DERA

DEFENCE EVALUATION and RESEARCH AGENCY
FRASER
Fort Cumberland Road
Portsmouth
PO4 9LJ

Report on Type Testing to RTCM SC110 of McMurdo Ltd 406MHz EPIRB Type G4

DERA/SS/PSD/RTCM/TT33/99-1.0

Cover + vi + 24 pages + Annex A to C

Issue 1.0 - Date: July 2000

Commissioned by;
McMurdo Ltd
Rodney Road
Portsmouth
Hants
PO4 8SG

UKAS TESTING
No. 1217

Issued by

Maritime Navigation Systems
DERA Fraser
Fort Cumberland Road
Portsmouth
England
PO4 9LJ

Authorisation

Position Held	Name	Signature	Date
Test Engineer	W T Harmer	W.T. Harmer.	3-7-00
Quality Manager	R. Rogers	R Rogers.	4/7/00
Head of Laboratory	B. Hawkins	B. Hawkins	3.7.2000

Record Of Changes

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Issue	Date	Details of Change
1.0	July 2000	First issue

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1 Introduction

1.1 The McMurdo 406 MHz EPIRB Type G4 was tested in accordance with the RTCM Recommended Standards for 406 MHz Satellite Emergency Position-Indicating Radio Beacons (EPIRBs) RTCM Paper 4-97/SC110-STD [1].

1.2 The test laboratory is a UKAS accredited Testing Laboratory No. 1217.

1.3 The G4 EPIRB is similar to the Type E3 EPIRB but includes a GPS module. The mechanics and antenna are identical to the E3. The strobe circuit, the 121.5MHz & 406MHz transmitters remain as E3. A small daughter board is added which houses the GPS receiver module. A 1.575GHz patch antenna has been added to the upward facing strobe PCB. The micro-controller and its firmware are new. The G4 uses a Sorep EWOS0519 oscillator to provide 406.028MHz.

1.4 Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

2 Equipment under test

2.1 McMurdo Ltd supplied the following items in March 00 for the duration of type testing.

ITEM	Type	ID Number
EPIRB	G4	1D1E0000BF81FE0
Dome with output connector		
3 additional Battery Packs	82-570-1	-

2.2 Photographs of the EPIRB can be seen in Annex A.

3 Test Location

3.1 The tests were executed at DERA Fraser, Fort Cumberland Road, Portsmouth, Hants.

4 Configuration of the EPIRB samples

4.1 The EPIRB supplied was standard but programmed with the test national location protocol (520ms, bits 37-39 = 111) and had the homer frequency offset. To perform the tests requiring a 50 ohm output a dome was provided with a lead and output connector in place of the antenna.

4.2 The changing of the configuration was undertaken by McMurdo Ltd in the presence of the DERA test engineer.

5 Tests

5.1 Only a subset of the tests from RTCM SC110 were conducted as the G4 beacon is similar to the E3 which had previously been tested. [3][4]

5.2 The corrosion test was not performed as the manufacturer made a declaration on the materials used. See annex B.

5.3 The summary of the test results is shown in section 7.

5.4 The frequency required by the RTCM SC110-STD is 406.025 ±0.002 MHz whereas the COSPAS SARSAT recommend 406.028 ±0.001 MHz for all new EPIRBs.[2]. The McMurdo G4 EPIRB operates on the new frequency and the limits in section 7 have been modified to comply with the COSPAS SARSAT requirement.

6 Conclusions

6.1 The McMurdo 406MHz EPIRB Type G4 was tested and found to meet the requirements of RTCM Paper 4-97/SC110-STD in aspects as detailed in this report.

6.2 The McMurdo 406 MHz EPIRB Type G4 is recommended for type approval.

Section 7

SUMMARY OF TEST RESULTS

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (...°C)	$T_{amb.}$ (+20 °C)	$T_{max.}$ (+55 °C)	
1. INITIAL ALIVENESS TEST (A1.0)						
• Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz		406.0277252		
• Power Output	35 - 39	dBm		38.1		
2. DRY HEAT CYCLE (A3.0)						
• Aliveness Test (during 2 hour period)						Soak at +70°C Measurement at +55°C
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz			406.027756	
- Power Output	35 - 39	dBm			38.2	
• Aliveness Test (at end of 2 hour period)						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz			406.027755	
- Power Output	35 - 39	dBm			38.1	

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (...°C)	$T_{amb.}$ (+20 °C)	$T_{max.}$ (40 °C)	
3. DAMP HEAT CYCLE (A4.0)						
Aliveness Test (during 2 hour period):					Not tested	The body and construction of the G4 EPIRB is the same as for the previously measured E3 EPIRB [3]
• Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz				
- Power Output	35 - 39	dBm				
• Aliveness Test (at end of 2 hour period):						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz				
- Power Output	35 - 39	dBm				
4. VIBRATION TEST (A5.0)						
• Exterior Mechanical Inspection	No damage	✓		✓		
• Aliveness Test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz		406.0277		
- Power Output	35 - 39	dBm		38.2		
• Activation	No activation during test	✓		✓		

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (°C)	$T_{amb.}$ (+20 °C)	$T_{max.}$ (°C)	
5. BUMP TEST (A6.0)						
• Exterior Mechanical Inspection	No Damage	✓		✓		
• Aliveness Test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz		406.0277		
- Power Output	35 - 39	dBm		38.2		
• Activation	No activation during test	✓		✓		
6. SALT FOG TEST (A7.0)						
• Exterior Mechanical Inspection	No damage	✓		Not Tested		See Annex B for the manufacturers statement on materials
• Aliveness test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz				
- Power Output	35 - 39	dBm				

