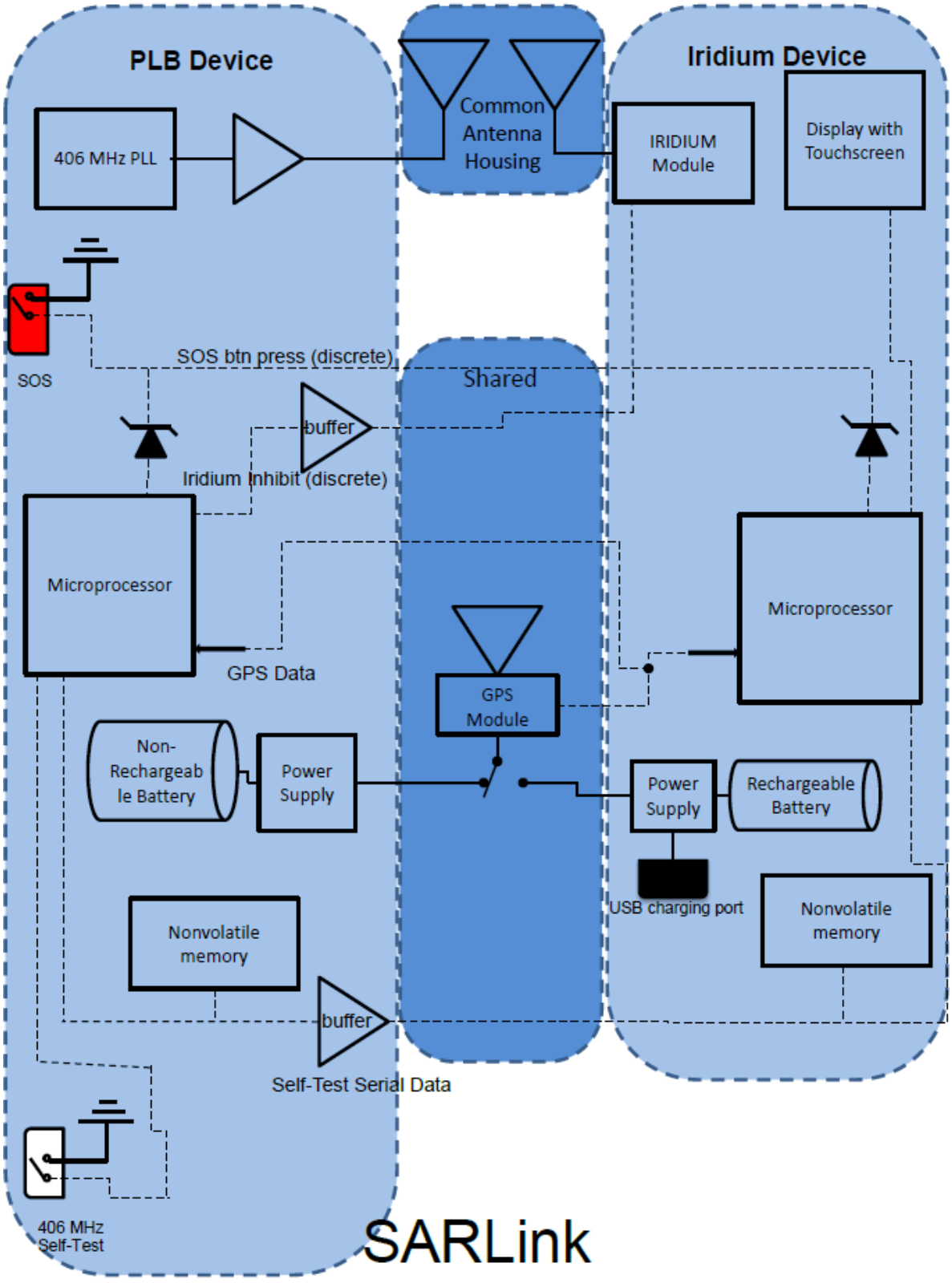
ACR PLB Models:
SARLink
External Ancillary Devices, Electrical Connections

Per C/S T.007 5(p-ii)

Please note that in case of SOS (activation) the user is instructed to disconnect the USB charging cable from the unit. However, it is referenced in this document for the purpose of explaining its functionality as it relates to this unit.

The entire Iridium portion of the device is treated as an ancillary device. However, the connections between the beacon and the Iridium portion of the device are explained individually in this document.

It is important to note that the beacon portion of the unit, only provides data and discretes to the Iridium device, it does not receive. The beacon is electrically protected from all failure events possible on the Iridium side, and the presence or absence of the Iridium portion of the unit, has absolutely no effect on the functionality or performance of the beacon.


