Test of Bright Star Engineering Inc. smartCable

To: FCC 47 CFR Part 15, SubPart 15.247

Test Report Serial No.: BSTR25-U1 Rev A

TEST REPORT

From

Test of: Bright Star Engineering Inc smartCable

To: FCC 47 CFR Part 15, SubPart 15.247

Test Report Serial No.: BSTR25-U1 Rev A

This report supersedes: None

Applicant: Bright Star Engineering Inc
299 Ballardvale Street
Suite 5
Wilmington, MA 1887
USA

Product Function: Wireless Data Communication

Copy No: pdf **Issue Date:** 11th March 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

ACCREDITED
TESTING CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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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)

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 March 2011	Initial Release

3 TEST RESULT CERTIFICATE

Applicant:	Bright Star Engineering Inc 299 Ballardvale Street Suite 5 Wilmington, MA 1887 USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
Product:	Bluetooth smartCable	Telephone:	+1 925 462 0304
Model No.:	WCB33	Fax:	+1 925 462 0306
S/No's:	Conducted: Not Available Radiated: WCB-00006		
Date(s) Tested:	4th – 10th March 2011	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15, SubPart 15.247	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
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

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247** and **Industry Canada RSS-210** and **Industry Canada RSS-Gen.**

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 and 99% Bandwidth	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	N/A Device is USB Powered	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.

6 PRODUCT DETAILS AND TEST CONFIGURATIONS

6.1 Test Program Scope

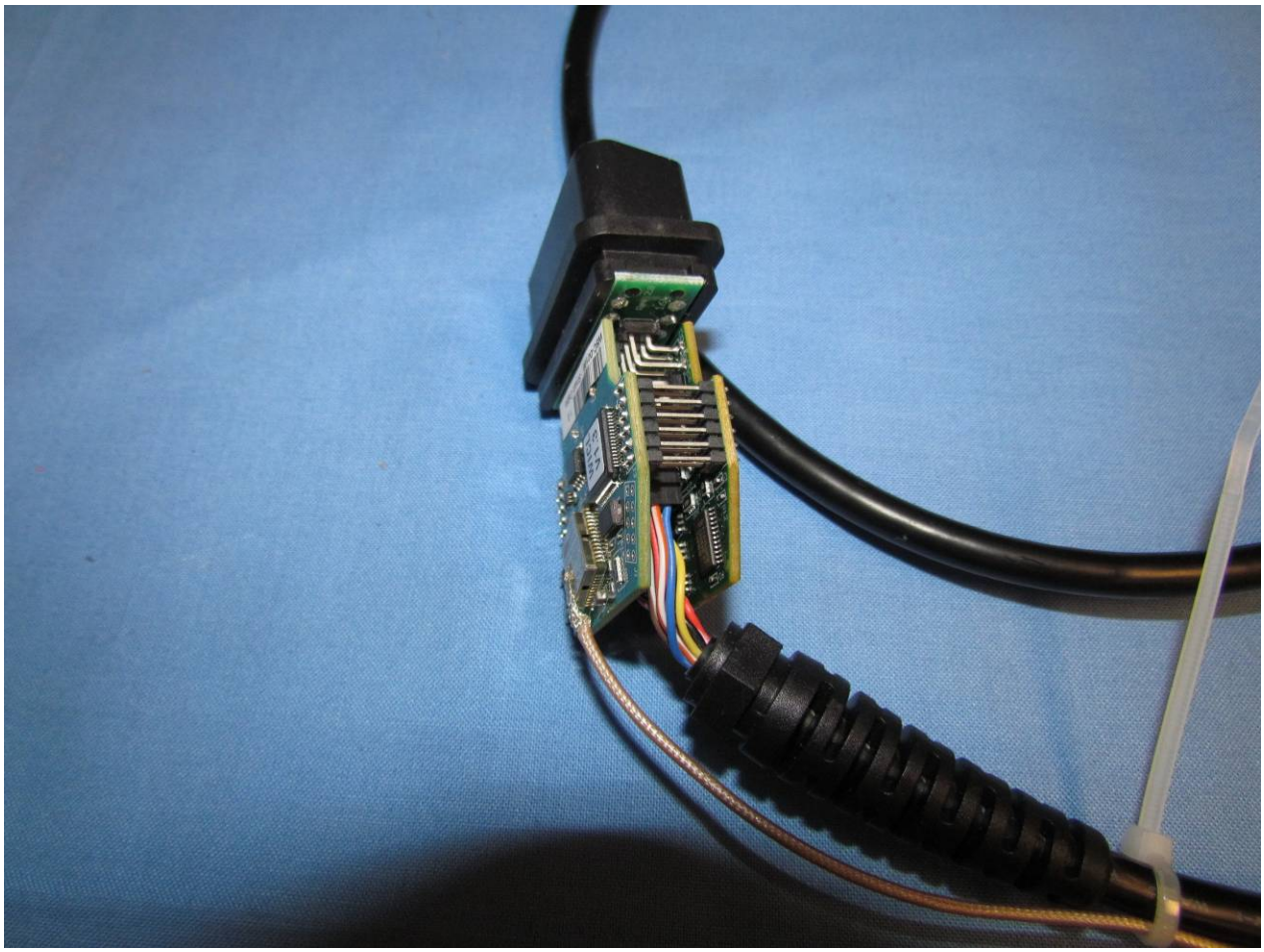
The scope of the test program was to test the BrightStar Engineering Inc BlueTooth frequency hopping (FHSS) smartCable data collection cable for compliance against FCC 47 CFR Part 15, SubPart 15.247 for 2.4 GHz frequency hopping operation.

The smartCable connects to the automobile processing and sending data to the Bright Star VCIPod for processing.

BrightStar Engineering Inc, 2.4 GHz smartCable with Bluetooth Technology

BrightStar Engineering Inc, 2.4 GHz smartCable with Bluetooth Technology

Internal to Cable Shell



This device was used for conducted testing

6.2 EUT Details

Detail	Description
Purpose:	Test of the BrightStar Engineering Inc BlueTooth frequency hopping (FHSS) smartCable data collection cable for compliance against FCC 47 CFR Part 15, SubPart 15.247
Applicant:	BrightStar Engineering Inc 299 Ballardvale Street, Suite 5 Wilmington, MA 1887 USA
Manufacturer:	As applicant
Test Laboratory:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	BSTR25-U1
Date EUT received:	1st March 2011
Dates of test (from - to):	4th – 10th March 2011
No of Units Tested:	2 (conducted + radiated)
Product Name:	smartCable
Manufacturers Trade Name:	smartCable
Model No.:	WCB-00006
Part No.:	450
Serial No.:	Conducted N/A, Radiated N/A
Equipment Primary Function:	Wireless Data Communication
Equipment Secondary Function(s):	Automotive Diagnostics
Type of Technology:	2.4 GHz BlueTooth (GFSK Modulation)
Installation type:	Indoor/Outdoor use
Software/Firmware Release:	0.11
Hardware Release:	3.3
Test Software Release:	1.0
Transmit/Receive Operation:	Frequency Hopping Spread Spectrum (FHSS)
Output Power Type:	Fixed, not variable
Automatic Transmit Power Control Available:	EUT does not exhibit ATPC
Remote Frequency Control Available:	EUT does not exhibit RFC
Rated Input Voltage and Current AC:	Battery Powered 12 Vdc
Operating Frequency:	2400 to 2483.5 MHz
Operating Temperature Range ºC:	Manufacturer's Declaration Min: -40°C Max: +85°C
Equipment Dimensions:	8.1 cm x 2.2 cm x 4.4 cm
Weight:	0.48 lbs

6.3 External A.C/D.C Power Adaptor

No external ac/dc power adapter will be supplied with the device

Detail	Description

6.4 Operational Power Range

Mode 1 DH1 (1 MBit/s)		Mode 2 DH2 (2 MBit/s)		Mode 3 DH3 (3 MBit/s)	
dBm					
Max	Min	Max	Min	Max	Min
+6.00	+4.00	+6.00	+4.00	+6.00	+4.00

6.5 Types of Modulation Supported

Mode	Modulation	Bandwidth
DH1-3	GFSK	1 MHz

6.6 Antenna Details

The following is a description of the EUT antennas.

Antenna Type:	Manufacturer	Model	Gain (dBi)	Frequency Range (MHz)
Multilayer Chip	Advanced Ceramic x	AT3216	0.5	2,400-2500

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	Screened (y/n)	Description	Qty	Tested
Vehicle	K-line, J1850, Can	N	--	1	Y
Can	Can 2.0 Bus	N	--	1	Y

6.8 EUT Configurations

Band (GHz)	Mode	Freq Band (MHz)	Freq Range (MHz)	Low ch	Mid ch	High ch	# of Ch	Ch Spacing (MHz)	Ch BW (MHz)
2.4	BT	2400 - 2483.5	2402 - 2480	2402	2441	2480	80	1	1

6.9 Equipment Details

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

Type (EUT/Support)	Equipment Description	Manufacturer	Model No.	Serial No (s).
EUT (Conducted)	BlueTooth device embedded in cable harness	Bright Star	Not Available	N/A
EUT (Radiated)	BlueTooth device embedded in cable harness	Bright Star	WCB-00006	N/A

6.10 Test Configurations

Operational Mode(s)	Data Rate Tested
DH1	1 MBit/s
DH2	2 MBit/s
DH3	3 MBit/s

6.11 Equipment Modifications

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

1).. No modifications required

No.	Test	Problem	Modification Required

6.12 Deviations from the Test Standard

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

1).. No deviations from the standard were required

No.	Test / Standard	Deviation	Rationale

7 TEST RESULTS

7.1 20 dB and 99% Bandwidth

Test Procedure

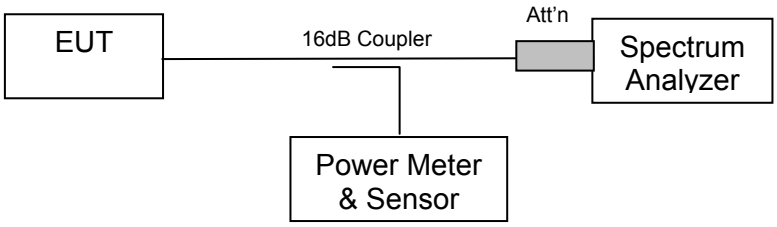
The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the 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

