Test of G2 Microsystems Model 501RT01

To: FCC 47 CFR Part15.247

Test Report Serial No.: GMIS03-A2 Rev A

TEST REPORT

FROM

Test of G2 Microsystems Model 501RT01
to
FCC 47 CFR Part15.247

Test Report Serial No.: GMIS03-A2 Rev A

This report supersedes: None

Manufacturer: G2 Microsystems
1475 South Bascom Avenue,
Suite 109.
Campbell
California 95008, USA

Product Function: 2.4 GHz Active RFID Tag

Copy No: pdf **Issue Date:** 4th April 2007

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
440 Boulder Court, Suite 200
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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ACCREDITATION & LISTINGS

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

MICOM LABS
Pleasanton, CA

for technical competence in the field of

Electrical Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC 17025 - 1999 "General Requirements for the Competence of Testing and Calibration Laboratories" and any additional program requirements in the identified field of testing.

Presented this 14th day of September 2005.

American Association for Laboratory Accreditation
Corporate SEAL 1978 District of Columbia
A2LA

President
For the Accreditation Council
Certificate Number 2381.01
Valid to: November 30, 2007

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

LISTINGS

MiCOM Labs test facilities are listed by the following organizations;

North America

United States of America
Federal Communications Commission (FCC) Listing #: 102167

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	4th April 2007	First issue.

1. TEST RESULT CERTIFICATE

Manufacturer:	G2 Microsystems 1475 South Bascom Avenue, Suite 109. Campbell California 95008, USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
EUT:	802.11b RFID Device	Telephone:	+1 925 462 0304
Model:	501RT01	Fax:	+1 925 462 0306
S/N:	Not Available		
Test Date(s):	7th to 20th March '07	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part15.247	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

ACCREDITED
CERTIFICATE #2381.01

Approved & Released for MiCOM Labs, Inc. by:

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Part 15.247	2006	Code of Federal Regulations
(ii)	ANSI C63.4	2003	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
(iii)	CISPR 22/ EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(iv)	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(v)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(vi)	ETSI TR 100 028	2001	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
(vii)	A2LA	14th September 2005	Reference to A2LA Accreditation Status – A2LA Advertising Policy

2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

3. PRODUCT DETAILS AND TEST CONFIGURATIONS

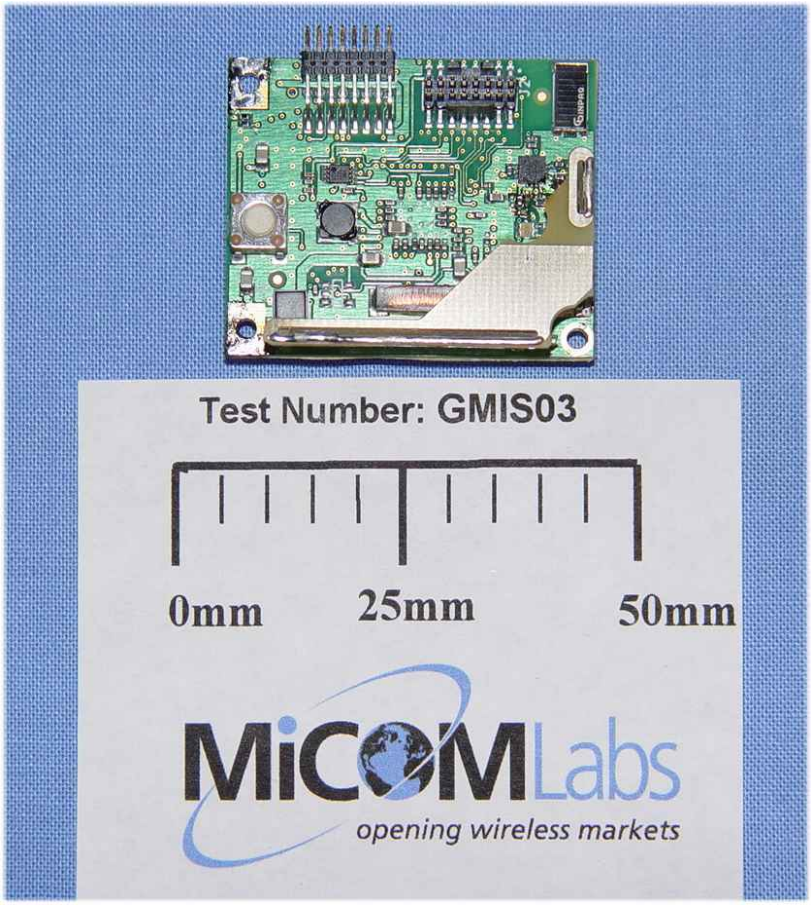
3.1. Technical Details

Details	Description
Purpose:	Test of the G2 Microsystems Model 501RT01 to FCC Part 15.247.
Applicant:	As Manufacturer
Manufacturer:	G2 Microsystems 1475 South Bascom Avenue, Suite 109. Campbell California 95008, USA
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	GMIS03-A2 Rev A
Date EUT received:	7TH March 2007
Standard(s) applied:	FCC 47 CFR Part15.247
Dates of test (from - to):	7th to 20th March '07
No of Units Tested:	1
Type of Equipment:	DSSS/802.11b RFID active tag
Model:	G2 Microsystems Model 501RT01
Location for use:	Indoor/Outdoor use
Declared Frequency Range(s):	2412 - 2462 MHz
Type of Modulation:	DSSS
Declared Nominal Output Power:	20 dBm
EUT Modes of Operation:	802.11b
Transmit/Receive Operation:	Half Duplex
Rated Input Voltage and Current:	3.0 Vdc @ 100 mA
Operating Temperature Range:	Declared range -40 to +85ºC
ITU Emission Designator:	16M0W7D
Microprocessor(s) Model:	SPARC
Clock/Oscillator(s):	32.768 kHz, 44 MHz
Frequency Stability:	±20 ppm
Equipment Dimensions:	1⅝”x1⅝”x ¾”
Weight:	2 oz
Primary function of equipment:	RFID and real time local positioning and tracking device

3.2. Scope of Test Program

The scope of the test program was to test the G2 Microsystems, RFID and real time local positioning and tracking device for compliance against FCC 47 CFR Part 15.247.

G2 Microsystems 2.4 GHz RFID



3.3. Equipment Model(s) and Serial Number(s)

Type (EUT/ Support)	Equipment Description (Including Brand Name)	Mfr	Part No.	Serial No.
EUT	RFID Tag	G2 Microsystems	38-0005005	None
Support	Laptop	Dell		

3.4. Antenna Details

Antenna Type	Gain (dBi)	Integral	Description
Chip	2.5	Yes	Inpaq model ACA7636
Monopole	1.0	Yes	Printed Circuit Board

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. NONE

3.6. Test Configurations

Matrix of test configurations

Frequencies (MHz)
2412
2437
2462

Only worst case plots are provided for each test parameter are identified within this report. Plots not included are held on file by the test laboratory and available upon request with client permission.

3.7. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE

3.8. Subcontracted Testing or Third Party Data

The following subcontracted testing was required in order to complete the test program:

1. NONE

4. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(a)(2)	6 dB and 99 % Bandwidths	>=500 kHz	Conducted	Complies	5.1.1
15.247(b)(3) **15.31(e)**	Peak Output Power Voltage Variation	Shall not exceed 1W Variation of supply voltage 85 % -115 %	Conducted	Complies	5.1.2
15.247(e)	Peak Power Spectral Density	Shall not be greater than +8 dBm in any 3 kHz band	Conducted	Complies	5.1.3
15.247(i)	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Conducted	Complies	5.1.4
15.247(d) **15.205 /** **15.209**	Spurious Emissions (30MHz - 26 GHz)	The radiated emission in any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density	Conducted	Complies	5.1.5

List of Measurements (continued)

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247.**

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(d) **15.205 /** **15.209**	Radiated Emissions	Restricted Bands	Radiated	Complies	5.1.6
	Transmitter Radiated Spurious Emissions, Peak Emissions, Band Edge	Emissions above 1 GHz		Complies	*5.1.6.1*
15.205 / **15.209**	Radiated Spurious Emissions	Emissions <1 GHz (30M-1 GHz)	Radiated	Complies	*5.1.6.2*
15.207	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Not Applicable Device dc powered	*5.1.7*

Note 1: *Test results reported in this document relate only to the items tested*
Note 2: *The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria*
Note 3: *Appendix A - Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix*

5. TEST RESULTS

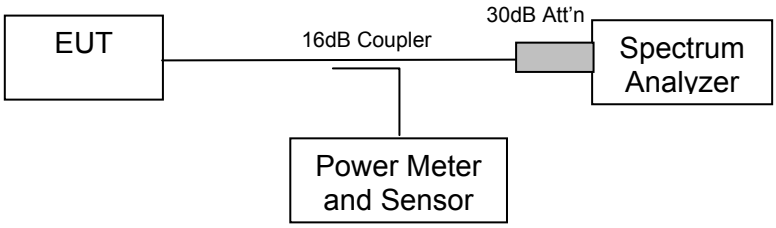
5.1. Device Characteristics

5.1.1. 6 dB and 99 % Bandwidth

FCC, Part 15 Subpart C §15.247(a)(2)

Test Procedure
The bandwidth at 6 dB and 99 % is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency. The analyzer was set for a 6 dB resolution bandwidth filter during this measurement.

Test Measurement Set up



Measurement set up for 6 dB and 99 % bandwidth test

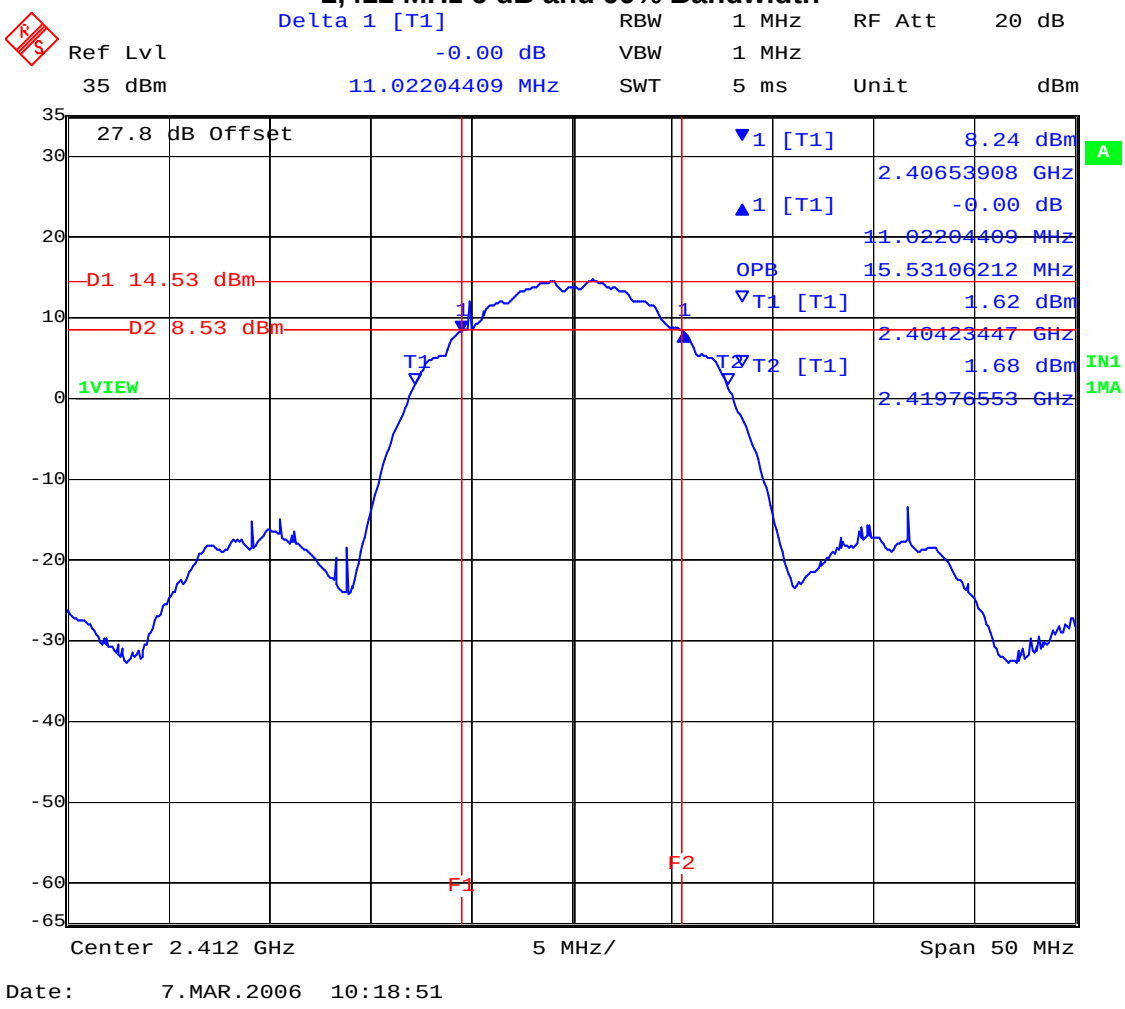
Measurement Results for 6 dB and 99 % Operational Bandwidth(s)