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (-30°C)	$T_{amb.}$ (20°C)	$T_{max.}$ (...°C)	
7-A. DROP TEST (A8.1)						
On Hard Surface						
• Exterior Mechanical Inspection	No damage	✓	✓			
• Aliveness Test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz	406.0277			
- Power Output	35 - 39	dBm	38.2			
• Activation	No activation during test	✓	✓			
7-B DROP TEST (A8.2)						
In Water						
• Exterior Mechanical Inspection	No damage	✓		✓		
• Aliveness test:						
- Carrier frequency	406.028 ± 0.001 (see para 5.4)	MHz		406.0277		
- Power Output	35 - 39	dBm		38.2		

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (-20°C)	$T_{amb.}$ (+20 °C)	$T_{max.}$ (+55 °C)	
8. LEAKAGE AND IMMERSION TEST (A9.0)				Not tested		The body and construction of the G4 EPIRB is the same as the previously tested E3.[3]
• Aliveness Test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz				
- Power Output	35 - 39	dBm				
• Interior Inspection	No water	✓				
9. SPURIOUS EMISSIONS TEST (A10.0)						
• 406 MHz	Figure 2-1	✓ (attach graphs)	✓	✓	✓	Figures 1 to 6
• 121.5 MHz	Figure 2-6	✓ (attach graphs)	✓	✓	✓	Figures 7 to 9

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (-2°C)	$T_{amb.}$ (...°C)	$T_{max.}$ (+40°C)	
10. THERMAL SHOCK (A11.0)						
• Self-activation in water	≤ 5	minutes	Not tested		Not tested	The automatic activation cicuitry of the G4 EPIRB is the same as the previously tested E3.[3] The COSPAS SARSAT thermal shock test has been carried out on the G4.[5]
• Aliveness Test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz				
- Power Output	35 - 39	dBm				
• Frequency Stability						
- short term stability	≤ 0.002	parts/ million in 100ms				
- medium term stability						
mean slope	≤ 0.001	parts/ million/ minute				
residual frequency variation	≤ 0.001	parts/ million				
11. COSPAS-SARSAT TYPE APPROVAL TESTS (A12.0)	C - S Certificate (attach test report)	✓	✓	✓	✓	See Test Report of COSPAS/SARSAT Tests [5]

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (-20 °C)	$T_{amb.}$ (... °C)	$T_{max.}$ (...°C)	
12. OPERATIONAL LIFE, STROBE LIGHT AND SELF TESTS (A13.0)						The EPIRB was operated for 12.2 hours prior to the test commencing. See Annex C for manufacturer's statement on battery self discharge.
Operational Life						
• Frequency						
• Nominal Carrier	406.028 ± 0.001 (see para 5.4)	MHz	Figure 10			
• Short term stability	≤ 0.002	parts/ million in 100 ms	Figure 11			
• Medium-term stability						
- Mean slope	≤ 0.001	parts/ million/ minute	Figure 12			
- Residual variation	≤ 0.003	parts/ million	Figure 13			
• RF output power	35 -39	dBm	Figure 14			
• Strobe flash rate	20 - 30	/min	22			
• Auxiliary radio-locating Peak envelope output power	14 – 20	dBm	18.3			

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (-2 °C)	$T_{amb.}$ (+20 °C)	$T_{max.}$ (+40 °C)	
13. STROBE LIGHT TEST (A13.2)			Not tested	Not tested	Not tested	
Flash rate	20 – 30	/min				The light circuitry and configuration of the G4 is identical to the previously measured E3 EPIRB [3]
Effective intensity	≥ 0.75	Cd				
Pulse duration	10^{-6} to 10^{-2}	s				
14. SELF TEST (A13.3)						
• RF pulse duration	≤ 0.444	✓	✓	✓	✓	
• Frame synchronization pattern	0 1101 0000	✓	✓	✓	✓	
• Number of RF bursts	1-burst	✓	✓	✓	✓	

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (... °C)	$T_{amb.}$ (... °C)	$T_{max.}$ (... °C)	
15. AUTOMATIC RELEASE MECHANISM TEST (A14.0)				Not tested		
Normal mounted orientation	Release and float free before 4 meters; automatic activation	✓				The automatic release housing is the same as was previously tested for the E3 EPIRB [4]
Rolling 90° starboard		✓				
• Rolling 90° port		✓				
• Rolling 90° bow down		✓				
• Rolling 90° stern down		✓				
• Upside down		✓				
16. STABILITY AND BUOYANCY TEST (A15.0)				Not tested		The body and construction of the G4 EPIRB is the same as the previously tested E3.[3]
Time to upright	≤ 2	s				
Reserve buoyancy	≥ 5	%				
Float upright; Antenna base	> 4	cm				
17. INADVERTENT ACTIVATION TEST (A16.0)				Not tested		The body and construction of the G4 EPIRB is the same as the previously tested E3.[3][4]
Activation release	EUT should not release from bracket or automatically activate	✓				

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			$T_{min.}$ (-20 °C)	$T_{amb.}$ (+20 °C)	$T_{max.}$ (+55 °C)	
18. AUXILIARY RADIO-LOCATING DEVICE TRANSMITTER TEST (A17.0)			Not tested	Not tested	Not tested	Homing device circuitry is same as for the previously measured E3 EPIRB.[3]
Carrier frequency	121.5 ± 0.006	MHz				
• PERP	14 – 20	dBm				
• Duty Cycle	100	%				
• Modulation						
- Frequency	≥ 700 Hz within range of 300 – 1600 Hz	Hz				
- Direction	Upward	✓				
- Duty cycle	33 – 55	%				
- Factor	0.85 – 1.0	#				
- Sweep repetition rate	2 – 4	Hz				
• Antenna						
- Pattern	Omnidirectional	✓		✓		
- Polarization	Vertical	✓		✓		
- VSWR	≤ 1.5:1	✓		Integral antenna		