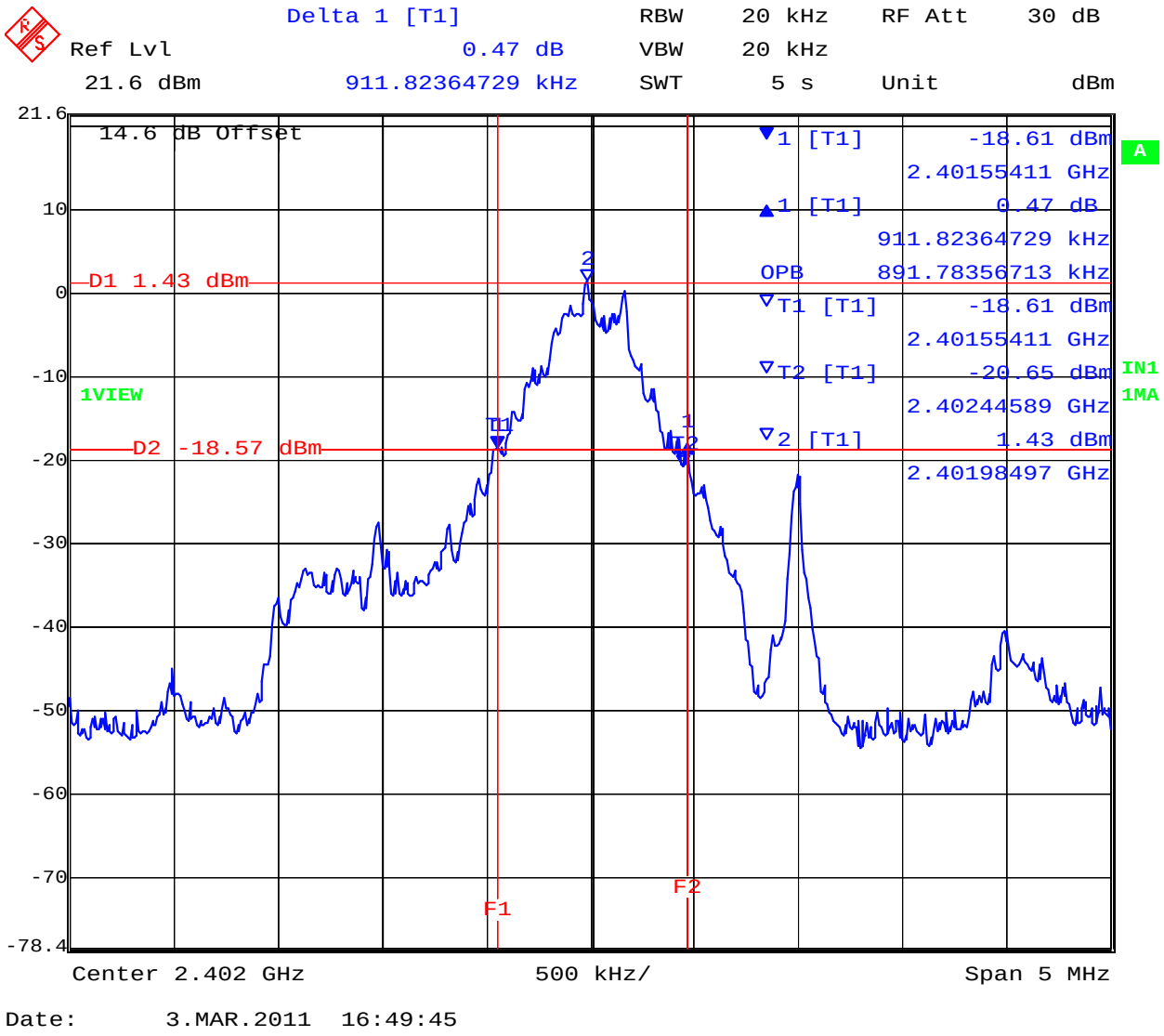
Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

7.1.1 20 dB and 99% Bandwidth Results:

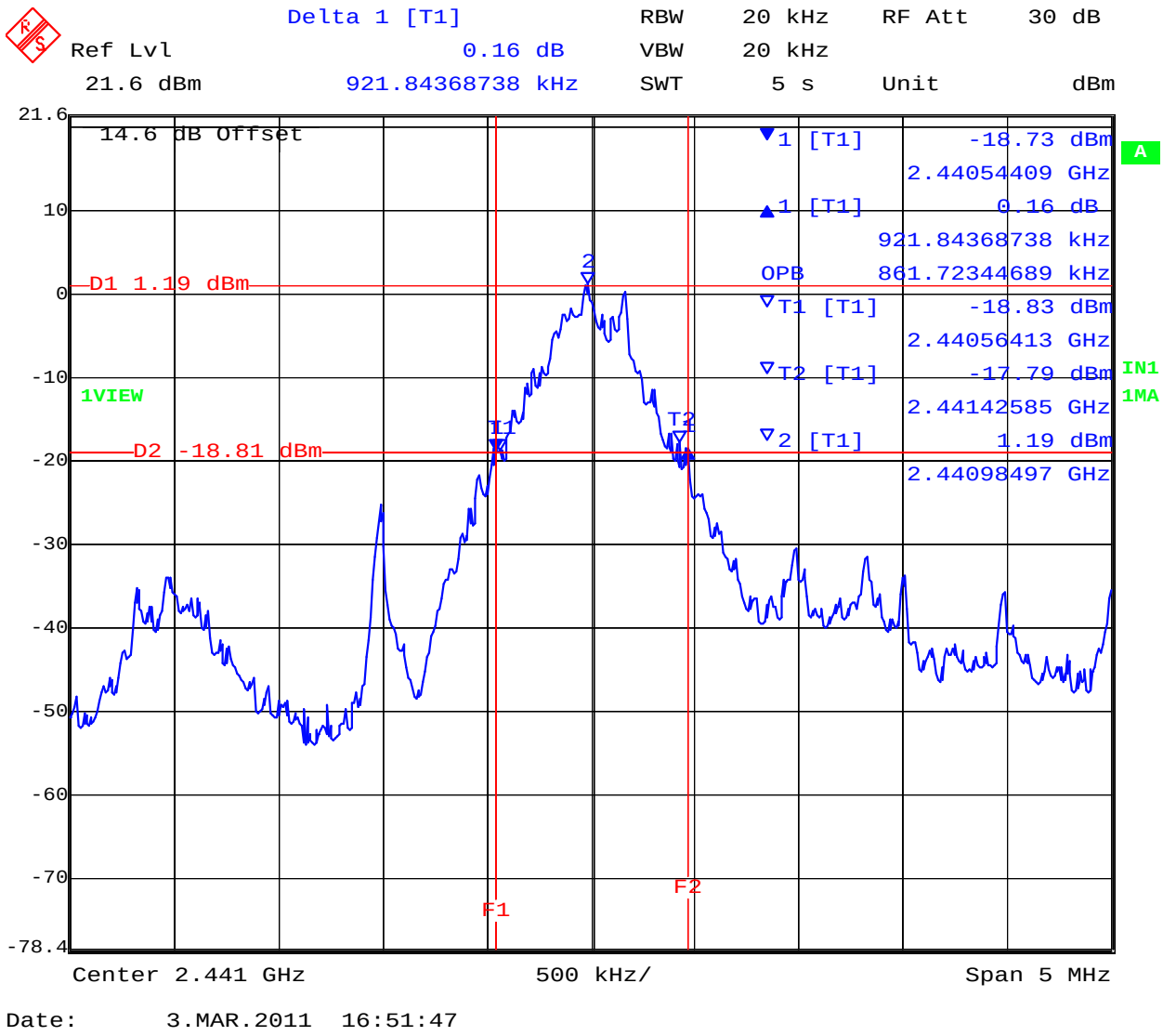
TABLE OF RESULTS – DH1

Center Frequency (MHz)	20 dB Bandwidth (MHz)	99 % BW (MHz)
2402	0.9118	0.8918
2441	0.9218	0.8617
2480	0.9118	0.8617

2402 MHz 20 dB and 99% Bandwidth



2441 MHz 20 dB and 99% Bandwidth



2480 MHz 20 dB and 99% Bandwidth

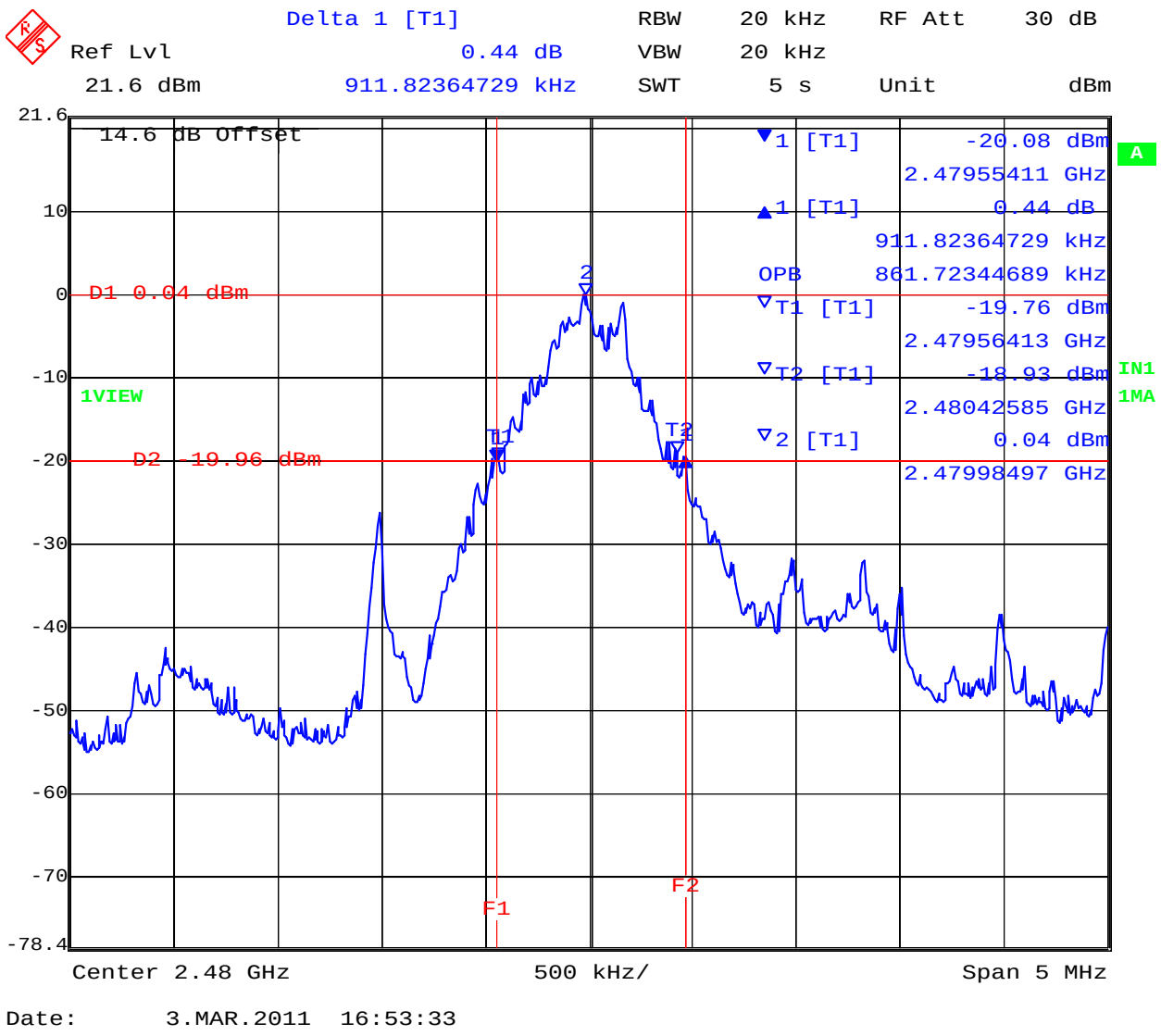
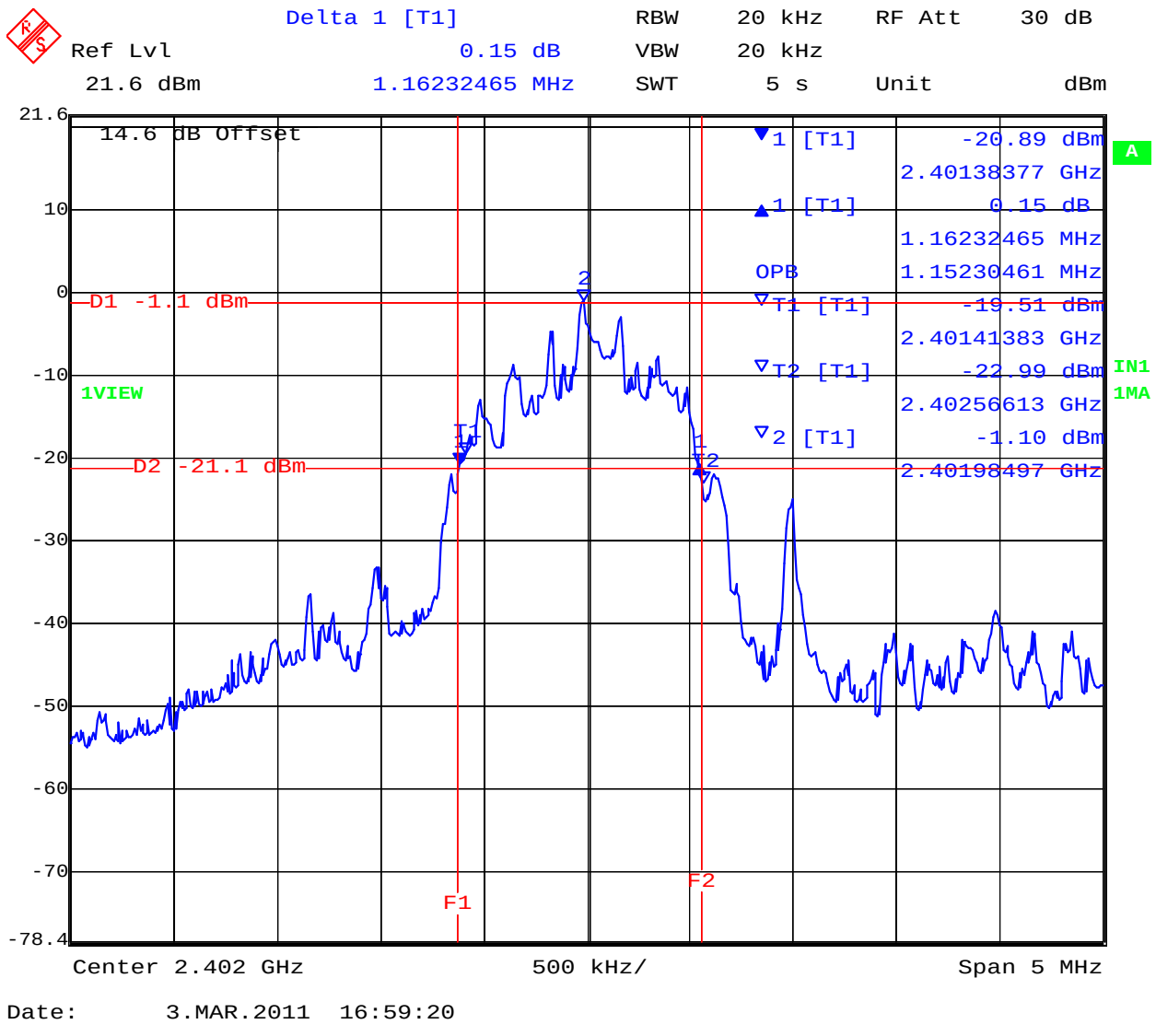