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS –

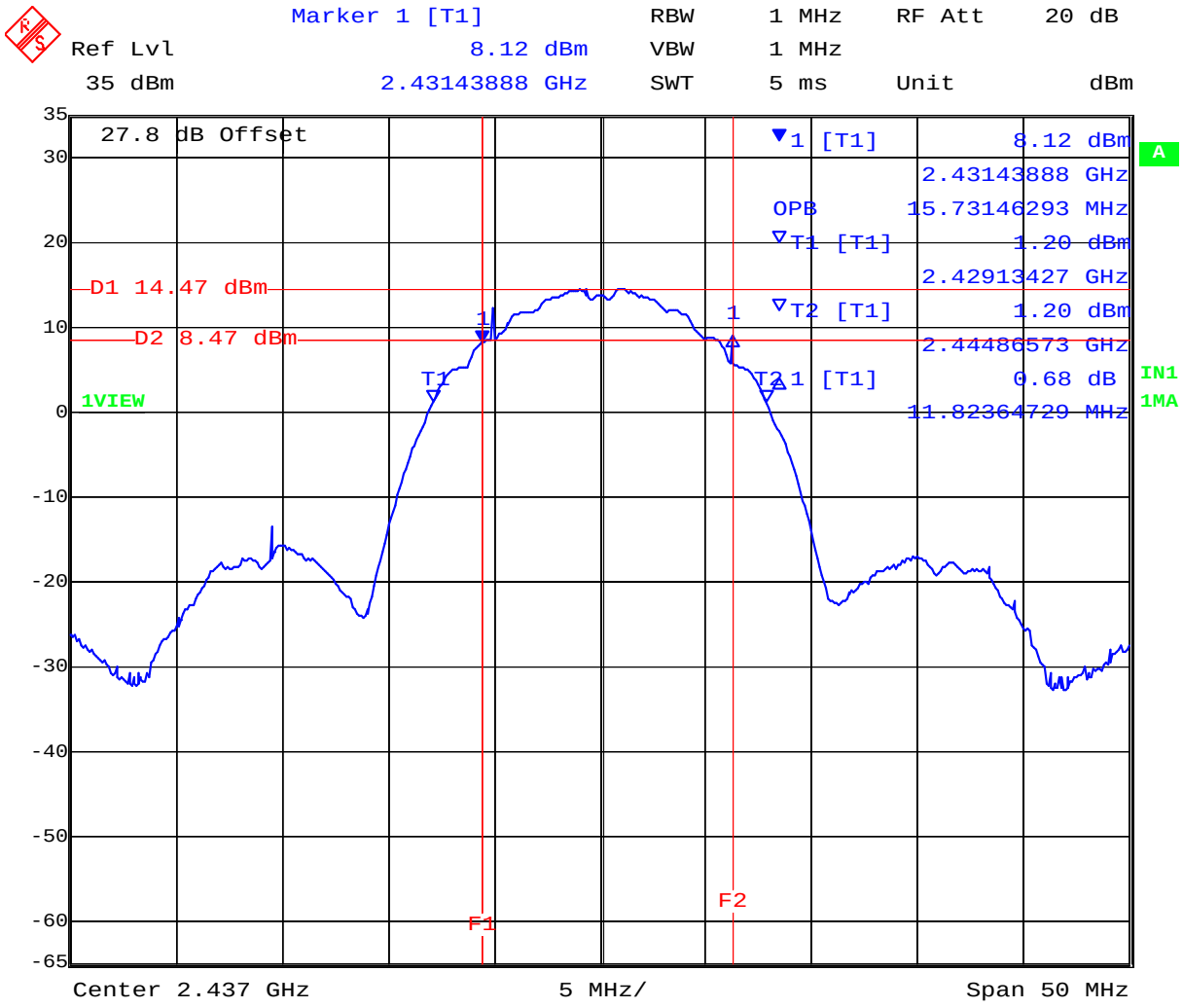
Center Frequency (MHz)	6 dB Bandwidth (MHz)	99 % BW (MHz)	6 dB & 99 % BW Plots
2412	11.022	15.531	01
2437	11.023	15.731	02
2462	11.623	15.931	03

PLOT 01
2,412 MHz 6 dB and 99% Bandwidth



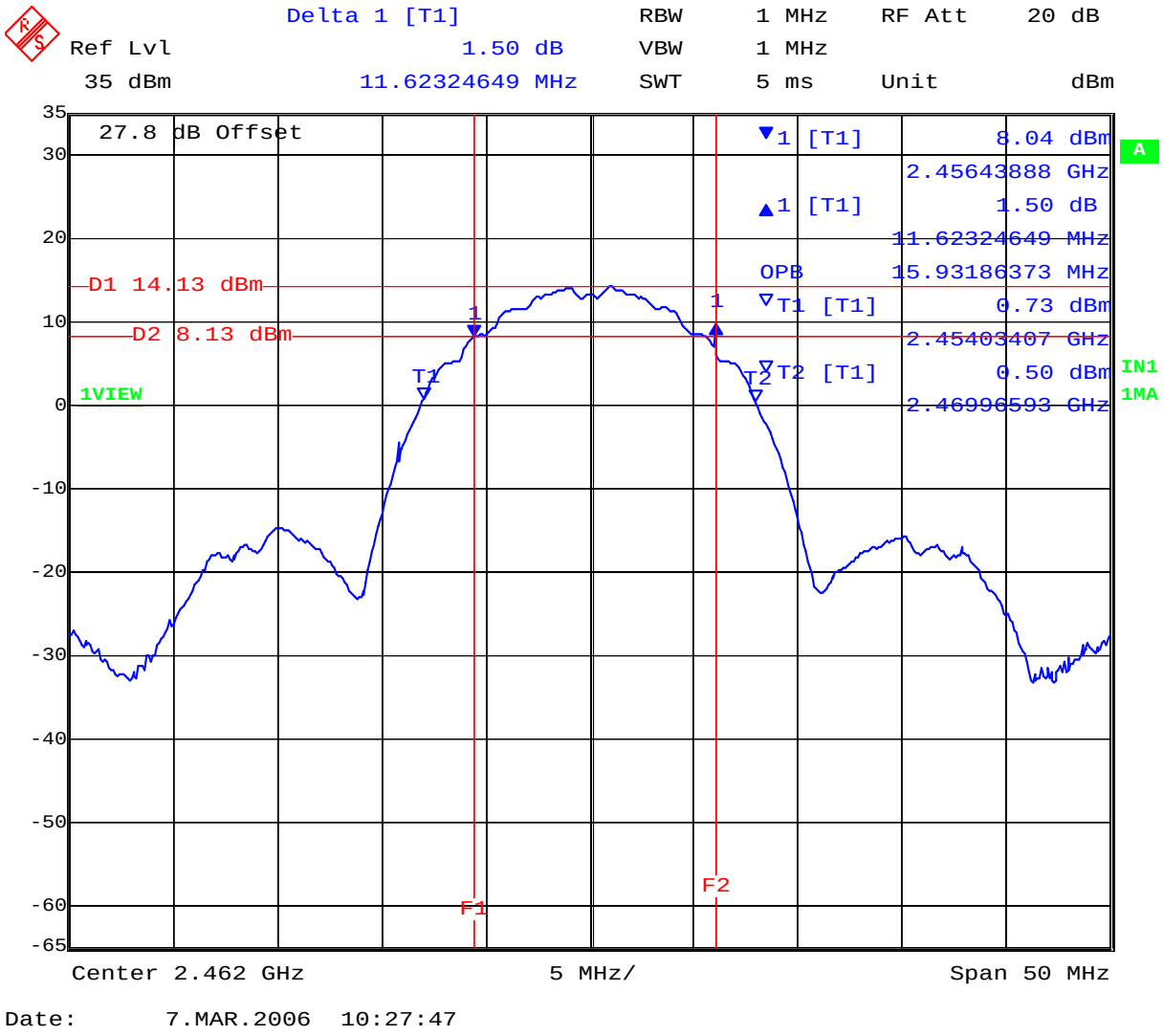
Plot 02

2437 MHz 6 db and 99 % Bandwidth



Plot 03

2462 MHz 6 dB and 99% Bandwidth



Date: 7.MAR.2006 10:27:47

Specification

Limits

§15.247 (a)(2) The minimum 6 dB bandwidth shall be at least 500 kHz. I.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

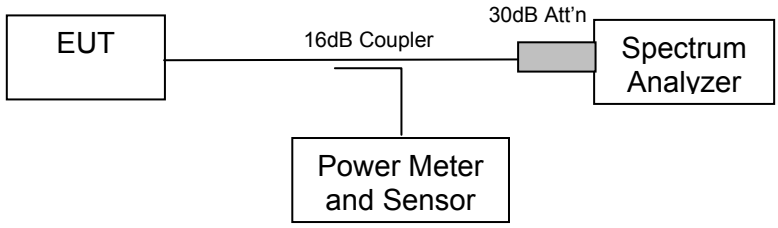
5.1.2. Peak Output Power

FCC, Part 15 Subpart C §15.247(b)(3), §15.31(e)

Test Procedure

The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure peak power. The resolution filter bandwidth was set to 6 dB, peak detector selected and the analyzer built-in power function was used to measure peak power over the 99 % bandwidth. Initial measurements were employed to define which data rate provided the highest output power. Measurements were made while EUT was operating in a continuous transmission mode i.e. 100 % duty cycle at the appropriate center frequency.

Test Measurement Set up



Measurement set up for Transmitter Peak Output Power

15.247 (c) Operation with directional antenna gains greater than 6 dBi

(1) Fixed point –to-point operation:

(i) Systems operating in the 2400 – 2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Ambient conditions.

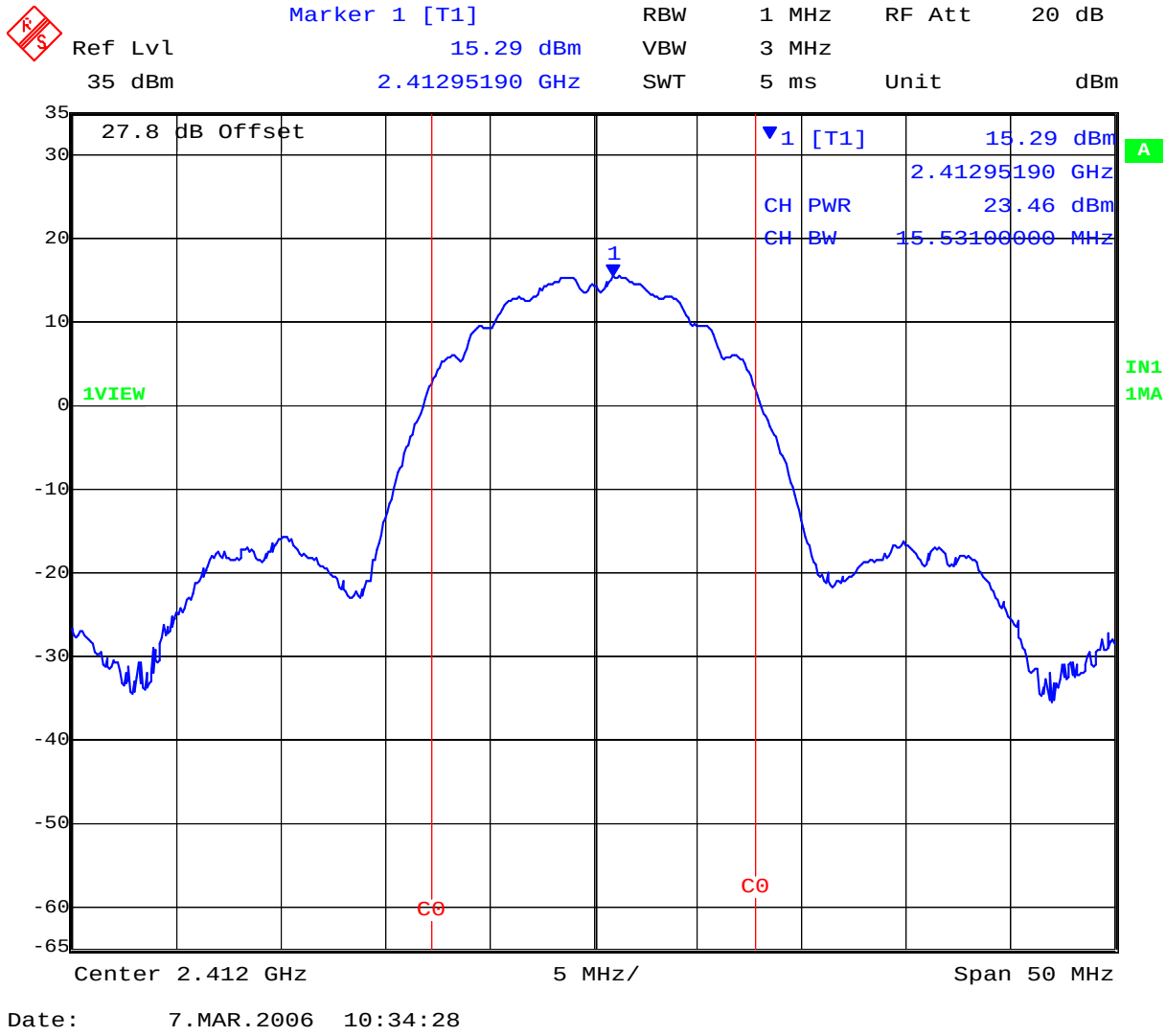
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS –

Center Frequency (MHz)	99%Measurement Bandwidth (MHz)	Peak Power (dBm)	EIRP (dBm)	Plot #
2,412	15.531	+23.46	+25.96	04
2,437	15.731	+23.19	+25.69	05
2,462	15.931	+23.38	+25.88	06

