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Report On

Emergency Beacons Limited Testing of the
McMurdo Limited Fastfind Max G (and Non GPS Variant)
In accordance with Cospas-Sarsat T.007 Issue 4 - Rev 4 October 2009

Document 75909629 Report 01 Issue 6 January 2011

Product Service

TUV Product Service Ltd, Octagon House, Concorde Way, Segensworth North,
Fareham, Hampshire, United Kingdom, PO15 5RL
Tel: +44 (0) 1489 558100. Website: www.tuvps.co.uk

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PREPARED FOR

McMurdo Limited
Silver Point
Airport Service Road
Hilsea
Portsmouth
PO3 5PB

PREPARED BY

R Hampton
Telecoms Test Engineer

APPROVED BY

N Forsyth
Authorised Signatory

DATED

21 January 2011

UKAS TESTING
0141

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CONTENTS PAGE

Product Service

SECTION 1

REPORT SUMMARY

Emergency Beacons Limited Testing of the
McMurdo Limited Fastfind Max G (and Non GPS variant) In accordance with
Cospas-Sarsat T.007 Issue 4 - Rev 4 October 2009

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Emergency Beacon Limited Testing of the McMurdo Limited Fastfind Max G (and Non GPS variant) to the requirements of Cospas-Sarsat T.007 Issue 4 - Rev 4 October 2009.

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.
Manufacturer	McMurdo Limited
Model Number(s)	Fastfind Max G Fastfind Max
Serial Number(s)	Fastfind Max G: 0001 Fastfind Max: 0001
Number of Samples Tested	2 (1 GPS and 1 Non GPS)
Test Specification/Issue/Date	Cospas-Sarsat T.007 Issue 4 - Rev 4 October 2009
Incoming Release Date	Application Form 07 June 2010
Date of Receipt of Test Samples	25 May 2010
Order Number Date	PC0004138 24 April 2010
Start of Test	02 June 2010
Finish of Test	19 January 2011
Name of Engineer(s)	M P Hardy R Hampton R Henley

1.2 APPLICATION FORM

1.2.1 Beacon Manufacturer and Beacon Model

Beacon Manufacturer	McMurdo Ltd
Beacon Model	Fastfind Max G
Other Model Names	Fastfind Max, Fastfind/Fastfind Plus, Safelink PLB PRO, XS-ER GPS

1.2.2 Beacon Type and Operational Configurations

Beacon Type	**Beacon used while:**	**Tick where appropriate**
EPIRB	Floating in water or on deck or in a safety raft	☐
PLB	On ground and above ground	☒
	On ground and above ground and floating in water	☐
ELT Survival	On ground and above ground	☐
	On ground and above ground and floating in water	☐
ELT Auto Fixed	Fixed ELT with aircraft external antenna	☐
ELT Auto Portable	In aircraft with an external antenna	☐
	On ground, above ground, or in a safety raft with an integrated antenna	☐
ELT Auto Deployable	Deployable ELT with attached antenna	☐
Other (specify)		☐

1.2.3 Beacon Characteristics

Characteristic	**Specification**
Operating frequency	406.040 MHz
Operating temperature range	Tmin = -20 °C Tmax = +55 °C
Operating lifetime	48 hours
Battery chemistry	Lithium iron di-sulphide
Battery cell model name, size and number of cells	AA x 7cells
Battery cell manufacturer	Energizer
Battery pack manufacturer and part number	All Batteries/ 85-722D
Battery pack replacement period	5 years

Characteristic	Specification
Oscillator type (e.g. OCXO, MCXO, TCXO)	TCXO
Oscillator manufacturer	Rakon
Oscillator part name and number	E5344LF
Oscillator satisfies long-term frequency stability requirements (Yes or No)	Yes
Antenna type: Integral or Other (e.g. External, Detachable – specify type)	Intergrated
Antenna manufacturer	Doig
Antenna part name and number	85-710B
Navigation device type (Internal, External or None)	Internal
Features in beacon that prevent degradation to 406 MHz signal or beacon lifetime resulting from a failure of navigation device or failure to acquire position data (Yes, No, or N/A)	Yes
Features in beacon that ensures erroneous position data is not encoded into the beacon message (Yes, No or N/A)	Yes
Navigation device capable of supporting global coverage (Yes, No or N/A)	Yes
For Internal Navigation Devices	
- Geodetic reference system (WGS 84 or GTRF)	WGS 84
- GNSS receiver cold start forced at every beacon activation (Yes or No)	Yes
- Navigation device manufacturer	Ublox
- Navigation device model name and part Number	NEO-6M
- GNSS system supported (e.g. GPS, GLONASS, Galileo)	GPS, Galileo
For External Navigation Devices	
- Data protocol for GNSS receiver to beacon interface	
- Physical interface for beacon to navigation device	
- Electrical interface for beacon to navigation device	
- Part number of the external navigation interface device (if applicable)	
- Navigation device model and manufacturer (if beacon designed to use specific devices)	

Characteristic	Specification	
Self-Test Mode Characteristics	Self-Test Mode	Optional GNSS Self-Test Mode
- Self-test has separate switch position (Yes or No)	Yes	No
- Self-test switch automatically returns to normal position when released (Yes or No)	Yes	
- Self-test activation can cause an operational mode transmission (Yes or No)	No	
- Self-test causes a single beacon self-test message burst only regardless of how long the self-test activation mechanism applied (Yes or No)	Yes	
- Results of self-test indicated by (e.g. Pass / Fail Indicator Light, Strobe Light, etc.)	Pass/Fail LED	
- Self-test can be activated from beacon remote activation points (Yes or No)	No	
- Self-test performs an internal check and indicates that RF power emitted at 406 MHz and 121.5 MHz if beacon includes a 121.5 MHz homer (Yes or No)	Yes	
- Self-test transmits a signal(s) other than at 406 MHz (Yes & details or No)	Yes, 121.5MHz	
- Self-test can be activated directly at beacon (Yes or No)	Yes	
- List of Items checked by self-test	406.040/121/5MHz power, PLL lock, GPS module	
- Self-test transmission burst duration (440 or 520 ms)	both supported	
- Self-test format bit (“0” or “1”)	1	
- Maximum duration of Self Test / GNSS Self-test	10 seconds	
- Maximum number of GNSS Self Tests (beacons with internal navigation devices only)	N/A	
- Self-test results in transmission of a single burst, irrespectively of the test result (Yes or No)	N/A	
- Maximum number of self-tests during battery pack replacement period	60	N/A

Characteristic	Specification	
Message Coding Protocols:	(x) Tick the boxes below against the intended protocol options	
User Protocol (tick where appropriate)	☒	Maritime with MMSI
	☒	Maritime with Radio Call Sign
	☐	EPIRB Float Free with Serial Number
	☒	EPIRB Non Float Free with Serial Number
	☒	Radio Call Sign
	☐	Aviation
	☐	ELT with Serial Number
	☐	ELT with Aircraft Operator and Serial Number
	☐	ELT with Aircraft 24-bit Address
	☒	PLB with Serial Number
	☐	National (Short Message Format)
	☐	National (Long Message Format)
Standard Location Protocol (tick where appropriate)	☒	EPIRB with MMSI
	☒	EPIRB with Serial Number
	☐	ELT with 24-bit Address
	☐	ELT with Aircraft Operator Designator
	☐	ELT with Serial Number
	☒	PLB with Serial Number
National Location Protocol (tick where appropriate)	☒	National Location: EPIRB
	☐	National Location: ELT
	☒	National Location: PLB
User Location Protocol (tick where appropriate)	☒	Maritime with MMSI
	☒	Maritime with Radio Call Sign
	☐	EPIRB Float Free with Serial Number
	☒	EPIRB Non Float Free with Serial Number
	☐	Radio Call Sign
	☐	Aviation
	☐	ELT with Serial Number
	☐	ELT with Aircraft Operator and Serial Number
	☐	ELT with Aircraft 24-bit Address
	☒	PLB with Serial Number

Characteristic	Specification
Beacon includes a homer transmitter (if yes identify frequency of transmission)	121.5 MHz
-Homer Transmit Power	20 dBm
-Homer Duty Cycle	99.13 %
-Duty Cycle of Homer Swept Tone	34 %
Beacon includes a strobe light (Yes or No)	No
- Strobe light intensity	
- Strobe light flash rate	
Beacon transmission repetition period satisfies C/S T.001 requirement that two beacon's repetition periods are not synchronised closer than a few seconds over 5 minute period, and the time intervals between transmissions are randomly distributed on the interval 47.5 to 52.5 seconds (Yes or No)	Yes
Other ancillary devices (e.g. voice transceiver, remote control, external audio and light indicators, external activation device). List details on a separate sheet if insufficient space to describe.	No
Beacon includes automatic activation mechanism (Yes or No) Specify type of automatic beacon activation mechanism	No.
Beacon includes software or hardware features and functions not listed above and non-related to 406 MHz (Yes or No) List features and use a separate sheet if insufficient space	No

1.2.4 Information Provided by the Cospas-Sarsat Accepted Test Facility

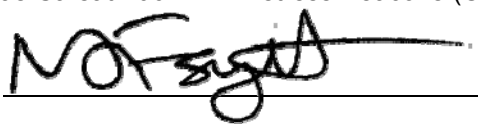
Name and Location of Beacon Test Facility: TÜV Product Service Ltd, United Kingdom

Date of Submission for Testing: May 2010

Applicable C/S Standards:

Document	Issue	Revision	Date
C/S T.001	3	10	Oct-09
C/S T.007	4	4	Oct-09

I hereby confirm that the 406 MHz beacon described above has been successfully tested in accordance with the Cospas-Sarsat Type Approval Standard (C/S T.007) and complies with the Specification for Cospas-Sarsat 406 MHz Distress Beacons (C/S T.001) as demonstrated in the attached report.

Signed: 

Name: N Forsyth

Position Held: Authorised Signatory

Date: 21 January 2011

1.2.5 Applicant Details

Company Name	McMurdo Ltd		
Address	Silver Point Airport Service Road Hilsea Portsmouth		
Category of Applicant	☒ Manufacturer	☐ Importer	
	☐ Distributor	☐ Agent	
Contact Name	Neil Jordan	Telephone	02392 623934
Email	neiljordan@mcmurdo.co.uk	Facsimile	02392 623997

1.2.6 Manufacturer Details

Company Name	Same as above		
Address			
Contact Name		Telephone	
Email		Facsimile	

1.2.7 Declaration of Build Status

Hardware Version	
- PCB Revision	Issue 3
- Battery Model	Energizer L91
Software Version	N/A
Firmware Version	1.4.100
Other (Specify)	

1.2.8 Applicant's Declaration

I hereby declare that I am entitled to sign on the behalf of the applicant and that the information supplied is correct and complete

Signed: Signature held on file

Name: Neil Jordan

Position Held: Engineering Manager

Date: 7-6-10

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a McMurdo Limited Fastfind Max G as shown in the photograph below. A full technical description can be found in the manufacturer's documentation.

Equipment Under Test

1.3.2 Physical Test Configuration

The EUT was a fully packaged beacon, operating using its own power source (internal battery), similar to the proposed production beacons equipped with its proper antenna. This EUT was used to perform Satellite Qualitative and Position Acquisition Time and Position Accuracy. The test configuration for these tests is a function of the beacon type and the operational environments supported by the beacon, as declared by the manufacturer.

1.3.3 Modes of Operation

Modes of operation of the EUT during testing were as follows:

Operating:

- 121 Homer active and offset (121.65 MHz)
- GPS receiver in normal duty cycle
- 406 MHz transmitter 'on frequency' and in test protocol

1.4 MODIFICATIONS

The table below details modifications made to the EUT during the test programme. The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Sample Number: 1			
0	As supplied by manufacturer.	N/A	N/A
1	Repair conducted after failure to reprogram the beacon protocol for the Configuration 8 testing. "*Q15 was found to be damaged. This was replaced. This transistor is used for programming of the beacon (protocol / serial number) via the infra-red USB pen. It has no effect on the performance of the beacon once programmed. No other changes were made.*"	McMurdo Ltd	23/07/2010

1.5 REPORT MODIFICATION RECORD

Issue 1 – First Issue
Issue 2 – Additional testing added: Navigation System – Position Acquisition Time and Position Accuracy Test (3 Protocols, Configuration 8) and Satellite Qualitative (Configuration 8)
Issue 3 – Missing Satellite Qualitative Test Results Table section (Configuration 8) completed
Issue 4 – Additional Satellite Qualitative Test Results added for the Non GPS variant. Position Acquisition Time and Position Accuracy Test (User and National Location Protocols) for Configuration 8 added and further navigation system tests for all three protocols added.
Issue 5 – Correction of firmware version as requested by McMurdo.
Issue 6 – Typographical errors and additional testing requested by Cospas Sarsat.

SECTION 2

TEST DETAILS

Emergency Beacons Limited Testing of the
McMurdo Limited Fastfind Max G (and Non GPS variant) In accordance with
Cospas-Sarsat T.007 Issue 4 - Rev 4 October 2009

TEST RESULTS TABLE

Parameter	Limits	Units	Test Results			Comments
			Tmin	Tamb	Tmax	
			(-20°C°C)	(+21°C)	(+55°C)	
5. 406 MHz Transmitted Frequency						**Result: Pass**
Test Sample: Fastfind Max G S/N: TUV REF: TSR0001 Mod State: 1						
Nominal Value	C/S T.001	MHz	406.040042	406.039999	406.039983	
Short-term stability	≤ $2x10^{-9}$	/100ms	$8.060x10^{-11}$	$2.111x10^{-10}$	$8.278x10^{-11}$	
Medium-term stability – Slope	(-1 to +1)$x10^{-9}$	/minutes	$4.511x10^{-11}$	$1.082x10^{-11}$	$5.668x10^{-12}$	
Medium-term stability – Residual frequency variation	≤ $3x10^{-9}$		$2.106x10^{-10}$	$1.356x10^{-10}$	$1.045x10^{-10}$	

Parameter	Limits	Units	Test Results		Comments
9. Thermal Shock					**Result: Pass**
Test Sample: Fastfind Max G S/N: TUV REF: TSR0001 Mod State: 1					
Soak Temperature	30°C difference	°C	20.5		Test Data: Page 20
Measurement Temperature		°C	-9.5		
Transmitted Frequency			Min		
Nominal value	C/S T.001	MHz	406.0400213	406.0400303	
Short-term stability	≤ $2x10^{-9}$	/100ms	$6.301x10^{-11}$	$1.696x10^{-10}$	
Medium-term stability – Slope	(-2 to +2)$x10^{-9}$	/min	$-1.221x10^{-10}$	$1.678x10^{-9}$	
Medium-term stability – Residual frequency variation	≤ $3x10^{-9}$		$7.75x10^{-11}$	$1.028x10^{-9}$	
Transmitter power output	35 - 39	dBm	36.798	36.876	
Digital message	correct	P/F	P		

