

FCC PART 80
IC RSS-182, ISSUE5 JANUARY 2012
MEASUREMENT AND TEST REPORT

TEST REPORT

For

Raymarine UK Limited

Raymarine UK Limited, Marine House, Cartwright Drive,
Fareham, Hampshire, PO15 5RJ, England

FCC ID: PJ5-RAY70
IC: 4069B-RAY70D

Report Type: Original Report	Product Type: RAY70 DSC Class D VHF Radio
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Report Number: RSZ141203005	
Report Date: 2014-12-22	
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Note: This test report is prepared for the customer shown above and for the equipment described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp.

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

The *Raymarine UK Limited*'s product, model number: *RAY70 (FCC ID: PJ5-RAY70/ IC: 4069B-RAY70D)* or the "EUT" in this report was a *RAY70 DSC Class D VHF Radio*, which was measured approximately: 204.6 mm (L) × 199.0 mm (W) × 98.5 mm (H), rated with input voltage: DC 12 V.

** All measurement and test data in this report was gathered from production sample serial number: 1412033 (Assigned by Shenzhen BACL). The EUT supplied by the applicant was received on 2014-12-03.*

Objective

This test report is prepared on behalf of *Raymarine UK Limited* in accordance with Part 2 and Part 80 of the Federal Communication Commissions rules.

Related Submittal(s)/Grant(s)

No related submittal(s)

Test Methodology

All tests and measurements indicated in this document were performed in accordance with the IC RSS-182 and the Code of federal Regulations Title 47 Part 2, Sub-part J as well as the following individual parts:

Part 80 –Stations in the Maritime Services

Applicable Standards: TIA 603-D and ANSI 63.4-2009.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters. Applicable Standards: RSS-182, Issue5 January 2012. Radio Transmitters and Receivers Operating in the Land Mobile and Fixed Services in the Frequency Range 156-162.5 MHz

Measurement uncertainty with radiated emission is 5.91 dB for 30MHz-1GHz.and 4.92 dB for above 1GHz, 1.95dB for conducted measurement.

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F, the 3rd Phase of WanLi Industrial Building, ShiHua Road, FuTian Free Trade Zone Shenzhen, Guangdong, China.

Test site at Bay Area Compliance Laboratories Corp. (Shenzhen) has been fully described in reports submitted to the Federal Communication Commission (FCC). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on December 06, 2010. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2009.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 382179. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in a test mode which has been done in the factory.

Equipment Modifications

No modification was made to the EUT tested.

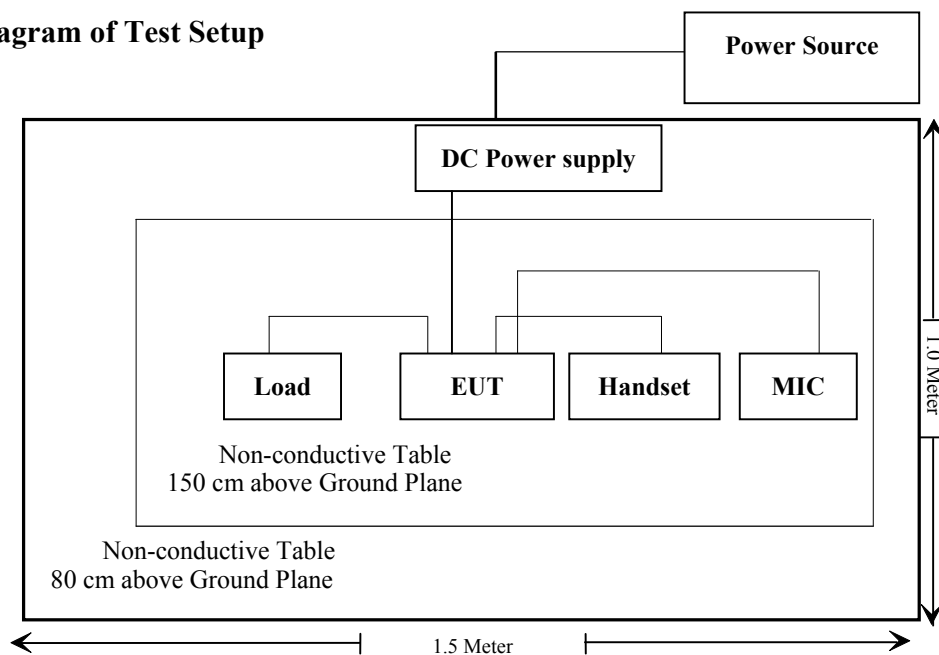
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
DC Power Supply	MEAN WELL	SP-320	N/A

External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielding Detachable DC Cable	2.5	DC Power Supply	EUT
Shielding Detachable RF Cable	0.3	EUT Tx port	Load
Un-shielding Detachable AC Cable	1.8	Power Source	DC Power Supply

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Results
FCC Part §1.1307 (b)(1), §2.1091;RSS-102	Maximum Permissible Exposure (MPE)	Compliance
FCC Part §2.1046,§80.215; RSS-182 § 7.5	RF Output Power	Compliance
FCC Part §2.1047,§80.213; RSS-182 § 7.3,7.8	Modulation requirements	Compliance
FCC Part §2.1049,§80.205; RSS-182 § 7.3	Bandwidth	Compliance
FCC Part §2.1051,§80.211 RSS-182 § 7.9	Emission limitations	Compliance
FCC Part §80.217	Suppression of Interference Aboard Ships	Compliance
FCC Part §2.1051,§80.211; RSS-182 § 7.9	Radiated Spurious Emissions	Compliance
FCC Part §2.1055,§80.209; RSS-182 § 7.4	Transmitter Frequency Tolerances	Compliance
RSS-182 § 7.11; RSS-Gen §7	Receiver Spurious Emissions	Compliance

FCC§1.1307 (b) (1) & §2.1091& RSS-102 - MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 1.1307 (b)(1), 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f ²)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f ²)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

According to RSS-102:

4.2 RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-1	280	2.19	-	6
1-10	280/ f	2.19/ f	-	6
10-30	28	2.19/ f	-	6
30-300	28	0.073	2*	6
300-1500	1.585 $f^{0.5}$	0.0042 $f^{0.5}$	$f/150$	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10 ⁻⁴ $f^{0.5}$	6.67 x 10 ⁻⁵ f	616000/ $f^{1.2}$

Note: f is frequency in MHz.

* Power density limit is applicable at frequencies greater than 100 MHz.

4.4 RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-1	600	4.9	-	6
1-10	600/ f	4.9/ f	-	6
10-30	60	4.9/ f	-	6
30-300	60	0.163	10*	6
300-1500	3.54 $f^{0.5}$	0.0094 $f^{0.5}$	$f/30$	6
1500-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ $f^{1.2}$
150000-300000	0.354 $f^{0.5}$	9.4 x 10 ⁻⁴ $f^{0.5}$	3.33 x 10 ⁻⁴ f	616000/ $f^{1.2}$

Note: f is frequency in MHz.

*Power density limit is applicable at frequencies greater than 100 MHz.

Result**Calculated Formulary:**

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm² for FCC, and W/m² for IC)

P = power input to the antenna (in appropriate units, e.g., mW for FCC, and W for IC).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm for FCC, and m for IC)

For FCC calculation:

Frequency (MHz)	Antenna Gain		Conducted Power (W)	The minimum Distance (m)	Calculated RF Exposure (mW/cm ²)	MPE Limit (mW/cm ²)	Note
	(dBi)	(numeric)					
156.8	3	2	25	1.5	0.1769	1.0	Controlled Environment
156.8	3	2	25	1.5	0.1769	0.2	UnControlled Environment

For IC calculation:

Frequency (MHz)	Antenna Gain		Conducted Power (W)	The minimum Distance (m)	Calculated RF Exposure (W/m ²)	MPE Limit (W/m ²)	Note
	(dBi)	(numeric)					
156.8	3	2	25	1.5	1.769	10	Controlled Environment
156.8	3	2	25	1.5	1.769	2.0	UnControlled Environment

Note: The Maximum power is 25 W which declared by manufacture

Radiation Exposure Statement:

To comply with RF exposure requirements, the minimum permissible distance is 1.5 m required between the antenna and the body of the user or nearby persons.

Result: Compliance

FCC §2.1046 & §80.215 & RSS-182 - RF OUTPUT POWER

Applicable Standard

FCC §2.1046 and §80.215 and RSS-182, Issue 4 §7.5

Ship station limit: 25W

Test Procedure

Conducted RF Output Power:

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

Spectrum Analyzer Setting:

R B/W	Video B/W
100 kHz	300 kHz

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	837405/023	2014-08-22	2015-08-22
HP Agilent	RF Communication test set	8920A	3325U00859	2014-06-03	2015-06-03
Agilent	Universal Frequency Center	Agilent 53220A	NCR	2014-10-09	2015-10-08
HP	ESG SERIES Signal Generator	E4421B	NCR	2014-02-21	2015-02-20
ICOM	GPS	IC-M91D	05081894	NCR	NCR

Test Data

Environmental Conditions

Temperature:	19~22 °C
Relative Humidity:	50~51 %
ATM Pressure:	100.0~101.0 kPa

The testing was performed by Candy Li from 2014-12-08 to 2014-12-17.

Test Mode: Transmitting

Test Result: Compliance. Please refer to following table.

Output power for Radio telephony:

Frequency	Power Level	Output Power (dBm)	Output Power (W)
156.025	High	43.54	22.59
	Low	28.71	0.74
156.8	High	43.56	22.70
	Low	28.68	0.74
157.425	High	43.57	22.75
	Low	28.76	0.75

Output power for DSC:

Frequency	Test Mode	Power Level	Output Power (dBm)	Output Power (W)
156.525	1300 Hz	High	43.57	22.75
		Low	28.69	0.74
	2100 Hz	High	43.61	22.96
		Low	28.65	0.73

Note: Ship station limit (25W)

FCC §2.1047 §80.213 & RSS-182 - MODULATION REQUIREMENTS**Applicable Standard**

FCC §2.1047 and §80.213 §RSS-182, Issue 4 §7.3, §7.8

- (a) Equipment which utilizes voice modulated communication shall show the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz. for equipment which is required to have a low pass filter, the frequency response of the filter, or all of the circuitry installed between the modulation limited and the modulated stage shall be supplied.
- (b) Equipment which employs modulation limiting, a curve showing the percentage of modulation versus the modulation input voltage shall be supplied.

Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
HP	RF Communication Test Set	8920A	3438A05201	2014-06-14	2015-06-13
LEADER	MILLIVOLTMETER	LMV-181A	6041126	2014-06-09	2015-06-09
Agilent	Universal Frequency Center	Agilent 53220A	NCR	2014-10-09	2015-10-08
HP	ESG SERIES Signal Generator	E4421B	NCR	2014-02-21	2015-02-20
ICOM	GPS	IC-M91D	05081894	NCR	NCR

Test Procedure

Test Method: TIA/EIA-603 2.2.3

Test Data**Environmental Conditions**

Temperature:	22~25 °C
Relative Humidity:	48~50 %
ATM Pressure:	100.0~101.0 kPa

The testing was performed by Candy Li from 2014-12-17 to 2014-12-19.

Test Mode: Transmitting

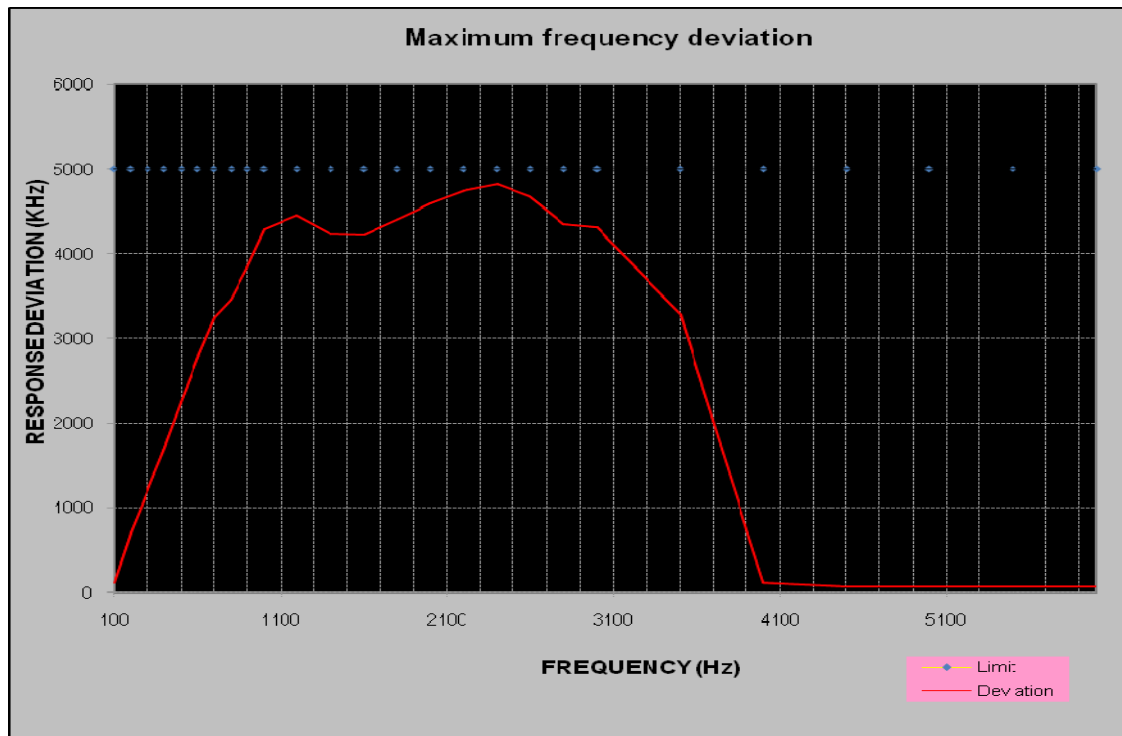
Result: Compliance.

Analog Modulation:

Maximum Deviation

Carrier Frequency: 156.8 MHz

Modulation Frequency (Hz)	Maximum Deviation (Hz)	Limit (Hz)
100	112	5000
200	702	5000
300	1191	5000
400	1712	5000
500	2252	5000
600	2751	5000
700	3248	5000
800	3464	5000
900	3837	5000
1000	4291	5000
1200	4457	5000
1400	4229	5000
1600	4226	5000
1800	4404	5000
2000	4596	5000
2200	4752	5000
2400	4827	5000
2600	4683	5000
2800	4352	5000
3000	4315	5000
3000	4315	5000
3500	3282	5000
4000	110	5000
4500	69	5000
5000	67	5000
5500	67	5000
6000	64	5000



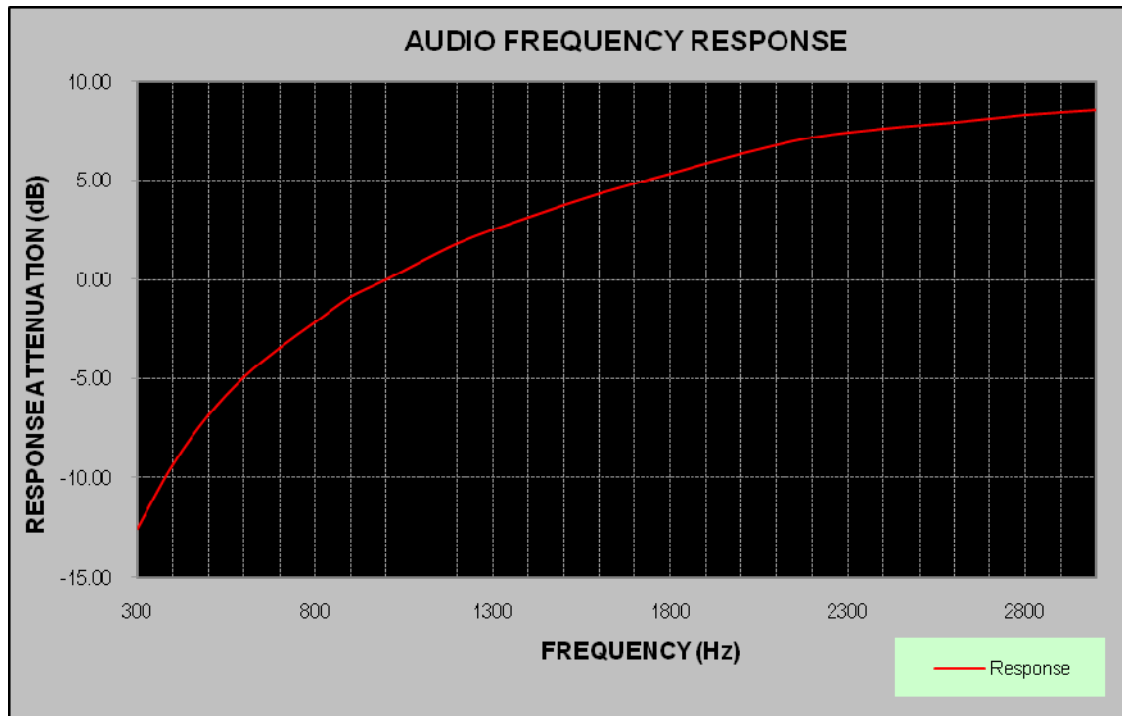
Carrier Frequency: 156.525 MHz, For DSC

Test Mode	Frequency Deviation(kHz)
1300Hz	2.573
2100Hz	3.962

Audio Frequency Response

Carrier Frequency: 156 MHz, Channel Separation: 25 kHz

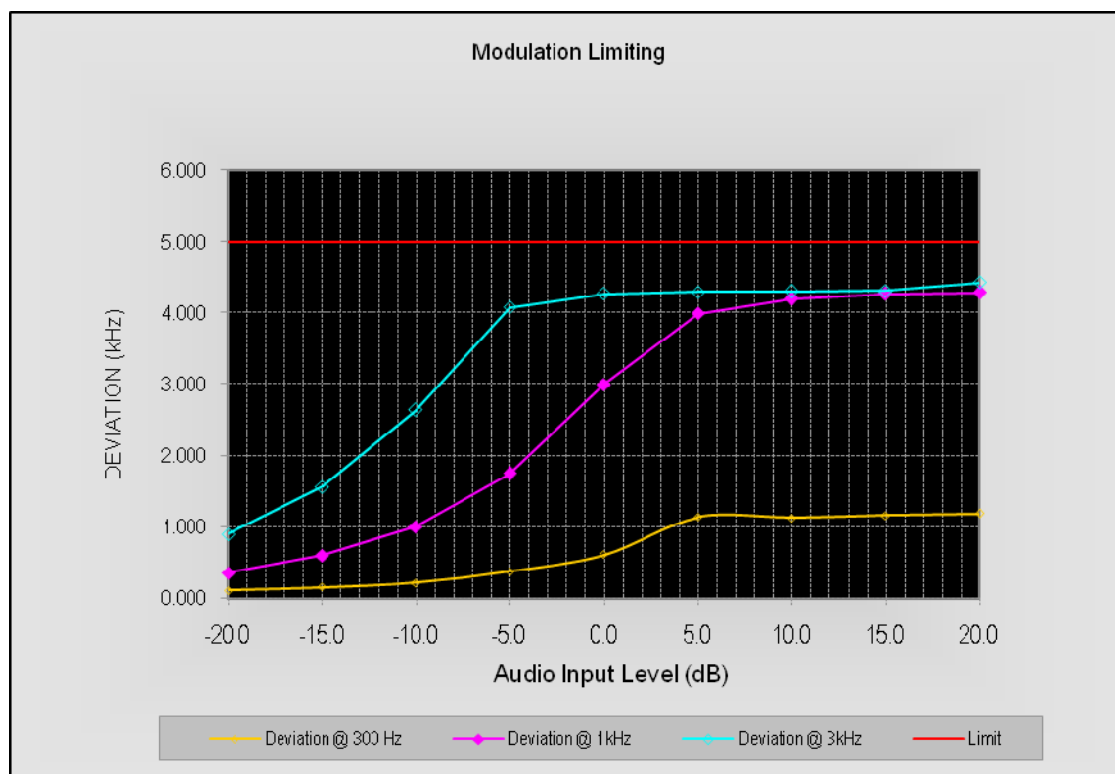
Modulation Frequency (kHz)	Response Data (dB)
300	-12.54
400	-9.29
500	-6.84
600	-4.93
700	-3.48
800	-2.12
900	-0.91
1000	0.00
1200	1.80
1400	3.15
1600	4.33
1800	5.34
2000	6.32
2200	7.14
2400	7.63
2600	7.93
2800	8.28
3000	8.54