PLB Device
406 MHz PLL
Common Antenna Housing
Iridium Device
IRIDIUM Module
Display with Touchscreen
SOS
SOS btn press (discrete)
Shared
buffer
Iridium Inhibit (discrete)
Microprocessor
GPS Data
GPS Module
Microprocessor
Non-Rechargeable Battery
Power Supply
Power Supply
Rechargeable Battery
USB charging port
Nonvolatile memory
Nonvolatile memory
buffer
Self-Test Serial Data
406 MHz Self-Test
SARLink

Product Service

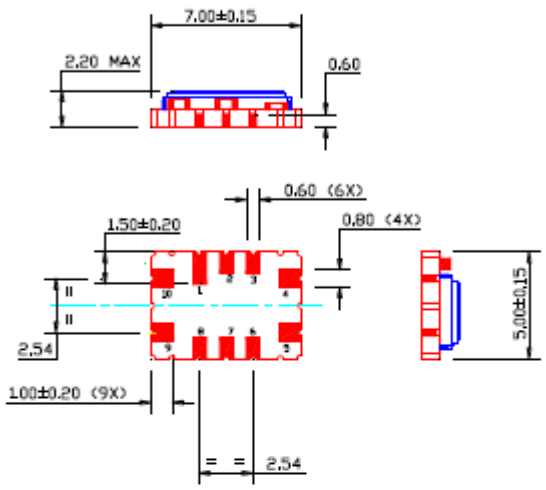
rakon

Oscillator Specification: E5344LF(T)

Issue A, 24th February 2010

Designed for use in "Cospas-Sarsat" Emergency Beacon Applications

Outline in mm



Pad Connections

1. Do not connect
2. NC
3. Do not connect
4. GND
5. RF Output
6. NC
7. NC
8. Tri-State Control (Enable)*
9. Supply, +Vs
10. Do not connect

* leave unconnected if not required

Weight 170mg (typical)

Marking includes

- Manufacturers ID (R)
- Manufacturing identifier (X XX)
- Pad 1 / Static sensitivity identifier (Δ)
- Abbreviated P/N (5344)
- Device date code (YW)
- Serial number (nnnn)

R X XX
Δ 5344YWnnnn

Electrical

Nominal Frequency, Fo	12.688750 MHz
Supply Voltage, Vs	3.3 V ± 10%
Input Current	≤ 4.0 mA
Output:	
Type	HCMOS
Load	15 pF
Vol	≤ 0.1 * Vs
Voh	≥ 0.9 * Vs
Duty cycle @ 50%	45% to 55%
Rise time, 10% to 90%	≤ 8 ns
Fall time, 90% to 10%	≤ 8 ns
Frequency Stability	
Calibration Tolerance at 25°C	≤ ± 0.5 ppm
Temperature, -20°C to 55°C	≤ ± 0.2 ppm reference to $(F_{MAX}+F_{MIN})/2$
Supply Voltage, ± 10%	≤ ± 0.1 ppm reference to frequency at 3.3V
Load, ± 5pF	≤ ± 0.1 ppm reference to frequency at 15 pF
Allan Variance (tau=100ms)	≤ 1.0 ppb

Product Service

rakon

Oscillator Specification: E5344LF(T)

Issue A, 24th February 2010

Designed for use in "Cospas-Sarsat" Emergency Beacon Applications

Medium Term Stability specified and measured according to C/S T.001 & T.007* (averaged over 18 measurements in 15 minute period, and following 15 minute power up period)

Mean Slope dF/dt	
Steady state conditions	≤ ± 0.7 ppb/min
During and 15 minutes after variable temperature conditions	≤ ± 1.7 ppb/min (dT/dt ≤ ± 5°C / hour)
Residual dF from slope	≤ ± 2.0 ppb (dT/dt ≤ ± 5°C / hour)

Test results shipped with each device, identified by date and serial number, retained for 10 years.

Reflow soldering	≤ ± 1.0 ppm
Ageing, first year	≤ ± 1.0 ppm
Ageing, 10 years	≤ ± 3.0 ppm
Tri-State	
Pad 8 open circuit or ≥ 0.6Vs	Output Enabled
Pad 8 ≤ 0.2Vs	Output High impedance

In Tri-state mode, the output stage is disabled but the oscillator and compensation circuit are still active (current consumption 1mA typ.).

Phase Noise (typical values)	-90 dBc/Hz at 10 Hz
	-115 dBc/Hz at 100 Hz
	-127 dBc/Hz at 1 kHz
	-137 dBc/Hz at 10 kHz
	-143 dBc/Hz at 100 kHz

Environmental

Operating Temperature Range	-20 to +55°C
Storage Temperature Range	-55 to +125°C
Vibration	IEC 60068-2-6 Test Fc, 10-60Hz 1.5mm displacement, at 98.1 ms^{-2}, 30 minutes in each of three mutually perpendicular axes at 1 octave per minute
Shock	IEC 60068-2-27 Test Ea, 980ms^{-2} acceleration for 6ms duration, 3 shocks in each direction along three mutually perpendicular axes
Soldering	SMD product suitable for Convection Reflow soldering. Peak temperature 260°C. Maximum time above 220°C, 60 secs.
Solderability	MIL-STD-202, Method 208, Category 3
RoHS	Parts are fully compliant with the European Union directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment. Note these RoHS compliant parts are suitable for assembly using both Lead-free solders and Tin/Lead solders.
Marking	Laser Marked
Packaging	Parts ordered with suffix 'T' are supplied on Tape-and-Reel.