Parameter	Limits	Units	Test Results		Comments
10. Operating Lifetime at Minimum Temperature					**Result: Pass**
Test Sample: Fastfind Max G S/N: TUV REF: TSR0001 Mod State: 1					
Pre-test battery discharge duration (operating) required		Hours	6.63		Test Data: Page 32
Pre-test battery discharge duration (operating)		Hours	8.0		
duration	>24	hours	76.00 Hours at Tmin = -20°C		
Effective Operating Lifetime duration	>24	hours	76.00 Hours at Tmin = -20°C		
Transmitted Frequency			Min	Max	
Nominal value	C/S T.001	MHz	406.0400393	406.0400453	
Short-term stability	≤ $2x10^{-9}$	/100ms	$3.365x10^{-11}$	$1.992x10^{-10}$	
Medium-term stability – Slope	(-1 to +1)$x10^{-9}$	/min	$-4.278x10^{-9}$	$1.278x10^{-10}$	
Medium-term stability – Residual frequency variation	≤ $3x10^{-9}$		$4.671x10^{-11}$	$1.263x10^{-8}$	
Transmitter power output	35 - 39	dBm	36.47	36.66	
Digital message	correct	P/F	P		

Parameter	Limits	Units	Test Results		Comments
11. Temperature Gradient (5°C/hr)					**Result: Pass**
Test Sample: Fastfind Max G S/N: TUV REF: TSR0001 Mod State: 1					
Transmitted Frequency			Min	Max	Test Data: Page 37
Nominal value	C/S T.007	MHz	406.0399531	406.0400396	Additional Data – see Annex B
Short-term stability	≤ $2x10^{-9}$	/100ms	$4.679x10^{-11}$	$4.835x10^{-10}$	
	(-1 to +1)$x10^{-9}$	/min	$-9.07x10^{-11}$	$1.81x10^{-10}$	Data for points A to B, C+15 min to D and E+15 min to F
Medium-term stability – Slope[1]	(-2 to +2)$x10^{-9}$	/min	$-6.80x10^{-10}$	$5.06x10^{-10}$	Data for points B to C+15 min and D to E+15 min
Medium-term stability – Residual frequency variation	≤ $3x10^{-9}$		$5.304x10^{-11}$	$4.825x10^{-10}$	
Transmitter power output	35 – 39	dBm	36.006	36.343	
Digital message	correct	P/F	P		

Parameter	Limits	Units	Test Results				Comments
14. Satellite Qualitative Tests							**Result: Pass**
Test Sample: Fastfind Max G S/N: TUV REF: TSR0001 Mod State: 0*							
Test Configuration	As per C/S T.007		Configuration				
			5	6	7	8	
15 Hex ID Decoded by LUT	correct	P / F	-	-	P	P	Test Data: Page 41
Doppler Location results with error ≤5km	≥80	%	-	-	100	100	*Configuration 8 Tested at Modification State 1

Parameter	Limits	Units	Test Results			Comments
17. Navigation System						**Result: Pass**
Test Sample: Fastfind Max G S/N: TUV REF: TSR0001 Mod State: 1*						
Location protocol	C/S T.001		National	Standard	User	
Position data default values	correct	P / F	P	P	P	Test Data: Page 44
Configuration 7						
Position accuracy - A.3.8.2.1		metres	109.5	61.9	1587.4	*Standard Location Protocol for Configuration 7 tested at Mod State 0
Position Acquisition Time - A.3.8.2.1	10min	min	2.0	2.0	2.87	
Position accuracy - A.3.8.2.2		metres	49.5	49.8	3372.8	
Position Acquisition Time - A.3.8.2.2	10min	min	2.0	2.0	2.0	
Configuration 8						
Position accuracy - A.3.8.2.1		metres	40.1	32.8	1545.2	
Position Acquisition Time - A.3.8.2.1	10min	min	2.03	2.03	2.03	
Position accuracy - A.3.8.2.2		metres	49.5	50.1	3372.8	
Position Acquisition Time - A.3.8.2.2	10min	min	2.03	2.03	2.91	
Encoded position data update interval	>20	min	20min 48sec	41min 34sec	42min 25sec	
Position clearance after deactivation	cleared	P / F	P	P	P	
Position data input update interval (as applicable)	20/1	min	N/A	N/A	N/A	
Position data encoding	correct	P / F	P	P	P	Tested by manufacturer in accordance with C/S T.007 Issue 4 – Rev 2 November 2007. Reviewed by TUV SUD Product Service.
Retained last valid position after navigation input lost	240(±5)	min	238min 43sec	238min 44sec	238min 42sec	
Default position data transmitted after 240(±5) minutes without valid position data	cleared	P / F	P	P	P	

Parameter	Limits	Units	Test Results	Comments
Information on protection against beacon degradation due to navigation device, interface or signal failure or malfunction	provided	Y / N	Y	Applicant's data, see Annex A for details

N/T – Not tested

2.1 THERMAL SHOCK

2.1.1 Equipment Under Test and Modification State

Fastfind Max G S/N: TUV REF: TSR0001 - Modification State 1

2.1.2 Date of Test

14 December 2010

2.1.3 Test Equipment Used

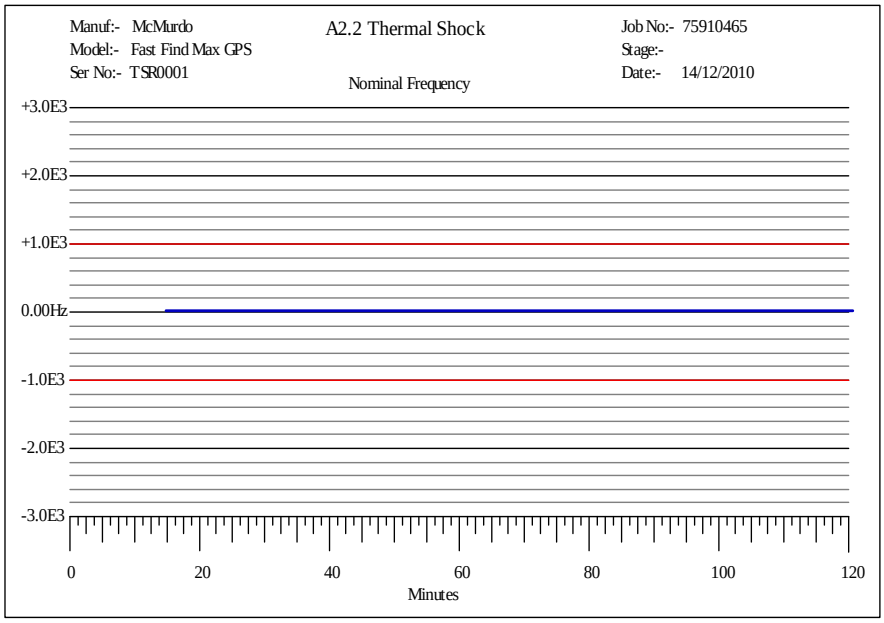
The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.4 Environmental Conditions

Ambient Temperature 20.5 °C
Relative Humidity 28 %

2.1.5 Test Results

Nominal Frequency



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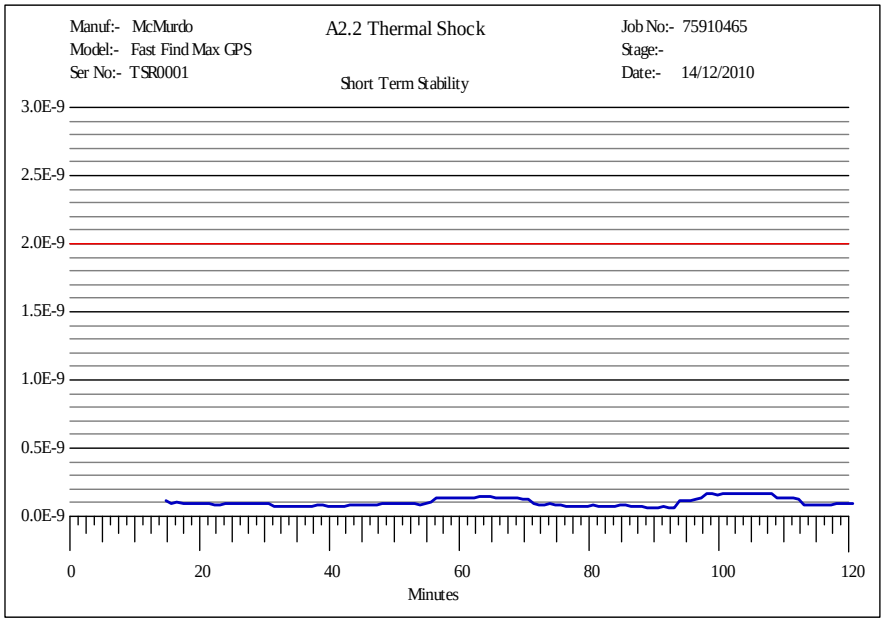
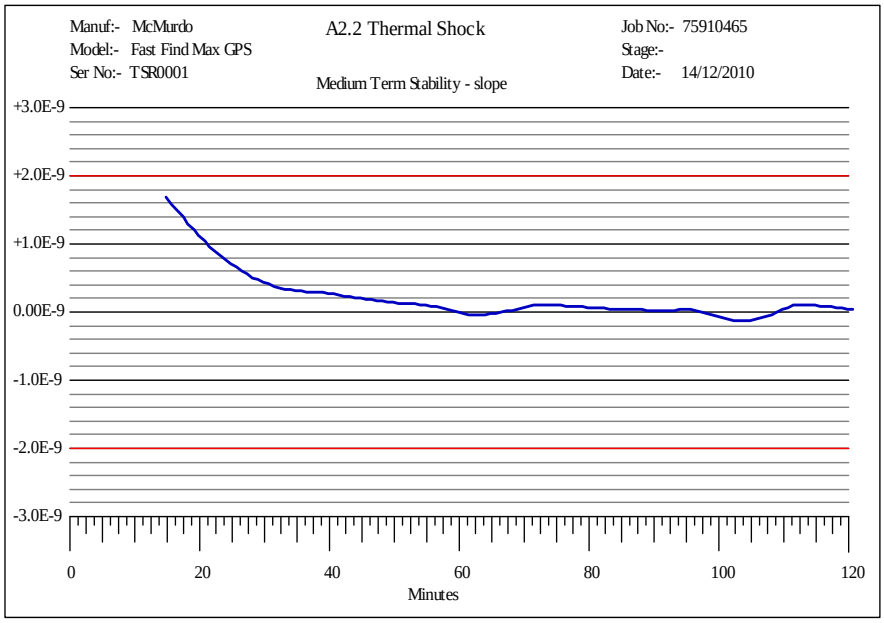
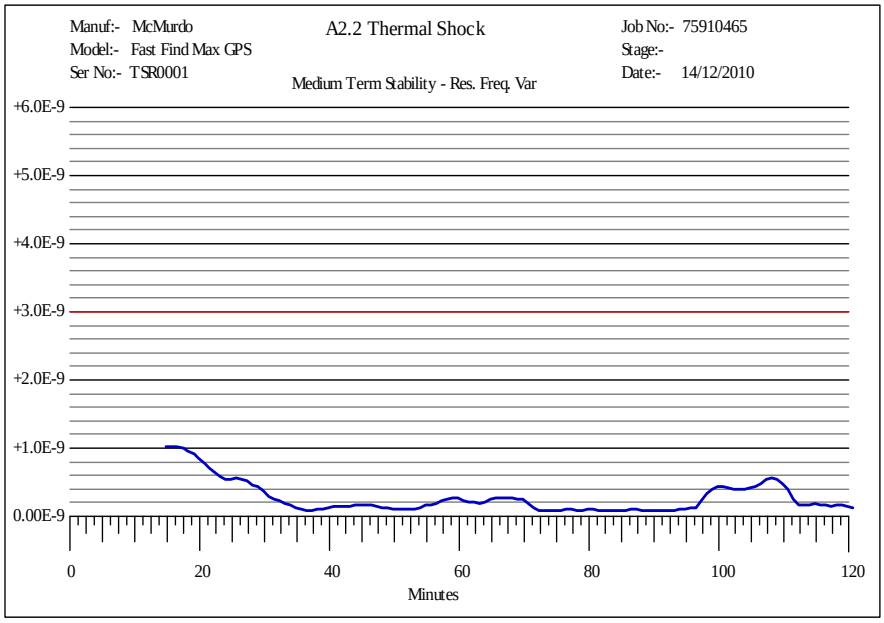
Short Term Stability



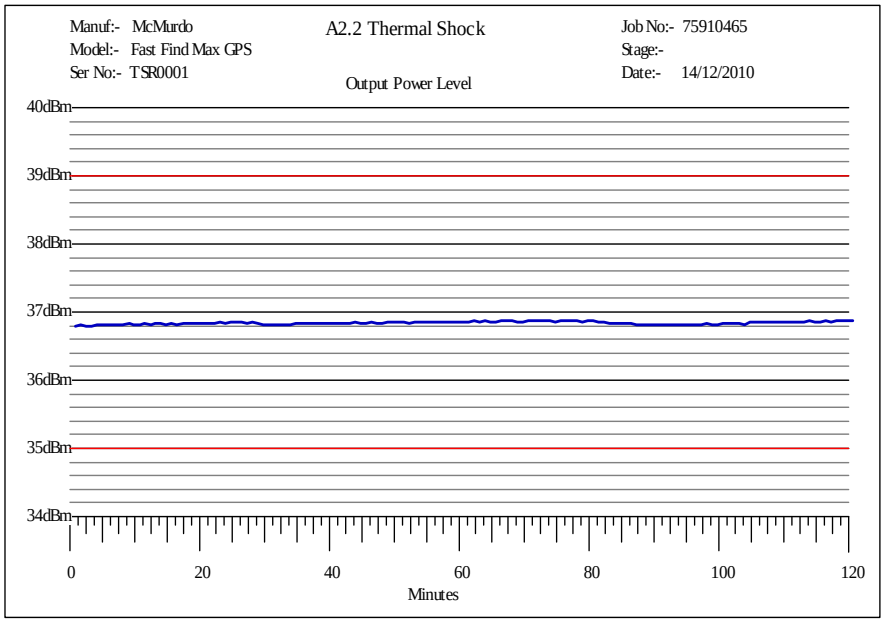
Medium Term Stability, Mean Slope



Medium Term Stability, Residual Frequency Variation



Output Power



Digital Message

```
================================================================================
 Beacon Id Format......... 30 Hex Id, Long Message, Bits 25-144
 15 Hex (Bits 26- 85) = 993F40018C00F9D              993F40018C00F9D Default_Id
 30 Hex (Bits 25-144) = CC9FA000C6007CE991E56FE0FF0146

   26   30   34   38   42   46   50   54   58   62   66   70   74   78   82
   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
 1 1001 1001 0011 1111 0100 0000 0000 0001 1000 1100 0000 0000 1111 1001 1101
   0011 0010 0011 1100 1010 1101 1111 1100 0001 1111 1110 0000 0010 1000 110
   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
   86   90   94   98  102  106  110  114  118  122  126  130  134  138  142

Field Name        Bit Pos    Value Decode                                Bits
----------        -------    ----- ------                                ----
Format Flag        25            1 Long Message                             1
Protocol Flag      26            1 User                                     1
MID                27- 36      201 ALBANIA                        0011 0010 01
User Protocol      37- 39        7 Test                                  111
Spare              40- 63                          1101 0000 0000 0000 0110 0011
Spare              64- 83               0000 0000 0011 1110 0111
Homing             84- 85        1 121.5                                   01
BCH Encoded        86-106          Errors=0          0011 0010 0011 1100 1010 1
BCH Generated      86-106                            0011 0010 0011 1100 1010 1
Spare             107-126                              1011 1111 1000 0011 1111
Spare             127-144                                 1100 0000 0101 0001 10

================================================================================
```