MODULATION LIMITING

Carrier Frequency: 156.8 MHz

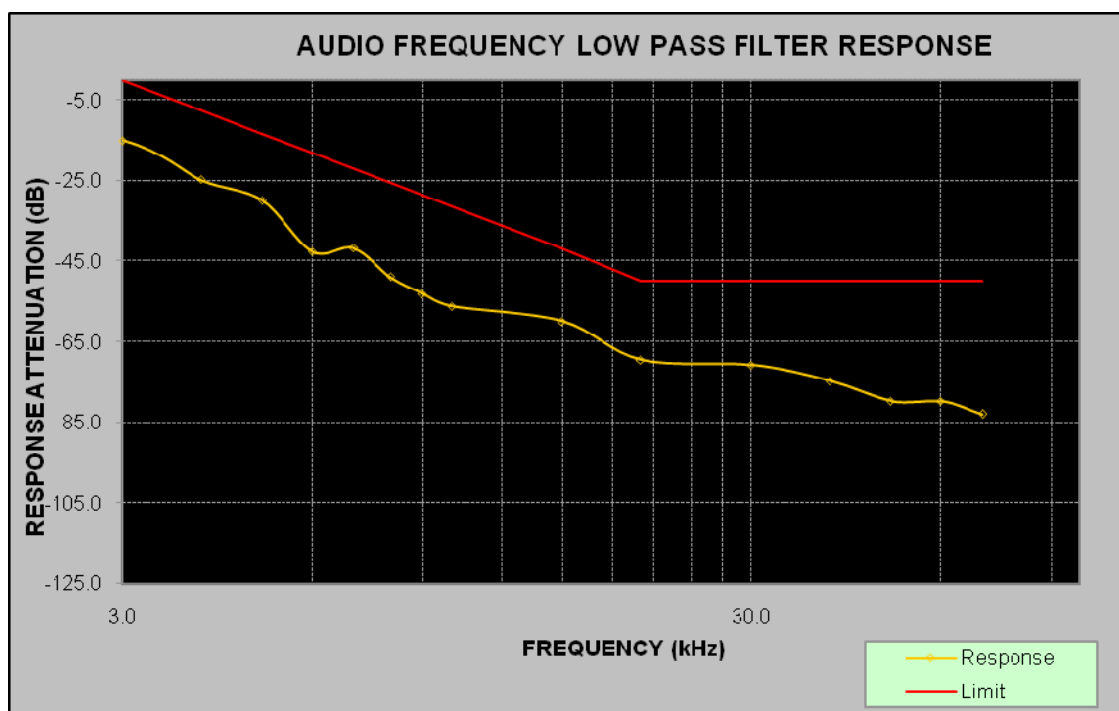
Audio Input Level [dB]	Frequency Deviation (kHz)			Limit [kHz]
	@ 300 Hz	@ 1kHz	@ 3 kHz	
20.0	1.187	4.289	4.431	5.0
15.0	1.162	4.270	4.312	5.0
10.0	1.127	4.197	4.303	5.0
5.0	1.139	3.994	4.295	5.0
0.0	0.612	3.000	4.274	5.0
-5.0	0.374	1.751	4.081	5.0
-10.0	0.221	1.008	2.642	5.0
-15.0	0.156	0.602	1.562	5.0
-20.0	0.112	0.360	0.904	5.0



Audio Frequency Low Pass Filter Response

Carrier Frequency: 156.8 MHz

Audio Frequency (kHz)	Response Attenuation (dB)	FCC Limit (dB)
1.0	0.0	/
3.0	-15.0	0.0
4.0	-24.7	-7.5
5.0	-29.8	-13.3
6.0	-42.5	-18.1
7.0	-41.7	-22.1
8.0	-48.8	-25.6
9.0	-53.0	-28.6
10.0	-56.1	-31.4
15.0	-59.9	-41.9
20.0	-69.4	-50.0



FCC §2.1049 & §80.205 & RSS-182 –BANDWIDTH**Applicable Standard**

FCC §2.1049 and §80.205, RSS-182 §7.3

(a) An emission designator shows the necessary bandwidth for each class of emission of a station except that in ship earth stations it shows the occupied or necessary bandwidth, whichever is greater. The class of emission and corresponding emission designator and authorized bandwidth can refer to §80.205

(b) For land stations the maximum authorized frequency deviation for F3E or G3E emission is as follows:

(1) 5 kHz in the 72.0-73.0 MHz, 75.4-76.0 MHz and 156-162 MHz bands;

(2) 15 kHz for stations which were authorized for operation before December 1, 1961, in the 73.0-74.6 MHz band.

Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set at 300 Hz and the spectrum was recorded in the frequency band ± 30 kHz from the carrier frequency.

Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	837405/023	2014-08-22	2015-08-22
HP	RF Communication Test Set	8920A	3438A05201	2014-06-14	2015-06-13
Agilent	Universal Frequency Center	Agilent53220A	NCR	2014-10-09	2015-10-08
HP	ESG SERIES Signal Generator	E4421B	NCR	2014-02-21	2015-02-20
ICOM	GPS	IC-M91D	05081894	NCR	NCR

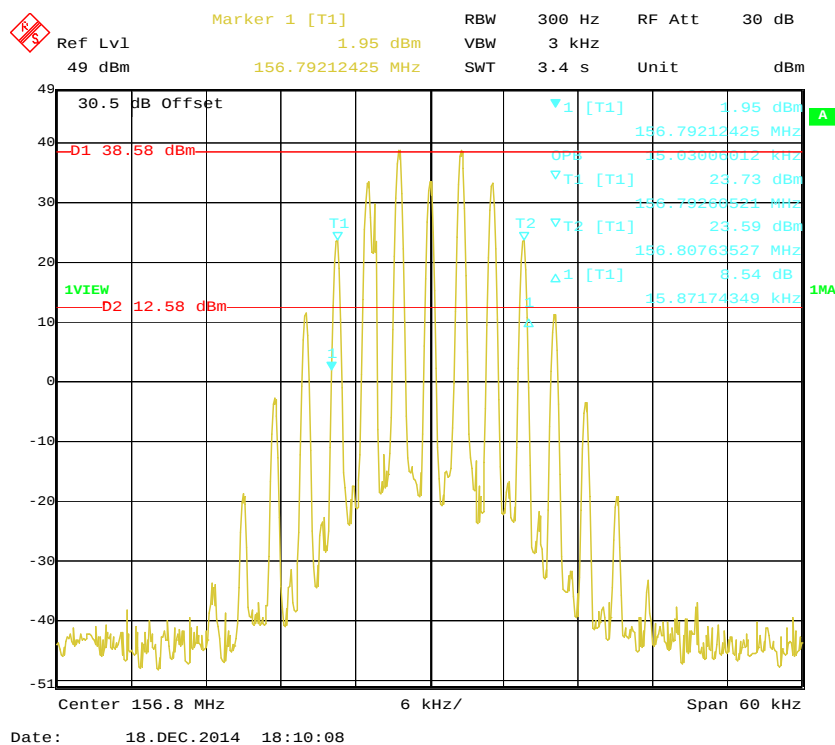
Test Data**Environmental Conditions**

Temperature:	20 °C
Relative Humidity:	49 %
ATM Pressure:	101.0 kPa

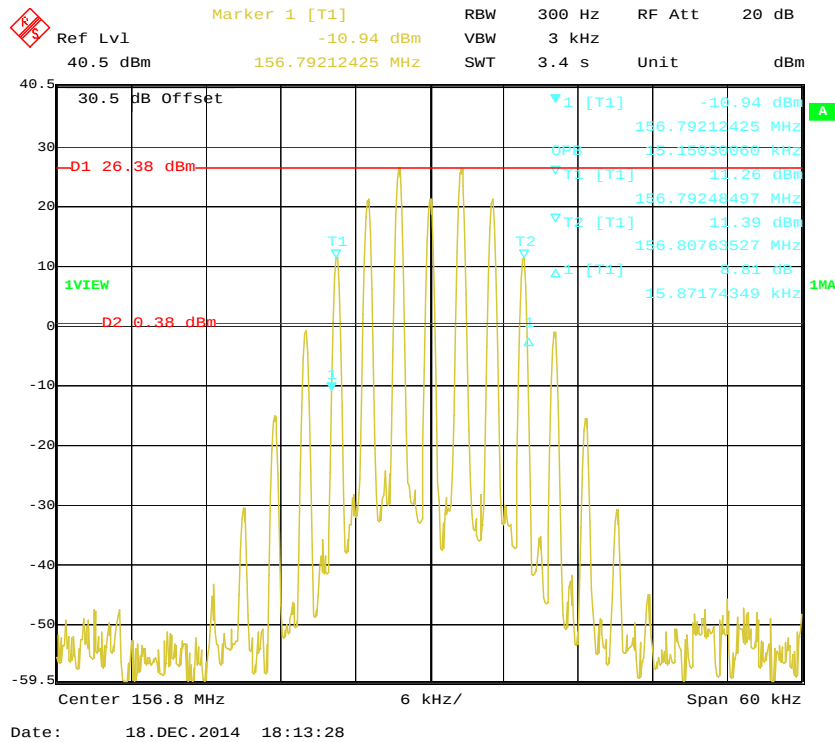
The testing was performed by Candy Li on 2014-12-18.