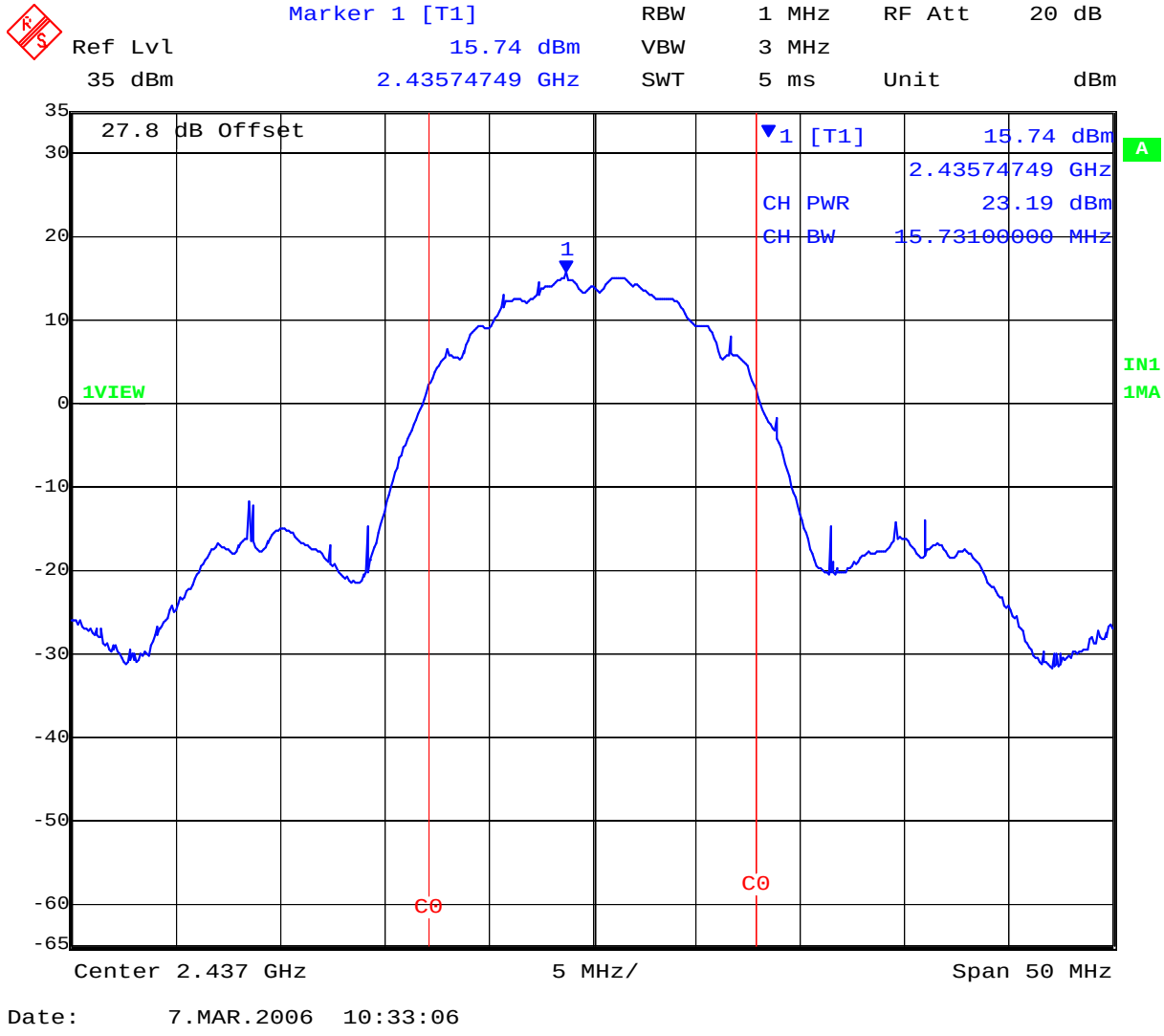
Plot 04

2,412 MHz Peak Power (dBm)



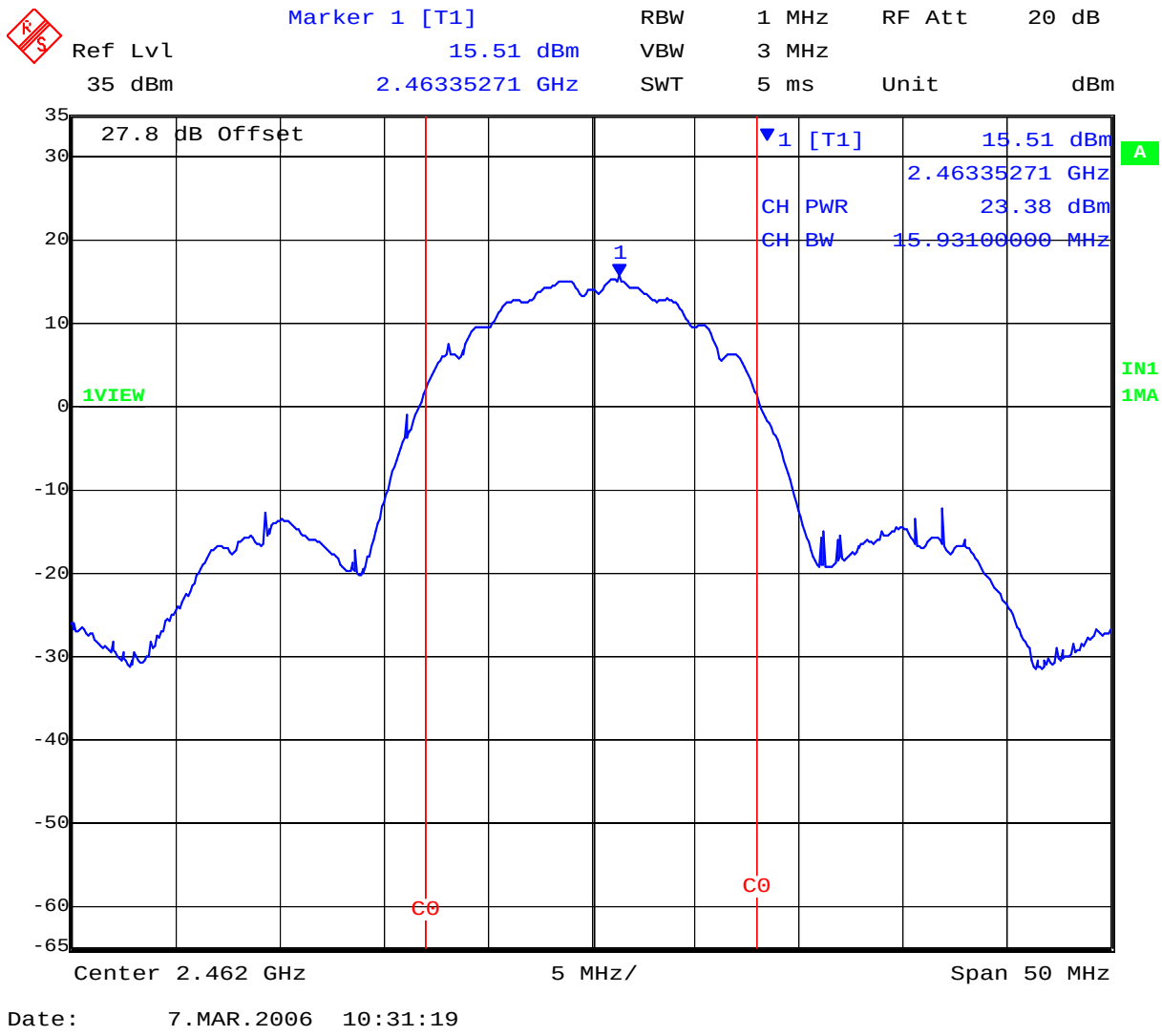
Plot 05

2,437 MHz Peak Power (dBm)



Plot 06

2,462 MHz Peak Power (dBm)



Specification

Limits

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

> **§15.247 (b) (3)** For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1.0 watt.

§15.31 (e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

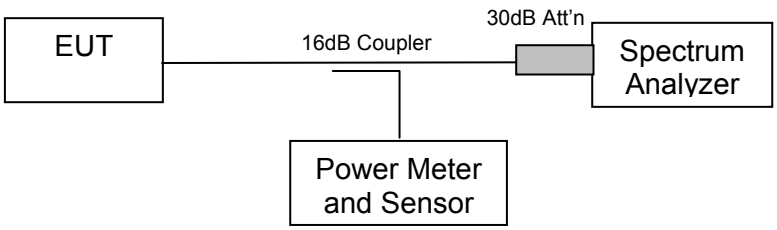
5.1.3. Peak Power Spectral Density

FCC, Part 15 Subpart C §15.247(e)

Test Procedure

The transmitter output was connected to a spectrum analyzer and the maximum level in a 3 kHz bandwidth was measured. A peak value was found over the full emission bandwidth and the frequency span reduced to obtain enhanced resolution. Sweep time => span / 3 kHz with video averaging turned off. The Peak Power Spectral Density is the highest level found across the emission in a 3 kHz resolution bandwidth. Spectrum analyzer settings:

Test Measurement Set up



Measurement set up for Peak Power Spectral Density

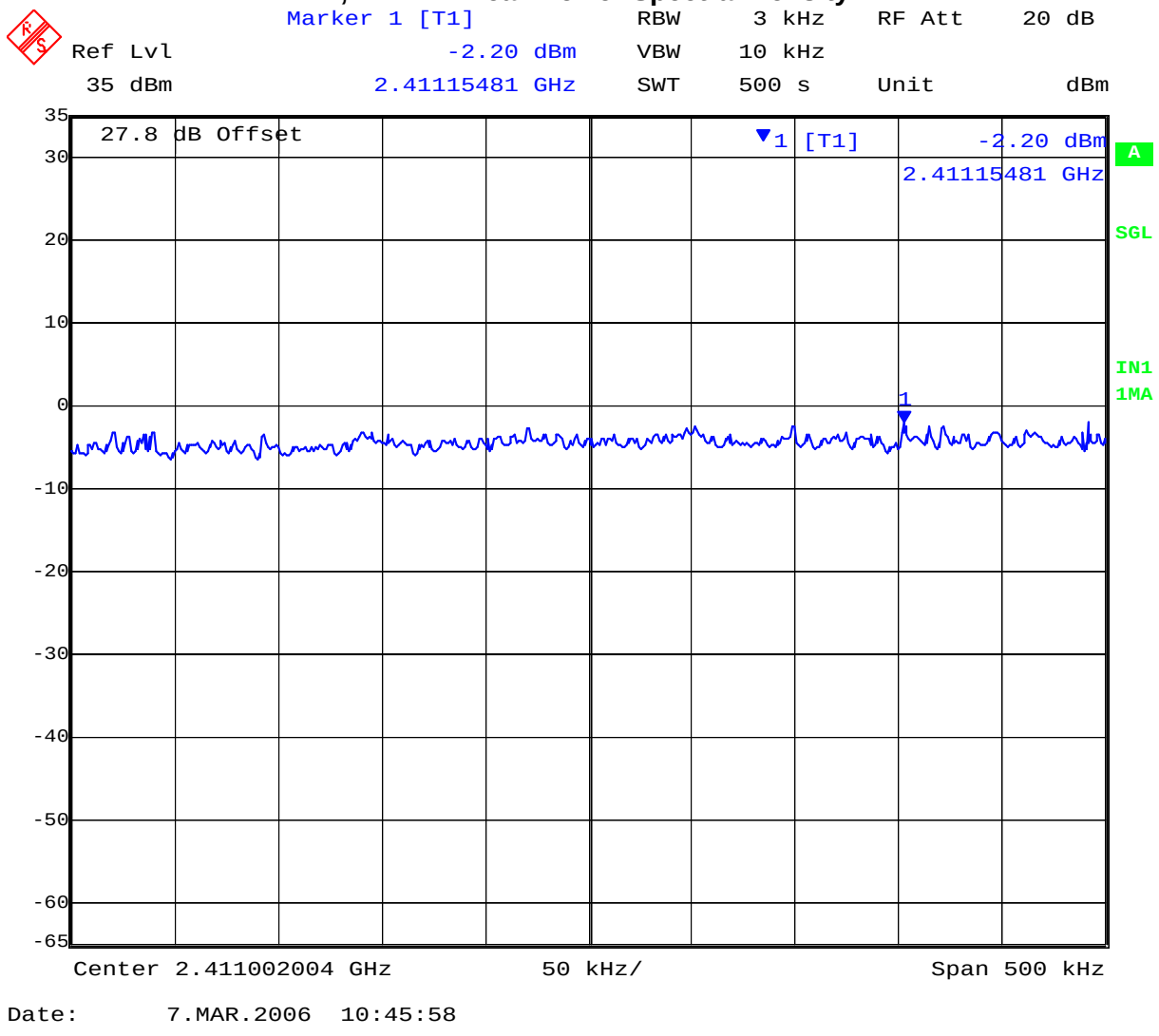
Measurement Results for Peak Power Spectral Density