* COSPAS SARSAT 406MHz distress beacons specification C/S T.001 (Issue 3, Revision 9, OCT 2008) and C/S T.007 (Issue 4, Revision 3, OCT 2008)

SOS-300

Table F-E.1: Beacon Operating Current PLB Primary Battery

Beacon Operating Modes	Mode: Manually selectable or Automatic	Measurement interval, sec	Average Current, mA	Peak Current, mA
Standby current with Iridium Off				
PLB Off, Iridium Off, rechargeable battery charged, charging cable not connected	Manually	900	0.00004029	0.00325500
PLB Off, Iridium Off, rechargeable battery charged, charging cable connected unpowered.	Manually	900	0.00004215	0.00345870
PLB Off, Iridium Off, rechargeable battery charged, charging cable connected and powered.	Manually	900	0.00004188	0.00358950
PLB Off, Iridium Off, rechargeable battery discharged, charging cable not connected	Manually	900	0.00004093	0.00364770
PLB Off, Iridium Off, rechargeable battery discharged, charging cable connected unpowered.	Manually	900	0.00004229	0.00334250
PLB Off, Iridium Off, rechargeable battery discharged, charging cable connected and powered.	Manually	900	0.00004094	0.00325530
PLB Off, Iridium Off, rechargeable battery removed, charging cable not connected	Manually	900	0.00004271	0.00364770
PLB Off, Iridium Off, rechargeable battery removed, charging cable connected unpowered.	Manually	900	0.00004274	0.00331340
PLB Off, Iridium Off, rechargeable battery removed, charging cable connected and powered.	Manually	900	0.00004162	0.00347330
Standby current with Iridium On				
PLB Off, Iridium On, GPS Off, rechargeable battery charged, charging cable not connected	Manually	900	0.00004148	0.00374940
PLB Off, Iridium On, GPS Off, rechargeable battery charged, charging cable connected unpowered.	Manually	900	0.00004226	0.00370580
PLB Off, Iridium On, GPS Off, rechargeable battery charged, charging cable connected and powered.	Manually	900	0.00004212	0.00386560
PLB Off, Iridium On, GPS Off, rechargeable battery discharged, charging cable not connected	Not possible			
PLB Off, Iridium On, GPS Off, rechargeable battery discharged, charging cable connected unpowered.	Not possible			
PLB Off, Iridium On, GPS Off, rechargeable battery discharged, charging cable connected and powered.	Manually	900	0.00004013	0.00360400
PLB Off, Iridium On, GPS Off, rechargeable battery removed, charging cable not connected	Not possible			
PLB Off, Iridium On, GPS Off, rechargeable battery removed, charging cable connected unpowered.	Not possible			
PLB Off, Iridium On, GPS Off, rechargeable battery removed, charging cable connected and powered.	Manually	900	0.00004104	0.00374940
PLB Off, Iridium On, GPS On, rechargeable battery charged, charging cable not connected	Manually	900	0.00003998	0.00334240
PLB Off, Iridium On, GPS On, rechargeable battery charged, charging cable connected unpowered.	Manually	900	0.00004105	0.00337150
PLB Off, Iridium On, GPS On, rechargeable battery charged, charging cable connected and powered.	Manually	900	0.00004052	0.00341510

PLB Off, Iridium On, GPS On, rechargeable battery discharged, charging cable not connected	Not possible			
PLB Off, Iridium On, GPS On, rechargeable battery discharged, charging cable connected unpowered.	Not possible			
PLB Off, Iridium On, GPS On, rechargeable battery discharged, charging cable connected and powered.	Manually	900	0.00004317	0.00348770
PLB Off, Iridium On, GPS On, rechargeable battery removed, charging cable not connected	Not possible			
PLB Off, Iridium On, GPS On, rechargeable battery removed, charging cable connected unpowered.	Not possible			
PLB Off, Iridium On, GPS On, rechargeable battery removed, charging cable connected and powered.	Manually	900	0.00004196	0.00348770
Self Test current with Iridium Off				
PLB Self Test, Iridium Off, rechargeable battery charged, charging cable not connected *NOTE 2	Manually	20	50.519	1605.200
PLB Self Test, GPS Off, Iridium Off, rechargeable battery charged, charging cable connected unpowered. *NOTE 2	Manually	20	50.758	1599.100
PLB Self Test, GPS Off, Iridium Off, rechargeable battery charged, charging cable connected and powered. *NOTE 2	Manually	20	49.166	1580.800
PLB Self Test, Iridium Off, rechargeable battery discharged, charging cable not connected *NOTE 2	Manually	20	51.340	1605.200
PLB Self Test, GPS Off, Iridium Off, rechargeable battery discharged, charging cable connected unpowered. *NOTE 2	Manually	20	50.223	1605.200
PLB Self Test, GPS Off, Iridium Off, rechargeable battery discharged, charging cable connected and powered. *NOTE 2	Manually	20	48.943	1574.700
PLB Self Test, GPS Off, Iridium Off, rechargeable battery removed, charging cable not connected *NOTE 2	Manually	20	50.530	1593.000
PLB Self Test, GPS Off, Iridium Off, rechargeable battery removed, charging cable connected unpowered. *NOTE 2	Manually	20	51.287	1599.100
PLB Self Test, GPS Off, Iridium Off, rechargeable battery removed, charging cable connected and powered. *NOTE 2	Manually	20	49.271	1586.900
PLB Self Test, GPS On, Iridium Off, rechargeable battery charged, charging cable not connected *NOTE 2	Manually	20	50.097	1666.300
PLB Self Test, GPS On, Iridium Off, rechargeable battery charged, charging cable connected unpowered. *NOTE 2	Manually	20	50.475	1733.400
PLB Self Test, GPS On, Iridium Off, rechargeable battery charged, charging cable connected and powered. *NOTE 2	Manually	20	49.598	1721.200
PLB Self Test, GPS On, Iridium Off, rechargeable battery discharged, charging cable not connected *NOTE 2	Manually	20	49.599	1721.200
PLB Self Test, GPS On, Iridium Off, rechargeable battery discharged, charging cable connected unpowered. *NOTE 2	Manually	20	49.220	1709.000
PLB Self Test, GPS On, Iridium Off, rechargeable battery discharged, charging cable connected and powered. *NOTE 2	Manually	20	49.580	1709.000
PLB Self Test, GPS On, Iridium Off, rechargeable battery removed, charging cable not connected *NOTE 2	Manually	20	50.998	1678.500
PLB Self Test, GPS On, Iridium Off, rechargeable battery removed, charging cable connected unpowered. *NOTE 2	Manually	20	51.326	1709.000