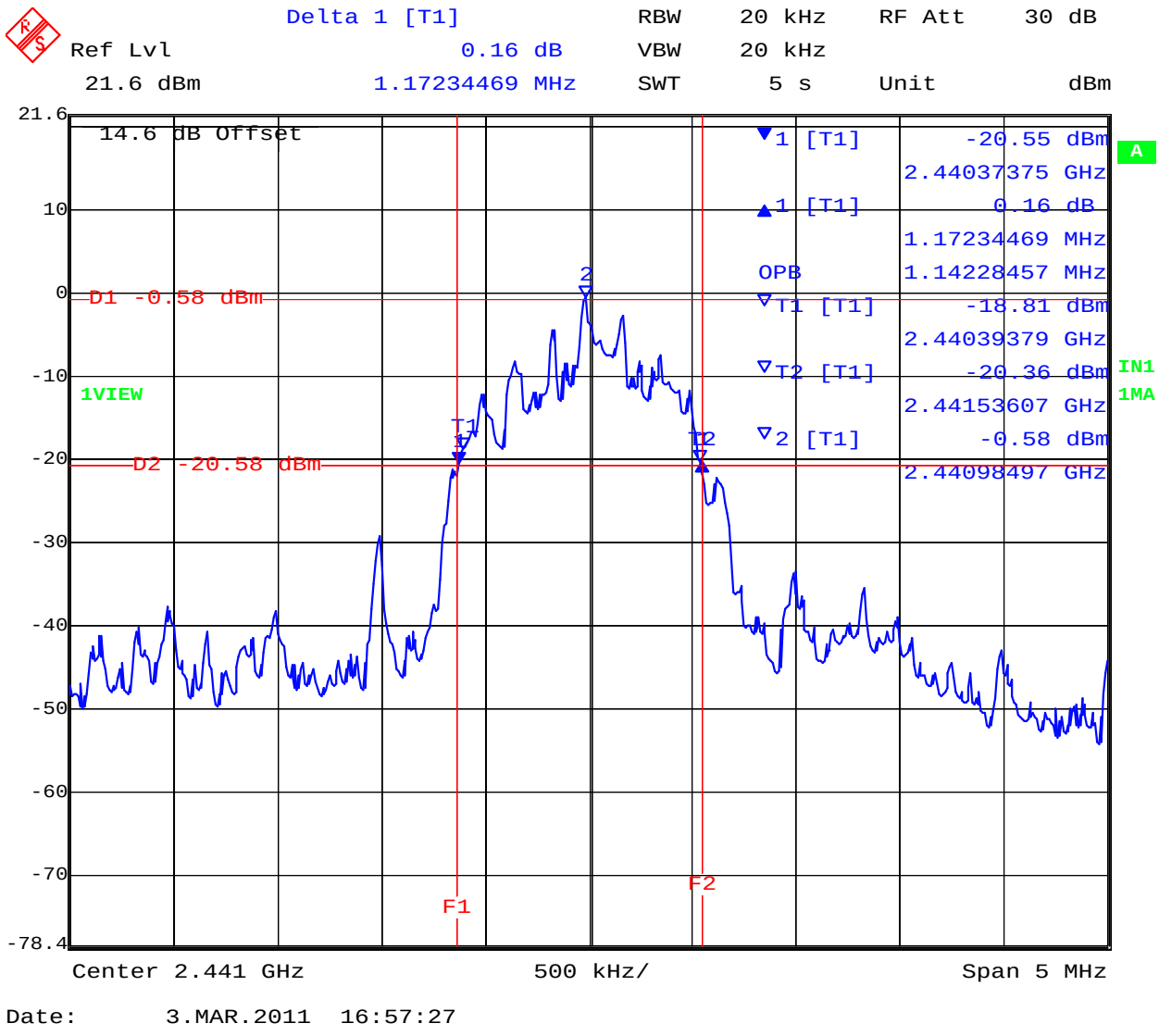
TABLE OF RESULTS – DH2

Center Frequency (MHz)	20 dB Bandwidth (MHz)	99 % BW (MHz)
2402	1.1623	1.1523
2441	1.1723	1.1423
2480	1.1623	1.1423

2402 MHz 20 dB and 99% Bandwidth



2441 MHz 20 dB and 99% Bandwidth



2480 MHz 20 dB and 99% Bandwidth

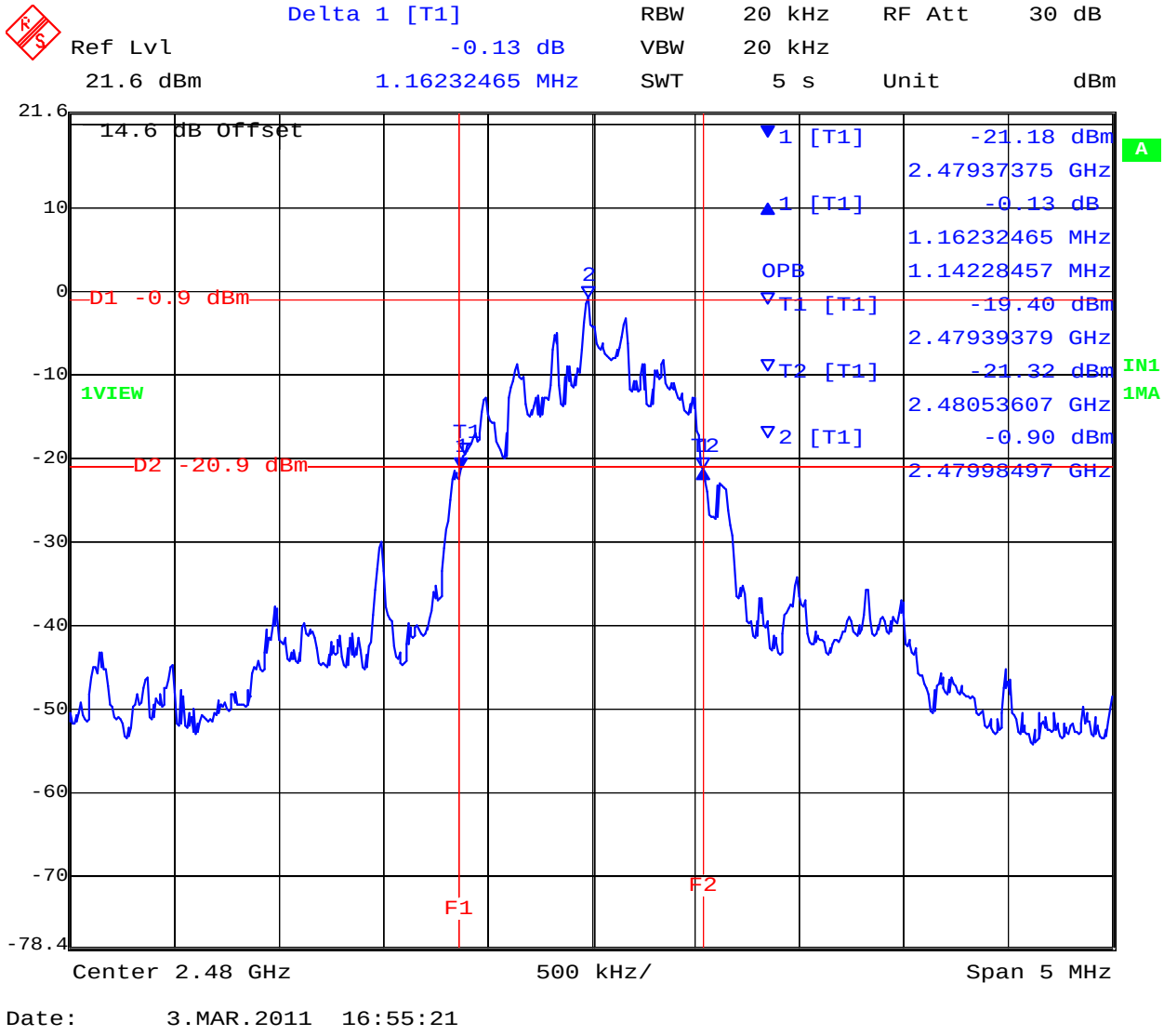
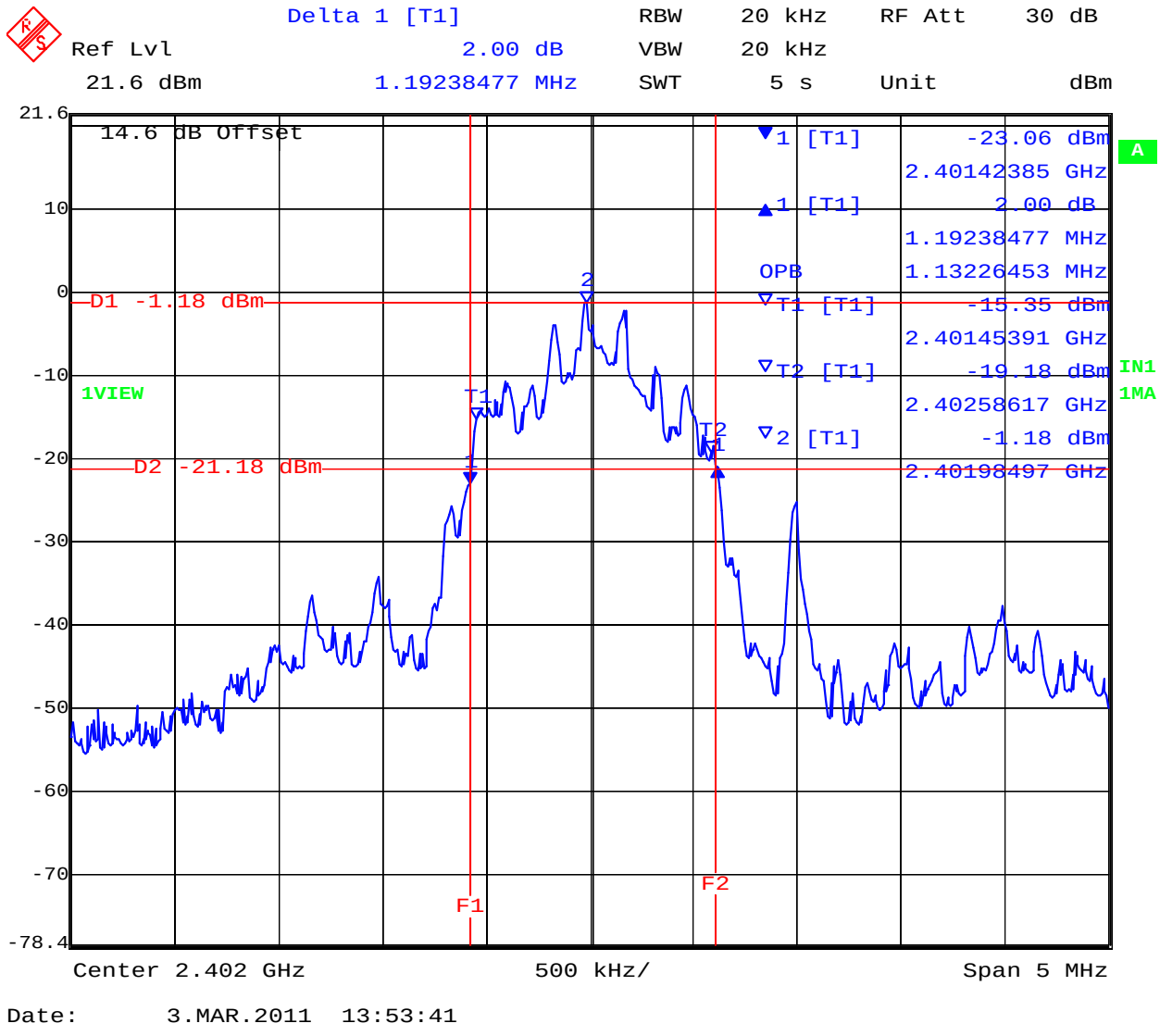


