



LS RESEARCH LLC
Wireless Product Development



W66 N220 Commerce Court • Cedarburg, WI 53012

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TEST REPORT #: 312230
LSR Job #: C-1544

Compliance Testing of:

FreeStar Module

Test Date(s):


September 17th – October 18th, 2012

Prepared For:

LS Research, LLC
Attn: William Steinike
W66N220 Commerce Court
Cedarburg, WI 53012

This Test Report is issued under the Authority of:

Shane D. Rismeyer, EMC Engineer

Signature: 

Date: 11/7/12

Quality Assurance by:
Peter Feilen, EMC Engineer

Signature:  Date: 11/5/12

Project Engineer:
Shane D. Rismeyer, EMC Engineer

Signature:  Date: 11/2/12

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1. RSS GEN and RSS 210 Annex 7
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low- Power License-Exempt Transmitters.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – 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.
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 – Normative References

Publication	Title
47 CFR, Parts 0-15 (FCC)	Code of Federal Regulations - Telecommunications
RSS 210 Annex 7	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
ANSI C63.4	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.
CISPR 16-1-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
FCC Procedures	Measurement of Digital Transmission Systems operating under Section 15.247.
KDB 558074	Digital Transmission Systems, measurements and procedures

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1.3 - LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:



TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756



Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1
File Number: IC 3088-A
On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1
File Number: IC 3088



U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility – Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).

Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

Date of Validation: November 20, 2002

Notified Body Identification Number: 1243

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 - Client Information

Manufacturer Name:	LS Research, LLC
Address:	W66N220 Commerce Court, Cedarburg, WI 53012
Contact Name:	William Steinike

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	FreeStar
Model Number:	ZFSM-101-3
Serial Number:	7, 8, 11, 14

2.3 - Associated Antenna Description

The EUT uses a 1.8 cm printed circuit board trace antenna, and does not have any other facilities for external or commercial antenna connections.

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2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2405-2480 MHz
ERP (in mW)	
Minimum:	1.38
Maximum:	97.72
Occupied Bandwidth (99% BW)	2.31 MHz
Type of Modulation	O-QPSK
Emission Designator	2M31G1D
Transmitter Spurious (worst case) at 3 meters	45.09 dBμV/m at 4880 MHz
Receiver Spurious (worst case) at 3 meters	29.10 dBμV/m at 996 MHz
Stepped (Y/N)	Yes
Step Value:	Non-linear
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	Freescale MC9S08GT60
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	PCB
Gain (in dBi)	4.8 (Measured above ground plane)
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	210
Modular Filing	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Portable or Mobile?	Mobile

RF Technical Information:

Type of Evaluation (check one)	<input type="checkbox"/>	SAR Evaluation: Device Used in the Vicinity of the Human Head
	<input type="checkbox"/>	SAR Evaluation: Body-worn Device
	<input checked="" type="checkbox"/>	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: General Public Use Controlled Use

Duty Cycle used in evaluation: 100 %

Standard used for evaluation: OET 65

Measurement Distance: 20 cm

RF Value: 0.0587 V/m A/m mW/cm²
 Measured Computed Calculated

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2.5 - Product Description

The LS Research FreeStar module is a direct sequence spread spectrum transceiver operating in the 2400 – 2483.5 MHz ISM band. This report covers the tests performed on the transmit portion of the transceiver.

The FreeStar module is based on the MC13192/3 RF transceiver from Freescale, operating within the IEEE 802.15.4 standard, with channels spaced at 5 MHz intervals in the ISM band. The module implements a proprietary communications protocol with the MC13192 and the ZigBee-compliant stack with the MC13193.

The system operates at a chip rate of 2 Mbps, a symbol rate of 62.5 kbps, and a bit rate of 250kbps. O-QPSK modulation is used with 16-ary orthogonal symbols. It transmits with a maximum power of 100 milliwatts (+20 dBm) into a printed circuit board inverted-F antenna with a measured nominal gain of 4.8 dBi above a ground plane.

The RF power level and channel are selectable within the operating mask provided by the manufacturer. Modulation characteristics are fixed by the transceiver. The samples provided to LS Compliance for testing were set at the maximum power level for the channel tested. The user will have the capability to reduce the power on each channel. They cannot go higher as the software has the ceiling set. The modules are specified to operate on an input of 2.4 to 3.6VDC.

The receiver is a low-IF receiver. The received RF signal is amplified by a low noise amplifier and down-converted to a 1st IF of 65MHz and then down-converted in quadrature (I and Q) to the intermediate frequency (IF) of 1 MHz. The digital back end performs Differential Chip Detection; the correlator de-spreads the Direct Sequence Spread Spectrum O-QPSK signal, determines the symbols and packets, and detects the data.

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EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	65°F
Humidity:	40%
Pressure:	750 mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247(a)(2) IC : RSS 210 A8.2(a)	6 dB Bandwidth of a Digital Modulation System	Yes
IC : RSS GEN section 4.6.1	99% Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC : 15.247(c) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(d) IC : RSS 210 A8.2(b)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC).		

3.3 - Modifications Incorporated In the EUT for Compliance Purposes

None Yes (explain below)

Reduced power is needed on Channels 24, 25 and 26 due to Upper Band Edge testing. See Exhibit 9 for power data.

3.4 - Deviations & Exclusions from Test Specifications

None Yes (explain below)

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EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210, Issue 7, Section Annex 8 (section 8.2) for a Digital Spread Spectrum (DTS) Transmitter.

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

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EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit and receive modes, using power as provided by a 3.3 V DC supply.

The applicable limits apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (2405 MHz), middle (2440 MHz) and high (2480 MHz) to comply with FCC Part 15.31(m). The channels and operating modes were changed using pins and headers.

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in 3 meter Semi-Anechoic and Compact Semi-Anechoic FCC listed Chambers. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. For the lower frequency ranges the EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber with the antenna mast placed so that the separation distance between the antenna and EUT was 3 meters. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz, a Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 4 GHz in the 3 meter Semi-Anechoic Chamber. The remaining measurements were taken in the Compact Semi-Anechoic Chamber at a separation distance of 1 meter. The Double-Ridged Waveguide Horn Antenna used from 4 GHz to 18 GHz and a Standard Gain Horn Antenna was used from 18 GHz to 25 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. The Agilent E4445A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 4 GHz to 25 GHz, an Agilent E4446A Spectrum Analyzer was used.

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 7, Annex 8 for a DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

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5.5 - Calculation of Radiated Emissions Limits

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3) and RSS 210 A8.4 is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d) and RSS 210 A8.2 (b), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c) for FCC and section 2.2, 2.6 and 2.7 of RSS 210 for IC.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS 210 section 2.7.

Frequency (MHz)	3 m Limit $\mu\text{V/m}$	3 m Limit (dB $\mu\text{V/m}$)	1 m Limit (dB $\mu\text{V/m}$)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength ($\mu\text{V/m}$ to dB $\mu\text{V/m}$):

$$\text{dB}\mu\text{V/m} = 20 \log_{10} (100) = 40 \text{ dB}\mu\text{V/m} \text{ (from 30-88 MHz)}$$

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

$$\begin{aligned} &960 \text{ MHz to } 10,000 \text{ MHz} \\ &500\mu\text{V/m or } 54.0 \text{ dB}\mu\text{V/m at 3 meters} \\ &54.0 + 9.5 = 63.5 \text{ dB}\mu\text{V/m at 1 meter} \end{aligned}$$

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample Calculation:

Raw Receiver Data + Antenna Factor + Cable Factor + = Reported Value

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 dB μV

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5.6 - Radiated Emissions Test Data Chart

3 and 1 Meter Measurements of Electromagnetic Radiated Emissions
Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	LS Research, LLC				
Date(s) of Test:	9/20/12				
Test Engineer(s):	Peter Feilen				
Voltage:	3.3 VDC				
Operation Mode:	Continuous Transmit and Receive				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C				
	Relative Humidity: 30 – 60 %				
EUT Power:	Single Phase ___ VAC		3 Phase ___ VAC		
	Battery		X	Other: 3.3 VDC	
EUT Placement:	X	80cm non-conductive table		10cm Spacers	
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS	
Measurements:		Pre-Compliance		Preliminary	X Final
Detectors Used:	X	Peak	X	Quasi-Peak	X Average

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RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 11:

Ant./EUT Polarity	Frequency (MHz)	Peak (dB μ V/m)	Average (dB μ V/m)	Height (meters)	Azimuth (degrees)	Limit (dB μ V/m)	Margin (dB)
Vertical/F	4810	63.2	53.7	1.00	325	63.5	9.8
Vertical/V	4810	58.9	49.1	1.30	56	63.5	14.4
Horizontal/S	12023	60.6	49.7	1.12	333	63.5	13.8

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 18:

Ant./EUT Polarity	Frequency (MHz)	Peak (dB μ V/m)	Average (dB μ V/m)	Height (meters)	Azimuth (degrees)	Limit (dB μ V/m)	Margin (dB)
Horizontal/V	4880	63.5	54.3	1.18	332	63.5	9.2
Vertical/F	4880	63.8	54.6	1.22	316	63.5	8.9
Vertical/S	7319	60.0	50.1	1.06	18	63.5	13.4
Vertical/F	12198	59.8	50.1	1.16	323	63.5	13.4
Horizontal/S	12198	60.3	50.1	1.19	328	63.5	13.4

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 26:

Ant./EUT Polarity	Frequency (MHz)	Peak (dB μ V/m)	Average (dB μ V/m)	Height (meters)	Azimuth (degrees)	Limit (dB μ V/m)	Margin (dB)
Vertical/V	4950	62.5	52.9	1.10	341	63.5	10.7
Horizontal/S	7425	62.7	52.8	1.04	232	63.5	10.7
Horizontal/S	12375	62.7	52.3	1.06	320	63.5	11.2

Notes:

A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.

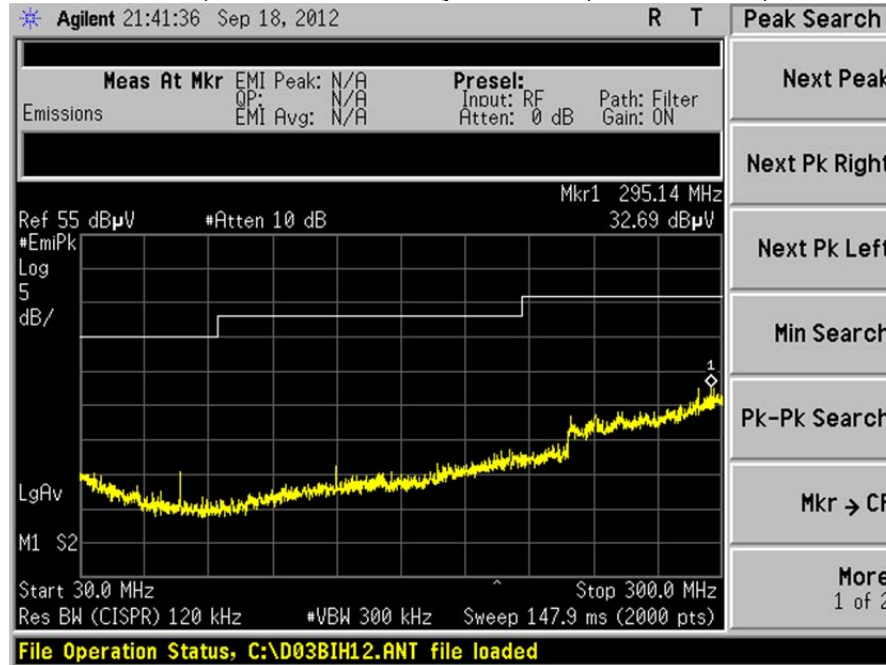
Measurements above 4 GHz were made at 1 meters of separation from the EUT.

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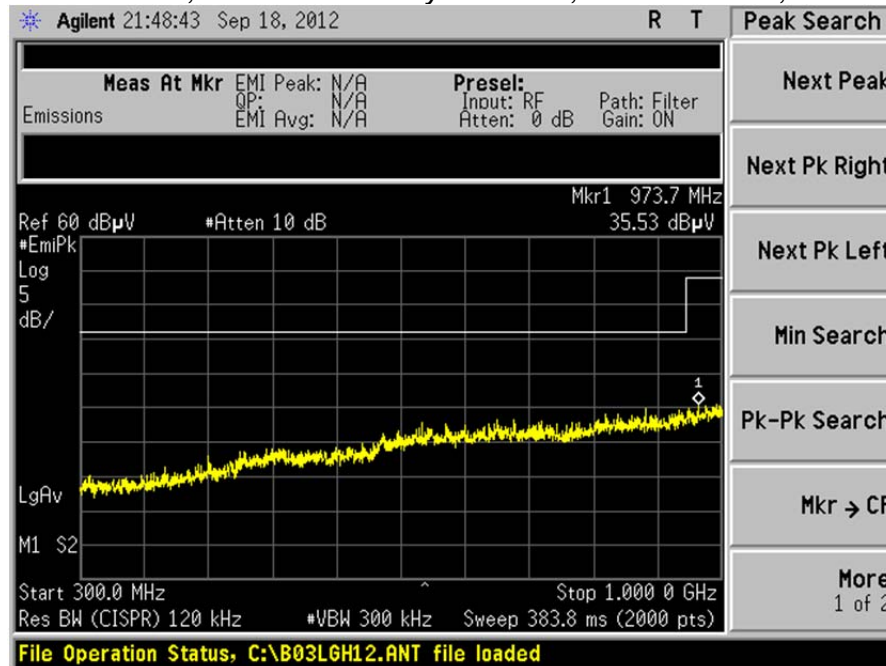
5.7 - Screen Captures - Radiated Emissions Test

These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

Channel 18, Antenna Vertically Polarized, 30-300 MHz, at 3m



Channel 18, Antenna Vertically Polarized, 300-1000 MHz, at 3m



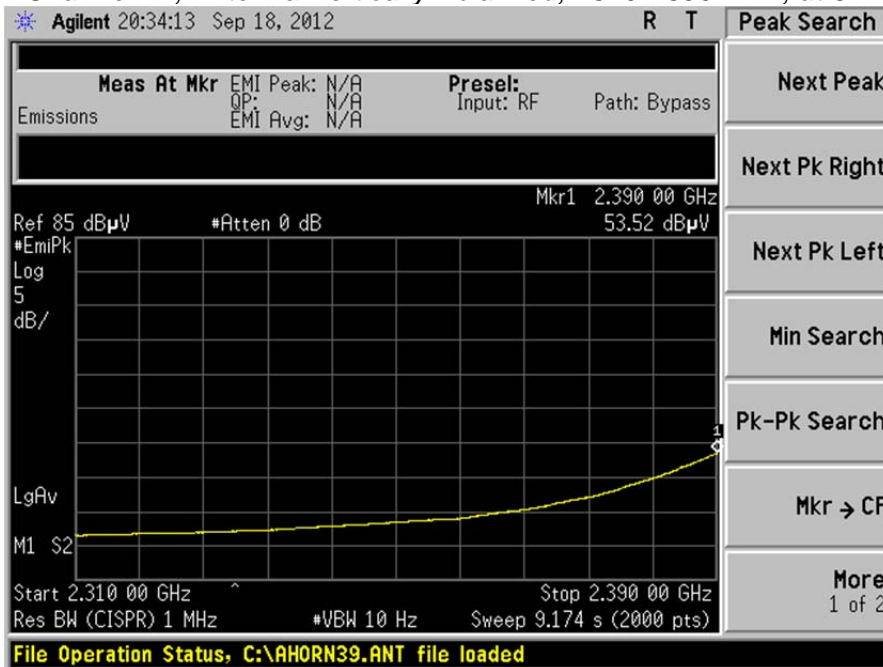
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Screen Captures - Radiated Emissions Testing (continued)

