

ENGINEERING TEST REPORT



Miniature VHF Radio Beacon
Model(s): MMB-1000 and MMB-7500
FCC ID: FOXMMB1000

Applicant:

Metocean Data Systems
21 Thornhill Dr.
Dartmouth, Nova Scotia
Canada B3B 1R9

Tested in Accordance With
Federal Communications Commission (FCC)
47 CFR, Part 80

UltraTech's File No.: METO-002F80

This Test report is Issued under the Authority of
Tri M. Luu
Vice President of Engineering
UltraTech Group of Labs

Date: January 3, 2013

Report Prepared by: Dan Huynh

Tested by: Mr. Wei Wu

Issued Date: January 3, 2013

Test Dates: November 8 - 13, 2012

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Parts 2 and 80
Title:	Code of Federal Regulations, Title 47 - Telecommunication, 47 CFR, Parts 2 and 80
Purpose of Test:	To gain FCC Equipment Authorization for Radio operating in the frequency band, 154 - 161 MHz (Maritime).
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with ANSI/TIA-603-D - Land Mobile FM or PM Communications Equipment Measurement and performance Standards.
Type of Station	Ship station

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2011	Code of Federal Regulations – Telecommunication
ANSI C63.4	2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI/TIA-603-D	2010	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
CISPR 22 & EN 55022	2008-09, Edition 6.0 2006	Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement
CISPR 16-1-1 +A1 +A2	2006 2006 2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-1-2 +A1 +A2	2003 2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Conducted disturbances

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January 3, 2013

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

Applicant	
Name:	Metocean Data Systems
Address:	21 Thornhill Dr. Dartmouth, Nova Scotia Canada B3B 1R9
Contact Person:	Mr. Tony Chedrawy Phone #: 1 (902) 468-2505 Fax #: 1 (902) 468-4442 Email Address: tony@metocean.com

Manufacturer	
Name:	Metocean Data Systems
Address:	21 Thornhill Dr. Dartmouth, Nova Scotia Canada B3B 1R9
Contact Person:	Mr. Tom Knox Phone #: 1 (902) 468-2505 ext 256 Fax #: 1 (902) 468-4442 Email Address: tknox@metocean.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Metocean Data Systems
Product Name:	Miniature VHF Radio Beacon
*Model(s):	MMB-1000 and MMB-7500
Serial Number:	Demo-040
Type of Equipment:	Licensed Non-Broadcast Station Transmitter
Power Supply Requirement:	21 VDC batteries (7 x CR123A Lithium cells)
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	Locator Beacon via DF

* Both models are electrical identical, the MMB-1000 chassis construction is made of aluminum material and the MMB-7500 is made of titanium material, MMB-1000 was selected as the test sample to represent both models.

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2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Mobile
Intended Operating Environment:	Maritime
Power Supply Requirement:	21 VDC batteries (7 x CR123A Lithium cells)
RF Output Power Rating:	0.05 W
Operating Frequency Range:	154 - 161 MHz
RF Output Impedance:	50 Ohm
Modulation Employed:	FSK
Occupied Bandwidth (99%):	10.92 kHz
Emission Designation:	16K0F1D
Antenna Type:	Larsen HQ Helical ¼ wave Low Profile, (M/N: KD22VHF3, 150-161 MHz, 0 dBi)

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Antenna Connector	1	5/16-24 THDS	N/A

2.5. ANCILLARY EQUIPMENT

No ancillary equipment.

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	21V DC nominal

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	N/A
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ohm RF Load for conducted tests and for radiated test the antenna was connected to the EUT.

Transmitter Test Signals	
Frequency Band(s):	154- 161 MHz
Test Frequency(ies):	154.585 MHz, 159.480 MHz & 160.785 MHz
Transmitter Wanted Output Test Signals:	
• Transmitter Power (measured maximum output power):	0.058 W
• Normal Test Modulation:	FSK
• Modulating signal source:	Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2014-04-04.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
2.1046 & 80.215	RF Power Output	Yes
2.1047(a) & 80.213(e)	Modulation Characteristics - Audio Frequency Response	N/A
2.1047(b) & 80.213	Modulation Characteristics - Modulation Limiting	See Note 1
2.1049, 80.205 & 80.211(f)	Occupied Bandwidth and Emission Limitations	Yes
2.1051, 2.1057 & 80.211(f)(3)	Spurious Emissions at Antenna Terminal	Yes
2.1053, 2.1057 & 80.211(f)(3)	Field Strength of Spurious Emissions	Yes
2.1055 & 80.209	Frequency Stability	Yes
80.217	Suppression of Interference aboard ships	See Note 2
1.1307, 1.1310 & 2.1091	RF Exposure Limit	Yes

NOTE 1: See applicant declared duty cycle in user manual

NOTE 2: Complies with FCC Part 15, Subpart B.

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None.

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EXHIBIT 5. TEST DATA

5.1. RF POWER OUTPUT [§§ 2.1046 & 80.215]

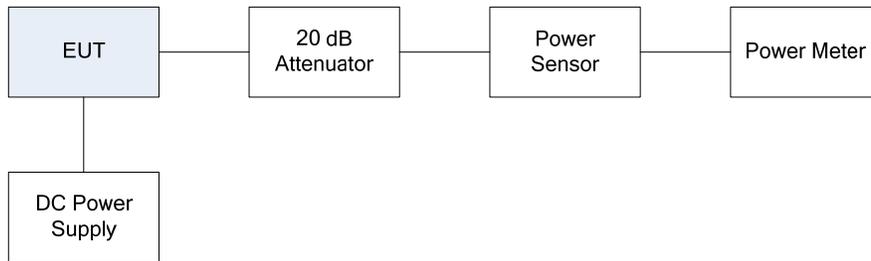
5.1.1. Limits

§ 80.215(m) For radiodetermination transmitters using A1D, A2D, F1D, F2D, G1D and G2D emissions on 154.585 MHz, 159.480 MHz, 160.725 MHz, 160.785 MHz, 454.000 MHz and 459.000 MHz the mean output power of the unmodulated carrier must not exceed 25 watts.