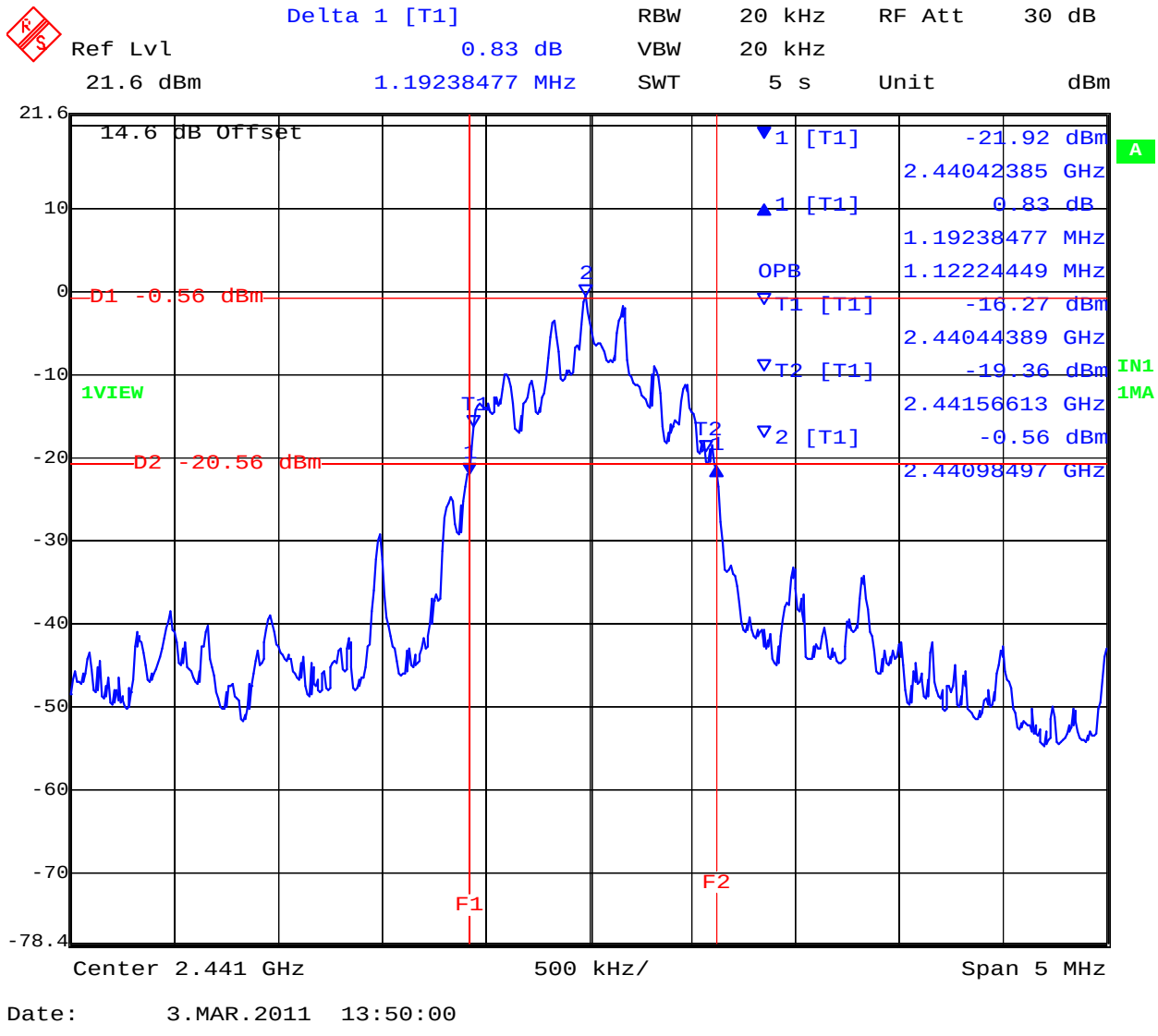
TABLE OF RESULTS – DH3

Center Frequency (MHz)	20 dB Bandwidth (MHz)	99 % BW (MHz)
2402	1.1924	1.1323
2441	1.1924	1.1222
2480	1.2024	1.1222

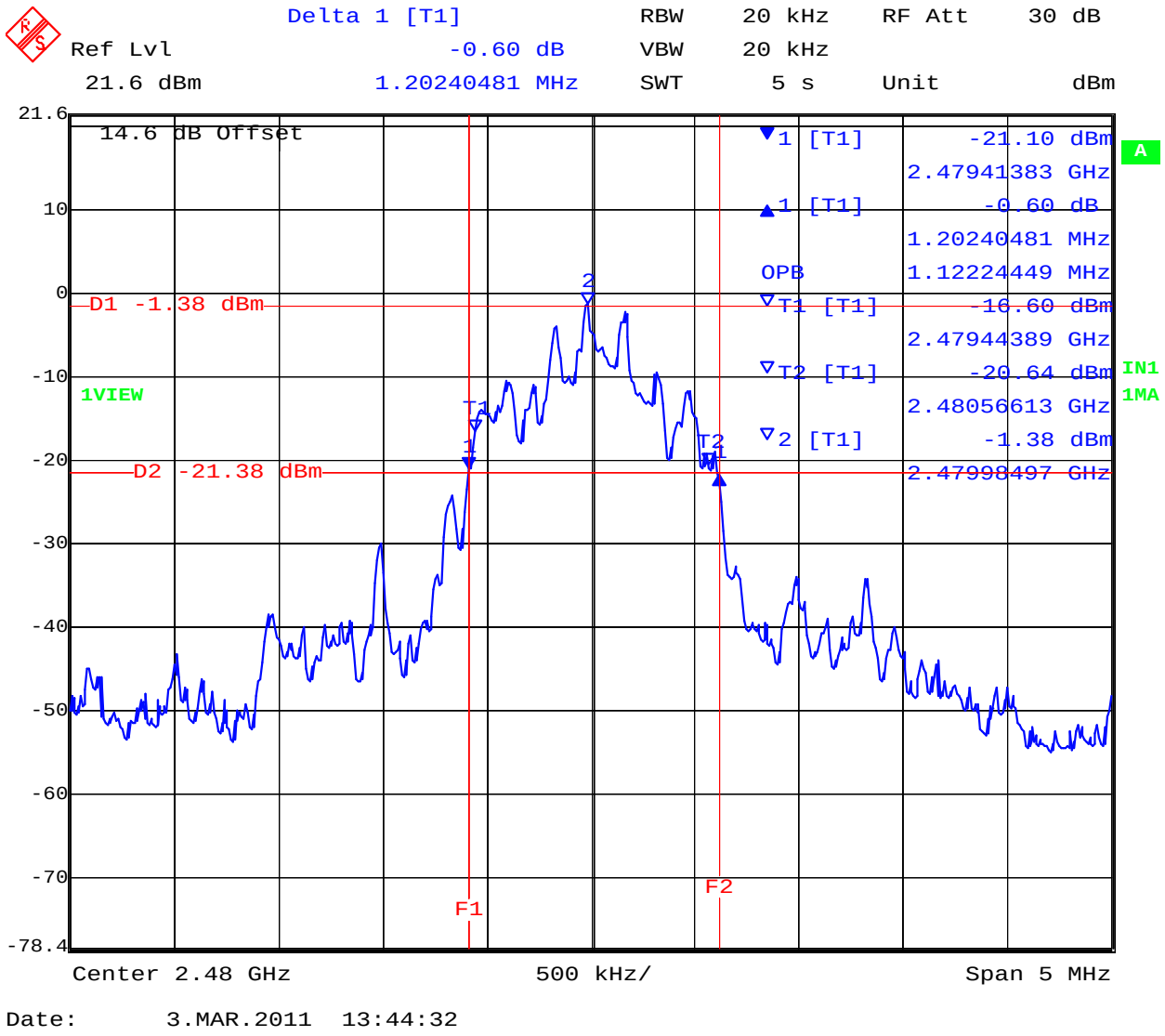
2402 MHz 20 dB and 99% Bandwidth



2441 MHz 20 dB and 99% Bandwidth



2480 MHz 20 dB and 99% Bandwidth



7.1.2 Carrier Frequency Separation

Test Procedure

The EUT must have its hopping function enabled.

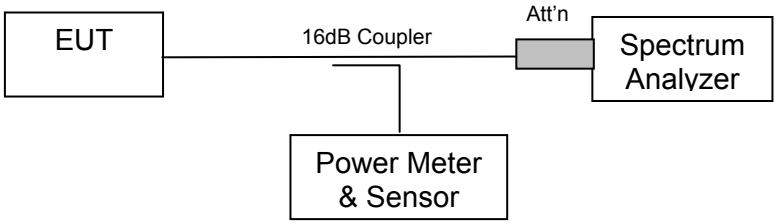
The following spectrum analyzer settings were used:

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.