PARAMETERS TO BE MEASURED DURING TESTS	RANGE OF SPECIFICATION	UNITS	TEST RESULTS			COMMENTS
			T_{min} (...°C)	T_{amb} (+20 °C)	T_{max} (40 °C)	
19. HUMIDITY TEST (A18.0)						
• Aliveness Test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz			406.027645	
- Power Output	35 - 39	dBm			38.3	
20. ORIENTATION TEST (A19.0)						
VERTICAL						
• Aliveness Test:						
- Carrier Frequency	406.028 ± 0.001 (see para 5.4)	MHz		406.0277		
- Power Output	35 - 39	dBm		38.1		
UPSIDE DOWN						
• Aliveness test:						
- Carrier frequency	406.028 ± 0.001 (see para 5.4)	MHz		406.0277		
- Power Output	35 - 39	dBm		38.1		
HORIZONTAL						
• Aliveness test:						
- Carrier frequency	406.028 ± 0.001 (see para 5.4)	MHz		406.0277		
- Power Output	35 - 39	dBm		38.1		

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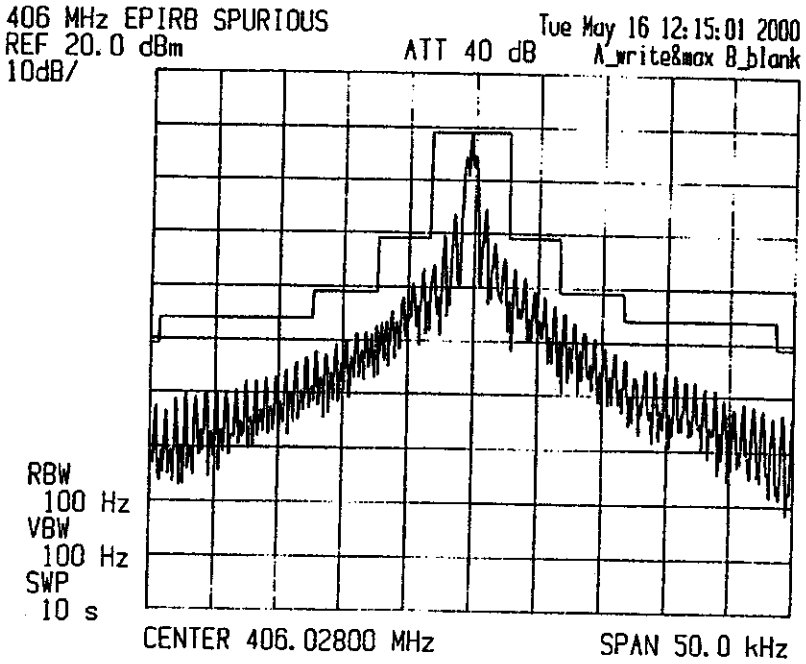
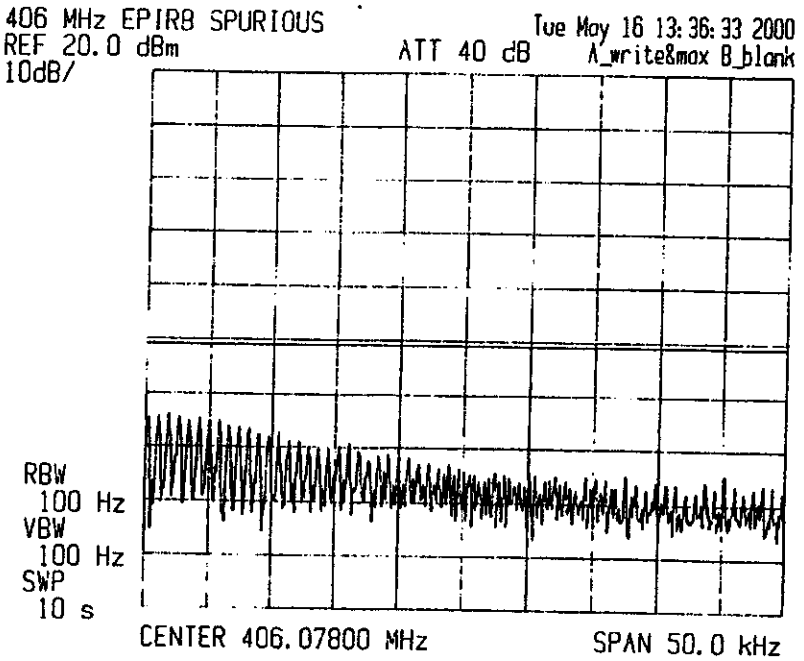
Section 8

Test Plots



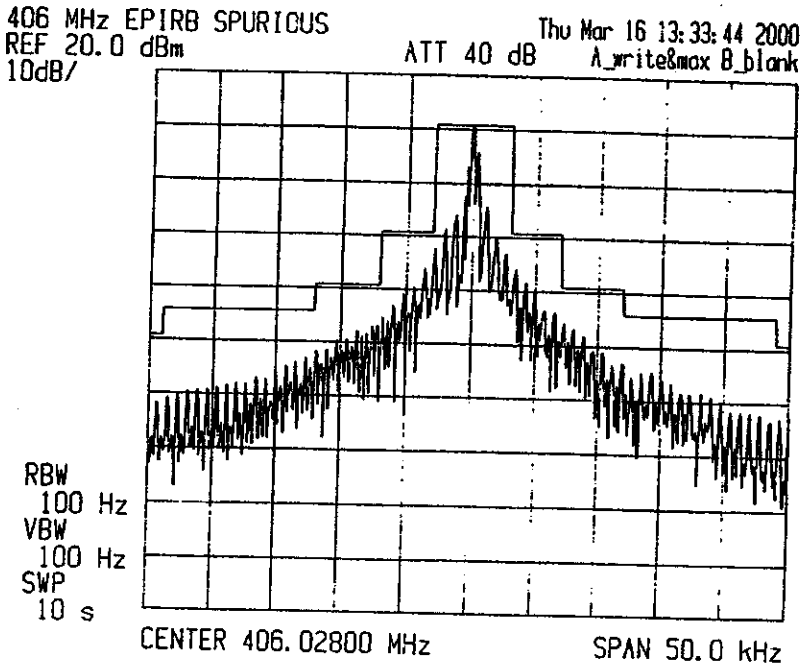
Spurious Emissions at –20°C from 406 MHz to 406.05 MHz