Channel 18, Antenna Vertically Polarized, 1000-2310 MHz, at 3m



Channel 11, Antenna Vertically Polarized, 2310-2390 MHz, at 3m

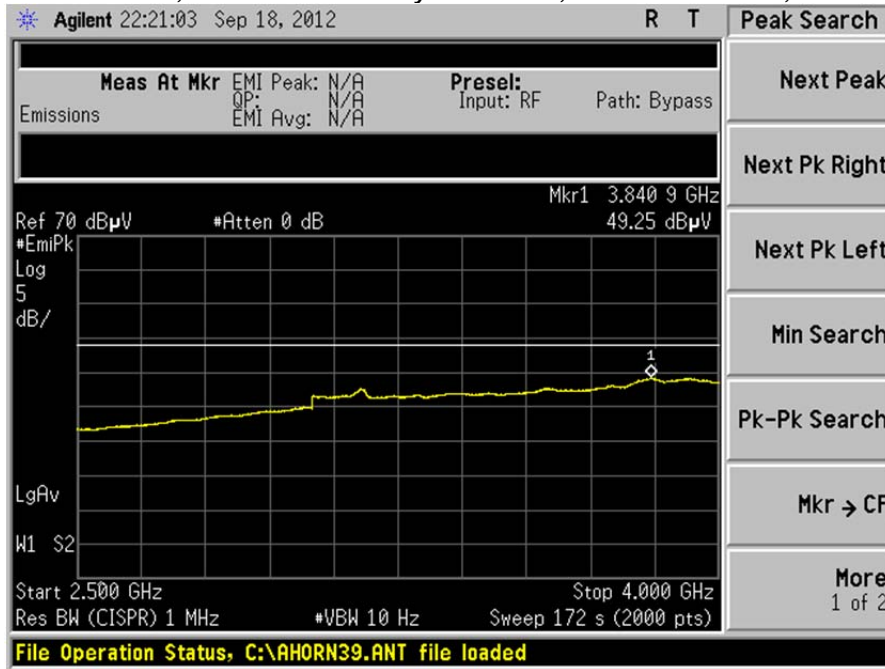


Note: Frequency ranges 2390-2400 MHz and 2483.5-2500 MHz are shown in the bandedge section, Exhibit 8

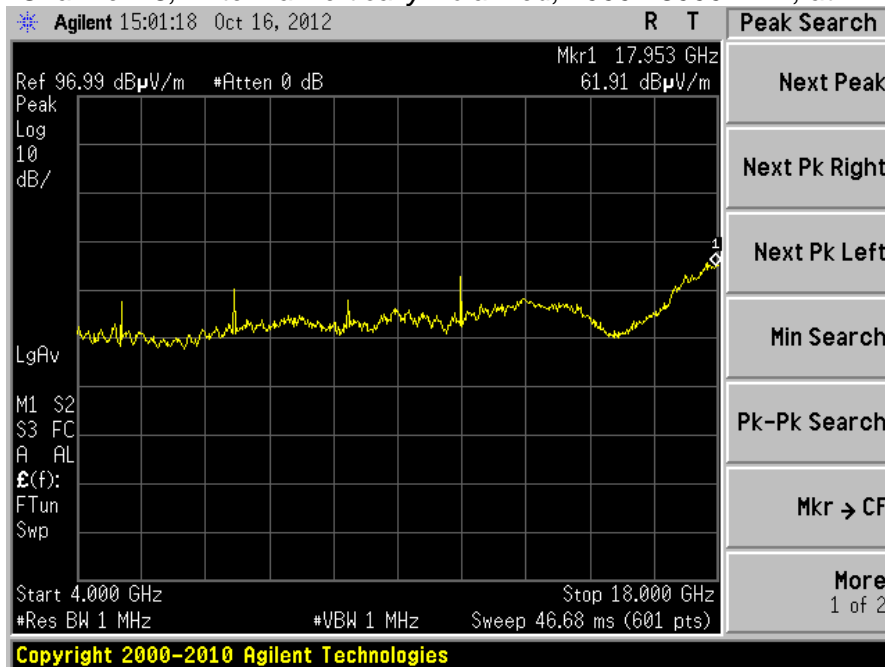
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
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Screen Captures - Radiated Emissions Testing (continued)

Channel 18, Antenna Vertically Polarized, 2500-4000 MHz, at 3m

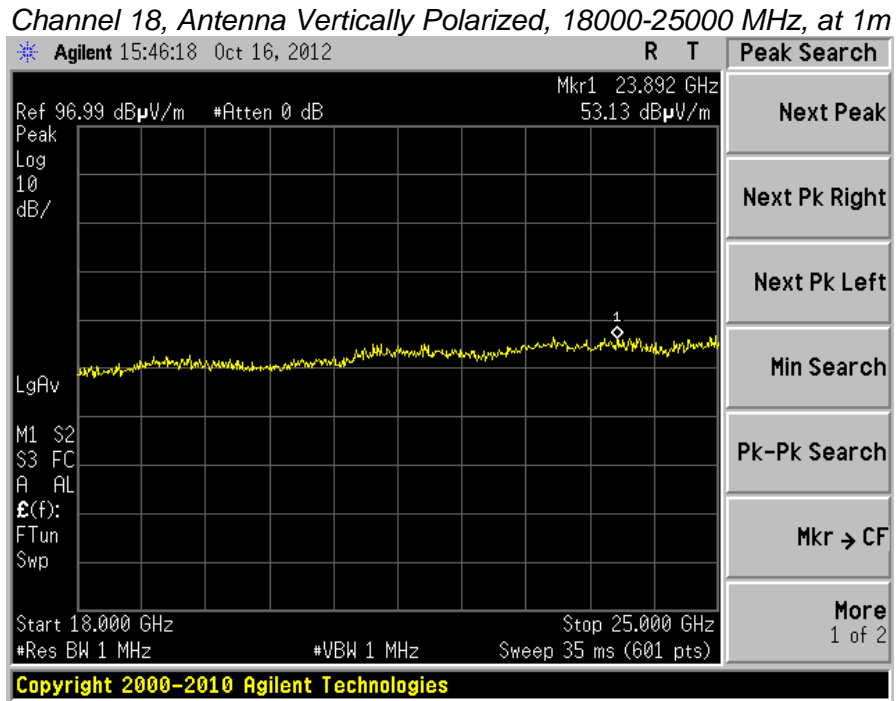


Channel 18, Antenna Vertically Polarized, 4000-18000 MHz, at 1m



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Screen Captures - Radiated Emissions Testing (continued)



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5.8 - Receive Mode Testing

Per the requirements of RSS-210, the EUT was placed in continuous receive mode and the radiated spurious emissions were measured and compared to the limits stated in RSS-Gen Section 4.10.

The test setup, procedure, and equipment utilized were identical to that described in sections 5.1, 5.2, and 5.3 of this document.

Measurement data and screen captures from the receive tests are presented below:

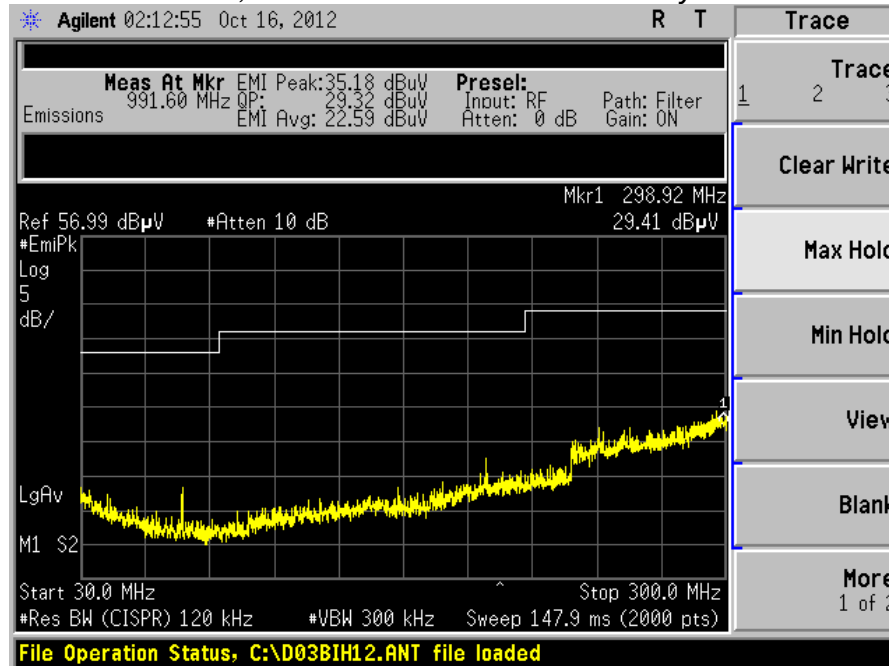
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
996.1	1.00	0	35.2	29.1	54.0	24.9	H	V
984.2	1.00	0	34.6	29.1	54.0	24.9	H	S
991.6	1.00	0	35.2	22.6	54.0	31.4	H	F

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

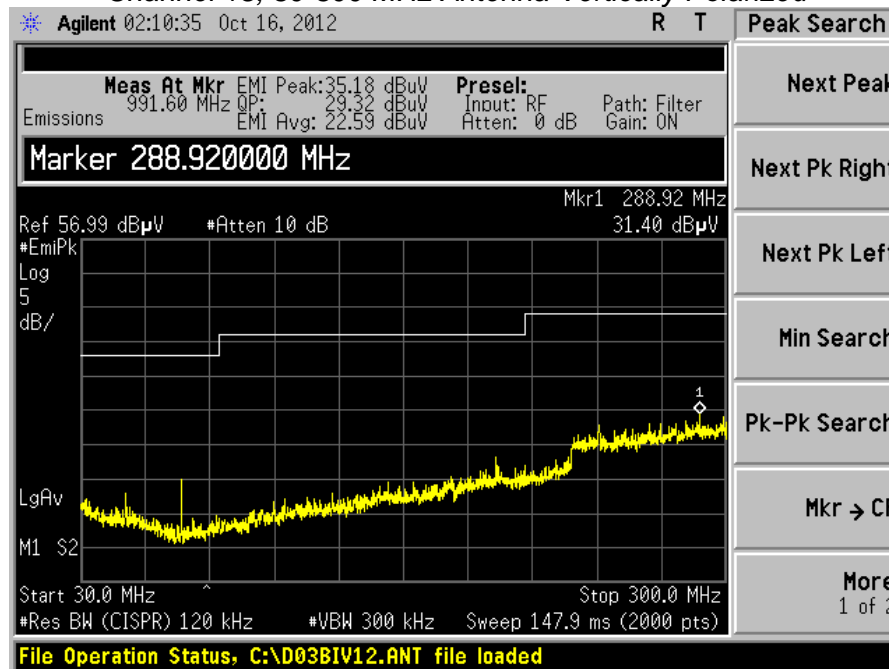
5.9 - Screen Captures - Radiated Emissions Testing - Receive Mode

These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

Channel 18, 30-300 MHz Antenna Horizontally Polarized

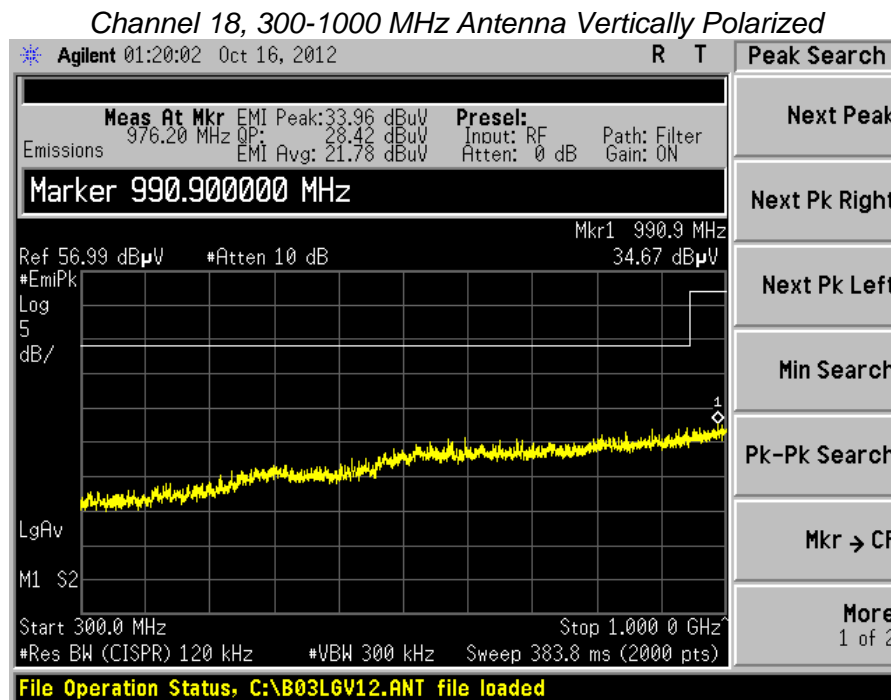
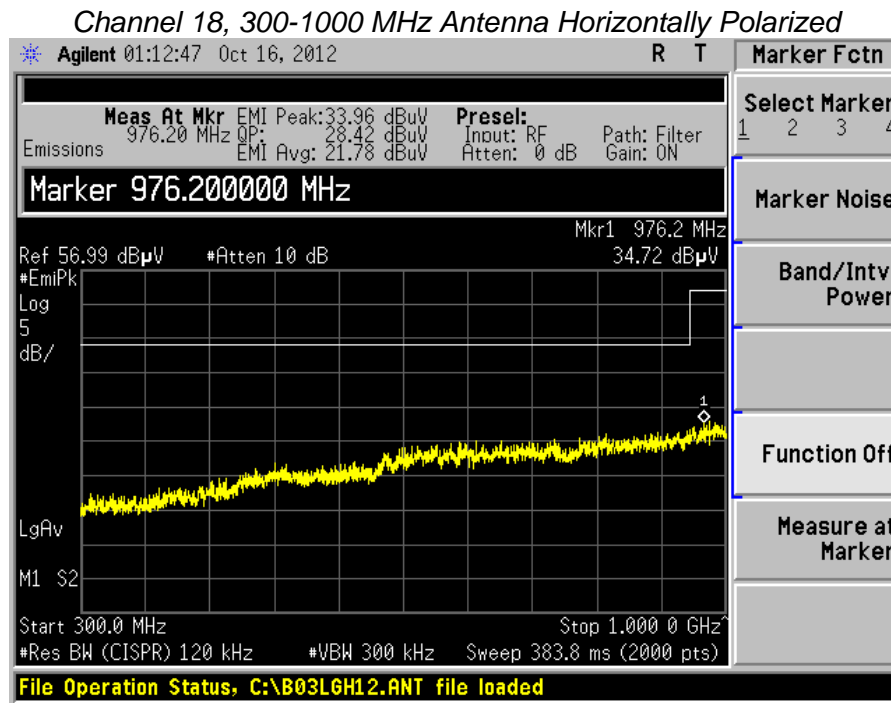