PLB Self Test, GPS On, Iridium Off, rechargeable battery removed, charging cable connected and powered. *NOTE 2	Manually	20	49.402	1672.400
Self Test current with Iridium On				
PLB Self Test, GPS Off, Iridium On, rechargeable battery charged, charging cable not connected *NOTE 2	Manually	20	43.544	1586.900
PLB Self Test, GPS Off, Iridium On, rechargeable battery charged, charging cable connected unpowered. *NOTE 2	Manually	20	43.703	1586.900
PLB Self Test, GPS Off, Iridium On, rechargeable battery charged, charging cable connected and powered. *NOTE 2	Manually	20	43.702	1586.900
PLB Self Test, GPS Off, Iridium On, rechargeable battery discharged, charging cable not connected	Not possible			
PLB Self Test, GPS Off, Iridium On, rechargeable battery discharged, charging cable connected unpowered.	Not possible			
PLB Self Test, GPS Off, Iridium On, rechargeable battery discharged, charging cable connected and powered. *NOTE 2	Manually	20	44.022	1586.900
PLB Self Test, GPS Off, Iridium On, rechargeable battery removed, charging cable not connected	Not possible			
PLB Self Test, GPS Off, Iridium On, rechargeable battery removed, charging cable connected unpowered.	Not possible			
PLB Self Test, GPS Off, Iridium On, rechargeable battery removed, charging cable connected and powered. *NOTE 2	Manually	20	43.413	1580.800
PLB Self Test, GPS On, Iridium On, rechargeable battery charged, charging cable not connected *NOTE 2	Manually	20	49.122	1641.800
PLB Self Test, GPS On, Iridium On, rechargeable battery charged, charging cable connected unpowered. *NOTE 2	Manually	20	50.306	1617.400
PLB Self Test, GPS On, Iridium On, rechargeable battery charged, charging cable connected and powered. *NOTE 2	Manually	20	50.216	1635.700
PLB Self Test, GPS On, Iridium On, rechargeable battery discharged, charging cable not connected	Not possible			
PLB Self Test, GPS On, Iridium On, rechargeable battery discharged, charging cable connected unpowered.	Not possible			
PLB Self Test, GPS On, Iridium On, rechargeable battery discharged, charging cable connected and powered. *NOTE 2	Manually	20	50.157	1635.700
PLB Self Test, GPS On, Iridium On, rechargeable battery removed, charging cable not connected	Not possible			
PLB Self Test, GPS On, Iridium On, rechargeable battery removed, charging cable connected unpowered.	Not possible			
PLB Self Test, GPS On, Iridium On, rechargeable battery removed, charging cable connected and powered. *NOTE 2	Manually	20	50.815	1654.100
Operating current with Iridium Off				
PLB On, Iridium Off, GPS Off, rechargeable battery charged, charging cable not connected	Not possible			
PLB On, Iridium Off, GPS Off, rechargeable battery charged, charging cable connected unpowered.	Not possible			
PLB On, Iridium Off, GPS Off, rechargeable battery charged, charging cable connected and powered.	Not possible			
PLB On, Iridium Off, GPS Off, rechargeable battery discharged, charging cable not connected	Manually	1800	35.927	1666.300
PLB On, Iridium Off, GPS Off, rechargeable battery discharged, charging cable connected unpowered.	Manually	1800	36.550	1666.300

