Test of Polycom Spectralink 8440 handset (Bluetooth transmitter)

To: FCC 47 CFR Part 15, SubPart C 15.247 & RSS-210 Annex 8

Test Report Serial No.: POLY06-U7b Rev A

TEST REPORT

From

MiCOM Labs

Test of: Polycom Spectralink 8440 handset (Bluetooth transmitter)

To: FCC 47 CFR Part 15, SubPart C 15.247 & RSS-210 Annex 8

Test Report Serial No.: POLY06-U7b Rev A

Reference Test Reports: POLY06-U18, POLY06-U7a

This report supersedes: None

Applicant:	Polycom 4750 Willow Road Pleasanton, CA 94588-2708 USA
Product Function:	Wi-Fi handset with Bluetooth
Copy No: pdf	**Issue Date:** 8th February 2011

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

A2LA ACCREDITED
TESTING CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

TABLE OF CONTENTS

1 ACCREDITATION, LISTINGS & RECOGNITION

1.1 TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard 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

1.2 RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA** countries. Our test reports are widely accepted for global type approvals.

COUNTRY	RECOGNITION BODY	STATUS	PHASE	IDENTIFICATION NO.
USA	Federal Communications Commission (FCC)	TCB	-	Listing #: 102167
Canada	Industry Canada (IC)	FCB	APEC MRA 2	Listing #: 4143A
Japan	VCCI	-	-	No. 2959
Europe	European Commission	NB	EU MRA	NB 2280
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	CAB	APEC MRA 1	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	CAB	APEC MRA 1	
Singapore	Infocomm Development Authority (IDA)	CAB	APEC MRA 1	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	CAB	APEC MRA 1	
Vietnam	Ministry of Communication (MIC)	CAB	APEC MRA 1	

**APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.
Phase I - recognition for product testing
Phase II – recognition for both product testing and certification
N/A – Not Applicable

**EU MRA – European Union Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

**NB – Notified Body

1.3 PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC Guide 65. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf

The American Association for Laboratory Accreditation

World Class Accreditation

Accredited Product Certification Body

A2LA has accredited

MICOM LABS

Pleasanton, CA

for technical competence as a

Product Certification Body

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC Guide 65:1996 *General requirements for bodies operating product certification systems*. This accreditation demonstrates technical competence for a defined scope and the operation of a quality management system for a Telecommunications Certification Body (TCB) meeting FCC (U.S.), and IC (Canada) requirements.

Presented this 24th day of June 2010.

President & CEO
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2011

For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

United States of America – Telecommunication Certification Body

TCB Identifier – US0159

Industry Canada – Certification Body

CAB Identifier – US0159

Europe – Notified Body

Notified Body Identifier - 2280

2 DOCUMENT HISTORY

Document History		
Revision	**Date**	**Comments**
Draft		
Rev A	8th February 2011	Initial Release

3 TEST RESULT CERTIFICATE

Applicant:	Polycom 4750 Willow Road Pleasanton California , 94588-2708, USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
Product:	8400 series handsets	Telephone:	+1 925 462 0304
Model No.:	Spectralink 8440 handset	Fax:	+1 925 462 0306
S/No's:	600826511 (radiated) 600826501 (conducted)		
Date(s) Tested:	Nov 19th - Dec 23rd, 2010	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15, SubPart C 15.247 & RSS-210 Annex 8	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
TESTING CERTIFICATE #2381.01

Approved & Released for MiCOM Labs, Inc. by:

Graeme Grieve
Quality Manager MiCOM Labs, Inc.

Gordon Hurst
President & CEO MiCOM Labs, Inc.

4 REFERENCES AND MEASUREMENT UNCERTAINTY

4.1 Normative References

Ref.	Publication	Year	Title
i.	FCC 47 CFR Part 15, Subpart C	2010	Title 47: Telecommunication PART 15—RADIO FREQUENCY DEVICES Subpart C—Intentional Radiators
ii.	RSS-210 Annex 8	2010	Radio Standards Specification 210, Issue 8, Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment
iii.	DA 00-705	2000	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems" released March 30, 2000
iv.	RSS-GEN	2010	Radio Standards Specification-Gen, Issue 3, General Requirements and Information for the Certification of Radiocommunication Equipment
v.	FCC 47 CFR Part 15, Subpart B	2010	47 CFR Part 15, SubPart B; Unintentional Radiators
vi.	ICES-003	2004	Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard Digital Apparatus; Issue 4
vii.	ANSI C63.4	2009	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
viii.	CISPR 22/ EN 55022	2008 2006+A1:2007	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
ix.	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
x.	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
xi.	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
xii.	A2LA	9th June 2010	Reference to A2LA Accreditation Status – A2LA Advertising Policy

4.2 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.

5 TEST SUMMARY

List of Measurements

Section(s)	Test Items/Description	Condition	Result	Test Report Section
FCC 15.247(a)(1) RSS-210 A8.1(a)	20 dB BW	Conducted	Complies	7.1.1
FCC 15.247(a)(1) RSS-210 A8.1(b)	Carrier Frequency Separation	Conducted	Complies	7.1.2
FCC 15.247(a)(1) RSS-210 A8.1 (d)	Number of Hopping Frequencies	Conducted	Complies	7.1.3
FCC 15.247(a)(1)(iii) RSS-210 A8.1(d)	Time of Occupancy (Dwell Time)	Conducted	Complies	7.1.4
FCC 15.247(a)(1)(iii) RSS-210 A8.1(d)	Channel Occupancy	Conducted	Complies	7.1.5
FCC 15.247(b)(2) RSS-210 A8.4(2)	Peak Output Power	Conducted	Complies	7.1.6
FCC 15.247(d) RSS-210 A8.5	Band-edge	Conducted	Complies	7.1.7
FCC 15.247(d) RSS-210 A8.5	Spurious RF Conducted Emissions - Transmitter	Conducted	Complies	7.1.8
RSS-210 2.3 RSS-Gen 4.10 RSS-Gen 6.2	Spurious RF Conducted Emissions - Receiver	Conducted	Complies	7.1.9

List of Measurements

Section(s)	Test Items	Description	Condition	Result	Test Report Section
FCC 15.247(d) **FCC 15.205(a)** **FCC 15.209(a)** **RSS-210 A8.5** **RSS-210 2.2** **RSS-210 2.5** **RSS-Gen 4.9** **RSS-Gen 6** **RSS-Gen 4.10**	Radiated Emissions	Transmitter Radiated Spurious Emissions; Band-edge; Peak Emissions; Receiver Radiated Emissions	Radiated	Complies	*7.2*
FCC 15.207(a) **RSS-Gen 7.2.4**	Conducted Emissions	AC Wireline Conducted Emissions	Conducted	Complies	*7.3*

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: Section 6.11 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix.

Note 4: Unintentional radiator test results for EUT and Accessories are presented in MiCOM Labs test report POLY06-U18.

Note 5: Radio's included within the 8400 Series wireless handsets are declared identical by the manufacturer. EUT's were tested for RF output power. Unit and model (Model: 8450 S/N: 600826501) with highest output power was utilized for testing.

6 PRODUCT DETAILS AND TEST CONFIGURATIONS

6.1 Test Program Scope

The scope of the test program was to test the Bluetooth transmitter (FHSS) contained within the Polycom Spectralink 8440 handset for compliance against FCC 47 CFR Part 15, SubPart C 15.247 & RSS-210 Annex 8.

SAR testing and/or evaluation is not considered in this test report.

Two Spectralink 8400 Series handsets (models 8440 and 8450) were tested during this test program. These products share the same RF circuitry. Conducted testing was performed only on the 8450 model. RF Conducted Emission results of 8450 model were used in this report.

APPLICANT: Polycom **PRODUCT:** Spectralink 8440 handsets front

APPLICANT: Polycom **PRODUCT:** Spectralink 8440 handsets back

APPLICANT: Polycom **PRODUCT:** AC-DC Adapter/ Charger for Spectralink 8400 series handsets

6.2 EUT Details

Detail	Description
Purpose:	Test of the Bluetooth transmitter (FHSS) contained within the Polycom Spectralink 8440 handset for compliance against FCC 47 CFR Part 15, SubPart C 15.247 & RSS-210 Annex 8
Applicant:	Polycom 4750 Willow Road Pleasanton, CA 94588-2708 USA
Manufacturer:	Same as Applicant
Test Laboratory:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	POLY06-U7B
Date EUT received:	11/11/2010
Dates of test (from - to):	11/19/2010 - 12/23/2010
No of Units Tested:	S/N: 600826511 (radiated) S/N: 600826501 (conducted)
Product Name:	8400 series handsets
Manufacturers Trade Name:	Polycom
Model No.:	Spectralink 8440 handset
Equipment Primary Function:	Wi-Fi handset with Bluetooth
Equipment Secondary Function(s):	N/A
Type of Technology:	Bluetooth (Wi-Fi portion tested under separate test report)
Installation type:	Portable
Construction/Location for Use:	Indoor/Outdoor
Software/Firmware Release:	BootROM Mink Phoenix E6 FCC Test14
Test Software Release:	BootROM Mink Phoenix E6 FCC Test14
Rated Input Voltage and Current DC:	Nominal:3.8V; Battery: 3.5V - 4.2V, Charger (USB or Base) supply: 5V +/- 10%
Operating Temperature Range ºC:	Min: 0 °C Max: 40 °C
Equipment Dimensions:	5.75” x 2.125” x 0.9”
Weight:	8 oz
Long Term Frequency Stability:	20 p.p.m.
Transmit/Receive Operation:	Full Duplex
Output Power Type	Fixed

6.3 External A.C. / D.C. Power Adaptor

Model	Description
SA106B-05	GCI Technologies switching adaptor: Input: 100-240V AC; 50-60 Hz; 0.25 Amp Output: 5V DC; 1 Amp

6.4 Operational Power Range

Declared O/P Power Range	Bluetooth	
	Max	Min
EUT	7 ± 2 dBm	N/A

6.5 Types of Modulation Supported

Modulation / Mode	BW 1
802.15.1	FHSS

6.6 Antenna Details

The following is a description of the EUT antennas.

Antenna Type:	Manufacturer	Model	Gain (dBi)	Frequency Range (MHz)
Plated antenna on PCB	Polycom	N/A	2.5	2400 - 2483.5 MHz 5150 - 5850 MHz

6.7 Cabling and I/O Ports

The following is a description of the cable and input, output ports available on the EUT.

Type of I/O Ports	Description	Shielded (Y/N)	Length	Qty	Tested (Y/N)
Battery terminal	Battery connections for removable battery	N	N/A	1	N
1/8th" Stereo connector	for connection to hands free headset	Y	< 3 meters	1	Y
Power supply	Power connector - mini USB for charging using power supply (Model: SA106B-05)	Y	< 3 meters	1	Y
Charging terminals	Charging terminal for charging EUT with docking options	N	N/A	1	Y

6.8 EUT Configurations

Band (GHz)	Mode	Freq Band (MHz)	Freq. Range (MHz)	Low Ch.	Mid Ch.	High Ch.	# Ch.	Ch. Spacing (MHz)
2.4	Bluetooth	2400 - 2483.5	2402- 2480	2402	2441	2480	79	1 MHz

6.9 Equipment Details

The following is a description of supporting equipment used during the test program.

Type	Equipment Description	Manufacturer	Model No.	Serial No (s).	Tested
Battery	Alpha SAMPLE	Polycom	ESB-RS657+002	AC10103200B7	N
Battery	Alpha SAMPLE	Polycom	ESB-RS657+002	AC1010320232	N
Battery	Alpha SAMPLE	Polycom	ESB-RS657+002	AC101032008E	Y
Battery	Alpha SAMPLE	Polycom	ESB-RS658+002	AD101032019C	N
Charging Dock	Alpha SAMPLE	Polycom	ESB-DCA39+001	AlphaB39174 1033	N
AC-DC Adapter	I.T.E. Power Supply	HON-KWANG	HK-U-120A050-CP	N/A	N
AC-DC Adapter/ Charger	Switching Adapter	GCi technologies	SA106B-05	N/A	Y
Speaker Dock	10uF @ U8 Pin4 to Ground Dock PCB Revision X4	Polycom	N/A	N/A	N
AC-DC Adapter	I.T.E. Power Supply	HON-KWANG	HK-AX-120A200-CP	N/A	N
Headset	Encore Headset	Plantronics	P/N: 29951-12	0E0723 K7	N

6.10 Test Configurations

Operational Mode(s)	Data Rate Tested	Duty Cycle
Bluetooth	CW mode	100 %
Bluetooth	1 Mbit/s	10 %
Bluetooth	2 Mbit/s	10 %
Bluetooth	3 Mbit/s	10 %

6.11 Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. None

6.12 Deviations from the Test Standard

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

1. None

7 TEST RESULTS

7.1 Conducted RF Emissions

7.1.1 20dB Bandwidth

Test Procedure

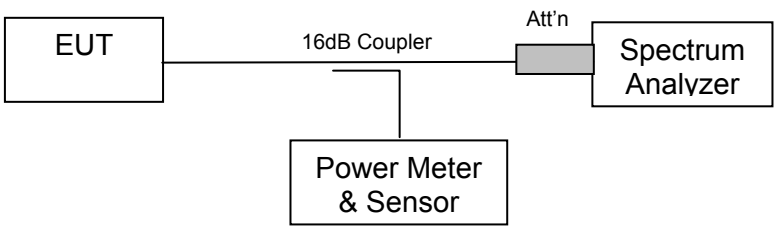
The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

The following spectrum analyzer settings were used:

Span = approximately 2 to 3 times the 20dB bandwidth, centered on a hopping channel
RBW ≥ 1 % of the 20 dB bandwidth
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for 20 dB Bandwidth Limits

FCC §15.247 (a)(1)

No 20dB BW limits are provided for frequency hopping systems in the 2400 – 2483.5 MHz band. However, 20 dB bandwidth maybe required to calculate carrier frequency separation limits.

(a) (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Industry Canada RSS-210 §A8.1 (a)

The bandwidth of a frequency hopping channel is the -20 dB emission bandwidth, measured with the hopping stopped. The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

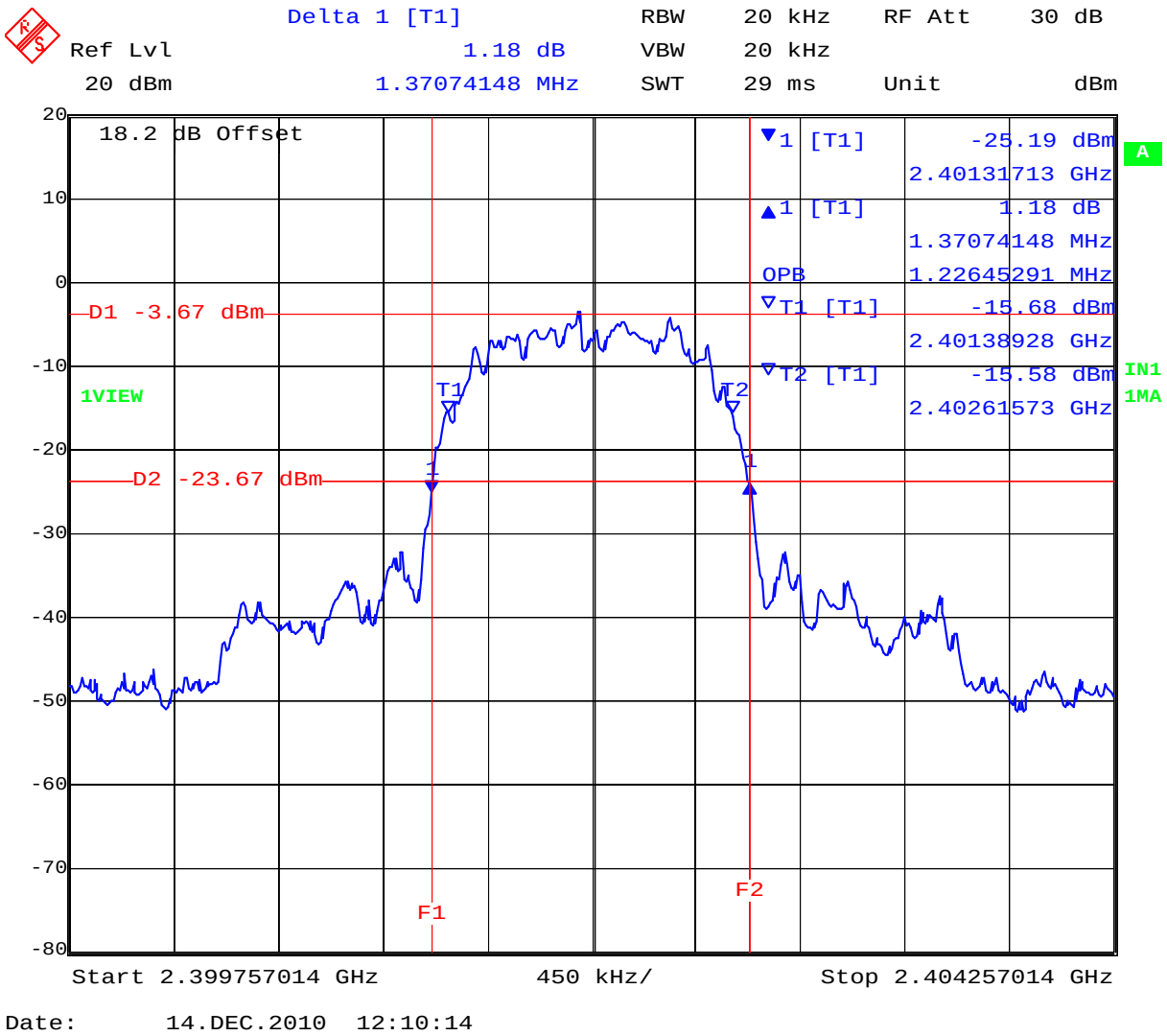
Test Results for 20 dB Bandwidth

Ambient conditions.

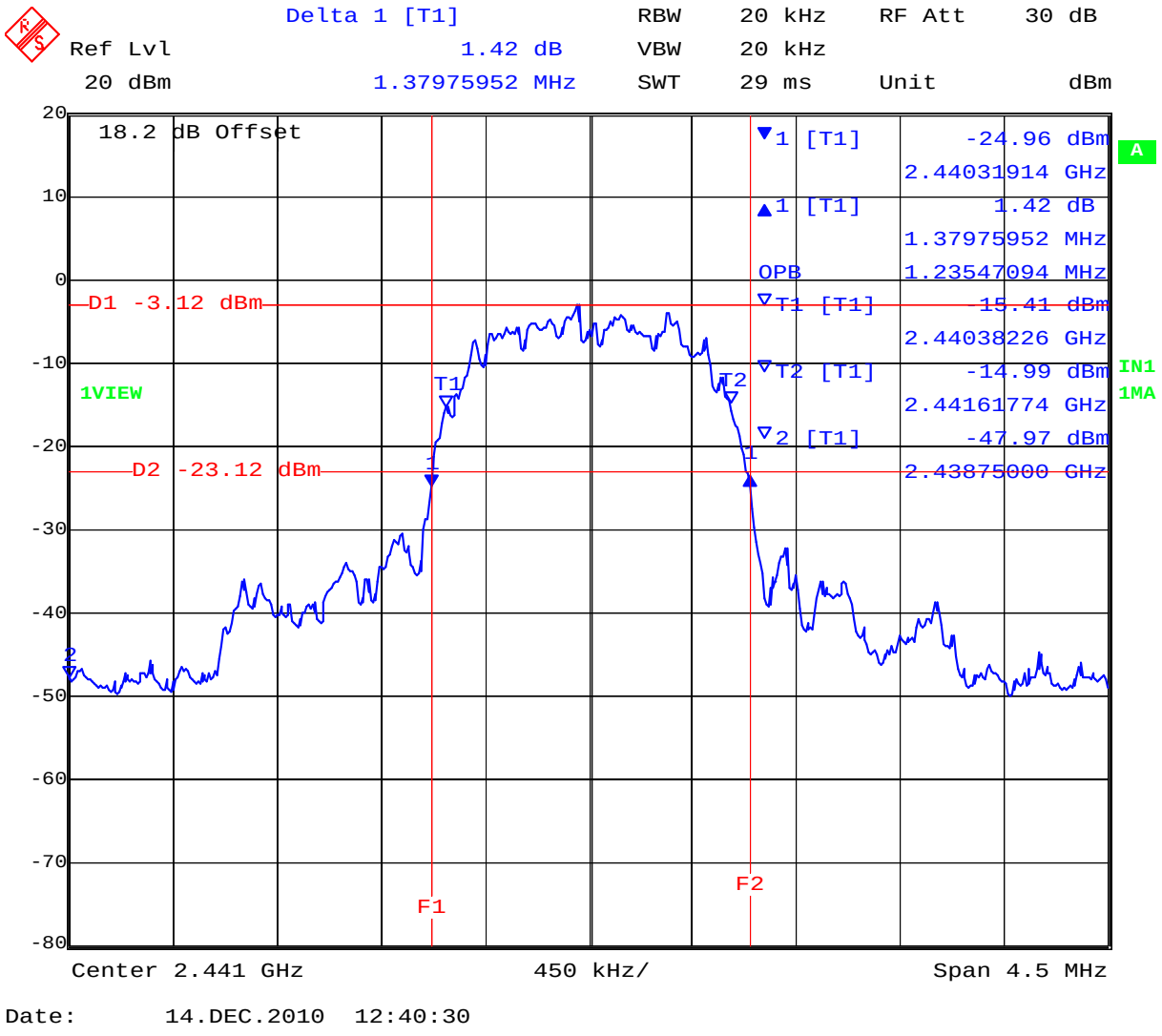
Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

Channel #	Center Frequency (MHz)	Data Rate (Mbs)	20 dB Bandwidth (MHz)	Specification (kHz)
0	2402	3	1.370	N/A
39	2441	3	1.379	N/A
78	2480	3	1.370	N/A

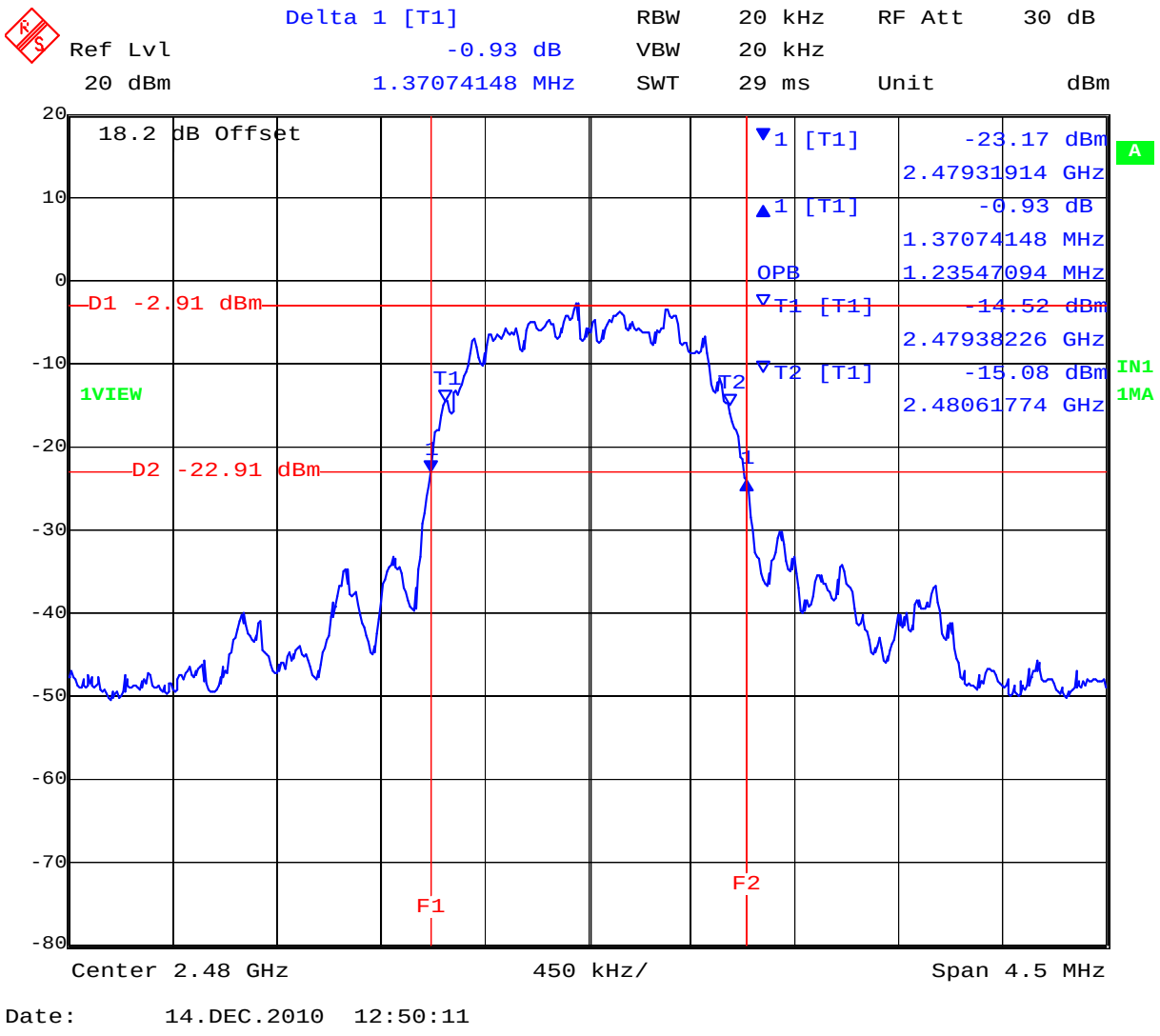
20 dB Bandwidth; 2402 MHz Channel 0; 3 Mbs Data Rate



20 dB Bandwidth; 2441 MHz Channel 39; 3 Mbs Data Rate



20 dB Bandwidth; 2480 MHz Channel 78; 3 Mbs Data Rate



7.1.2 Carrier Frequency Separation

Test Procedure

The EUT must have its hopping function enabled.