2.2 OPERATING LIFETIME AT MINIMUM TEMPERATURE

2.2.1 Equipment Under Test and Modification State

Fastfind Max G S/N: TUV REF: TSR0001 - Modification State 1

2.2.2 Date of Test

16 December 2010, 20 December 2010, 4 January 2011 & 19 January 2011

2.2.3 Test Equipment Used

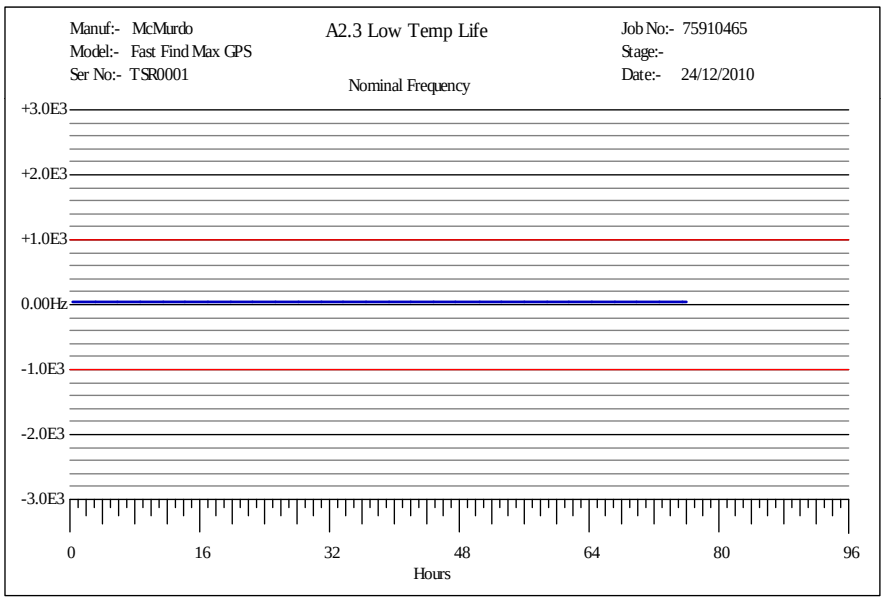
The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.4 Environmental Conditions

Ambient Temperature 20 - 22 °C
Relative Humidity 28 - 32 %

2.2.5 Test Results

Nominal Frequency



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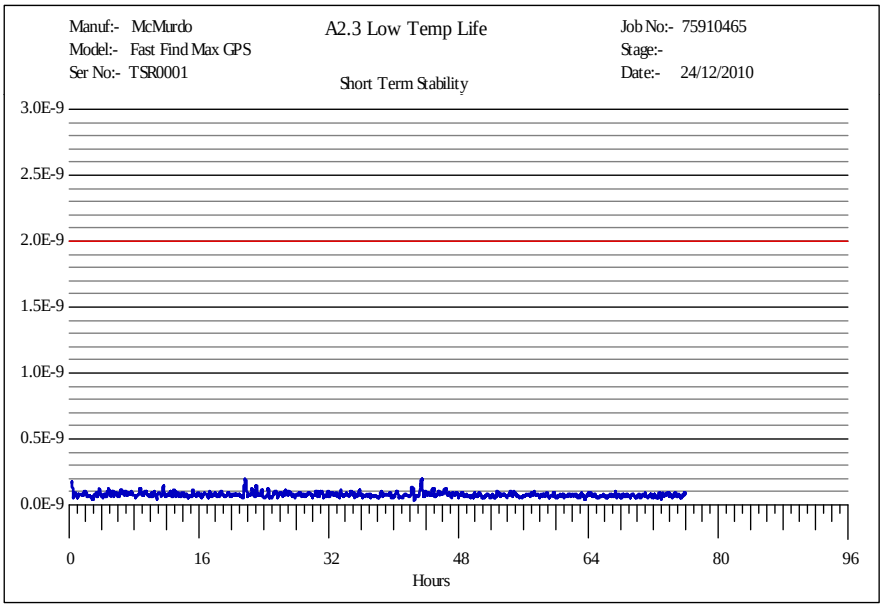
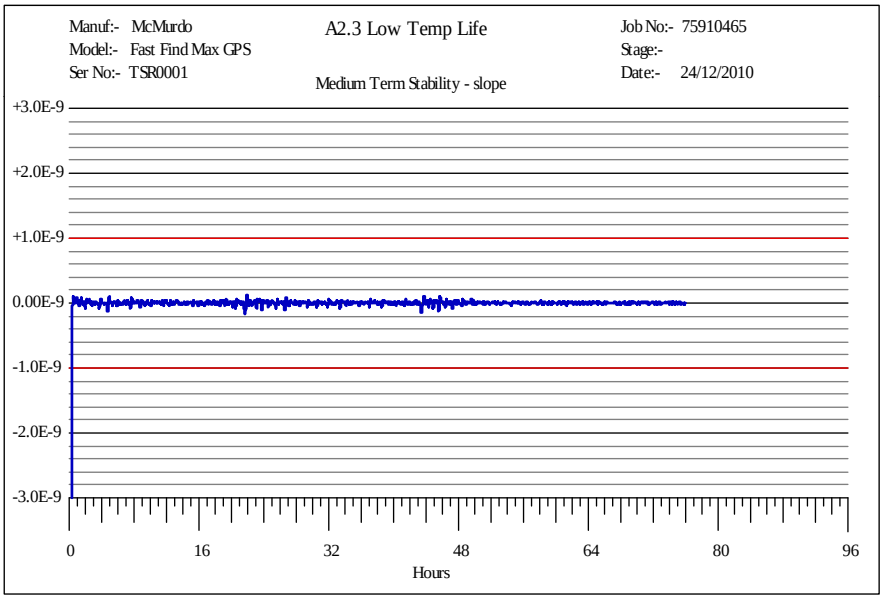
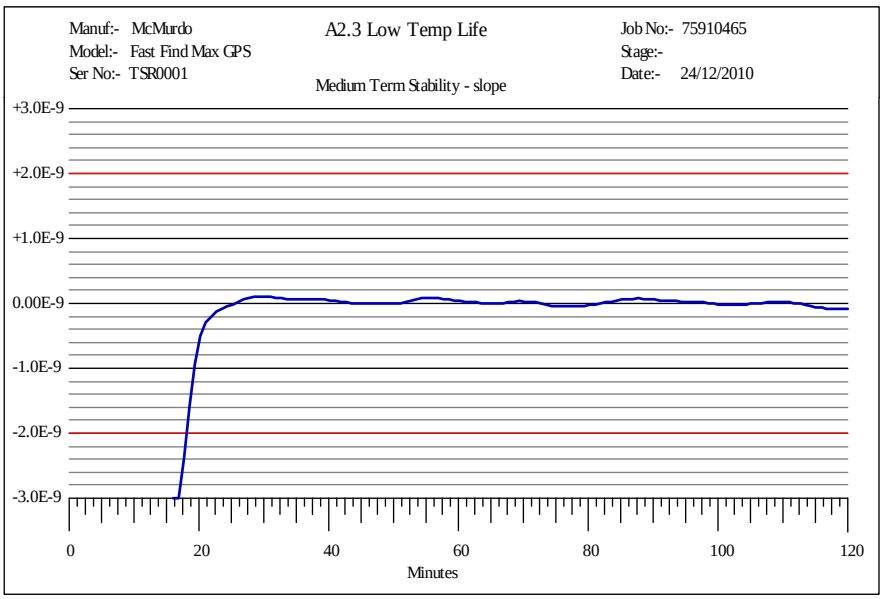
Short Term Stability



Medium Term Stability, Mean Slope

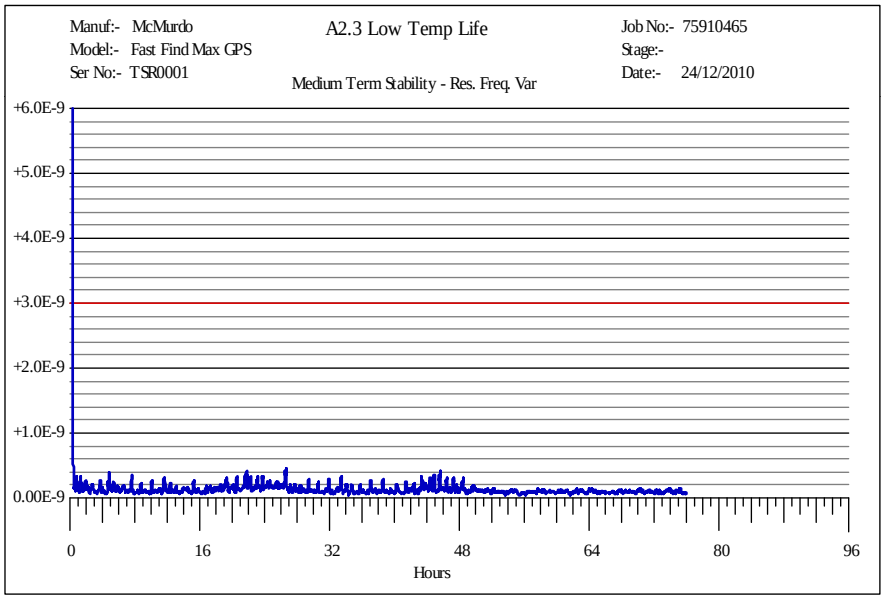


Medium Term Stability, Mean Slope (First 2 Hours)

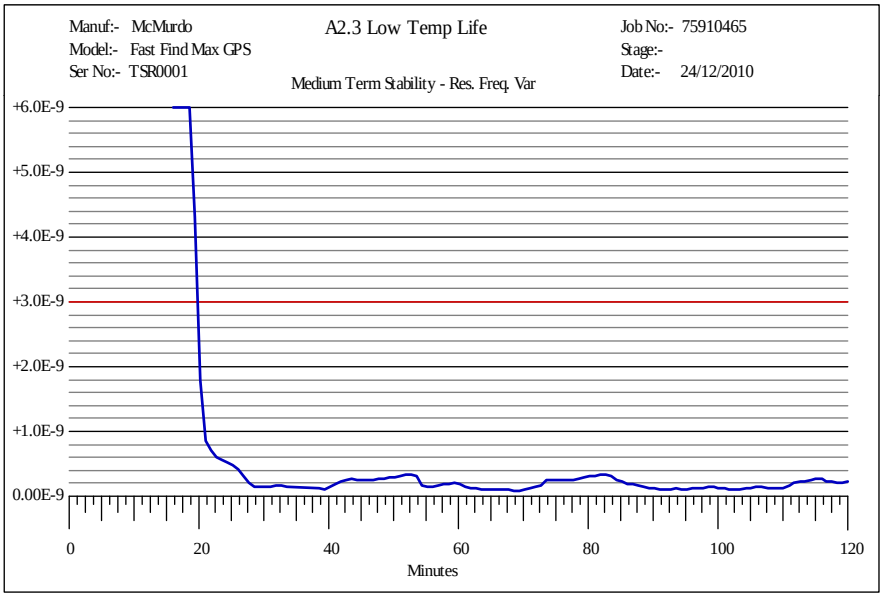


Product Service

Medium Term Stability, Residual Frequency Variation

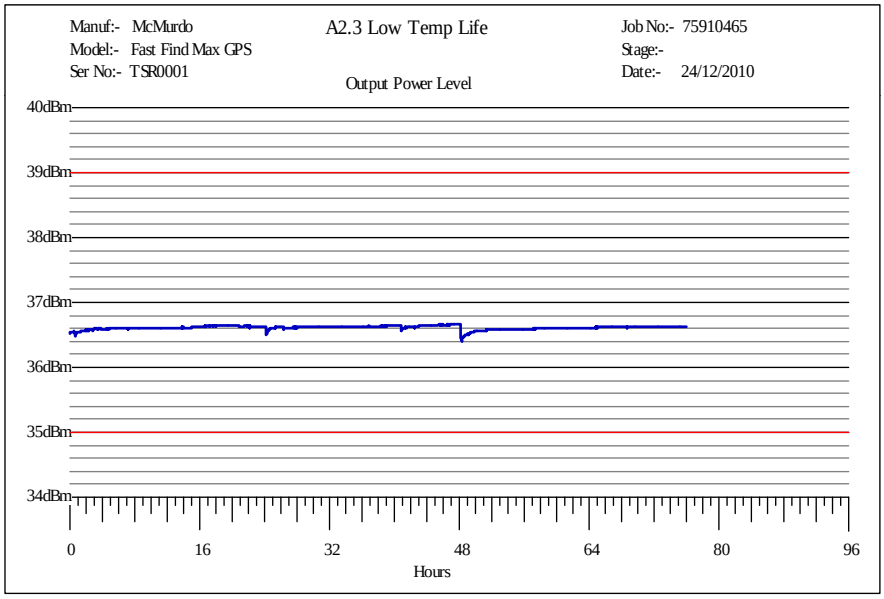


Medium Term Stability, Residual Frequency Variation (First 2 Hours)



Product Service

Output Power



Result Data (First 30 mins)

Burst No.	Freq	STS	MTS - Slope	MTS - Res	Power	Time (hrs)
1	0	0.00E+00	0.00E+00	0.00E+00	36.515	0.032135
2	0	0.00E+00	0.00E+00	0.00E+00	36.516	0.046588
3	0	0.00E+00	0.00E+00	0.00E+00	36.535	0.059826
4	0	0.00E+00	0.00E+00	0.00E+00	36.536	0.074219
5	0	0.00E+00	0.00E+00	0.00E+00	36.533	0.087539
6	0	0.00E+00	0.00E+00	0.00E+00	36.534	0.101844
7	0	0.00E+00	0.00E+00	0.00E+00	36.534	0.11523
8	0	0.00E+00	0.00E+00	0.00E+00	36.536	0.129488
9	0	0.00E+00	0.00E+00	0.00E+00	36.536	0.143003
10	0	0.00E+00	0.00E+00	0.00E+00	36.532	0.157231
11	0	0.00E+00	0.00E+00	0.00E+00	36.535	0.170764
12	0	0.00E+00	0.00E+00	0.00E+00	36.537	0.184857
13	0	0.00E+00	0.00E+00	0.00E+00	36.539	0.198468
14	0	0.00E+00	0.00E+00	0.00E+00	36.54	0.212548
15	0	0.00E+00	0.00E+00	0.00E+00	36.545	0.226215
16	0	0.00E+00	0.00E+00	0.00E+00	36.543	0.240178
17	0	0.00E+00	0.00E+00	0.00E+00	36.541	0.253928
18	4.06E+08	1.63E-10	-4.28E-09	1.26E-08	36.544	0.267864
19	4.06E+08	1.73E-10	-3.28E-09	1.11E-08	36.543	0.281697
20	4.06E+08	1.67E-10	-2.38E-09	9.27E-09	36.544	0.296159
21	4.06E+08	1.67E-10	-1.59E-09	6.91E-09	36.547	0.309414
22	4.06E+08	1.66E-10	-9.37E-10	4.32E-09	36.549	0.323798
23	4.06E+08	1.62E-10	-4.91E-10	1.80E-09	36.549	0.337179
24	4.06E+08	1.57E-10	-2.90E-10	8.52E-10	36.55	0.351471
25	4.06E+08	1.48E-10	-1.98E-10	7.01E-10	36.552	0.364909
26	4.06E+08	1.43E-10	-1.35E-10	6.08E-10	36.55	0.379201
27	4.06E+08	1.33E-10	-8.42E-11	5.56E-10	36.551	0.392674
28	4.06E+08	1.32E-10	-3.96E-11	5.19E-10	36.551	0.406831
29	4.06E+08	1.29E-10	-1.07E-11	4.84E-10	36.549	0.420343
30	4.06E+08	1.23E-10	2.34E-11	4.18E-10	36.55	0.434479
31	4.06E+08	1.11E-10	5.94E-11	3.20E-10	36.562	0.448081
32	4.06E+08	1.02E-10	8.52E-11	2.01E-10	36.559	0.462105
33	4.06E+08	1.03E-10	9.62E-11	1.52E-10	36.561	0.475794
34	4.06E+08	9.05E-11	9.77E-11	1.47E-10	36.564	0.48977
35	4.06E+08	8.03E-11	9.92E-11	1.43E-10	36.565	0.503542