Figure 1



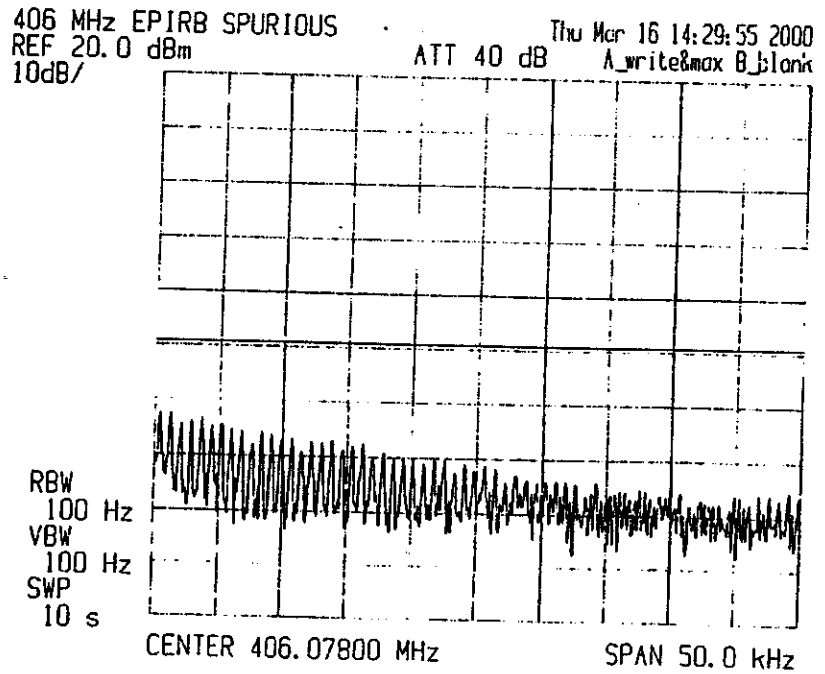
Spurious Emissions at –20°C from 406.05 MHz to 406.1 MHz

Figure 2



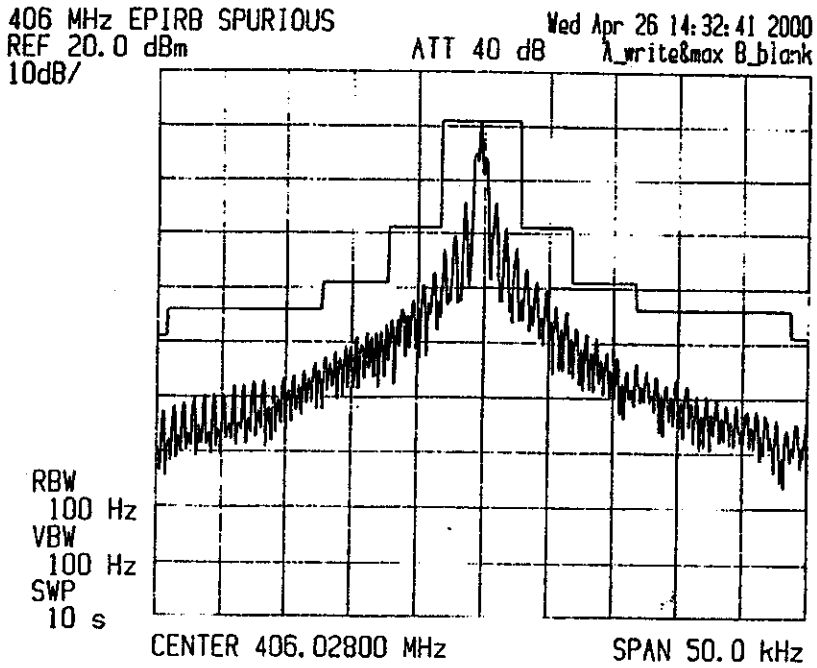
Spurious Emissions at +20°C from 406 MHz to 406.05 MHz