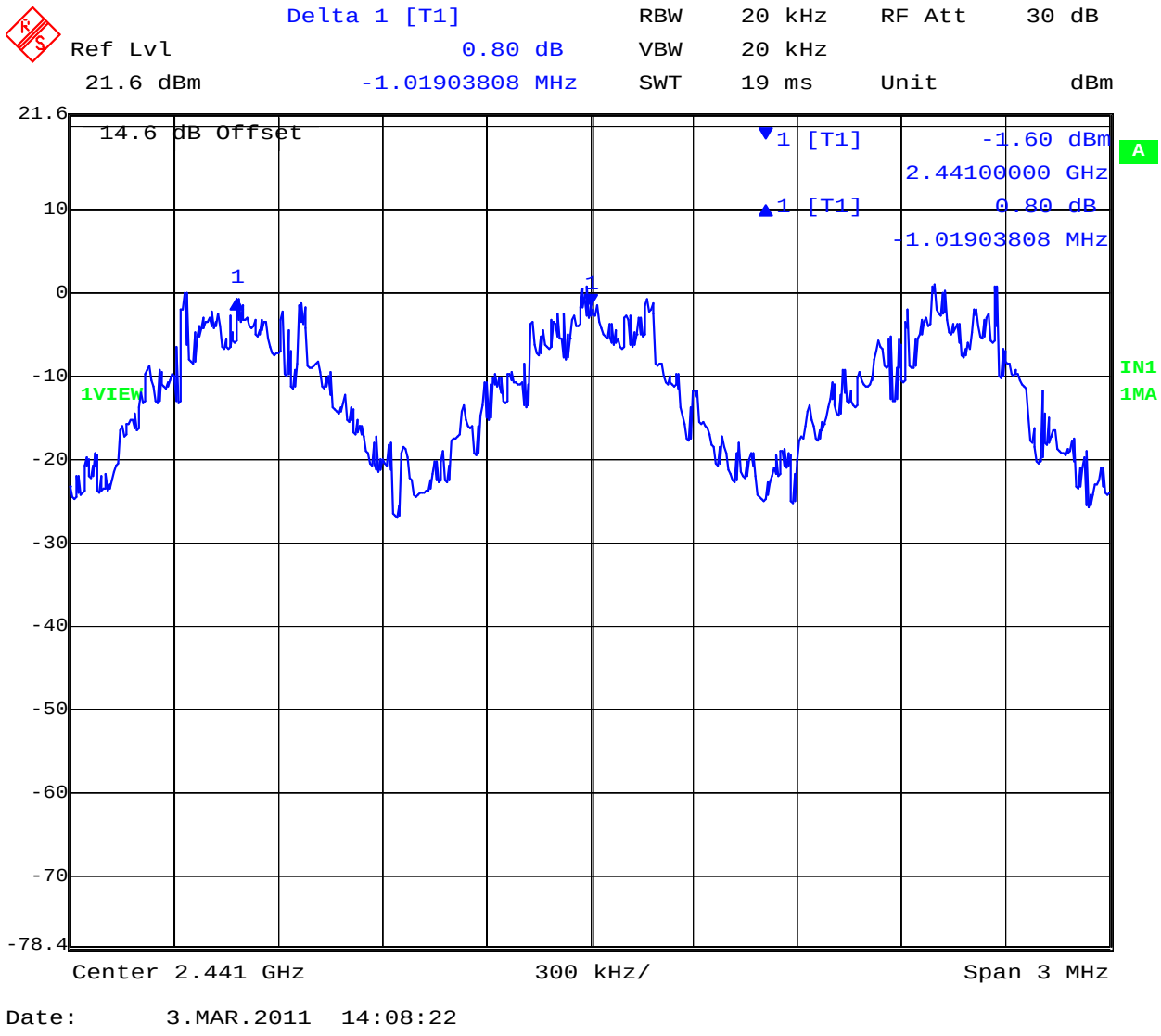
Temperature: **Error! Reference source not found.** °C
Relative humidity: **Error! Reference source not found.** %
Pressure: **Error! Reference source not found.** mbar

Test Channel – 2441 MHz

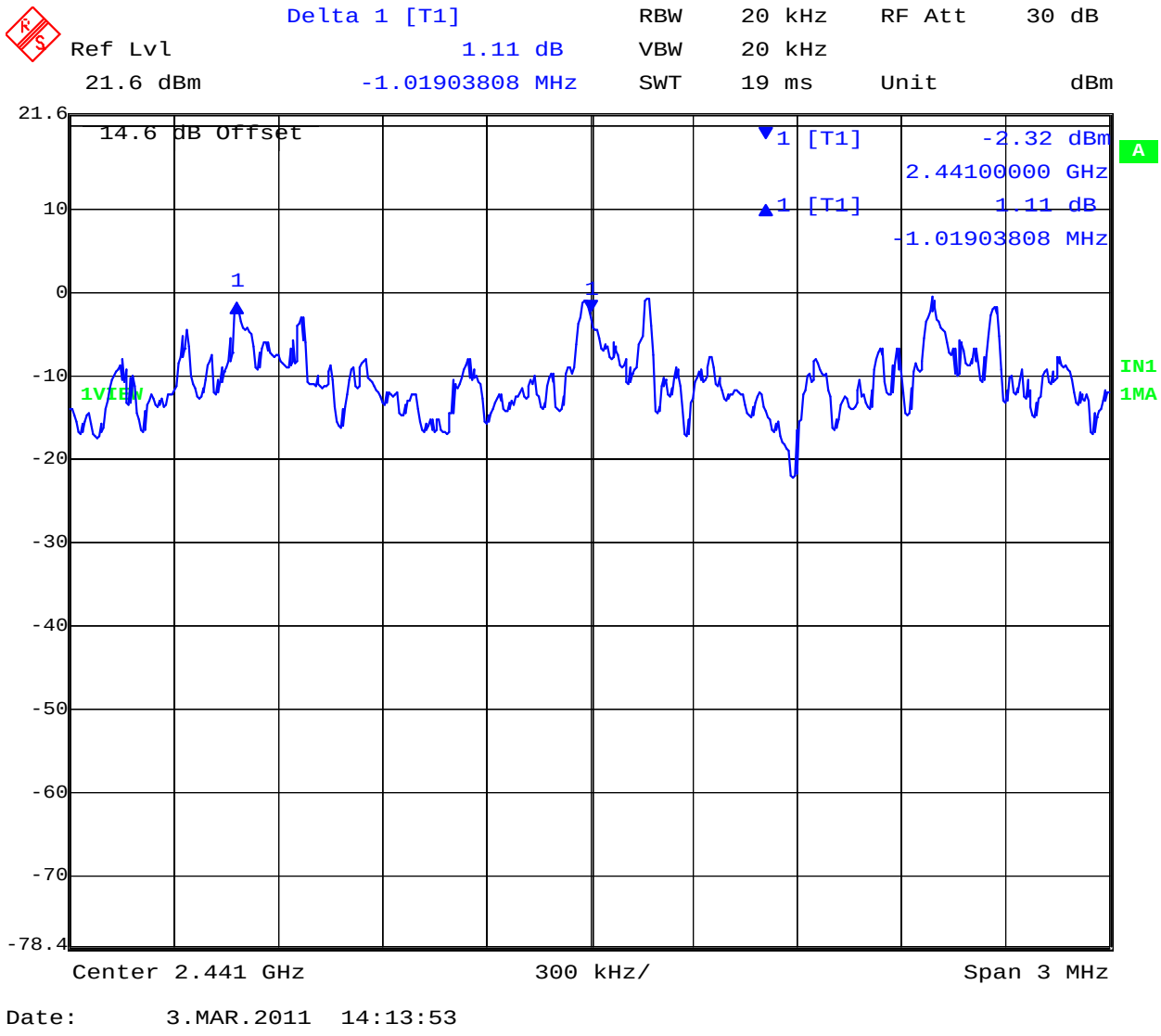
Data Rate (Mbs)	Channel Spacing (MHz)	Maximum 20 dB Bandwidth (Maximum Data Rate) (MHz)	Specification	Results
1	1.019	0.9218	Greater than 2/3 of 20 dB Bandwidth	PASS
2	1.019	1.1723	Greater than 2/3 of 20 dB Bandwidth	PASS
3	1.019	1.2024	Greater than 2/3 of 20 dB Bandwidth	PASS

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

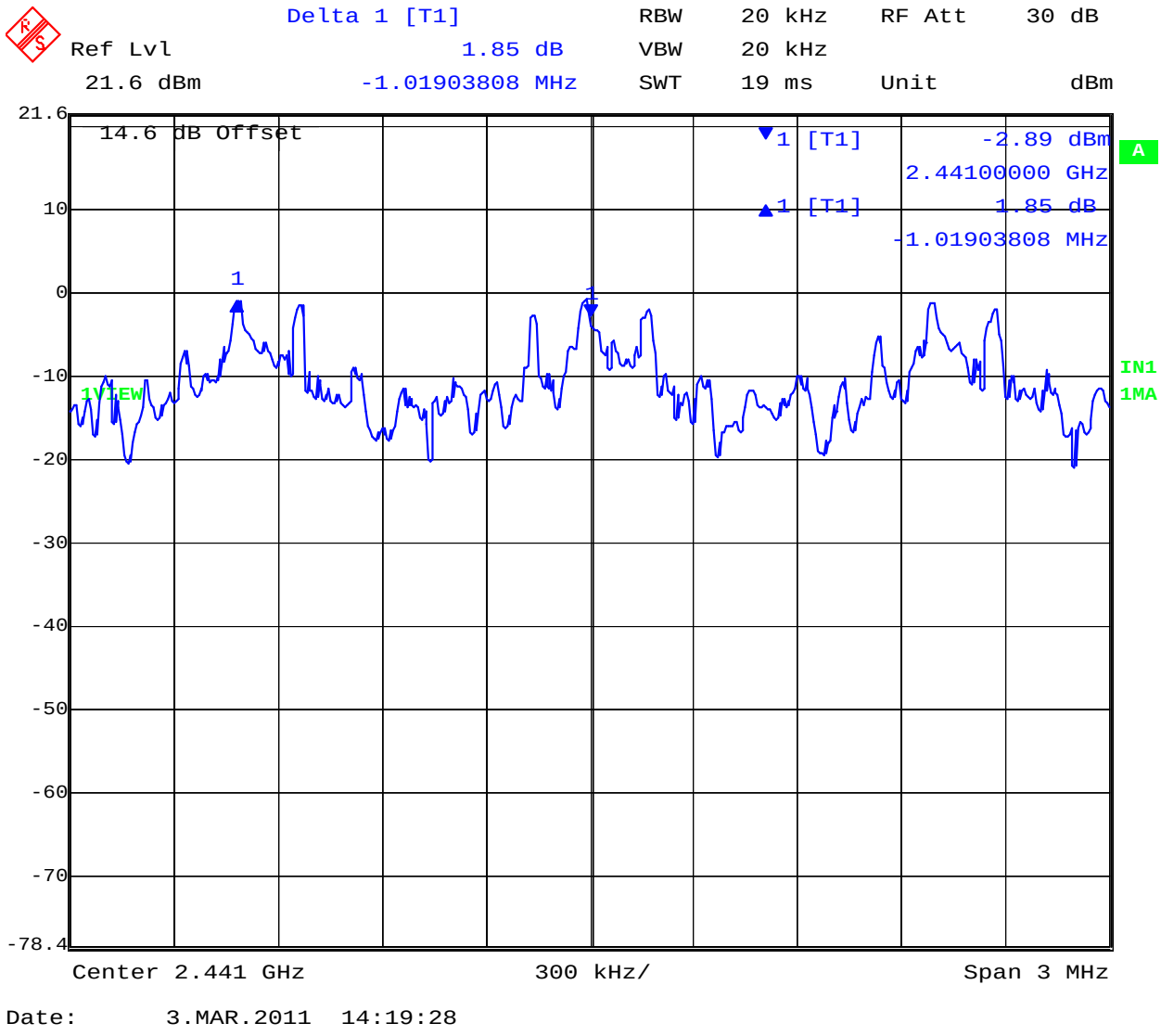
Carrier Frequency Separation; Hopping On; 1 Mbs Data Rate



Carrier Frequency Separation; Hopping On; 2 Mbs Data Rate



Carrier Frequency Separation; Hopping On; 3 Mbs Data Rate



7.1.3 Number of Hopping Frequencies

Test Procedure

The EUT must have its hopping function enabled.