5.1.2. Method of Measurements

Refer to 47 CFR §§ 2.947, 2.1041, 2.1046 and ANSI/TIA-603-D Section 2.2.1 for measurement details.

5.1.3. Test Arrangement



5.1.4. Test Data

Transmitter Channel Output	Fundamental Frequency (MHz)	Measured (Average) Conducted Power (W)	Power Rating (W)
Lowest	154.585	0.058	0.05
Highest	160.785	0.044	0.05

5.2. MODULATION LIMITING [§ 80.213 & § 2.1047(d)]

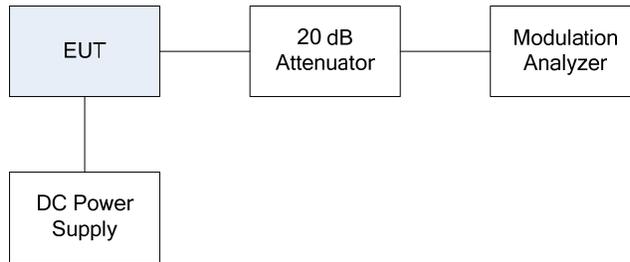
5.2.1. Limits

§ 80.213 (d) Ship and coast station transmitters operating in the 156-162 MHz and 216-220 bands must be capable of proper operation with a frequency deviation that does not exceed ± 5 kHz when using any emission authorized by Sec. 80.207.

5.2.2. Method of Measurements

Connect the equipment as illustrated in section 5.2.3 test arrangement, turn ON the EUT and an internally generated non-audio modulation emission is applied to the input of modulation analyzer, the system maximum deviation was measured and recorded.

5.2.3. Test Arrangement



5.2.4. Test Data

Measured Maximum System Deviation	Limit
4.84 kHz	± 5 kHz

5.3. OCCUPIED BANDWIDTH AND EMISSION LIMITATIONS [§§2.1049, 80.205 & 80.211]

5.3.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

Emission designator	Maximum Authorized BW (kHz)	Frequency Deviation (kHz)	Applicable Mask
16K0F1D*	20	5	See § 80.211 (f)

* Applicable to radiolocation and associated telecommand ship stations operating on 154.585 MHz, 159.480 MHz, 160.725 MHz, 160.785 MHz, 454.000 MHz, and 459.000 MHz; emergency position indicating radiobeacons operating in the 406.000–406.1000 MHz frequency bank; and data transmissions in the 156–162 MHz band.

§ 80.211 (f) Emission Limitations:

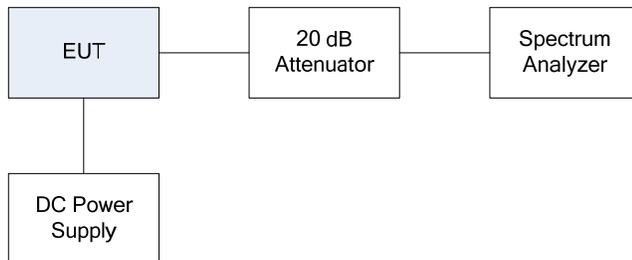
- (1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;
- (2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and
- (3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

5.3.2. Method of Measurements

47 CFR § 2.1049, ANSI C63.4-2009 Section 13.7 and ANSI/TIA-603-D Section 2.2.11 shall apply with the following modification.

The emission mask in § 80.211 (f) Emission Limitations shall apply.