Figure 3



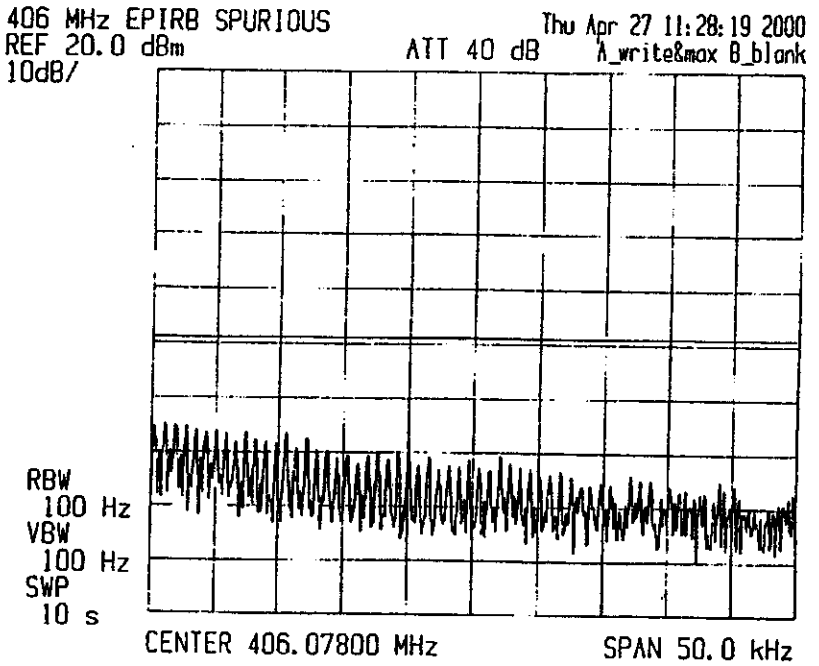
Spurious Emissions at +20°C from 406.05 MHz to 406.1 MHz

Figure 4



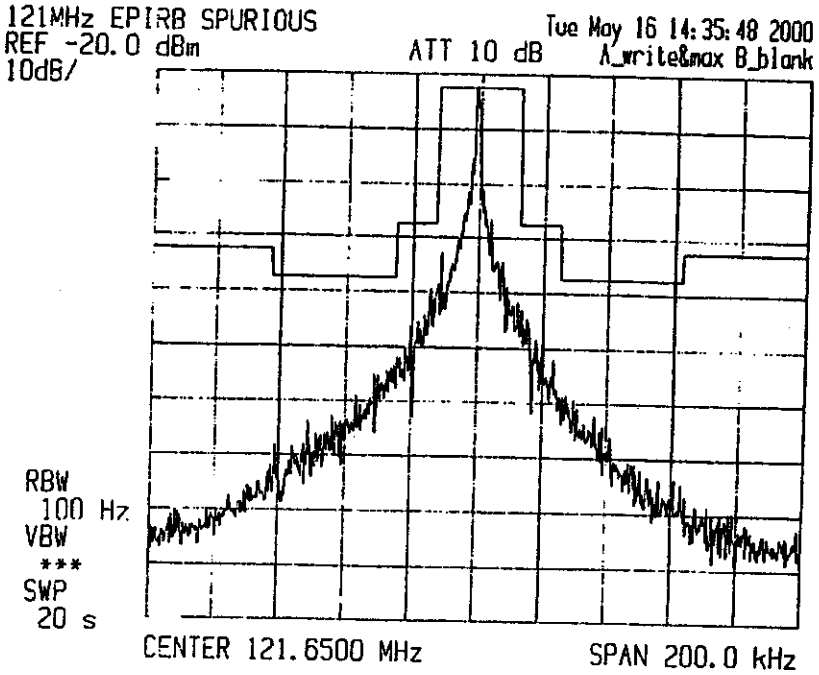
Spurious Emissions at +55°C from 406 MHz to 406.05 MHz

Figure 5



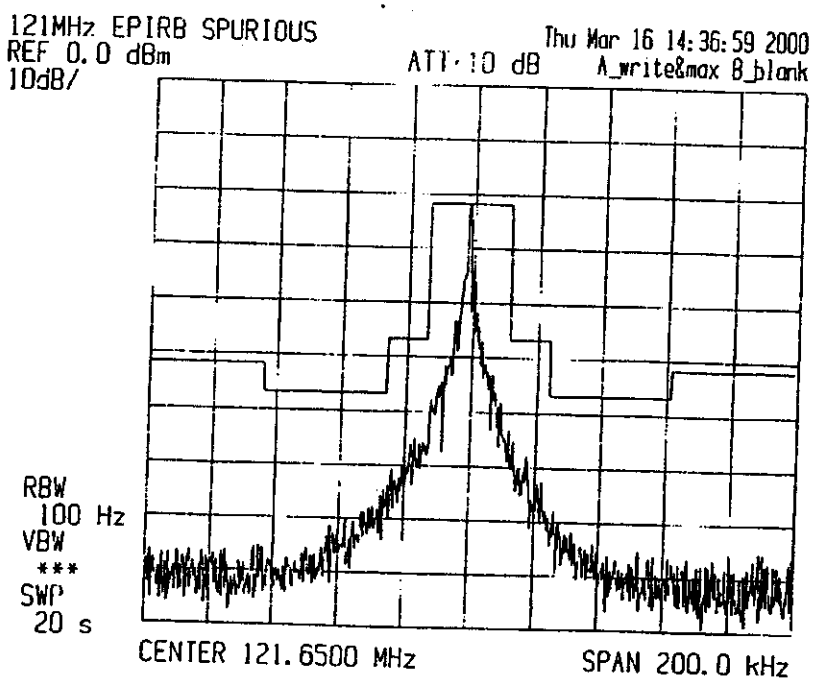
Spurious Emissions at +55°C from 406.05 MHz to 406.1 MHz