Channel 18, 30-300 MHz Antenna Vertically Polarized



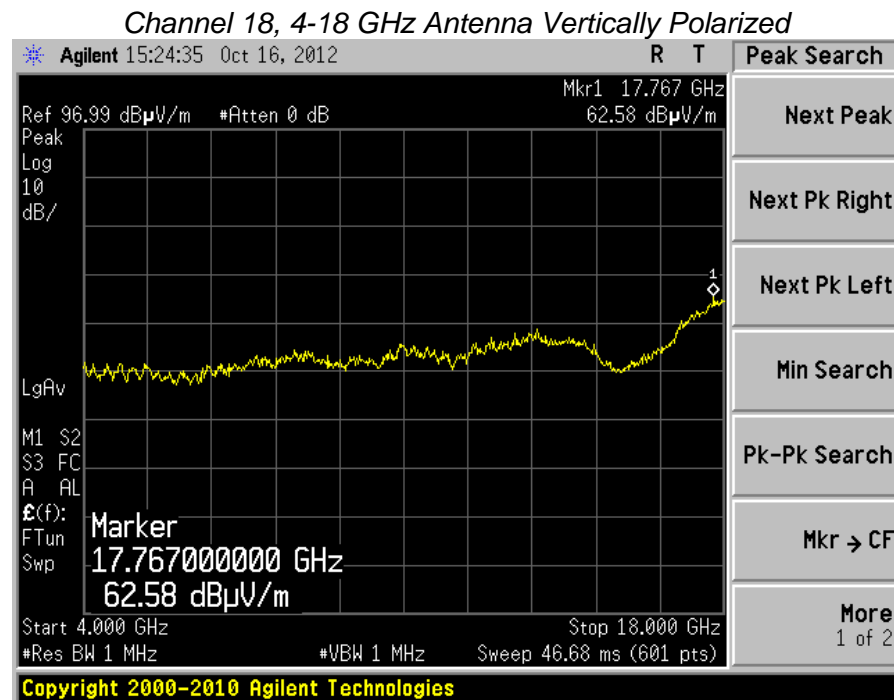
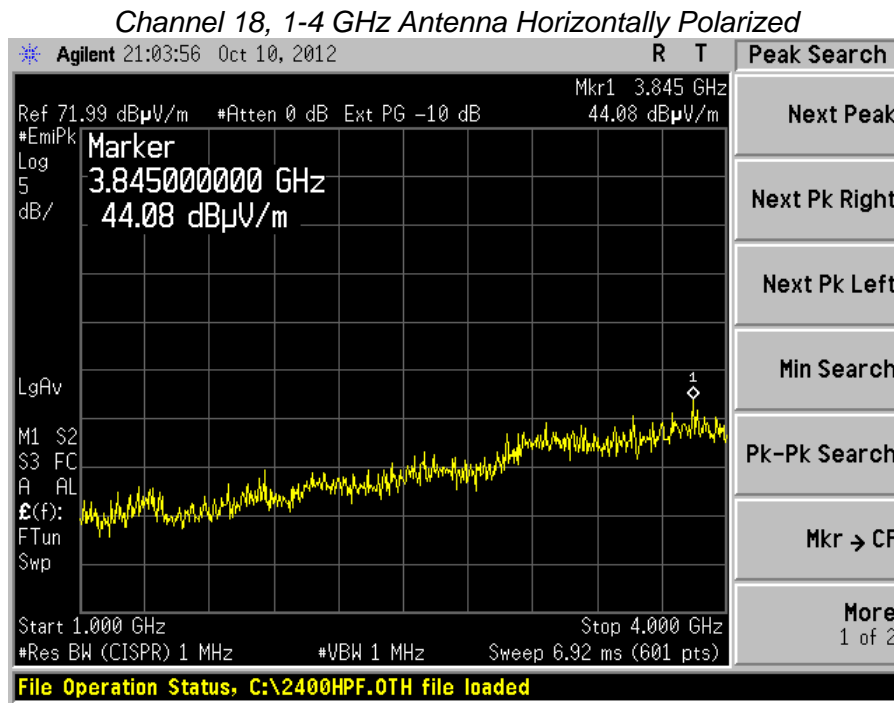
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Screen Captures - Radiated Emissions Testing – Receive Mode (continued)



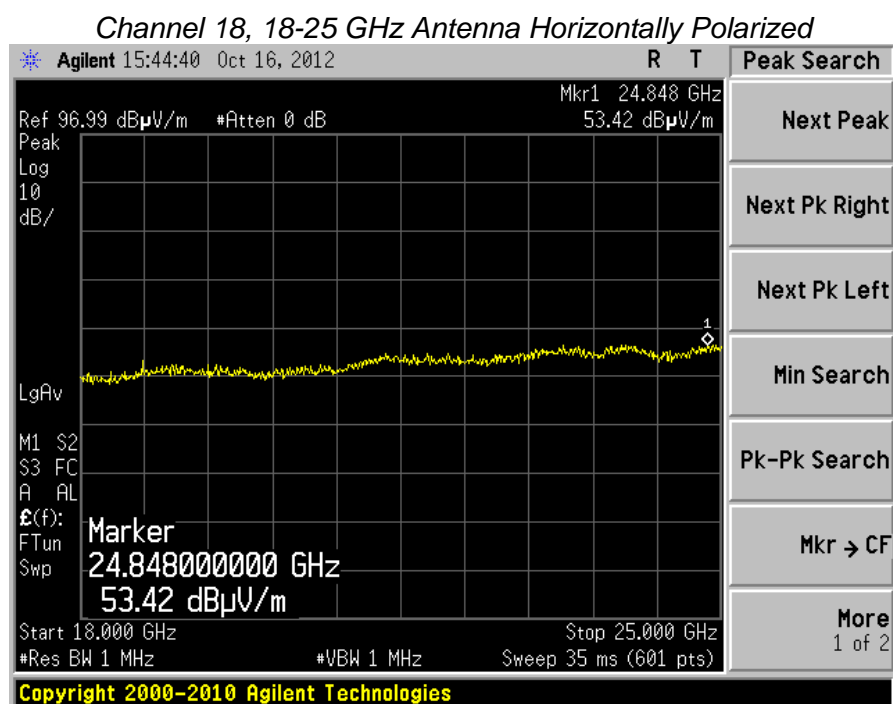
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Screen Captures - Radiated Emissions Testing – Receive Mode (continued)



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Screen Captures - Radiated Emissions Testing – Receive Mode (continued)



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

6.1 - Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided inside the 3 Meter Semi-Anechoic Chamber via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

6.2 - Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

6.3 - Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A.

6.4 - Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

6.5 - FCC Limits of Conducted Emissions at the AC Mains Ports

The follow table represents the limits for Conducted Emissions Class B taken from CFR 15.207:

Frequency Range (MHz)	Quasi-Peak Limit (dBμV)	Average Limit (dBμV)
0.150 -0.50 *	66-56	56-46
0.5 – 5.0	56	46
5.0 – 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

Sample calculation for the limits in the 0.15 to 0.5 MHz:

$$\text{Limit} = -19.12 (\text{Log}_{10} (F [\text{MHz}] / 0.15 [\text{MHz}])) + 66.0 \text{ dB}\mu\text{V}$$

For a frequency of 200 kHz for example:

$$\text{Quasi-Peak Limit (F=200 kHz)} = -19.12 (\text{Log}_{10} (0.2[\text{MHz}] / 0.15 [\text{MHz}])) + 66.0 \text{ dB}\mu\text{V}$$

$$\text{Quasi-Peak Limit (F=200 kHz)} = 63.6 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F=200 kHz)} = -19.12 (\text{Log}_{10} (0.2[\text{MHz}]/0.15[\text{MHz}])) + 56.0 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F = 200 kHz)} = 53.6 \text{ dB}\mu\text{V}$$

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

6.6 – Conducted Emissions Test Data Chart

Frequency Range inspected: 150 KHz to 30 MHz

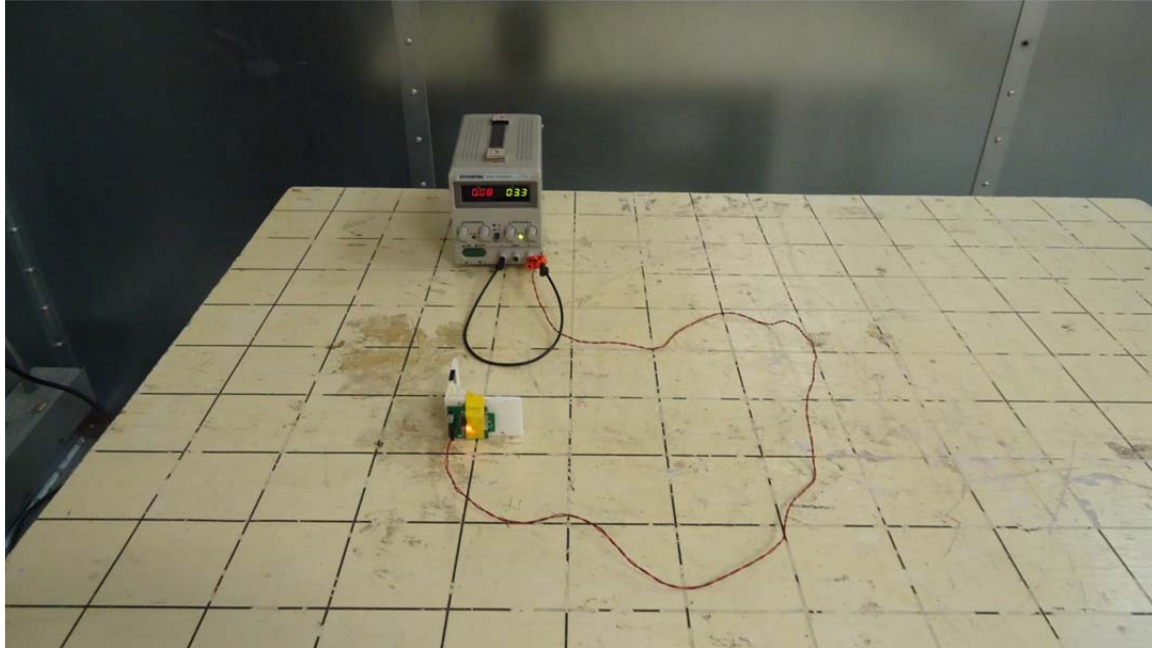
Manufacturer:	CEL				
Date(s) of Test:	9/18/12				
Test Engineer:	Peter Feilen				
Voltage:	3.3 VDC				
Operation Mode:	Continuous Transmit and Receive				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %				
Test Location:	<input checked="" type="checkbox"/>	Conducted Test Area			Chamber
EUT Placed On:	<input checked="" type="checkbox"/>	40cm from Vertical Ground Plane			10cm Spacers
	<input checked="" type="checkbox"/>	80cm above Ground Plane			Other:
Measurements:		Pre-Compliance		Preliminary	<input checked="" type="checkbox"/> Final
Detector Used:		Peak	<input checked="" type="checkbox"/>	Quasi-Peak	<input checked="" type="checkbox"/> Average

Notes:

- 1) *No emissions found.*
- 2) *The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.*

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

6.7 - Test Setup Photo(s) - Conducted Emissions Test

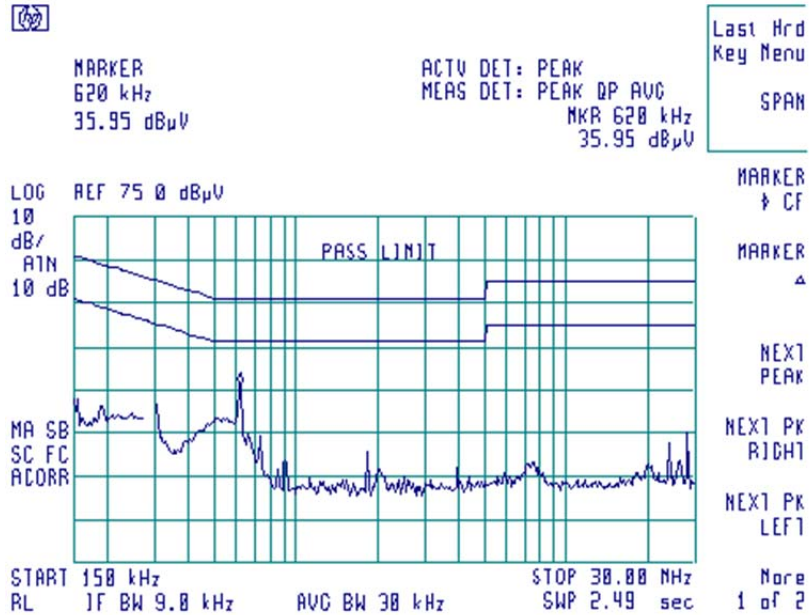


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

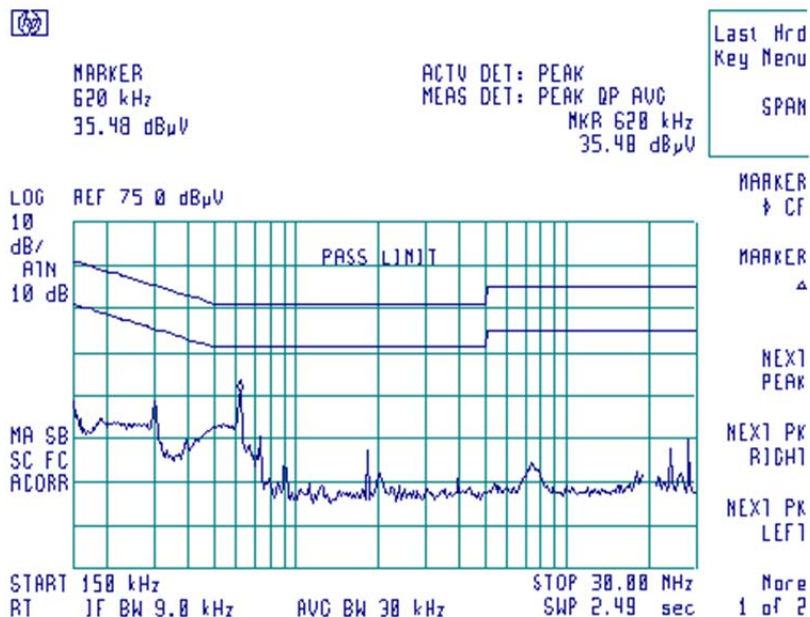
6.8 - Screen Captures - Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized.

Channel 18, Line 1



Channel 18, Line 2



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

EXHIBIT 7. OCCUPIED BANDWIDTH

7.1 - Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

7.2 - Method of Measurements

Refer to ANSI C63.4 and FCC Procedures for Digital Transmission Systems operating under 15.247.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer.

The bandwidth requirement found in FCC Part 15.247(a)(2) and RSS 210 A8.2(a) requires a minimum -6dBc occupied bandwidth of 500 kHz. In addition, Industry Canada (IC RSS GEN 4.6.1) requires the measurement of the 99% occupied bandwidth. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the Agilent E4446A spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

From this data, the closest measurement (6 dB bandwidth) when compared to the specified limit, is 1.25 MHz, which is above the minimum of 500 kHz.