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

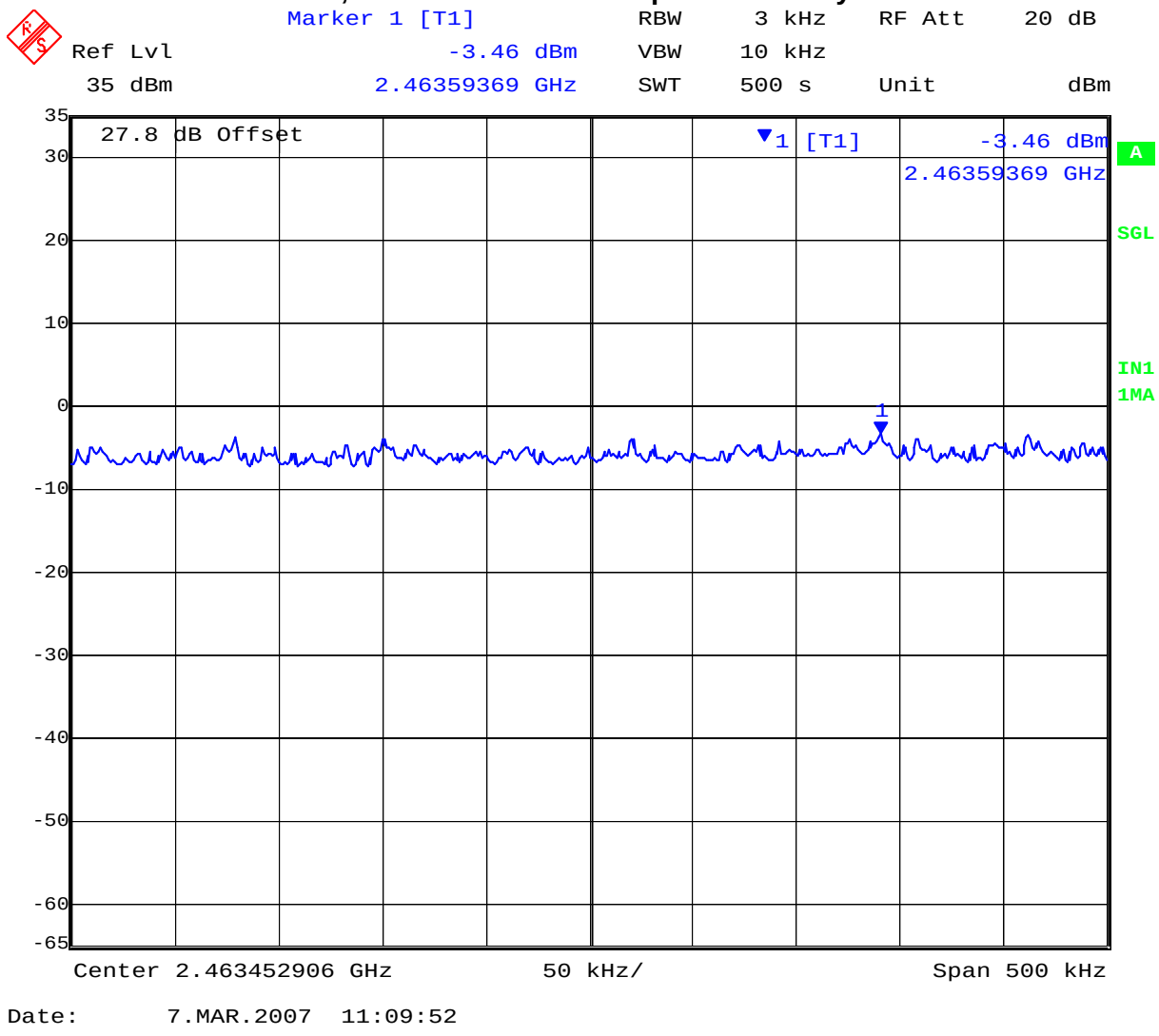
TABLE OF RESULTS –

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dBm)	Plot #
2,412	2411.15481	-2.20	+8	-10.20	07
2,437	2436.15982	-2.34	+8	-10.34	On File
2,462	2463.59369	-3.46	+8	-13.46	08

Plot 07
2,412 MHz Peak Power Spectral Density



Plot 08
2,462 MHz Peak Power Spectral Density



Specification
Peak Power Spectral Density Limits

§15.247(e) For digitally modulated 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

Laboratory Measurement Uncertainty for Spectral Density

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

5.1.4. Maximum Permissible Exposure

FCC, Part 15 Subpart C §15.247(i)

Calculations for Maximum Permissible Exposure Levels

Power Density = Pd (mW/cm^2) = $EIRP/(4\pi d^2)$

EIRP = P * G

P = Peak output power (mW)

G = Antenna numeric gain (numeric)

d = Separation distance (cm)

Numeric Gain = 10 ^ (G (dBi)/10)

P (worst case) = +23.46 dBm, 221.82 mW

Antenna Gain (Worst Case) = 2.5 dBi, 1.78 numeric

Because the EUT belongs to the General Population/Uncontrolled Exposure the limit of power density is 1.0 mW/cm^2

The MPE calculations are calculated using the maximum allowable power levels calculated for each antenna in Section 5.1.2 "Peak Output Power" of the report.

Antenna Gain (dBi)	Numeric Gain (numeric)	Max Allowable Peak Power (dBm)	Max Allowable Peak Power (mW)	Calculated Safe Distance at 1 mW/cm^2 (cm)
2.5	1.78	+23.46	221.82	5.6

Specification

Maximum Permissible Exposure Limits

§15.247(i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency levels in excess of the Commission's guidelines.

Limit S = 1mW / cm^2 from 1.310 Table 1

Note: for mobile or fixed location transmitters the minimum separation distance is 20cm, even if calculations indicate the MPE distance to be less.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

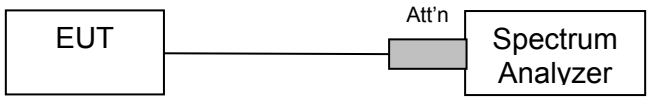
5.1.5. Conducted Spurious Emissions

FCC, Part 15 Subpart C §15.247(d); 15.205; 15.209

Test Procedure

Conducted emissions were measured at a limit of 20 dB below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. Emissions at the band edge were measured and recorded. Measurements were made while EUT was operating in transmit mode of operation at the appropriate center frequency.

Test Measurement Set up



Band-edge measurement test configuration

Measurement Results of Conducted Spurious Emissions

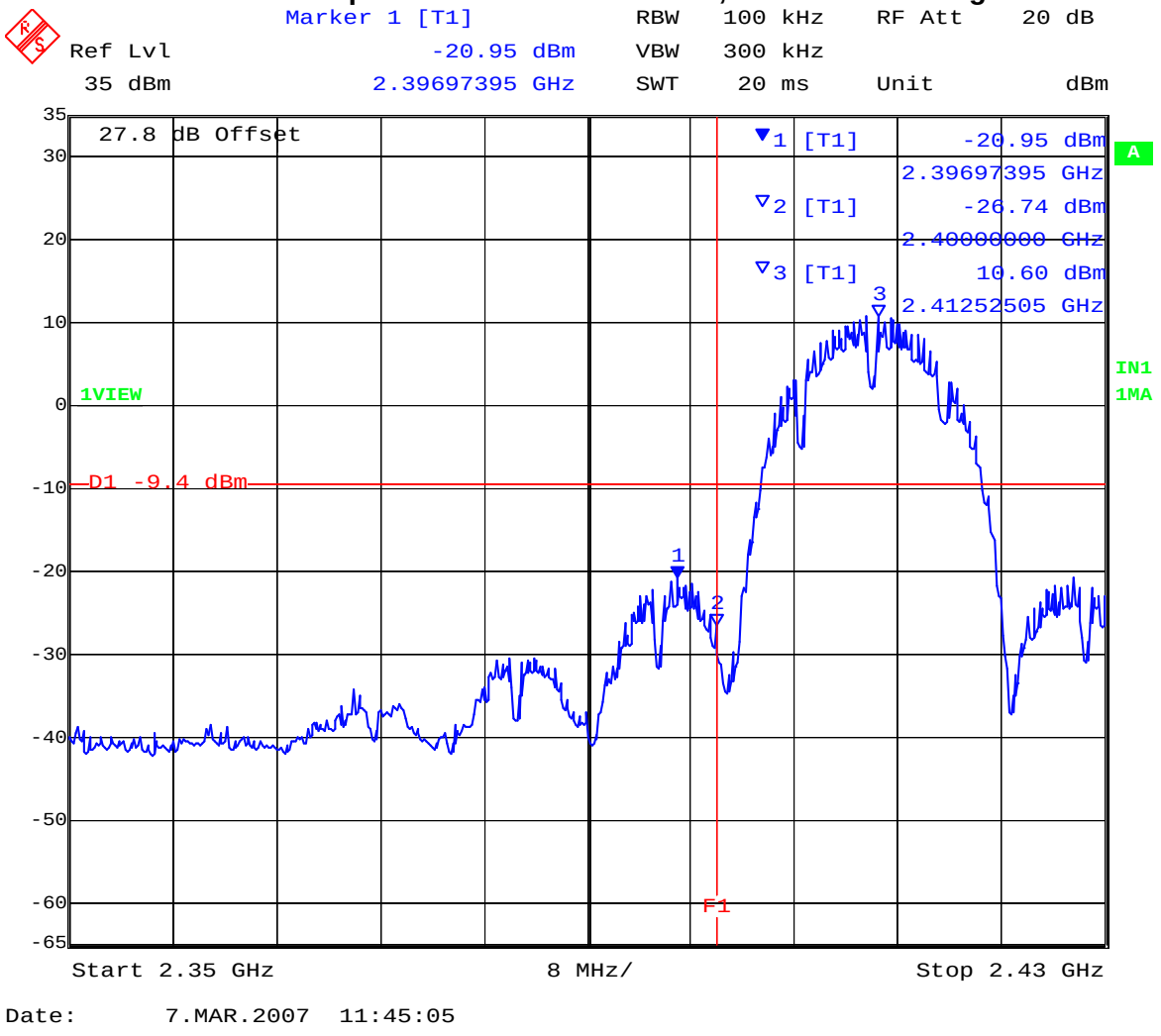
Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Conducted Band-Edge Results

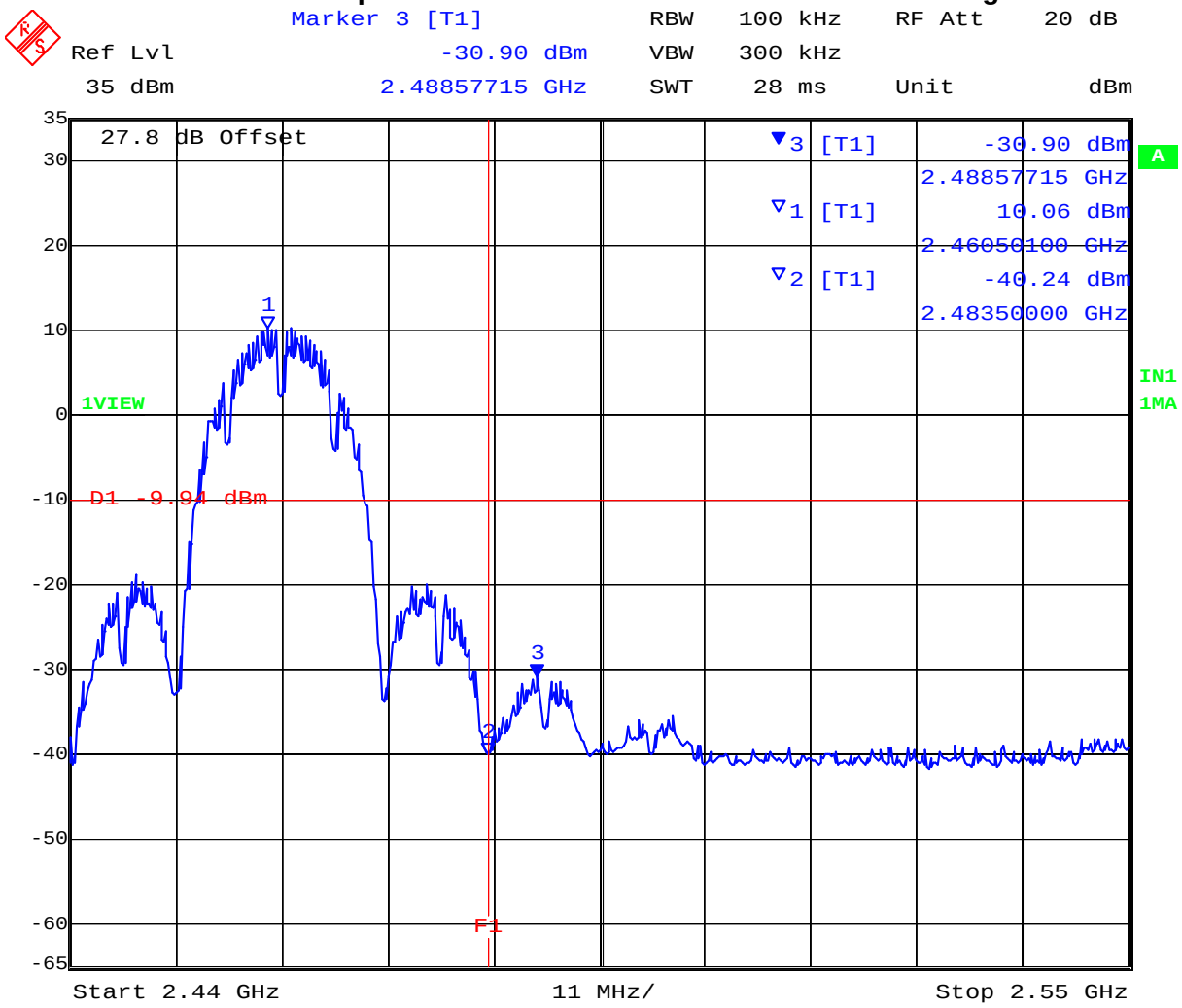
Measurements were performed with the transmitter tuned to the channel closest to the band-edge being measured. All emissions were maximized during measurement. Limits which were derived from the band-edge measurements provided below are drawn on each plot.