Figure 6



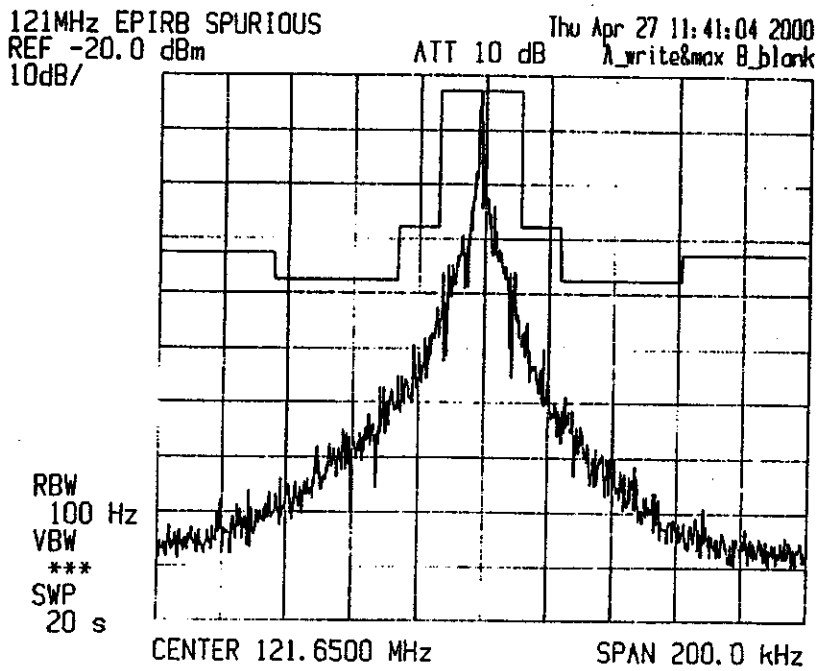
Spurious Emissions at -20°C from 121.55 MHz to 121.75 MHz

Figure 7



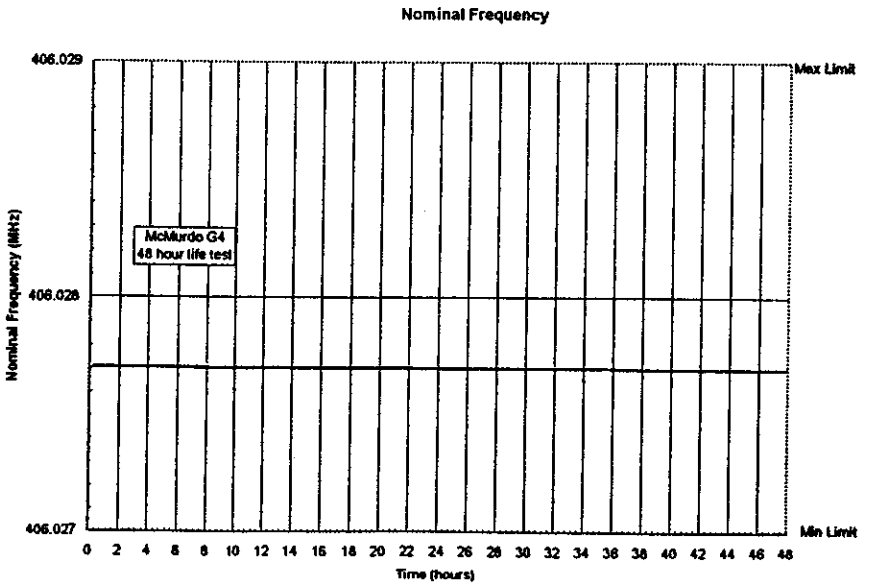
Spurious Emissions at +20°C from 121.55 MHz to 121.75 MHz

Figure 8



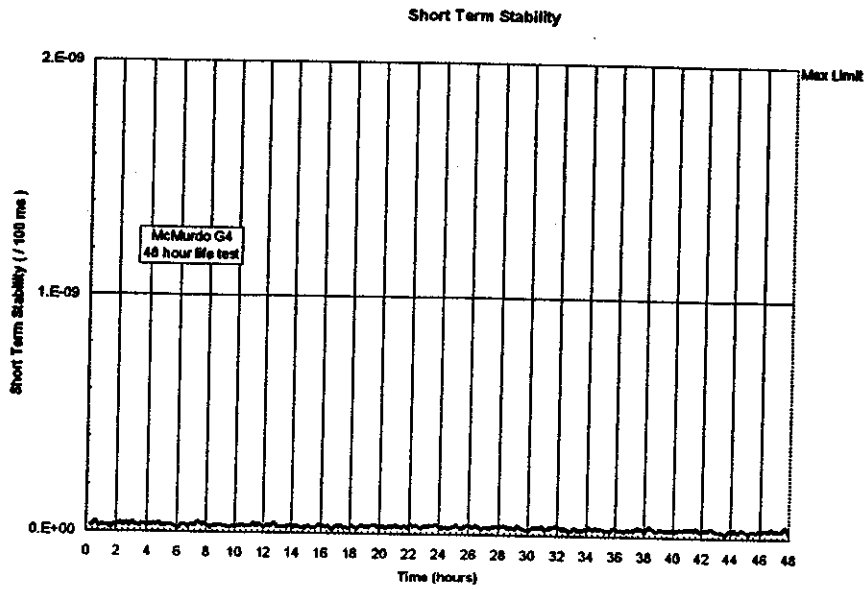
Spurious Emissions at +55oC from 121.55 MHz to 121.75 MHz