Test Mode: Transmitting

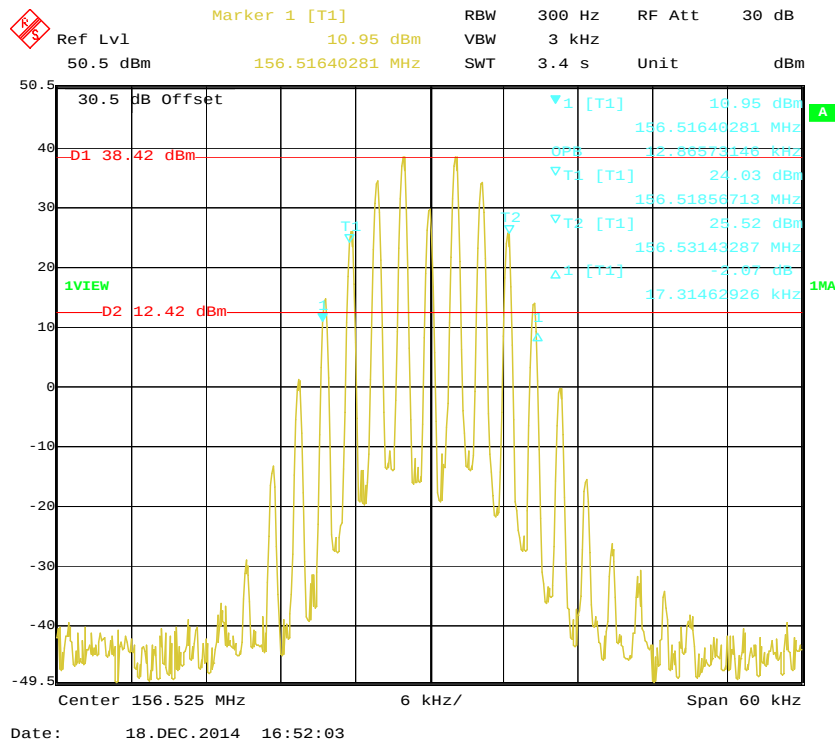
Test mode		Frequency(MHz)	Power level	99% Bandwidth(kHz)	26 dB Emission Bandwidth(kHz)
Radio Telephony		156.8	High	15.03	15.87
			Low	15.15	15.87
DSC	2100Hz	156.525	High	12.87	17.31
			Low	12.87	17.31
	1300Hz		High	8.06	10.94
			Low	8.06	10.94

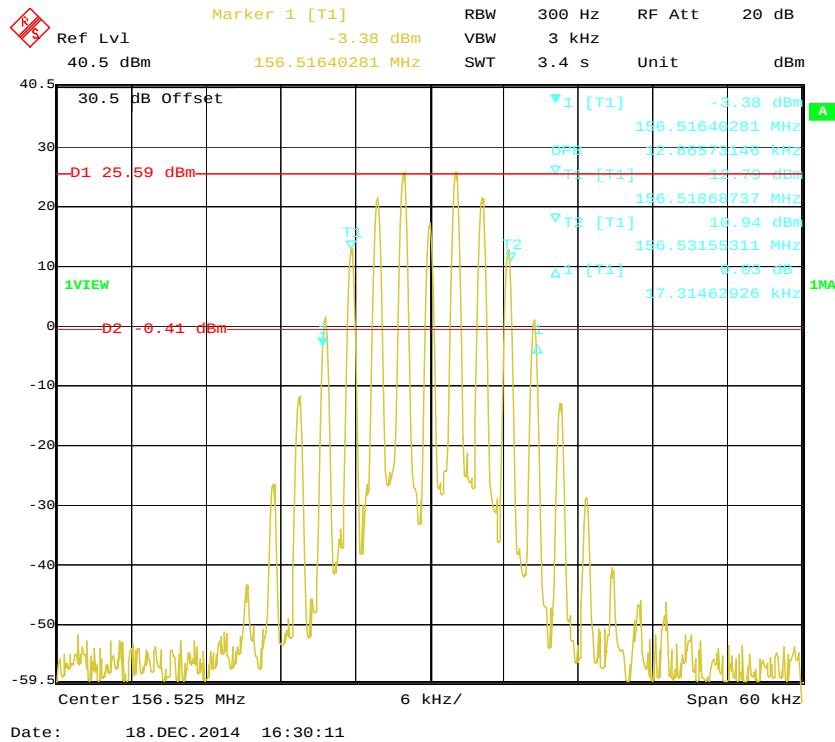
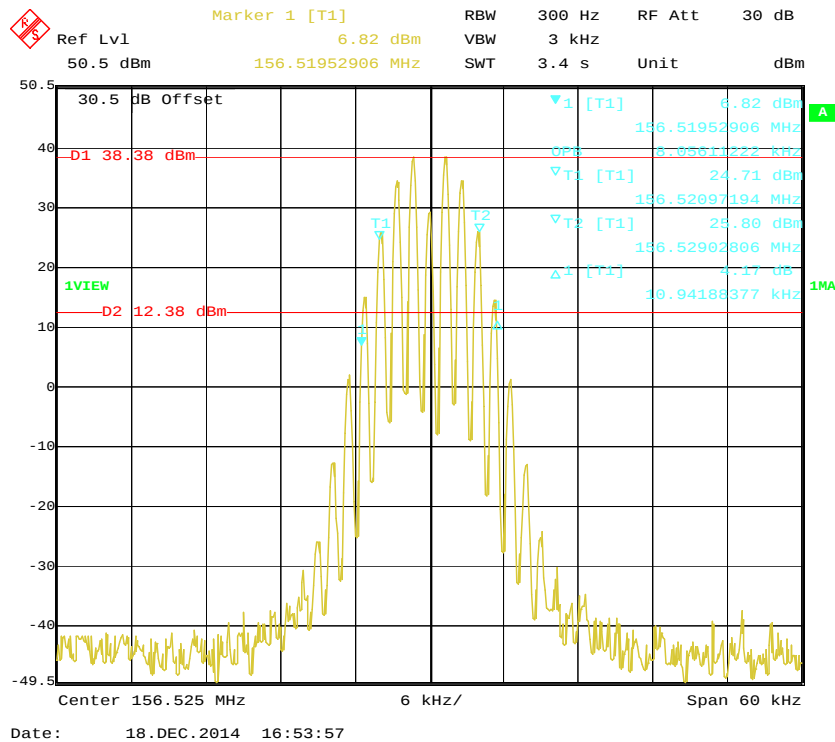
99% Occupied Bandwidth & 26 dB Emissions Bandwidth (156.8 MHz, High Power)

99% Occupied Bandwidth & 26 dB Emissions Bandwidth (156.8 MHz, Low Power)

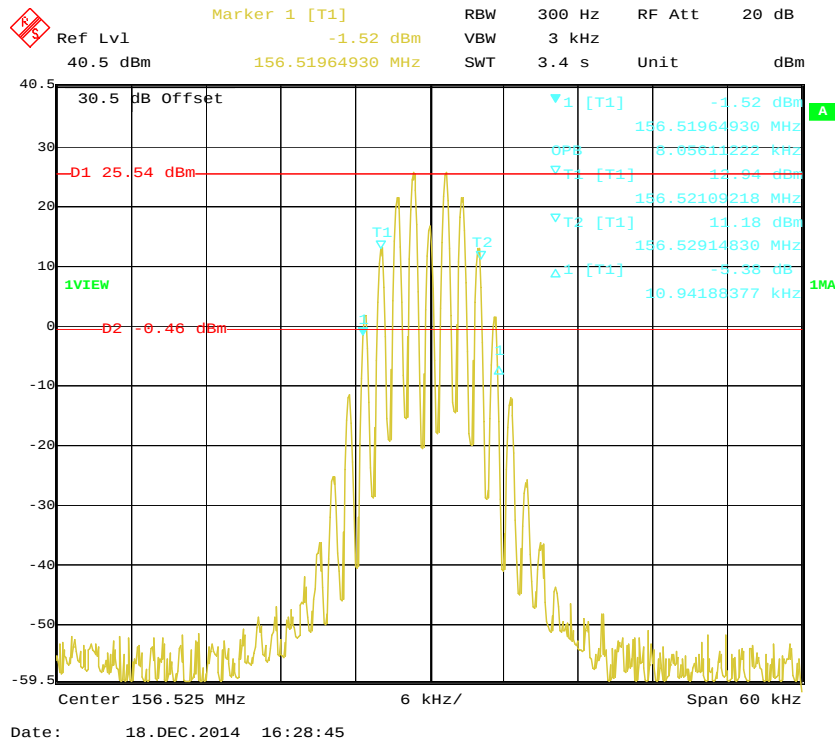


99% Occupied Bandwidth & 26 dB Emissions Bandwidth (156.525 MHz, High Power)



99% Occupied Bandwidth & 26 dB Emissions Bandwidth (156.525 MHz, DSC2100, Low Power)**99% Occupied Bandwidth & 26 dB Emissions Bandwidth (156.525 MHz, DSC1300, High Power)**

99% Occupied Bandwidth & 26 dB Emissions Bandwidth (156.525 MHz, DSC1300, Low Power)



§2.1051 & §80.211 & RSS-182 - EMISSION LIMITATIONS.**Applicable Standard**

According to FCC §80.211 & RSS-182 §7.9

Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz for below 1GHz, and 1MHz for above 1GHz. sufficient scans were taken to show any out of band emissions up to 10th harmonic.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	837405/023	2014-08-22	2015-08-22
HP Agilent	RF Communication test set	8920A	3325U00859	2014-06-03	2015-06-03
Agilent	Universal Frequency Center	Agilent53220A	NCR	2014-10-09	2015-10-08
HP	ESG SERIES Signal Generator	E4421B	NCR	2014-02-21	2015-02-20
ICOM	GPS	IC-M91D	05081894	NCR	NCR