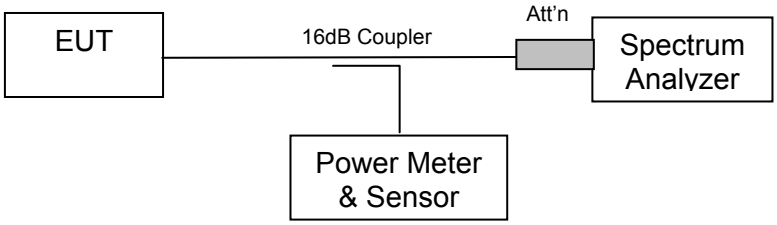
The following spectrum analyzer settings were used:

Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ≥ 1 % of the span
Video (or Average) Bandwidth (VBW) ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Carrier Frequency Separation Limits

FCC §15.247 (a)(1)

(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Industry Canada RSS-210 §A8.1 (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

Test Results for Carrier Frequency Separation

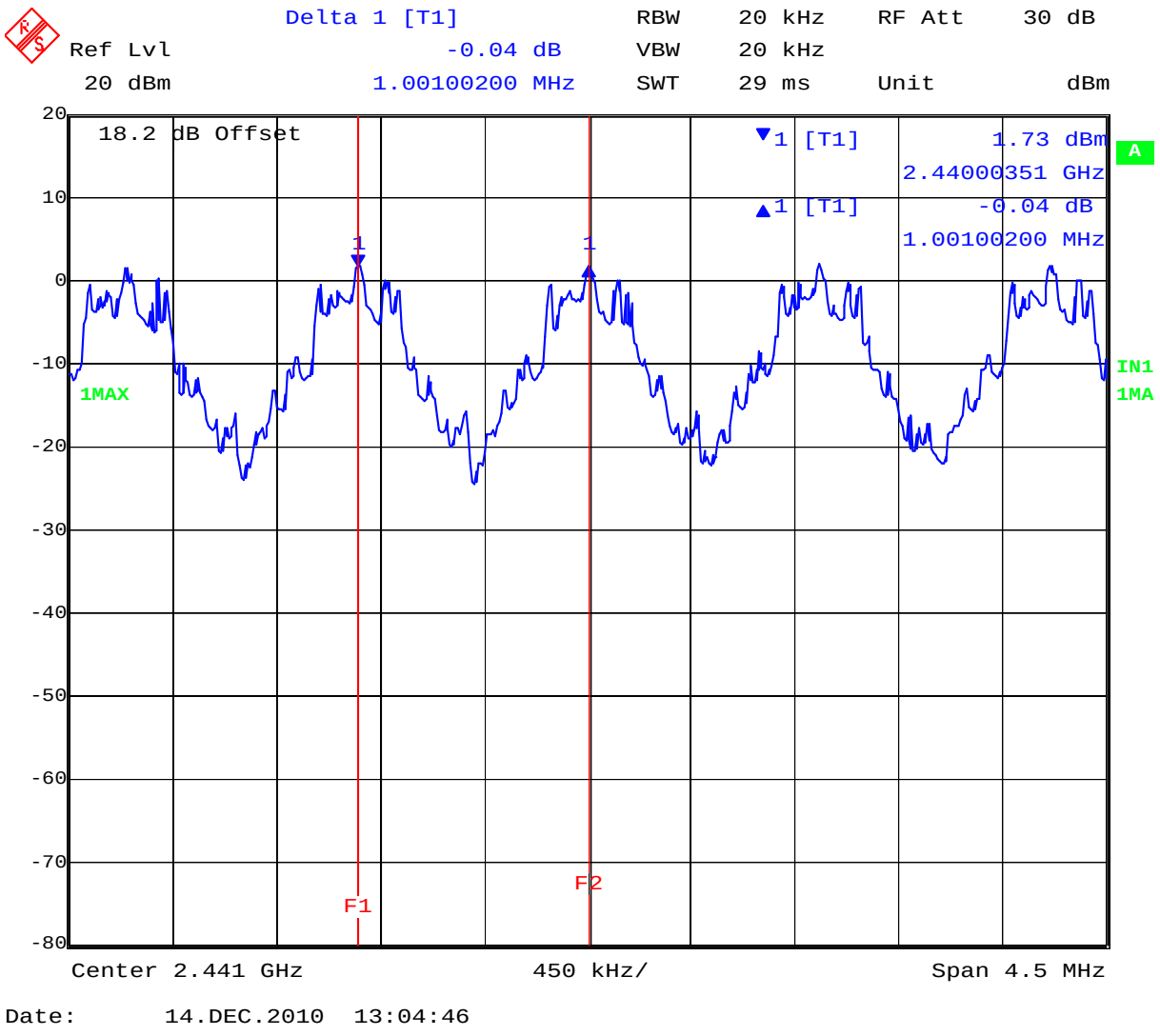
Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

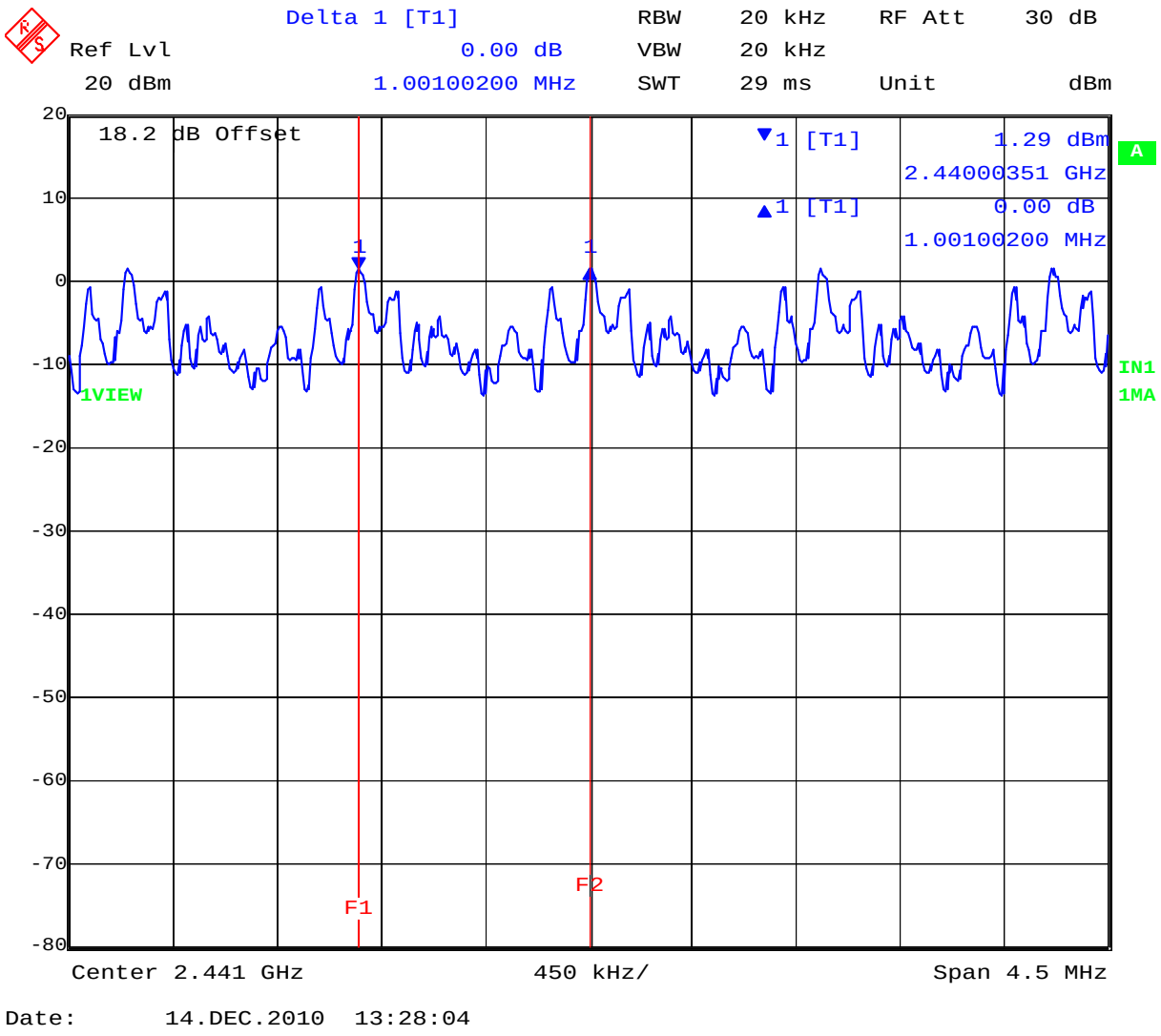
Data Rate (Mbs)	Channel Spacing (MHz)	Maximum 20 dB Bandwidth (Maximum Data Rate) (MHz)	Specification	Results
1	1.001	1.379	Greater than 2/3 of 20 dB Bandwidth	PASS
2	1.001	1.379	Greater than 2/3 of 20 dB Bandwidth	PASS
3	1.001	1.379	Greater than 2/3 of 20 dB Bandwidth	PASS

Maximum data rate was chosen to provide worst case carrier frequency separation limits.

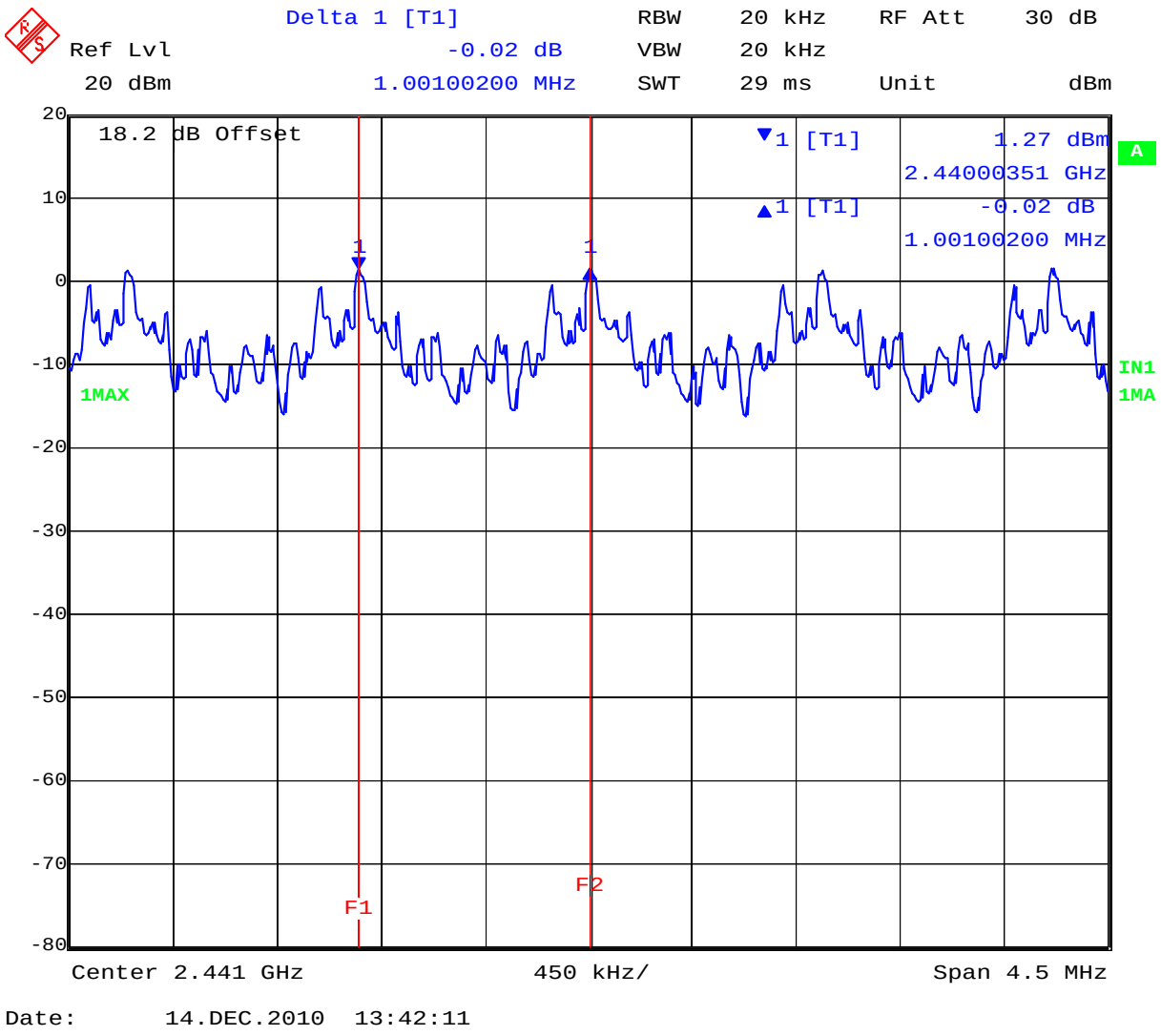
Carrier Frequency Separation 1.001 MHz; Hopping On; 1 Mbs Data Rate



Carrier Frequency Separation 1.001 MHz; Hopping On; 2 Mbs Data Rate



Carrier Frequency Separation 1.001 MHz; Hopping On; 3 Mbs Data Rate



7.1.3 Number of Hopping Frequencies

Test Procedure

The EUT must have its hopping function enabled.

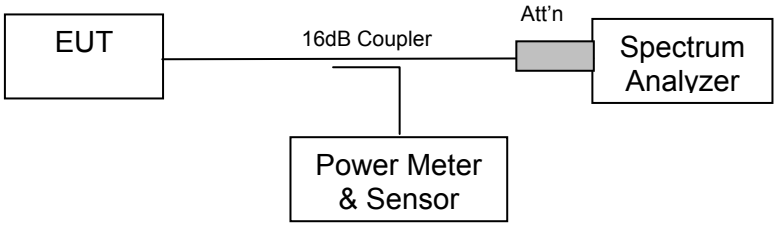
The following spectrum analyzer settings were used:

Span = the frequency band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Number of Hopping Frequencies Limits

FCC §15.247 (a)(1)(iii)

(a)(1)(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Industry Canada RSS-210 §A8.1 (d)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

Test Results for Number of Hopping Frequencies

Ambient conditions.

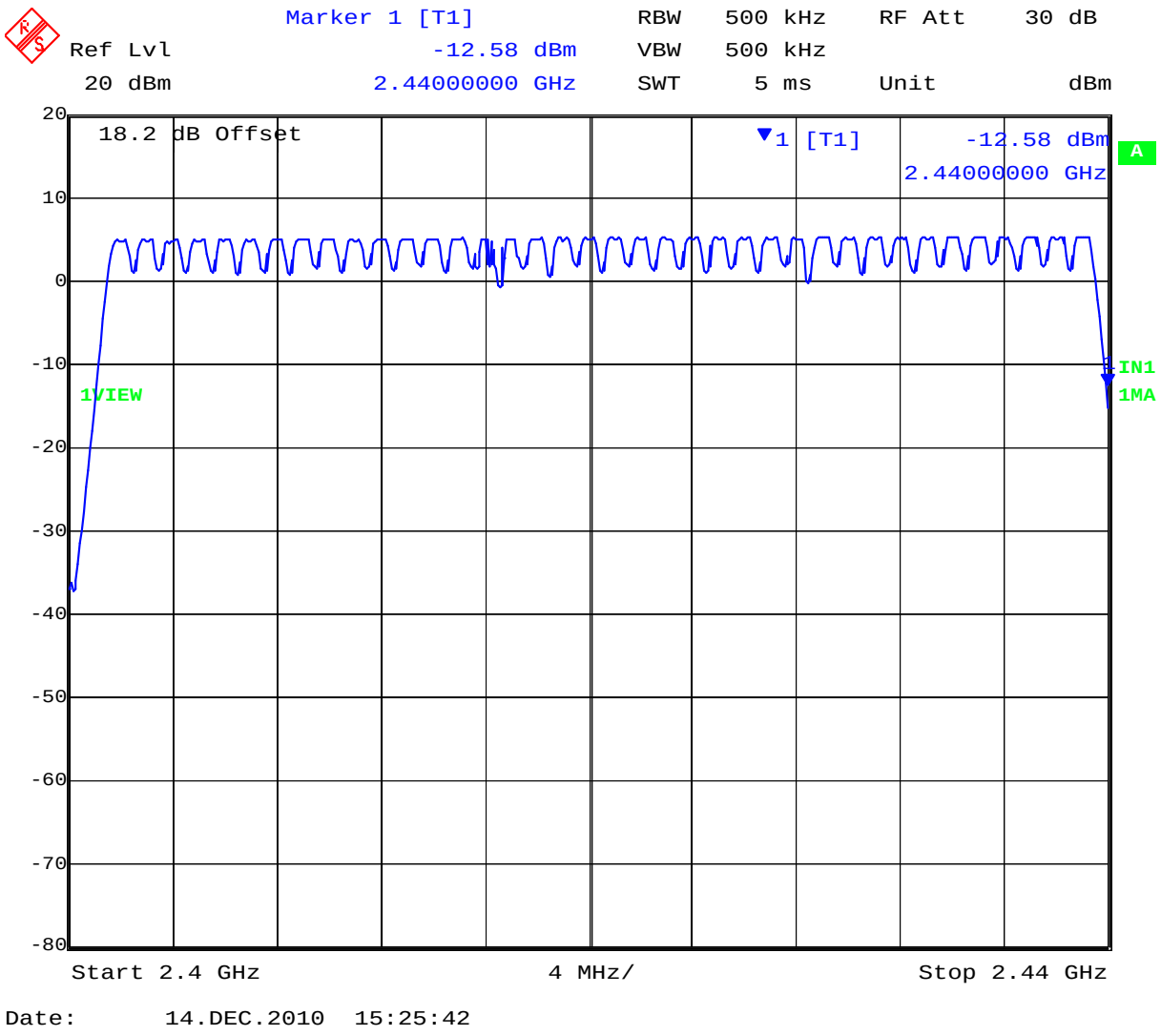
Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

Number of Channels	Specification
79	1 Watt Output Power - Minimum 75 hopping channels 0.125 Watt Output Power - Minimum of 15 hopping channels

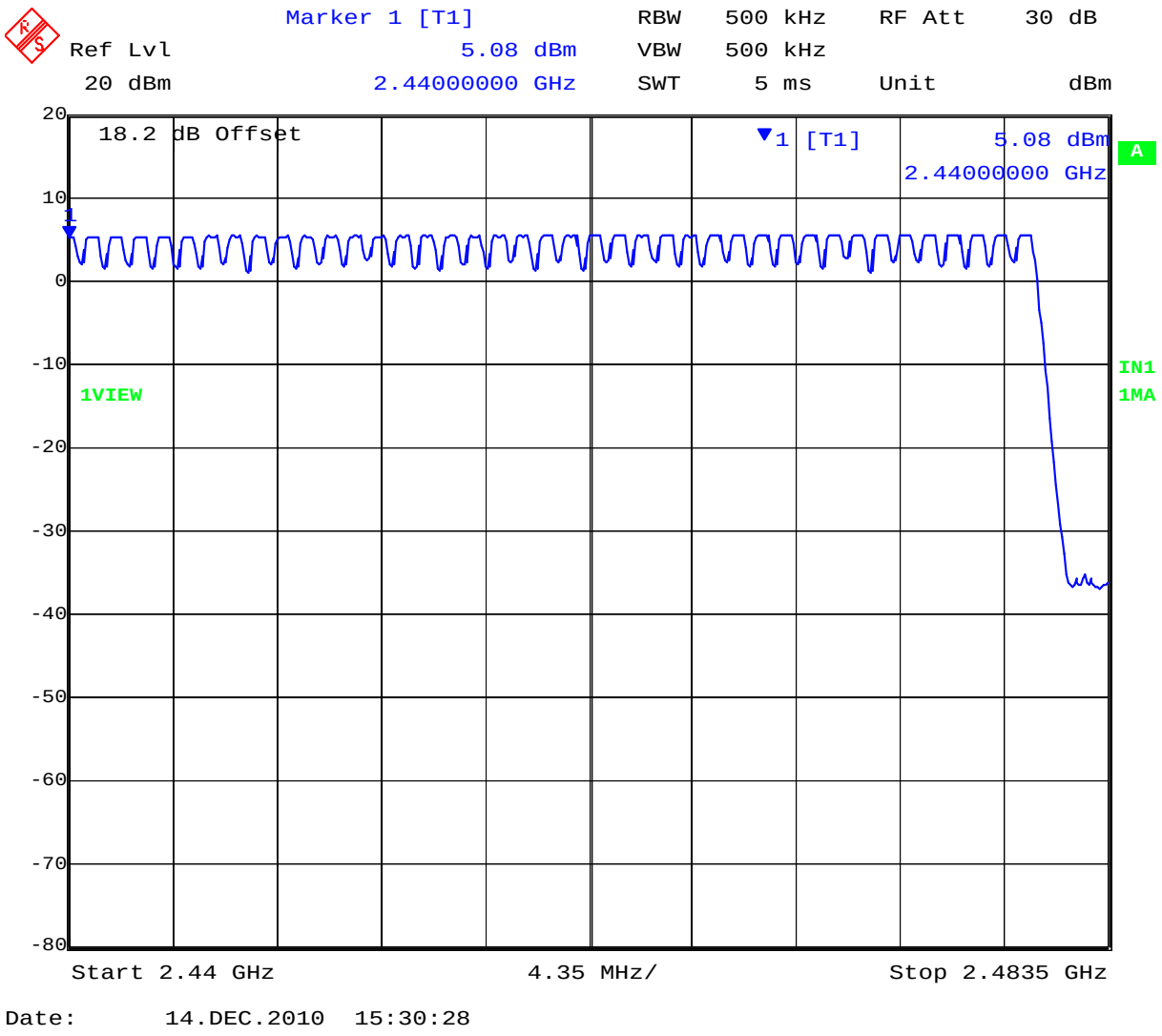
There is also a provision for avoiding interference in the band by hopping around channels being interfered with (Adaptive Frequency Hopping). There will always be at least 20 channels in the list of hopping channels.

EUT operates at a peak output power less than 0.125 Watts.

Number of Hopping Frequencies; Hopping On; 1 Mbs Data Rate; 2400-2440 MHz



Number of Hopping Frequencies; Hopping On; 1 Mbs Data Rate; 2440-2483.5 MHz



7.1.4 Time of Occupancy (Dwell Time)

Test Procedure

The EUT must have its hopping function enabled.