Figure 9



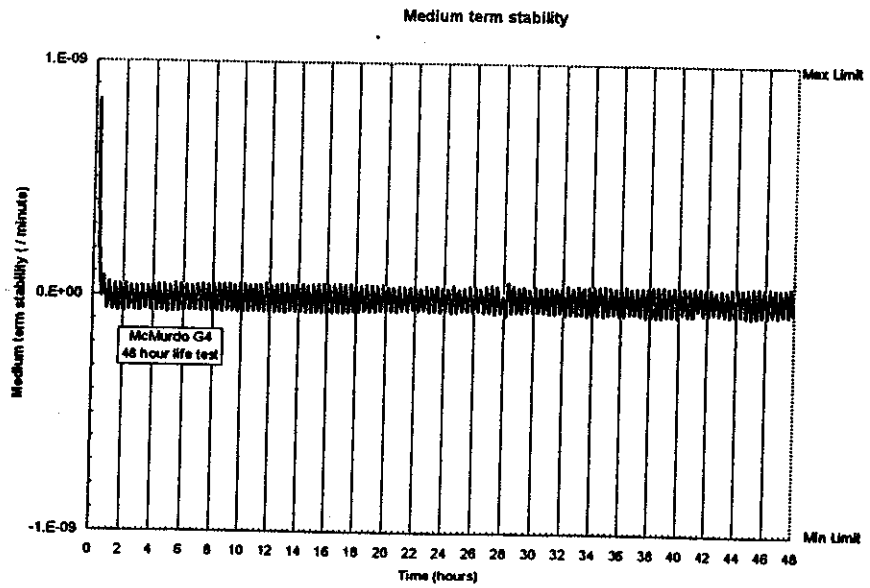
Operational Life Nominal Frequency

Figure 10



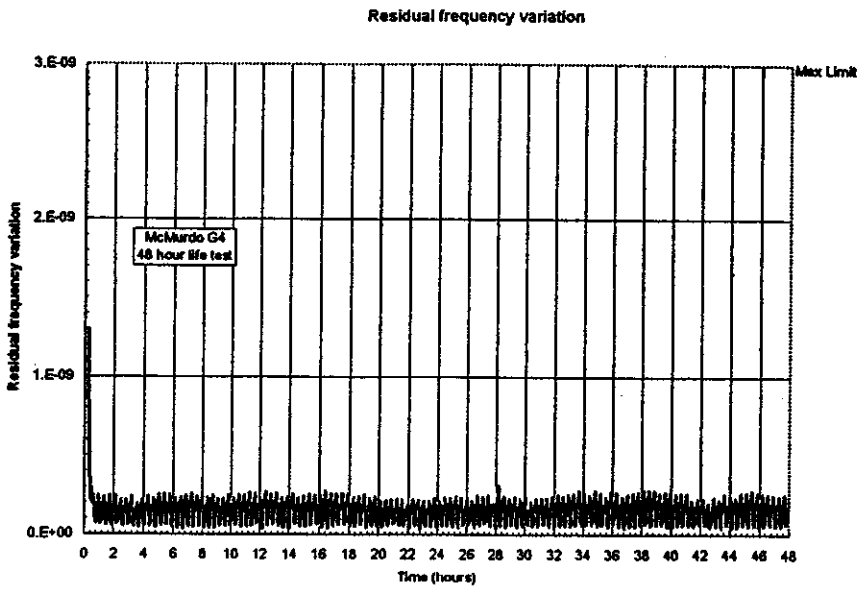
Operational Life Short Term Stability

Figure 11



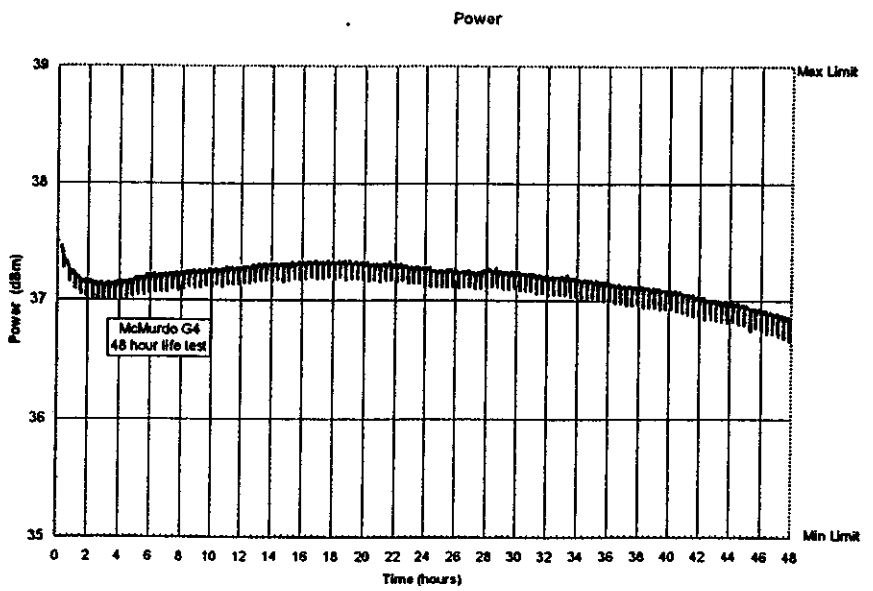
Operational Life Medium Term Stability

Figure 12



Operational Life Residual Frequency Variation

Figure 13



Operational Life Output Power

Figure 14

Section 9

References

1 *RTCM Recommended Standards for 406 MHz Satellite Emergency Position-Indicating Radio Beacons (EPIRBs).* RTCM Paper 4-97/SC110-STD Version 2.0 February 5,1997.

2 *COSPAS/SARSAT 406 MHz Distress Beacon Type Approval Standard* C/S T.007 Issue 3 – Revision 6 Oct 1999

3 *Report on Type Testing to RTCM SC110-STD of McMurdo Ltd 406 MHz EPIRB Type E3* DERA/SS/WI//RTCM/R-TT7/98-1.0 February 1999

4 *Report on Type Testing to RTCM SC110-STD of Float Free Enclosure for McMurdo Ltd EPIRB Type E3* DERA/SS/CI//RTCMFF/TT7/98-1.0 April 1999

5 *Report on Type Testing to C/S T.007 of McMurdo Ltd 406MHz EPIRB Type G4* DERA/SS/CI/CS/TT33/99-1.0 June 2000

Section 10

Distribution List

Copy No	Recipient	Location
1/3	John Norrish	McMurdo Ltd. Rodney Road, Portsmouth, Hants. PO4 8SG
Master	File TT 33/99	DERA Fraser, Portsmouth.