Test Data**Environmental Conditions**

Temperature:	19~22 °C
Relative Humidity:	50~51 %
ATM Pressure:	100.0~101.0 kPa

The testing was performed by Candy Li from 2014-12-17 to 2014-12-18

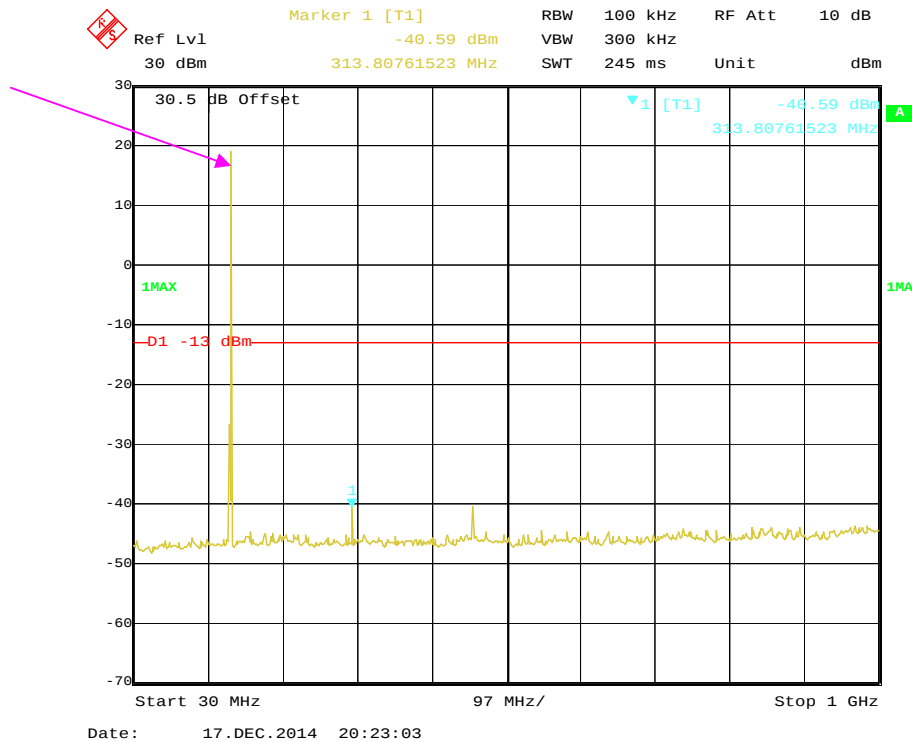
Test Mode: Transmitting

Please refer to the following plots.

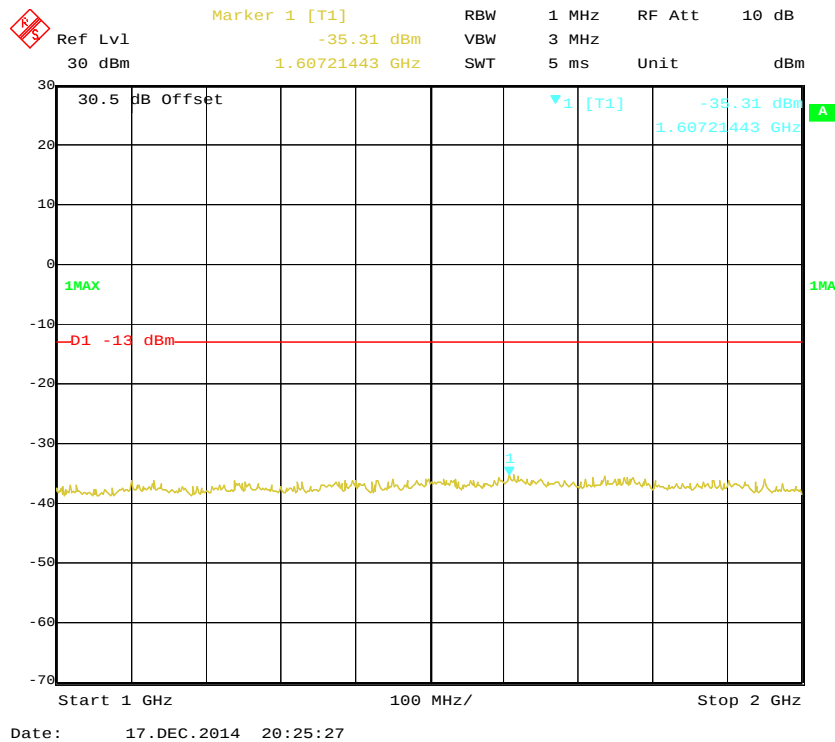
Radio Telephony (156.8 MHz):