7.3 - Test Equipment List

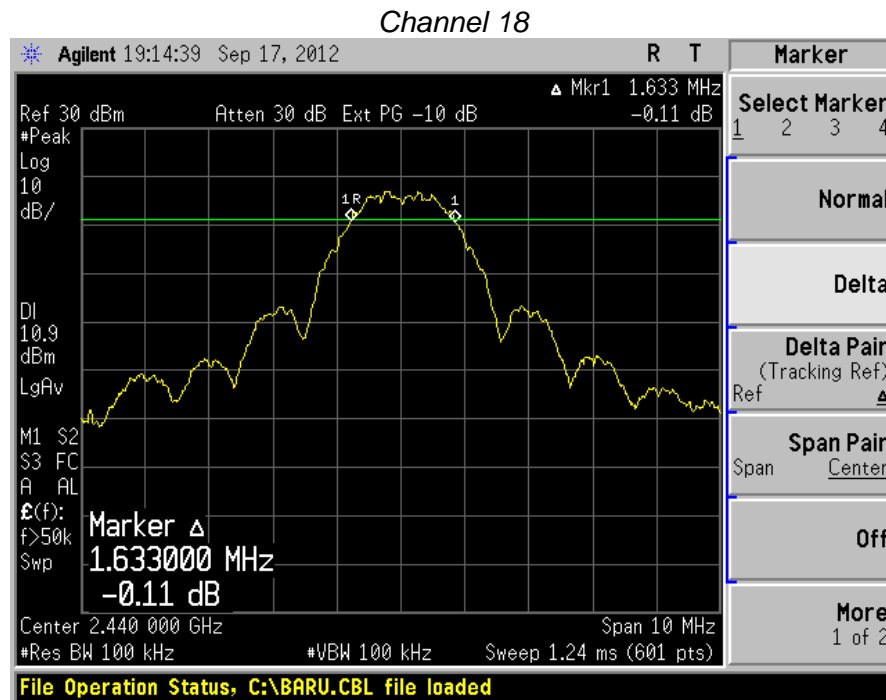
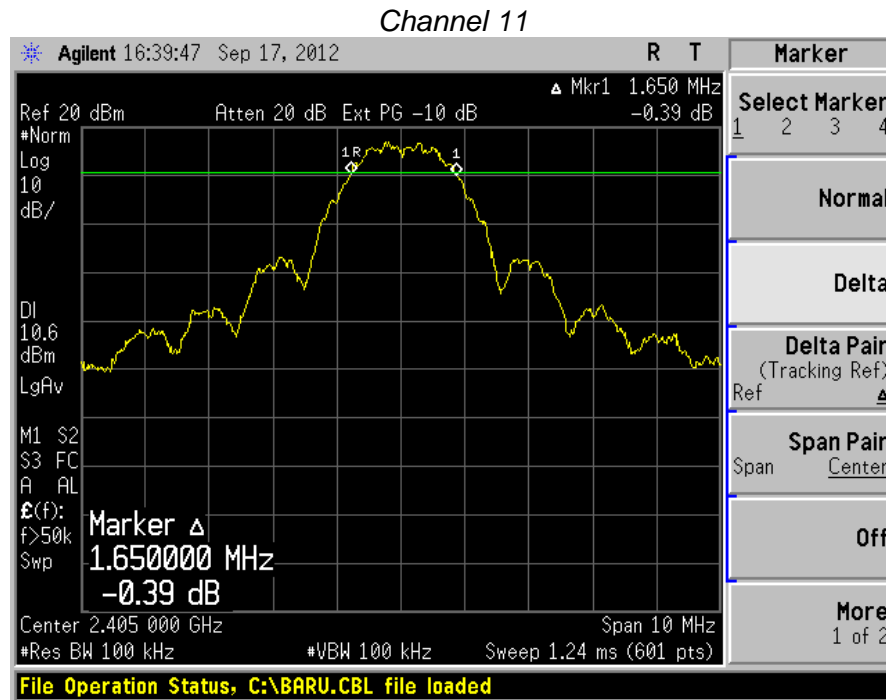
A complete list of test equipment that was used for this test can be found in Appendix A.

7.4 - Test Data

Channel	Center Freq (MHz)	-6 dBc OBW (MHz)	99% OBW (MHz)
11	2405	1.65	2.28
18	2440	1.63	2.29
23	2465	1.65	2.31
24	2470	1.67	2.29
25	2475	1.65	2.30
26	2480	1.67	2.29

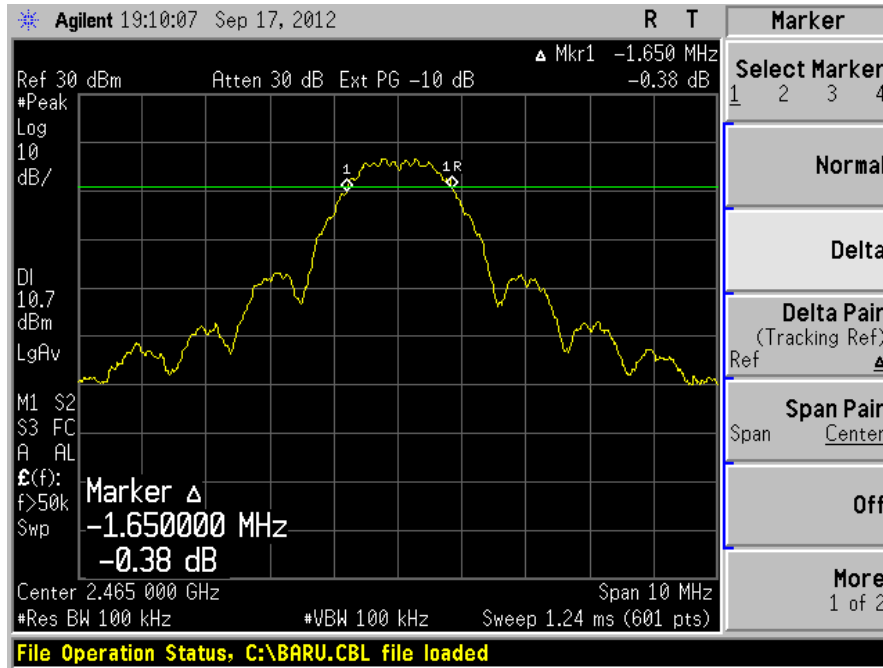
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

7.5 - Screen Captures - Occupied Bandwidth 6dB

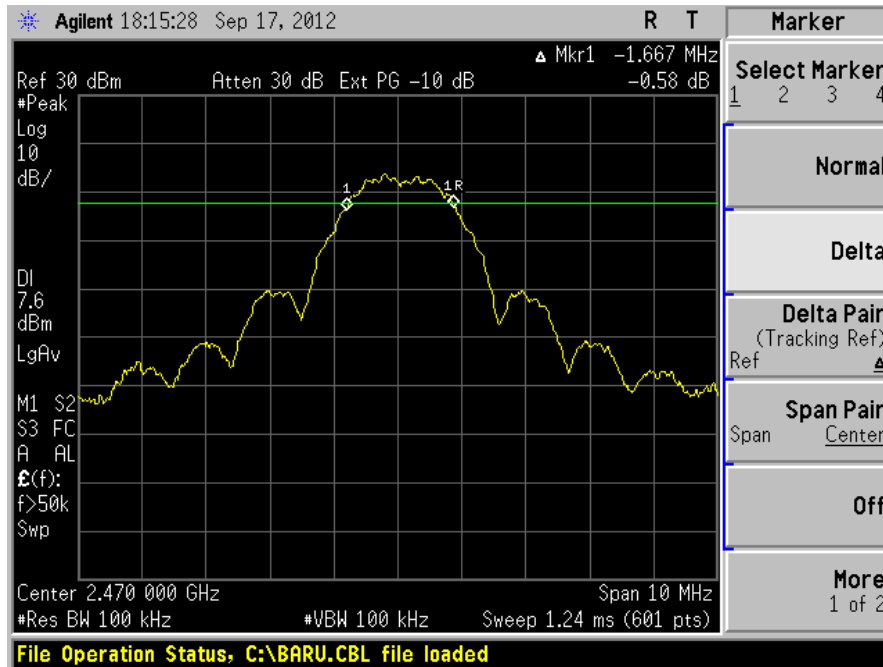


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 23

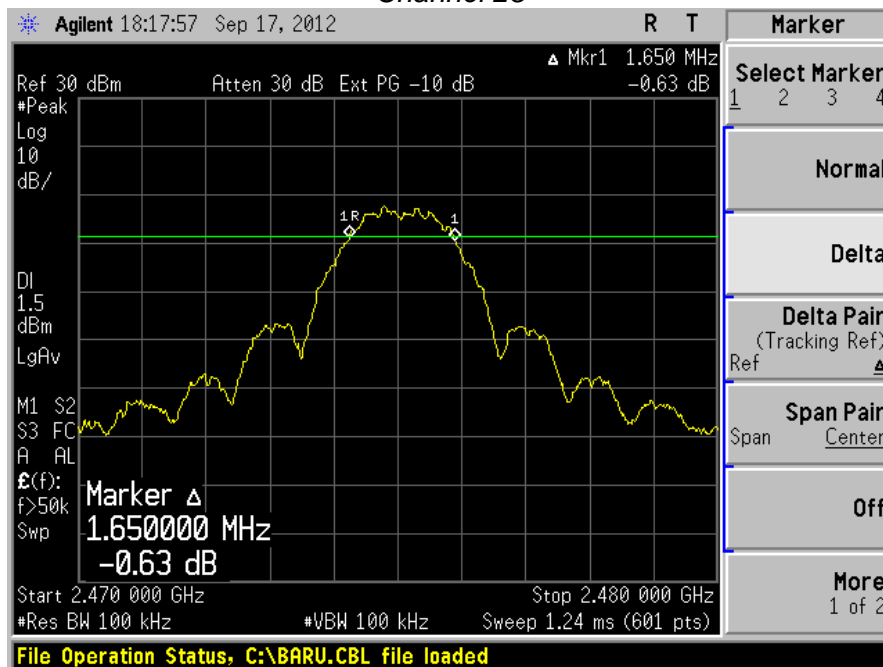


Channel 24

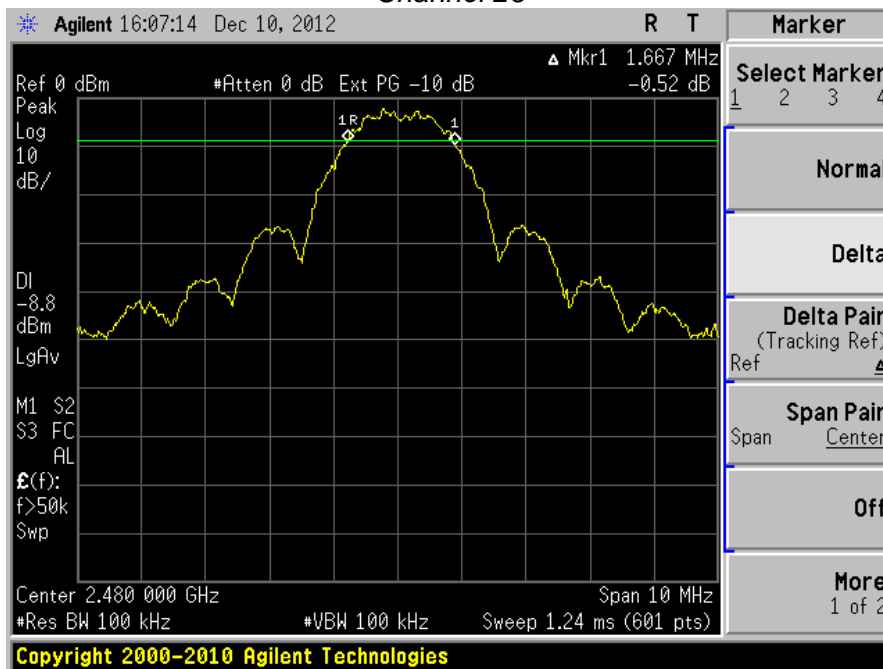


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 25

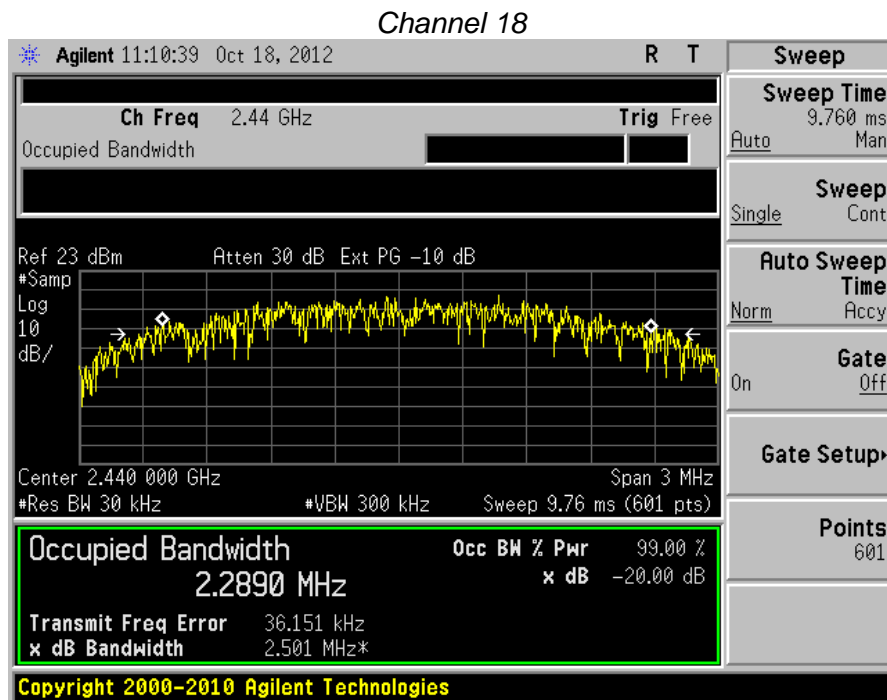
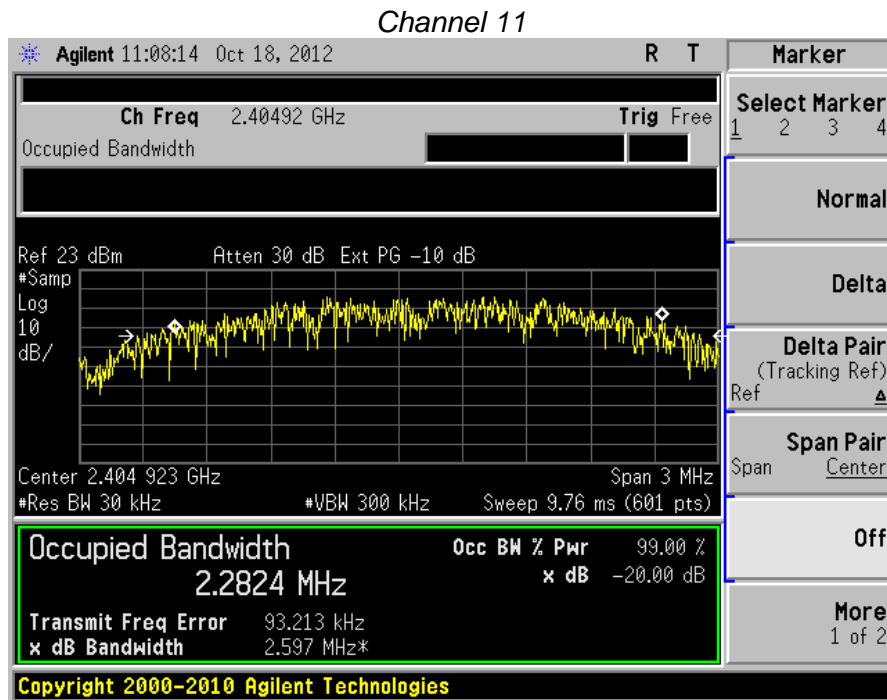