5.3.3. Test Arrangement



5.3.4. Test Data

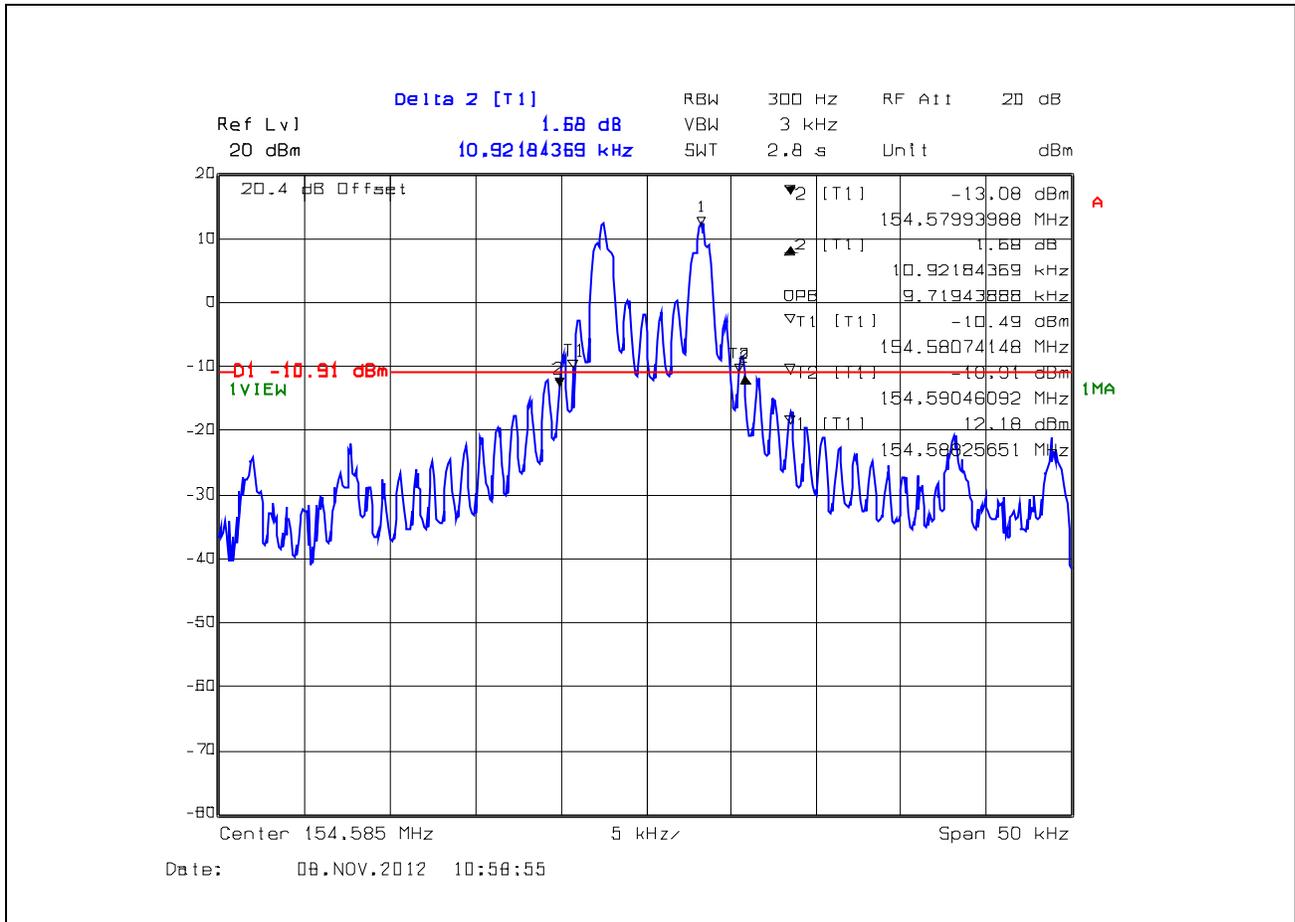
5.3.4.1. 99% Occupied Bandwidth

Remark: 99% Occupied Bandwidth measurements were done using the built-in auto function of the analyzer.

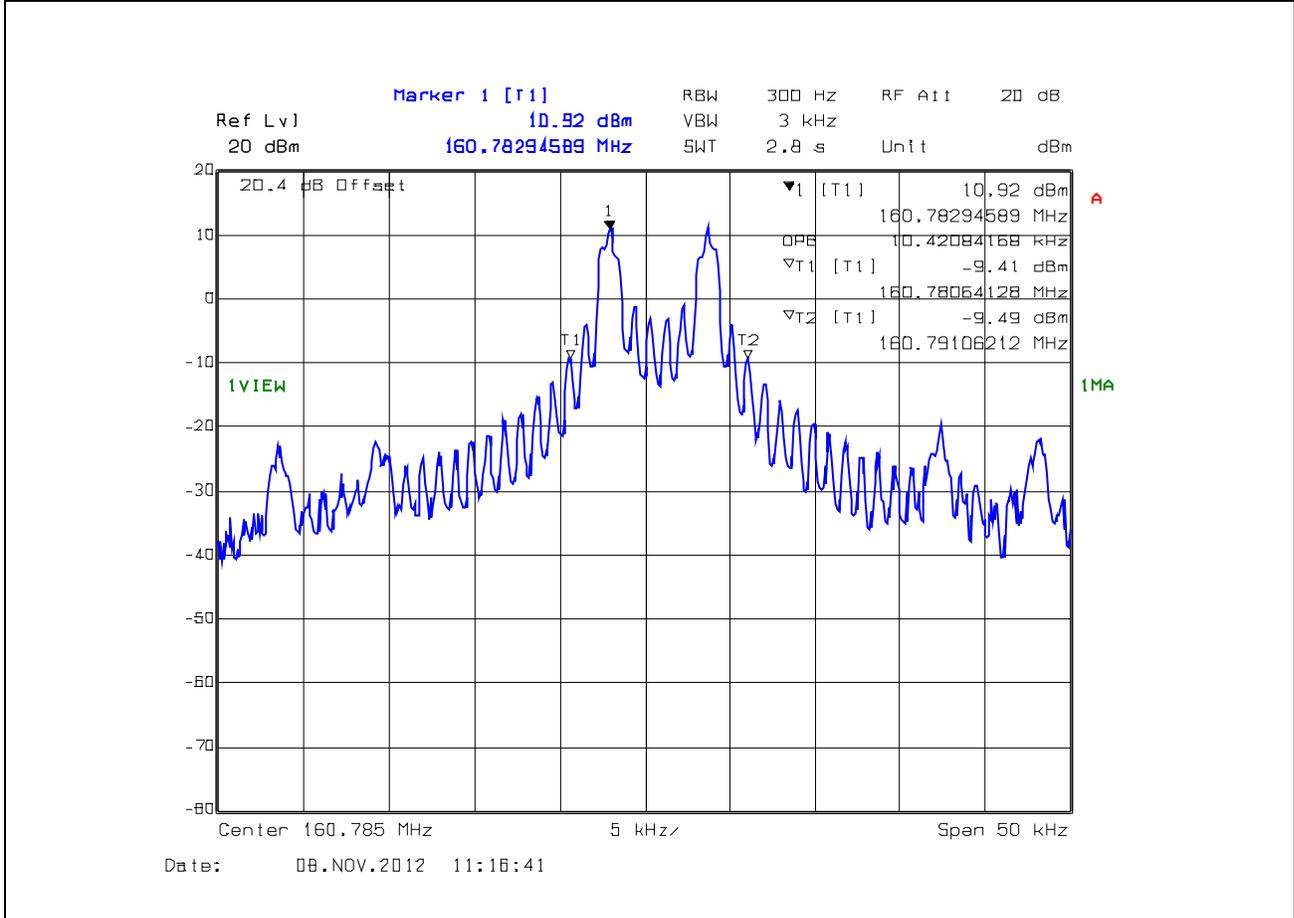
Frequency (MHz)	Measured 99% OBW (kHz)	Authorized Bandwidth (kHz)
156.025	10.92	20
157.425	10.42	20

See the following plots for details of measurements.