30 MHz – 1 GHz

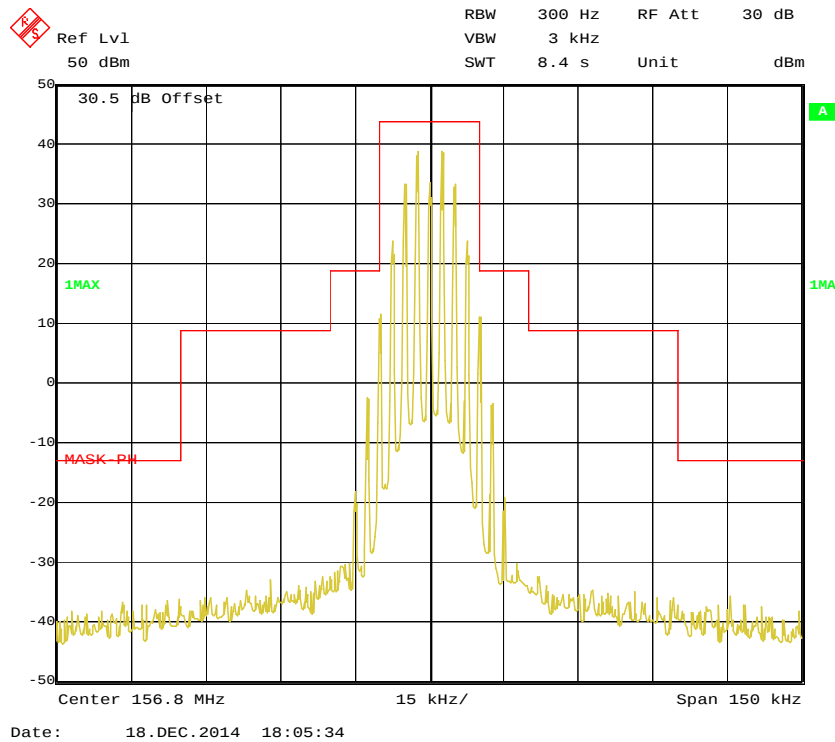
Fund. test with notch filter



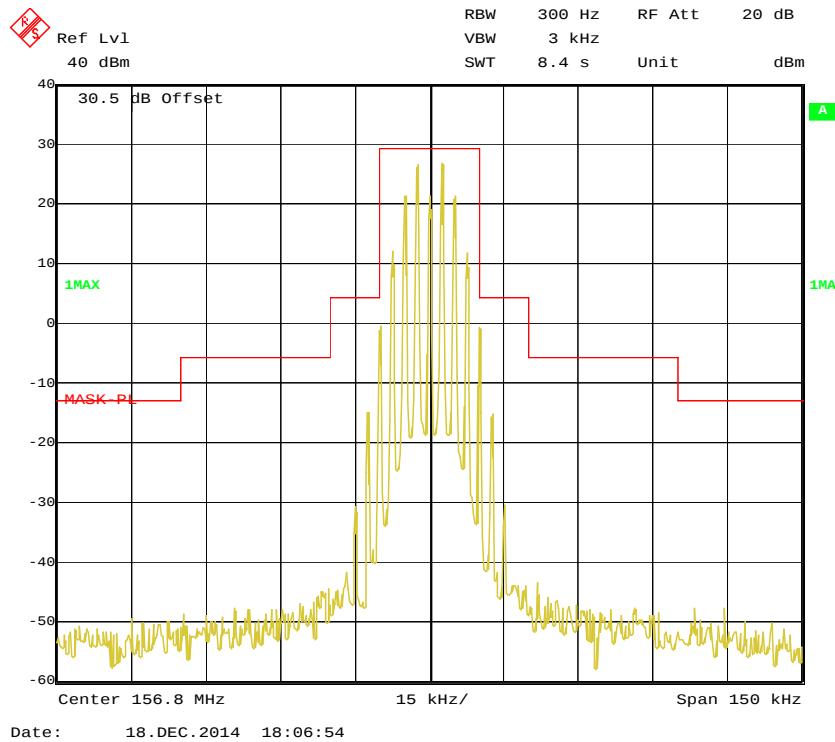
1 GHz – 2 GHz



Emission Mask, High Power



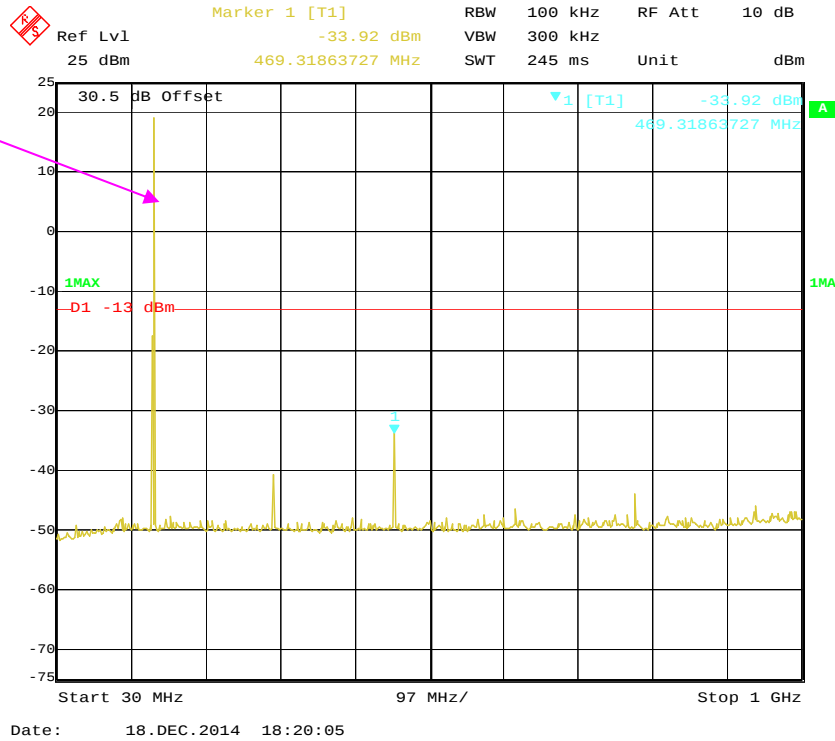
Emission Mask, Low Power



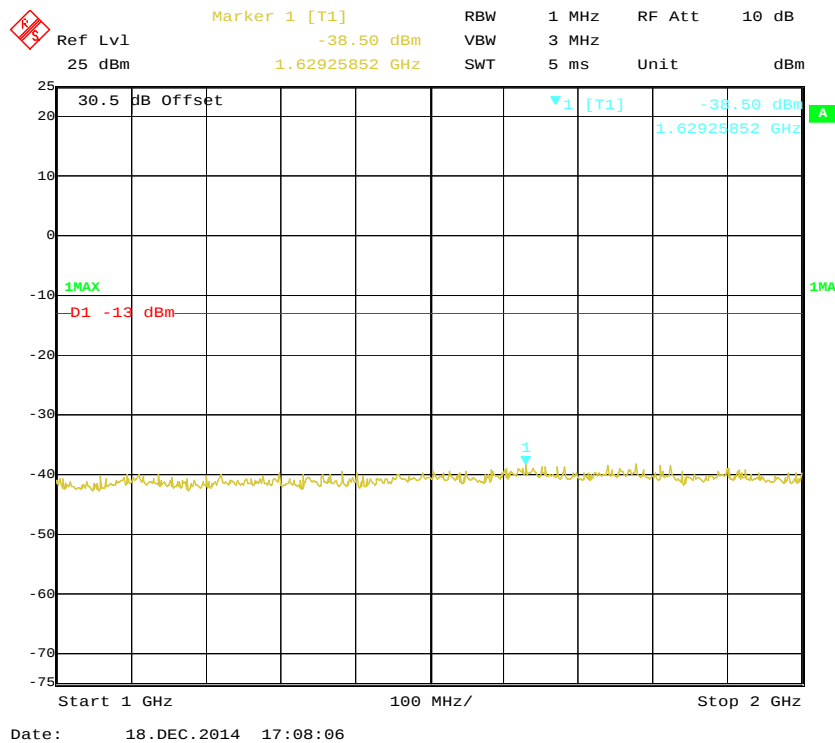
DSC (152.525 MHz):

30 MHz – 1 GHz (DSC1300 Hz)

Fund.test with
notch filter

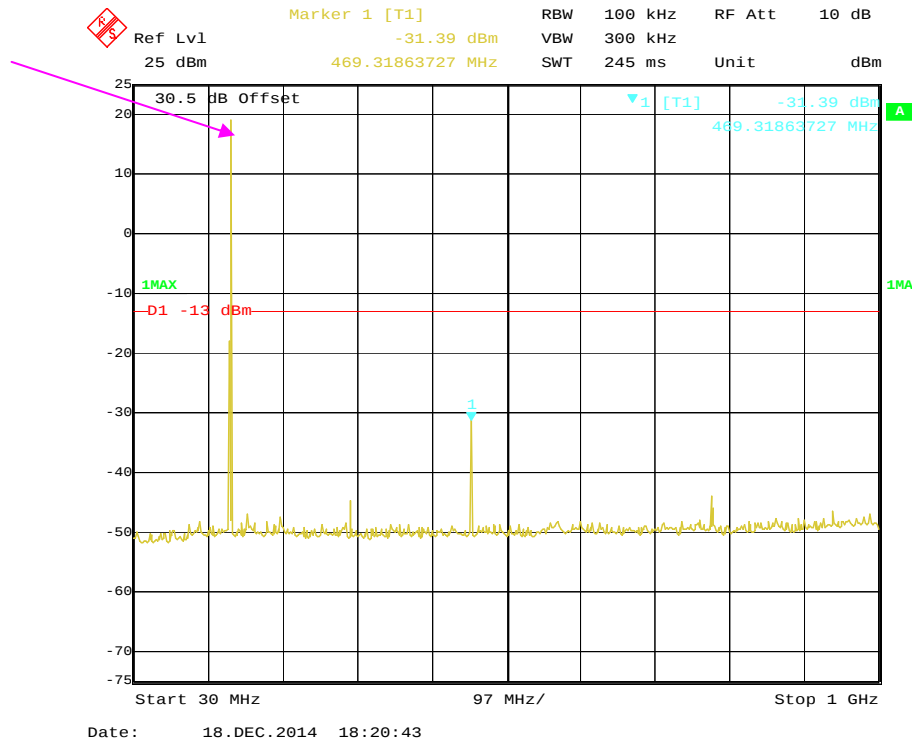


1 GHz – 2 GHz (DSC1300 Hz)

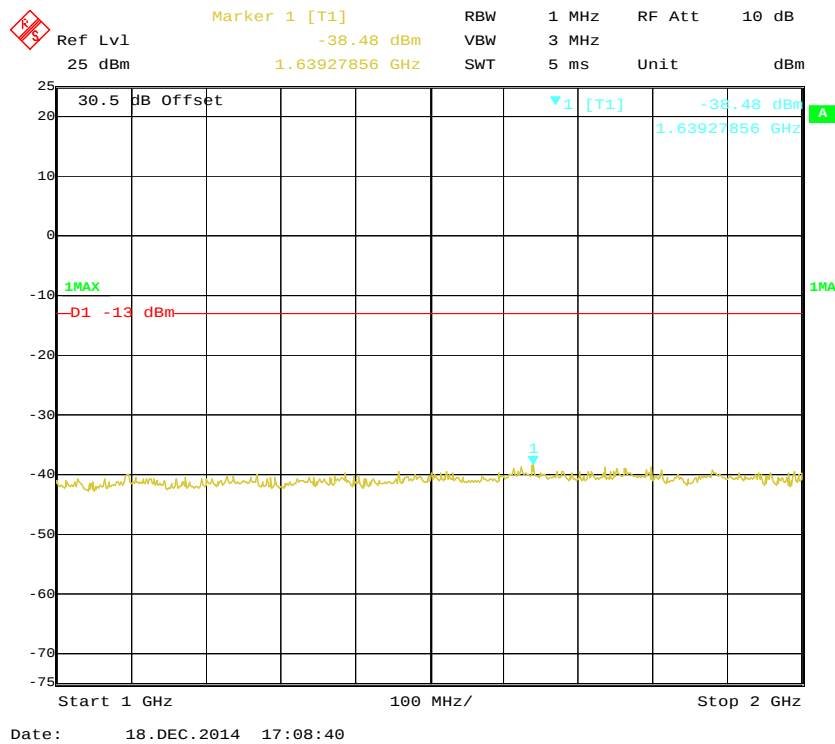


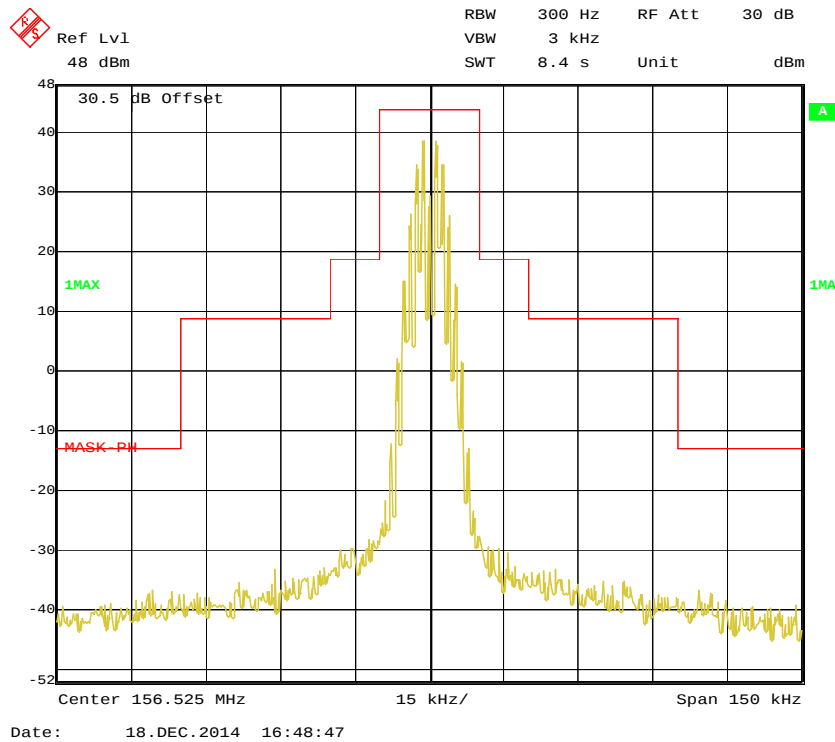
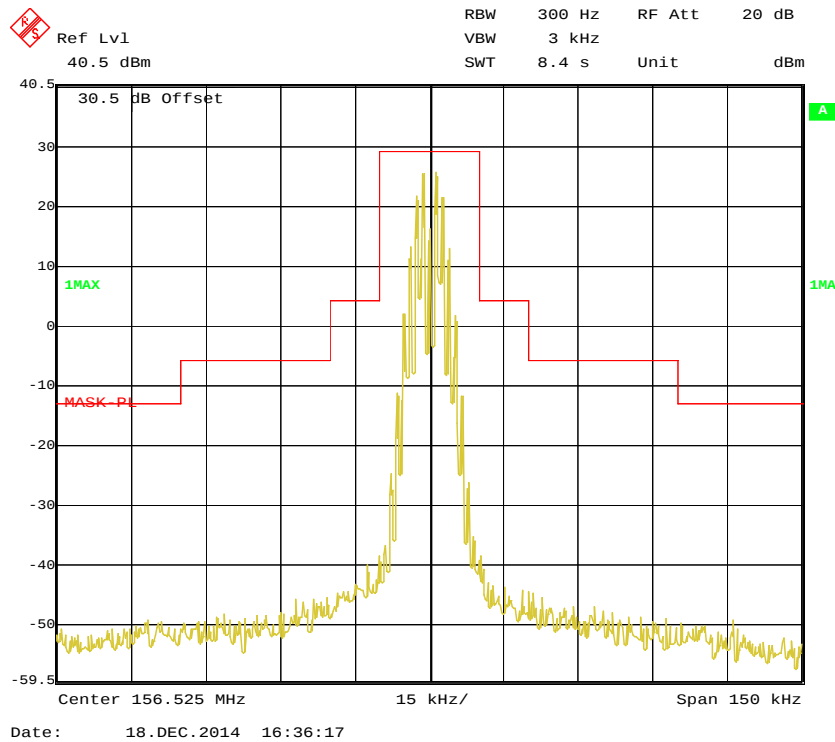
30 MHz – 1 GHz (DSC2100 Hz)