Center Frequency (MHz)	Band edge Frequency (MHz)	Limit (20 dB below peak of fundamental) (dBm)	Amplitude @ Band edge (dBm)	Plot #	Margin (dB)
2412	2,400	-9.40	-26.74	09	-17.34
2462	2,483.5	-9.94	-40.24	10	-30.30

Plot 09
Conducted Spurious Emissions at the 2,400 MHz Band Edge



Plot 10
Conducted Spurious Emissions at the 2483.5 MHz Band Edge

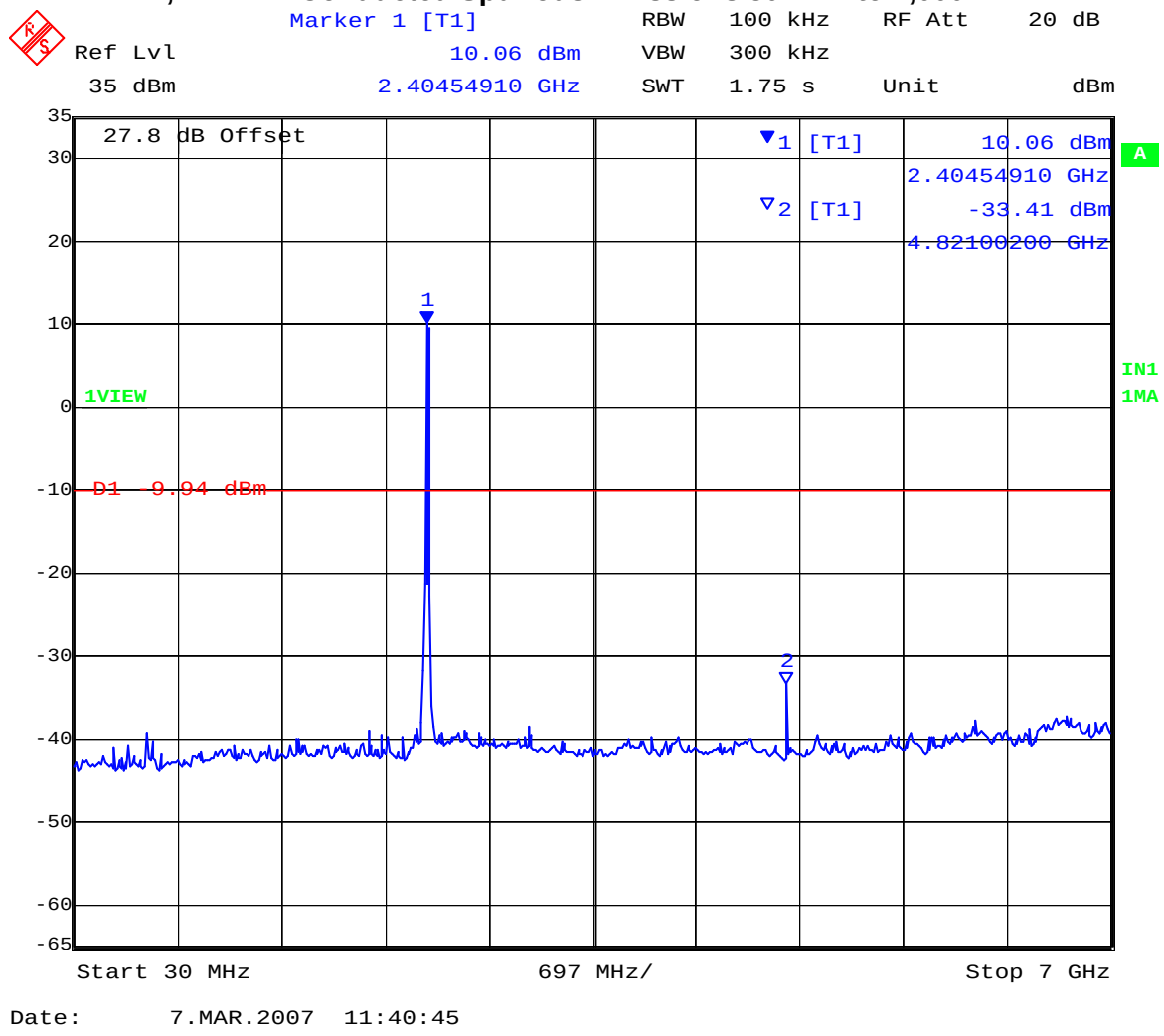


Spurious Emissions (1-26 GHz)

TABLE OF RESULTS –

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Plot #	Margin (dB)
2,412	30	7,000	-33.41	-9.94	11	-23.47
2,412	7,000	26,500	-37.17	-9.94	12	-27.23

Plot 11
2,412 MHz Conducted Spurious Emissions 30 MHz to 7,000 MHz



Plot 12
2,412 MHz Conducted Spurious Emissions 7,000 MHz to 26,500 MHz

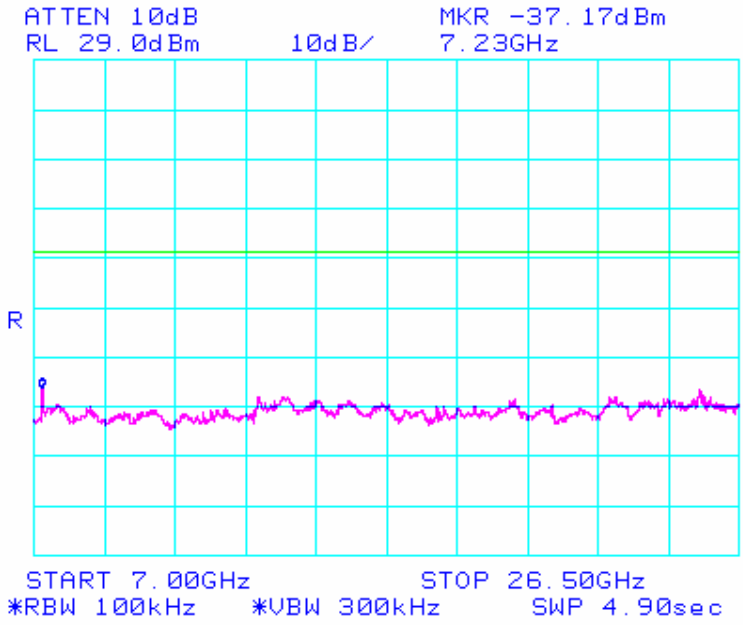
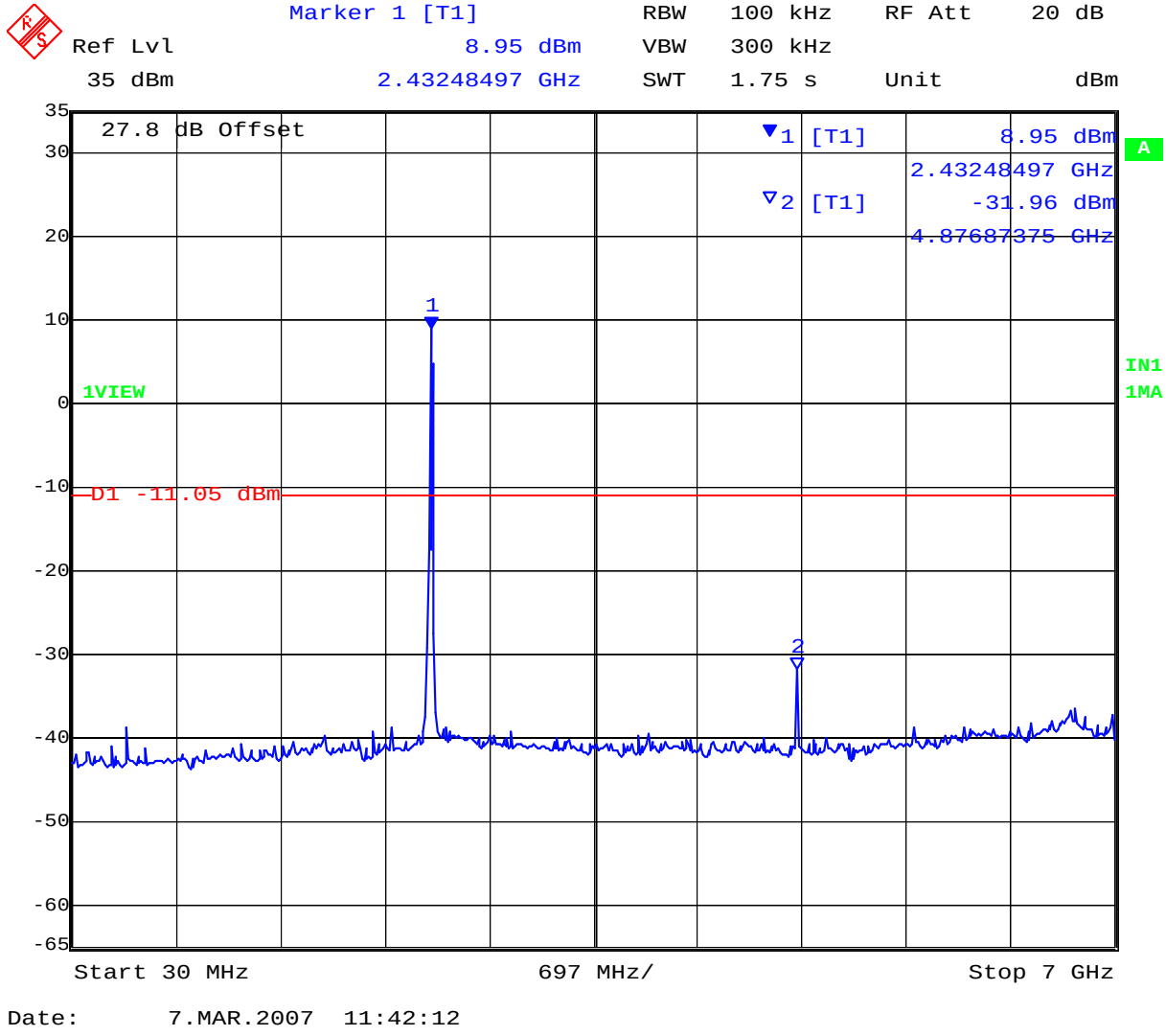


TABLE OF RESULTS –

Channel Centre Frequency	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Plot #	Margin (dB)
2,437	30	7,000	-31.96	-11.05	13	-20.91
2,437	7,000	26,500	-37.50	-11.05	14	-26.45

Plot 13
2,437 MHz Conducted Spurious Emissions 30 MHz to 7,000 MHz



Plot 14
2,437 MHz Conducted Spurious Emissions 7,000 MHz to 26,500 MHz

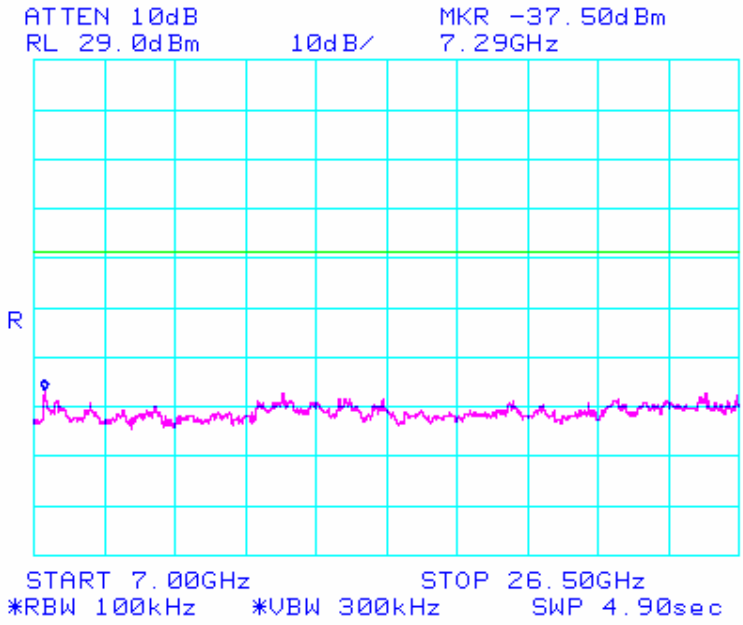
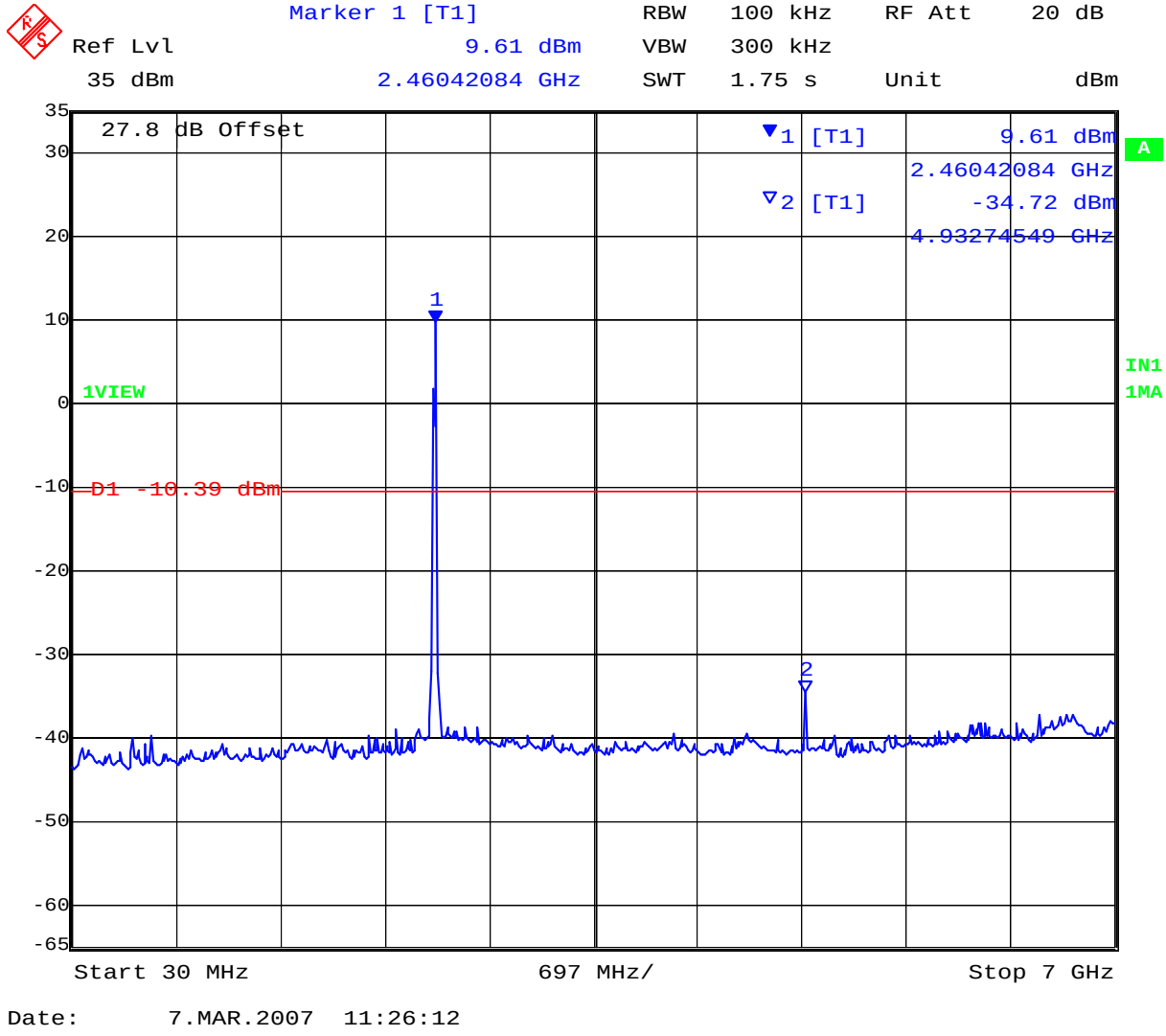