Channel 26



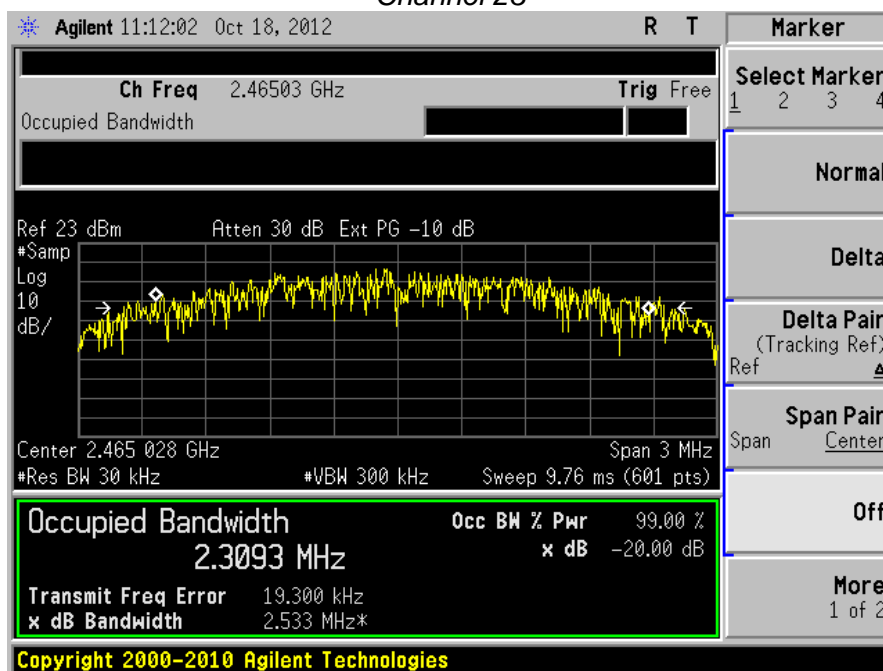
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

7.6 - Screen Captures - Occupied Bandwidth 99%

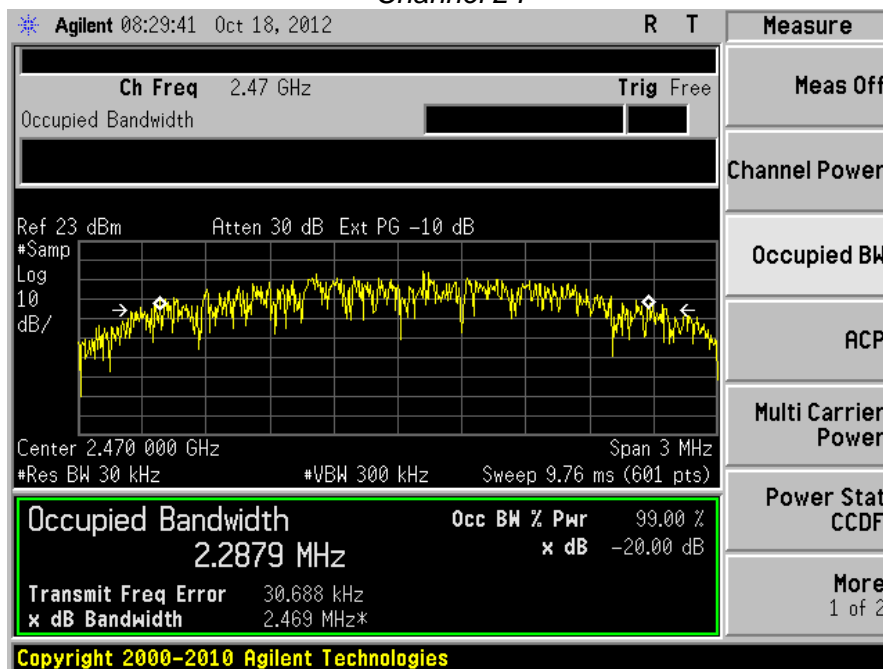


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 23

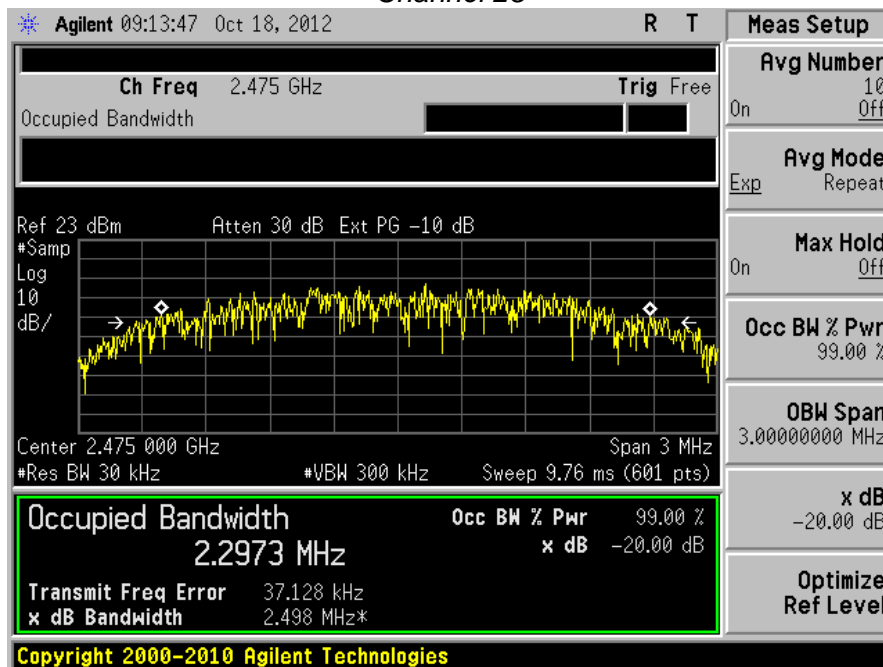


Channel 24

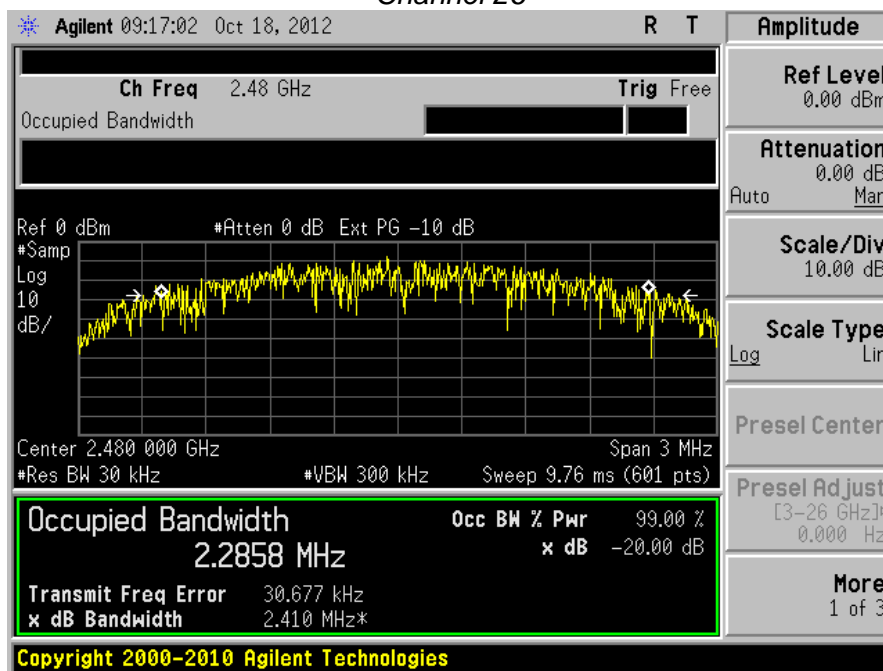


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 25



Channel 26



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

EXHIBIT 8. BAND EDGE MEASUREMENTS

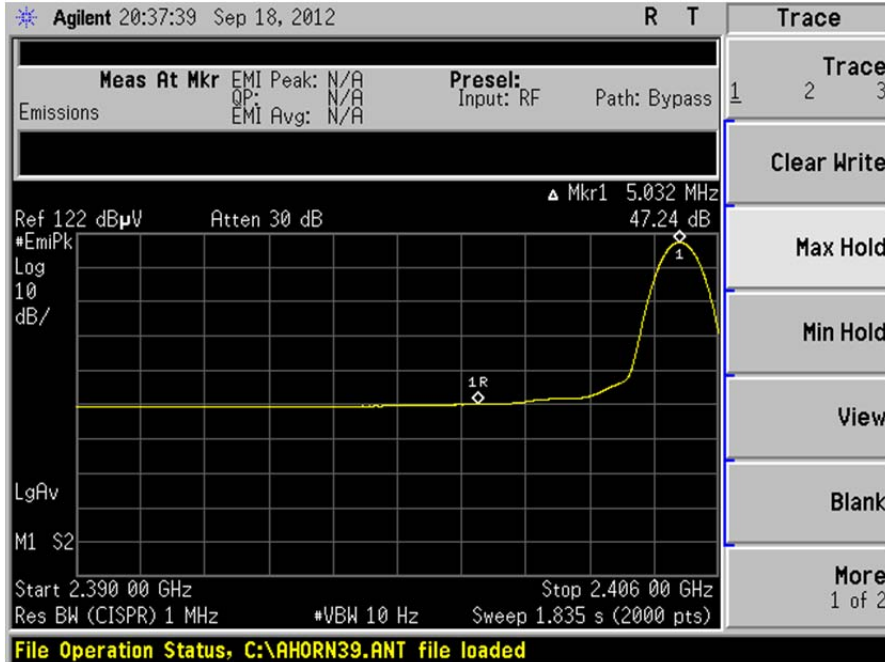
8.1 - Method of Measurements

FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in tables 2 and 3 of the same standard and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

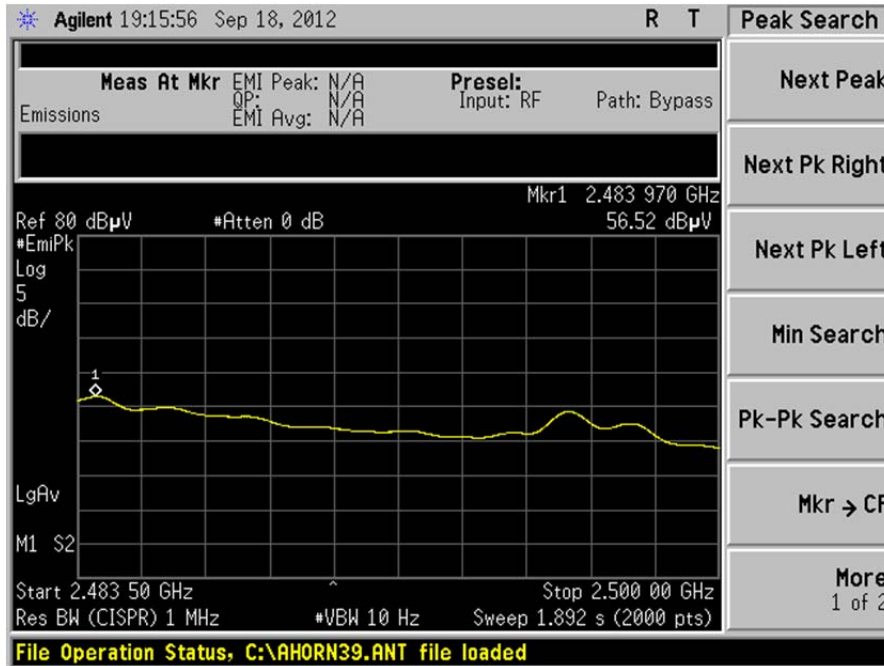
The Upper Band-Edge limit, in this case, would be + 54 dB μ V/m at 3m

Screen Capture Demonstrating Compliance at the Lower Band-Edge



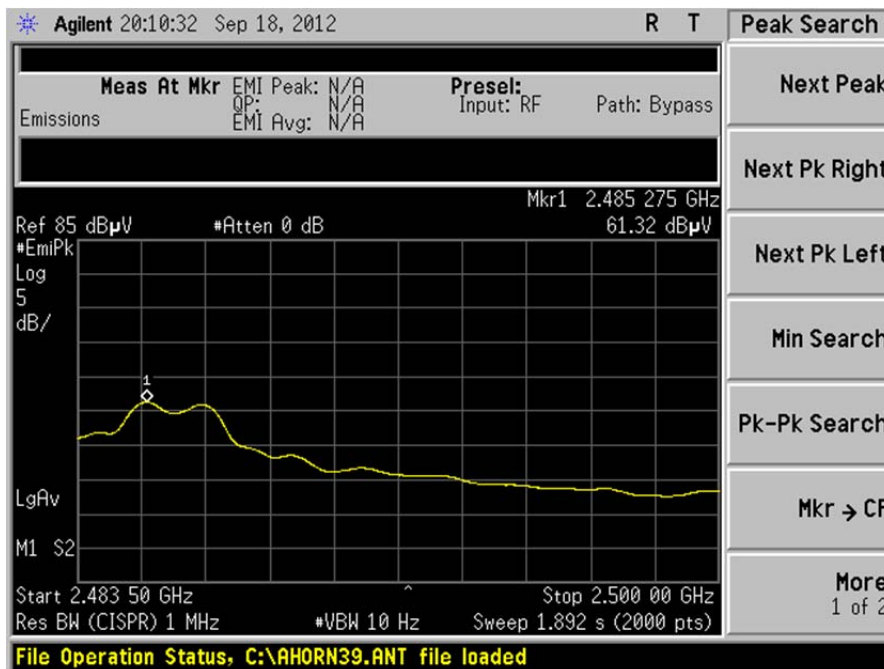
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Screen Capture Demonstrating Compliance at the Higher Band-Edge



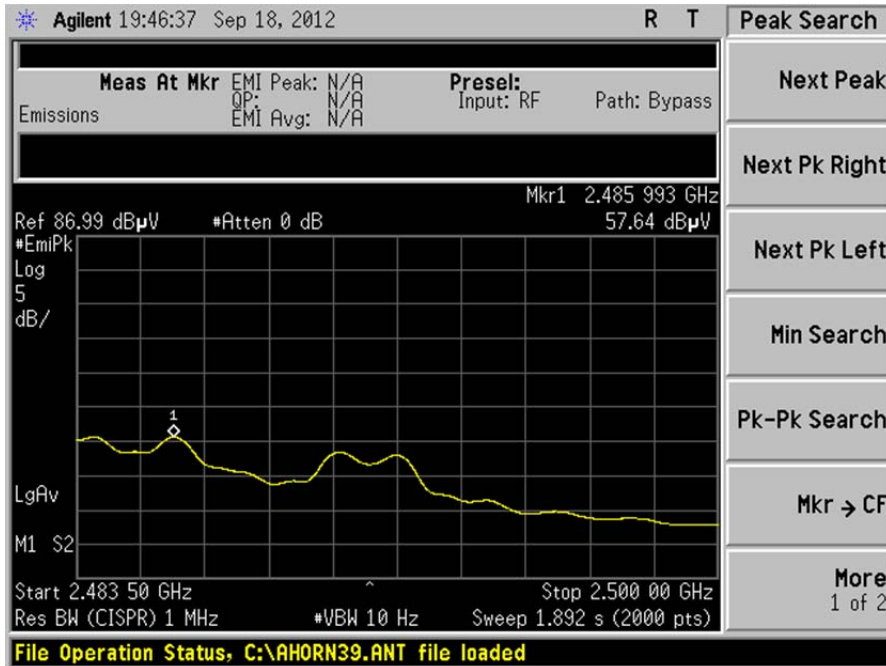
Channel 23 (passes with duty cycle) Example below:

$$56.52 \frac{dB\mu V}{m} - 21.25 dB = 35.27 dB\mu V/m \text{ (under limit of } 54 dB\mu V/m\text{)}$$