Fund. test with notch filter

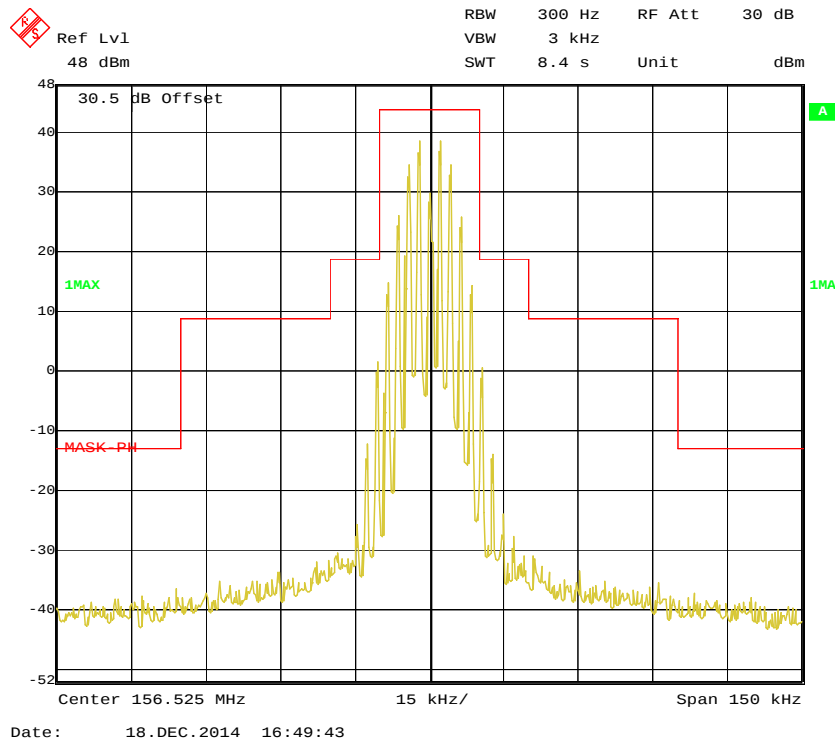


1 GHz – 2 GHz (DSC2100Hz)

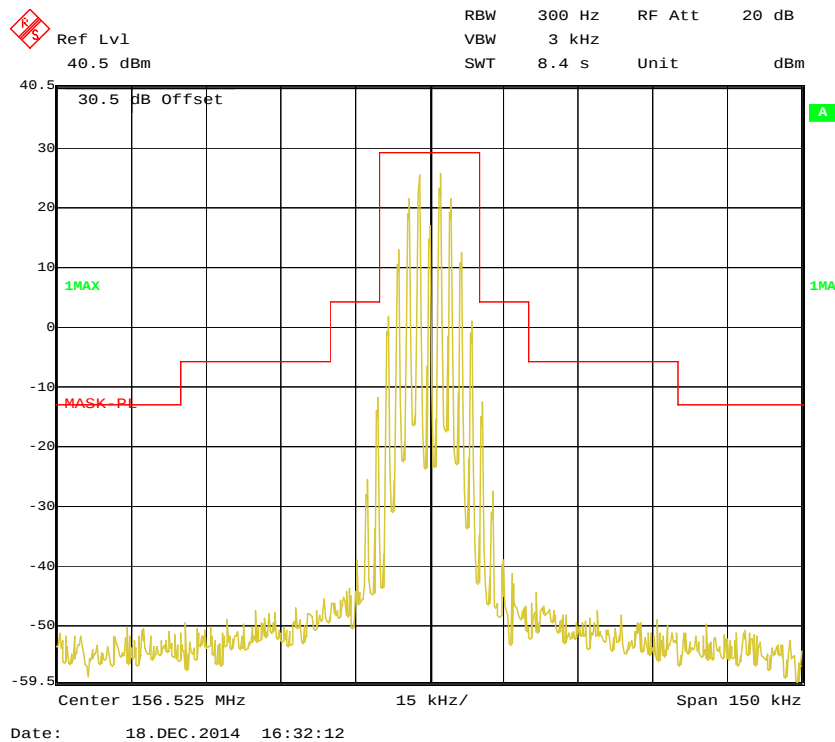


Emission Mask, (DSC1300Hz, High Power)**Emission Mask, (DSC1300Hz, Low Power)**

Emission Mask, (DSC2100Hz, High Power)



Emission Mask, (DSC2100Hz, Low Power)



FCC§80.217 - SUPPRESSION OF INTERFERENCE ABOARD SHIPS**Applicable Standard**

FCC §80.217

- (a) A voluntarily equipped ship station receiver must not cause harmful interference to any receiver required by statute or treaty.
- (b) The electromagnetic field from receivers required by statute or treaty must not exceed the following value at a distance over sea water of one nautical mile from the receiver or Deliver not more than the following amounts of power, to an artificial antenna having electrical characteristics equivalent to those of the average receiving antenna(s) use on shipboard:

Test Procedure

The EUT was connected to a spectrum analyser via a 10 dB attenuator. The spectrum was measured between 9 kHz to 2 GHz. A resolution bandwidth of 100 kHz was used below 1GHz and 1 MHz was used above 1GHz. The traces were recorded as shown on the following pages.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	837405/023	2014-08-22	2015-08-22
HP Agilent	RF Communication test set	8920A	3325U00859	2014-06-03	2015-06-03
Agilent	Universal Frequency Center	Agilent53220A	NCR	2014-10-09	2015-10-08
HP	ESG SERIES Signal Generator	E4421B	NCR	2014-02-21	2015-02-20
ICOM	GPS	IC-M91D	05081894	NCR	NCR

Test Data

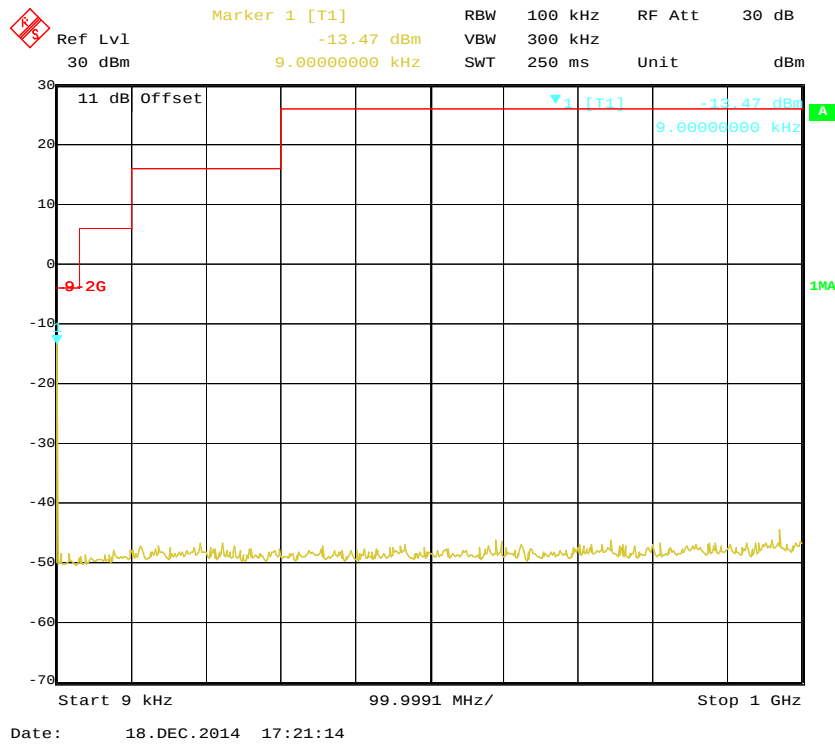
Environmental Conditions

Temperature:	20 °C
Relative Humidity:	49 %
ATM Pressure:	101.0 kPa

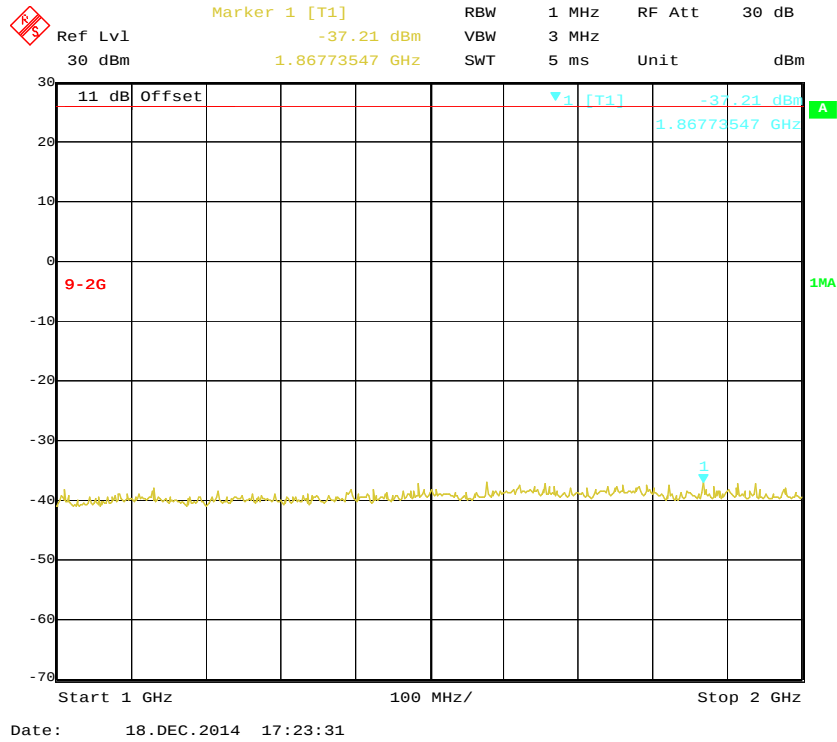
The testing was performed by Candy Li on 2014-12-18