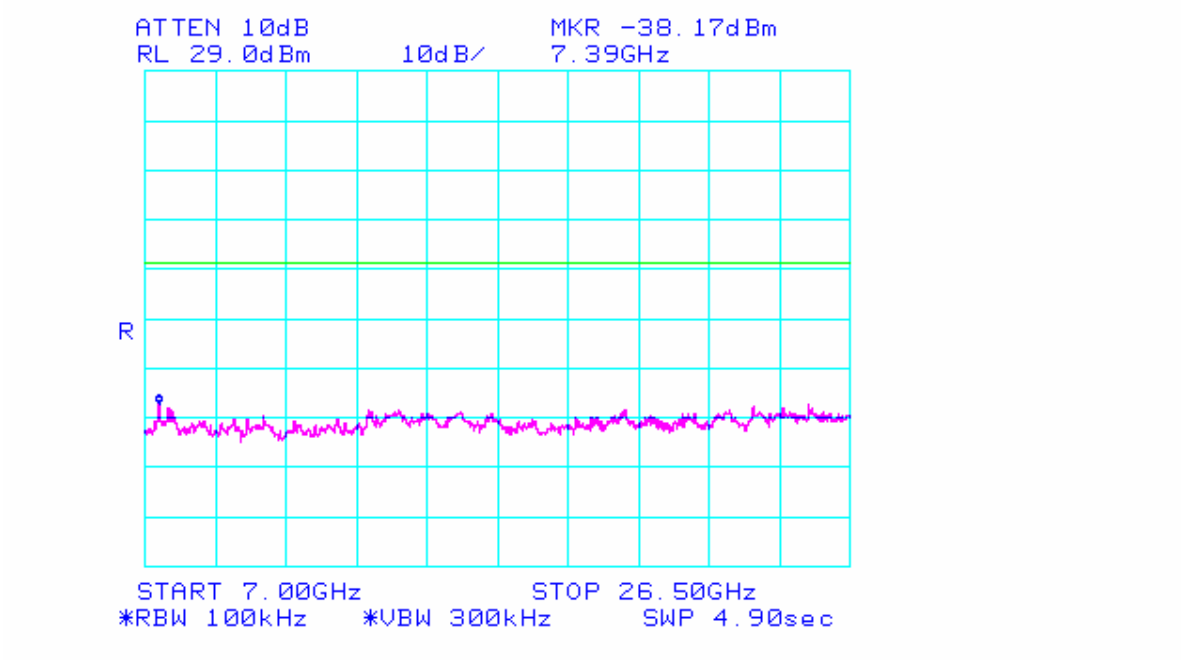
TABLE OF RESULTS –

Channel Centre Frequency	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Plot #	Margin (dB)
2,462	30	7,000	-34.72	-10.39	15	-24.33
2,462	7,000	26,500	-38.17	-10.39	16	-27.78

Plot 15
2,462 MHz Conducted Spurious Emissions 30 MHz to 7,000 MHz



Plot 16
2,462 MHz Conducted Spurious Emissions 7,000 MHz to 26,500 MHz



Specification

Limits Band-Edge

Lower Limit Band-edge	Upper Limit Band-edge	Limit below highest level of desired power
2,400 MHz	2,483.5 MHz	≥ 20 dB

§15.247(d) 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 radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

§15.247(d)
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section §15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(a)).

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0088, 0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117.

5.1.6. Radiated Emissions

5.1.6.1. Transmitter Radiated Spurious Emissions (above 1 GHz)

FCC, Part 15 Subpart C §15.247(d) 15.205; 15.209

Test Procedure

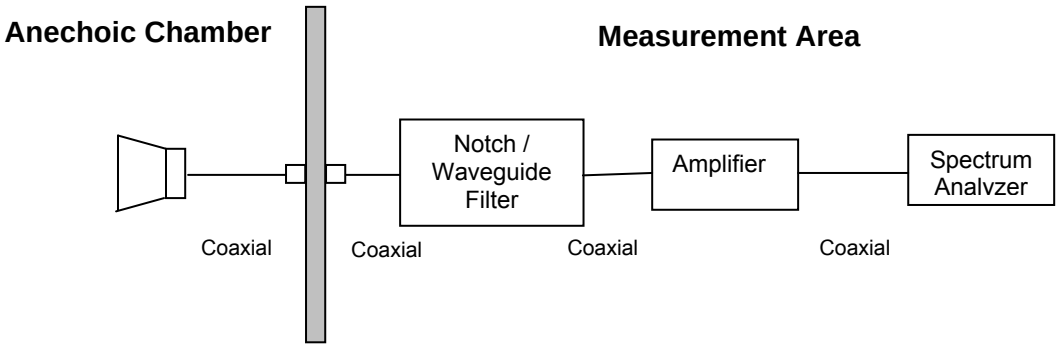
Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

The product was initially tested to find worst case orientation for the maximization of spurious emissions. Worst case orientation was used for all emission testing.

Due to the battery drain as a result of the 100% duty cycle transmission the internal battery was disconnected and an external power source (3.6 Vdc) was used.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO

where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

Radiated Spurious Emissions above 1 GHz

Ambient conditions.
Temperature: 17 to 23°C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Measurements performed with EUT set for 100% Duty Cycle

Manufacturer's Declared Operational Duty Cycle: 25%

Chip Antenna - Channel 2412MHz

TABLE OF RESULTS –

Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Peak.	2413.487	69.87	2.96	30.45	103.27	--	--	--
Band Edge[1]	2384.600	35.63	2.95	30.36	68.94	49.78	54	-4.22

Note 1; The peak emission level at the band edge was measured at the frequency with the highest level emissions within the adjacent restricted band.

Chip Antenna - Channel 2412MHz

Plot 17
2412 MHz Configuration Spurious Emissions >1GHz

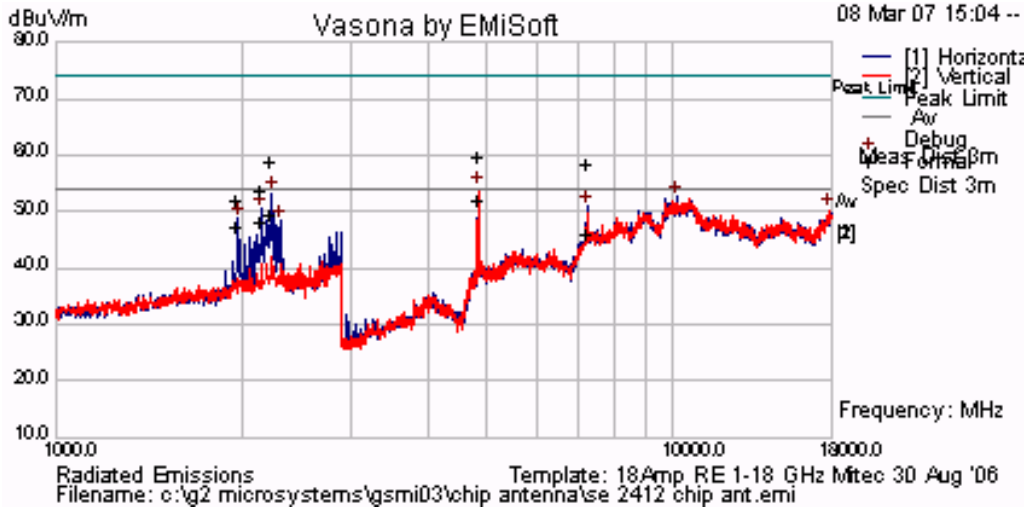


TABLE OF RESULTS –

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
1971.974	H	61.50	-11.55	49.95	74	-24.05
2148.245	H	62.63	-10.82	51.81	74	-22.19
2235.550	H	67.18	-10.49	56.69	74	-17.31
4824.042	H	62.37	-4.58	57.79	74	-16.21
7233.876	H	54.27	+2.29	56.56	74	-17.44

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Average Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)
1971.974	H	56.73	-11.55	45.18	54	-8.82
2148.245	H	56.85	-10.82	46.03	54	-7.97
2235.55	H	57.90	-10.49	47.41	54	-6.59
4824.042	H	54.44	-4.58	49.86	54	-4.14
7233.876	H	41.79	+2.29	44.08	54	-9.92

Measurements performed with EUT set for 100% Duty Cycle

Chip Antenna - Channel 2437MHz

Plot 18
2437 MHz Configuration Spurious Emissions

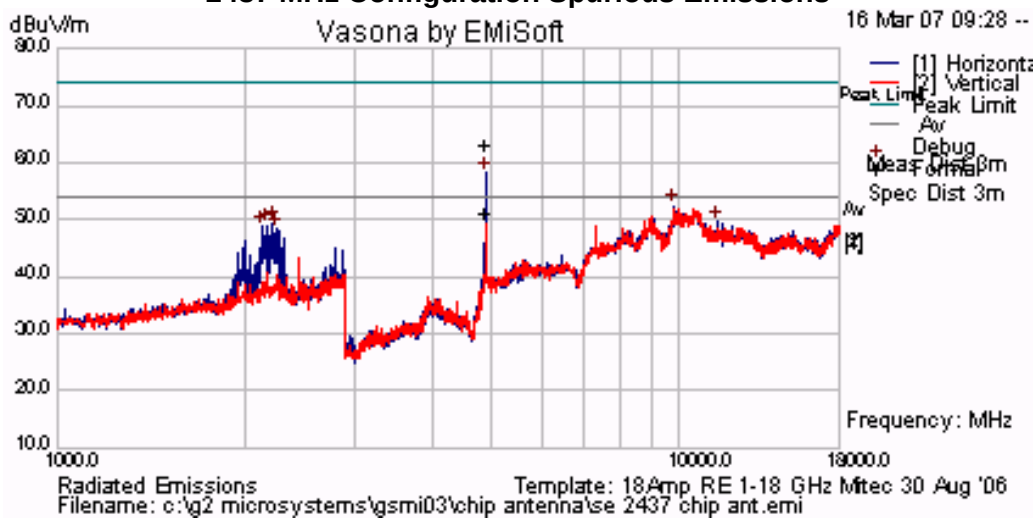


TABLE OF RESULTS –

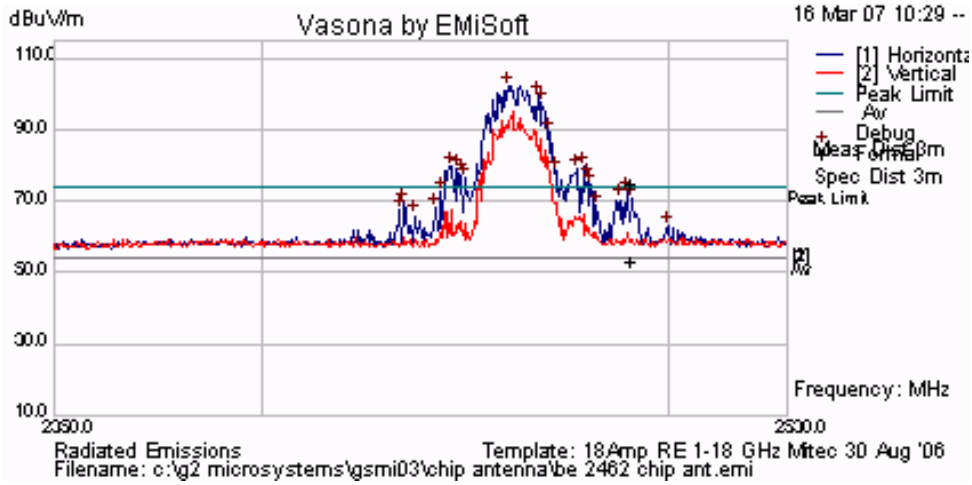
Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
4873.933	H	65.36	-4.36	61	74	-13

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Average Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)
4873.933	H	53.4	-4.36	49.04	54	-4.96

Measurements performed with EUT set for 100% Duty Cycle

Chip Antenna - Channel 2462 MHz

Plot 19
2462 MHz Configuration Peak Emissions & Band Edge



Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Peak.	2460.02	68.77	2.98	30.58	102.34	--	--	--
Band Edge[1]	2490.90	38.02	3.00	30.67	71.69	49.93	54	-4.07

Note 1; The peak emission level at the band edge was measured at the frequency with the highest level emissions within the adjacent restricted band.