Plot 5.3.4.1.1. Occupied Bandwidth for 154.585 MHz, F1D



Plot 5.3.4.1.2. Occupied Bandwidth for 160.785 MHz, F1D



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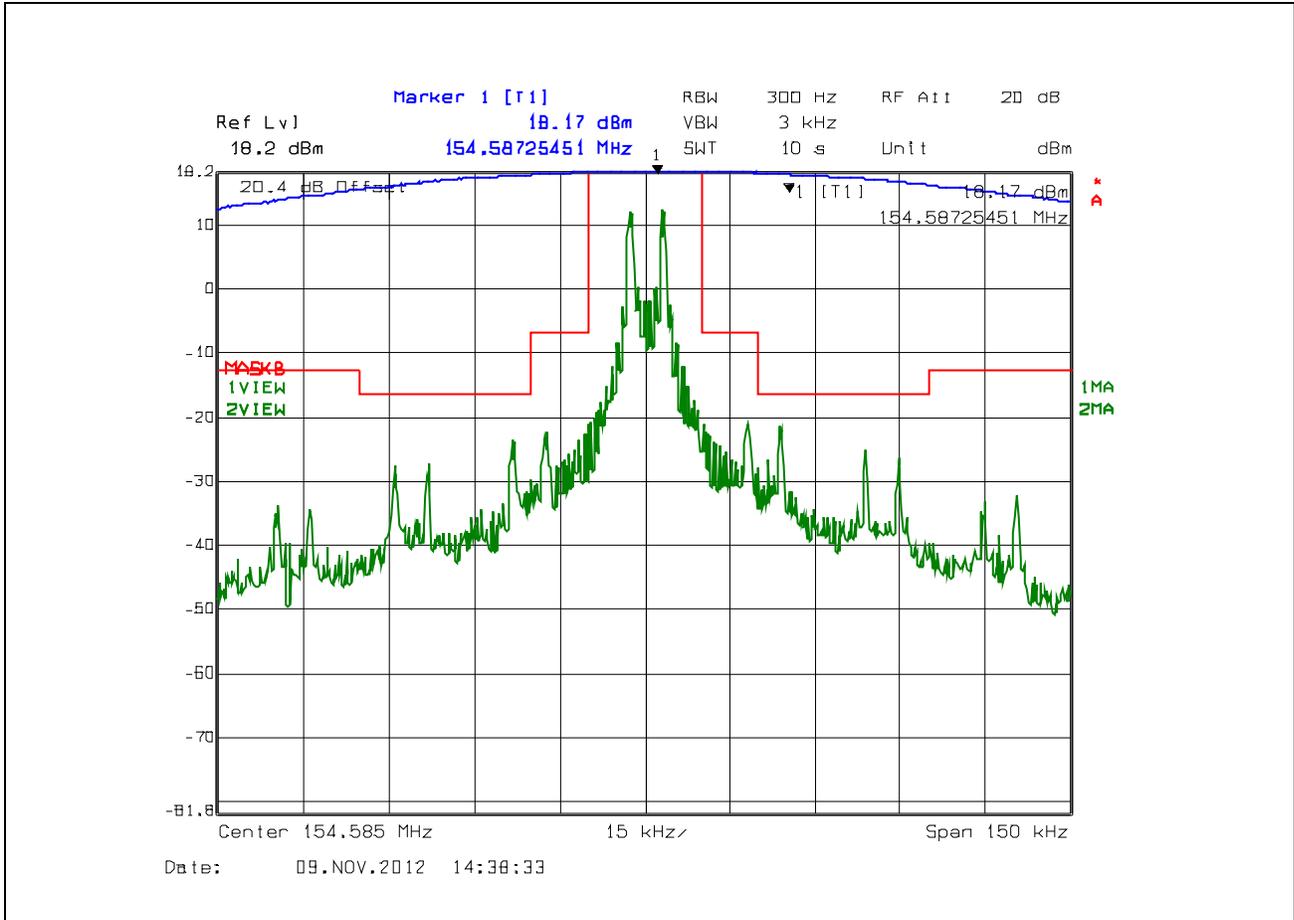
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5.3.4.2. Emission Limitation