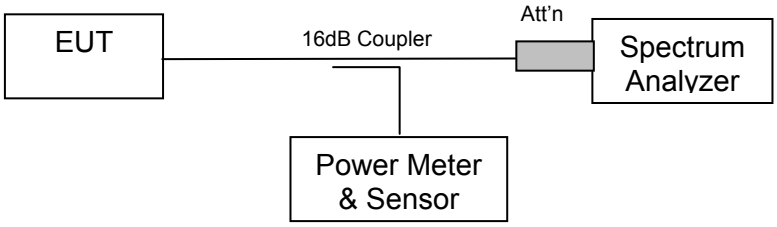
The following spectrum analyzer settings were used:

Span = zero span, centered on a hopping channel
RBW = 1MHz
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector function = peak
Trace = max hold

If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope may be used instead of a spectrum analyzer.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Time of Occupancy (Dwell Time) Limits

FCC §15.247 (a)(1)(iii)

(a)(1)(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Industry Canada RSS-210 §A8.1 (d)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

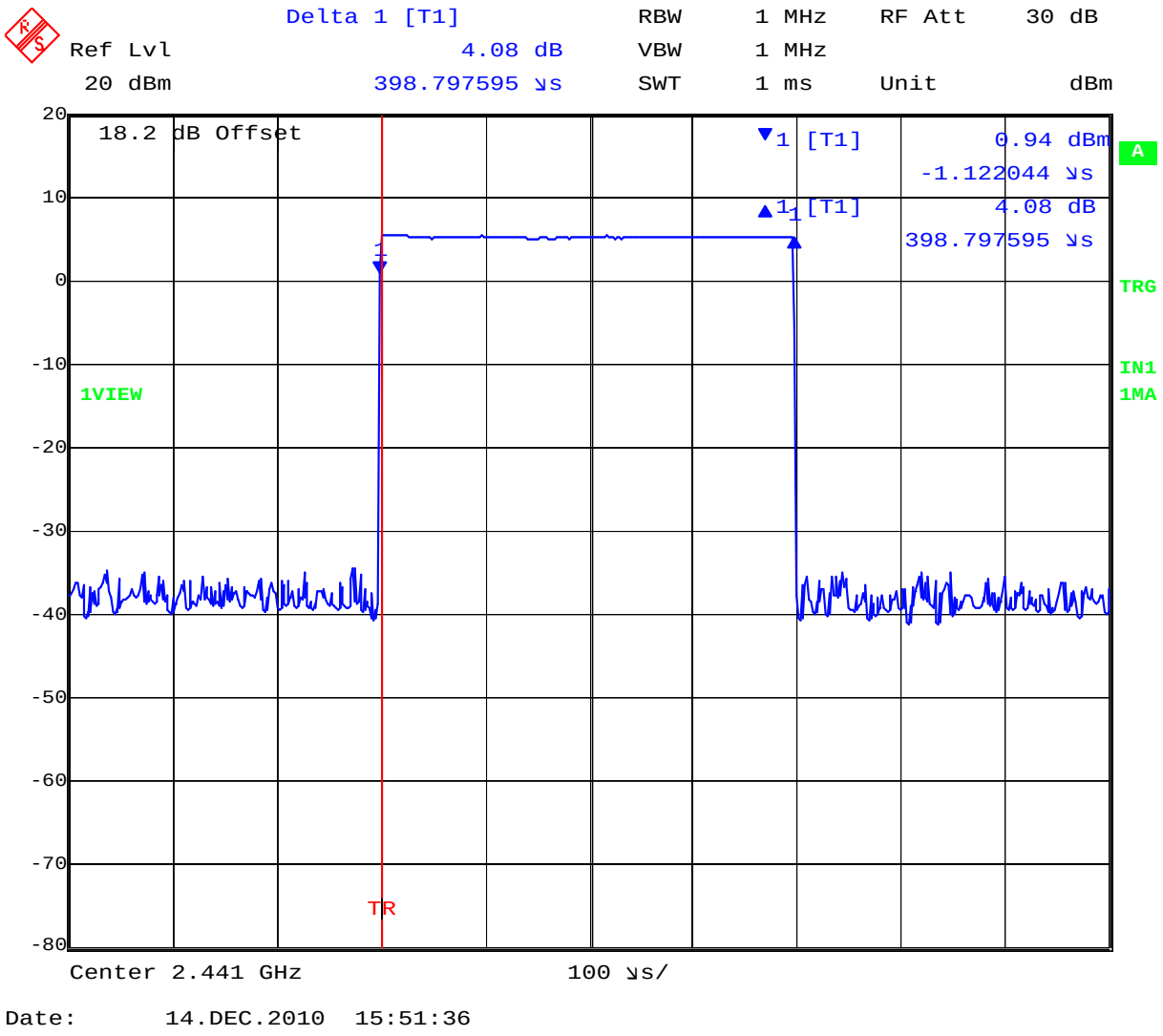
Test Results for Time of Occupancy (Dwell Time)

Ambient conditions.

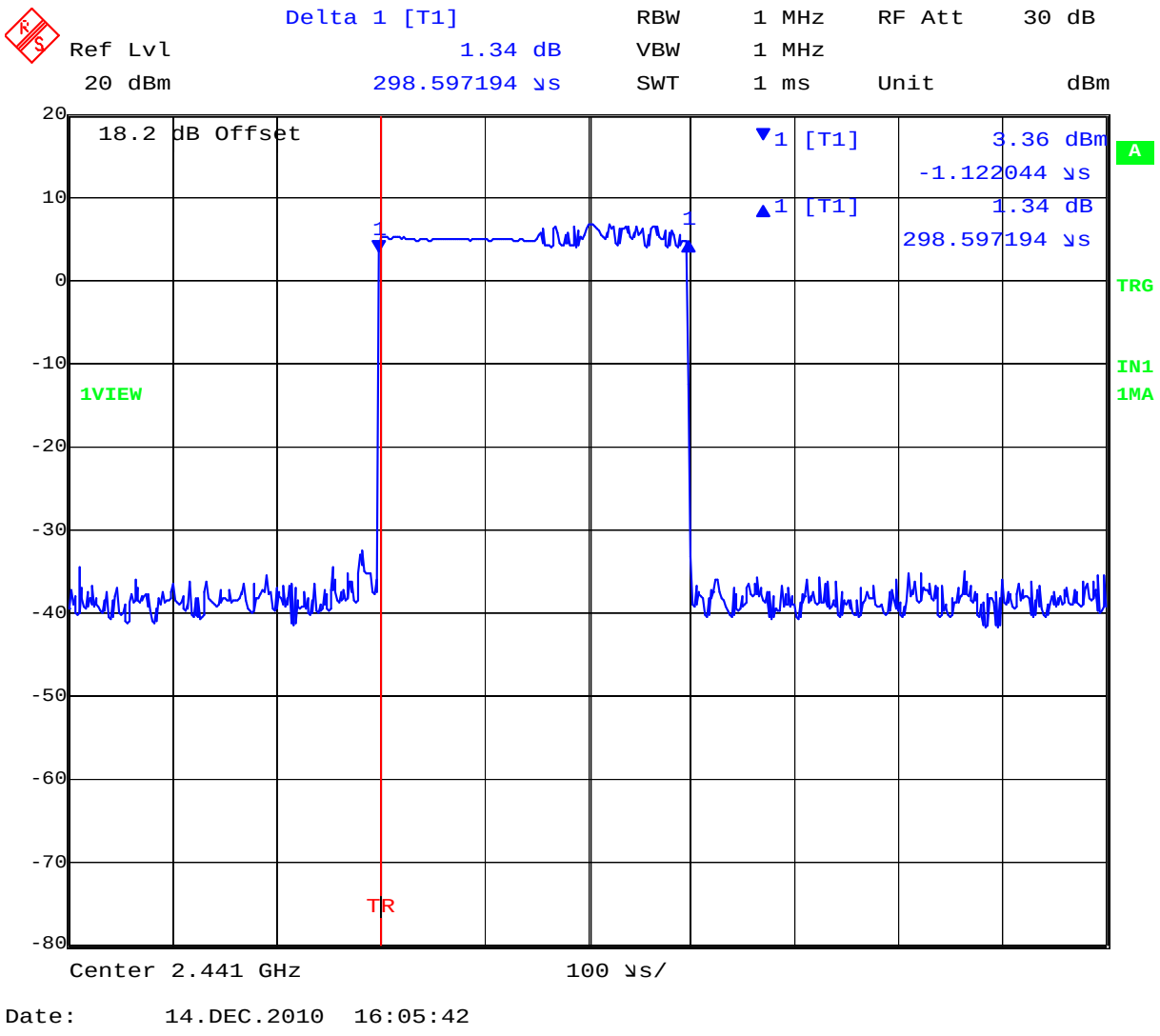
Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

Centered on Channel	Center Frequency (MHz)	Data Rate (Mbs)	Channel Dwell Time (single channel) (µs)
39	2441	1	398.797
39	2441	2	298.597
39	2441	3	258.517

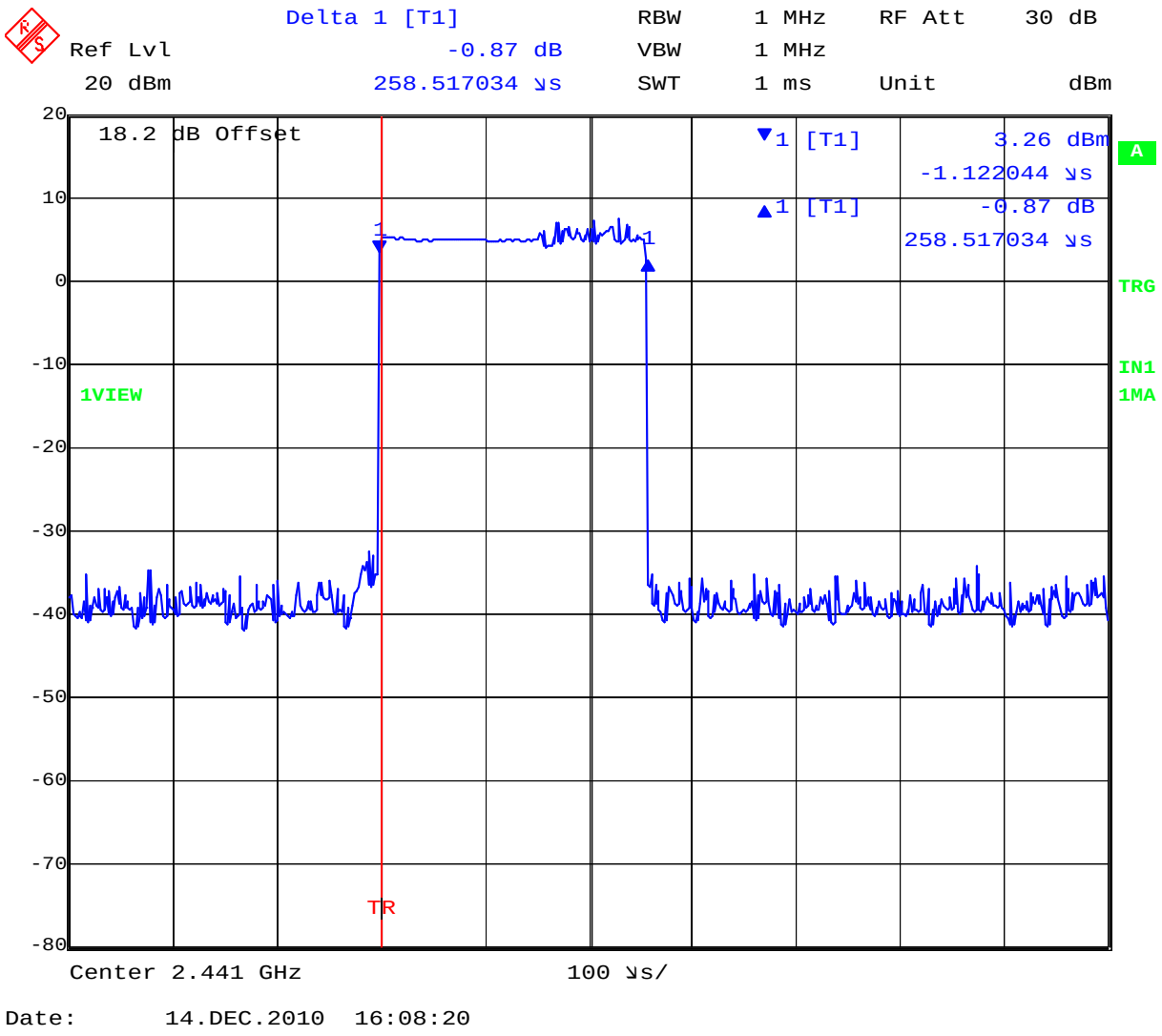
Time of Occupancy; Hopping On; 2441 MHz; 1 Mbs Data Rate; Dwell Time 398.797 µs



Time of Occupancy; Hopping On; 2441 MHz; 2 Mbs Data Rate; Dwell Time 298.597 µs



Time of Occupancy; Hopping On; 2441 MHz; 3 Mbs Data Rate; Dwell Time 258.517 µs



7.1.5 Channel Occupancy

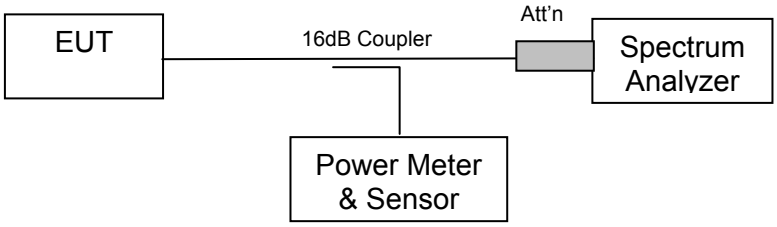
Test Procedure

The EUT must have its hopping function enabled.

The following spectrum analyzer settings were used:

Span = zero span, centered on a hopping channel
RBW = 1MHz (or appropriate RBW to distinguish center channel from adjacent channels)
VBW ≥ RBW
Sweep = 0.4 seconds x Number of Hopping Frequencies
Detector function = peak
Trace = max hold

Test Setup



Specification for Number of Channels and Channel Occupancy Limits

FCC §15.247 (a)(1)(iii)

(a)(1)(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Industry Canada RSS-210 §A8.1 (d)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

Test Results for Channel Occupancy

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

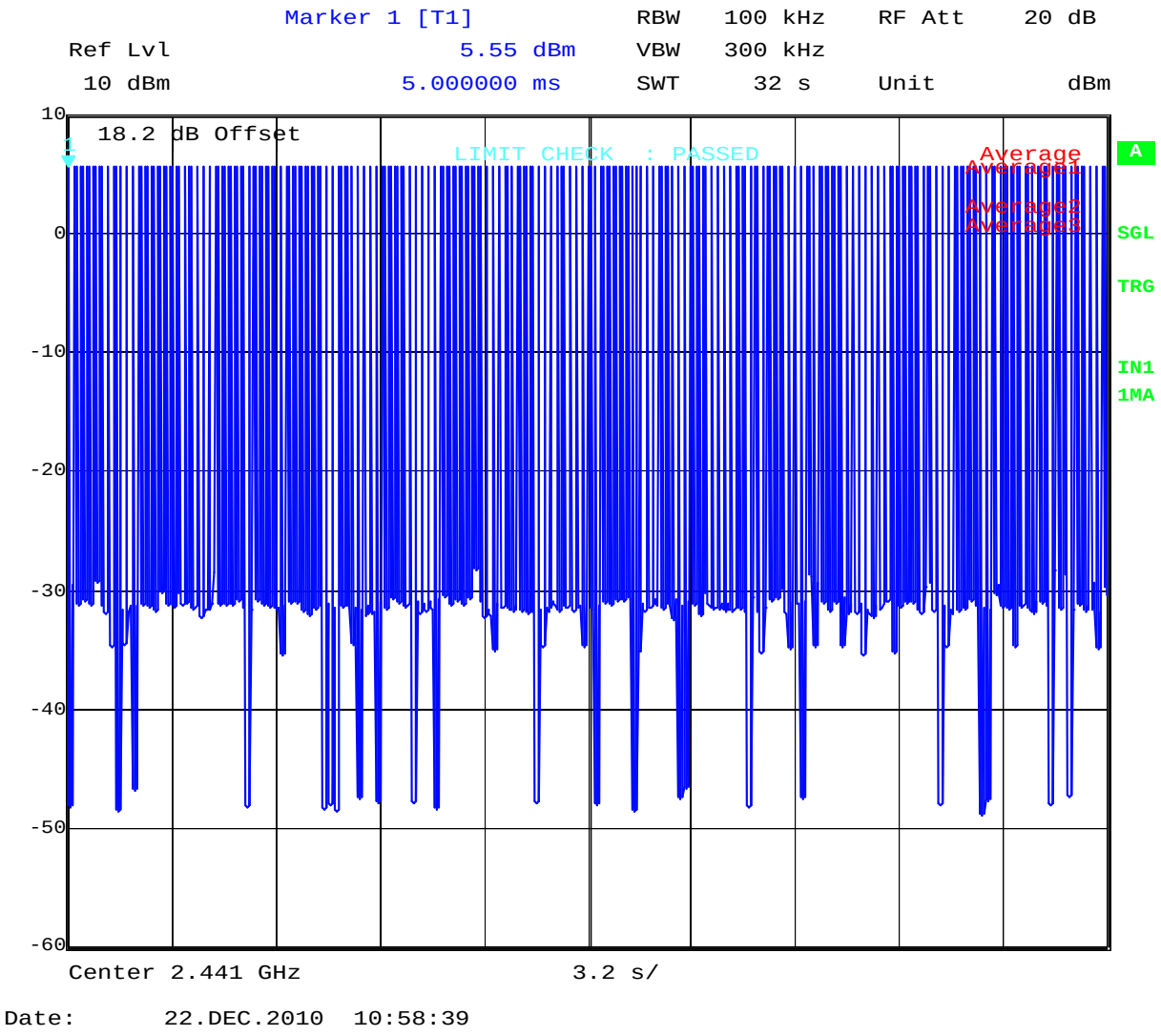
Channel #	Center Frequency (MHz)	Data Rate (Mbs)	Channel Dwell Time (single channel) (µs)	Number of Hops	Channel Occupancy (ms)	Limit (ms)	Result
39	2441	1	398.797	316	126.020	400	PASS
39	2441	2	298.597	316	94.357	400	PASS
39	2441	3	258.517	316	81.691	400	PASS

Channel occupancy was performed using a sweep time of 32 seconds.
(79 x 0.4 = 31.6 seconds) and the data rate with the highest dwell time.

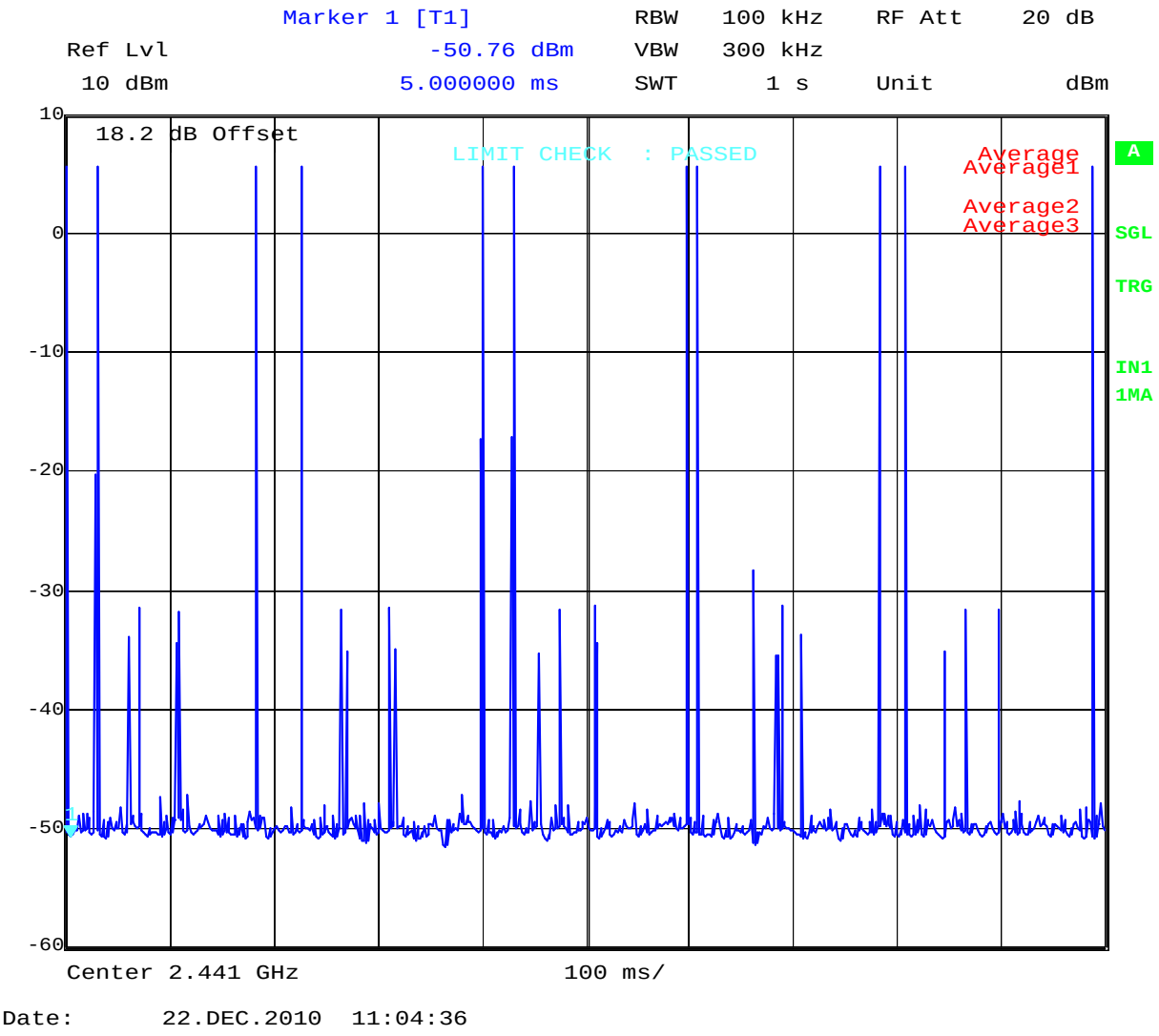
All data rates were then checked with a sweep time of 1 second to verify the number of time the transmitter occupied Channel 39 (2441 MHz). Each data rate transmitted on Channel 39 a total of 10 times per second.

Number of hops = 10 hops per sec x 31.6 seconds = 316 hops

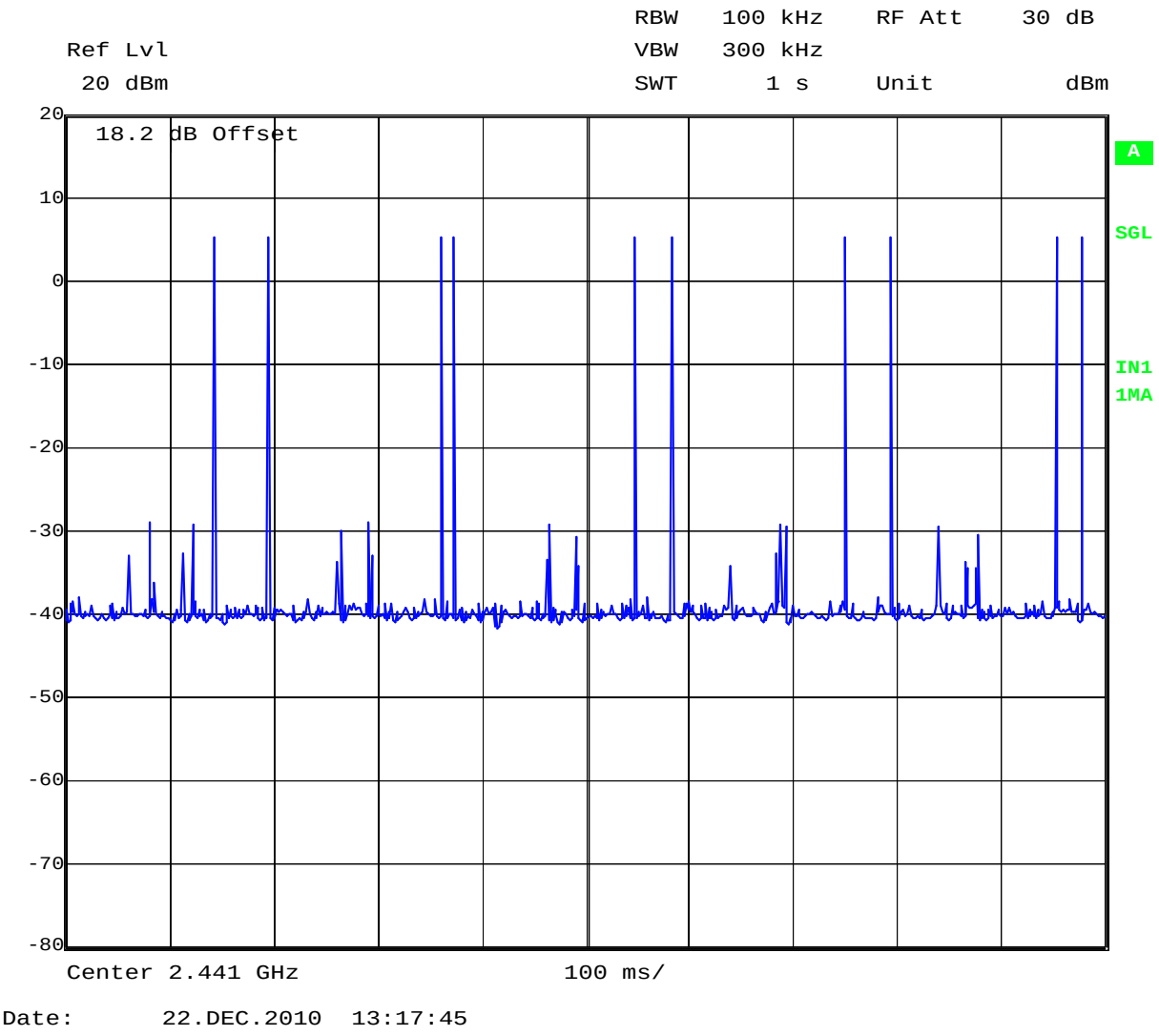
Channel Occupancy; 2441 MHz Channel 39; 1 Mbs Data Rate; Sweep Time 32 s