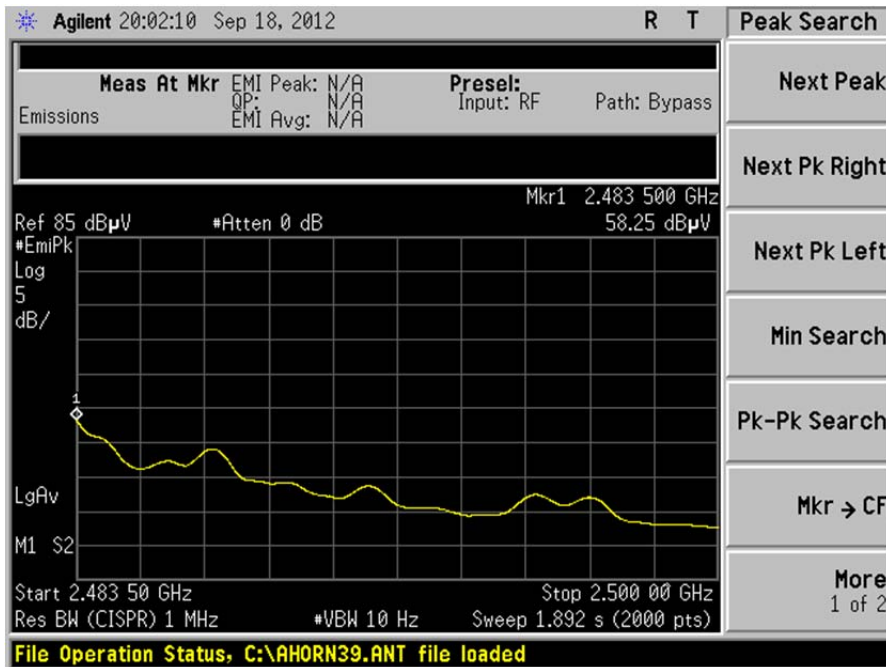


Channel 24 (passes with duty cycle)

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544



Channel 25 (passes with duty cycle)



Channel 26 (passes with duty cycle)

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 20 MHz, with measurements from a peak detector presented in the chart below.

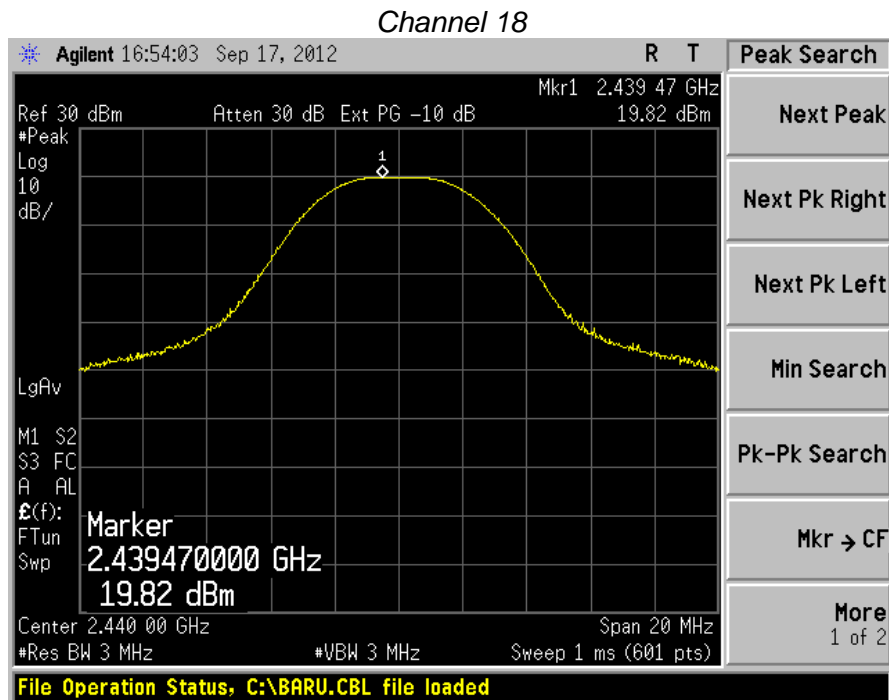
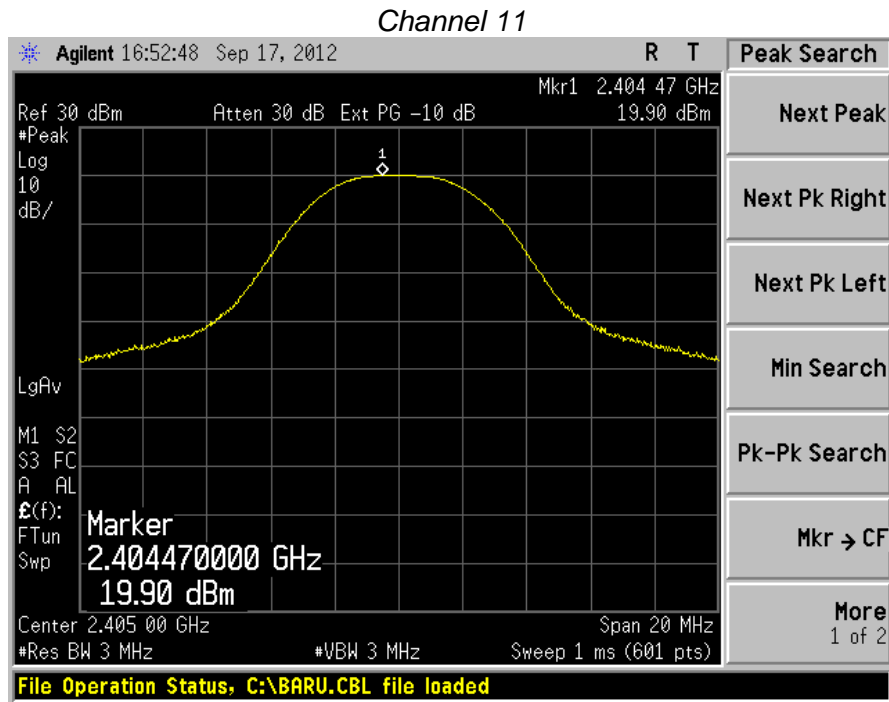
9.2 - Test Equipment List

A complete list of test equipment that was used for this test can be found in Appendix A.

9.3 - Test Data

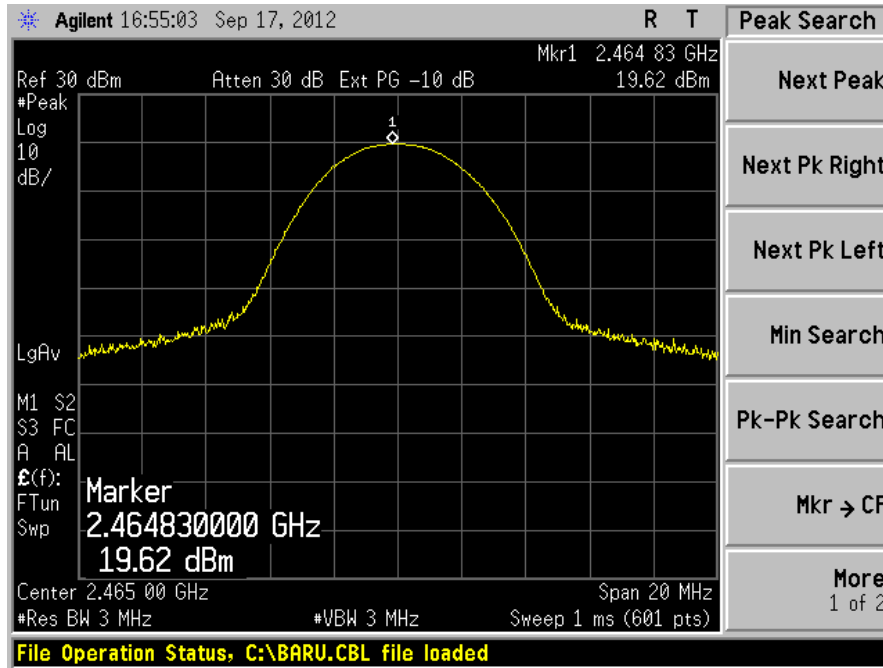
CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
11	2405	30.0	19.9	10.1
18	2440	30.0	19.8	10.2
23	2465	30.0	19.6	10.4
24	2470	30.0	16.7	13.3
25	2475	30.0	10.3	19.7
26	2480	30.0	1.4	28.6

9.4 - Screen Captures - Power Output (Conducted)

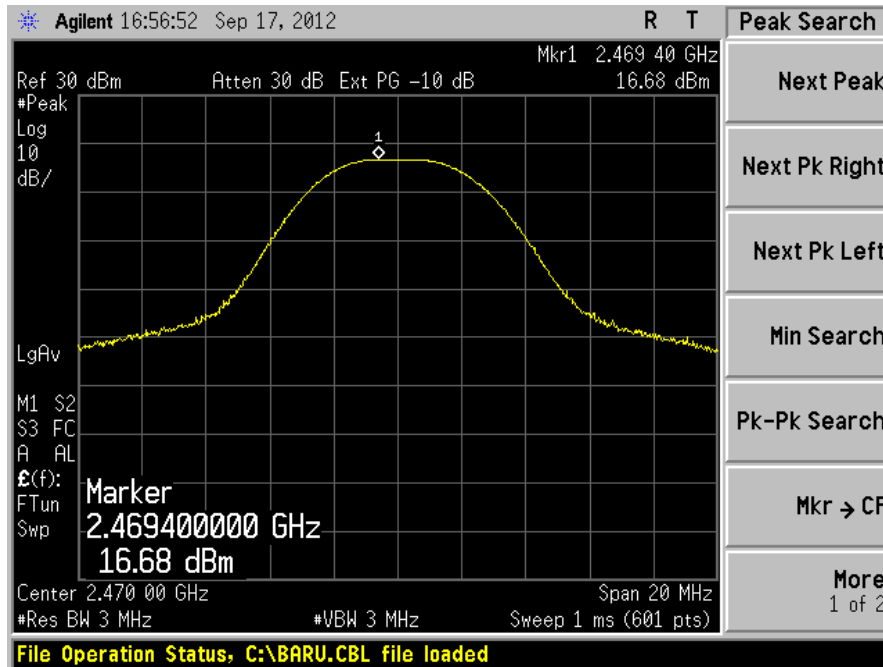


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 23

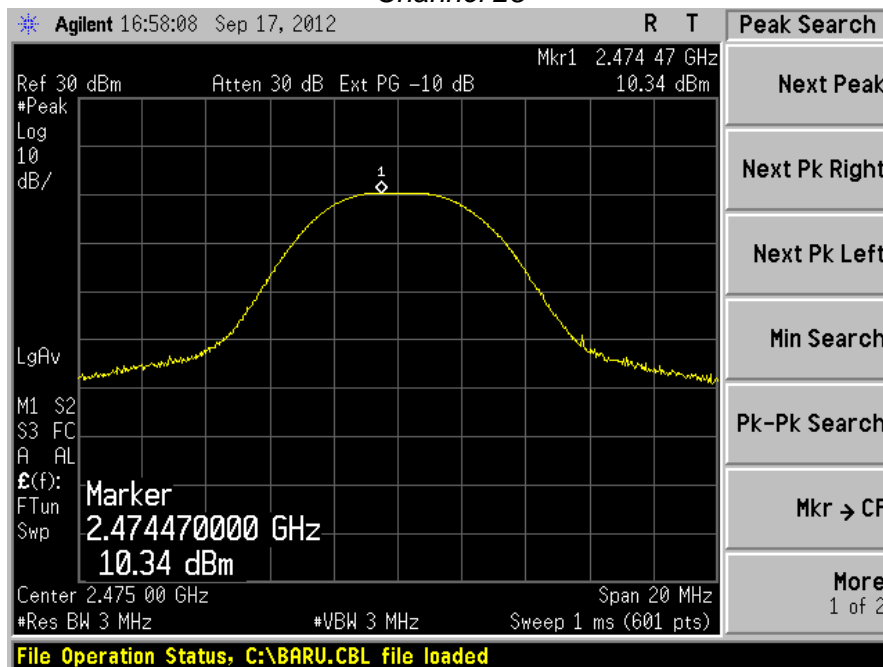


Channel 24

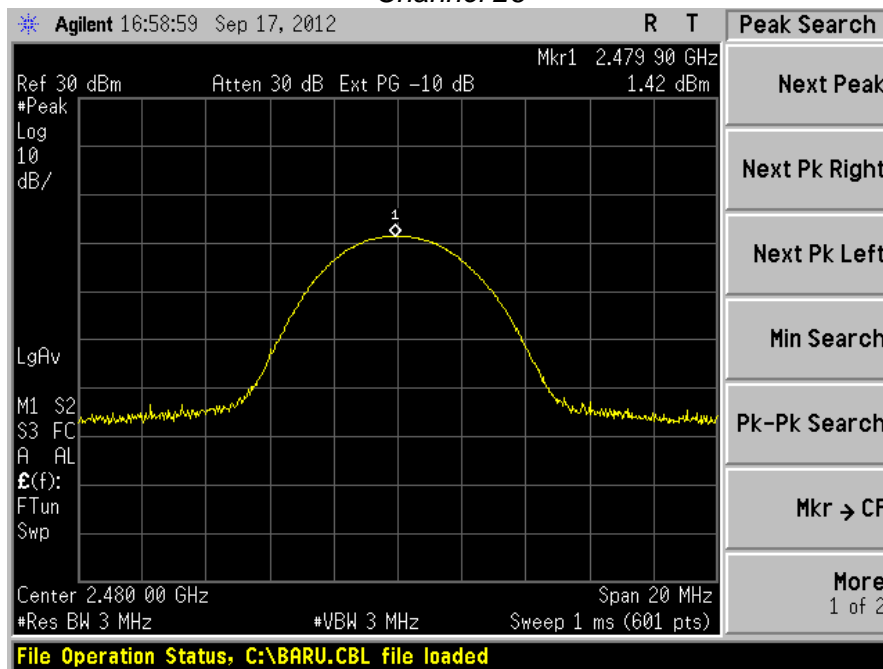


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 25



Channel 26



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

10.1 - Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e) and RSS 210 A8.2(b), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed. The highest density was found to be no greater than 4.62 dBm, which is under the allowable limit by 3.38 dB.