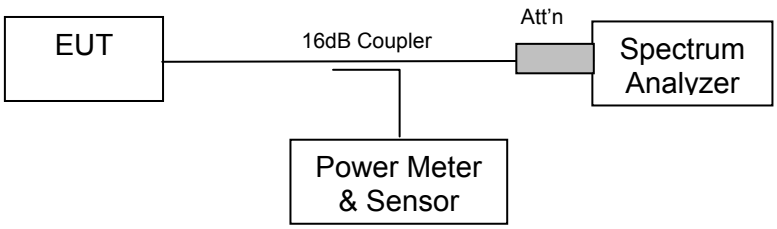
The following spectrum analyzer settings were used:

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

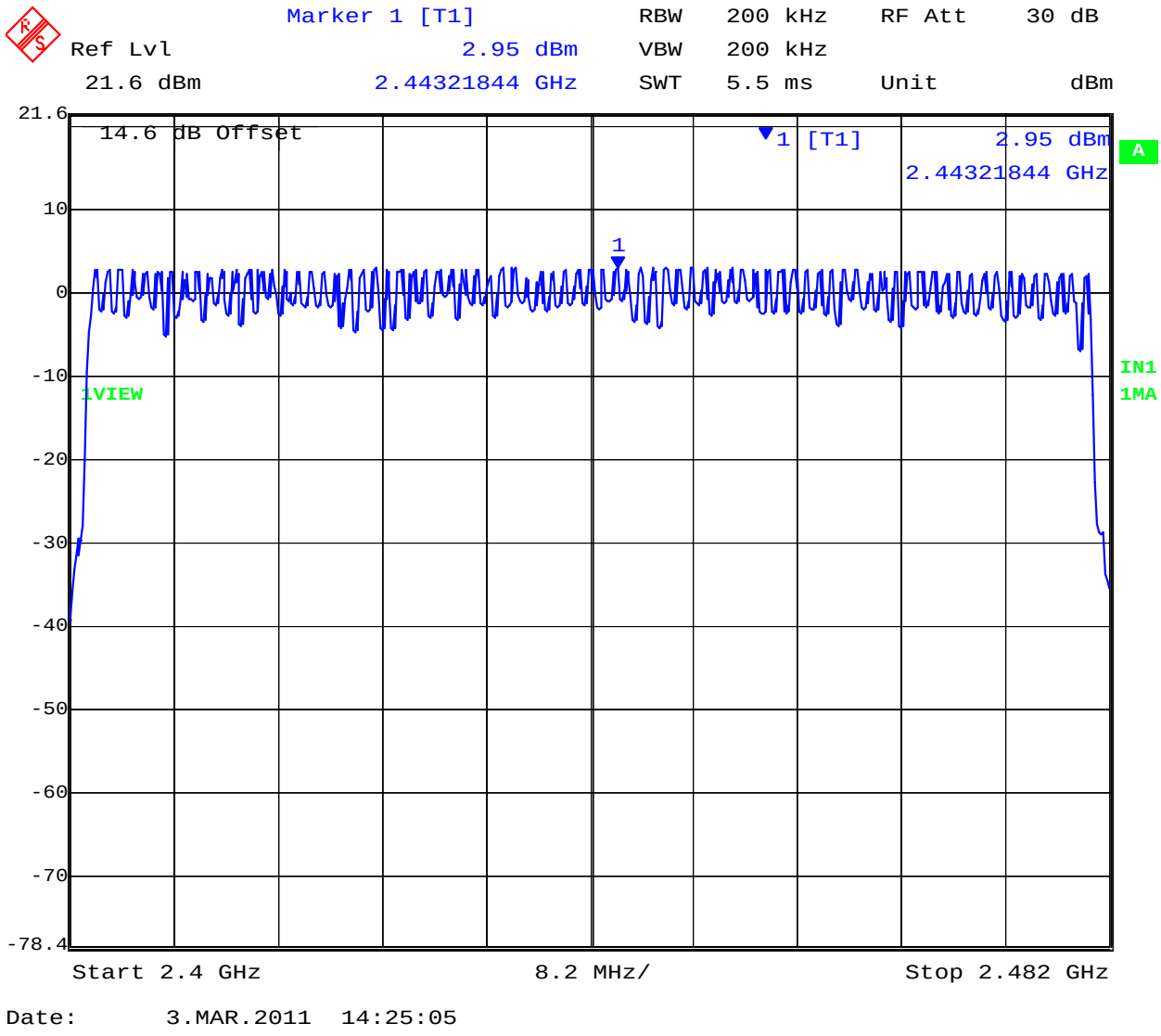
Ambient conditions.

Observed Number of Operating 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; 3 Mbs Data Rate; 2400-2482 MHz



7.1.4 Time of Occupancy (Dwell Time)

Test Procedure

The EUT must have its hopping function enabled.

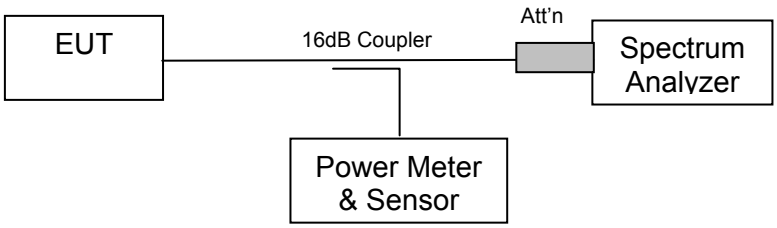
The following spectrum analyzer settings were used:

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

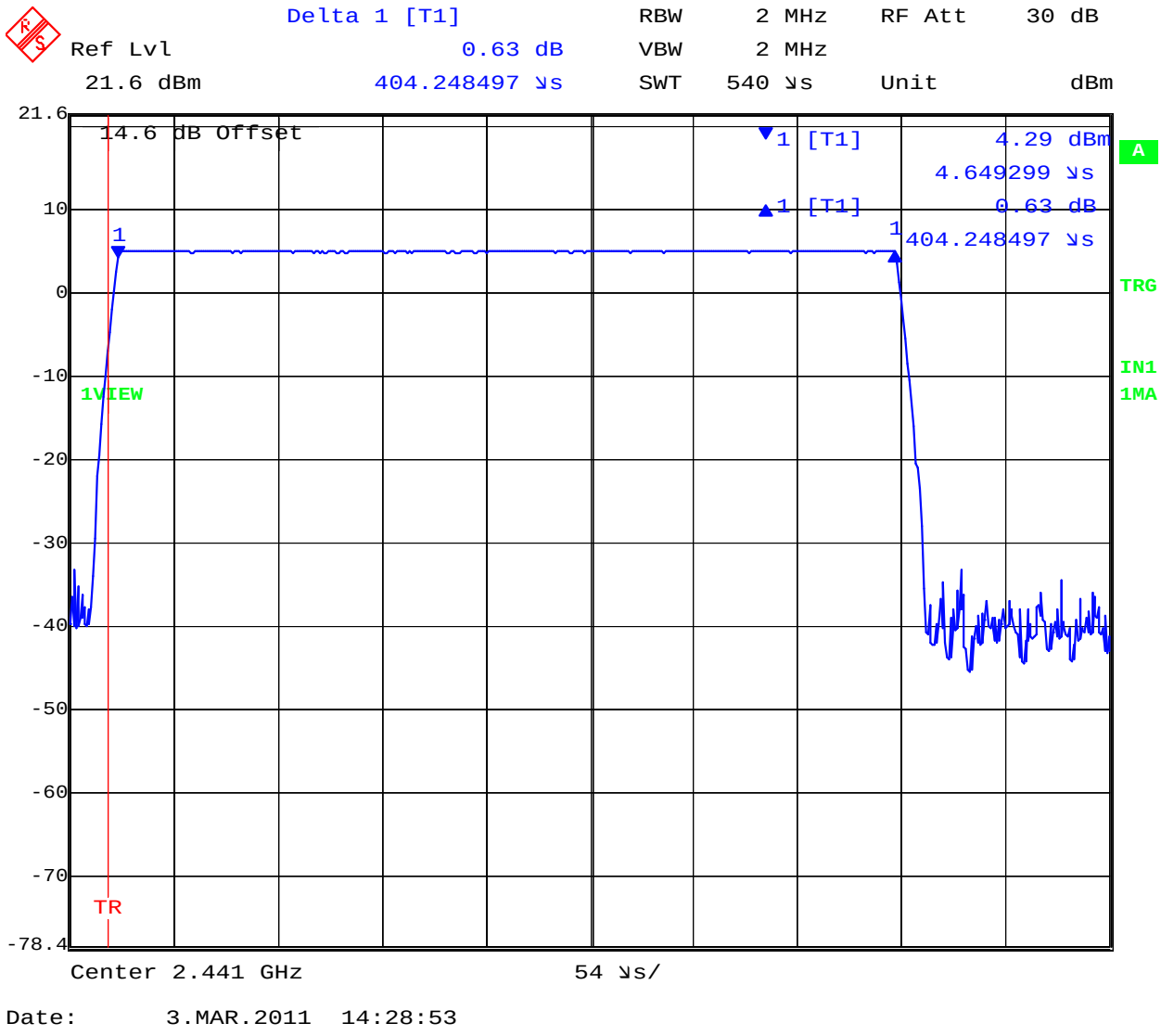
Test Results for Time of Occupancy (Dwell Time)

Ambient conditions.