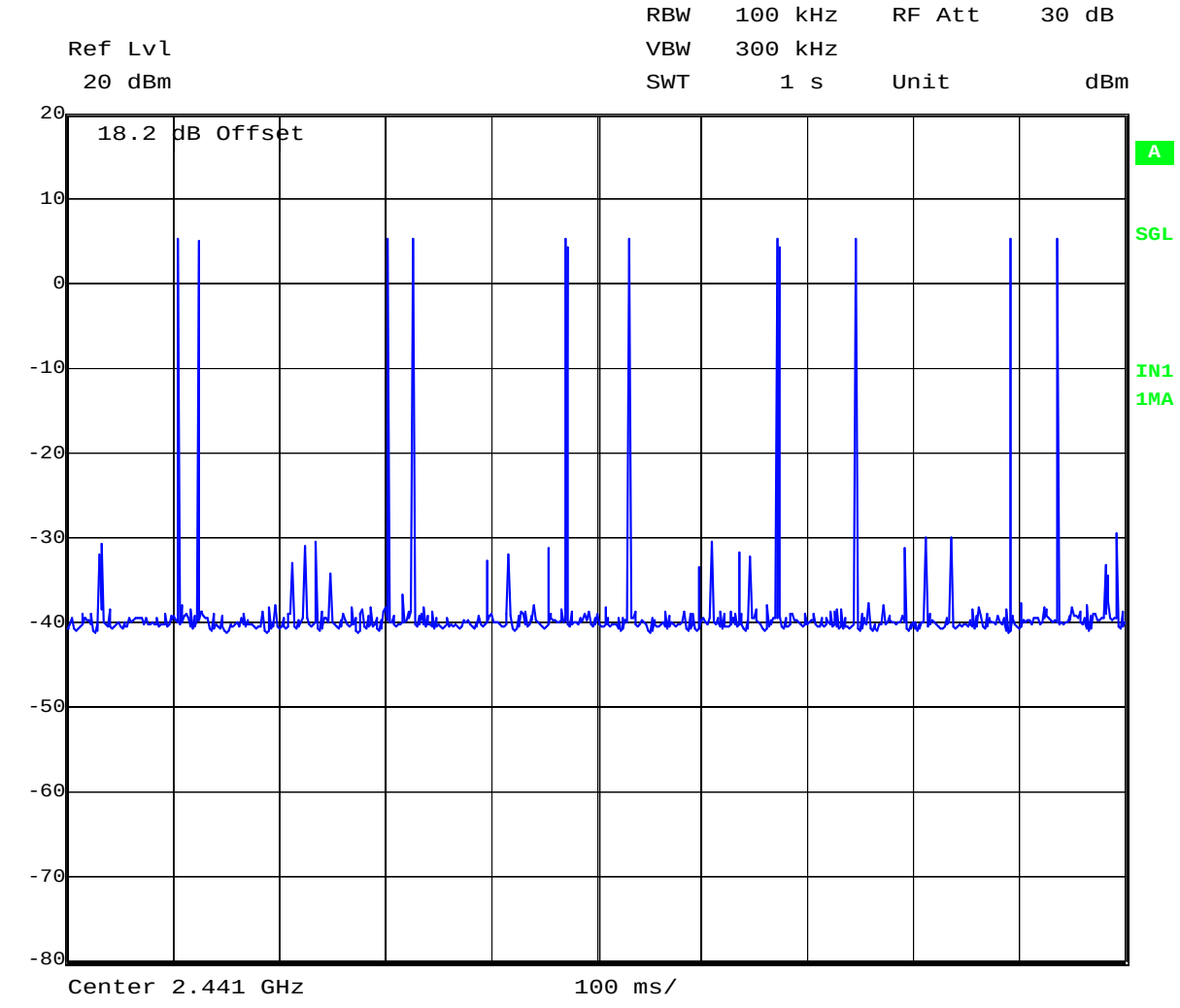
Channel Occupancy; 2441 MHz Channel 39; Data Rate 1 Mbs; Sweep Time 1 s



Channel Occupancy; 2441 MHz Channel 39; Data Rate 2 Mbs; Sweep Time 1 s



Channel Occupancy; 2441 MHz Channel 39; Data Rate 3 Mbs; Sweep Time 1 s



7.1.6 Peak Output Power

Test Procedure

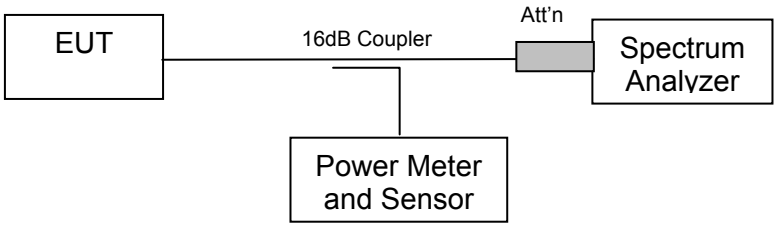
The following spectrum analyzer settings were used:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
RBW > the 20 dB bandwidth of the emission being measured
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the NOTE above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Peak Output Power Limits

FCC Part 15 Subpart C §15.247 (b)(1)

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Industry Canada RSS-210 §A8.4 (2)

For frequency hopping systems operating in the band 2400-2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. Except as provided in Section A8.4 (5), the e.i.r.p. shall not exceed 4 W.

Frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

Test Results for Peak Output Power

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

Peak output power levels at 3 Mbs data rate are the highest levels measured.

TABLE OF RESULTS: 1 Mbs

Channel #	Center Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)
0	2402	+5.34	+4.93
39	2441	+5.67	+5.46
78	2480	Note 1	Note 1

TABLE OF RESULTS: 2 Mbs

Channel #	Center Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)
0	2402	+7.04	+4.44
39	2441	+7.45	+4.97
78	2480	+7.61	+5.28

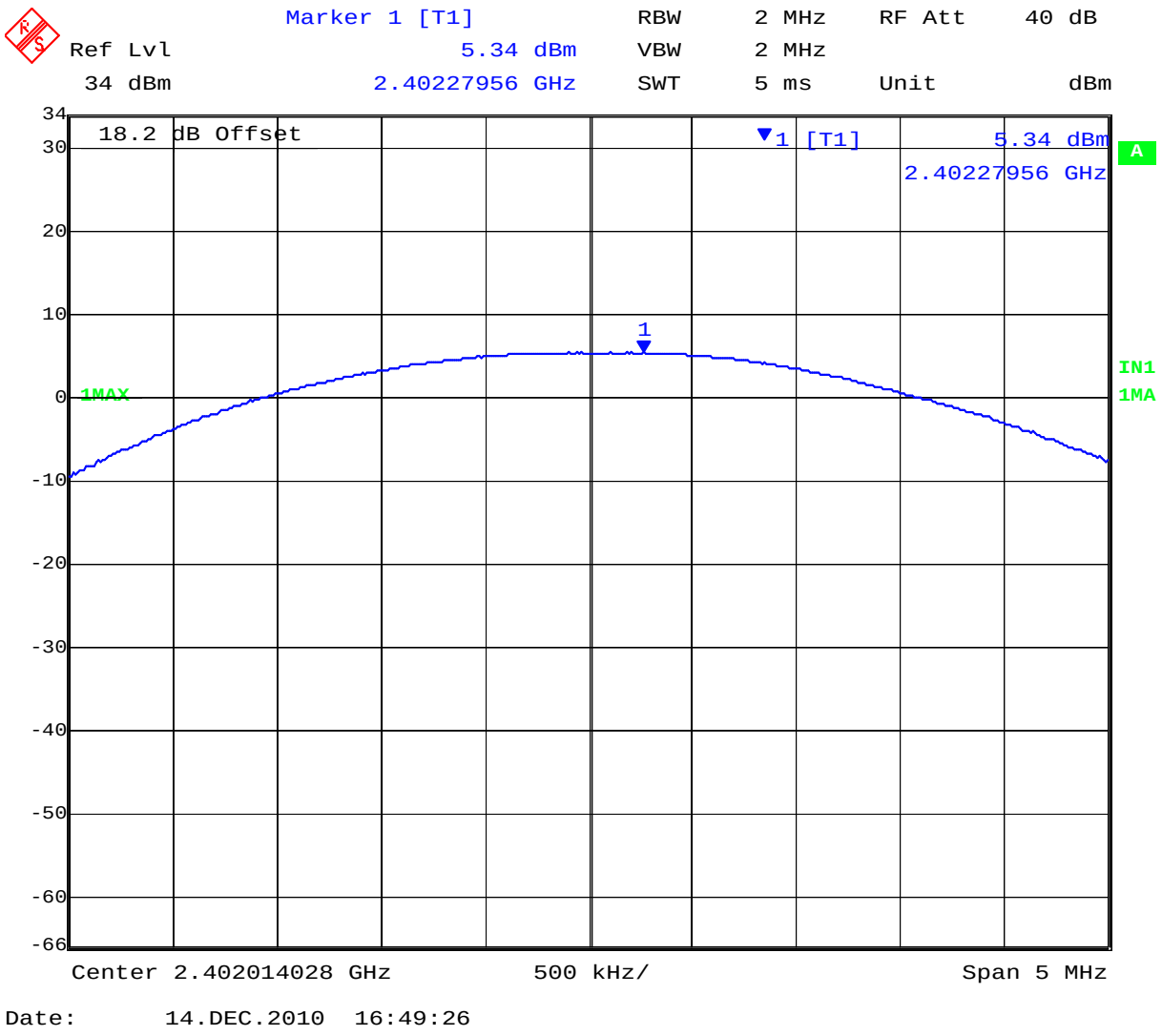
TABLE OF RESULTS: 3 Mbs

Channel #	Center Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)
0	2402	+7.57	+4.42
39	2441	+8.13	+4.96
78	2480	+8.28	+5.30

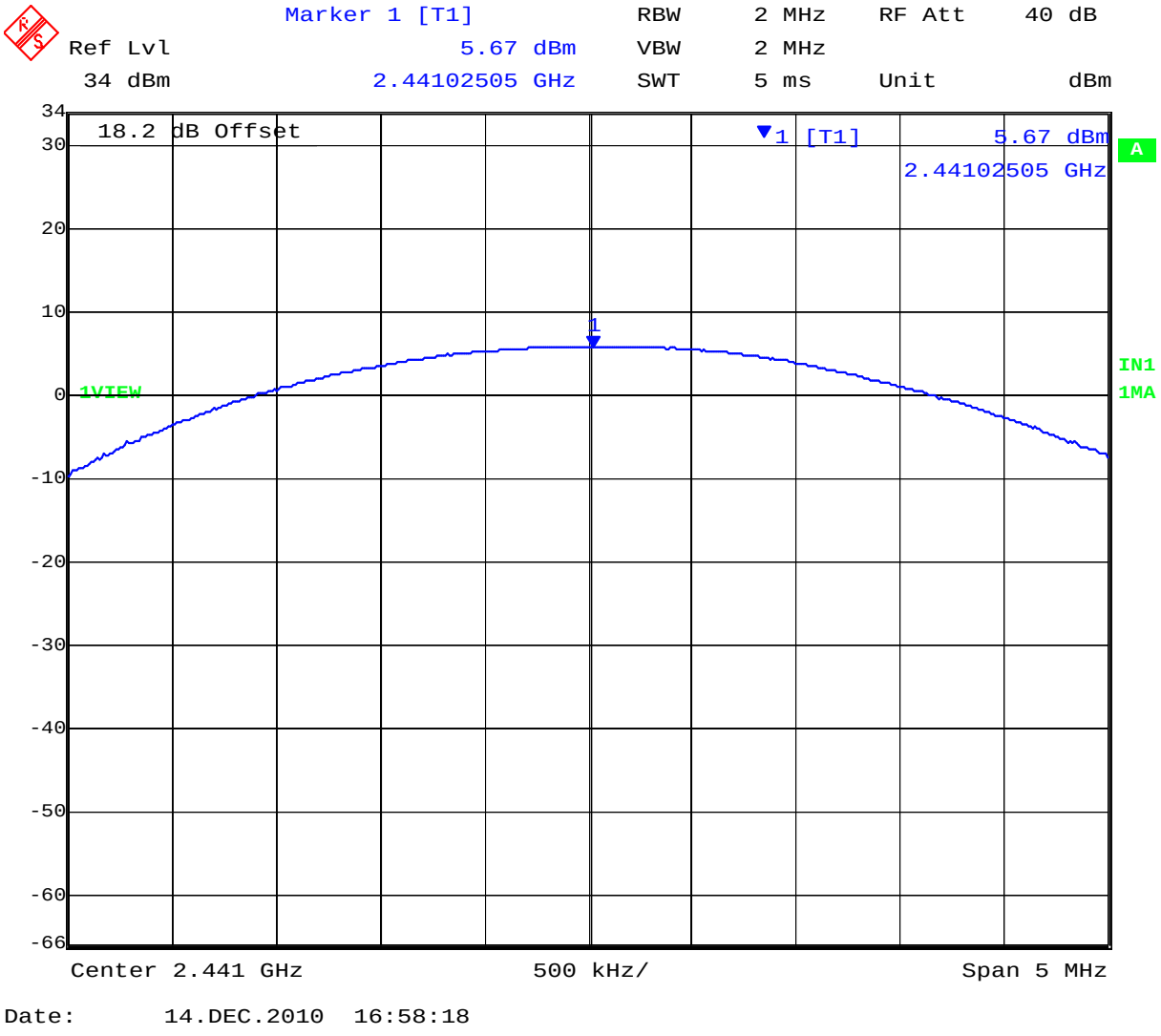
Note 1: EUT test code would not allow transmissions on Channel 78 @ 1 Mbs. Power measurements were performed at 2 Mbs and 3 Mbs data rates. Maximum power obtained with maximum data rate, therefore peak power at 1 Mbs was not performed.

Note 2: Average power is provided for reference only. Average power was measured with an RMS power head and power meter.