Plot 5.3.4.2.1. Emission Limitation for 154.585 MHz, F1D



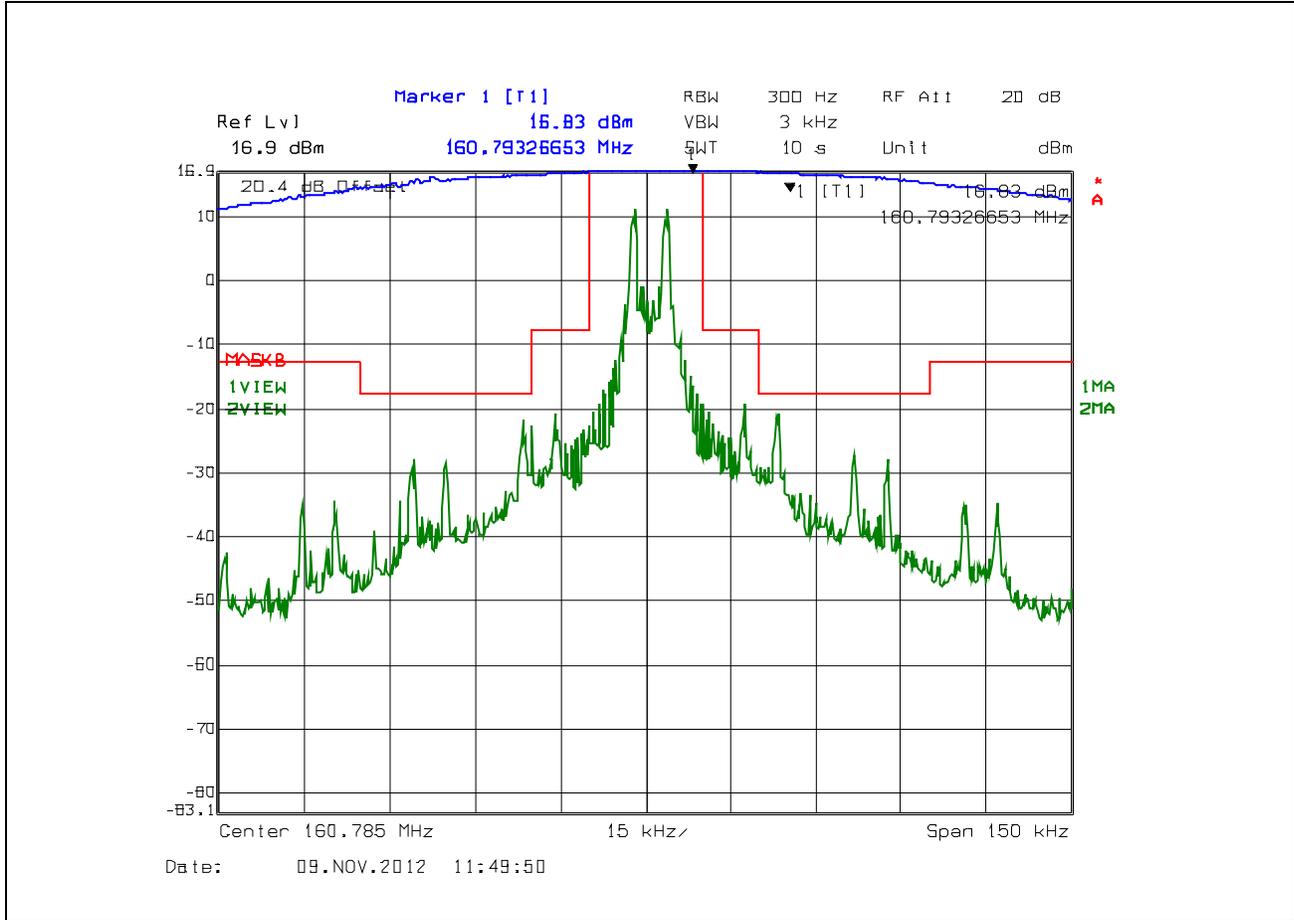
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Plot 5.3.4.2.2. Emission Limitation for 160.785 MHz, F1D



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5.4. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§ 80.211(f)(3)]

5.4.1. Limits

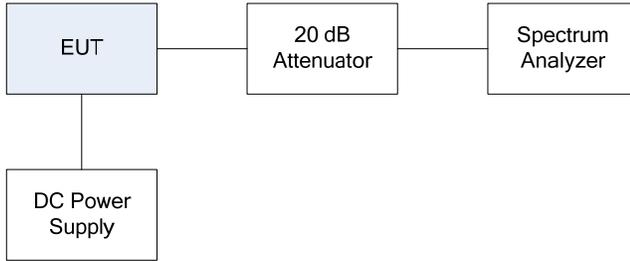
§ 80.211(f)(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

5.4.2. Method of Measurements

47 CFR §§ 2.1051, 2.1057

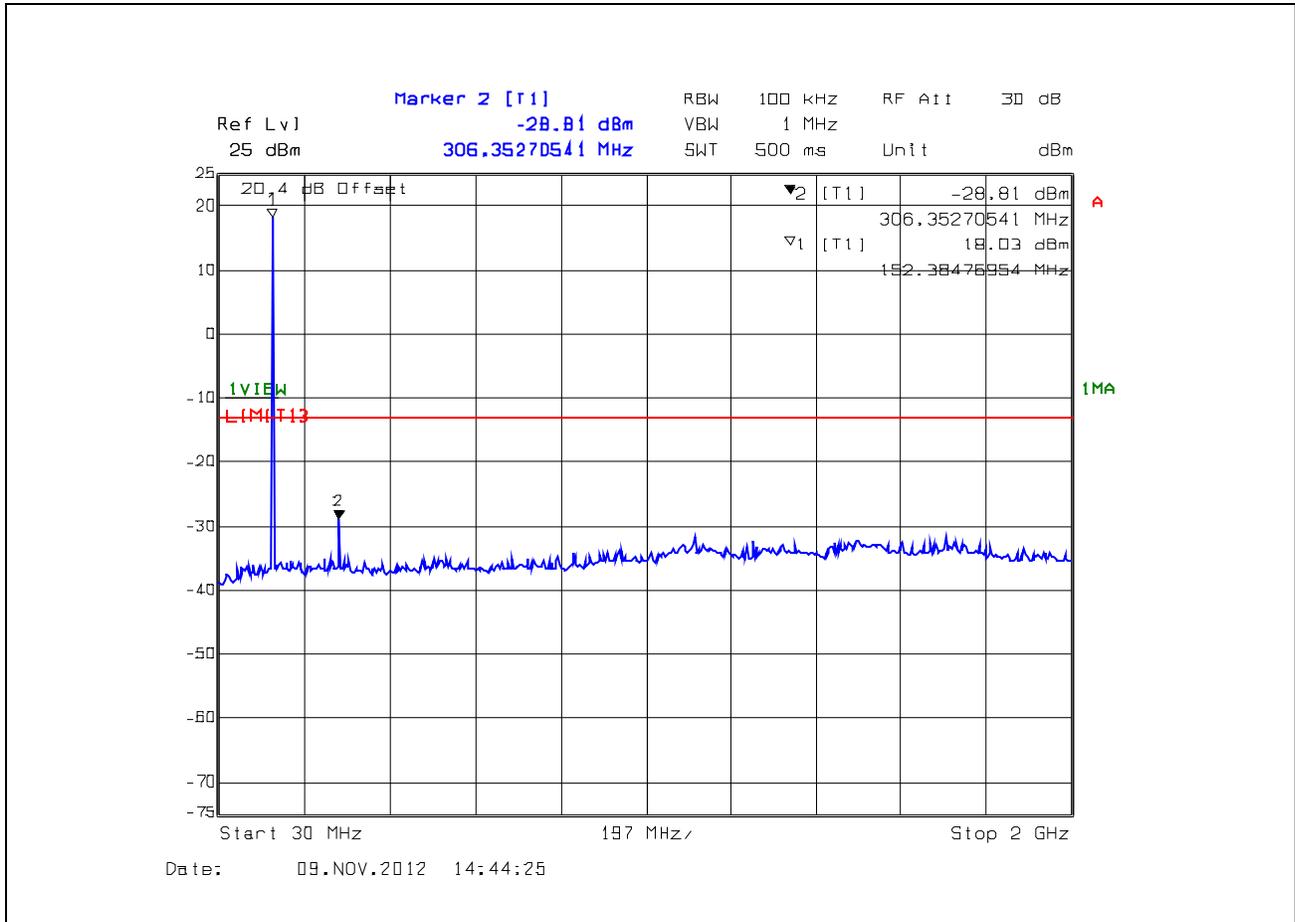
The output of the transmitter is connected as illustrated in Section 5.4.3 test arrangement. The level of spurious emissions is recorded by the spectrum analyzer and plotted.