PLB On, Iridium Off, GPS Off, rechargeable battery discharged, charging cable connected and powered.	Not possible			
PLB On, Iridium Off, GPS Off, rechargeable battery removed, charging cable not connected	Manually	1800	36.647	1678.500
PLB On, Iridium Off, GPS Off, rechargeable battery removed, charging cable connected unpowered.	Manually	1800	36.384	1666.300
PLB On, Iridium Off, GPS Off, rechargeable battery removed, charging cable connected and powered.	Not possible			
PLB On, Iridium Off, GPS On, rechargeable battery charged, charging cable not connected	Not possible			
PLB On, Iridium Off, GPS On, rechargeable battery charged, charging cable connected unpowered.	Not possible			
PLB On, Iridium Off, GPS On, rechargeable battery charged, charging cable connected and powered.	Not possible			
PLB On, Iridium Off, GPS On, rechargeable battery discharged, charging cable not connected	Manually	1800	29.075	1861.600
PLB On, Iridium Off, GPS On, rechargeable battery discharged, charging cable connected unpowered.	Manually	1800	29.357	1666.300
PLB On, Iridium Off, GPS On, rechargeable battery discharged, charging cable connected and powered.	Not possible			
PLB On, Iridium Off, GPS On, rechargeable battery removed, charging cable not connected	Manually	1800	35.736	1940.900
PLB On, Iridium Off, GPS On, rechargeable battery removed, charging cable connected unpowered.	Manually	1800	35.882	1696.800
PLB On, Iridium Off, GPS On, rechargeable battery removed, charging cable connected and powered.	Not possible			
Operating current with Iridium On				
PLB On, Iridium On, GPS Off, rechargeable battery charged, charging cable not connected	Manually	1800	27.784	1690.700
PLB On, Iridium On, GPS Off, rechargeable battery charged, charging cable connected unpowered.	Manually	1800	27.549	1812.700
PLB On, Iridium On, GPS Off, rechargeable battery charged, charging cable connected and powered.	Manually	1800	26.869	1660.200
PLB On, Iridium On, GPS Off, rechargeable battery discharged, charging cable not connected	Not possible			
PLB On, Iridium On, GPS Off, rechargeable battery discharged, charging cable connected unpowered.	Not possible			
PLB On, Iridium On, GPS Off, rechargeable battery discharged, charging cable connected and powered.	Manually	1800	25.842	1672.400
PLB On, Iridium On, GPS Off, rechargeable battery removed, charging cable not connected	Not possible			
PLB On, Iridium On, GPS Off, rechargeable battery removed, charging cable connected unpowered.	Not possible			
PLB On, Iridium On, GPS Off, rechargeable battery removed, charging cable connected and powered.	Manually	1800	25.904	1794.400
PLB On, Iridium On, GPS On, rechargeable battery charged, charging cable not connected	Manually	1800	26.833	1647.900
PLB On, Iridium On, GPS On, rechargeable battery charged, charging cable connected unpowered.	Manually	1800	26.765	1684.600
PLB On, Iridium On, GPS On, rechargeable battery charged, charging cable connected and powered.	Manually	1800	25.885	1672.400

PLB On, Iridium On, GPS On, rechargeable battery discharged, charging cable not connected	Not possible			
PLB On, Iridium On, GPS On, rechargeable battery discharged, charging cable connected unpowered.	Not possible			
PLB On, Iridium On, GPS On, rechargeable battery discharged, charging cable connected and powered.	Manually	1800	25.737	1635.700
PLB On, Iridium On, GPS On, rechargeable battery removed, charging cable not connected	Not possible			
PLB On, Iridium On, GPS On, rechargeable battery removed, charging cable connected unpowered.	Not possible			
PLB On, Iridium On, GPS On, rechargeable battery removed, charging cable connected and powered.	Manually	1800	25.881	1709.000

All possible modes of operation for SOS-300 are listed in the table above. In each case the Measurement Interval was sufficient to cover all modes of operation of the beacon including all transient conditions such as the Iridium signal being on and off. Current measured at the PLB primary battery.

NOTE 1: When the PLB part of SOS-300 is turned On (pushing the SOS button), it will burst 406 MHz signal. The beacon also periodically tries to acquire GPS signal in order to obtain its location and is referred to as "GPS Active". The period of time in between beacon's GPS acquisition attempts is referred to as "GPS Inactive". When the beacon obtains valid GPS signal during "GPS active" period, it will immediately end the "GPS Active" and go into "GPS Inactive" mode. Therefore, the presence of a valid GPS signal will shorten the "GPS Active" time and equally increase the "GPS Inactive" time. In this table "GPS On" indicates an operational scenario where a valid GPS signal is provided to the beacon. And "GPS Off" indicates an operational scenario where GPS signal is NOT provided to the beacon.

NOTE 2: Maximum duration of self-test is 10 seconds. As requested by the Secretariat, in order to capture any residual energy consumption, the current measurement time was increased and average current recorded.

1. The **standby mode** that draws highest current of **43.167 nA**, was measured with the PLB Off, Iridium On, GPS On, rechargeable battery discharged, charging cable connected and powered.

2. The **self-test mode** that draws highest current of 51.326 mA over 20 seconds, which equals to **102.681 mA over declared 10 seconds for self-test**. This was measured with the PLB Self Test, GPS On, Iridium Off, rechargeable battery removed, charging cable connected unpowered.

3. The **mode of operation** that is used for pre-discharge calculation draws **36.647 mA**, was measured with PLB On, Iridium Off, GPS Off, rechargeable battery removed, charging cable not connected.