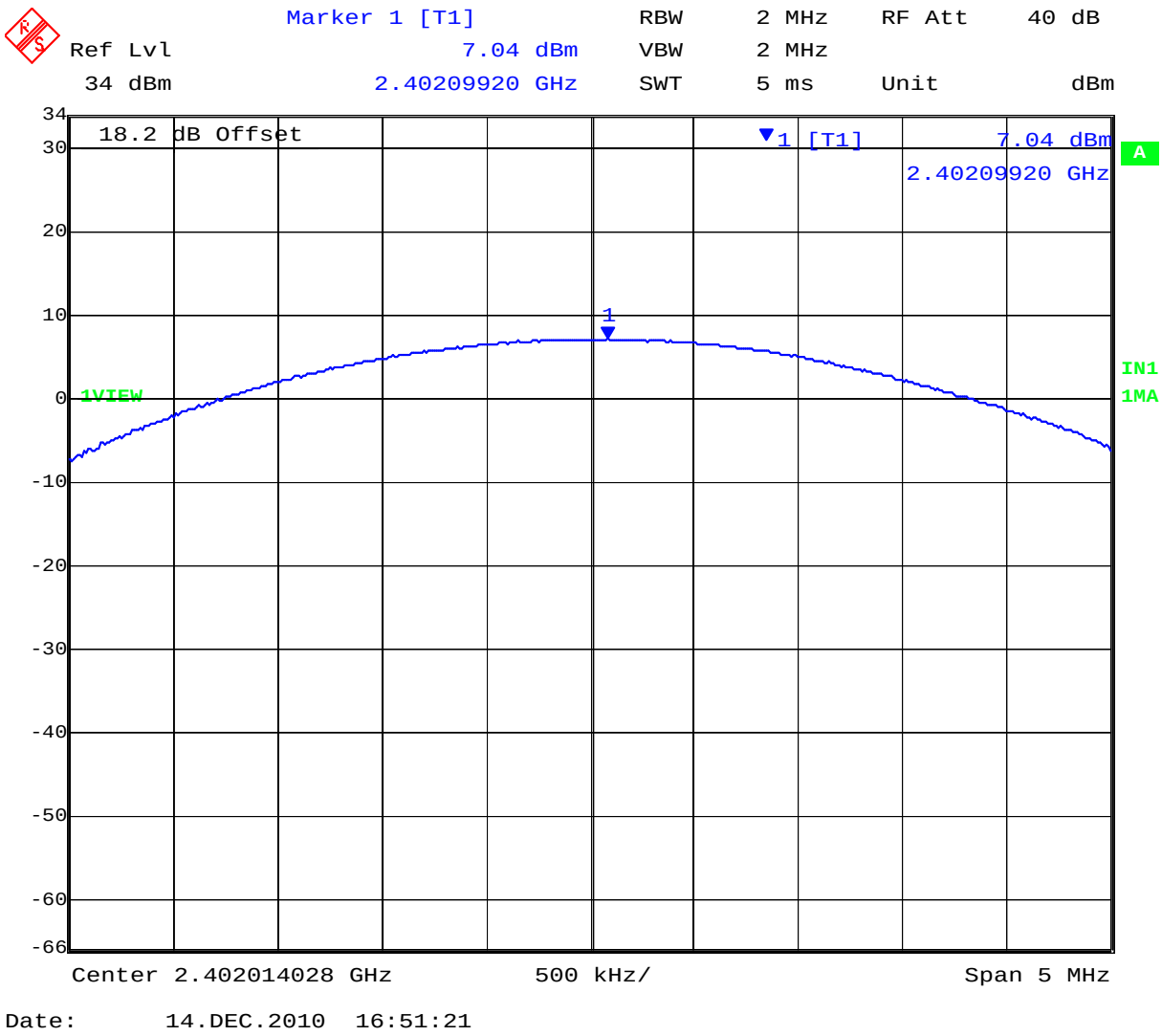
Peak Power; Channel 0; 1 Mbs Data Rate



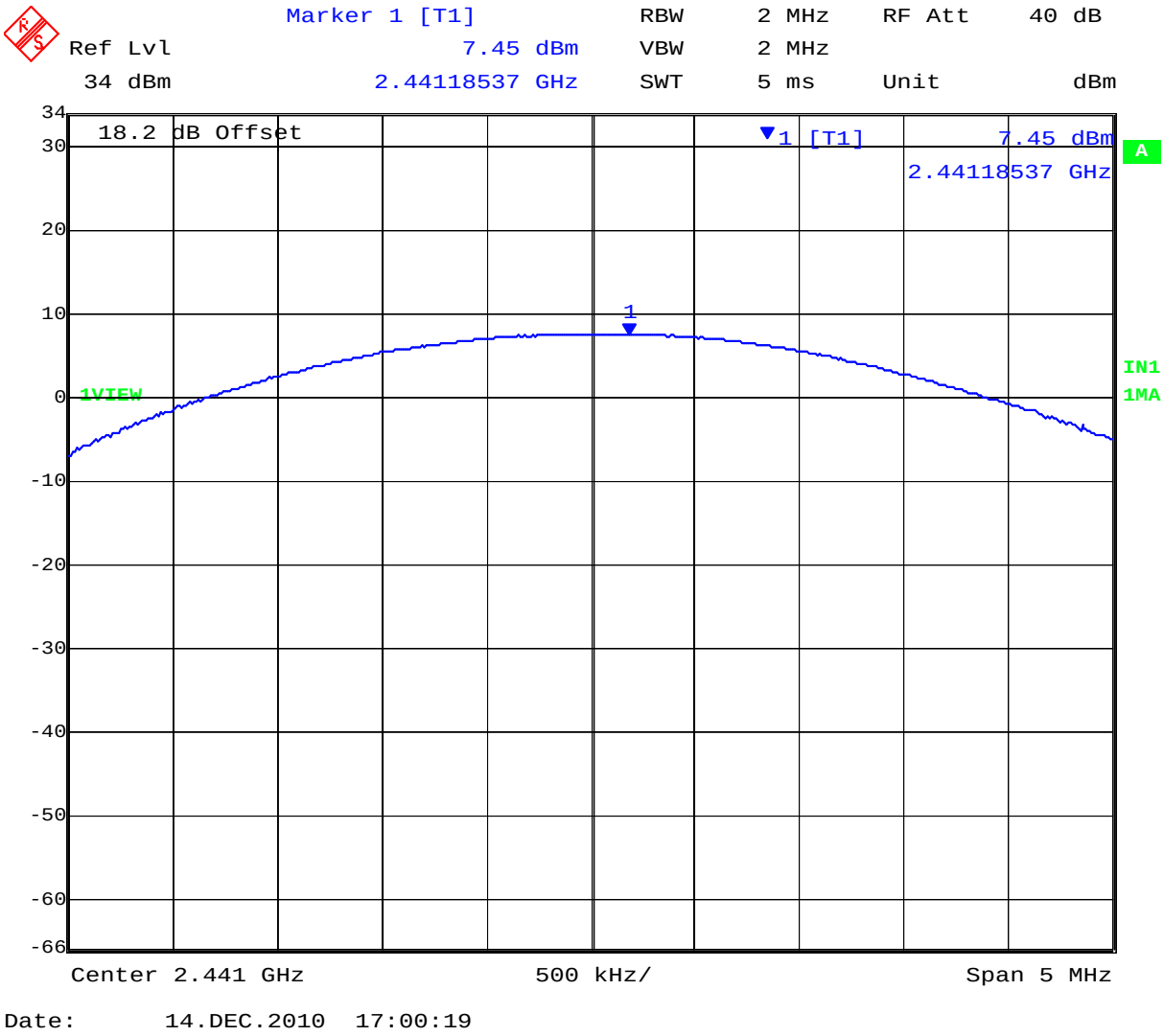
Peak Power; Channel 39; 1 Mbs Data Rate



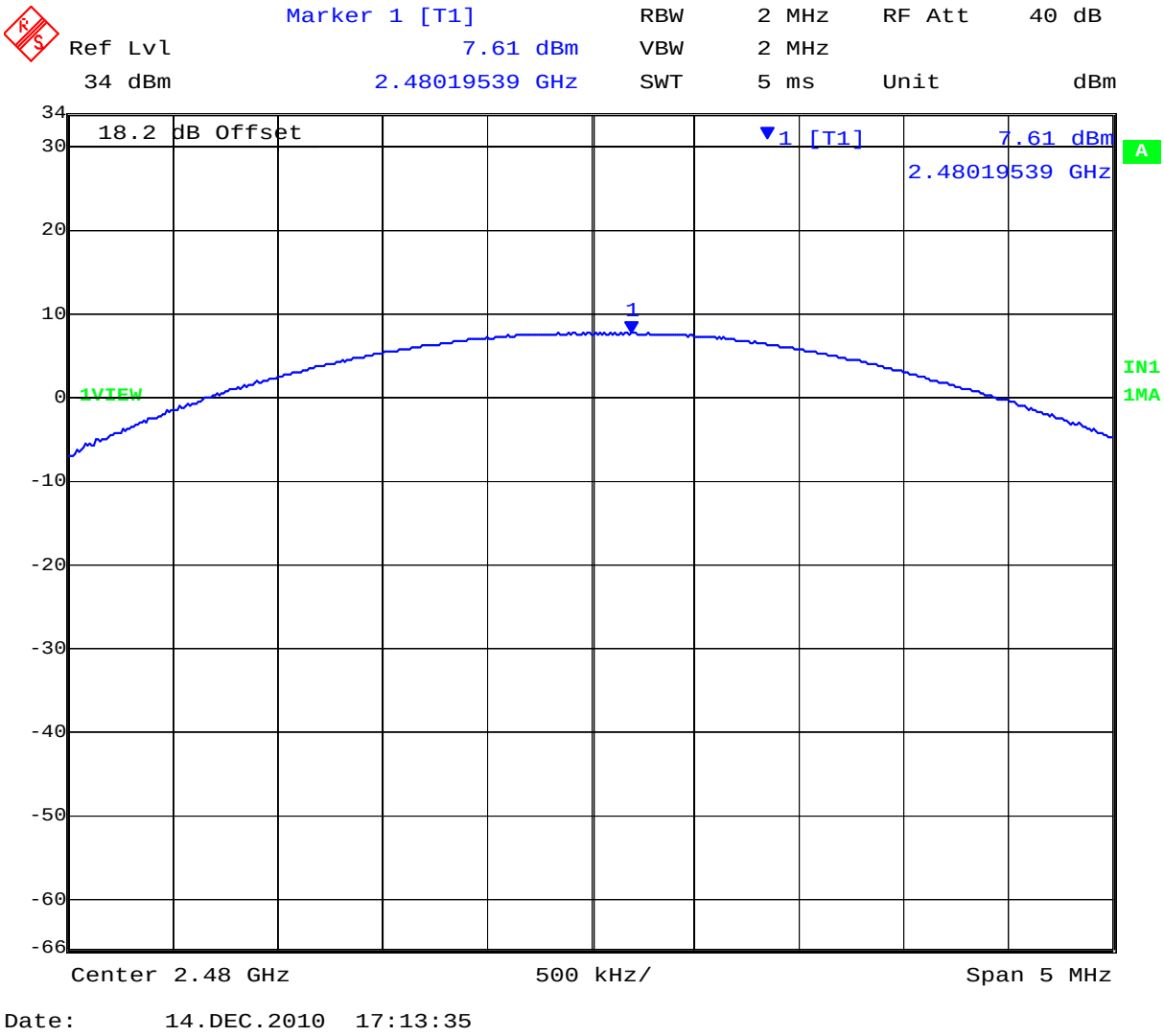
Peak Power; Channel 0; 2 Mbs Data Rate



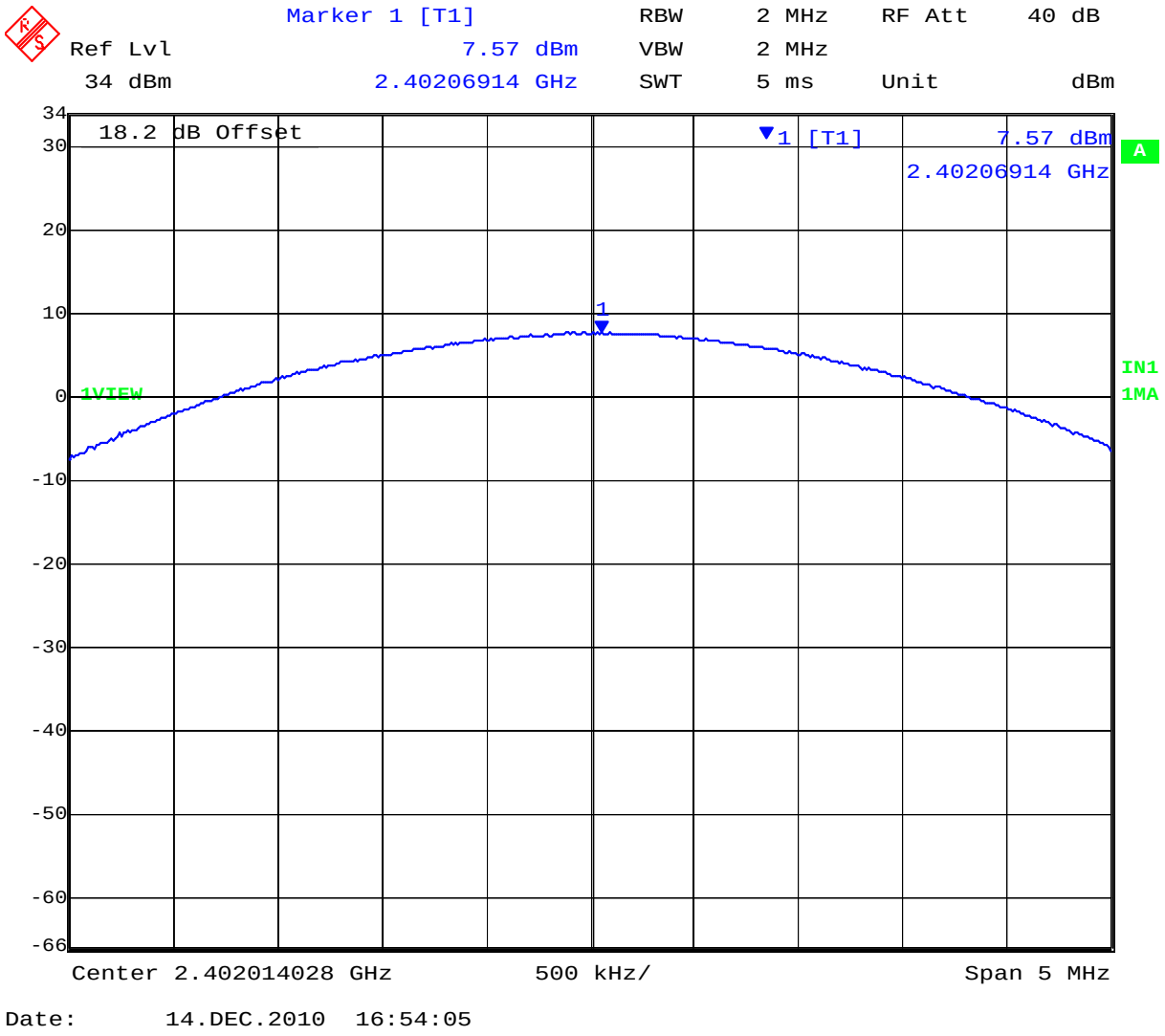
Peak Power; Channel 39; 2 Mbs Data Rate



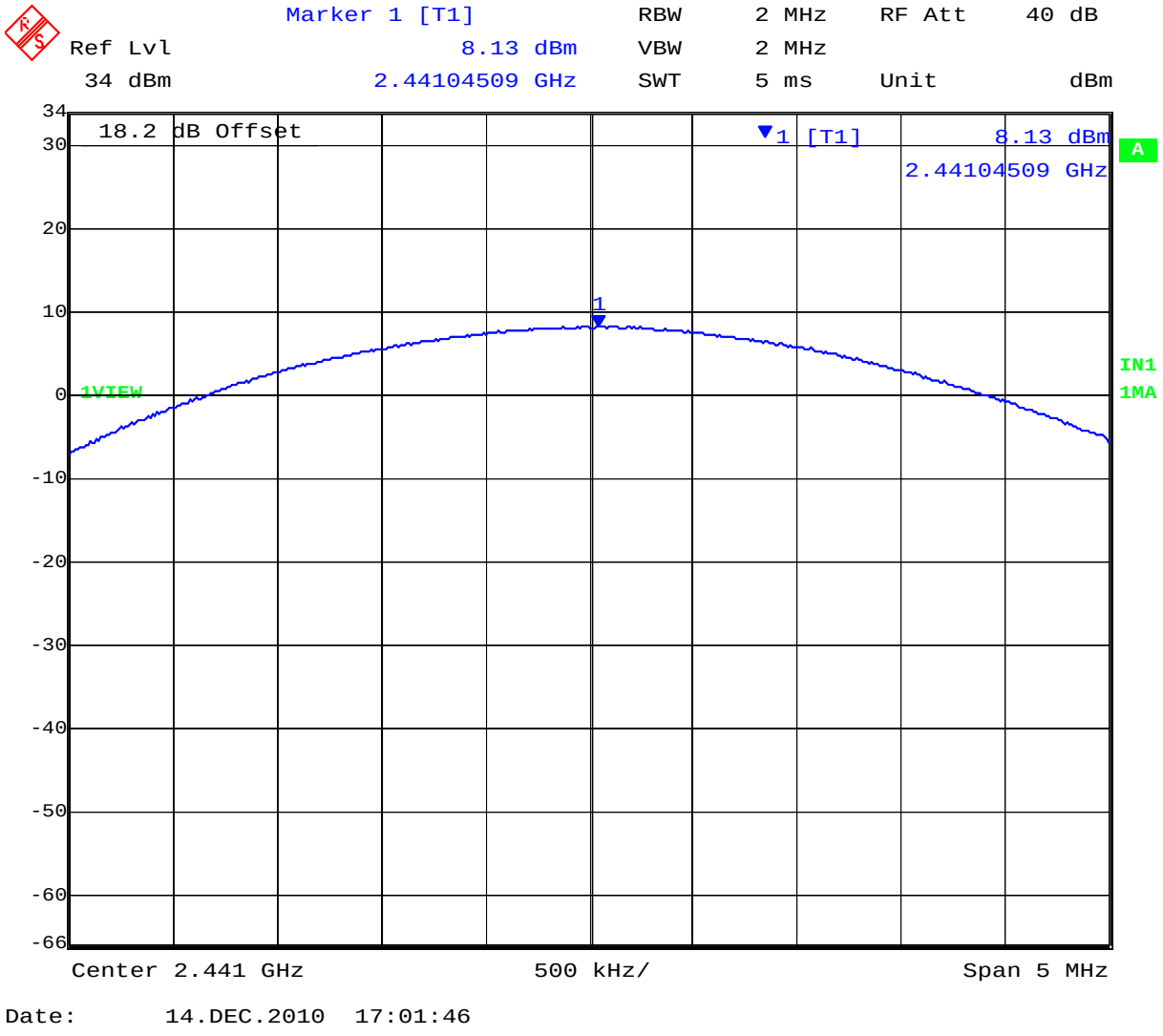
Peak Power; Channel 78; 2 Mbs Data Rate



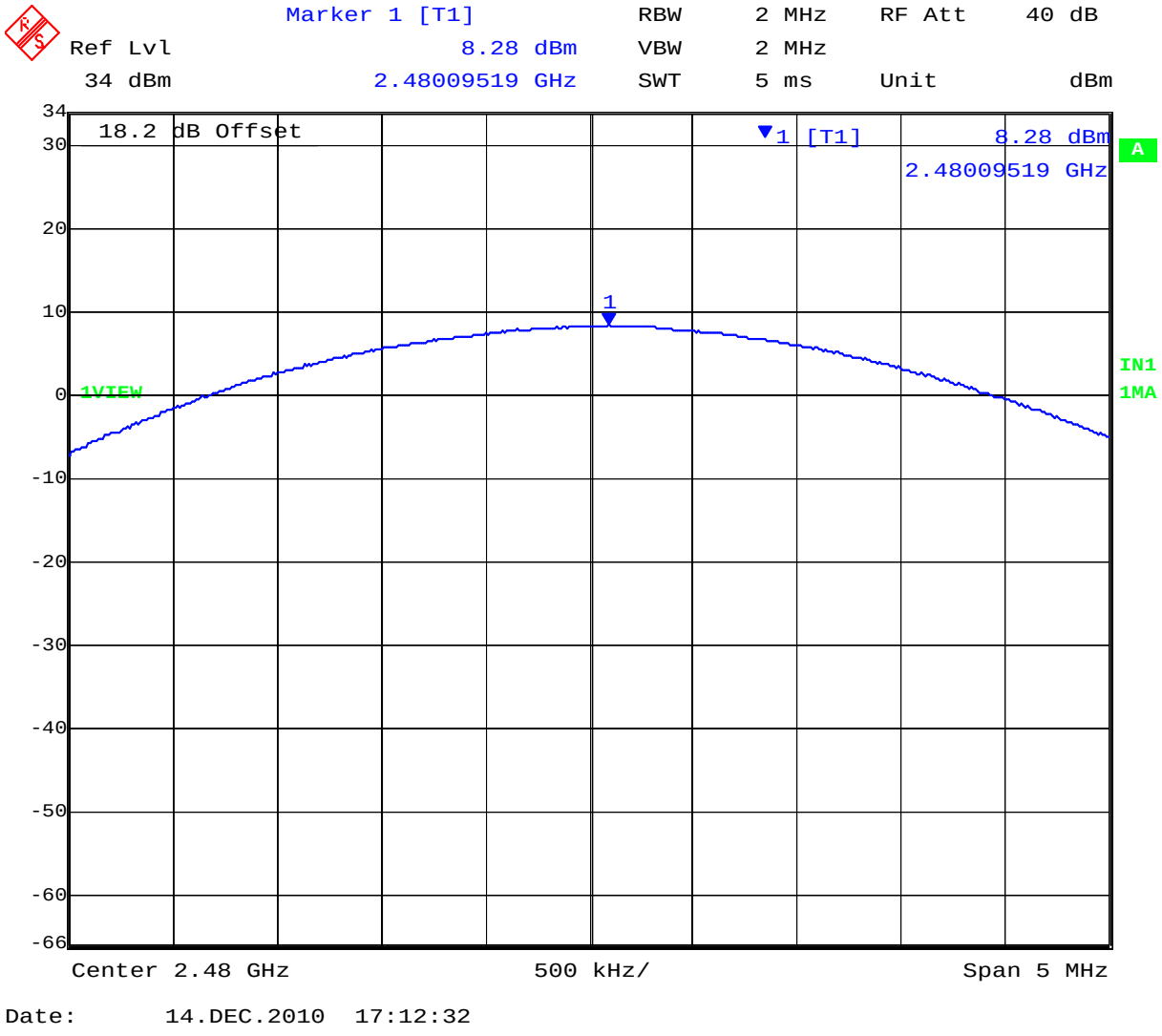
Peak Power; Channel 0; 3 Mbs Data Rate



Peak Power; Channel 39; 3 Mbs Data Rate



Peak Power; Channel 78; 3 Mbs Data Rate



7.1.7 Band-edge Compliance of RF Conducted Emissions

Test Procedure

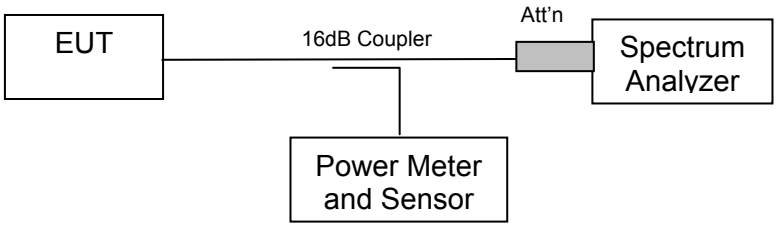
The following spectrum analyzer settings were used:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section. Submit this plot.

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit. Submit this plot.

Test Setup



Specification for Band-edge Limits

FCC Part 15 Subpart C §15.247(d)

(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 a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. 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 in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Industry Canada RSS-210 §A8.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

RSS-GEN 6.2

If the receiver has a detachable antenna of known impedance, antenna conducted spurious emissions measurement is permitted as an alternative to radiated measurement. However, the radiated method of Section 6.1 is recommended:

The antenna conducted test shall be performed with the antenna disconnected and the receiver antenna terminals connected to a measuring instrument having equal impedance to that specified for the antenna

The receiver spurious emissions measured at the antenna terminals by the antenna conducted method shall then comply with the following limits:

Receiver spurious emissions at any discrete frequency shall not exceed 2 nanowatts in the band 30-1000 MHz, and 5 nanowatts above 1000 MHz.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

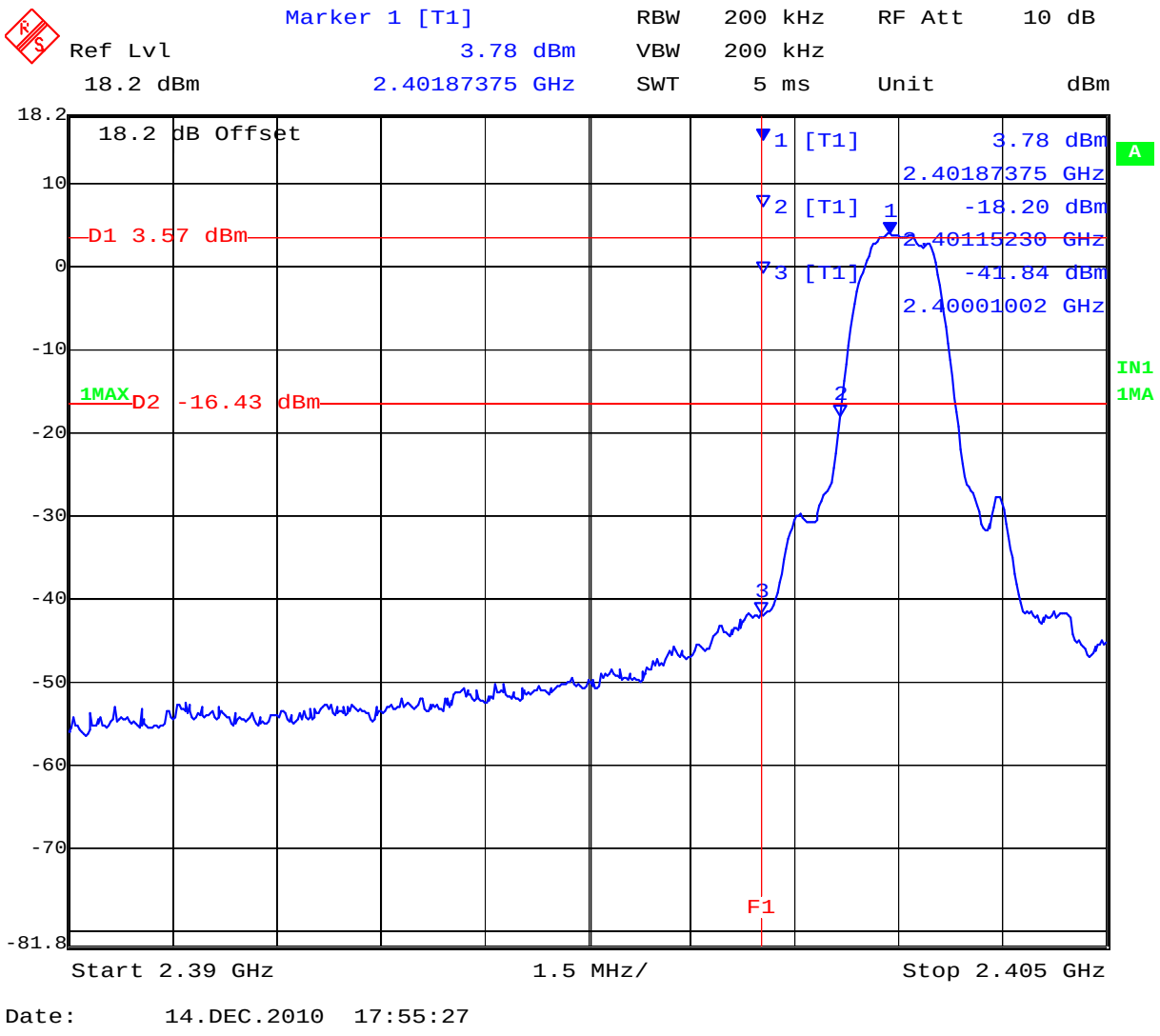
Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

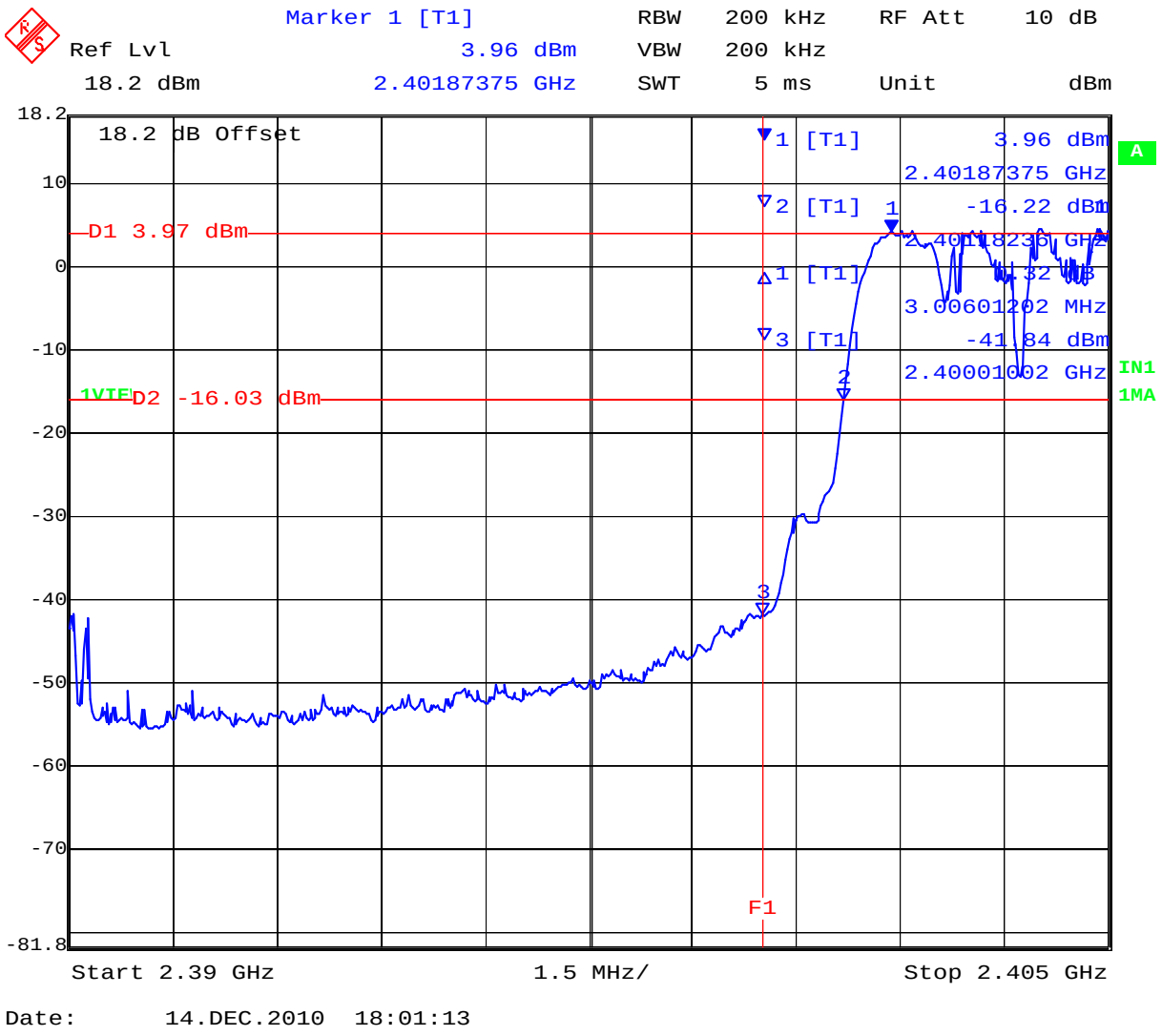
Test Results for Band-edge Compliance of RF Conducted Emissions

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

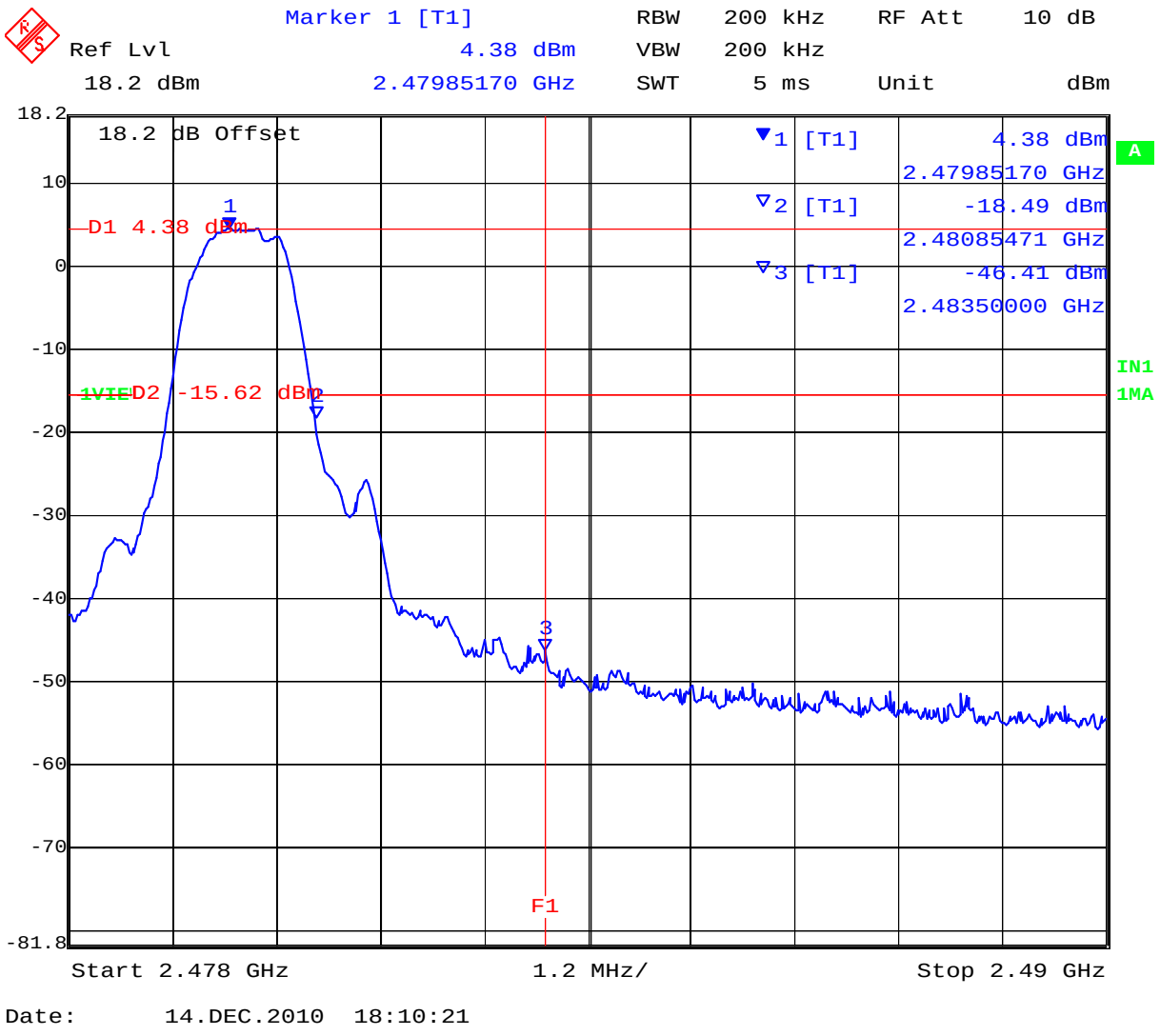
Lower Band-edge; Channel 0 - 2402 MHz; Hopping Off; 3 Mbs Data Rate