Digital Message

```
================================================================================
 Beacon Id Format......... 30 Hex Id, Long Message, Bits 25-144
 15 Hex (Bits 26- 85) = 993F40018C00F9D              993F40018C00F9D Default_Id
 30 Hex (Bits 25-144) = CC9FA000C6007CE991E56FE0FF0146

   26   30   34   38   42   46   50   54   58   62   66   70   74   78   82
   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
 1 1001 1001 0011 1111 0100 0000 0000 0001 1000 1100 0000 0000 1111 1001 1101
   0011 0010 0011 1100 1010 1101 1111 1100 0001 1111 1110 0000 0010 1000 110
   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
   86   90   94   98  102  106  110  114  118  122  126  130  134  138  142

Field Name        Bit Pos    Value Decode                                Bits
----------        -------    ----- ------                                ----
Format Flag        25            1 Long Message                             1
Protocol Flag      26            1 User                                     1
MID                27- 36      201 ALBANIA                         0011 0010 01
User Protocol      37- 39        7 Test                                   111
Spare              40- 63                          1101 0000 0000 0000 0110 0011
Spare              64- 83                               0000 0000 0011 1110 0111
Homing             84- 85        1 121.5                                   01
BCH Encoded        86-106          Errors=0            0011 0010 0011 1100 1010 1
BCH Generated      86-106                              0011 0010 0011 1100 1010 1
Spare             107-126                                1011 1111 1000 0011 1111
Spare             127-144                                   1100 0000 0101 0001 10

================================================================================
```

Product Service

Battery Discharge Current

The discharge current for the batteries was measured for each of the following beacon states.

- Beacon in the Off or Standby State, "Standby Current"
- Beacon performing a Self-test, "Self-test Current"
- Beacon activated and transmitting, "Operating Current"

The individual tests were conducted for the following durations:

Standby Current	:	20	minutes		(1200240 ms)
Self-test Current	:	9.92	seconds		(9920 ms)
Operating Current	:	12	minutes		(718640 ms)

Assumptions / Supplied Data

Battery Replacement Interval	:	6 years
Battery Capacity	:	3.3 Ah
Battery Self Drain	:	1.00 % per year
Self-test Interval	:	10 tests per year

Test Results

Mode Current	=	Accumulated Charge	/	Time			
Standby Current	=	16261669 pC	/	1200240 ms	=	13.55	nA
Self-test Current	=	965474.4 uC	/	9920 ms	=	97.33	mA
Operating Current	=	23942962 uC	/	718640 ms	=	33.32	mA

Battery Preconditioning / Discharge Time Calculations

Battery Self Drain	=	Capacity - [(100% - Self Drain/Year%)$^{\text{Replacement Interval}}$ x Capacity]
	=	3.3- ((1- 0.0100) ^{6} x 3.3) = 0.1931 Ah
Standby Drain	=	Hours per year x Battery Replacement Interval x Standby Current
	=	365 x 24 x 6 x 13.55 x 10^{-9} = 0.0007 Ah
Worst Case	=	1.65 x 0.0007 Ah = 0.0012 Ah
Self-test Drain	=	Self-tests per battery x Self-test Current x Self-test duration (in hours)
	=	10 x 6 x 97.33 x 10^{-3} x (9.9 / 3600) = 0.0161 Ah
Worst Case	=	1.65 x 0.0161 Ah = 0.0266 Ah
Total Drain	=	Self Drain + Standby Drain (Worst Case) + Self-test Drain (Worst Case)
	=	0.1931 + 0.0012 + 0.0266 = 0.2208 Ah

Battery Preconditioning / Discharge Time	=	Worst Case drain / Operational Current
	=	0.2208 / (33.32 x 10^{-3})
	=	6.63 hours

Product Service

Beacon Operating Current

As per C/S T.007 Table F-E.1:

Beacon Operating Modes	Mode: Manually selectable or Automatic	Measurement Interval	Average Current, mA	Peak Current, mA
Operating - GPS Receiver Active (subject to duty cycle), 406 On, 121 On.**	Manual	76hours	33.92 note1	Not measured
Operating - GPS Receiver Active, 406 On, 121 On.	Manual	18mins	50.93	1191.16
Operating - GPS Receiver Inactive, 406 On, 121 On.*	Manual	12mins	33.12	1168.6
Operating - GPS Receiver Active for 17.5mins Inactive for 12.5mins, 406 On, 121 On.**	Manual	30mins	43.90	1191.16
Self Test	Manual	10sec***	97.33	1200.66
Standby	Automatic	20mins	13.55(nA)	19.96(nA)

At all times the sampling interval was 80 ms

* Used for battery current discharge calculation (worst case)

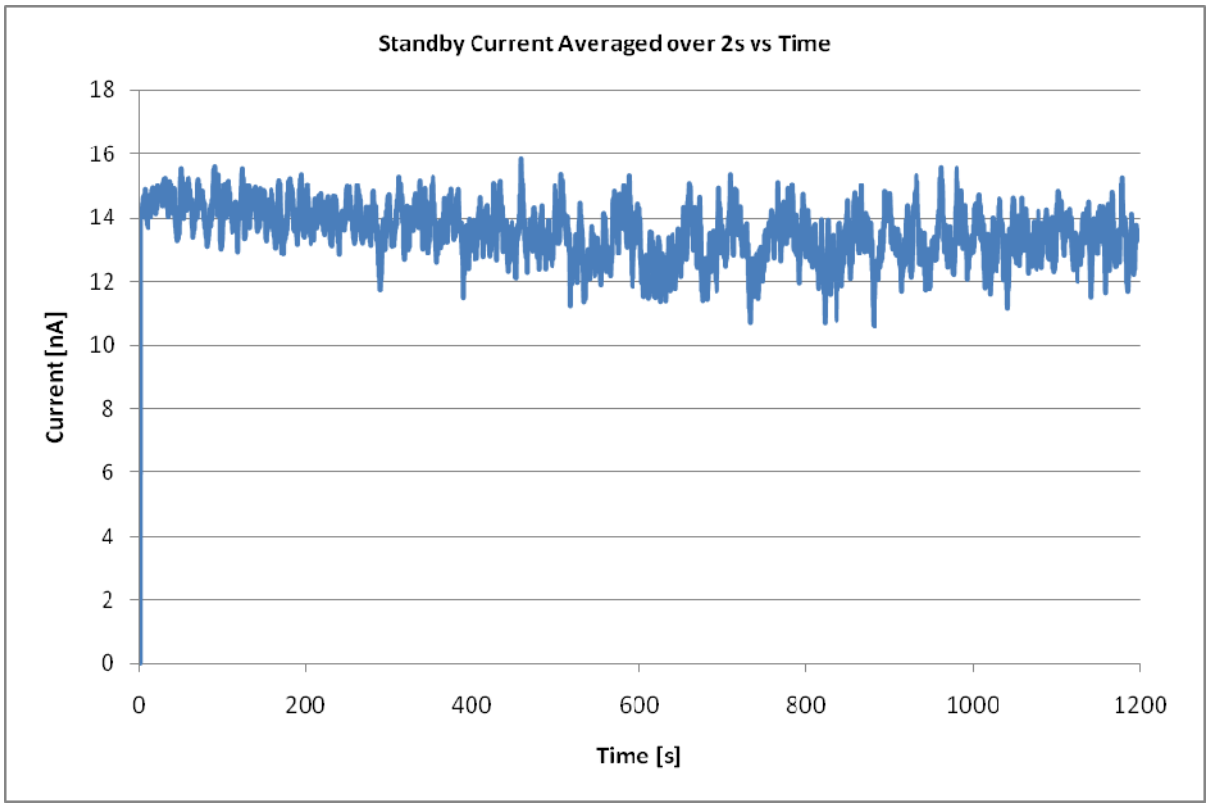
** Operating Mode during Lifetime test

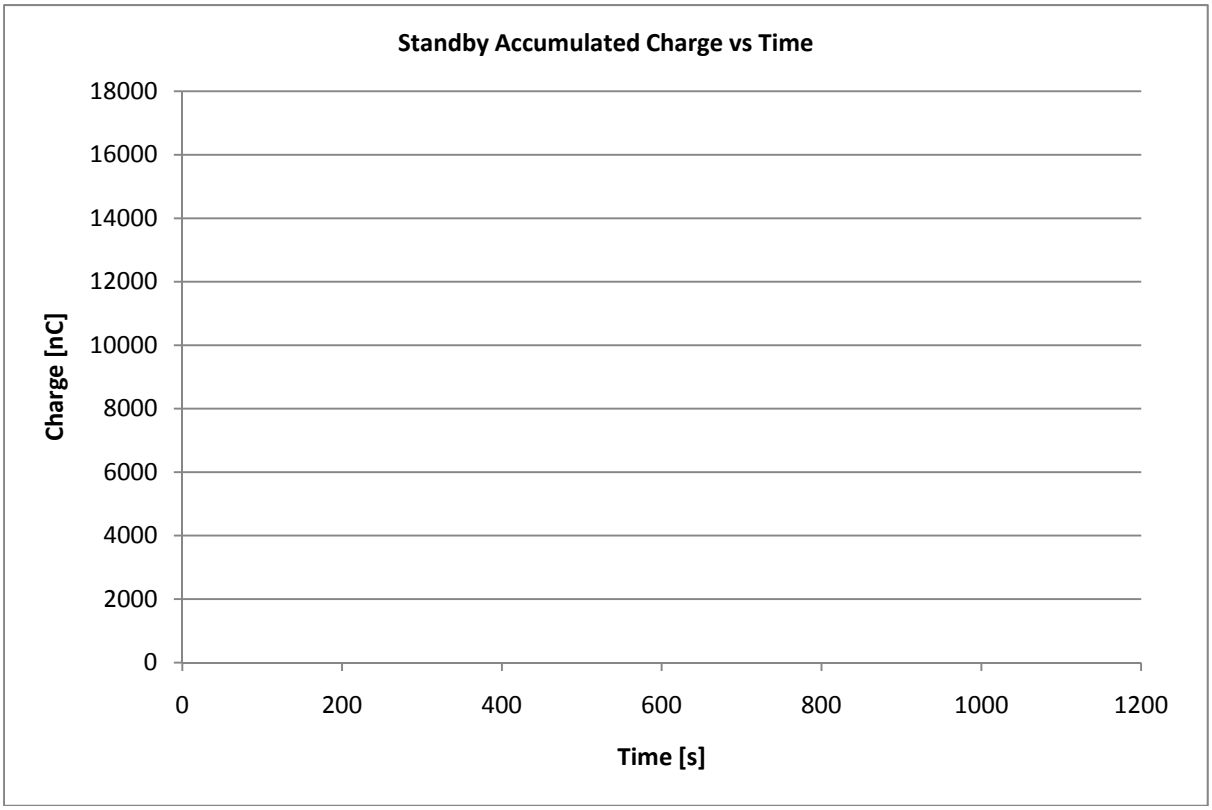
*** Recommended length of self test duration stated in manufacturers operator instructions.

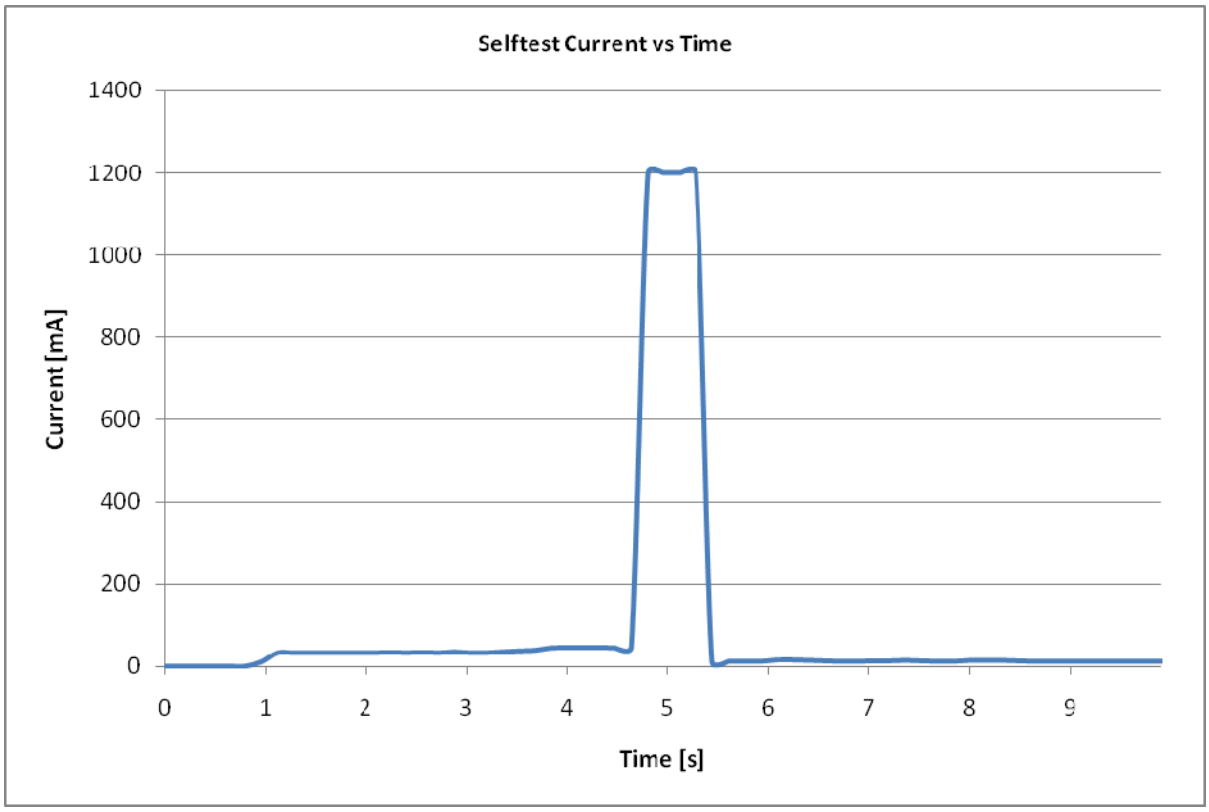
Note 1: This is an approximate calculated value over the life test of the beacon, based on customer supplied information regarding the GPS receiver duty cycle. The GPS receiver duty cycle only operates for the first 48.5 hours of the test (64% of 76 hours) and is only actually active for 7% of that time.