Annex A

Photographs of McMurdo G4 EPIRB

G4 EPIRB Front View

EPIRB with 50 ohm test lead

View of Switch on G4 EPIRB

Annex B

Statement on materials used.

G4 GPS EPIRB MATERIALS LIST

The materials listed below are in contact with the marine environment.

EPIRB	Material
BODY SECTION	
Moulding	Cycoloy C1200 UV stabilised. Polycarbonate/ ABS blend.
Identity label	Polyester. UV stabilised. Printed to rear. Adhesive 3M type 467
Front label	Polyester. Litho printed then laminated. Adhesive 3M type 467
SWITCH	
Button overlay	Polyester. UV stabilised. Printed to rear. Adhesive 3M type 467
Slider and rim	Pulse A35/110 UV stabilised. Polycarbonate/ ABS blend.
Label	Polyester. Litho printed then laminated. Adhesive 3M type 467
Tamper seal	Frangible polyester
MAIN SEAL	
Gasket	Sarlink. Polypropylene/ ABS blend thermo-elastomer.
Screws	Stainless steel.
O-rings on screws	Nitrile rubber.
LENS DOME	
Moulding	Polycarbonate. UV stabilised.
Reflective tape	3M Solas approved retro-reflective tape.
Expiry label	Fascal 940 all weather PVC.
ANTENNA	
Conductor	Stainless steel wire rope.
Fixing stud	
O-ring seal	EPDM (Ethylene Propylene Diene Monomer).
Sleeving	Polyolefin heat shrink tube.
Top cap	PVC fixed with cyano-acrylate adhesive.
LANYARD	
Former	Pulse A35/110 UV stabilised. Polycarbonate/ ABS blend.
Cord	Woven polypropelene.

BRACKET	Material
Moulding	Pulse A35/110 UV stabilised. Polycarbonate/ ABS blend.
Clamping pad	Sarlink. Polypropylene/ ABS blend thermo-elastomer.
Spring	Stainless steel.
Magnet potting	Flexible epoxy resin. 3M type DP105.
Mounting screws	Stainless steel.
Instruction label	Fascal 940 all weather PVC.

ENCLOSURE	Material
Base and cover	Acrylic capped ASA (Acrylate Styrene Arylonitrile).
Test window	Silicone rubber sheet. Primed and glued with specialist Bostik adhesive)
Spring	Stainless steel.
Circular weight	Nickel plated brass.
Fixings	All stainless steel.
Breakable rod	Acetal copolymer
Magnet holder	Acetal copolymer
Magnet potting	Flexible epoxy resin. 3M type DP105.
Foam pads	High density polyethylene foam.
Labels	Fascal 940 all weather PVC.

Annex C

Battery self-discharge statement

McMurdo G4 GPS EPIRB

Battery self-discharge statement

This statement details the discharge regime that must be applied to a fresh G4 battery pack to compensate for self-discharge effects. It is based upon:

ETS 300 066 paragraph 4.13.1
RTCM SC110 version 2, paragraph 2.3.1.5.
C/S T.007 issue 3 rev. 6, paragraph A2.3.

McMurdo Ltd wishes to quote a 6-year shelf life, which implies a 12-year self-discharge regime.

Self discharge at 20°C:

ETS 300 066 paragraph 4.13.1
RTCM SC110 version 2, paragraph 2.3.1.5.

The battery pack comprises of three FRIWO M20 'D' size Lithium Manganese dioxide cells. The quoted self-discharge rate is 1% per year. Over 12 years this equates to a loss of 12% capacity. During battery discharge tests, McMurdo have measured the FRIWO battery as 9.6Ah under true PCB loading. Hence the self-discharge loss is 9.6 x 0.12 = 1.152Ah.

Self test

ETS 300 066 paragraph 4.13.1
RTCM SC110 version 2, paragraph 2.3.1.5.

The G4 self-test regime lasts for 6 seconds and consists of 3 sweeps of 121MHz, a frame inverted (short) 406MHz transmission and confirmation that the GPS module outputs data of the correct format. This gives a current profile of:
(0.2A x 6s) + (1.8A x 0.44s) + (0.15A x 5s) = 2.742As = 0.00076Ah. Based on user testing once per week, over 12 years this equates to 0.00076 x 52 x 12 = 0.475Ah.

C/S T.007 issue 3 rev. 6, paragraph A2.3.

The McMurdo G4 user manual recommends carrying out self-test on a monthly basis. From the figures above, this equates to a drain of 0.00076 x 12 x 12 = 0.11Ah.

Standby loads

The G4 uses a CMOS 4001 chip, which is permanently powered. The worst case 20°C current is 0.24uA. Over 12 years this equates to 12 x 365 x 24 x 0.24uA = 0.025Ah.

Total Losses

ETS 300 066 paragraph 4.13.1
RTCM SC110 version 2, paragraph 2.3.1.5.

Total losses come to 1.152 + 0.475 + 0.025 = **1.652Ah**. This can either be extracted from a fresh battery prior to life test (ETS 300 066) or it can be included as an overtest to **60.2 hours**, (RTCM).
The overtest factor is given by F=[48 + (1.652Ah/0.135A0] / 48 = 1.255

C/S T.007 issue 3 rev. 6, paragraph A2.3.

Total losses come to 0.11 + 0.025 = 0.135Ah
Applying the C/S correction coefficient of 1.65, yields a loss of 1.65 x 0.135 = 0.223Ah. This should be extracted from a fresh battery prior to the start of the life test.

Richard Read
Senior Engineer.

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