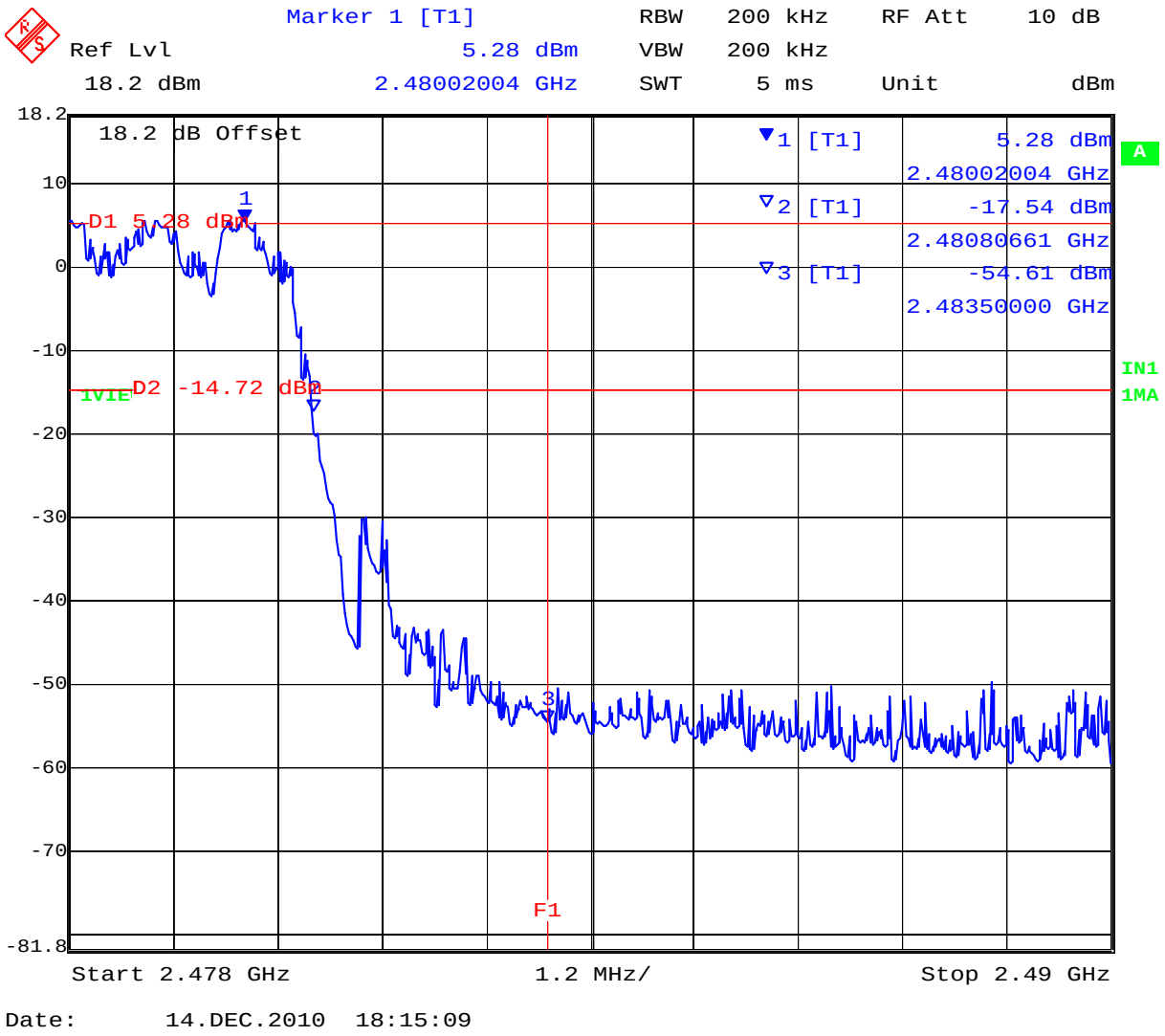
Lower Band-edge; Channel 0 - 2402 MHz; Hopping On; 3 Mbs Data Rate



Upper Band-edge; Channel 78 - 2480 MHz; Hopping Off; 3 Mbs Data Rate



Upper Band-edge; Channel 78 - 2480 MHz; Hopping On; 3 Mbs Data Rate



7.1.8 Spurious RF Conducted Emissions - Transmitter

Test Procedure

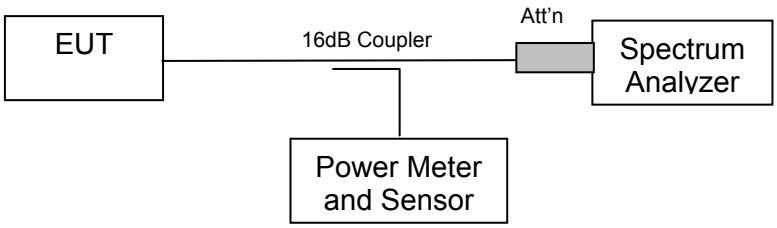
The following spectrum analyzer settings were used:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the
10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section. Submit these plots.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Spurious RF Conducted Emissions

FCC Part 15 Subpart C §15.247(d)

(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 a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. 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 in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Industry Canada RSS-210 §A8.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

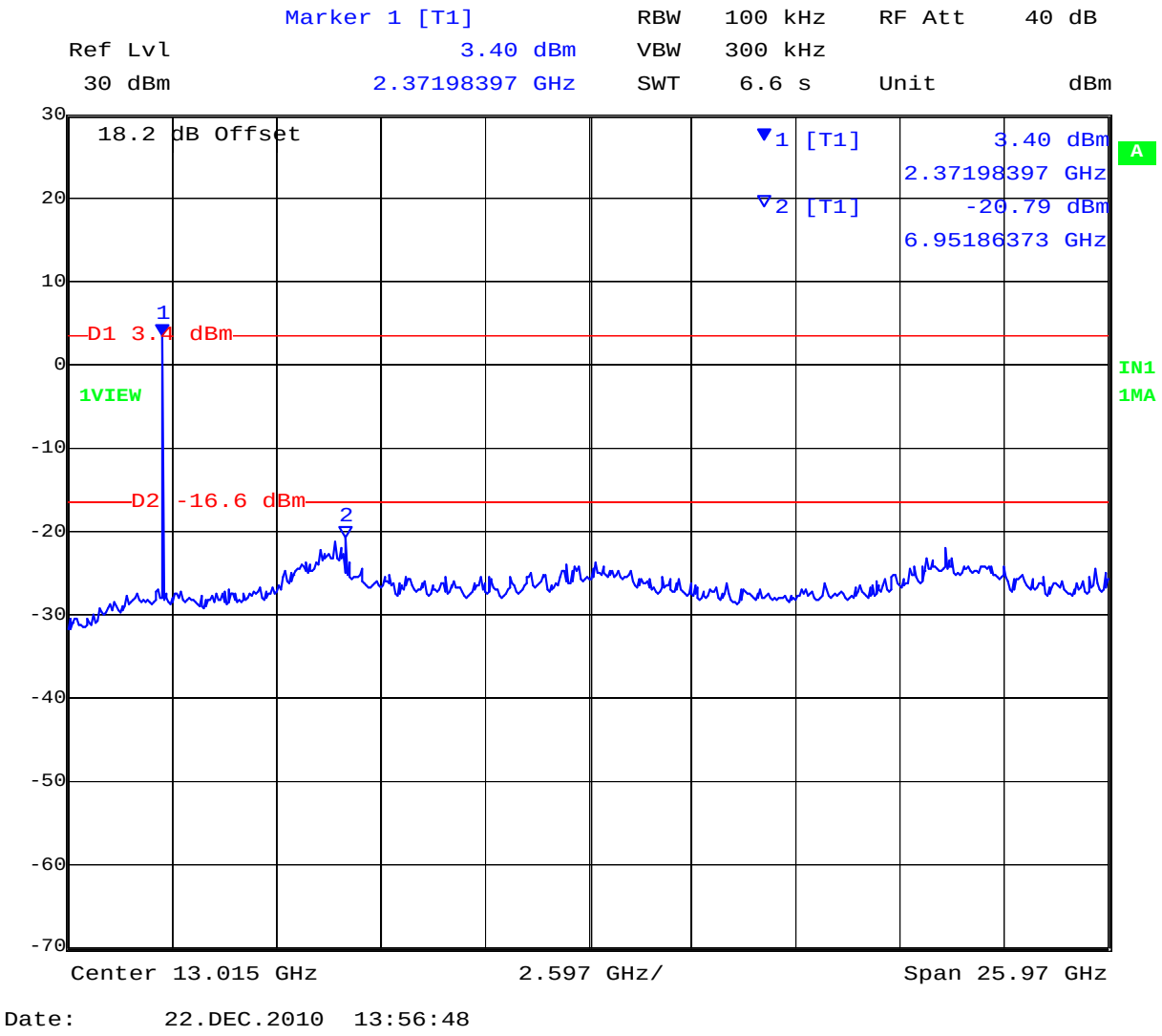
Test Results for Spurious RF Conducted Emissions

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 32 to 57 % Pressure: 999 to 1012 mbar

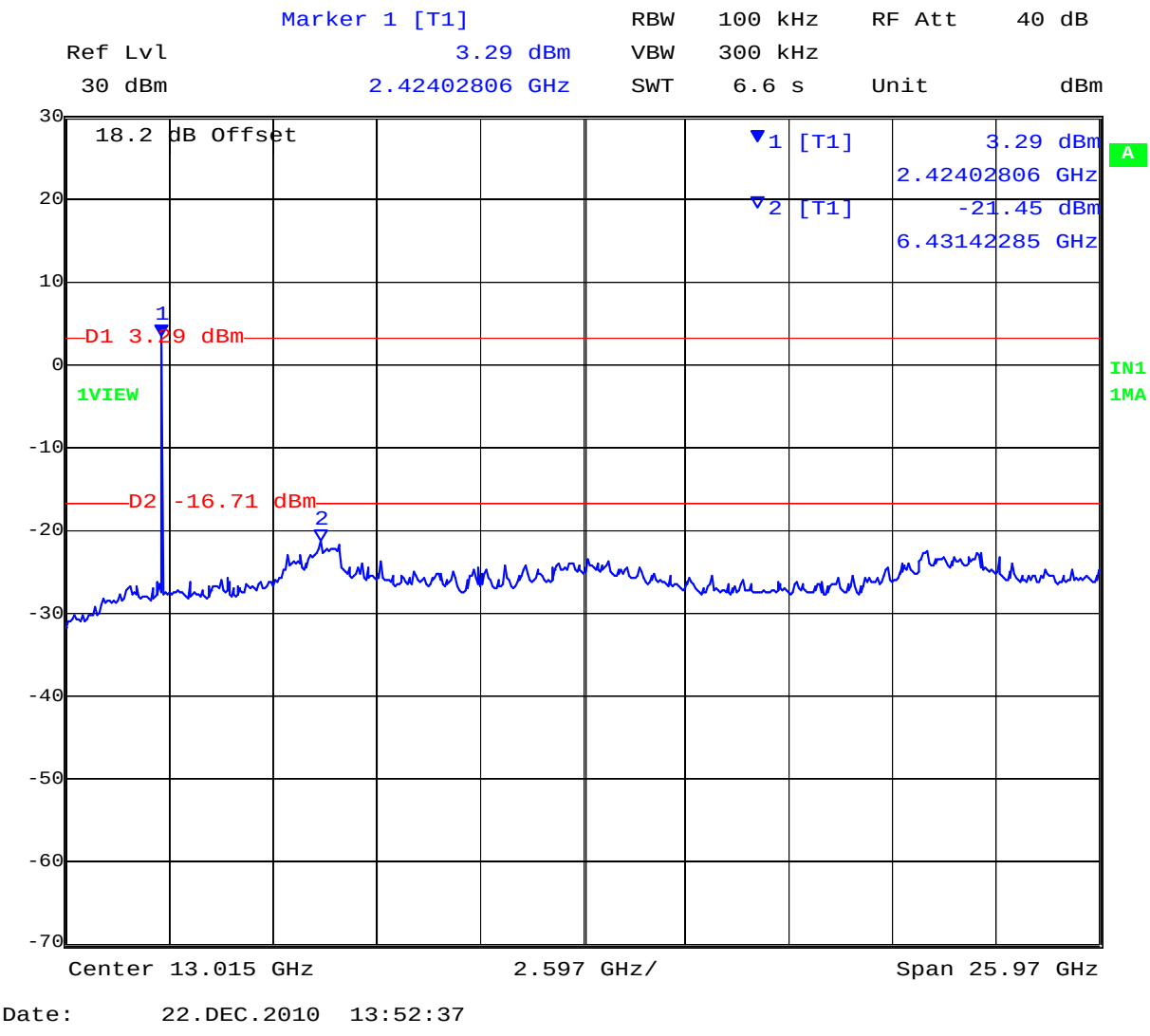
Conducted spurious emissions (30 MHz - 26 GHz) are provided below. The maximum emissions observed are indicated in the table below.

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Date Rate	Limit (dBm)	Margin (dB)
2402	30	26000	-20.79	CW	-16.60	-4.19
2441	30	26000	-21.45	CW	-16.71	-4.74
2480	30	26000	-21.15	CW	-15.84	-5.31
Hopping ON	30	26000	-21.50	1 Mbs	-15.43	-6.07

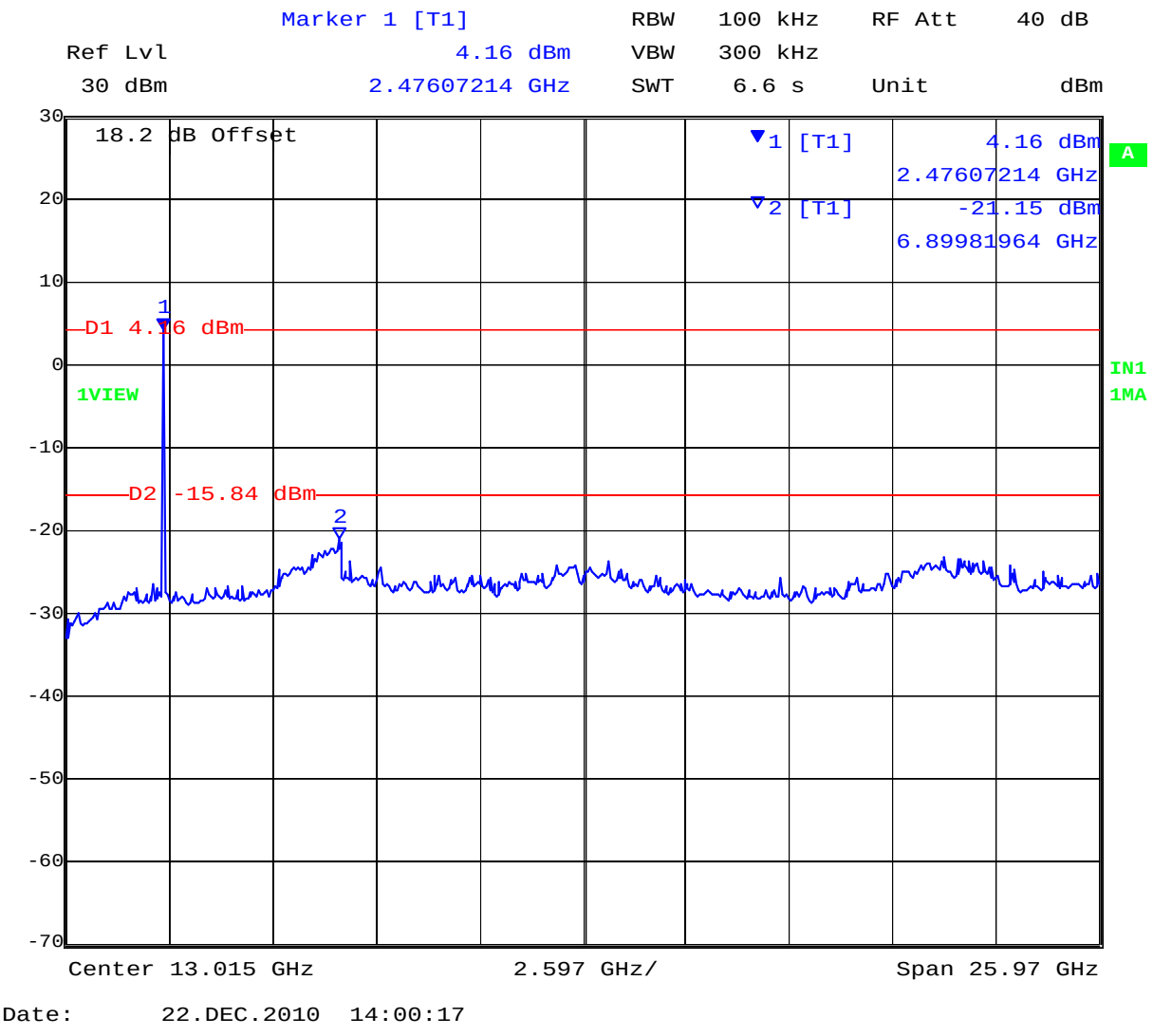
Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 0; CW Data Rate



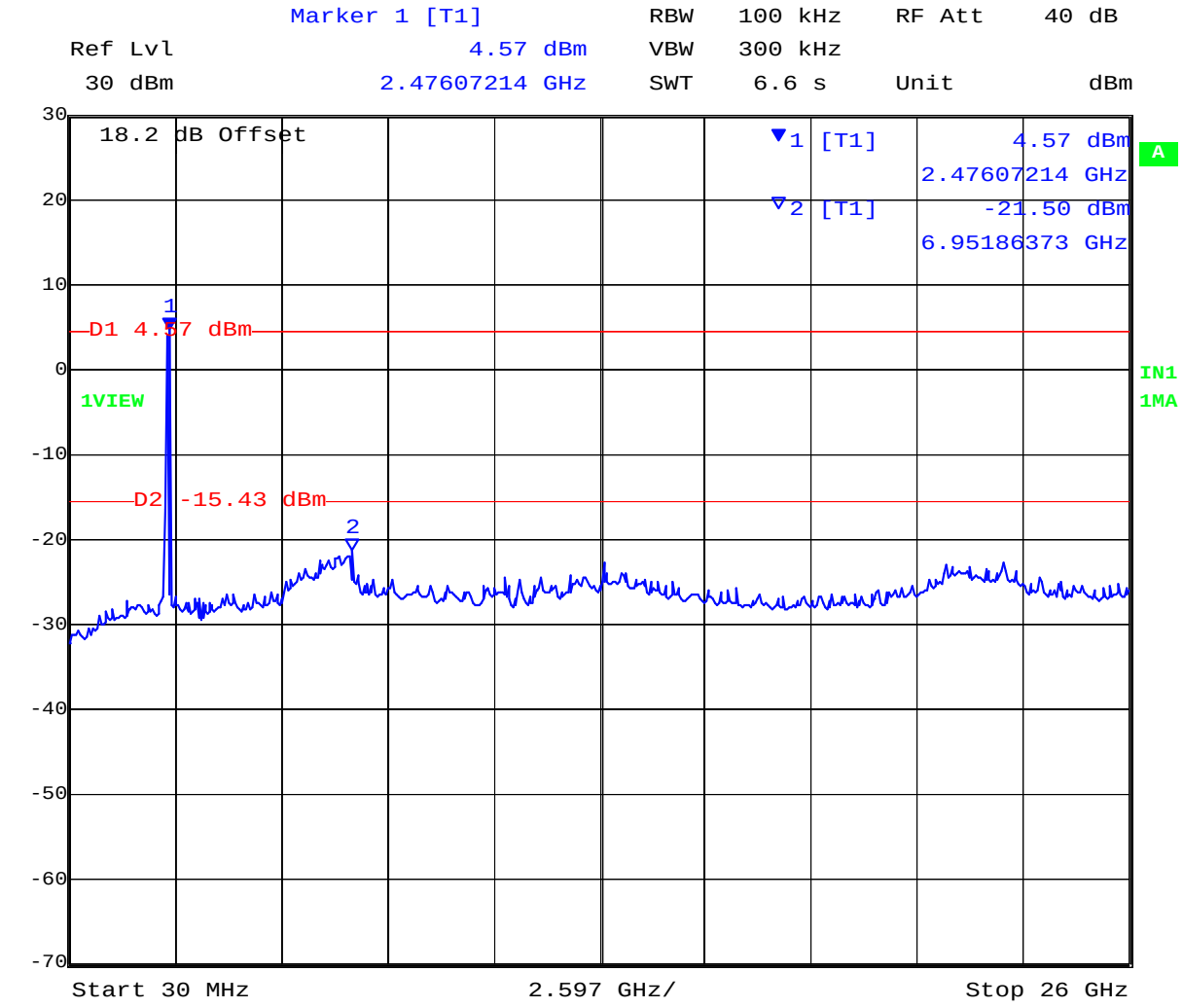
Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 39; CW Data Rate



Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 78; Data Rate CW



Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Hopping ON; Data Rate 1Mbs



7.1.9 Spurious RF Conducted Emissions - Receiver

Test Procedure

The receiver shall be operated in the normal receive mode near the mid-point of the band in which the receiver is designed to operate.

Radiated emission measurements are to be performed on a test site registered with Industry Canada. As an alternative, the conducted measurement method may be used when the antenna is detachable. In such a case, the receiver spurious signal may be measured at the antenna port.

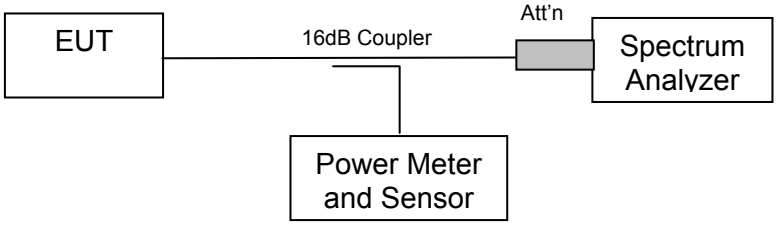
If the receiver is super-regenerative, stabilize it by coupling to it an unmodulated carrier on the receiver frequency (antenna conducted measurement) or by transmitting an unmodulated carrier on the receiver frequency from an antenna in the proximity of the receiver (radiated measurement). Taking care not to overload the receiver, vary the amplitude and frequency of the stabilizing signal to obtain the highest level of the spurious emissions from the receiver.

For either method, the search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least 3 times the highest tuneable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.

For emissions below 1000 MHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. As an alternative to CISPR quasi-peak measurement, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization as required, with an equal or greater measurement bandwidth relative to the applicable CISPR quasi-peak bandwidth.

Above 1000 MHz, measurements shall be performed using an average detector with a minimum resolution bandwidth of 1 MHz.

Test Setup



Specification for Conducted Spurious Emissions - Receiver

RSS-GEN 6.2

If the receiver has a detachable antenna of known impedance, antenna conducted spurious emissions measurement is permitted as an alternative to radiated measurement. However, the radiated method of Section 6.1 is recommended:

The antenna conducted test shall be performed with the antenna disconnected and the receiver antenna terminals connected to a measuring instrument having equal impedance to that specified for the antenna

The receiver spurious emissions measured at the antenna terminals by the antenna conducted method shall then comply with the following limits:

Receiver spurious emissions at any discrete frequency shall not exceed 2 nanowatts (-57 dBm) in the band 30-1000 MHz, and 5 nanowatts (-53 dBm) above 1000 MHz.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

Measurement Results for Conducted Spurious Emissions Stand-By

Radiated receiver emissions were performed, therefore no conducted receiver emissions are presented in this report.

7.1.10 Pseudorandom Frequency Hopping Sequence

Description

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirement specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

The hopping sequence is selected according to the Bluetooth standard. There are a total of 79 channels available in the 2.4 GHz band. The standard defines an algorithmic basis for determining the pseudorandom sequence to use. There is also a provision for avoiding interference in the band by hopping around channels being interfered with (Adaptive Frequency Hopping). There will always be at least 20 channels in the list of hopping channels.

7.1.11 Equal Hopping Frequency Use

Description

Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

Bluetooth uses a packet based air interface with a fixed timing. Each packet goes out on a different channel in the sequence, so all frequencies in the hopping sequence get used equally.

7.1.12 System Receiver Input Bandwidth

Description

Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

Chipset by TI (WL1273 WLAN and Bluetooth) is used in the design and complies with Bluetooth specifications. There are no external channel filters present, but filters are present in the chipset design in order to achieve the receiver sensitivity.

7.1.13 System Receiver Hopping Capability

Description

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

A slave device follows the master device's hopping sequence by scanning quickly through channels to find the master's transmission (this is called discovery). It then uses information in that packet and the same algorithmic process described in the standard to determine what the hopping sequence is that the master is using. The slave also synchronizes to the master's transmit packet timing so it knows when to hop.