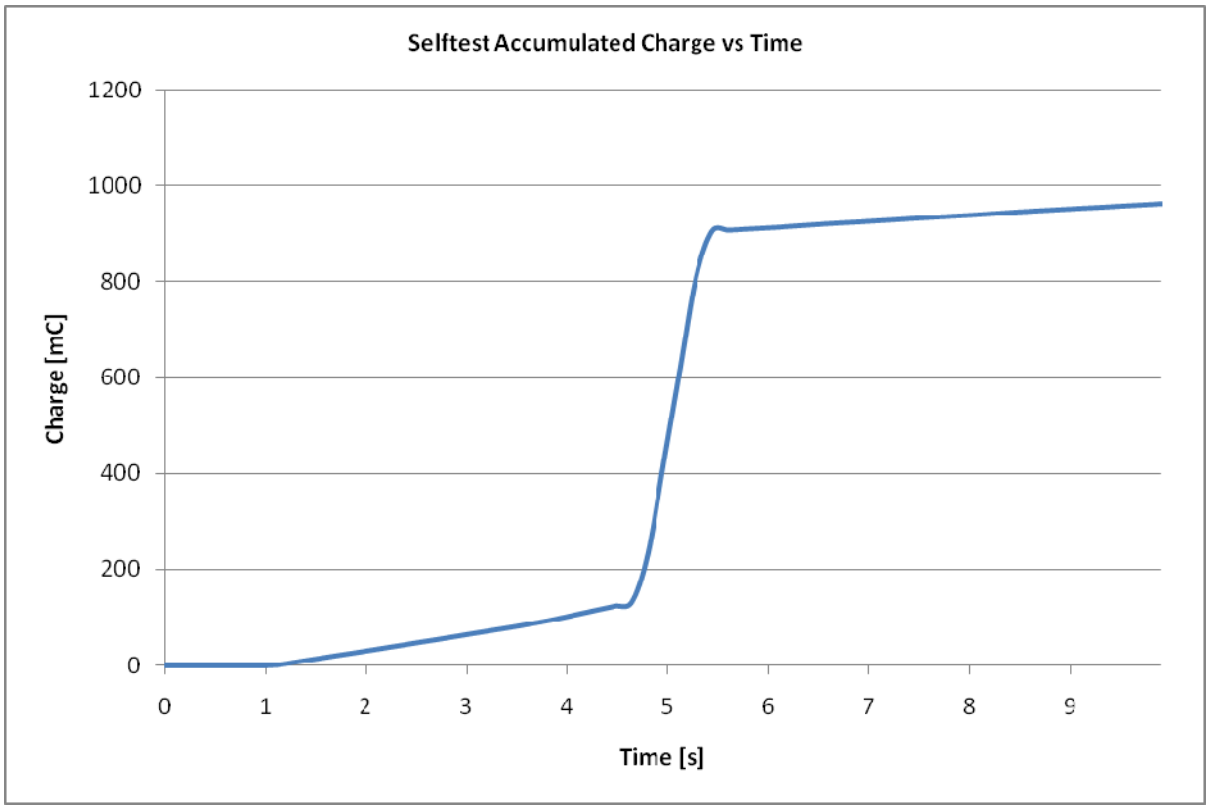
Operating Current: (50.93mA (GPS On) x 0.07(% Duty Cycle On)) + (33.12mA (GPS Off) x 0.93 (93% Duty Cycle Off)) = 34.37mA

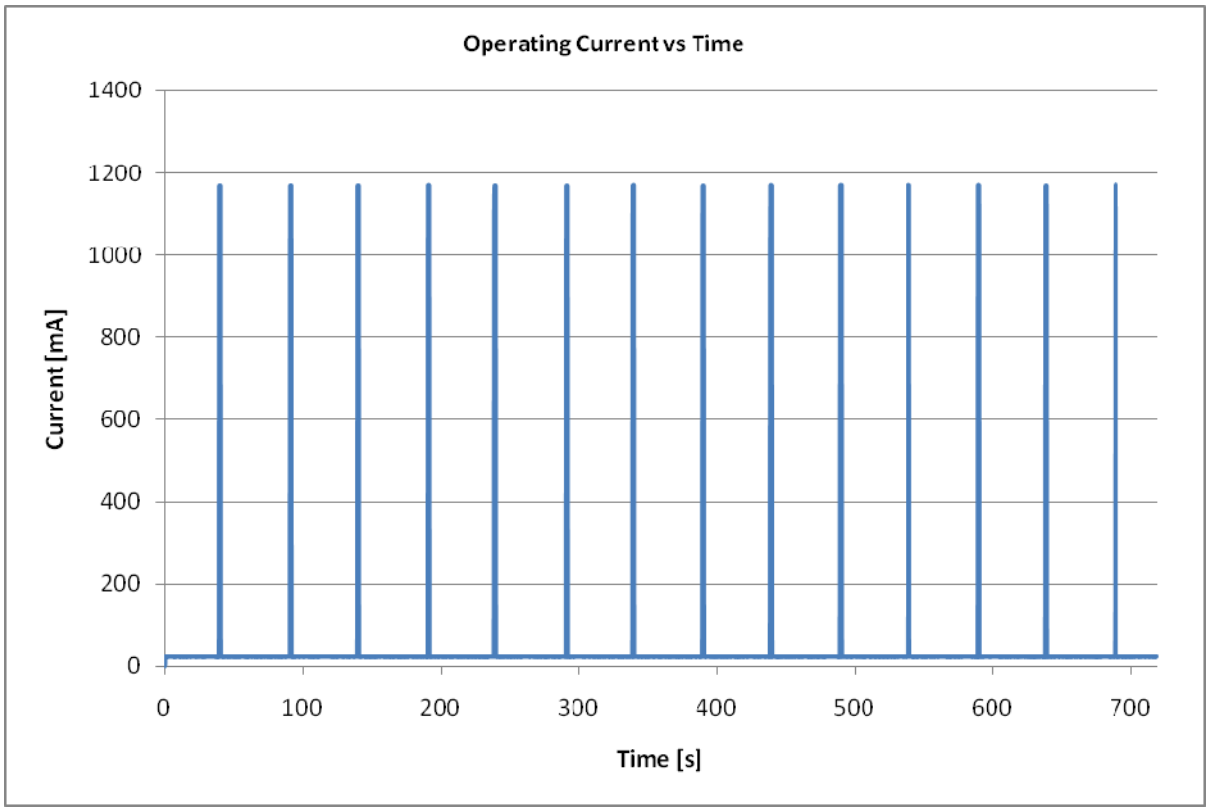
(34.37mA x 0.64 (64% of life duration)) + (33.12mA x 0.36 (36% of life duration)) = **33.92mA (Approximate overall average operating current)**

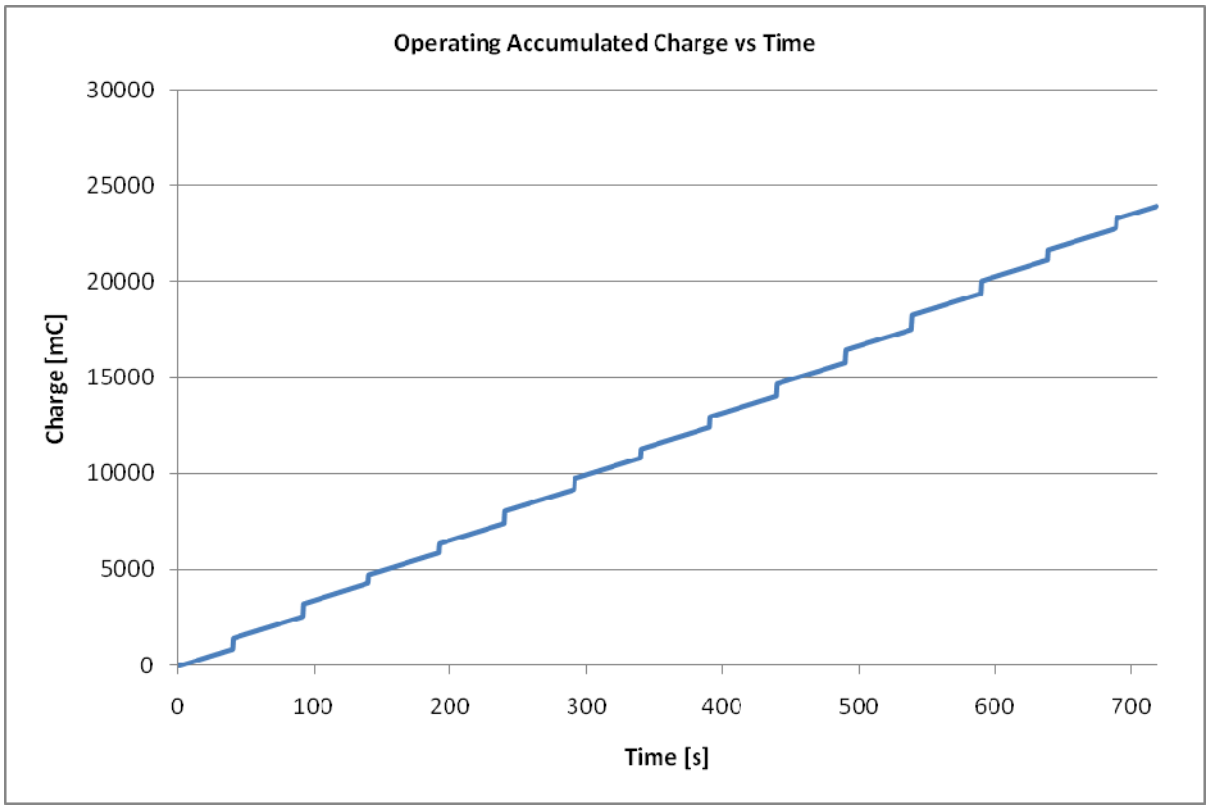

Standby Current Averaged over 2s vs Time
Current [nA]
18
16
14
12
10
8
6
4
2
0
0
200
400
600
800
1000
1200
Time [s]


Standby Accumulated Charge vs Time
Charge [nC]
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
200
400
600
800
1000
1200
Time [s]


Selftest Current vs Time
Current [mA]
1400
1200
1000
800
600
400
200
0
0
1
2
3
4
5
6
7
8
9
Time [s]


Selftest Accumulated Charge vs Time
Charge [mC]
1200
1000
800
600
400
200
0
0
1
2
3
4
5
6
7
8
9
Time [s]


Operating Current vs Time
Current [mA]
1400
1200
1000
800
600
400
200
0
0
100
200
300
400
500
600
700
Time [s]


Operating Accumulated Charge vs Time
Charge [mC]
30000
25000
20000
15000
10000
5000
0
0
100
200
300
400
500
600
700
Time [s]

2.3 TEMPERATURE GRADIENT

2.3.1 Equipment Under Test and Modification State

Fastfind Max G S/N: TUV REF: TSR0001 - Modification State 1

2.3.2 Date of Test

6 January 2011

2.3.3 Test Equipment Used

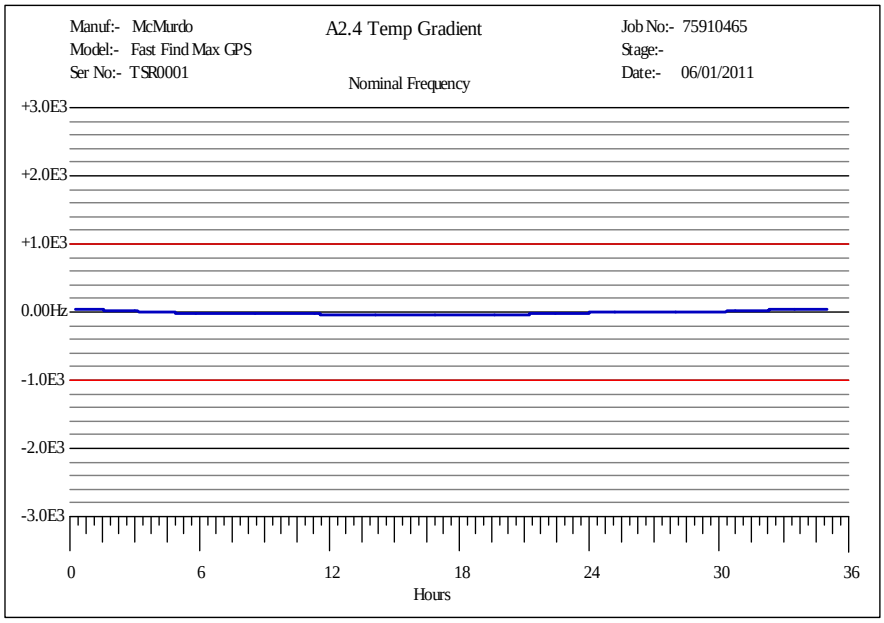
The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.4 Environmental Conditions

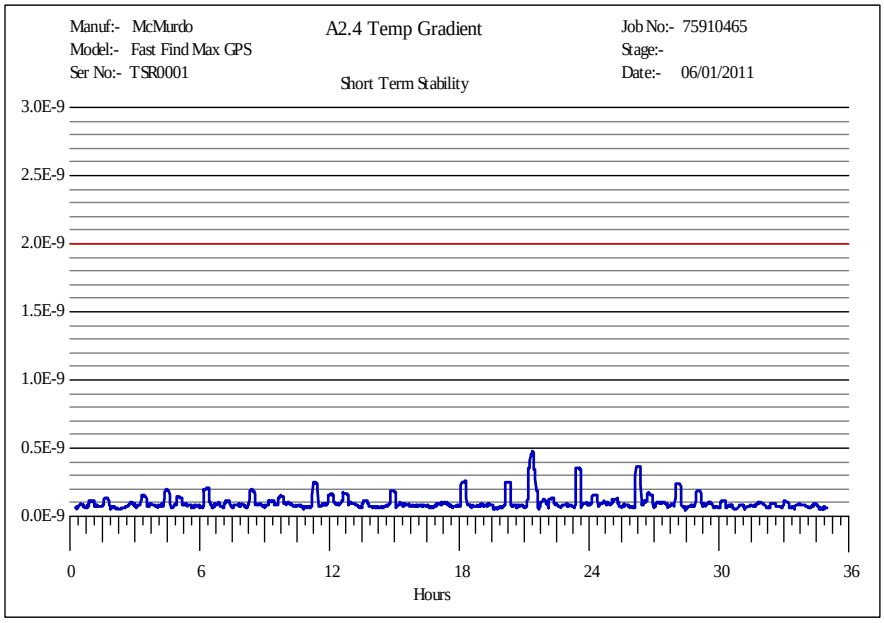
Ambient Temperature 21 °C
Relative Humidity 38 %