5.4.3. Test Arrangement

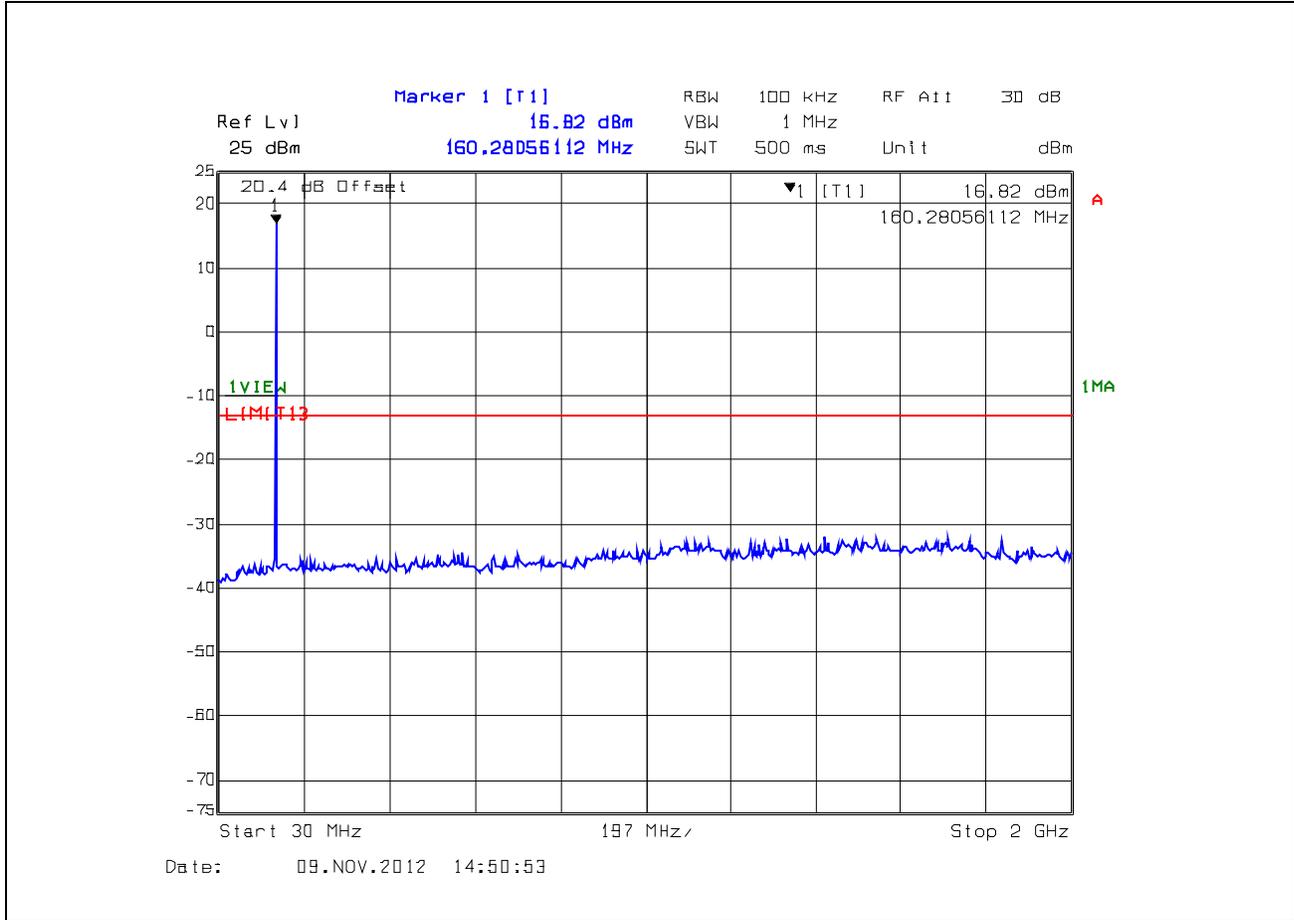


5.4.4. Test Data

Plot 5.4.4.1. Spurious Emissions at Antenna Terminals, 154.585 MHz, 30 MHz - 2 GHz



Plot 5.4.4.2. Spurious Emissions at Antenna Terminals, 160.785 MHz, 30 MHz - 2 GHz



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5.5. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§ 80.211(f)(3)]

5.5.1. Limits

§ 80.211(f)(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

5.5.2. Method of Measurements

47 CFR §§ 2.1053, 2.1057.

The spurious/harmonic ERP measurements use substitution method specified in 8.2 of this report.

5.5.3. Test Data

Remark(s):

- The emissions were scanned from 30 MHz to 2 GHz; all spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.