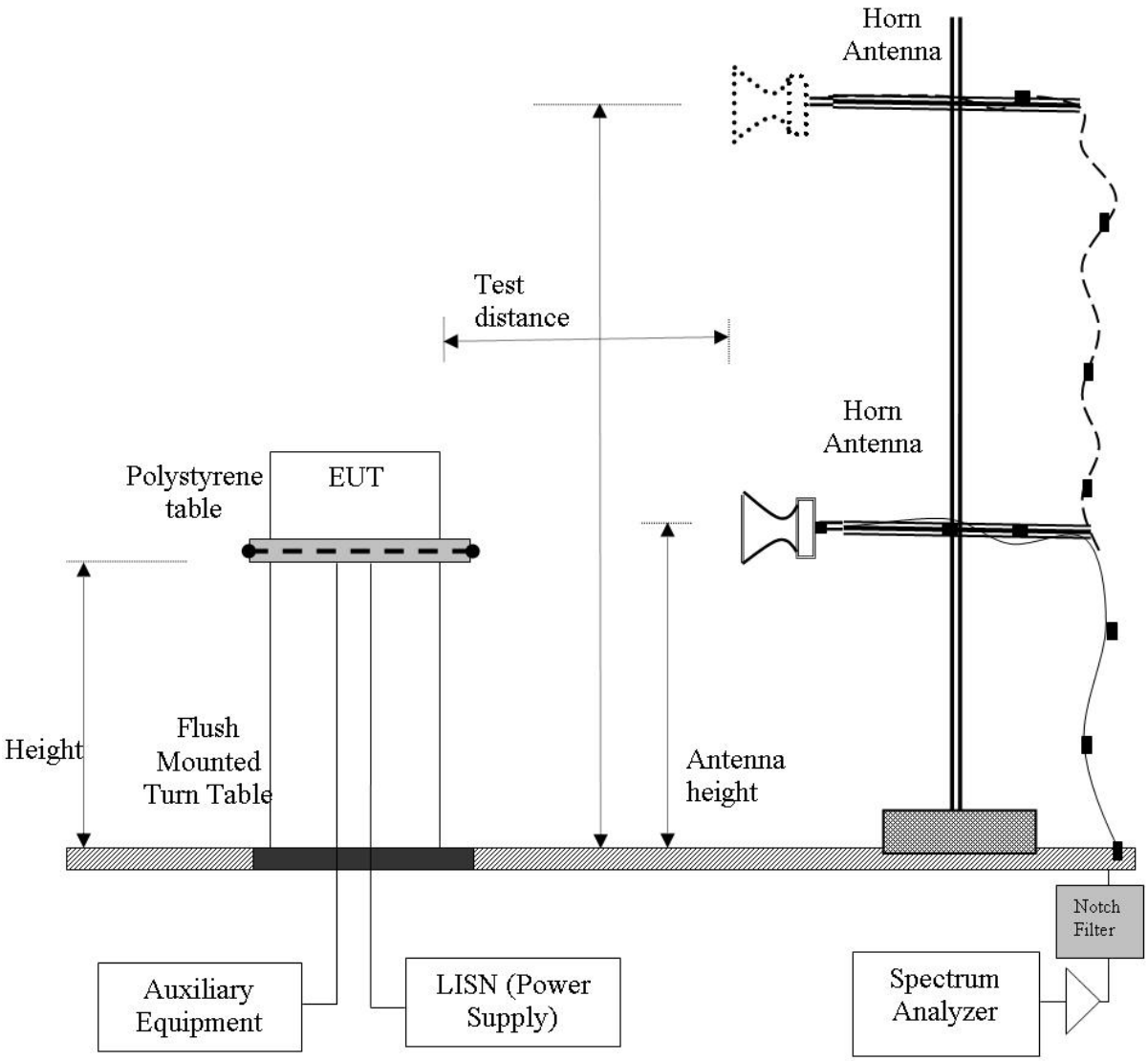
7.2 Radiated Emissions - Radio

Test Procedure

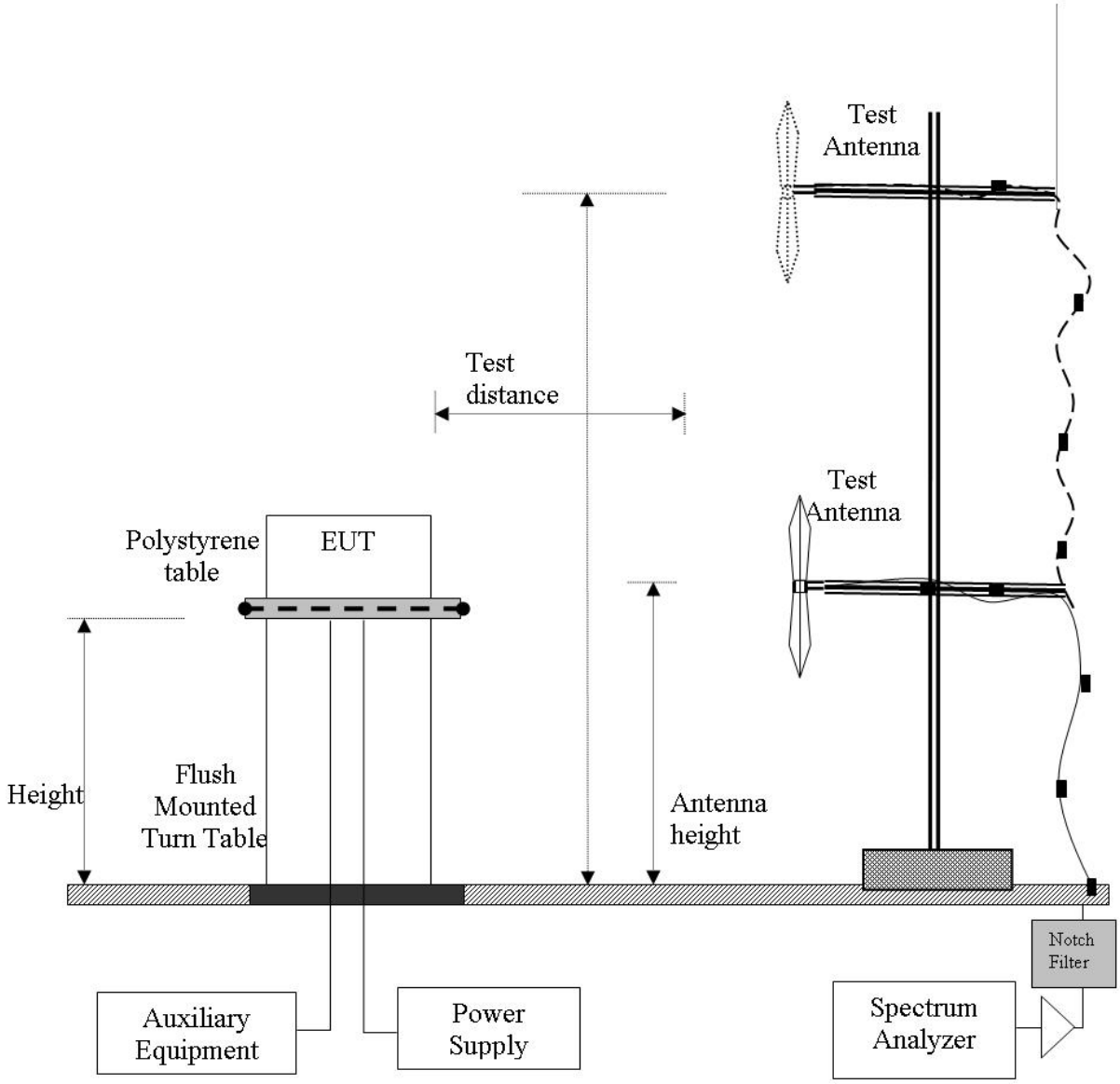
Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed.

Radiated Emission Measurement Setup – Above 1 GHz



Radiated Emission Measurement Setup – Below 1 GHz



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

FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
FO = Distance Falloff Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss
AG = Amplifier Gain
NFL = Notch Filter Loss or Waveguide Loss

Field Strength Calculation 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

Specification

Radiated Spurious Emissions

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.

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.

Table 1: FCC §15.209 Spurious Emissions Limits

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

Specification

Radiated Spurious Emissions

RSS-Gen §4.10
The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

RSS-Gen §6
Radiated spurious emission measurements shall be performed with the receiver antenna connected to the receiver antenna terminals. Spurious emissions from receivers shall not exceed the radiated limits shown in the table below:

Table 1: RSS-Gen §6 Radiated Limits of Receiver Spurious Emissions

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 Spectrum Measurement

Measurement Uncertainty	+5.6/ -4.5 dB

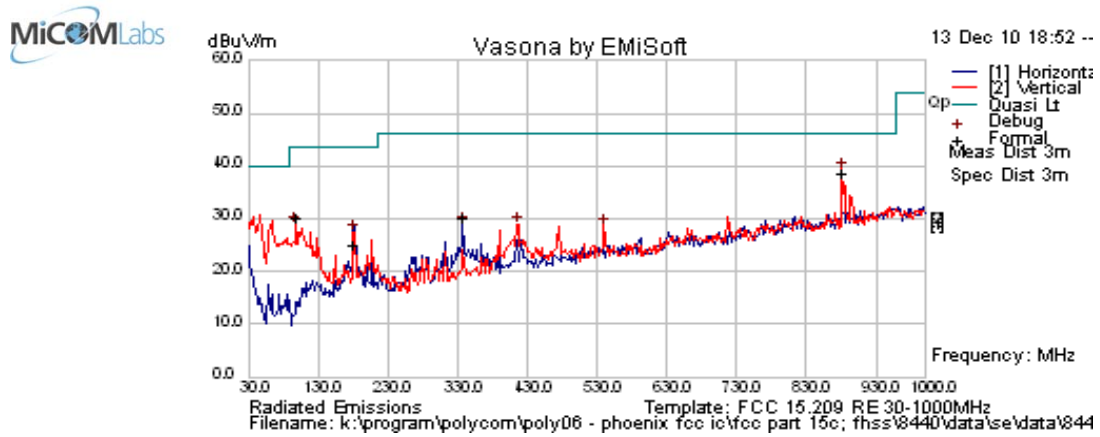
Traceability

Method	Test Equipment Used
Work instruction WI-03	0287, 0193, 0342, 0158, 0303, 0304, 0134, 0310, 0312

7.2.1 Transmitter Radiated Spurious Emissions

Transmitter spurious emissions were investigated below 1 GHz. All emissions were identified, and no radio emissions were present. Highest spectral density mode was utilized during test.

Test Freq.	CH 39	**Engineer**	EVF
Variant	Bluetooth - CW Mode	**Temp (ºC)**	22
Freq. Range	30 - 1000 MHz	**Rel. Hum. (%)**	43
Power Setting	Maximum	**Press. (mBars)**	1003
Antenna	Integral	**Duty Cycle (%)**	10
Test Notes 1	Fundamental attenuated by band-stop filter. Handset (Model: 8440) with battery (SN: AC101032008E) , also connected to charger (Model: SA106B-05)		
Test Notes 2	Mode: BT Channel 39 Transmit; rate: CW; WLAN=0, BT=1, BC=0, DK=0		

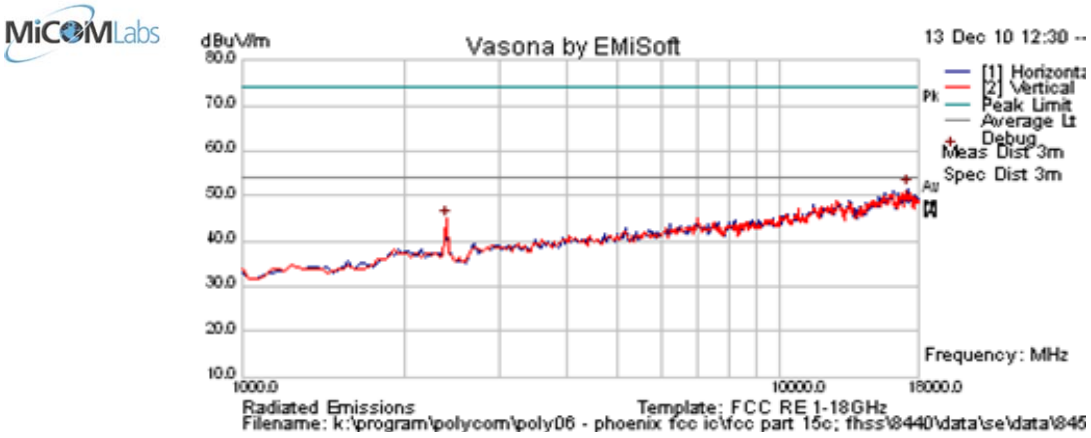


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
98.092	46.3	4.1	-21.6	28.9	Peak [Scan]	V	98	0	43.5	-14.7	Pass	FM Radio
179.994	42.4	4.7	-19.7	27.4	Peak [Scan]	H	98	0	43.5	-16.1	Pass	DIG
337.977	39.7	5.4	-16.2	28.9	Peak [Scan]	H	98	0	46	-17.1	Pass	DIG
539.993	34.2	6.2	-11.9	28.5	Peak [Scan]	V	98	0	46	-17.5	Pass	DIG
415.994	37.1	5.7	-14.0	28.8	Peak [Scan]	V	98	0	46	-17.2	Pass	DIG
881.032	39.4	7.3	-7.7	38.9	Peak [Scan]	V	98	0	46	-7.1	Pass	DIG

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. RB = Restricted Band.

Test Freq.	CH 0	**Engineer**	EVF
Variant	Bluetooth - CW Mode	**Temp (°C)**	21
Freq. Range	1000 - 18000 MHz	**Rel. Hum.(%)**	46
Power Setting	Maximum	**Press. (mBars)**	1005
Antenna	Integral	**Duty Cycle (%)**	10
Test Notes 1	Fundamental attenuated by band-stop filter. Handset (Model: 8440) with battery (SN: AC101032008E) , also connected to charger (Model: SA106B-05)		
Test Notes 2	Mode: BT Channel 0 Transmit; rate: CW; WLAN=0, BT=1, BC=0, DK=0		

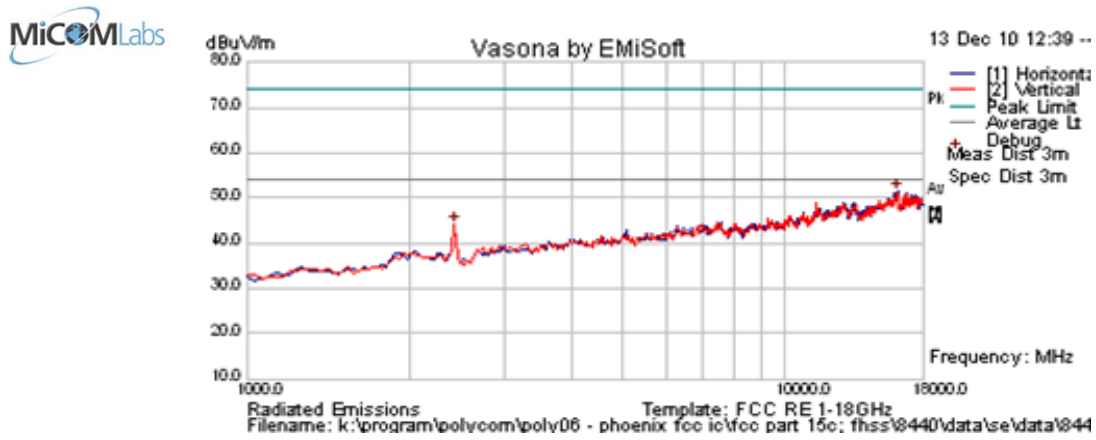


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
17182.365	42.1	8.6	0.8	51.5	Peak [Scan]	H	100	0	54.0	-2.5	Pass	noise floor
2397.181	53.1	3.0	-11.1	44.9	Peak [Scan]	V	--	--	--	--	n/a	FUND

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. RB = Restricted Band.

Test Freq.	CH 39	**Engineer**	EVF
Variant	Bluetooth - CW Mode	**Temp (ºC)**	21
Freq. Range	1000 - 18000 MHz	**Rel. Hum.(%)**	46
Power Setting	Maximum	**Press. (mBars)**	1005
Antenna	Integral	**Duty Cycle (%)**	10
Test Notes 1	Fundamental attenuated by band-stop filter. Handset (Model: 8440) with battery (SN: AC101032008E) , also connected to charger (Model: SA106B-05)		
Test Notes 2	Mode: BT Channel 39 Transmit; rate: CW; WLAN=0, BT=1, BC=0, DK=0		

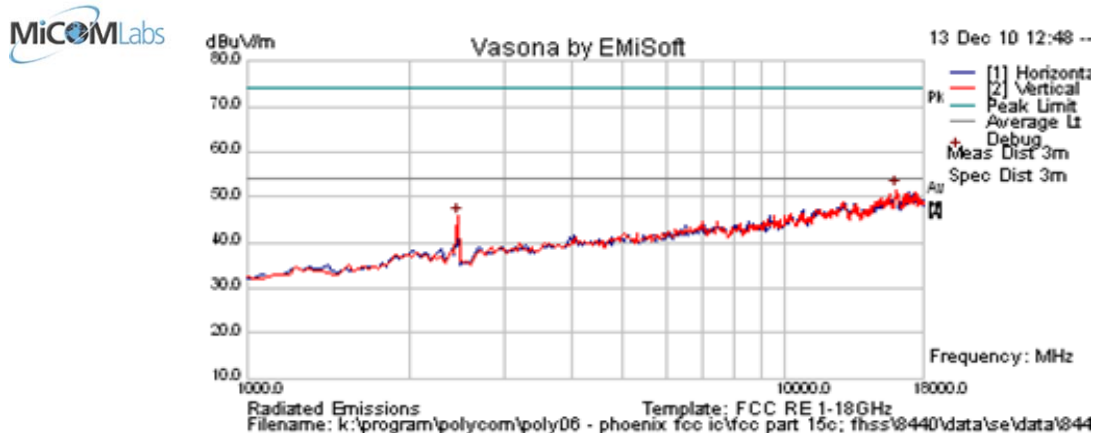


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
16160.321	41.5	9.0	1.0	51.4	Peak [Scan]	H	200	0	54.0	-2.6	Pass	noise floor
2430.882	52.2	3.0	-11.1	44.1	Peak [Scan]	H	--	--	--	--	n/a	FUND

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. RB = Restricted Band.

Test Freq.	CH 78	**Engineer**	EVF
Variant	Bluetooth - CW Mode	**Temp (°C)**	21
Freq. Range	1000 - 18000 MHz	**Rel. Hum.(%)**	46
Power Setting	Maximum	**Press. (mBars)**	1005
Antenna	Integral	**Duty Cycle (%)**	10
Test Notes 1	Fundamental attenuated by band-stop filter. Handset (Model: 8440) with battery (SN: AC101032008E) , also connected to charger (Model: SA106B-05)		
Test Notes 2	Mode: BT Channel 78 Transmit; rate: CW; WLAN=0, BT=1, BC=0, DK=0		



Formally measured emission peaks

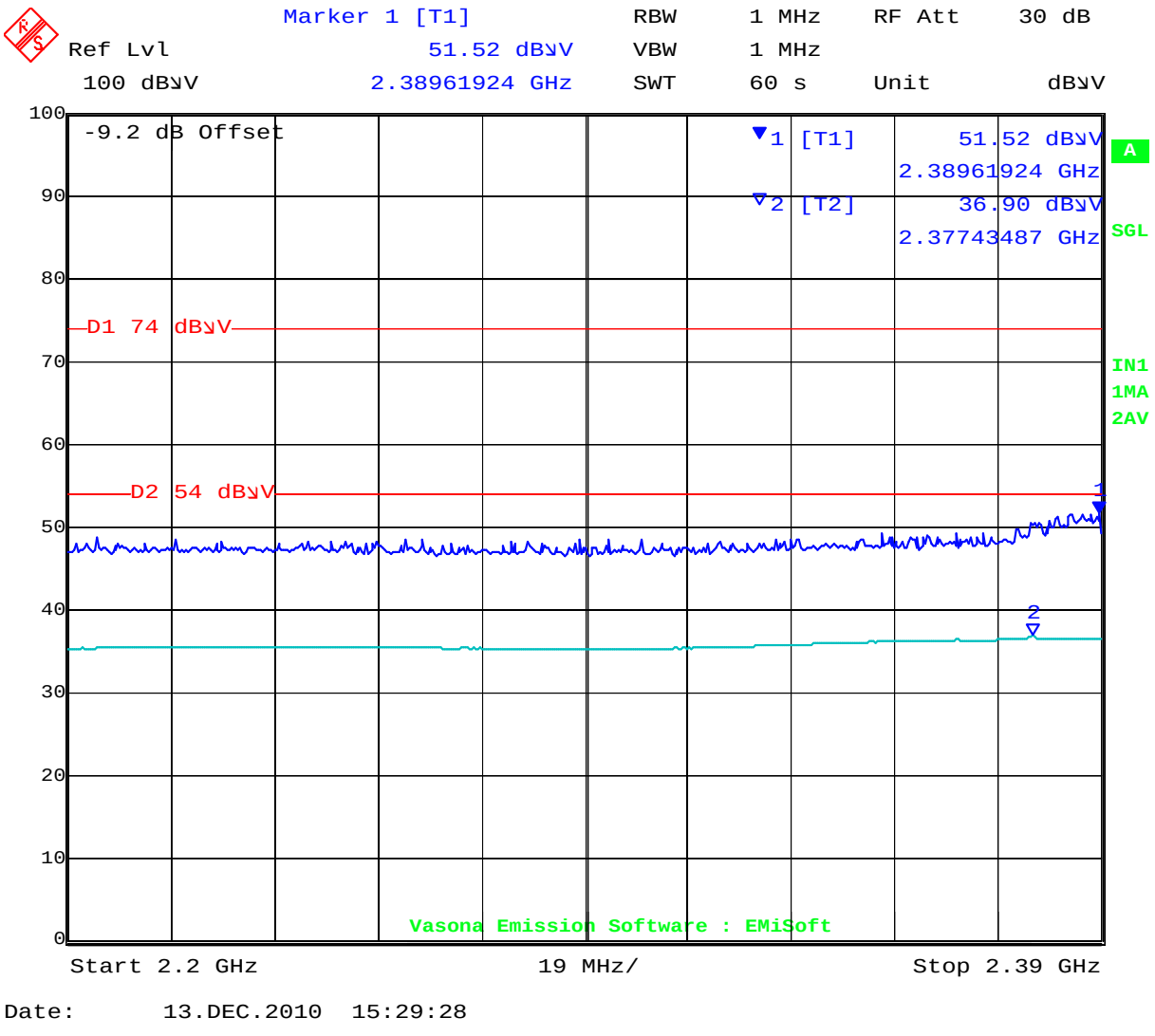
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
16024.048	42.1	9.0	0.5	51.5	Peak [Scan]	V	150	0	54.0	-2.5	Pass	noise floor
2465.542	53.6	3.0	-11.1	45.5	Peak [Scan]	V	--	--	--	--	n/a	FUND

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	NRB = Non-Restricted Band. RB = Restricted Band.

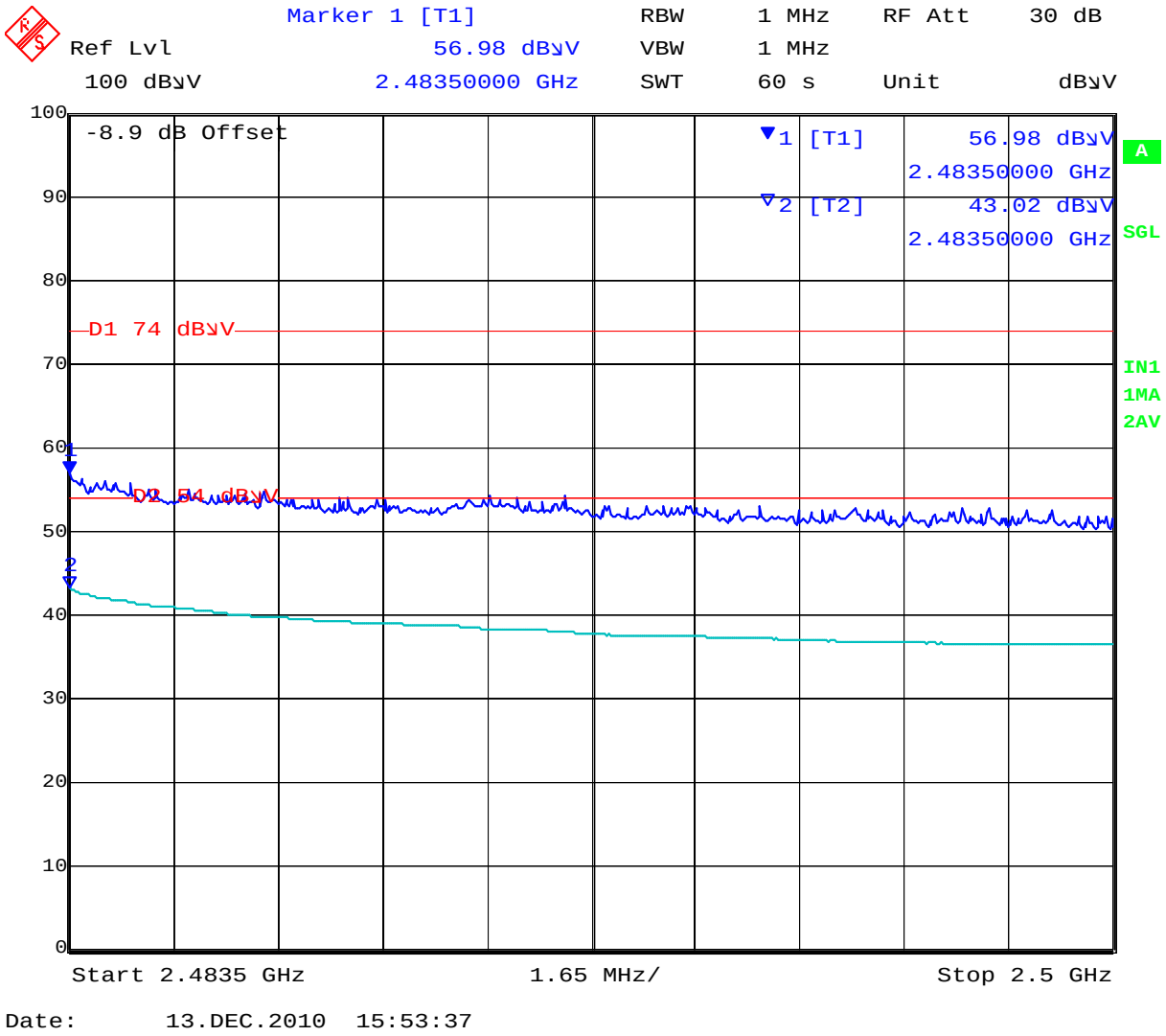
7.2.2 Band-edge Measurements

Mode with highest BW was utilized during test.