2.3.5 Test Results

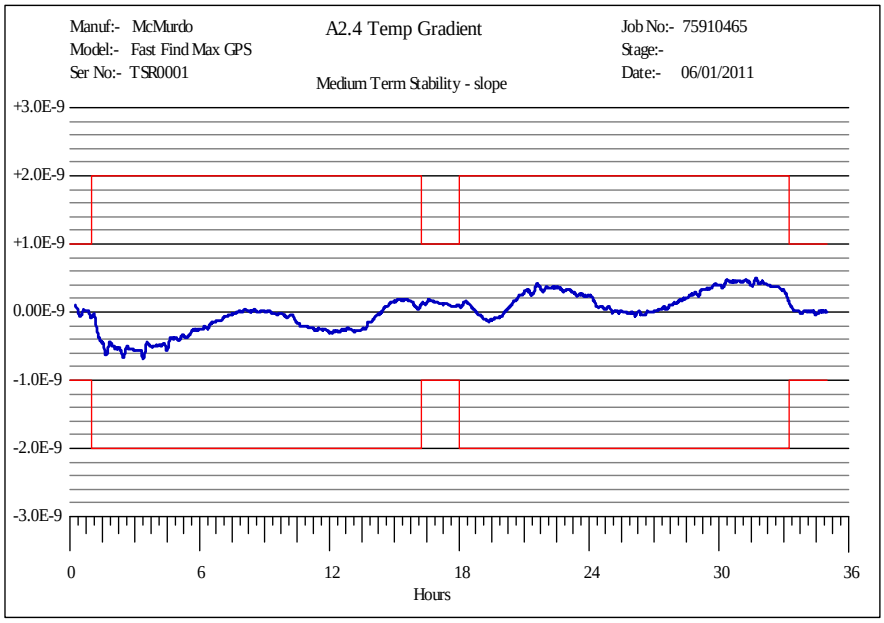
Nominal Frequency



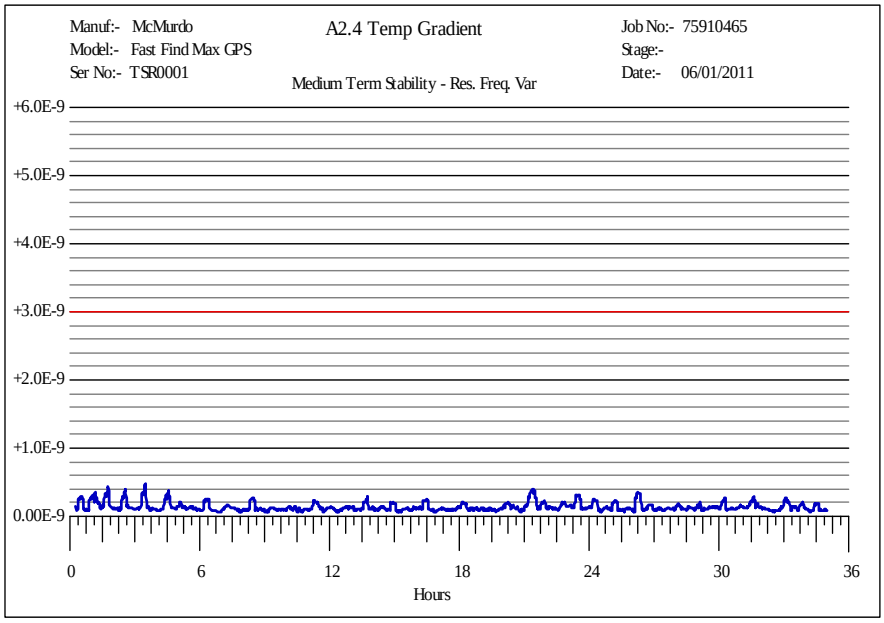
Short Term Stability



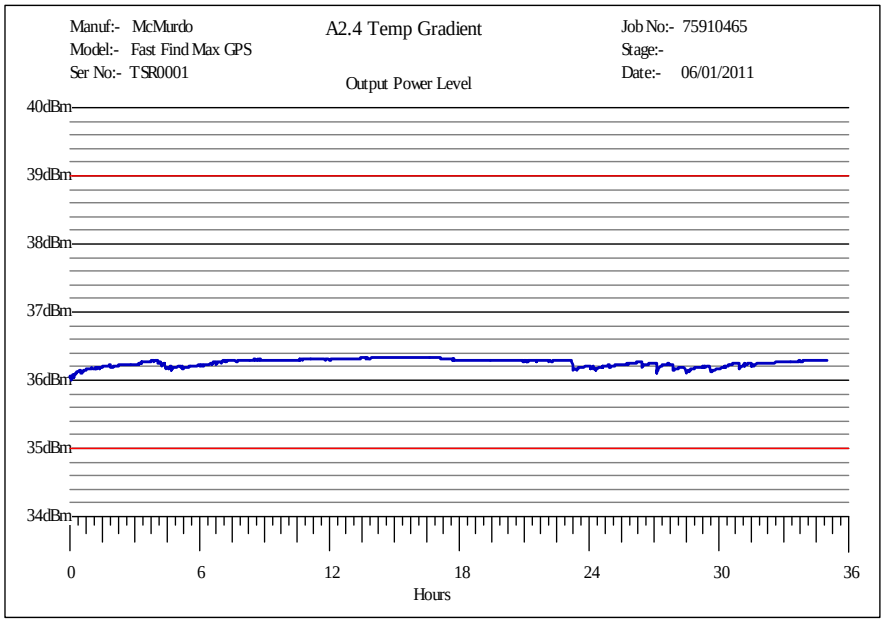
Medium Term Stability, Mean Slope



Medium Term Stability, Residual Frequency Variation



Output Power



Digital Message

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================================================================================
 Beacon Id Format......... 30 Hex Id, Long Message, Bits 25-144
 15 Hex (Bits 26- 85) = 993F40018C00F9D              993F40018C00F9D Default_Id
 30 Hex (Bits 25-144) = CC9FA000C6007CE991E56FE0FF0146

   26   30   34   38   42   46   50   54   58   62   66   70   74   78   82
   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
 1 1001 1001 0011 1111 0100 0000 0000 0001 1000 1100 0000 0000 1111 1001 1101
   0011 0010 0011 1100 1010 1101 1111 1100 0001 1111 1110 0000 0010 1000 110
   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
   86   90   94   98  102  106  110  114  118  122  126  130  134  138  142

Field Name        Bit Pos    Value Decode                                Bits
----------        -------    ----- ------                                ----
Format Flag        25            1 Long Message                             1
Protocol Flag      26            1 User                                     1
MID                27- 36      201 ALBANIA                        0011 0010 01
User Protocol      37- 39        7 Test                                  111
Spare              40- 63                          1101 0000 0000 0000 0110 0011
Spare              64- 83               0000 0000 0011 1110 0111
Homing             84- 85        1 121.5                                   01
BCH Encoded        86-106          Errors=0          0011 0010 0011 1100 1010 1
BCH Generated      86-106                            0011 0010 0011 1100 1010 1
Spare             107-126                              1011 1111 1000 0011 1111
Spare             127-144                                 1100 0000 0101 0001 10

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2.1 SATELLITE QUALITATIVE TESTS

2.1.1 Equipment Under Test and Modification State

Fastfind Max G S/N: TUV REF: TSR0001 - Modification State 0

2.1.2 Date of Test

Configuration 7: 02 and 03 June 2010
Configuration 8: 22 and 23 July 2010

2.1.3 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.4 Environmental Conditions

Ambient temperature 21 - 22 °C
Relative Humidity 41 %

2.1.5 Test Results

Configuration 7

Beacon 15 Hex ID: 193DF 380C6 FFBFF
Actual location of the test beacon: Latitude: 050° 49.091´ N
Longitude: 001° 11.870´W

Satellite ID	Satellite Pass Number	15 Hex ID Provided by LUT	Doppler Latitude	Doppler Longitude	Mean Rx Power (dBm)	TCA	CTA (deg)	Location Error (km)
S11	18784	193DF 380C6 FFBFF	50.81992	-1.19500	-123.32	22:25:48	-14.838	0.277
S9	41266	193DF 380C6 FFBFF	50.82220	-1.18964	-123.77	21:13:24	-8.717	0.728
S9	41272	193DF 380C6 FFBFF	50.80859	-1.19997	-128.33	07:42:56	-18.608	1.077
S8	49986	193DF 380C6 FFBFF	50.81777	-1.20691	-122.84	07:08:44	-3.207	0.639
S7	62677	193DF 380C6 FFBFF	50.81778	-1.19630	-124.36	06:34:25	10.040	0.117
S8	49985	193DF 380C6 FFBFF	50.81930	-1.20067	-127.87	05:27:01	-19.253	0.235
S10	25946	193DF 380C6 FFBFF	50.82240	-1.19553	-130.46	05:10:19	19.936	0.496
S7	62676	193DF 380C6 FFBFF	50.82059	-1.20661	-121.97	04:54:46	-4.989	0.672
S7	62675	193DF 380C6 FFBFF	50.82260	-1.20012	-123.64	03:13:40	-20.925	0.516
S10	25945	193DF 380C6 FFBFF	50.81894	-1.19641	-123.61	03:30:53	6.892	0.131
S12	6792	193DF 380C6 FFBFF	50.81694	-1.19635	-123.19	03:09:21	6.147	0.173
S10	25944	193DF 380C6 FFBFF	50.81729	-1.20150	-124.18	01:50:01	-8.595	0.276
S12	6791	193DF 380C6 FFBFF	50.81702	-1.20304	-123.21	01:28:23	-9.438	0.388

Ratio of Successful Solutions = $\frac{\text{number of Doppler solutions within 5km with 1°<CTA<21°}}{\text{number of satellite passes over test duration with °<CTA<21°}}$

$= \frac{13}{13} = 100\%$

Product Service

Configuration 8

Beacon 15 Hex ID: 193DF 380C6 FFBFF
Actual location of the test beacon: Latitude: 050° 49.091´ N
Longitude: 001° 11.870´W

Satellite ID	Satellite Pass Number	15 Hex ID Provided by LUT	Doppler Latitude	Doppler Longitude	Mean Rx Power (dBm)	TCA	CTA (deg)	Location Error (km)
S9	41978	193DF 380C6 FFBFF	50.81962	-1.19358	-117.67	21:45:50	-14.675	0.339
S12	7490	193DF 380C6 FFBFF	50.81808	-1.19894	-117.66	14:38:48	-15.502	0.079
S11	19494	193DF 380C6 FFBFF	50.82552	-1.19257	-118.19	21:50:23	-9.320	0.895
S11	19493	193DF 380C6 FFBFF	50.82418	-1.20532	-110.53	20:10:08	6.162	0.849
S11	19492	193DF 380C6 FFBFF	50.82105	-1.20881	-116.95	18:31:17	19.373	0.834
S9	41977	193DF 380C6 FFBFF	50.81936	-1.21982	-121.59	20:05:16	1.151	1.549
S8	50685	193DF 380C6 FFBFF	50.82377	-1.19078	-122.35	19:03:12	-8.933	0.794
S9	41976	193DF 380C6 FFBFF	50.82494	-1.21154	-124.07	18:26:06	15.352	1.221
S9	41972	193DF 380C6 FFBFF	50.82295	-1.19632	-122.94	11:57:47	19.686	0.540
S8	50684	193DF 380C6 FFBFF	50.82341	-1.20734	-121.92	17:22:26	6.550	0.885
S7	63381	193DF 380C6 FFBFF	50.82235	-1.18887	-120.48	16:43:09	-6.617	0.781
S8	50683	193DF 380C6 FFBFF	50.82353	-1.21041	-126.65	15:43:05	19.604	1.064
S7	63380	193DF 380C6 FFBFF	50.82489	-1.20721	-121.36	15:03:22	8.589	0.994
S10	26643	193DF 380C6 FFBFF	50.82243	-1.19191	-122.75	14:44:50	-13.550	0.629
S10	26642	193DF 380C6 FFBFF	50.82218	-1.20886	-118.03	13:03:32	2.313	0.893
S10	26641	193DF 380C6 FFBFF	50.81837	-1.20650	-119.09	11:23:40	16.318	0.609
S11	19488	193DF 380C6 FFBFF	50.81571	-1.19879	-119.38	12:02:16	15.174	0.283
S12	7488	193DF 380C6 FFBFF	50.82538	-1.20605	-122.07	11:17:13	14.828	0.986
S9	41984	193DF 380C6 FFBFF	50.81401	-1.18856	-122.13	08:15:29	-12.647	0.799
S8	50692	193DF 380C6 FFBFF	50.81820	-1.20994	-121.52	07:19:42	-2.682	0.850
S7	63389	193DF 380C6 FFBFF	50.82013	-1.19668	-121.84	06:33:00	9.938	0.231
S8	50691	193DF 380C6 FFBFF	50.81105	-1.19737	-124.86	05:38:02	-18.714	0.793
S7	63388	193DF 380C6 FFBFF	50.82050	-1.20717	-118.92	04:53:22	-5.101	0.704
S10	26651	193DF 380C6 FFBFF	50.81785	-1.19954	-123.38	04:41:30	16.220	0.125
S10	26650	193DF 380C6 FFBFF	50.81496	-1.18914	-120.20	03:01:38	2.201	0.708
S10	26649	193DF 380C6 FFBFF	50.81508	-1.19993	-119.31	01:20:19	-13.667	0.375
S12	7496	193DF 380C6 FFBFF	50.81635	-1.20350	-121.67	01:14:21	-11.446	0.447

Ratio of Successful Solutions = $\frac{\text{number of Doppler solutions within 5km with 1°<CTA<21°}}{\text{number of satellite passes over test duration with °<CTA<21°}}$

$= \frac{27}{27} = 100\%$

2.2 NAVIGATION SYSTEM

2.2.1 Equipment Under Test and Modification State

Fastfind Max G S/N: TUV REF: TSR0001 - Modification State 0 (A.3.8.2, SLP, C7 Only)
Fastfind Max G S/N: TUV REF: TSR0001 - Modification State 1

2.2.2 Date of Test

Modification State 0: 4 June 2010
Modification State 1: 29 July 2010, 30 July 2010, 9 November 2010, 11 November 2010, 12 November 2010, 15 November 2010, 17 November 2010 & 13 January 2011

2.2.3 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.4 Environmental Conditions

Modification State 0:
Ambient temperature 21.8 - 23.8 °C
Relative Humidity 41 - 45 %

Modification State 1:
Ambient temperature 21 °C
Relative Humidity 41 - 43 %

2.3.6 Test Results

National Protocol

Position Data Default Values (C/S T.007 A.3.8.1)

No position data was provided for > 4 hours before the test started. The beacon was activated and operated for 30 minutes without providing data. Message content was checked for all bursts during this period.