SOS-300

Table F-E.2: Pre-test Battery Discharge Calculations

Characteristic	Designation	Units	Value	Comments
Beacon manufacturers declared maximum allowed cell shelf-life (from date of cell manufacture to date of battery pack installation in the beacon)	T_{CS} or TCS	Number of Years	0.25	
Declared beacon battery replacement period (from date of installation in the beacon to expiry date marked on the beacon)	T_{BR} or TBR	Number of Years	7	
Battery pack electrical configuration	Series			
Cell model and cell chemistry	CR123A. 2/3A, Chemistry $LiMnO_2$			
Nominal cell capacity		A-hrs	1.400	
Nominal battery pack capacity	C_{BN}	A-hrs	1.400	
Annual battery cell capacity loss (self-discharge) due to aging, as specified by cell manufacturer at ambient temperature	L_{SDC}	%	1	
Calculated battery pack capacity loss due to self-discharge: $L_{CBN}=C_{BN} - [C_{BN} *(1 - L_{SDC} /100)^{TBR+TCS}]$	L_{CBN}	A-hrs	0.0984	
Number of self-tests per year	N_{ST}		12	
Average battery current during a self-test	I_{ST}	mA	102.68	
Maximum duration of a self-test	T_{ST}	sec	10	
Calculated battery pack capacity loss due to self-tests during battery replacement period: $L_{ST}=I_{ST}*T_{ST}*T_{BR}*N_{ST}/3600$	L_{ST}	mA-hrs	23.96	
Maximum Number of GNSS self-tests between battery replacements	N_{GST}		0	
Average battery current during a GNSS self-test of maximum duration	I_{GST}	mA	0.0000	
Maximum duration of a GNSS self-test	T_{GST}	sec	0	
Calculated battery pack capacity loss due to GNSS self-tests during battery replacement period: $L_{GST}=I_{GST}*T_{GST}*N_{GST}/3600$	L_{GST}	mA-hrs	0.0000	
Average stand-by battery pack current	I_{SB}	mA	0.000043167	
Other Capacity Losses	LOTH	mA-hrs	0	
Battery pack capacity loss due to constant operation of circuitry prior to beacon activation: $L_{ISB}=I_{SB}*T_{BR}*8760$	L_{ISB}	mA-hrs	2.6470	
Calculated value of the battery pack pre-test discharge $L_{CDC} = L_{CBN} + 1.65*(L_{ST} + L_{GST} + L_{ISB})/1000 + L_{OTH}/1000$	L_{CDC}	A-hrs	0.1423	

Battery Preconditioning/Discharge time = Worst Case drain/operational current

Battery Preconditioning	0.1423	AmpHours
Operating Current obtained from Table F-E.1	0.0366	Amps
Battery Preconditioning/Discharge time	3.88	Hours

Product Service

SOS-300, 7 year battery life analysis in support of T.007 Section 5.c.

In support of T.007 Section 5.c, ACR Electronics is providing data and analysis in support of SOS-300 having sufficient battery power to perform as required up to and including 7 years of storage and recommended usage as specified in the Product Support Manual, No Y1-03-0304.

Description:

SOS-300 battery pack, uses 3 Panasonic CR123A $LiMnO_2$ battery cells, in the configuration shown in Diagram 1: (3 in series, PN A1-13-0118).

Each cell provides 3 Volts DC with 1.4 Ampere Hours of capacity, Table 2. When packaged in the ACR battery pack, the combined voltage is 9 Volts DC with 1.4 Ampere Hours of capacity.

Self-Discharge Analysis:

Based on battery cell manufacturer's data (Panasonic), self-drain at 20°C over 10 years is less than 1% per year (Graph 1), but for our analysis we are using 1% per year (Table 1). As observed in Graph 1, self-drain is affected by storage temperature, mainly at temperatures higher than 20°C. Therefore, based on this data, prolonged exposure of the battery to higher temperatures would reduce operational life of the beacon. As a result of this analysis, the following warning is included in the Product Support Manual, No Y1-03-0304:

> **WARNING: Battery contains lithium**
> To avoid possible fire, explosion, leakage or burn hazard, do not open, recharge, disassemble or heat beacon above +70ºC (+158ºF) or incinerate.
>
> If this beacon is kept above room temperature for prolonged periods of time, the Battery Capacity will be degraded. This will need the battery to be replaced at a date earlier than stated on the beacon or the quoted operating life of the beacon (24 hours) may be reduced. The effect is more pronounced as temperature increases.
> In tropical regions this could reduce the battery life by a year. In hot desert regions, this could be two years.
> Note: Storage in lower temperatures (below ambient) does not extend battery life longer that the replacement date on the unit.

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Total Battery discharge as a result of specified operation over 7 year period:

In the data provided by the beacon testing lab, TUV-SUD in England (75934030 Report 01, Battery Current Measurement Results) total battery life consumption due to specified beacon operation and battery self-discharge over the 7 year period is 3.87 hours Following a pre-discharge of 3.87 hours at ambient temperature, the beacon was placed at -20°C and allowed to run (activated) until transmission power dropped below 35 dBm for the 406 MHz signal. As per Cospas-Sarsat T.007, Clause A.2.3, SOS-300 performance was monitored, recorded and exceeded the minimum 24 hours of satisfactory performance for 406 MHz. SOS-300 continued to perform at 406 MHz additional 10.99 hours.

As specified in JC-24/5/7, 8% safety correction factor due to High Storage Temperature Losses was applied to battery discharge calculation in Table 3. Based on Table 3 calculation the pre-discharge time increases by 0.31 hours, which reduces the beacon spare battery capacity (past the 24 hours) at 406 MHz to 10.68 hours. Even with high storage temperature factored, the beacon has adequate spare battery capacity.

Conclusion:

Based on test data obtained and analysis performed, ACR is confident that the SOS-300 beacon has adequate battery power capacity to perform and meet specifications up to and including 7 years of storage and recommended usage as specified in the Product Support Manual, No Y1-03-0304.