Band-edge; Channel 0; 3 Mbs Data Rate; 2200-2390 MHz; Vert. Hg=98 Ang=97

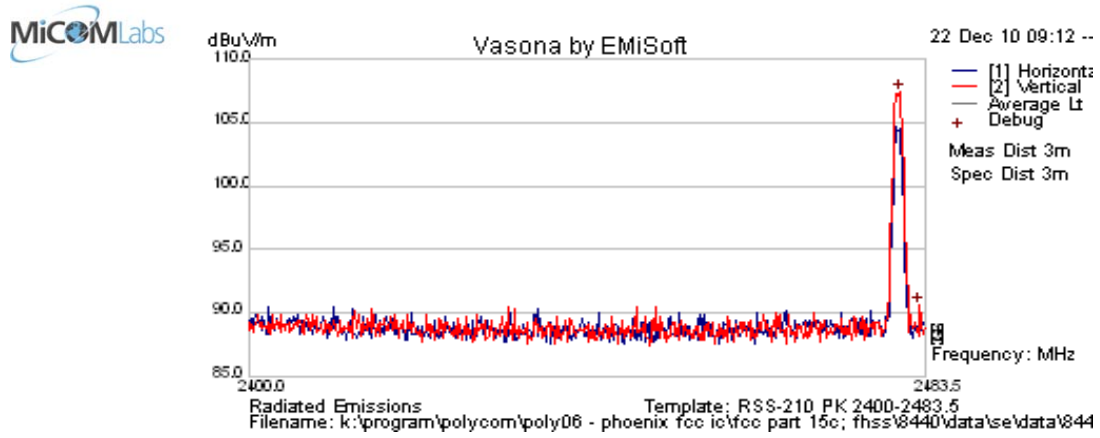


Band-edge; Channel 78; 3 Mbs Data Rate; 2483.5-2500 MHz; Vert. Hg=121 Ang=105



7.2.3 Peak Emissions

Test Freq.	2480 MHz	**Engineer**	EVF
Variant	Bluetooth; CW	**Temp (°C)**	20.5
Freq. Range	2400 - 2483.5 MHz	**Rel. Hum.(%)**	42
Power Setting	default	**Press. (mBars)**	993
Antenna	integral	**Duty Cycle (%)**	100
Test Notes 1	Handset (Model: 8440) with battery (SN: AC1010320232) , also connected to charger (Model: SA106B-05)		
Test Notes 2	CW mode was chosen, since it provides highest spectral density and therefore highest peak emissions; Mode: BT Channel 78 Transmit; rate: CW; WLAN=0, BT=1, BC=0, DK=0		



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2480.321	62.1	13.0	32.3	107.4	Peak [Scan]	V						PK

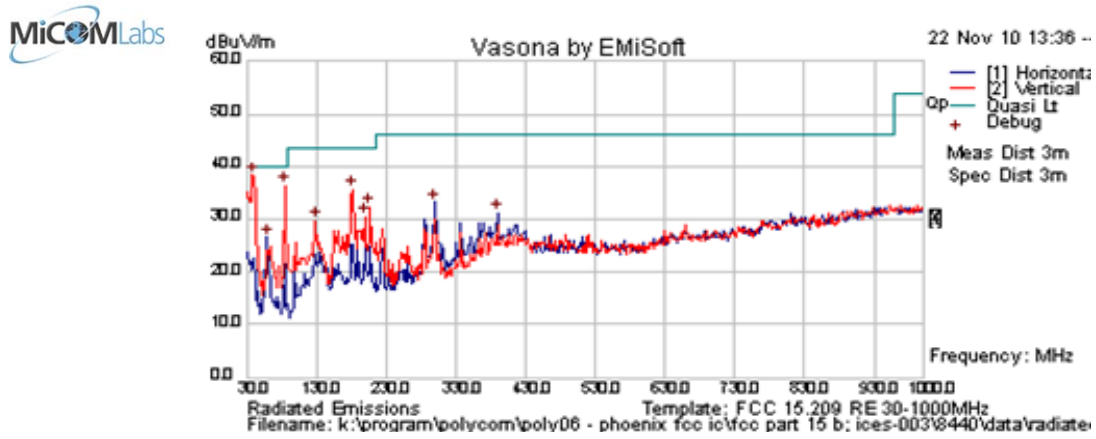
Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	PK = Peak Emission

Peak emissions were performed only on the channel with the highest power, using CW mode. This presents the highest measured peak value transmitted from the EUT.

7.2.4 Receiver Radiated Emissions

Stand alone Charger - Measurement Results for Radiated Spurious Emissions. Both WLAN and Bluetooth receivers were active during testing from 30 MHz -1000 MHz.

Test Freq.	N/A	**Engineer**	EVF
Variant	Digital Emissions	**Temp (°C)**	21
Freq. Range	30 MHz - 1000 MHz	**Rel. Hum. (%)**	34
Power Setting	Charger: 120VAC/ 60Hz	**Press. (mBars)**	1009
Antenna	Integral		
Test Notes 1	Handset (Model: 8440) with discharged battery (SN: AC101032008E) , headset connected, also connected to charger (Model: SA106B-05)		
Test Notes 2	Preliminary testing performed. EUT tested in vertical position/ Mode: BT Channel 39 Receive; WLAN Channel 06 Receive; WLAN=1, BT=1, BC=0, DK=1		

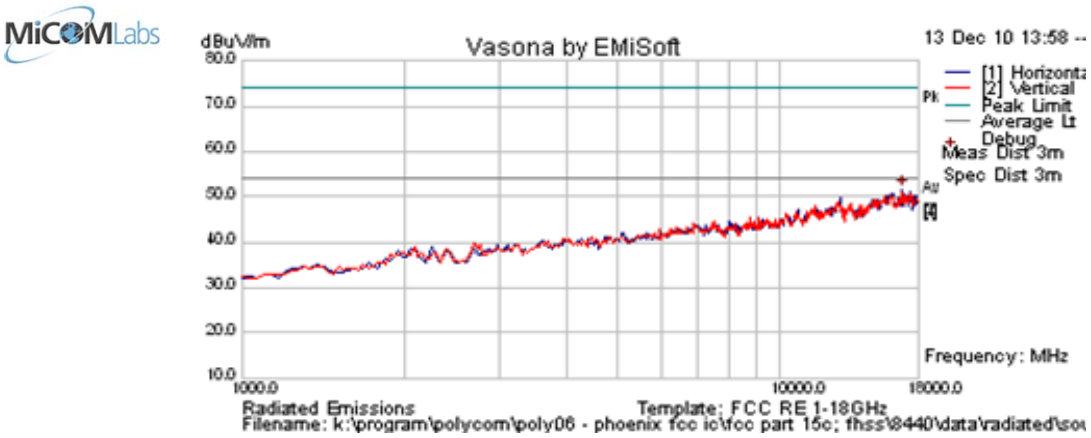


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
40.423	48.0	3.6	-17.1	34.5	Quasi Max	V	137	77	40	-5.5	Pass	DIG
85.932	47.4	4.0	-23.7	27.8	Quasi Max	V	98	246	40	-12.3	Pass	DIG
182.000	49.5	4.7	-19.6	34.5	Quasi Max	V	104	167	43.5	-9.0	Pass	DIG
207.999	46.1	4.8	-19.6	31.3	Quasi Max	V	102	171	43.5	-12.2	Pass	DIG
299.999	45.0	5.2	-16.9	33.4	Quasi Max	H	120	51	46	-12.6	Pass	DIG
200.461	45.0	4.8	-17.9	31.9	Quasi Max	V	98	0	43.5	-11.6	Pass	DIG

Legend:	DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency
	NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band

Test Freq.	CH 39	**Engineer**	EVF
Variant	Receive in Test Utility	**Temp (°C)**	21
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	46
Power Setting	Not Applicable in Receive Mode	**Press. (mBars)**	1004
Antenna	Integral Antenna's connected during testing		
Test Notes 1	Handset (Model: 8440) with battery (SN: AC101032008E) , also connected to charger (Model: SA106B-05)		
Test Notes 2	Mode: BT Channel 39 Receive; WLAN=0, BT=1, BC=0, DK=0		



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
No Receiver Emissions within 6dB of limit.												

Legend:	TRANS = Transient Emission; RB = Restricted Band; NRB = Non-Restricted Band;
	BE = Emission in Restricted Band Nearest Transmission Band Edge; FUND = Fundamental Freq.

7.3 Conducted Disturbance at Mains Terminal

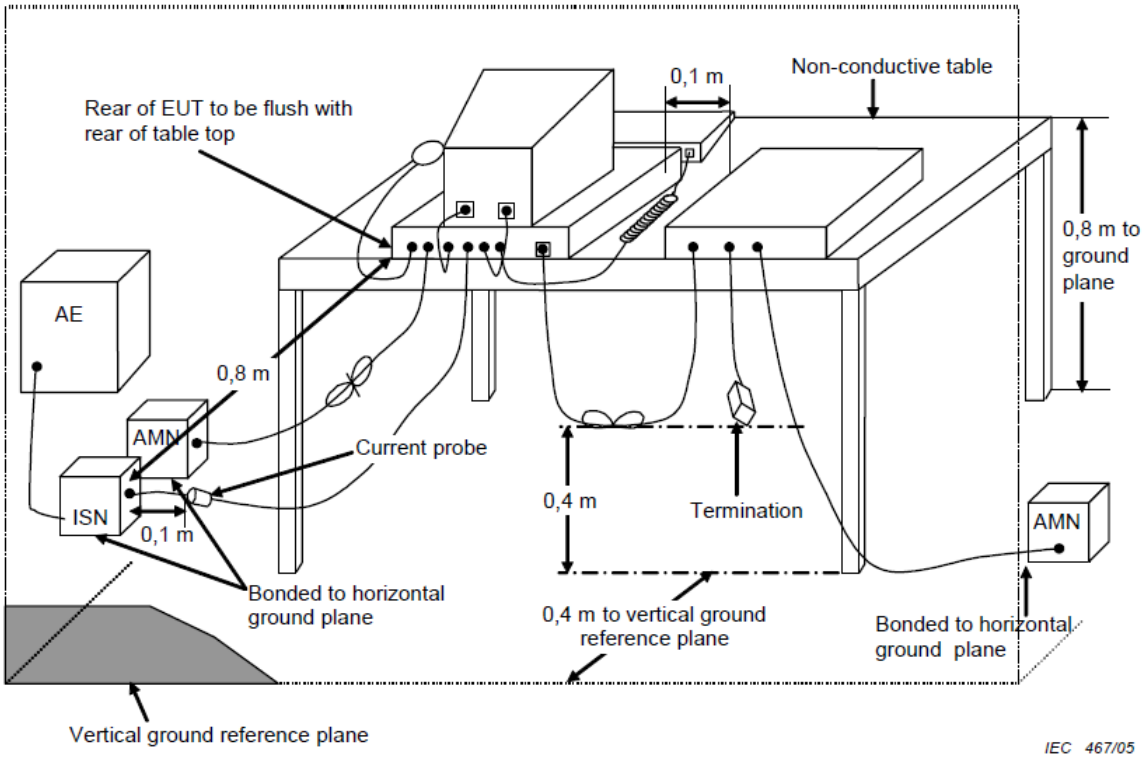
Test Procedure

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.

If the average limit is met when using a quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

If the reading of the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the higher reading shall be recorded with the exception of any brief isolated high reading which shall be ignored.

Test Measurement Setup



Measurement Setup for Conducted Disturbance at Mains Terminals

Specification

§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.

RSS-Gen §7.2.4
Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table below. The more stringent limit applies at the frequency range boundaries.

The conducted emissions shall be measured with a 50 ohm/50 microhenry line impedance stabilization network (LISN).

§15.207 (a) and **RSS-Gen §7.2.4** 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

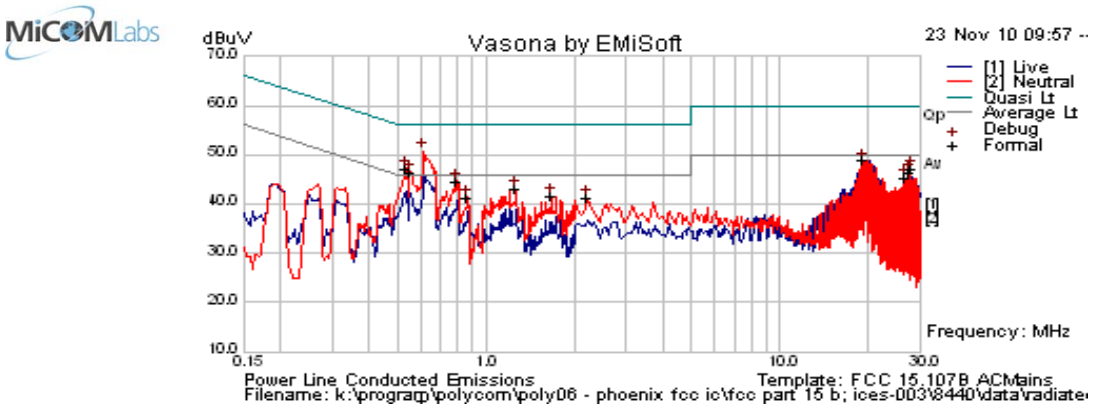
Measurement uncertainty	±2.64 dB

Traceability

Method	Test Equipment Used
Work instruction WI-EMC-01	0158, 0184, 0193, 0190, 0293, 0307

Stand Alone Charger - Conducted Disturbance at Mains Terminal (150 kHz – 30 MHz)

Test Freq.	N/A	**Engineer**	EVF
Variant	AC Line Emissions	**Temp (°C)**	19.5
Freq. Range	0.150 MHz - 30 MHz	**Rel. Hum. (%)**	37
Power Setting	Charger: 120VAC/ 60Hz	**Press. (mBars)**	1002
Antenna	Integral		
Test Notes 1	Handset (Model: 8440) with discharged battery (SN: AC101032008E) , headset connected, also connected to charger (Model: SA106B-05)		
Test Notes 2	Mode: BT Channel 39 Receive; WLAN Channel 06 Receive; WLAN=1, BT=1, BC=0, DK=1		



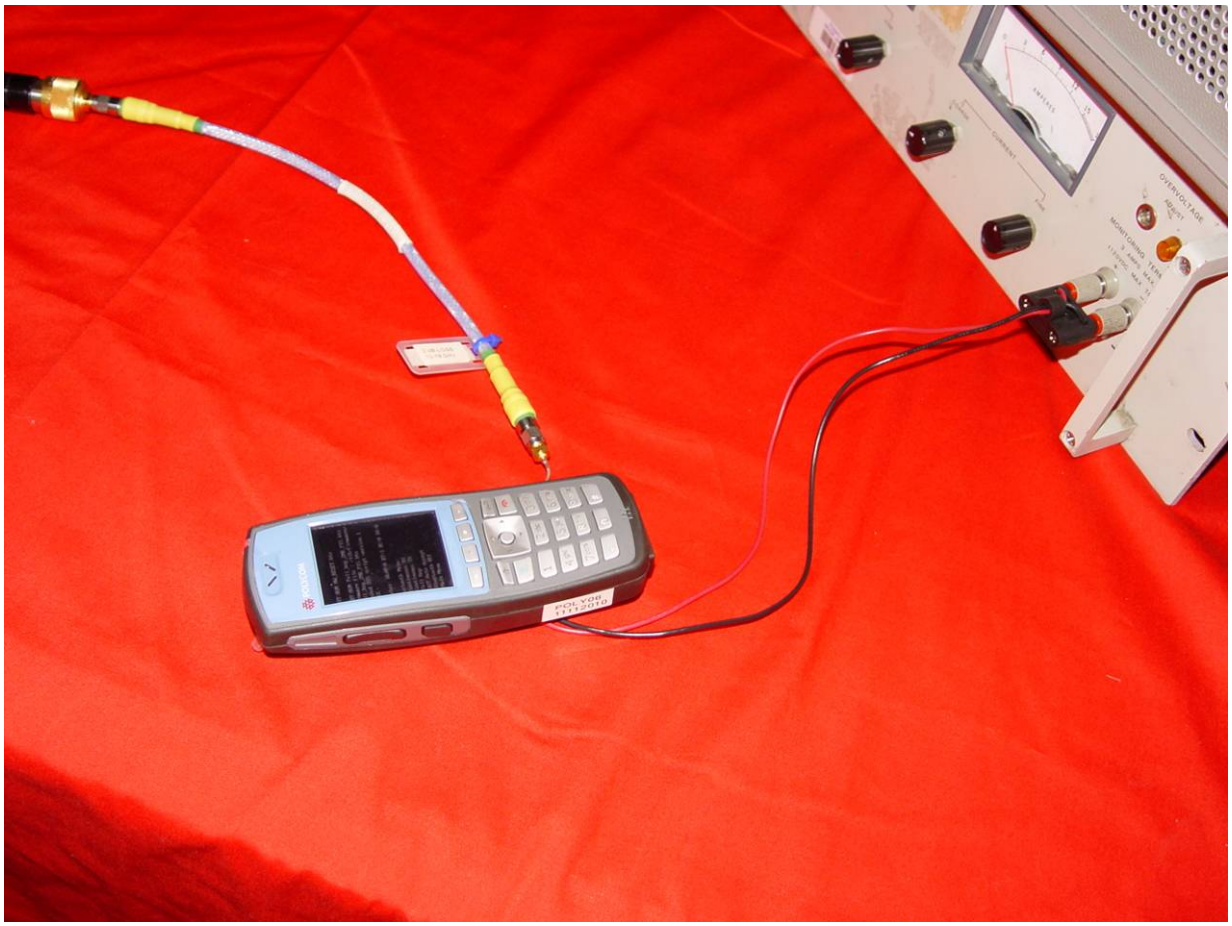
Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comments
0.534	21.4	9.9	0.1	31.4	Average	Neutral	46.0	-14.6	Pass	
0.534	36.0	9.9	0.1	46.0	Quasi Peak	Neutral	56	-10.0	Pass	
0.553	22.5	9.9	0.1	32.5	Average	Neutral	46	-13.5	Pass	
0.553	35.9	9.9	0.1	45.9	Quasi Peak	Neutral	56	-10.1	Pass	
0.614	25.7	10.0	0.1	35.7	Average	Neutral	46.0	-10.3	Pass	
0.614	39.7	10.0	0.1	49.8	Quasi Peak	Neutral	56	-6.3	Pass	
0.801	22.5	10.0	0.1	32.5	Average	Neutral	46	-13.5	Pass	
0.801	33.3	10.0	0.1	43.3	Quasi Peak	Neutral	56	-12.7	Pass	
0.869	16.9	9.9	0.1	26.9	Average	Neutral	46.0	-19.1	Pass	
0.869	29.8	9.9	0.1	39.8	Quasi Peak	Neutral	56	-16.2	Pass	
1.269	20.4	10.0	0.1	30.4	Average	Neutral	46.0	-15.6	Pass	
1.269	30.2	10.0	0.1	40.3	Quasi Peak	Neutral	56	-15.7	Pass	

1.673	22.0	10.0	0.1	32.1	Average	Neutral	46.0	-13.9	Pass	
1.673	27.8	10.0	0.1	37.9	Quasi Peak	Neutral	56	-18.1	Pass	
2.206	22.0	10.1	0.1	32.2	Average	Neutral	46.0	-13.9	Pass	
2.206	28.4	10.1	0.1	38.5	Quasi Peak	Neutral	56	-17.5	Pass	
19.183	16.1	10.5	0.7	27.3	Average	Neutral	50	-22.7	Pass	
19.183	31.6	10.5	0.7	42.8	Quasi Peak	Neutral	60	-17.2	Pass	
26.837	12.2	10.7	0.9	23.8	Average	Neutral	50.0	-26.2	Pass	
26.837	27.1	10.7	0.9	38.7	Quasi Peak	Neutral	60	-21.3	Pass	
27.779	12.1	10.7	0.9	23.7	Average	Neutral	50.0	-26.3	Pass	
27.779	27.1	10.7	0.9	38.8	Quasi Peak	Neutral	60	-21.2	Pass	
28.069	11.8	10.7	0.9	23.5	Average	Neutral	50	-26.5	Pass	
28.069	27.6	10.7	0.9	39.2	Quasi Peak	Neutral	60	-20.8	Pass	

8 Photographs

8.1 Conducted RF Emissions - EUT



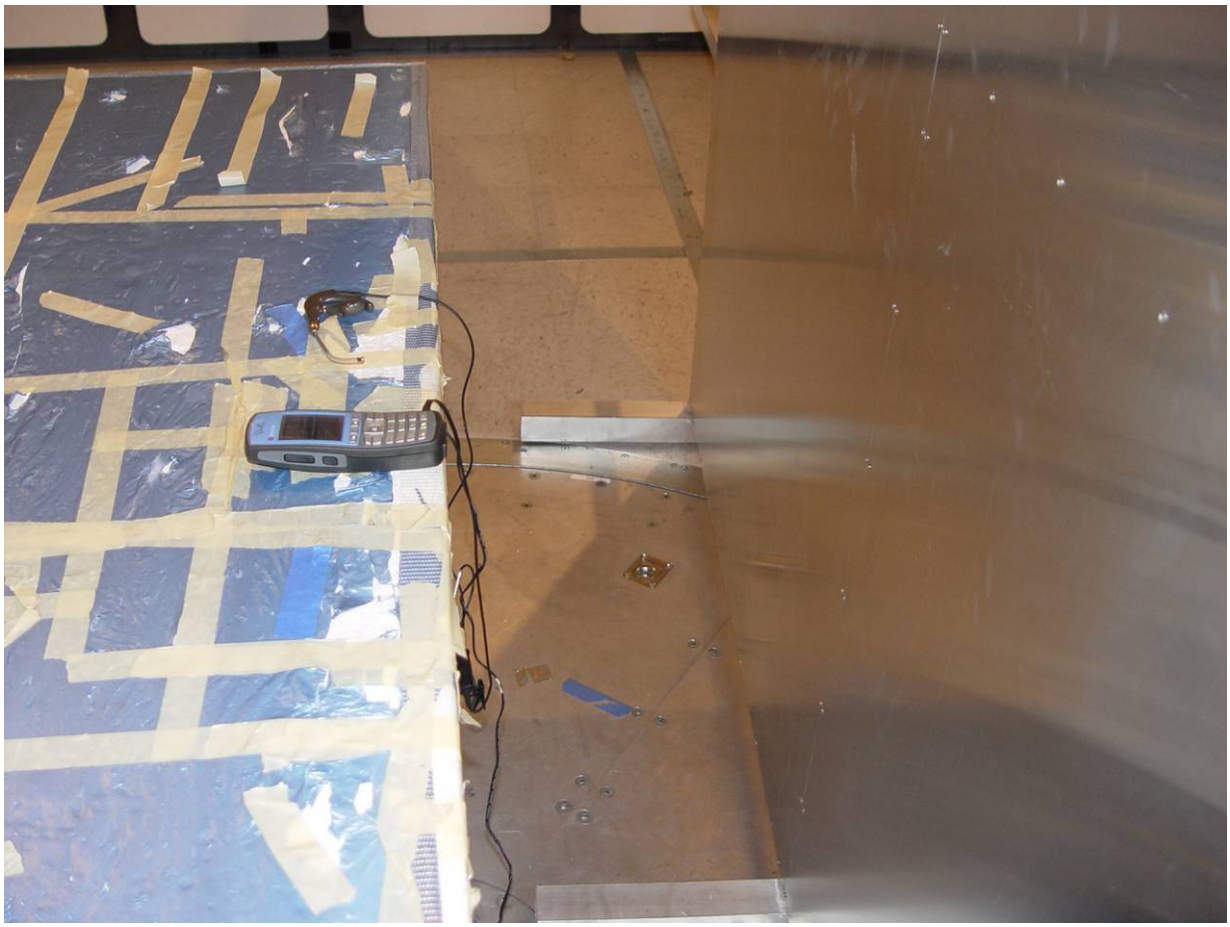
8.2 Conducted RF Emissions - Test Equipment

8.3 Transmitter Radiated Spurious Emission above 1 GHz with Charger

8.4 Receiver Radiated Emissions below 1 GHz with Charger

8.5 Receiver Radiated Emissions above 1 GHz with Charger

8.6 AC Mains Conducted Emissions with Charger



9 TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0134	Amplifier	Com Power	PA 122	181910
0158	Barometer /Thermometer	Control Co.	4196	E2846
0287	EMI Receiver	Rhode & Schwartz	ESIB 40	100201
0193	EMI Receiver	Rhode & Schwartz	ESIB 7	838496/007
0252	SMA Cable	Megaphase	Sucoflex 104	None
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
0301	5.6 GHz Notch Filter	Micro-Tronics	RBC50704	001
0302	5.25 GHz Notch Filter	Micro-Tronics	BRC50703	002
0303	5.8 GHz Notch Filter	Micro-Tronics	BRC50705	003
0304	2.4GHzHz Notch Filter	Micro-Tronics	--	001
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002
0335	1-18GHz Horn Antenna	ETS- Lindgren	3117	00066580
0337	Amplifier	MiCOM Labs	--	--
0338	Antenna	Sunol Sciences	JB-3	A052907
0342	2.4 GHz Notch Filter	EWT	EWT-14-0203	H1

440 Boulder Court, Suite 200
Pleasanton, CA 94566, USA
Tel: 1.925.462.0304
Fax: 1.925.462.0306
www.micomlabs.com