Carrier Frequency:	154.585 MHz					
Power:	0.058 W					
Limit:	-13 dBm					
Frequency (MHz)	E-Field (dB μ V/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
772.925	68.85	Peak	V	-32.46	-13	-19.46
927.510	72.08	Peak	V	-27.82	-13	-14.82
927.510	70.49	Peak	H	-29.41	-13	-16.41
1082.095	75.07	Peak	V	-28.43	-13	-15.43
1082.095	71.65	Peak	H	-31.85	-13	-18.85
1236.680	70.75	Peak	H	-29.08	-13	-16.08
1391.265	71.45	Peak	H	-29.35	-13	-16.35
1545.850	74.49	Peak	H	-29.52	-13	-16.52

Carrier Frequency:	160.785 MHz					
Power:	0.044 W					
Limit:	-13 dBm					
Frequency (MHz)	E-Field (dB μ V/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
1125.495	75.94	Peak	V	-26.75	-13	-13.75
1125.495	81.14	Peak	H	-21.55	-13	-8.55
1286.280	69.55	Peak	V	-29.89	-13	-16.89
1286.280	80.57	Peak	H	-18.87	-13	-5.87
1447.065	74.66	Peak	V	-27.76	-13	-14.76
1447.065	83.57	Peak	H	-18.85	-13	-5.85
1607.850	76.36	Peak	V	-27.67	-13	-14.67
1607.850	82.27	Peak	H	-21.76	-13	-8.76

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5.6. FREQUENCY STABILITY [§§ 2.1055 & 80.209]

5.6.1. Limits

Frequency Band	Coast Stations		Ship Stations
	Below 3 W	3 to 100 W	
156–162 MHz	10 ppm	¹ 5 ppm	² 10 ppm

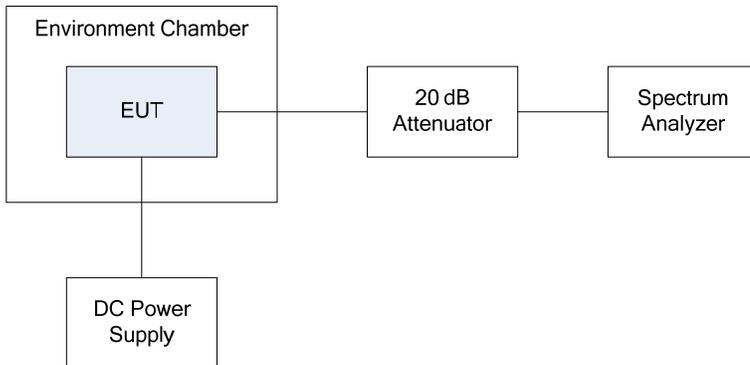
¹ For transmitters operated at private coast stations with antenna heights less than 6 meters (20 feet) above ground and output power of 25 Watts or less the frequency tolerance is 10 parts in 10⁶.

² For transmitters in the radiolocation and associated telecommand service operating on 154.585 MHz, 159.480 MHz, 160.725 MHz and 160.785 MHz the frequency tolerance is 15 parts in 10⁶.

5.6.2. Method of Measurements

47 CFR § 2.1055

5.6.3. Test Arrangement



5.6.4. Test Data

Center Frequency:	159.480 MHz		
Full Power Level:	17.12 dBm		
Frequency Tolerance Limit (Worst Case):	±15 ppm or 2392 Hz		
Max. Frequency Tolerance Measured:	-2054 Hz or 12.88 ppm		
Input Voltage Rating:	21 VDC		
Ambient Temperature (°C)	Frequency Drift (Hz)		
	21 Volts (Nominal Value)	Variation of Primary Supply Voltage	
		17.85 Volts (85% of the Nominal Value)	24.15 Volts (115% of the Nominal Value)
-40	-2054	--	--
-30	-802	--	--
-20	-401	--	--
-10	+401	--	--
0	+401	--	--
+10	+401	--	--
+20	0	0	0
+30	-802	--	--
+40	-1202	--	--
+50	-1603	--	--
+60	-2004	--	--

5.7. RF EXPOSURE REQUIREMENTS [§§ 1.1310 & 2.1091]

5.7.1. Limits

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

Limits for Maximum Permissible Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
(B) Limits for General Population/Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30

Note: f is frequency in MHz

5.7.2. Method of Measurements

Calculation Method of RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where,
 P: power input to the antenna in mW
 EIRP: Equivalent (effective) isotropic radiated power.
 S: power density mW/cm²
 G: numeric gain of antenna relative to isotropic radiator
 r: distance to centre of radiation in cm

$$r = \sqrt{\frac{PG}{4\pi \cdot S}} = \sqrt{\frac{EIRP}{4\pi \cdot S}}$$

5.7.3. Evaluation of RF Exposure Compliance Requirements

Maximum RF Power conducted, **P** = 58 mW

Maximum Antenna Gain, **G** = 0 dBi = 1 numeric

MPE Limit for General Population/Uncontrolled Exposure, **S** = 0.2 mW/cm² (see above table)

$$\text{(Minimum Safe Distance, } r) = \sqrt{\frac{PG}{4 \cdot \pi \cdot S}} = \sqrt{\frac{(58)(1)}{4 \cdot \pi \cdot (0.2)}} \approx 4.8\text{cm}$$

Calculated RF Safety Distance for General Population/Uncontrolled Exposure = 4.8 cm