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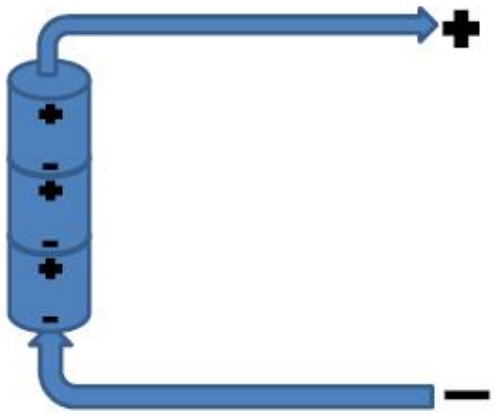

Diagram 1: Battery cell configuration in SOS-300 Battery Pack,

COMPARISON TABLE OF LITHIUM BATTERY TYPES

Item	Type	Primary battery		Rechargeable battery			
	Model	BR	CR	VL	ML	NBL	MT
Material	⊕ electrode	(CF)n	MnO_2	V_2O_5	LixMnOy	Nb_2O_5	LixOy
	⊖ electrode	Li	Li	LiAl	LiAl	LiAl	LixTiOy
Nominal voltage		3.0	3.0	3.0	3.0	2.0	1.5
Operating temperature range (°C)		cylindrical : -40 to +85 coin : -30 to +80 high operating temperature coin : -40 to +125 pin : -30 to +80	cylindrical : -40 to +70 coin : -30 to +60	-20 to +60	-20 to +60	-20 to +60	-10 to +60
Self-discharge (per year) under standard conditions	Cylindrical type	0.5%	1.0% *	2.0%	2.0%	2.0%	2.0%
	Coin type	1.0%	1.0% *				
Average discharge voltage (V)		-	-	2.85	2.5	1.5	1.2
Charge voltage (V)		-	-	3.25 to 3.55	2.8 to 3.2	1.8 to 2.5	1.6 to 2.6
Cut-off voltage (V)		2.0	2.0	2.5	2.0	1.0	1.0
Charge-discharge cycles		-	-	1,000 charge/discharge partly (charge/discharge for 10% of discharge depth)	1,000 charge/discharge partly (charge/discharge for 10% of discharge depth)	1,000 charge/discharge partly (charge/discharge for 10% of discharge depth)	500 charge/discharge up to 1V or discharge limit voltage (charge/discharge for 100% of discharge depth)

* Annual self-discharge @ 23°C for 15 years.

Table 1: Panasonic CR123A, Reference CR column for Nominal Voltage and Self-discharge %

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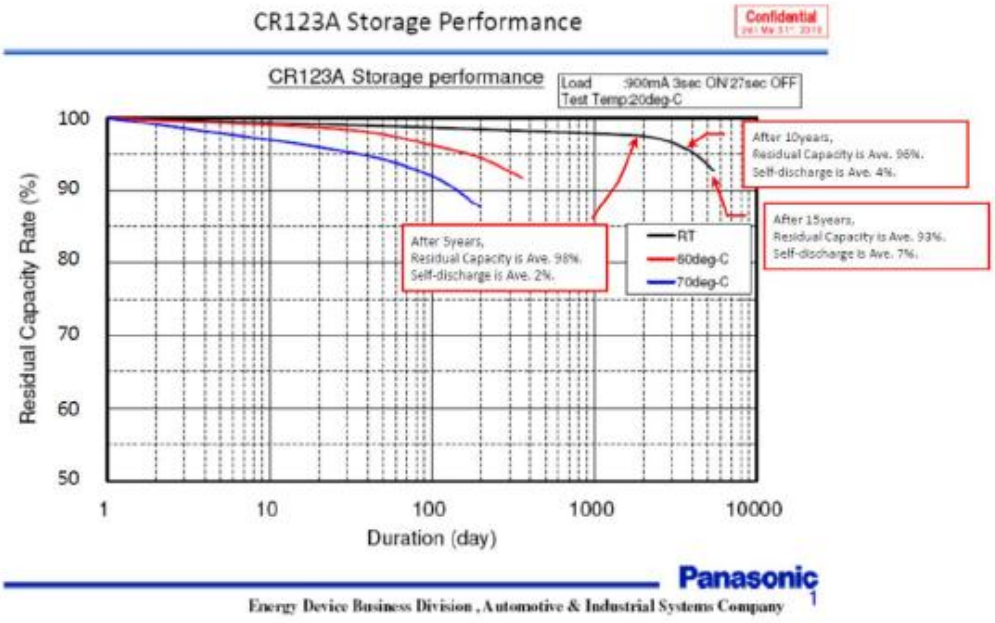
GENERAL SPECIFICATIONS

Model number*1	Electrical Characteristics at 20 °C			Dimensions (mm)		Approx. Weight (g)	JIS	IEC
	Nominal Voltage (V)	Nominal Capacity (mAh)*2	Continuous Standard Drain (mA)	Diameter	Height			
CR-2*1,3	3	850	20	15.6	27.0	11.0	CR-2,CR-15H270	CR-15H270
CR-123A*1,3	3	1,400	20	17.0	34.5	17.0	CR-123A, CR-17345	CR-17345
2CR-5*2,3	6	1,400	20	34.0	45.0	36.0	2CR-5	2CR-5
CR-P2*2,3	6	1,400	20	35.0	36.0	37.0	CR-P2	CR-P2
CR-V3*1,3	3	3,300	200	29.0 x 14.5	52.0	39.0	-	-

Table 2: Panasonic CR123A, Reference CR123A row for Nominal Voltage and Nominal capacity



Graph 1: Panasonic CR123A, Storage Performance showing Residual Capacity as a result of time and temperature.