Chip Antenna - Channel 2462 MHz

Plot 20
2462 MHz Configuration Peak Emissions

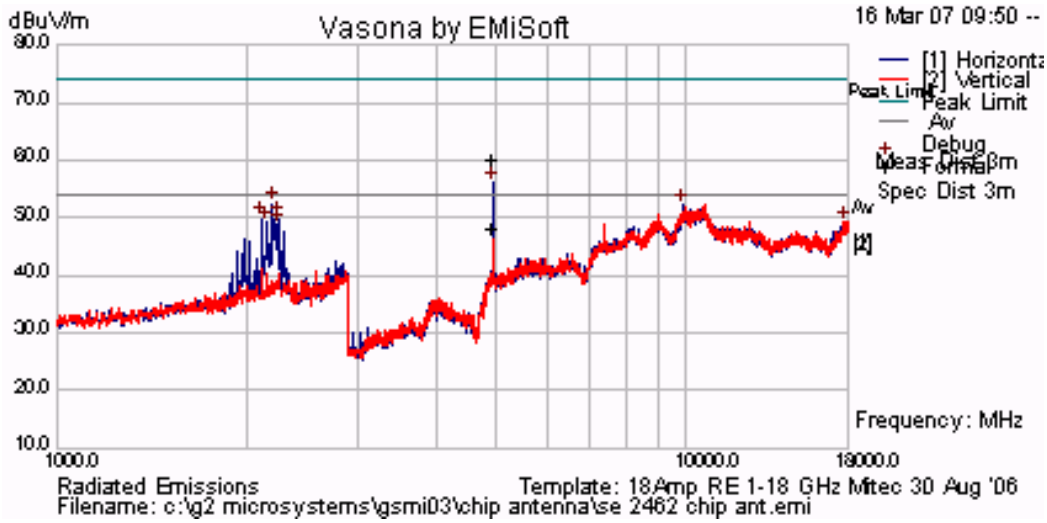


TABLE OF RESULTS –

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
4923.908	H	62.42	-4.28	58.14	74	-15.86

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Average Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)
4923.908	H	50.41	-4.28	46.13	54	-7.87

Measurements performed with EUT set for 100% Duty Cycle

Manufacturer's Declared Operational Duty Cycle: 25%

Monopole Antenna - Channel 2412MHz

TABLE OF RESULTS –

Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	[2]Duty Cycle Corr (dB)	Limit (dBuV/m)	Margin (dB)
Peak.	2413.493	69.87	2.96	30.45	102.27	--	-12	--	--
Band Edge[1]	2390.000	35.22	2.95	30.38	68.55	49.80	-12	54	-16.20

.

Note 1; The peak emission level at the band edge was measured at the frequency with the highest level emissions within the adjacent restricted band.

Note 2; Band edge measurement: Per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Average value - 20 Log (duty cycle)

Operational duty cycle: 25%

Average value - 20 Log (0.25) = -12 dB

=49.80 -12 = 37.80 dBuV/m.

Monopole Antenna - Channel 2412MHz

Plot 21
2412 MHz Configuration Spurious Emissions >1GHz

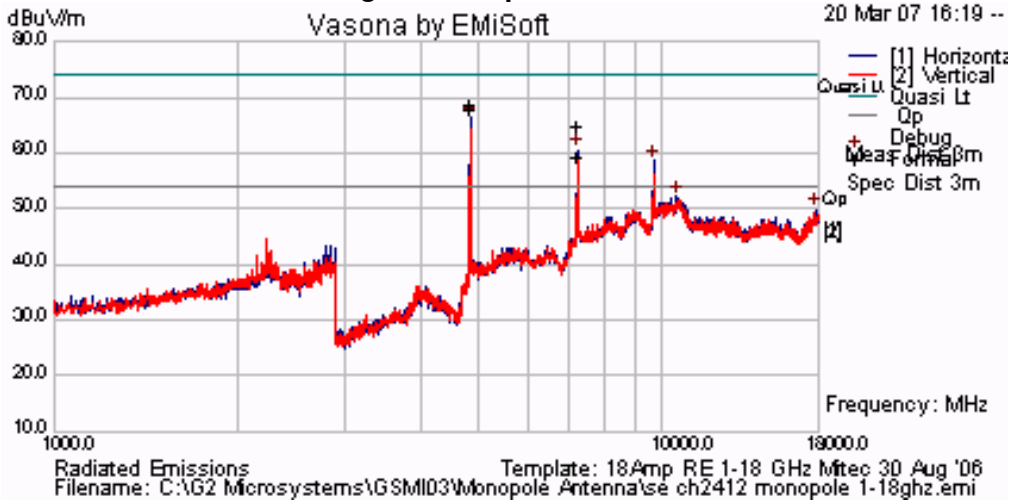


TABLE OF RESULTS –

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
4824.02	H	71.34	-4.58	66.76	74	-7.24
7234.966	H	60.46	+2.29	62.75	74	-11.25

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Average Field Strength (dBµV/m)	[3]Duty Cycle Correction (dB)	Average Limit (dBµV/m)	Margin (dB)
4824.02	H	70.5	-4.58	65.92	-12	54	-0.08
7234.966	H	55.11	+2.29	57.40	-12	54	-8.6

Manufacturer's Declared Operational Duty Cycle: 25%

Note 3: Radiated emissions measurements per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Average value - 20 Log (duty cycle)

Operational duty cycle: 25%

Average value - 20 Log (0.25)

= Average value -12 dB

Measurements performed with EUT set for 100% Duty Cycle

Monopole Antenna - Channel 2437MHz

Plot 22
2437 MHz Configuration Spurious Emissions

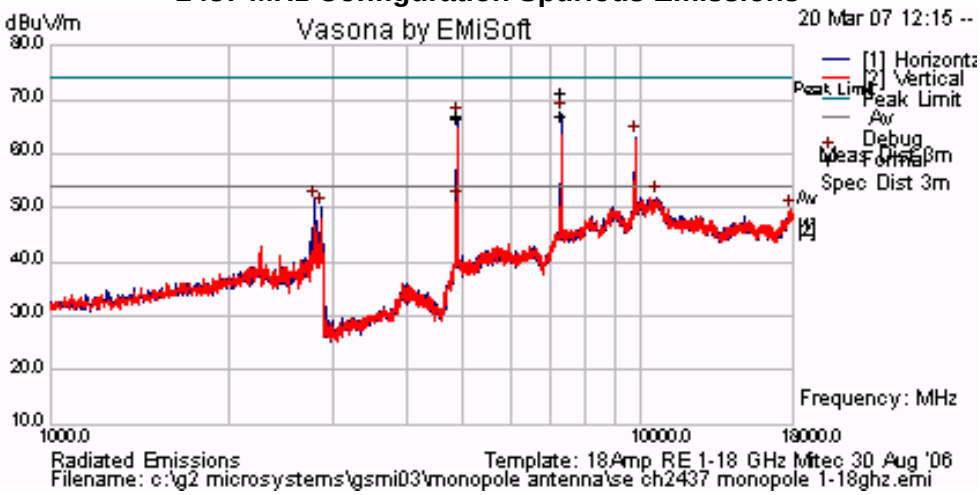


TABLE OF RESULTS –

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
4873.901	H	69.46	-4.36	65.10	74	-8.90
7310.103	H	66.73	+2.42	69.15	74	-4.85

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Average Field Strength (dBµV/m)	[3]Duty Cycle Correction (dB)	Average Limit (dBµV/m)	Margin (dB)
4873.901	H	68.79	-4.36	64.43	-12	54	-1.57
7310.103	H	62.67	+2.42	65.09	-12	54	-0.91

Manufacturer's Declared Operational Duty Cycle: 25%

Note 3: Radiated emissions measurements per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Average value - 20 Log (duty cycle)

Operational duty cycle: 25%

Average value - 20 Log (0.25)

= Average value -12 dB

Measurements performed with EUT set for 100% Duty Cycle

Monopole Antenna - Channel 2462 MHz

Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	[2]Duty Cycle Corr (dB)	Limit (dBuV/m)	Margin (dB)
Peak.	2463.267	73.52	2.98	30.59	107.09	--	-12	--	--
Band Edge[1]	2491.759	36.57	3.00	30.68	70.25	50.36	-12	54	-15.64

Manufacturer's Declared Operational Duty Cycle: 25%

Note 1; The peak emission level at the band edge was measured at the frequency with the highest level emissions within the adjacent restricted band.

Note 2; Band edge measurement: Per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Average value - 20 Log (duty cycle)

Operational duty cycle: 25%

Average value - 20 Log (0.25) = -12 dB

=49.80 -12 = 38.36 dBuV/m.

Monopole Antenna - Channel 2462 MHz

Plot 23
2462 MHz Configuration Peak Emissions

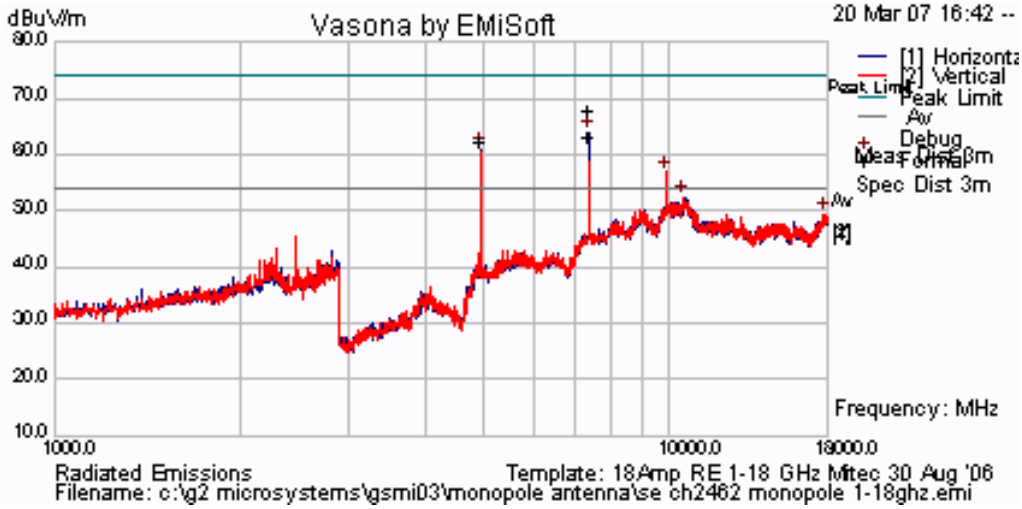


TABLE OF RESULTS –

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
4923.896	V	64.67	-4.28	60.39	74	-13.61
7387.081	H	63.47	+2.51	65.98	74	-8.02

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV)	Correction Factor (dB)	Corrected Average Field Strength (dBµV/m)	[3]Duty Cycle Correction (dB)	Average Limit (dBµV/m)	Margin (dB)
4923.896	V	64.51	-4.28	60.23	-12	54	-5.77
7387.081	H	58.47	+2.51	60.98	-12	54	-5.02

Manufacturer's Declared Operational Duty Cycle: 25%

Note 3: Radiated emissions measurements per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Average value - 20 Log (duty cycle)

Operational duty cycle: 25%

Average value - 20 Log (0.25)

Specification Limits

FCC §15.247(d) 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 radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

FCC §15.247(d)
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section §15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(a)).

FCC §15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

FCC §15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

FCC §15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

Frequency (MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

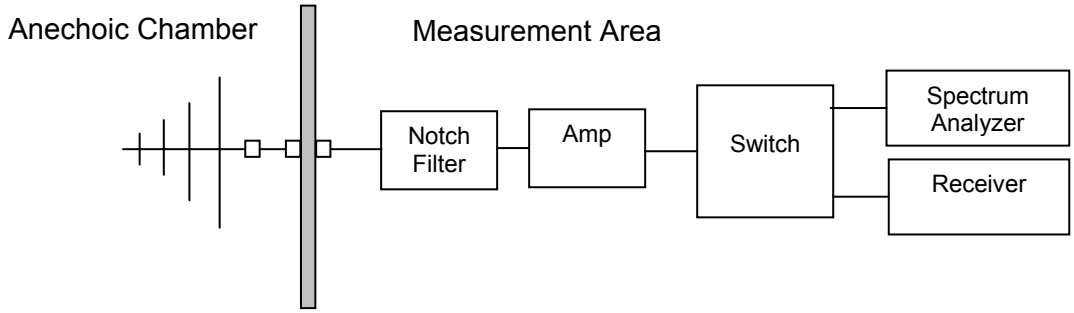
5.1.6.2. Radiated Spurious Emissions (30M-1 GHz)

FCC, Part 15 Subpart C §15.205/ §15.209

Test Procedure

Testing 30M-1 GHz was subcontracted to the company identified in Section 3.9 Subcontracted Testing. Preliminary radiated emissions are measured in the anechoic chamber at a 10-meter distance on every azimuth in both horizontal and vertical polarity. The emissions are recorded with a spectrum analyzer in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

System operation was completed with five operational transmitters terminated in a 50Ω load at maximum power and one 2.4 GHz transmitter terminated in the 16.4 dBi Sector antenna.



Test Measurement Set up

The product was initially tested to find worst case orientation for the maximization of spurious emissions. Worst case orientation was used for all emission testing.