Test Mode: Transmitting

9 kHz – 1 GHz, 156.8 MHz



1 GHz – 2 GHz, 156.8 MHz



FCC §2.1053&§80.211&RSS-182§7.9 - RADIATED SPURIOUS EMISSIONS**Applicable Standard**

FCC §2.1053 and § 80.211 ,RSS-182 §7.9

Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load, which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT .The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to teeth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB =10 lg (TXpwr in Watts/0.001)-the absolute level

Spurious attenuation limit in dB =43+10 Log₁₀ (power out in Watts)

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2014-11-03	2015-11-03
HP	Amplifier	8447E	1937A01046	2014-05-06	2015-05-06
Sunol Sciences	Broadband Antenna	JB3	A111513	2014-06-18	2017-06-17
Rohde & Schwarz	Signal Analyzer	FSIQ26	837405/023	2014-08-22	2015-08-22
Sunol Sciences	Horn Antenna	DRH-118	A052304	2012-12-01	2015-11-30
HP	Synthesized Sweeper	8341B	2624A00116	2014-06-03	2015-06-03
Mini-Circuits	Amplifier	ZVA-183-S+	5969001149	2014-04-23	2015-04-23
A.H. System	Horn Antenna	SAS-200/571	135	2012-02-11	2015-02-10
COM POWER	Dipole Antenna	AD-100	041000	NCR	NCR

Test Data**Environmental Conditions**

Temperature:	19 °C
Relative Humidity:	51 %
ATM Pressure:	100.0 kPa

The testing was performed by Candy Li on 2014-12-17.

Test Mode: Transmitting

30 MHz – 5 GHz:

Frequency (MHz)	Receiver Reading (dBμV)	Turn Table Angle Degree	Rx Antenna		Substituted			Absolute Level (dBm)	FCC Part 80/RSS 182	
			Height (m)	Polar (H/V)	SG Level (dBm)	Cable Loss (dB)	Antenna Gain (dB)		Limit (dBm)	Margin (dB)
Radio telephony: 156.8 MHz										
313.60	43.20	170	2.3	H	-52.8	0.36	0	-53.16	-13	40.16
313.60	39.48	339	1.8	V	-56.5	0.36	0	-56.86	-13	43.86
470.40	46.39	267	2.0	H	-49.6	0.47	0	-50.07	-13	37.07
470.40	44.75	245	2.2	V	-51.2	0.47	0	-51.67	-13	38.67
627.20	51.63	167	1.4	H	-44.4	0.57	0	-44.97	-13	31.97
627.20	45.98	97	1.6	V	-50.0	0.57	0	-50.57	-13	37.57
1190.7	37.42	337	1.8	H	-61.0	0.80	8.50	-53.30	-13	40.30
1190.7	38.04	175	1.4	V	-63.0	0.80	8.50	-55.30	-13	42.30
DSC: 156.525 MHz										
313.05	41.45	246	1.7	H	-54.5	0.36	0	-54.86	-13	41.86
313.05	35.56	169	2.3	V	-60.4	0.36	0	-60.76	-13	47.76
469.58	38.52	336	1.5	H	-57.5	0.47	0	-57.97	-13	44.97
469.58	34.19	53	1.6	V	-61.8	0.47	0	-62.27	-13	49.27
626.10	39.57	302	1.8	H	-56.4	0.57	0	-56.97	-13	43.97
626.10	38.34	317	2.4	V	-57.7	0.57	0	-58.27	-13	45.27
1220.7	36.30	279	1.5	H	-62.2	0.80	8.50	-54.50	-13	41.50
1220.7	36.96	348	2.0	V	-64.0	0.80	8.50	-56.30	-13	43.30

Note:

Absolute Level = SG Level - Cable loss + Antenna Gain

Margin = Limit- Absolute Level

FCC §2.1055 & §80.209 & § RSS-182 - TRANSMITTER FREQUENCY TOLERANCES

Applicable Standard

FCC §2.1055, §80.209 and RSS-182 §7.4

Test Procedure

Frequency Stability vs. Temperature:

From -20° to +50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.

The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

The frequency stability shall be measured with variation of primary supply voltage as follows

- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
- (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
- (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.

Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
Hewlett-Packard	Frequency Counter	5343A	2232A00827	2013-05-09	2016-05-08
ESPEC	Temperature & Humidity Chamber	EL-10KA	09107726	2014-11-01	2015-11-01
Agilent	Universal Frequency Center	Agilent53220A	NCR	2014-10-09	2015-10-08
HP	ESG SERIES Signal Generator	E4421B	NCR	2014-02-21	2015-02-20
ICOM	GPS	IC-M91D	05081894	NCR	NCR
MEAN WELL	DC Power Supply	SP-320	/	NCR	NCR

Test Data**Environmental Conditions**

Temperature:	19 °C
Relative Humidity:	51 %
ATM Pressure:	100.0 kPa

The testing was performed by Candy Li on 2014-12-17.

Test Mode: Transmitting

For Radio Telephony mode:

Reference Frequency: 156.8 MHz, Limit: ± 2.5 ppm, 12.5 kHz			
Test Environment		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supplied (V _{DC})	Measured Frequency (MHz)	Frequency Error (ppm)
Frequency Stability versus Input Temperature			
50	12	156.800004	0.026
40	12	156.800002	0.013
30	12	156.800003	0.019
20	12	156.800004	0.026
10	12	156.800002	0.013
0	12	156.800005	0.032
-10	12	156.800006	0.038
-20	12	156.800004	0.026

Reference Frequency: 156.8 MHz, Limit: ± 2.5 ppm, 12.5 kHz			
Test Environment		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supplied (V _{DC})	Measured Frequency (MHz)	Frequency Error (ppm)
Frequency Stability versus Input Temperature			
50	10.2	156.800005	0.032
40	10.2	156.800006	0.038
30	10.2	156.800003	0.019
20	10.2	156.800004	0.026
10	10.2	156.800002	0.013
0	10.2	156.800003	0.019
-10	10.2	156.800007	0.045
-20	10.2	156.800005	0.032

Reference Frequency: 156.8 MHz, Limit: ± 2.5 ppm, 12.5 kHz			
Test Environment		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supplied (V _{DC})	Measured Frequency (MHz)	Frequency Error (ppm)
Frequency Stability versus Input Temperature			
50	13.8	156.800006	0.038
40	13.8	156.800008	0.051
30	13.8	156.800004	0.026
20	13.8	156.800003	0.019
10	13.8	156.800005	0.032
0	13.8	156.800004	0.026
-10	13.8	156.800006	0.038
-20	13.8	156.800007	0.045

For DSC mode:

Reference Frequency: 156.525 MHz			
Test Conditions		Transmitter Frequency (Hz)	
Environment Temperature (°C)	Power Supplied (V _{dc})	B-State(2100Hz)	B-State(1300Hz)
25	12	2099.9713	1299.9846

Note: Not limit is defined 80.209. Therefore limit from ITU 1371 is used

± 3 ppm

RSS-182 §7.11, RSS-GEN §7 – RECEIVER SPURIOUS EMISSION**Applicable Standard**

According to RSS-182 Issue 4 §7.11 and RSS-Gen §7

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The data was recorded in the QP detection mode for below 1 GHz, and Peak & Average for above 1GHz.

Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
Sunol Sciences	Broadband Antenna	JB3	A111513	2014-06-18	2017-06-17
Rohde & Schwarz	Signal Analyzer	FSIQ26	8386001028	2014-11-12	2015-11-12
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2014-11-03	2015-11-03
HP	Amplifier	8447E	1937A01046	2014-05-06	2015-05-06
Mini-Circuits	Amplifier	ZVA-213+	N/A	NCR	NCR
A.H. System	Horn Antenna	SAS-200/571	135	2012-02-11	2015-02-10
HP	Signal Generator	8657A	3217A04699	2014-12-19	2015-12-18

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements, traceable to National Primary Standards and International System of Units (SI).

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Data**Environmental Conditions**

Temperature:	21 °C
Relative Humidity:	50 %
ATM Pressure:	100.0 kPa

The testing was performed by Candy Li from 2014-12-17.

Test Mode: Receiving

Frequency	Receiver		Turntable	Rx Antenna		Corrected	Corrected	RSS-GEN	
(MHz)	Reading (dBμV)	Detector (PK/QP/AV)	Degree	Height (m)	Polar (H / V)	Factor (dB/m)	Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
951.61	22.08	QP	258	1.7	H	-1.9	20.18	46	25.82
1174.24	37.59	PK	196	2.0	H	0.19	37.78	74	36.22
1174.24	21.61	Ave.	196	2.0	H	0.19	21.80	54	32.20
1174.24	38.33	PK	341	1.7	V	0.19	38.52	74	35.48
1174.24	20.49	Ave.	341	1.7	V	0.19	20.68	54	33.32

******* END OF REPORT *******