10.2 - Test Equipment List

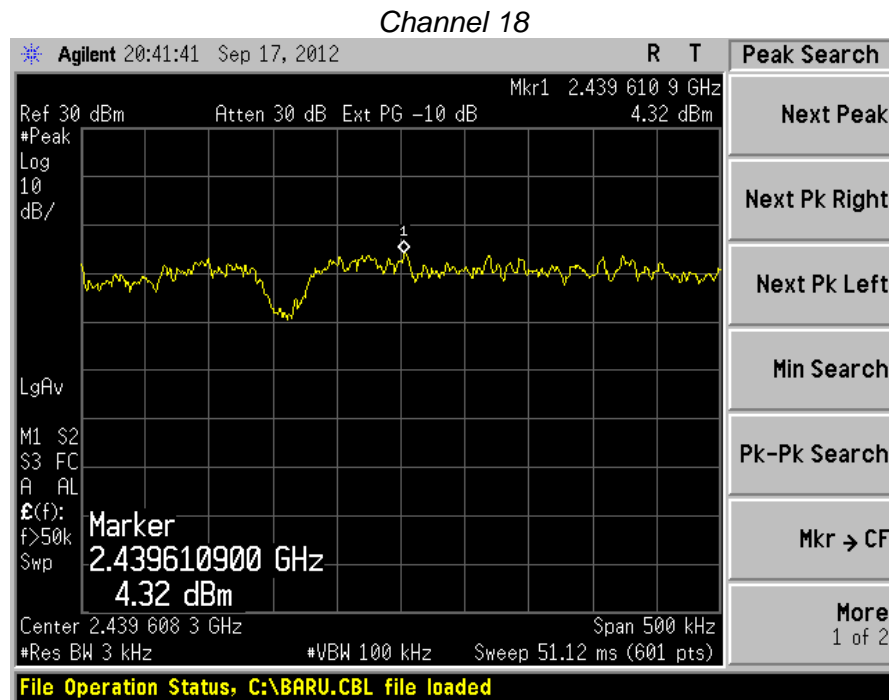
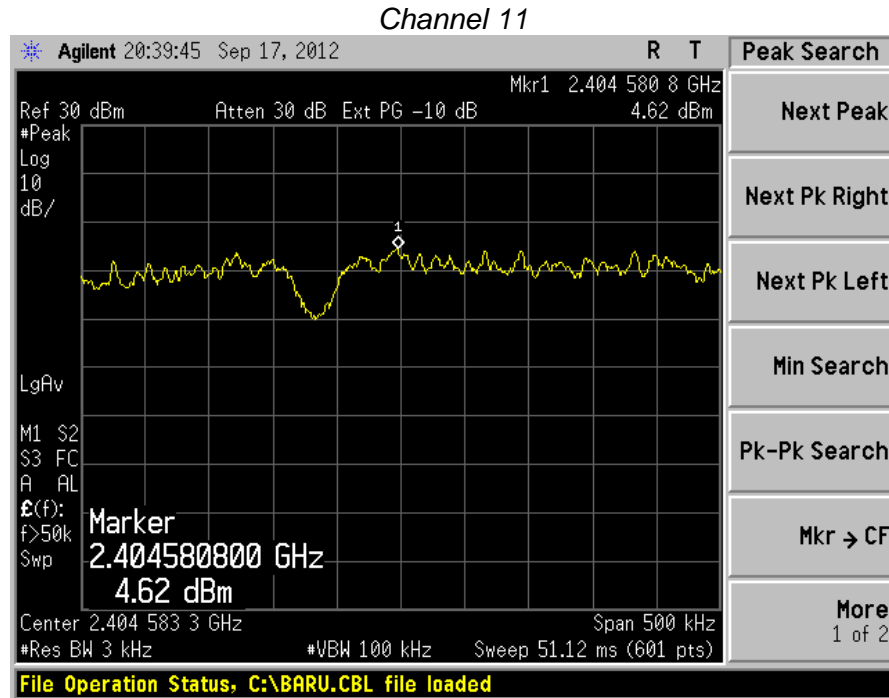
A complete list of test equipment can be found in Appendix A.

10.3 - Test Data

Transmitter Channel	Frequency (MHz)	RF Power Level In 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)
11	2405	4.62	8.0	3.38
18	2440	4.32	8.0	3.68
23	2465	4.12	8.0	3.88
24	2470	1.88	8.0	6.12
25	2475	-4.71	8.0	12.17
26	2480	-13.84	8.0	21.84

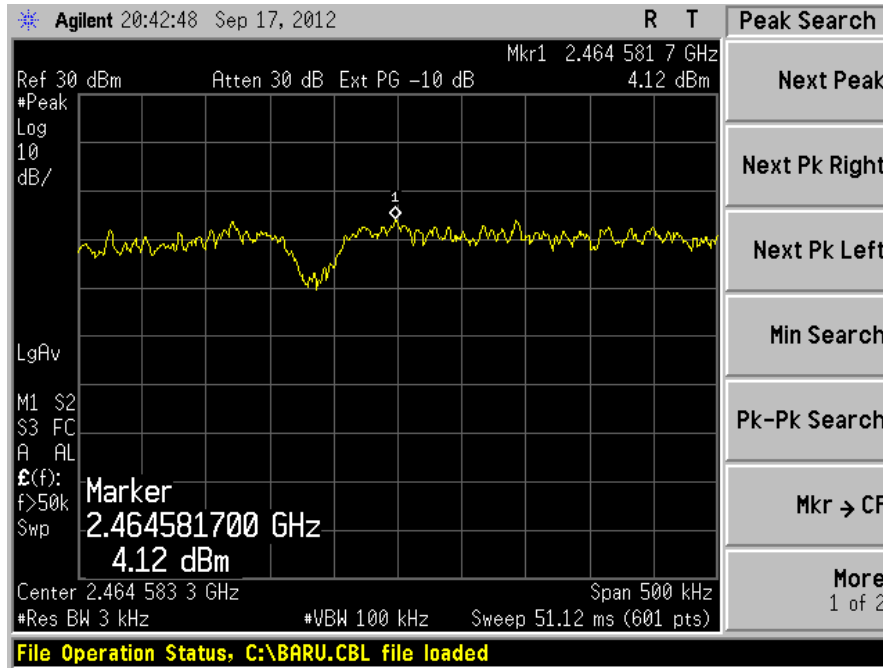
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

10.4 - Screen Captures – Power Spectral Density

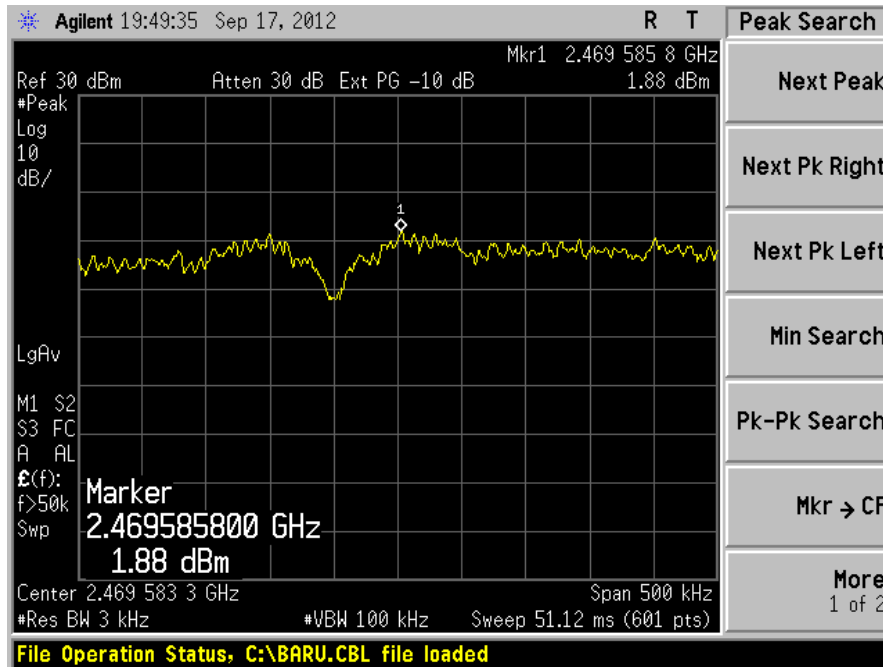


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 23

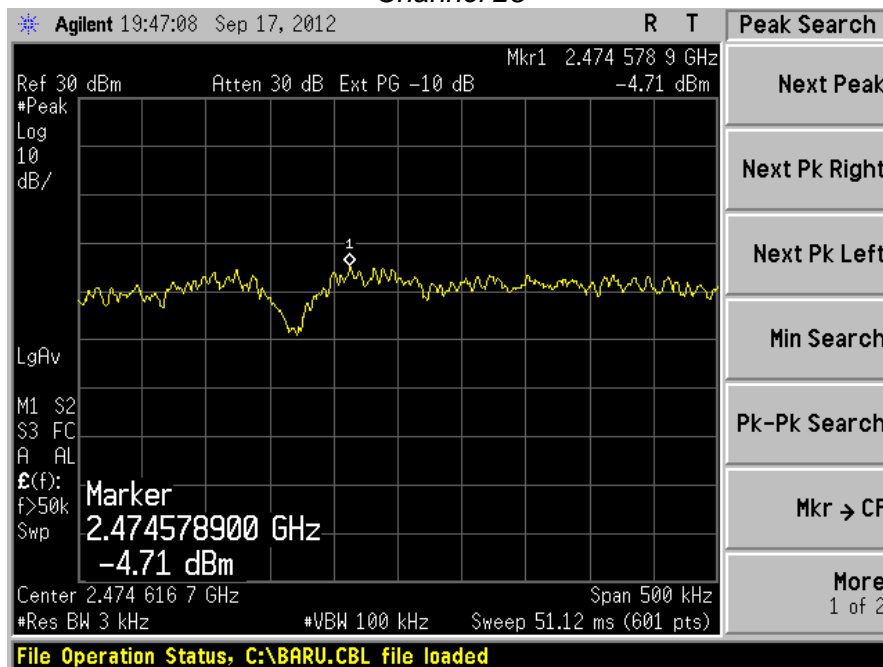


Channel 24

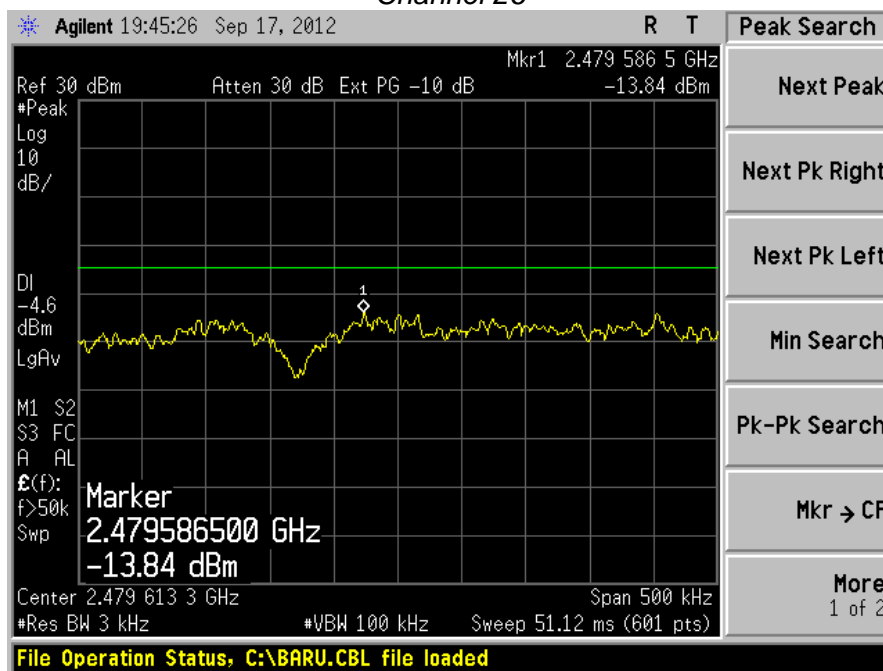


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 25



Channel 26



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

11.1 - Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

11.2 - Conducted Harmonic And Spurious RF Measurements

FCC Part 15.247(d) and IC RSS 210 A8.5 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable. An Agilent E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

No significant emissions could be noted within -50 dBc of the fundamental level for this product.

Frequency	Channel 11 [2405 MHz]	Channel 18 [2440 MHz]	Channel 23 [2465 MHz]	Channel 24 [2470 MHz]	Channel 25 [2475 MHz]	Channel 26 [2480 MHz]
Fundamental	16.1	16.5	16.2	13.4	6.3	-2.0
2 nd Harmonic	-47.5	-49.7	-50.1	-58.6	-68.9	-69.5
3 rd Harmonic	-58.7	-59.1	-56.8	-62.7	-67.4	-66.7
4 th Harmonic	-57.8	-57.5	-57.7	-62.4	-66.9	-67.9
5 th Harmonic	-66.4	-65.9	-67.0	-66.0	-65.9	-66.6
6 th Harmonic	-62.3	-63.9	-63.7	-63.8	-63.8	-63.7
7 th Harmonic	-64.4	-64.3	-65.2	-63.7	-63.9	-65.5
8 th Harmonic	-64.8	-66.2	-65.1	-64.6	-64.1	-65.2
9 th Harmonic	-64.0	-62.9	-63.3	-62.6	-63.4	-64.0
10 th Harmonic	-60.5	-62.5	-60.4	-60.7	-60.2	-61.9

Spurious Conducted Emissions

Freq(MHz)	Channel	Level(dBm)
443.9	11	-51.7
542.50	11	-59.48

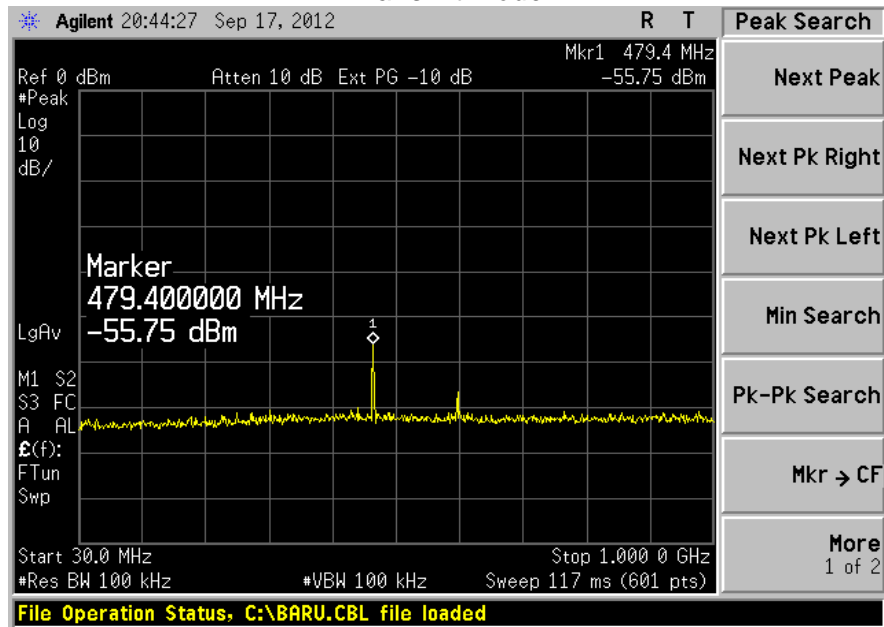
11.3 - Test Equipment List

A complete list of test equipment that was used for this test can be found in Appendix A.