Due to the battery drain as a result of the 100% duty cycle transmission the internal battery was disconnected and an external power source (3.6 Vdc) was used.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

$$FS = R + AF + CORR$$

where:

FS = Field Strength
R = Measured Receiver Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBμV; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100μV/m
48 dBμV/m = 250μV/m

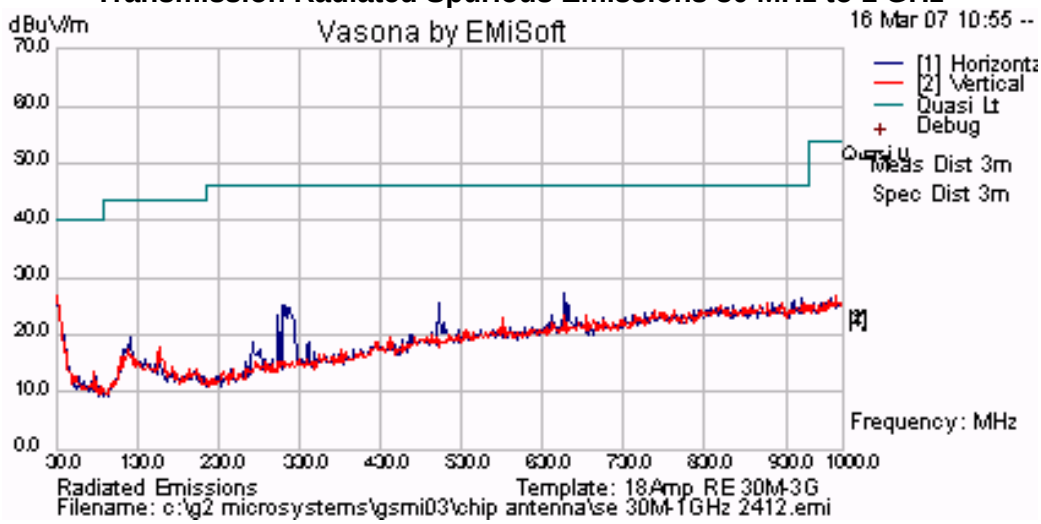
Measurement Results for Spurious Emissions (30 MHz – 1 GHz)

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS

Channel 2412 MHz

Plot 24
Transmission Radiated Spurious Emissions 30 MHz to 1 GHz

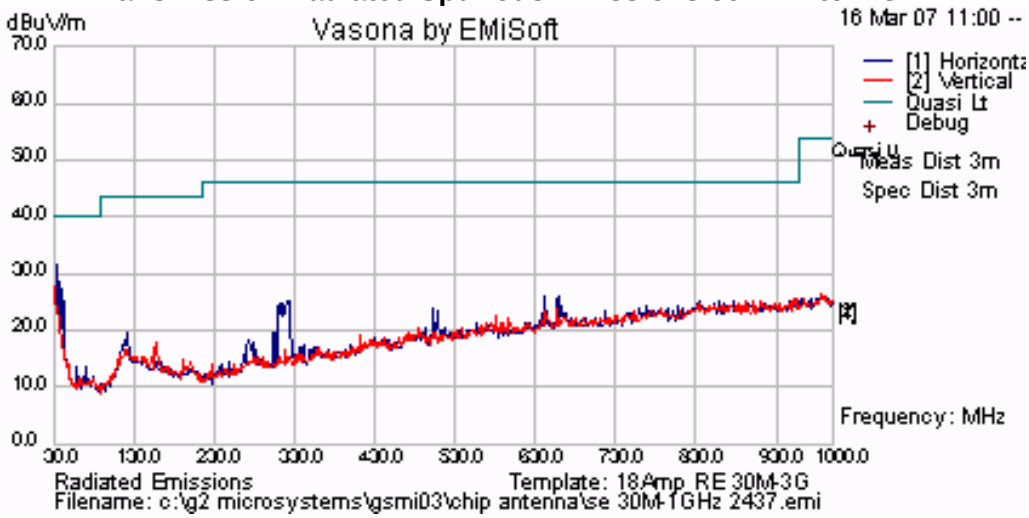


Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Polarity

No emissions were found within 6 dB of the limit

Channel 2437 MHz

Plot 25
Transmission Radiated Spurious Emissions 30 MHz to 1 GHz

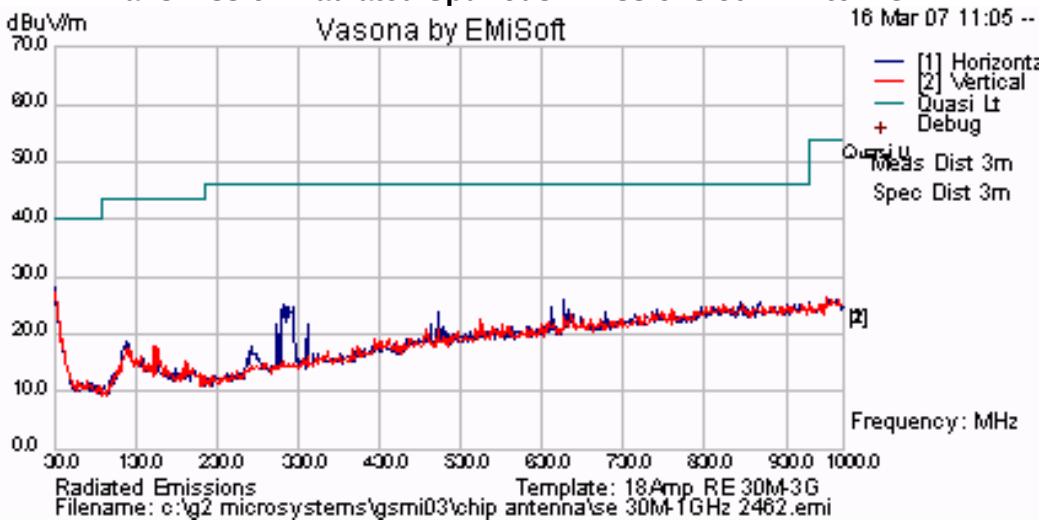


Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Polarity

No emissions were found within 6 dB of the limit

Channel 2462 MHz

Plot 26
Transmission Radiated Spurious Emissions 30 MHz to 1 GHz



Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Polarity

No emissions were found within 6 dB of the limit

Specification

Limits

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

§15.209 (a) and **RSS-Gen §2.2** Limit Matrix

Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per Sanmina work instruction	8546A HP Receiver and RF Filter, HP Pre-amp, Antenna EMCO Biconilog

5.1.7. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

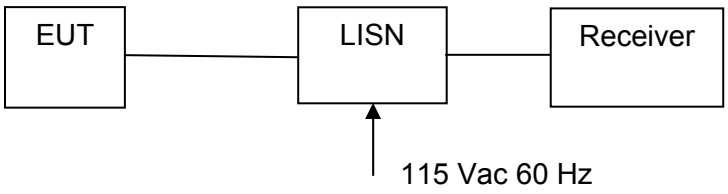
FCC, Part 15 Subpart C §15.207

Test Procedure

The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

All six transmitters were operational and terminated in a 50Ω load.

Test Measurement Set up



Measurement set up for AC Wireline Conducted Emissions Test

Measurement Results for AC Wireline Conducted Emissions (150 kHz – 30 MHz)

No test required the device was battery operated

Specification

Limit

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

§15.207 (a) Limit Matrix
The lower limit applies at the boundary between frequency ranges

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

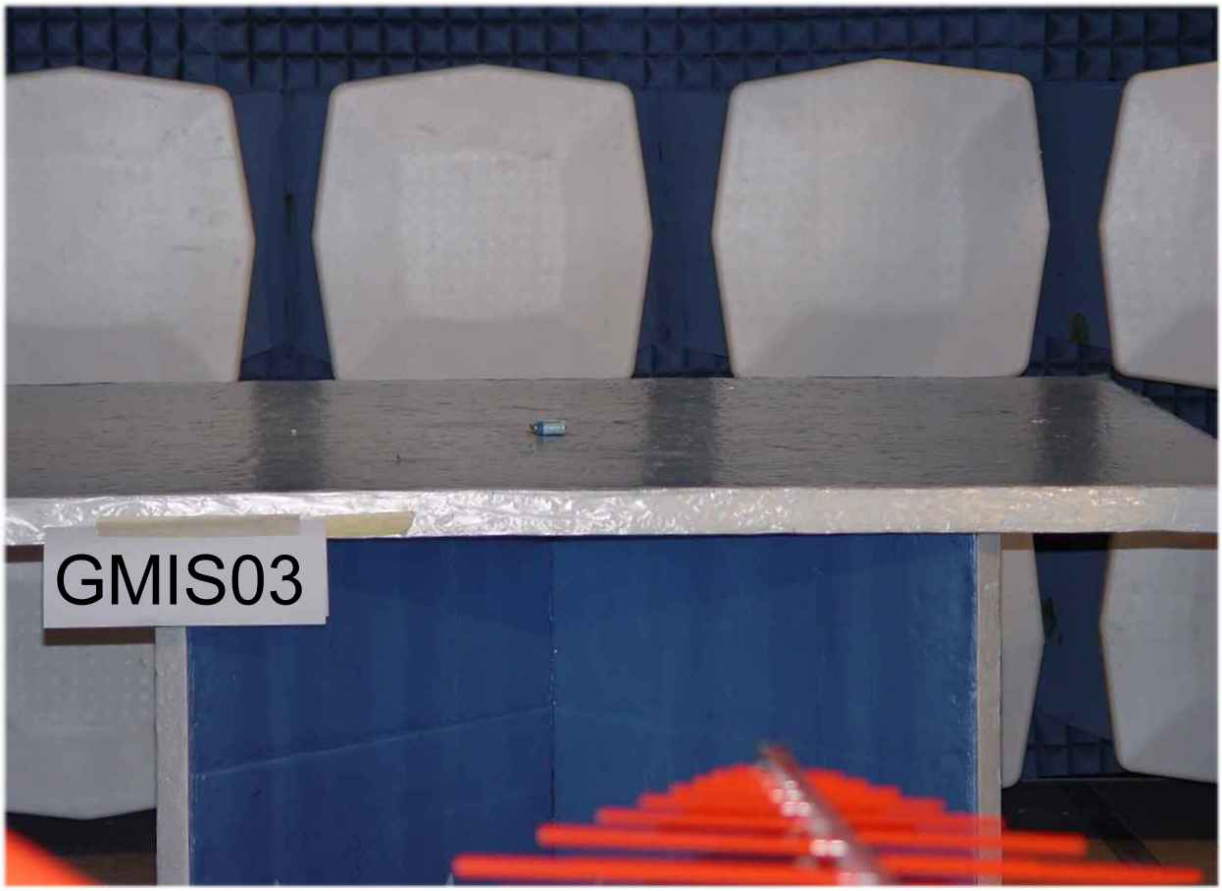
Measurement uncertainty	±2.64 dB

Traceability

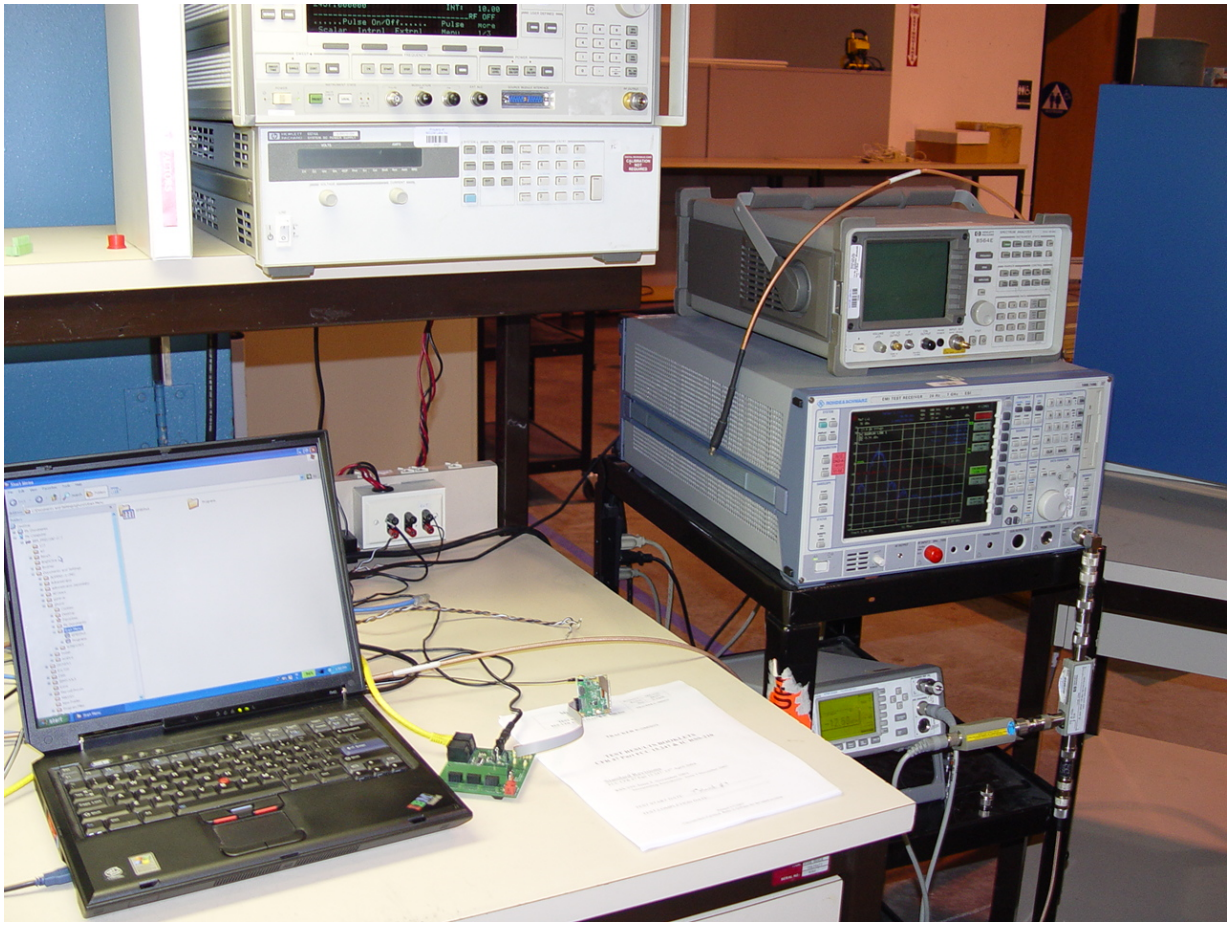
Method	Test Equipment Used
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	0158, 0184, 0193, 0190, 0293, 0307

6. PHOTOGRAPHS

6.1. Radiated Emissions (above 1 GHz)



6.2. General Measurement Test Set-Up



7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0088	Spectrum Analyzer	Hewlett Packard	8564E	3410A00141
0104	1-18GHz Horn Antenna	The Electro-Mechanics Company	3115	9205-3882
0134	Amplifier	Com Power	PA 122	181910
0158	Barometer /Thermometer	Control Co.	4196	E2846
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007
0252	SMA Cable	Megaphase	Sucoflex 104	None
0304	2.4GHzHz Notch Filter	Micro-Tronics	--	001
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	209092-001
0313	Coupler	Hewlett Packard	86205A	3140A01285
0314	30dB N-Type Attenuator	ARRA	N9444-30	1623
0070	Power Meter	Hewlett Packard	437B	3125U11552
0116	Power Sensor	Hewlett Packard	8485A	3318A19694
0117	Power Sensor	Hewlett Packard	8487D	3318A00371
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	357.8810.52
0190	LISN	Rhode & Schwartz	ESH3Z5	836679/006
0293	BNC Cable	Megaphase	1689 1GVT4	15F50B001
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002

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