Recommended Distance to specify in the user manual: 20 cm

EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	R/S	FSEK	834157/005	9 kHz - 40 GHz	30 Jul 2013
Attenuator (30dB)	Aeroflex/Weinschel	46-30-34	BR9127	DC - 18 GHz	Cal. on use
High Pass Filter	Mini Circuit	SHP 250	--	Cut off 250 MHz	Cal. on use
Frequency Counter	EIP	545A	2683	10 Hz - 18 GHz	01 Mar 2013
Infinium Digital Oscilloscope	Hewlett-Packard	54801A	US38380192	DC - 500 MHz 1G sampling	15 Jun 2013
Environmental Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177 °C	16 Aug 2013
RF Synthesized Signal Generator	HP	8648C	3343U00391	100 kHz -3200 MHz AM/ FM/ PM	14 Dec 2012
Power Supply	Tenma	72-7295	490300297	1-40V DC 5A	Cal. on use
Horn Antenna	ETS-LINDGREN	3117	00119425	1-18GHz	02 Apr 2013
Preamplifier	Hewlett Packard	8449B	3008A00769	1-26.5GHz	01 Dec 2012
High Pass Filter	Mini Circuit	SHP 600	--	Cut off 560 MHz	Cal. on use
Power Supply	XANTREX	XKW 60-50	26509	0-60V 0-50A DC	Cal. on use
Attenuator	Aeroflex/Weinschel	23-20-34	BH7876	DC - 18 GHz	Cal. on use
Antenna	ETS	93148	1101	200 - 2000 MHz	22 Mar 2013
Antenna	EMCO	3142C	26873	26 - 3000MHz	04 May 2013
EMI Receiver	R/S	ESU 40	100037	20 Hz-40 GHz	19 Mar 2013
Preamplifier	AH System	Pam-0118	225	20MHz-18GHz	16 Mar 2013
Power Meter	Hewlett Packard	438A	3008A06729	100K--50G sensor dependent	24 Feb 2013
Power Sensor	Hewlett Packard	8482A	US37295944	0.1 - 4GHz	17 Feb 2013

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File #: METO-002F80
 January 3, 2013

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

	Line Conducted Emission Measurement Uncertainty (150 kHz – 30 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 1.57	± 1.8
U	Expanded uncertainty U: $U = 2u_c(y)$	± 3.14	± 3.6

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.15	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.30	± 5.2

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.39	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.78	± 5.2

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 1.87	Under consideration
U	Expanded uncertainty U: $U = 2u_c(y)$	± 3.75	Under consideration

EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER MEASUREMENTS

The following shall be applied to the combination(s) of the radio device and its intended antenna(e).

- If the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
 - The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
 - The measurement shall be performed using normal operation of the equipment with modulation.
- Test procedure shall be as follows:

Step 1: Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, $x = \text{Tx on} / (\text{Tx on} + \text{Tx off})$ with $0 < x < 1$, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

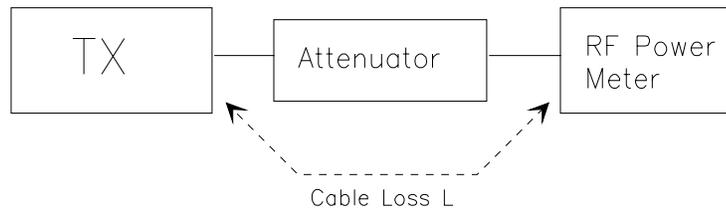
Step 2: Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x , and the applicable antenna assembly gain "G" in dBi, according to the formula:

$$\text{EIRP} = \text{A} + \text{G} + 10\log(1/x)$$

{ $X = 1$ for continuous transmission $\Rightarrow 10\log(1/x) = 0 \text{ dB}$ }

Figure 1.



8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

8.2.1. Maximizing RF Emission Level (E-Field)

- (a) The measurements was performed with full rf output power and modulation.
- (b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
- (c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
- (d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
- (e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (f) Set the EMI Receiver and #2 as follows:

Center Frequency: test frequency
Resolution BW: 100 kHz
Video BW: same
Detector Mode: positive
Average: off
Span: 3 x the signal bandwidth

- (g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (h) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
- (k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
- (l) Repeat for all different test signal frequencies

8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

- (a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency: equal to the signal source
Resolution BW: 100 kHz
Video BW: VBW > RBW
Detector Mode: positive
Average: off
Span: 3 x the signal bandwidth

- (b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
 - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
 - ◆ HORN antenna for frequency above 1 GHz }.(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
(f) Use one of the following antenna as a receiving antenna:
 - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
 - ◆ HORN antenna for frequency above 1 GHz }.(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
(i) Tune the EMI Receivers to the test frequency.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$

$$\text{EIRP} = P + G1 = P3 + L2 - L1 + A + G1$$

$$\text{ERP} = \text{EIRP} - 2.15 \text{ dB}$$

Total Correction factor in EMI Receiver # 2 = $L2 - L1 + G1$

Where: P: Actual RF Power fed into the substitution antenna port after corrected.
P1: Power output from the signal generator
P2: Power measured at attenuator A input
P3: Power reading on the Average Power Meter
EIRP: EIRP after correction
ERP: ERP after correction

- (o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
(p) Repeat step (d) to (o) for different test frequency
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

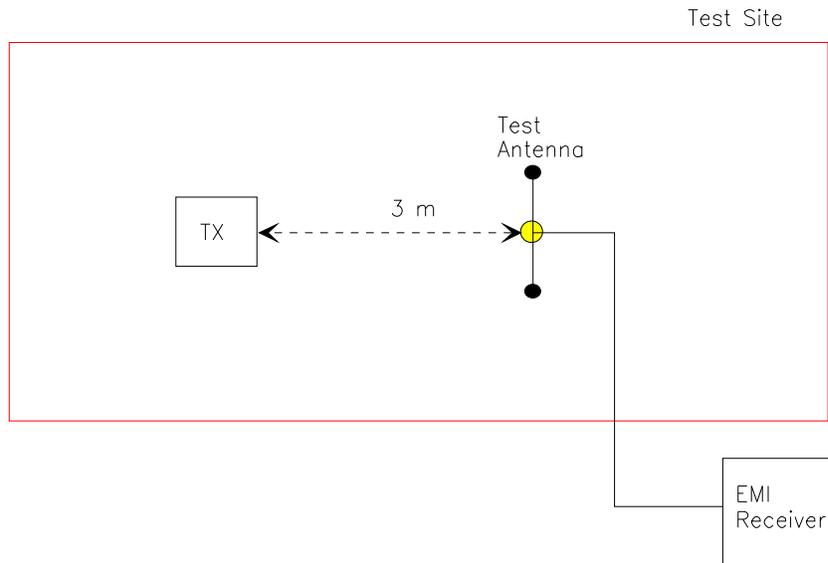


Figure 3