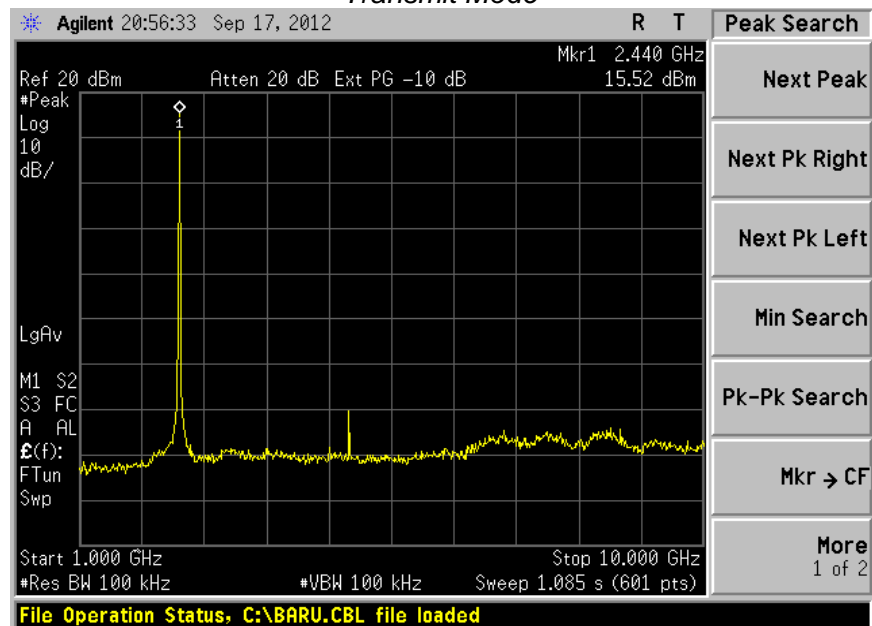
Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

11.4 - Screen Captures – Spurious Radiated Emissions

Channel 18, shown from 30 MHz up to 1000 MHz
Transmit Mode

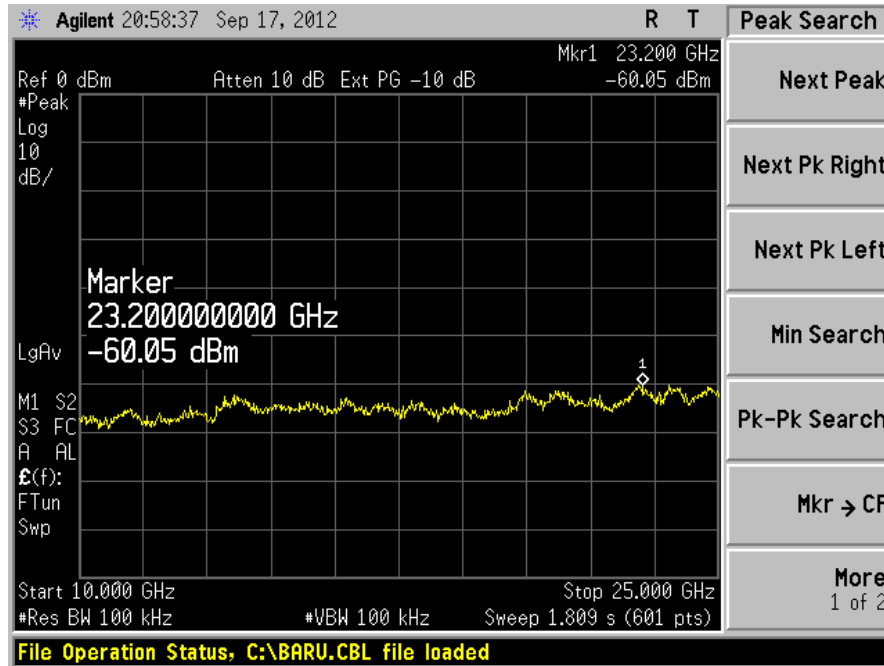


Channel 18, shown from 1000 MHz up to 10000 MHz
Transmit Mode

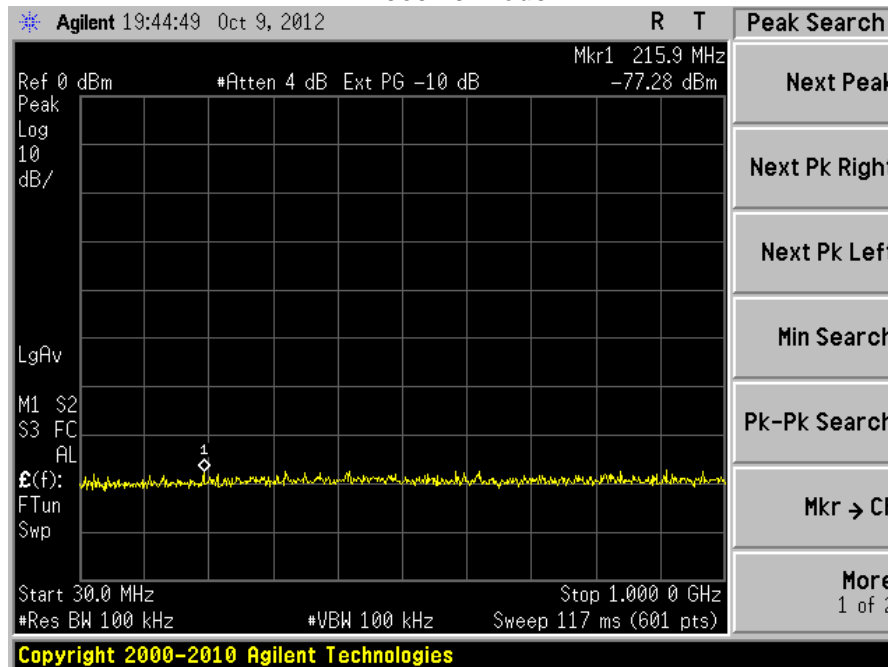


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

Channel 18, shown from 10000 MHz up to 25000 MHz
Transmit Mode

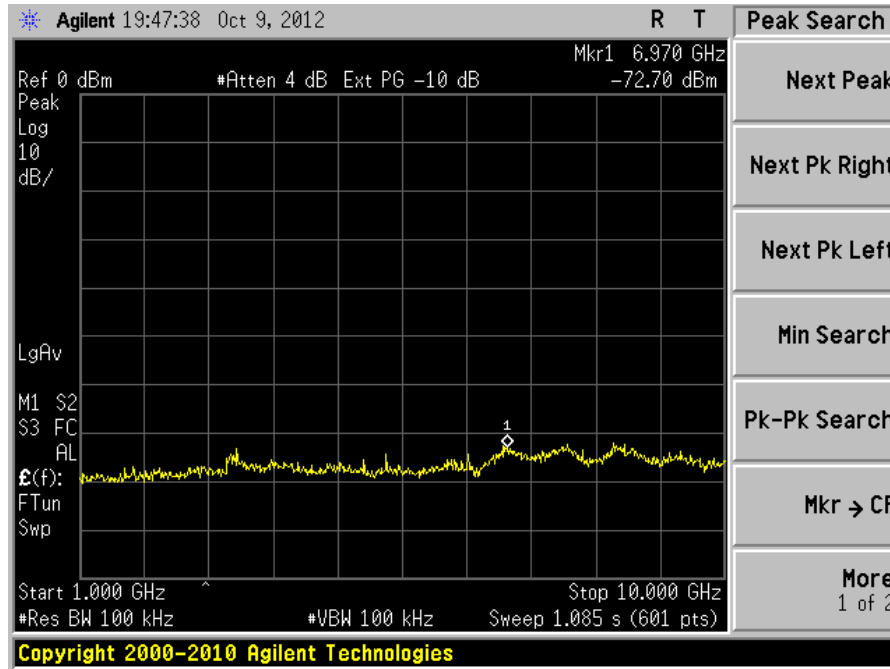


Channel 18, shown from 30 MHz up to 1000 MHz
Receive Mode

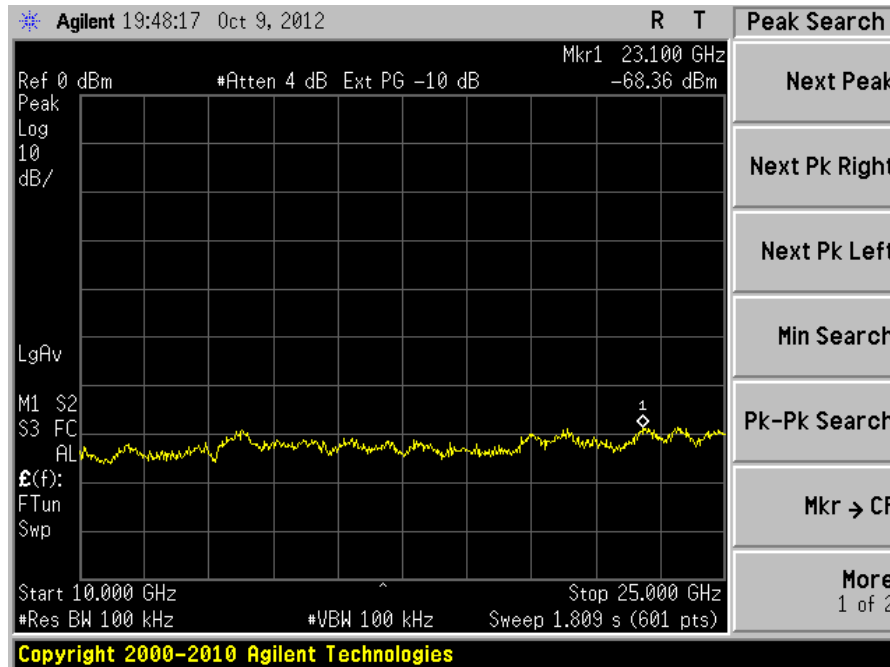


Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
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Channel 18, shown from 1000 MHz up to 10000 MHz
Receive Mode



Channel 18, shown from 10000 MHz up to 25000 MHz
Receive Mode



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=1 kHz settings while the voltage was varied. The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=3 MHz setting while the voltage was varied.

2.8 VDC		3.3 VDC		3.8 VDC		
Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Channel
19.72	2404582500	20.08	2404582500	20.36	2404581700	11
19.44	2439582500	19.84	2439582500	20.13	2439582500	18
19.33	2464582500	19.69	2464582500	19.98	2464581700	23
15.61	2469584000	15.89	2469584000	16.16	2469584000	24
8.74	2474585900	9.02	2474585100	9.28	2474585100	25
0.22	2479587400	0.48	2479586400	0.74	2479586700	26

Channel	Maximum Frequency (Hz)	Minimum Frequency (Hz)	Frequency Drift (Hz)
11	2404582500	2404581700	800
18	2439582500	2439582500	0
23	2464582500	2464581700	800
24	2469584000	2469584000	0
25	2474585900	2474585100	800
26	2479587400	2479586400	1000

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characterizes were well behaved, and the system returned to the same state of operation as before the power cycle.

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

APPENDIX A – Test Equipment List



Date: 9-Oct-2012 Type Test: Conducted AC Emissions Job #: C-1544
 Prepared By: Peter Customer: LSR Quote #: 312230

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	8546A System	3617A00320,3448A	11/22/2011	11/22/2012	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	11/22/2011	11/22/2012	Active Calibration
3	AA 960008	LISN	EMCO	3816/2NM	9701-1057	1/3/2012	1/3/2013	Active Calibration
4	EE 960077	DC Power Supply	GV Instek	GPS-3030DD	EJ810521	Uncalibrated	Uncalibrated	Not For Compliance Measurement
5	EE 960001	Multimeter	HP	971A	JP36004055	3/12/2012	3/12/2013	Active Calibration

Project Engineer: *Peter Fubin* Quality Assurance: *Eric Rasmussen*



Date: 18-Sep-2012 Type Test: Conducted Power Output Job #: C-1544
 Prepared By: Shane Rismeyer Customer: LSR Quote #: 312230

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/1/2011	6/1/2013	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/9/2012	5/9/2013	Active Calibration

Project Engineer: *Eric Rasmussen* Quality Assurance: *Shane Rismeyer*



Date: 18-Sep-2012 Type Test: Radiated Emissions Job #: C-1544
 Prepared By: Shane Rismeyer Customer: LSR Quote #: 312230

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960158	RF Preselector	Agilent	N9039A	MY4652010	6/29/2012	6/29/2013	Active Calibration
2	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/29/2012	6/29/2013	Active Calibration
3	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	11/15/2011	11/15/2012	Active Calibration
4	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	11/15/2011	11/15/2012	Active Calibration
5	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	5/16/2012	5/16/2013	Active Calibration
6	EE 960147	Pre-Amp	Adv. Micro	\LA612	123101	1/6/2012	1/6/2013	Active Calibration
7	EE 960156	100kHz-1GHz Analog Signal Generator	Agilent	N5181A	MY49060062	6/30/2012	6/30/2013	Active Calibration
8	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro	\LA622-4	123001	11/3/2011	11/3/2012	Active Calibration

Project Engineer: *Eric Rasmussen* Quality Assurance: *Shane Rismeyer*

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

APPENDIX B - Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
RSS 210	2007-06		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2009		
FCC Public Notice DA 00-1407	2000		
FCC ET Docket # 99-231	2002		
FCC Procedures	2007		
KDB 558074	2005		

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

APPENDIX C - Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
Temperature/Humidity	Thermo-hygrometer	0.64° / 2.88 %RH

Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544

APPENDIX D - Justifications of Average Duty Factor Calculations

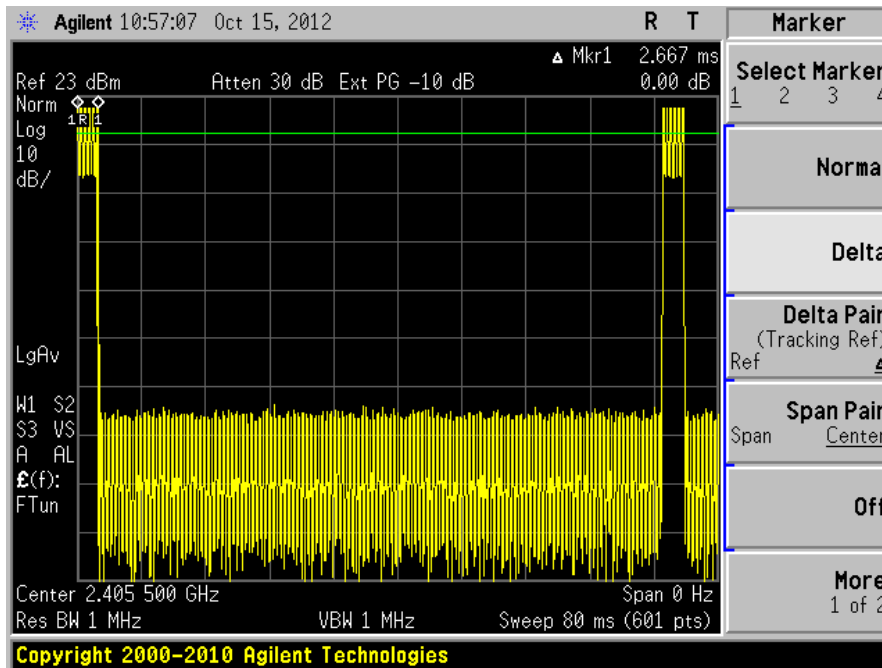
Average (Relaxation) Factor

Average Factor = $20 * \text{Log}_{10}$ (Worst Case EUT On-time over transmission cycle (or 100ms whichever is less))

The transmit packets occupy 5.6 ms of time, within any 64.67 ms window. Therefore, the relaxation factor allowance is calculated as:

$$\text{Average Factor} = 20 * \text{Log}_{10} (5.6 / 64.67 \text{ ms}) = -21.25 \text{ dB}$$

A relaxation factor of 21.25 dB would be allowable for this product.



Prepared For: LS Research	Model Number: ZFSM-101-3	Report #: 312230
EUT: FreeStar	Serial Number: 7, 8, 11, 14	LSR Job #: C-1544