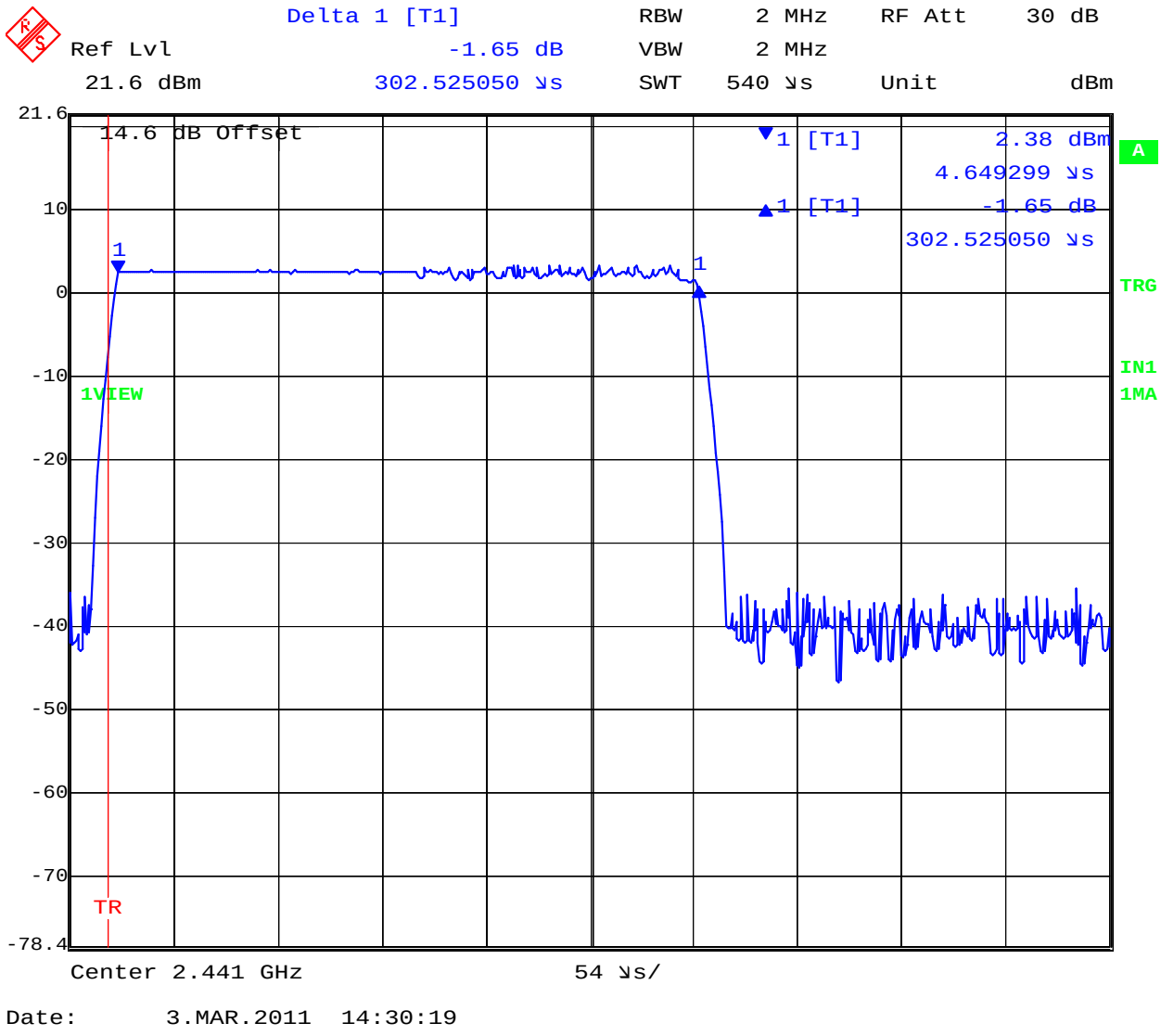
Temperature: **Error! Reference source not found.** °C
Relative humidity: **Error! Reference source not found.** %
Pressure: **Error! Reference source not found.** mbar

Centered on Channel	Center Frequency (MHz)	Data Rate (Mbs)	Channel Dwell Time (single channel) (µs)
39	2441	1	404.25
39	2441	2	302.25
39	2441	3	260.32

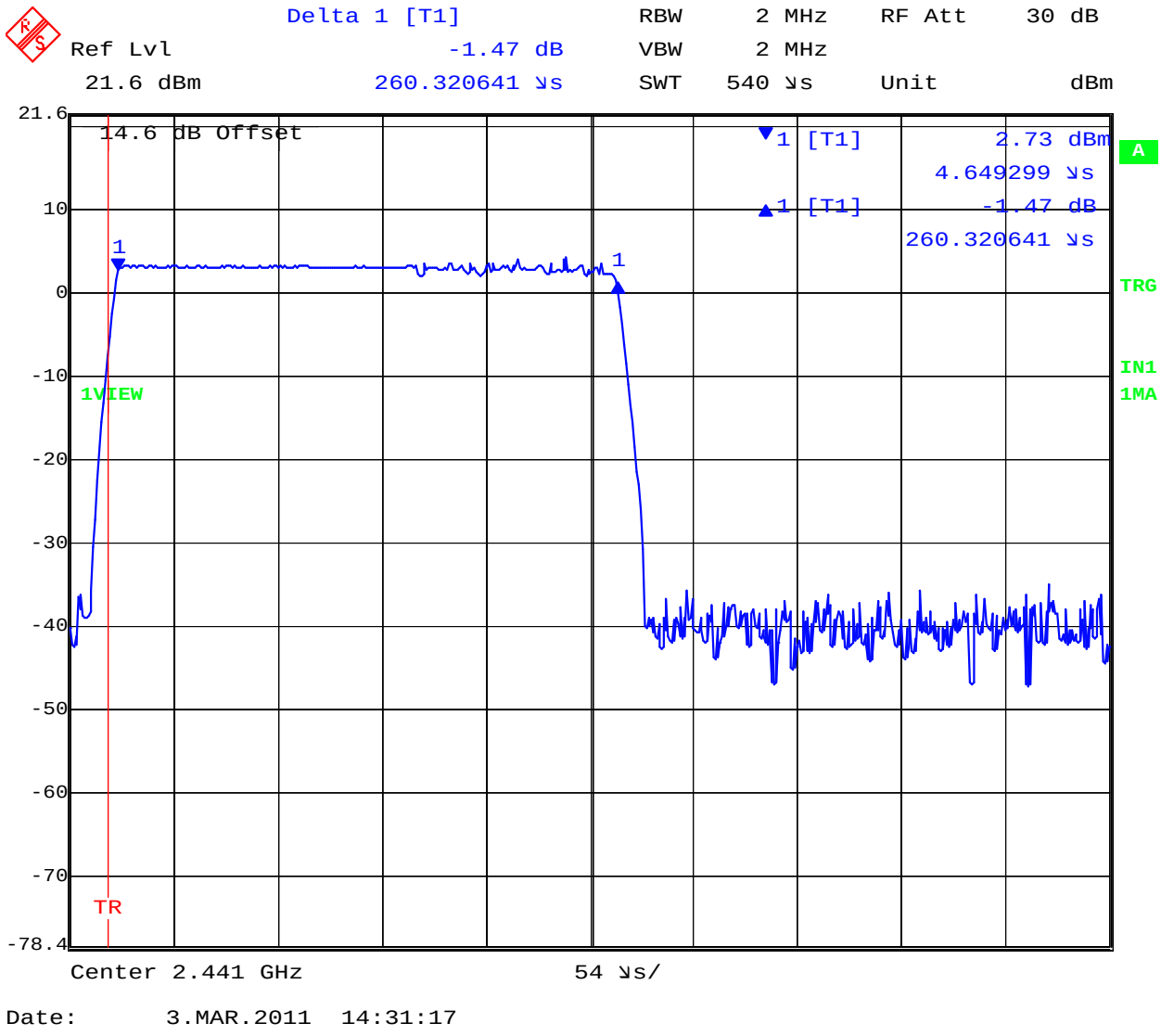
Time of Occupancy; Hopping On; 2441 MHz; 1 Mbs Data Rate



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



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



7.1.5 Channel Occupancy

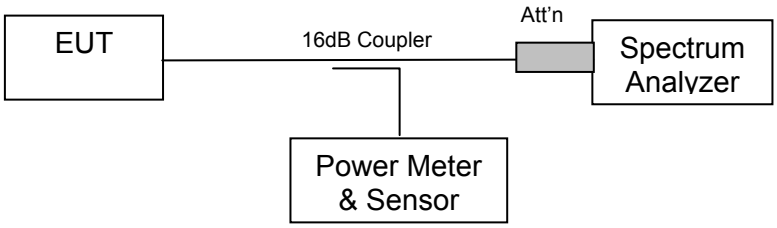
Test Procedure

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.

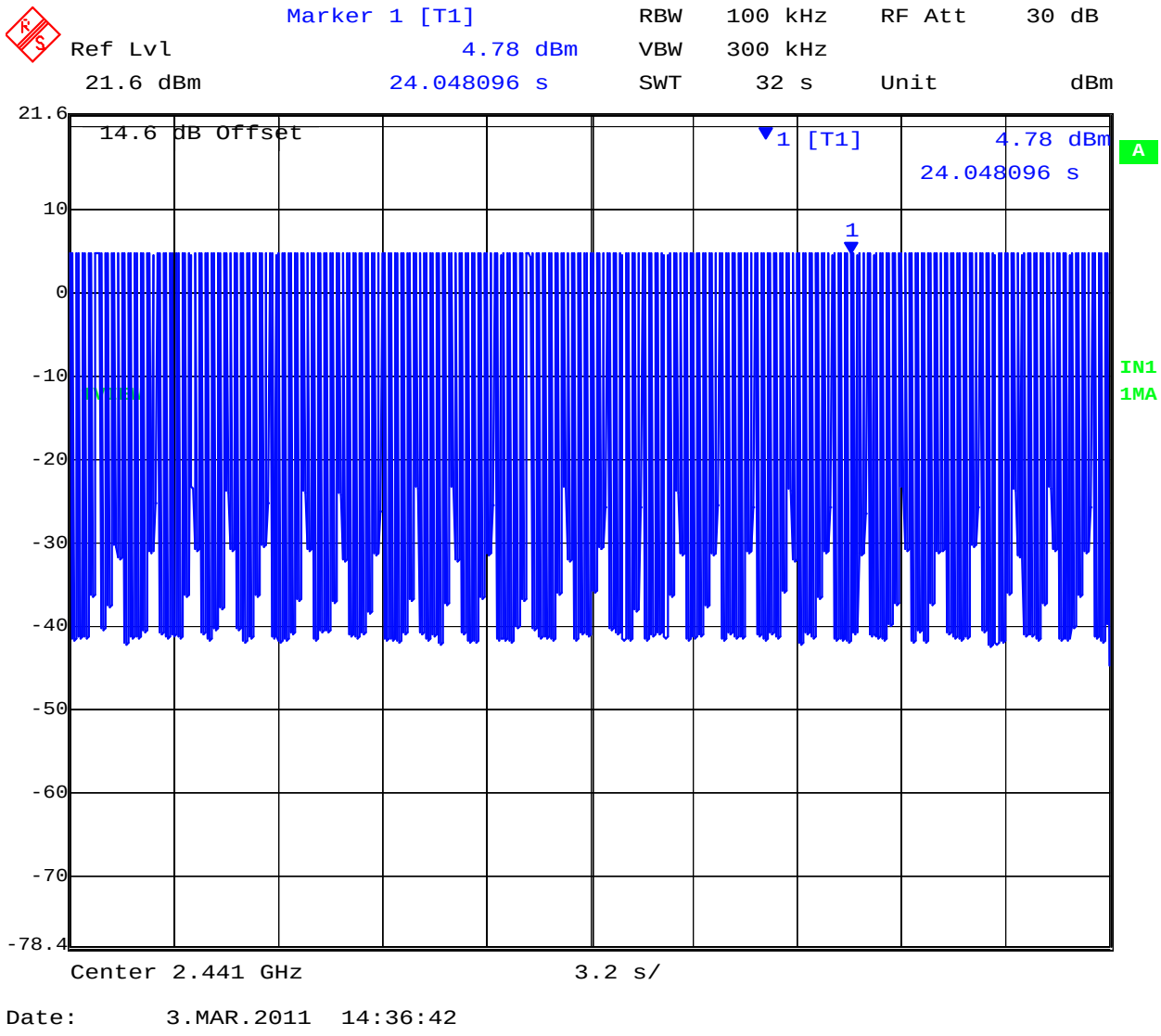
Channel #	Center Frequency (MHz)	Data Rate (Mbs)	Channel Dwell Time (single channel) (µs)	Number of Hops	Channel Occupancy (ms)	Limit (ms)	Result
39	2441	1	404.25	316	127.7	400	PASS
39	2441	2	302.25	316	95.5	400	PASS
39	2441	3	260.32	316	82.3	400	PASS

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.