36 Hex Message	Message Count
FFFE2F8C9F0018DFC0FF04F9E4379F3C0010	35

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

Locations:

A.3.8.2.1:	50° 52.135' N	001° 14.701' W	①
A.3.8.2.2:	51° 22.583 'N	001° 49.833' W	②

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 A3.8.2.1		C/S T.007 Section A3.8.2.2	
	Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres
Configuration 7	120	109.5	120	49.5
Configuration 8	121.9	40.1	121.8	49.5

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

① GPS Site Survey – Live Location

② Input from GPS simulator

Encoded Position Data Update Interval (C/S T.007 A.3.8.3)

Location: N 51° 22.583' W 1° 49.833' ①		
Data Acquired at	12:00:07	FFFE2F8C9F0018CCD701C85E1A37920C0AB2
Location: N 21° 4.600' W 6° 3.400' ①		
Data Updated at	12:20:55	FFFE2F8C9F0018C5450611173277922408CC
Data Update Interval	20 min 48 s	

① Input from GPS simulator

Position Clearance After Deactivation (C/S T.007 A.3.8.4)

Following the Encoded Position Data Update Interval test, the beacon was deactivated and reactivated without providing navigation data. The Digital Message output was encoded with the default position data.

Last Valid Position (C/S T.007 A.3.8.6)

Location: N 51° 22.583' W 1° 49.833' ①		
Data Acquired at	11:07:03	FFFE2F8C9F0018CCD701C85E1A37920C0AB2
GPS Signal Navigation Data Removed		
Data Updated at	15:05:46	FFFE2F8C9F0018DFC0FF04F9E4379F3C0010
Last Valid Position Held	238min 43s	
Return to Default Position	✓	

① Input from GPS simulator

Standard Protocol

Position Data Default Values (C/S T.007 A.3.8.1)

No position data was provided for > 4 hours before the test started. The beacon was activated and operated for 30 minutes without providing data. Message content was checked for all bursts during this period.

36 Hex Message	Message Count
FFFE2F8C9EF9C0637FDFF83D15B783E0F66C	36

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

Locations:

A.3.8.2.1:	50° 52.135' N	001° 14.701' W	①
A.3.8.2.2:	51° 22.583 'N	001° 49.833' W	②

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 A3.8.2.1		C/S T.007 Section A3.8.2.2	
	Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres
Configuration 7	120	61.9	120	49.8
Configuration 8	121.6	32.8	121.6	50.1

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

① GPS Site Survey – Live Location

② Input from GPS simulator

Encoded Position Data Update Interval (C/S T.007 A.3.8.3)

Location: N 51° 22.583' W 1° 49.833' ①		
Data Acquired at	09:28:27	FFFE2F8C9EF9C06333A03ECA66771DA4D4D0
Location: N 21° 4.600' W 6° 3.400' ①		
Data Updated at	10:10:01	FFFE2F8C9EF9C0631520C69510B792636F3C
Data Update Interval	41 min 34 s	

① Input from GPS simulator

Position Clearance After Deactivation (C/S T.007 A.3.8.4)

Following the Encoded Position Data Update Interval test, the beacon was deactivated and reactivated without providing navigation data. The Digital Message output was encoded with the default position data.

Last Valid Position (C/S T.007 A.3.8.6)

Location: N 51° 22.583' W 1° 49.833' ①		
Data Acquired at	11:58:59	FFFE2F8C9EF9C06333A03ECA66771DA4D4D0
GPS Signal Navigation Data Removed		
Data Updated at	15:57:43	FFFE2F8C9EF9C0637FDFF83D15B783E0F66C
Last Valid Position Held	238min 44s	
Return to Default Position	✓	

① Input from GPS simulator

User Protocol

Position Data Default Values (C/S T.007 A.3.8.1)

No position data was provided for > 4 hours before the test started. The beacon was activated and operated for 30 minutes without providing data. Message content was checked for all bursts during this period.

36 Hex Message	Message Count
FFFE2FCC9FA000C6007CE991E56FE0FF0146	35

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

Locations:

A.3.8.2.1:	50° 52.131' N	001° 14.694' W	①
A.3.8.2.2:	51° 22.583 'N	001° 49.833' W	②

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 A3.8.2.1		C/S T.007 Section A3.8.2.2	
	Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres
Configuration 7	172	1587.4	120	3372.8
Configuration 8	121.6	1545.2	174.6	3372.8

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

① GPS Site Survey – Live Location

② Input from GPS simulator

Encoded Position Data Update Interval (C/S T.007 A.3.8.3)

Location: N 51° 22.583' W 1° 49.833' ①		
Data Acquired at	10:20:31	FFFE2FCC9FA000C6007CE991E5666D01C026
Location: N 21° 4.600' W 6° 3.400' ①		
Data Updated at	11:02:56	FFFE2FCC9FA000C6007CE991E562A3061E74
Data Update Interval	42 min 25 s	

① Input from GPS simulator

Position Clearance After Deactivation (C/S T.007 A.3.8.4)

Following the Encoded Position Data Update Interval test, the beacon was deactivated and reactivated without providing navigation data. The Digital Message output was encoded with the default position data.

Last Valid Position (C/S T.007 A.3.8.6)

Location: N 51° 22.583' W 1° 49.833' ①		
Data Acquired at	11:53:17	FFFE2FCC9FA000C6007CE991E5666D01C026
GPS Signal Navigation Data Removed		
Data Updated at	15:51:59	FFFE2FCC9FA000C6007CE991E56FE0FF0146
Last Valid Position Held	238min 42s	
Return to Default Position	✓	

① Input from GPS simulator

SECTION 3

FASTFIND MAX (NON GPS VARIANT) TESTING

3.1 SATELLITE QUALITATIVE TESTS

3.1.1 Equipment Under Test and Modification State

Fastfind Max S/N: 001 - Modification State 0

3.1.2 Date of Test

Configuration 7: 25 and 26 October 2010
Configuration 8: 26 and 27 October 2010

3.1.3 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

3.1.4 Environmental Conditions

Ambient temperature 12.2 - 15 °C
Relative Humidity 47 - 71 %

3.1.5 Test Results

Product Service

Configuration 7

Test Start: 2010-10-25 14:10 GMT
Test End: 2010-10-26 08:00 GMT
15 Hex ID: 993F4 0018C 00F9D

Actual location of the test: N 50° 52.121´
(TÜV Product Service Ltd, Fareham Site) W 1° 14.685´

Satellite ID	Satellite Pass Number	15 Hex ID provided by LUT	Doppler Latitude	Doppler Longitude	Mean Rx Power (dBm)	TCA	CTA (deg)	Location Error (km)
S8	52033	993F4 0018C 00F9D	50.81673	-1.20189	-129.44	06:58:55	-8.179	0.327
S7	64742	993F4 0018C 00F9D	50.81489	-1.18949	-129.97	06:48:33	12.235	0.691
S7	64741	993F4 0018C 00F9D	50.81606	-1.20415	-127.39	05:09:08	-2.481	0.502
S12	8838	993F4 0018C 00F9D	50.81359	-1.20795	-136.36	04:56:47	20.709	0.875
S10	27991	993F4 0018C 00F9D	50.81609	-1.20109	-131.07	04:34:17	14.687	0.326
S7	64740	993F4 0018C 00F9D	50.82251	-1.20015	-131.64	03:28:17	-18.393	0.508
S12	8837	993F4 0018C 00F9D	50.81666	-1.19213	-128.19	03:17:24	7.858	0.435
S12	8836	993F4 0018C 00F9D	50.81680	-1.20217	-129.40	01:36:37	-7.554	0.341
S10	27989	993F4 0018C 00F9D	50.81289	-1.19923	-132.40	01:12:45	-15.616	0.596
S7	64734	993F4 0018C 00F9D	50.82200	-1.19073	-127.37	16:59:03	-9.301	0.655
S11	20844	993F4 0018C 00F9D	50.82148	-1.19269	-128.70	22:24:29	-14.910	0.514
S9	43330	993F4 0018C 00F9D	50.82207	-1.19147	-130.78	21:24:55	-12.976	0.621
S11	20842	993F4 0018C 00F9D	50.80527	-1.24190	-128.27	19:04:25	15.164	3.411
S8	52027	993F4 0018C 00F9D	50.81752	-1.19414	-135.01	20:24:10	-19.462	0.270
S9	43329	993F4 0018C 00F9D	50.82389	-1.20201	-129.06	19:44:30	2.755	0.699
S8	52026	993F4 0018C 00F9D	50.82440	-1.18748	-129.51	18:42:26	-3.414	1.003
S9	43328	993F4 0018C 00F9D	50.82734	-1.20913	-134.11	18:05:29	16.688	1.290
S8	52025	993F4 0018C 00F9D	50.82393	-1.20445	-130.28	17:02:09	11.452	0.790
S7	64733	993F4 0018C 00F9D	50.82387	-1.20784	-127.52	15:19:02	6.152	0.945
S12	8830	993F4 0018C 00F9D	50.81931	-1.18947	-135.05	15:01:13	-19.414	0.600
S10	27983	993F4 0018C 00F9D	50.82532	-1.18464	-129.88	14:37:24	-11.646	1.219

$$\text{Ratio of Successful Solutions} = \frac{\text{number of Doppler solutions within 5 km with } 1^\circ<\text{CTA}<21^\circ}{\text{number of satellite passes over test duration with } 1^\circ<\text{CTA}<21^\circ}$$

$$= \frac{21}{21}$$

$$= 100\ \%$$

Product Service

Configuration 8

Test Start: 2010-10-26 10:00 GMT
Test End: 2010-10-27 10:00 GMT
15 Hex ID: 993F4 0018C 00F9D

Actual location of the test: N 50° 52.121´
(TÜV Product Service Ltd, Fareham Site) W 1° 14.685´

Satellite ID	Satellite Pass Number	15 Hex ID provided by LUT	Doppler Latitude	Doppler Longitude	Mean Rx Power (dBm)	TCA	CTA (deg)	Location Error (km)
S8	52049	993F4 0018C 00F9D	50.82147	-1.20276	-133.86	10:07:17	18.778	0.503
S10	28010	993F4 0018C 00F9D	50.83452	-1.17779	-137.41	12:34:58	7.227	2.297
S11	20866	993F4 0018C 00F9D	50.81590	-1.20135	-132.85	11:54:41	14.253	0.354
S12	8852	993F4 0018C 00F9D	50.82201	-1.19042	-133.88	04:46:36	19.567	0.672
S12	8851	993F4 0018C 00F9D	50.81703	-1.42782	-130.93	03:07:06	6.222	16.147
S9	43352	993F4 0018C 00F9D	50.81693	-1.20311	-136.00	10:51:08	12.568	0.396
S11	20864	993F4 0018C 00F9D	50.81449	-1.20032	-128.45	08:34:25	-16.005	0.446
S9	43351	993F4 0018C 00F9D	50.81661	-1.20844	-133.18	09:11:41	-2.142	0.765
S8	52048	993F4 0018C 00F9D	50.81897	-1.19868	-130.67	08:27:49	5.481	0.106
S9	43350	993F4 0018C 00F9D	50.81319	-1.19764	-132.54	07:30:47	-18.057	0.555
S8	52047	993F4 0018C 00F9D	50.81467	-1.20345	-134.47	06:46:57	-10.099	0.555
S7	64756	993F4 0018C 00F9D	50.81671	-1.20411	-129.74	06:24:46	8.896	0.470
S7	64755	993F4 0018C 00F9D	50.81395	-1.20328	-128.40	04:45:01	-6.263	0.606
S10	28005	993F4 0018C 00F9D	50.81565	-1.20176	-131.41	04:23:44	13.290	0.394
S10	28004	993F4 0018C 00F9D	50.81871	-1.21513	-131.54	02:43:32	-1.326	1.216
S12	8850	993F4 0018C 00F9D	50.81627	-1.20182	-134.17	01:26:08	-9.207	0.351
S10	28003	993F4 0018C 00F9D	50.81079	-1.20066	-133.96	01:01:53	-17.340	0.845
S11	20858	993F4 0018C 00F9D	50.82366	-1.19138	-126.90	22:03:32	-11.590	0.759
S11	20857	993F4 0018C 00F9D	50.80176	-1.23960	-129.18	20:23:05	4.088	3.454
S9	43344	993F4 0018C 00F9D	50.82321	-1.19111	-130.75	21:01:18	-9.250	0.731
S11	20856	993F4 0018C 00F9D	50.82135	-1.21411	-128.36	18:44:03	17.702	1.196
S8	52041	993F4 0018C 00F9D	50.82238	-1.18858	-133.22	20:12:05	-17.544	0.800
S9	43343	993F4 0018C 00F9D	50.82662	-1.19911	-131.86	19:21:13	6.223	0.942
S8	52040	993F4 0018C 00F9D	50.82370	-1.19732	-131.52	18:30:31	-1.535	0.614
S9	43342	993F4 0018C 00F9D	50.83167	-1.17069	-138.39	17:42:31	19.446	2.424
S8	52039	993F4 0018C 00F9D	50.82760	-1.20816	-135.23	16:50:24	13.059	1.273
S7	64748	993F4 0018C 00F9D	50.82404	-1.19225	-129.76	16:34:52	-5.480	0.760
S7	64747	993F4 0018C 00F9D	50.82408	-1.20364	-128.49	14:55:11	9.600	0.772
S12	8844	993F4 0018C 00F9D	50.82108	-1.19273	-132.75	14:50:38	-17.759	0.482
S10	27997	993F4 0018C 00F9D	50.82430	-1.19061	-128.72	14:26:35	-9.921	0.848
S12	8843	993F4 0018C 00F9D	50.82017	-1.20082	-127.26	13:08:54	-1.710	0.305
S10	27996	993F4 0018C 00F9D	50.82613	-1.20362	-127.98	12:45:37	5.682	0.972
S10	27995	993F4 0018C 00F9D	50.82205	-1.20777	-128.57	11:06:03	19.003	0.819
S11	20852	993F4 0018C 00F9D	50.81855	-1.19851	-126.73	12:15:04	16.866	0.063
S12	8842	993F4 0018C 00F9D	50.82337	-1.20772	-128.86	11:28:38	12.989	0.902
S9	43338	993F4 0018C 00F9D	50.81648	-1.19825	-129.40	11:14:13	15.622	0.191
S11	20851	993F4 0018C 00F9D	50.81644	-1.19274	-122.88	10:35:56	3.034	0.407
S8	52035	993F4 0018C 00F9D	50.81302	-1.19781	-131.55	10:18:55	20.126	0.574

Ratio of Successful Solutions $= \frac{\text{number of Doppler solutions within 5 km with } 1° < CTA < 21°}{\text{number of satellite passes over test duration with } 1° < CTA < 21°}$