Note: Panasonic data in Graph 1 at a 10 year mark, shows average self-discharge rate of 0.4% at 20°C, however, in our analysis we used 1%. as declared in Table 1.

Table 3: SARLink, Remaining Operational Capacity Calculation

Parameter	Units	Amount	Notes
Nominal capacity of a fresh battery pack capacity	mA-hrs	1400.000	As per battery pack composition and battery cell technical data sheet
a) Loss due to battery self-discharge	mA-hrs	98.383	Obtained from Table F-E.2
b) Loss due to constant circuit operation	mA-hrs	4.368	2.647 mA-hrs (Table F-E.2) with correction factor 1.65 = 4.368
c) Loss due to self-test	mA-hrs	39.532	23.959 mA-hrs (Table F-E.2) with correction factor 1.65 = 39.532
d) Loss due to GNSS Self-test	mA-hrs	0.000	0 mA-hrs (Table F-E.2) with correction factor 1.65 = 0
e) Battery capacity loss due to low temperature	mA-hrs	0.000	N/A
f) Loss due to other reasons	mA-hrs	0.000	N/A
Total Losses	mA-hrs	142.283	sum of the losses (a) – (f)
Other Safety Correction Factor (OSCF)		1.080	8% safety correction factor due to High Storage Temperature Losses per JC-24/5/7
Estimated minimum fresh battery discharge threshold (FBDT)	mA-hrs	153.665	Total Losses multiplied by the OSCF

Operating Current	36.65 mA	Obtained from Table F-E.1
Temp Compensated Calculated pre-discharge at Ambient	4.19 Hrs	153.665 mA-hrs (FBDT) / 36.65 mA (Operating current)
Non-Temp Compensated Calculated pre-discharge at Ambient	3.88 Hrs	Obtained from Table F-E.2
Additional pre-discharge Time due to temperature	0.31 Hrs	Temp Compensated Calculated pre-discharge at Ambient 4.19 Hrs - Non-Temp Compensated Calculated pre-discharge at Ambient 3.88 Hrs
Beacon 406 MHz Operating life measured at -20 C	34.99 Hrs	From TUV report 75934030 Report 1
Calculated 406 MHz Remaining Operating capacity at -20C, with High storage Temperature Compensation.	34.68 Hrs	34.99 Hrs (Measured Operating Life) - 0.31 Hrs (Calculated Additional pre-discharge)
Minimum Required operation for 406 MHz	24 Hrs	As declared in Annex G.
Remaining 406 MHz Operational Capacity in excess of required	**10.68 Hrs**	**34.68 Hrs (Calculated capacity) - 24 Hrs (Required / Declared Capacity)**

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ANNEX B

SUPPLEMENTARY TESTING

SUPPLEMENTARY TESTING - METHOD

The following testing was performed:

1) With 406 MHz beacon battery fit, LIRB removed, USB connected, GNSS signal provided, activate and operate Iridium,
2) Confirm Iridium Rx and TX are OK,
3) Confirm GNSS is OK,
4) Activate 406 MHz beacon,
5) Within 5 seconds after 406 MHz beacon activation, disconnect USB and block GNSS signal,
6) Monitor and report content of the first two 406 MHz messages.

The test is passed, if 406 MHz message has default values in position fields.

Perform the above functional test for ULP, NLP and SLP

TEST RESULTS

Equipment Under Test and Modification State

ULP: SAR Link S/N: #1762 - Modification State 0
NLP: SAR Link S/N: #1765 - Modification State 0
SLP: SAR Link S/N: #1760 - Modification State 0

Date of Test

24 and 26 August 2016

Test Equipment Used

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Antenna (Double Ridge Guide,1GHz-18GHz)	EMCO	3115	35	12	27-Nov-2016
Beacon Tester	WS Technologies	BT 100S	87	-	TU
Signal Generator (10MHz to 40GHz)	Rohde & Schwarz	SMR40	1002	12	25-Sep-2016
Beacon Tester	WS Technologies	BT100S	3263	-	TU
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	2-Mar-2017

Environmental Conditions

Ambient Temperature: 25.2 - 27.8 °C
Relative Humidity 43.6 - 63.0 %

Test Setup

Test Setup

Test Results

The test was completed satisfactorily, messages were as follows:

Parameter	Full Hex Message	Encoded Position Data
User Location Protocol		
First message	FFFE2FCC9E2000C6007CE5E56E2FE0FF0146	Default
Second Message	FFFE2FCC9E2000C6007CE5E56E2FE0FF0146	Default
Standard Location Protocol		
First message	FFFE2F8C9EF9C0637FDFF83D15B683E0F00E	Default
Second Message	FFFE2F8C9EF9C0637FDFF83D15B683E0F00E	Default
National Location Protocol		
First message	FFFE2F8C9F70465FC0FF01F754769F3C0672	Default
Second Message	FFFE2F8C9F70465FC0FF01F754769F3C0672	Default