$= \frac{37}{38}$

$= 97.4\ \%$

SECTION 4

TEST EQUIPMENT USED

4.1 TEST EQUIPMENT

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

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Section x.x Beacons - Battery Current Measurements					
Hygrometer	Rotronic	I-1000	3068	12	10-Jul-2011
8 Channel Datalogger + Terminal Board	Pico Technology Ltd	ADC-16	3287	12	17-Dec-2011
Resistor (Nominal 0.25ohm)	TUV	2x RS Components 188-071 R5/100W Resistors	3343	12	21-Oct-2011
Section x.x Beacons - Navigation System					
Beacon Tester	WS Technologies	BT 100S	87	-	TU
GPS/SBAS Simulator	Spirent	STR4500	3056	-	TU
Copper GRP	TUV	27cm Diameter	3538	-	TU
Section x.x Beacons - Operating Lifetime					
Climatic Chamber	Heraeus Votsch	VMT 04/30	40	-	O/P Mon
Power Meter	Hewlett Packard	436A	83	12	17-Aug-2011
Signal Generator (100kHz to 2.6GHz)	Hewlett Packard	8663A	1063	12	17-Feb-2011
Beacon RF Unit	TUV	N/A	3066	-	TU
Hygrometer	Rotronic	I-1000	3068	12	10-Jul-2011
Termination (50ohm, 0.5W)	Hewlett Packard	HP11593A	3086	-	TU
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3159	12	10-Jun-2011
Attenuator (3dB, 20W)	Aeroflex / Weinschel	23-03-34	3162	12	23-Jun-2011
Bandpass Filter	Trilithic	5BE406/35-1-AA	3207	12	13-Aug-2011
Time Interval Analyser	Yokogawa	TA720 704510	3253	12	8-Nov-2011
ScopeCorder	Yokogawa	DL750 701210	3254	12	8-Nov-2011
Power Sensor	Agilent	8482A	3289	12	8-Dec-2011
Cable (1m, N Type)	Rhophase	NPS-1601-1000-NPS	3353	12	20-Apr-2011
Cable (1m, N Type)	Rhophase	NPS-1601-1000-NPS	3354	12	20-Apr-2011
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3355	12	20-Apr-2011
Section x.x Beacons - Satellite Qualitative Test					
Beacon Tester	WS Technologies	BT 100S	87	-	TU
Copper GRP	TUV	27cm Diameter	3538	-	TU
Section x.x Beacons - Temperature Gradient					
Power Meter	Hewlett Packard	436A	83	12	17-Aug-2011
Climatic Chamber	Heraeus Votsch	VM 04/100	85	-	O/P Mon
Signal Generator (100kHz to 2.6GHz)	Hewlett Packard	8663A	1063	12	17-Feb-2011
Beacon RF Unit	TUV	N/A	3066	-	TU
Hygrometer	Rotronic	I-1000	3068	12	10-Jul-2011
Termination (50ohm, 0.5W)	Hewlett Packard	HP11593A	3086	-	TU
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3159	12	10-Jun-2011

Attenuator (3dB, 20W)	Aeroflex / Weinschel	23-03-34	3162	12	23-Jun-2011
Bandpass Filter	Trilithic	5BE406/35-1-AA	3207	12	13-Aug-2011
Time Interval Analyser	Yokogawa	TA720 704510	3253	12	8-Nov-2011
ScopeCorder	Yokogawa	DL750 701210	3254	12	8-Nov-2011
Power Sensor	Agilent	8482A	3289	12	8-Dec-2011
Cable (1m, N Type)	Rhophase	NPS-1601-1000-NPS	3354	12	20-Apr-2011
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3355	12	20-Apr-2011
Cable (2m, N Type)	Rhophase	NPS-1601-2000-NPS	3356	12	20-Apr-2011
Section x.x Beacons - Thermal Shock					
Climatic Chamber	Heraeus Votsch	VMT 04/30	40	-	O/P Mon
Power Meter	Hewlett Packard	436A	83	12	17-Aug-2011
Attenuator 10dB/10W)	Trilithic	HFP-50N	454	12	21-Jul-2011
Signal Generator (100kHz to 2.6GHz)	Hewlett Packard	8663A	1063	12	17-Feb-2011
Beacon RF Unit	TUV	N/A	3066	-	TU
Hygrometer	Rotronic	I-1000	3068	12	10-Jul-2011
Termination (50ohm, 0.5W)	Hewlett Packard	HP11593A	3086	-	TU
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3159	12	10-Jun-2011
Attenuator (3dB, 20W)	Aeroflex / Weinschel	23-03-34	3162	12	23-Jun-2011
Bandpass Filter	Trilithic	5BE406/35-1-AA	3207	12	13-Aug-2011
Time Interval Analyser	Yokogawa	TA720 704510	3253	12	8-Nov-2011
ScopeCorder	Yokogawa	DL750 701210	3254	12	8-Nov-2011
Power Sensor	Agilent	8482A	3289	12	8-Dec-2011
Cable (1m, N Type)	Rhophase	NPS-1601-1000-NPS	3354	12	20-Apr-2011

TU – Traceability Unscheduled

SECTION 5

PHOTOGRAPHS

5.1 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

Front View with antenna raised

Rear View

Configuration 7

Configuration 8

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

Customer Supplied Information

Product Service

mcmurdo
EMERGENCY LOCATION BEACONS

Statement on protection against beacon degradation due to internal navigation device failure

The internal GPS navigation device is an NEO-6M 50-channel module made by uBlox in the Switzerland.

Software protection:

The positional data is sent from the GPS module in serial NMEA format. This data is checked for validity by examining the message field quality bit and calculated HDOP (Horizontal dilution of precision) figure. The quality bit is calculated by the GPS module to determine the quality of the position fix and requires three or more satellites with good signal to noise ratios. The HDOP figure is calculated from the relative geometry of the satellites used to determine the position fix. The smaller the figure the better the positional accuracy. The software rejects position fixes with a HDOP figure greater than 20. This figure being derived from extensive trials work.

With these checks in place it is considered unlikely that false position data could be encoded in the 406MHz message.

If no valid GPS data is available, the beacon will revert to transmitting default position data.

Hardware protection:

The serial NMEA data is input to the micro-controller, this input is only connected to the GPS module. If the uBlox GPS module fails in such a way to output incorrect logic levels, this input is protected by diodes from excessive voltage on the input. A fault on the NMEA line will not inhibit normal operation of the beacon.

The GPS module is not continuously powered in order to comply with the maximum positional update rate defined in C/S T.001. Hence in any one hour, at least 64 406MHz transmissions are made with the GPS module in-active.

The GPS module is supplied by P-channel logic level FET, which is enabled or disabled by a discrete control line from the microprocessor.

Neil Jordan
Engineering Manager
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McMurdo Ltd.
Registered in England No. 06952856 Registered Office: Silver Point, Airport Service Road, Portsmouth PO3 5PB
VAT NO GB 980 2079 17

Annex B

Interim TCXO Procedure

Product Service

Interim Procedure for the Determination of Compliance of 406 MHz Beacons equipped with a TCXO with Cospas-Sarsat Type Approval Requirements

Two data sets, Temperature Gradient Test Data (see section 2.3) and TCXO Manufacturer Data (file reference "E5344 Date Code JG Serial Number 6178.xlsx"), were combined and 'synchronised' based on time into the Temperature Gradient profile.

Data synchronised was:

R_{tot} The Medium Term Stability – Residual Frequency Variation measured during the Temperature Gradient test

R_{osc} The Medium Term Stability – Residual Frequency Variation provided for the specific oscillator in the beacon tested

S_{tot} the Medium Term Stability – Slope measured during the Temperature Gradient test

S_{osc} The Medium Term Stability – Slope provided for the specific oscillator in the beacon tested

The individual data pair matching and the following calculations can be found in the supporting Document 75910465 Spreadsheet CS IP TCXO Rev 1 Spreadsheet.xlsx.

NB: The values shown in the calculation steps herein are displayed rounded to 3 decimal places. For the actual calculation the **unrounded** value is used, using the rounded figure may provide different values.

1. Residual Component of the Medium-Term Frequency Stability

The contribution of the beacon design (R_{beacon}) was calculated for each matched data pair as per the following equation:

$$R_{\text{beacon}} = \sqrt{{R_{\text{tot}}}^2 - {R_{\text{osc}}}^2}$$

If R_{osc} was greater than R_{tot}, then allowance was made for measurement inaccuracies by adding/subtracting the measurement uncertainty contained within document C/S T.008 from R_{tot} /R_{osc} (MU = 0.1 ppm).

NB: If R_{osc} – MU was greater than R_{tot} + MU, i.e. the error was persistent, the data pair was discarded.

NB: If R_{osc} was less than MU (which would result in a negative adjusted R_{osc}) then R_{osc} was set to zero (0), i.e. $R_{beacon} = R_{tot}$.

Total discards for this test was 1832 (73.0%).

The maximum was chosen:

$$\text{Maximum } R_{\text{beacon}} = 3.945 \times 10^{-10}$$

The worst-case beacon residual component performance (R_{beacon_max}) is then recalculated by adding the maximum oscillator contribution (R_{osc_max} = i.e. 2.0 ppb) as follows:

$$R_{\text{beacon\_max}} = \sqrt{R_{\text{beacon}}{}^2 + R_{\text{osc\_max}}{}^2}$$

$$R_{\text{beacon\_max}} = \sqrt{(3.945 \times 10^{-10})^2 + (2.0 \times 10^{-9})^2}$$

$$R_{\text{beacon\_max}} = \sqrt{(1.557 \times 10^{-19}) + (4.0 \times 10^{-18})}$$

$$R_{\text{beacon\_max}} = \sqrt{4.156 \times 10^{-18}}$$

$$R_{\text{beacon\_max}} = 2.039 \times 10^{-9}$$

The performance after five years ($R_{beacon\_5year\_max}$) is estimated by adding an ageing contribution ($R_{aging\_contribution}$ = 0.2 ppb).

$$R_{\text{beacon\_5year\_max}} = R_{\text{beacon\_max}} + R_{\text{aging\_contribution}}$$

$$R_{\text{beacon\_5year\_max}} = 2.039 \times 10^{-9} + 0.2 \times 10^{-9}$$

$$R_{\text{beacon\_5year\_max}} = 2.239 \times 10^{-9}$$

The final value obtained shall be less than the Cospas-Sarsat requirement for the medium-term frequency stability residual, 3.0 ppb:

2. Positive and Negative Slopes

A similar procedure is used for the evaluation of the Medium Term Stability – Slope beacon design contribution (S_{beacon}) except that results were divided amongst four categories:

Positive Static: Positive S_{tot} result during the steady state temperature portion of the test
Positive Gradient: Positive S_{tot} result during the temperature change portion of the test
Negative Static: Negative S_{tot} result during the steady state temperature portion of the test
Negative Gradient: Negative S_{tot} result during the temperature change portion of the test

Note: Only the first calculation is broken down, step-by-step to show the method. All calculation results are then shown in the summary table along with the corresponding limits.

Positive Static:
The contribution of the beacon design (R_{beacon}) was calculated for each matched data pair as per the following equation:

$$S_{\text{beacon}} = \sqrt{S_{\text{tot}}{}^2 - S_{\text{osc}}{}^2}$$

If $|S_{osc}|$ was greater than $|S_{tot}|$ then allowance was made for measurement inaccuracies by adding/subtracting the measurement uncertainty contained within document C/S T.008 from S_{tot} /S_{osc} (MU = 0.1 ppm).

NB: If $|S_{osc}|$ – MU was greater than $|S_{tot}|$ + MU, i.e. the error was persistent, then the data pair was discarded.

NB: If $|S_{osc}|$ was less than MU (which would result in a negative adjusted S_{osc}) then S_{osc} was set to zero (0), i.e. $S_{beacon} = S_{tot}$.

NB: For a proportion of data pairs the slope direction (sense) did not match, e.g. a positive S_{tot} matched to a negative S_{osc}, this was termed a "sense mismatch". In the absence of guidance in C/S IP TCXO, two methods were pursued:

Method A:

No action taken in case of sense mismatch. (The above MU allowances were still performed and persistent errors still discarded.)

Total discards for this method was 343 (13.7%).

Method B:

If either of S_{tot} and S_{osc} was positive and the other negative (i.e. sense mismatch) the data pair was discarded. (The above MU allowances were still performed and persistent errors still discarded.)

Total discards for this test was 1036 (41.3%).

The maximum was chosen:

Method A:

$$\text{Maximum } S_{\text{beacon}} = 2.363 \times 10^{-10}$$

Method B:

$$\text{Maximum } S_{\text{beacon}} = 2.363 \times 10^{-10}$$

The worst case beacon positive slope component performance (S_{beacon_max}) is then recalculated by adding the maximum oscillator contribution (S_{osc_max} = i.e. 0.7 ppb) as follows:

$$S_{\text{beacon\_max}} = \sqrt{S_{\text{beacon}}{}^2 + S_{\text{osc\_max}}{}^2}$$

Method A:

$$S_{\text{beacon\_max}} = \sqrt{(2.363 \times 10^{-10})^2 + (0.7 \times 10^{-9})^2}$$

$$S_{\text{beacon\_max}} = \sqrt{(5.586 \times 10^{-20}) + (0.49 \times 10^{-18})}$$

$$S_{\text{beacon\_max}} = \sqrt{5.459 \times 10^{-19}}$$

$$S_{\text{beacon\_max}} = 7.388 \times 10^{-10}$$

Method B:

$$S_{\text{beacon\_max}} = 7.388 \times 10^{-10}$$

The Cospas-Sarsat performance requirement is 1.0 ppb /min.

No ageing factors were applied for the calculations of the negative and positive slope.

Slope Summary Table – Method A:

All Values in min^{-1}	S_{beacon}	S_{osc_max}	S_{beacon_max}	Cospas-Sarsat performance requirement
Positive Slope Static Temp	$2.363x10^{-10}$	$+0.7x10^{-9}$	$7.388x10^{-10}$	$1.0x10^{-9}$
Positive Slope Gradient Temp	$4.128x10^{-10}$	$+1.7x10^{-9}$	$1.749x10^{-9}$	$2.0x10^{-9}$
Negative Slope Static Temp	$-[1.690x10^{-10}]$	$-0.7x10^{-9}$	$-[7.201x10^{-10}]$	$-1.0x10^{-9}$
Negative Slope Gradient Temp	$-[4.923x10^{-10}]$	$-1.7x10^{-9}$	$-[1.770x10^{-9}]$	$-2.0x10^{-9}$

Values in square brackets (e.g. "$[1.234x10^{-9}]$") are from equations giving positive results, but as the Root-mean-square method strips the positive or negative sense of numbers, they are reverted to a negative number to restore their sense.

Slope Summary Table – Method B:

Values differing from Method A are asterisked and highlighted in red (e.g.*).

All Values in min^{-1}	S_{beacon}	S_{osc_max}	S_{beacon_max}	Cospas-Sarsat performance requirement
Positive Slope Static Temp	$2.363x10^{-10}$	$+0.7x10^{-9}$	$7.388x10^{-10}$	$1.0x10^{-9}$
Positive Slope Gradient Temp	$4.128x10^{-10}$	$+1.7x10^{-9}$	$1.749x10^{-9}$	$2.0x10^{-9}$
Negative Slope Static Temp	$-[1.690x10^{-10}]$	$-0.7x10^{-9}$	$-[7.201x10^{-10}]$	$-1.0x10^{-9}$
Negative Slope Gradient Temp	$-[4.923x10^{-10}]$	$-1.7x10^{-9}$	$-[1.770x10^{-9}]$	$-2.0x10^{-9}$