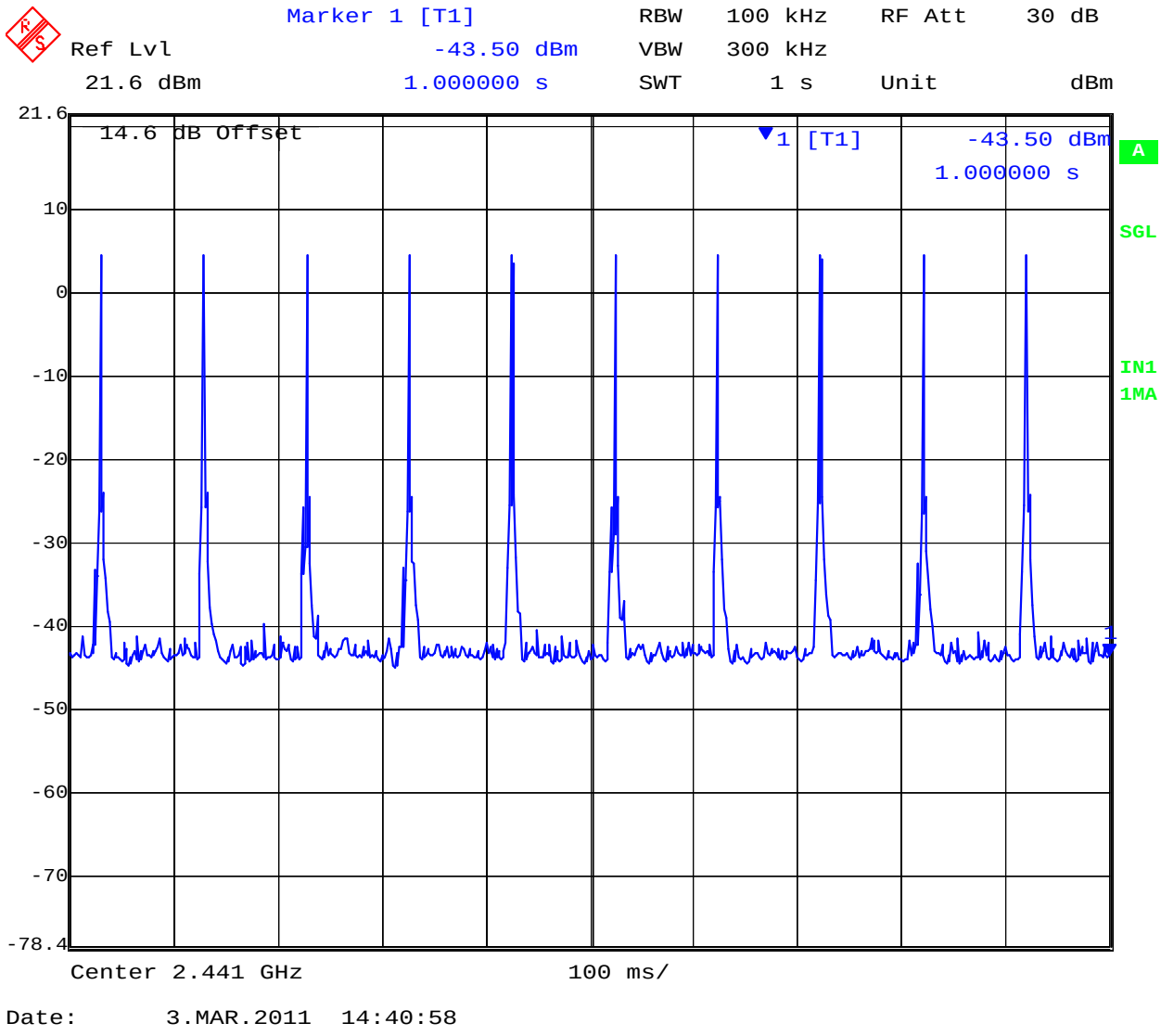
All data rates were then checked with a sweep time of 1 second to verify the number of time the transmitter occupied Channel 39 (2441 MHz). Each data rate transmitted on Channel 39 a total of 10 times per second.

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

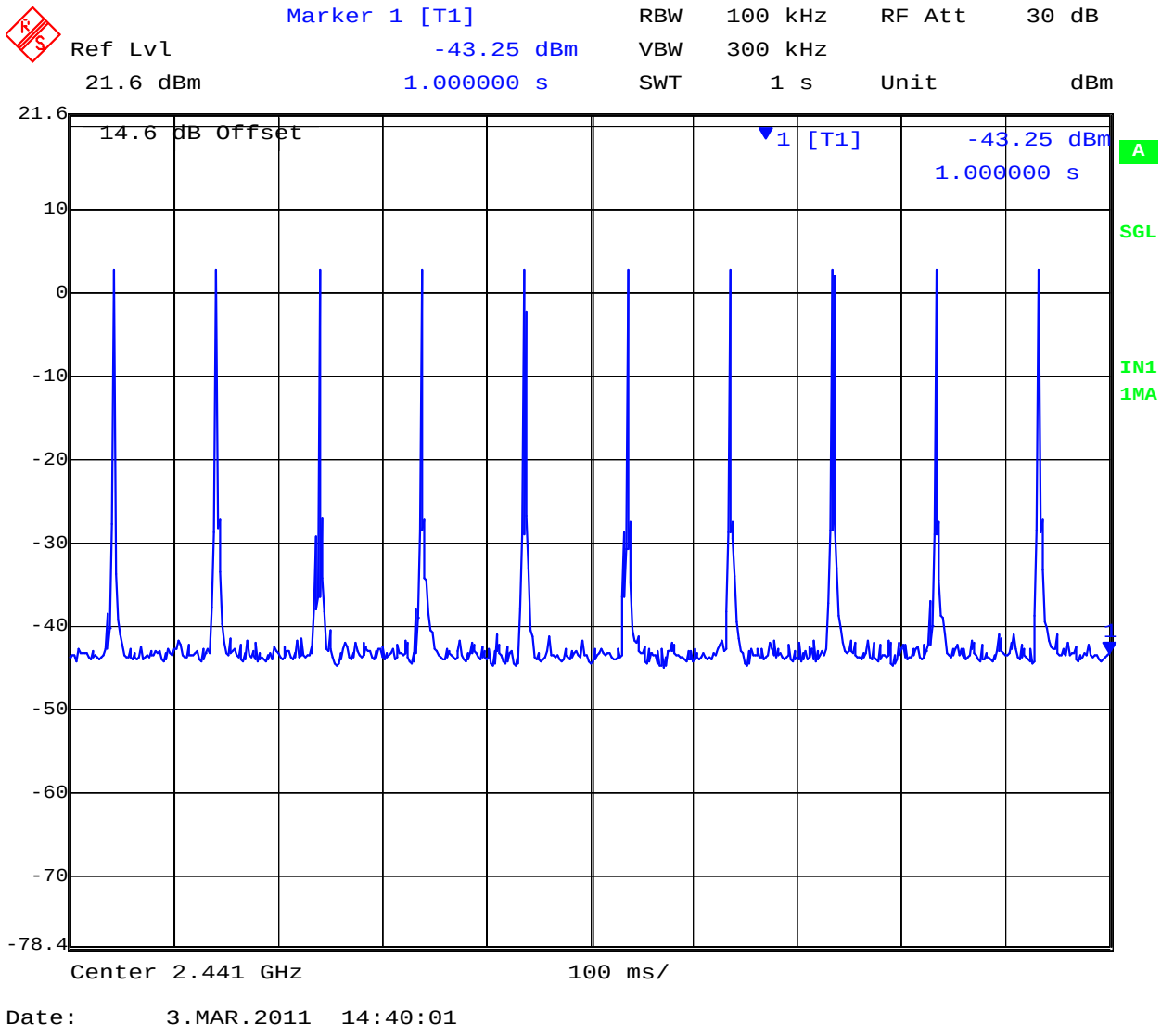
Channel Occupancy; 2441 MHz Channel 39; 1 Mbs Data Rate; Sweep Time 32 s



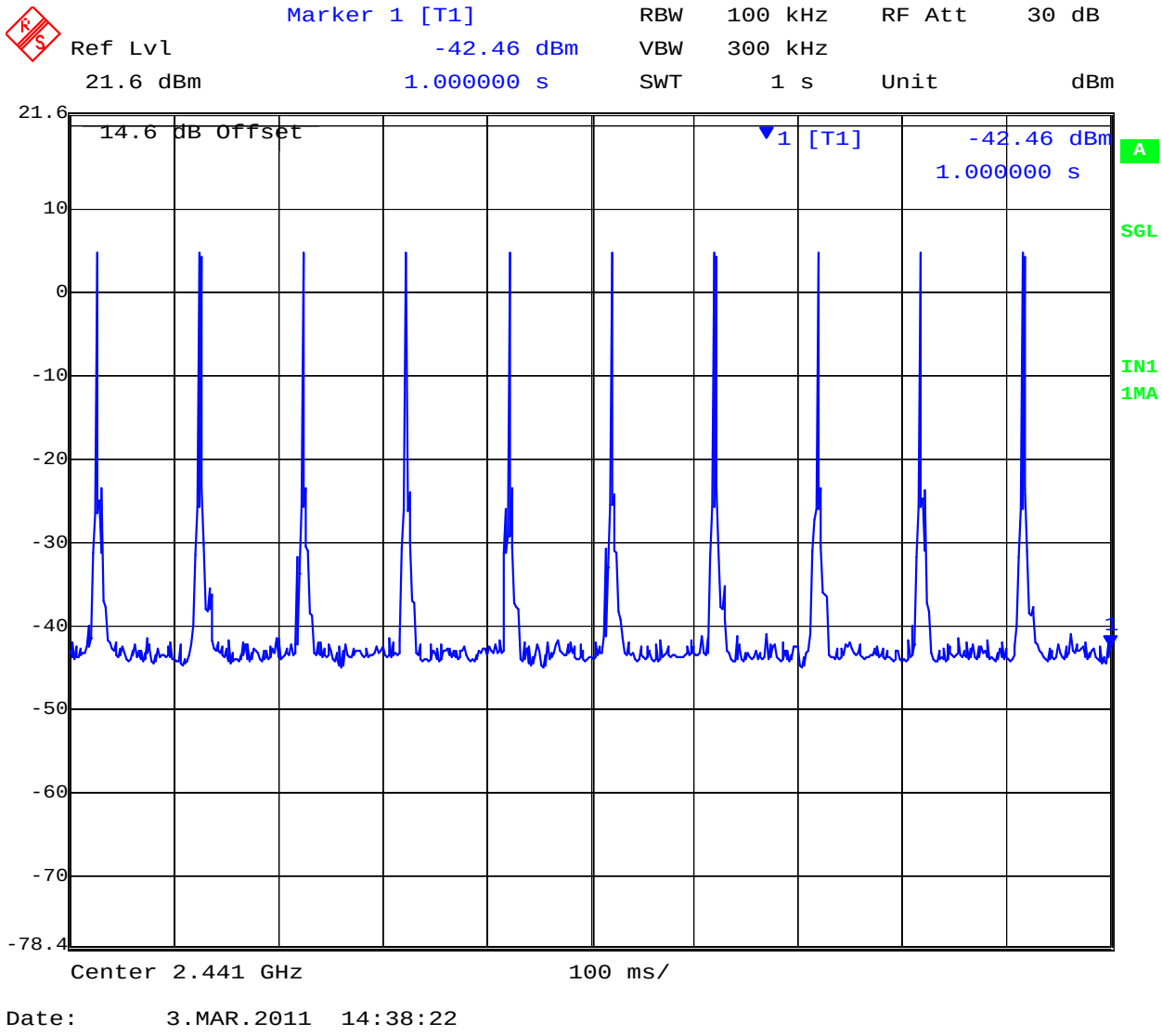
Channel Occupancy; 2441 MHz Channel 39; Data Rate 1 Mbs; Sweep Time 1 s



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

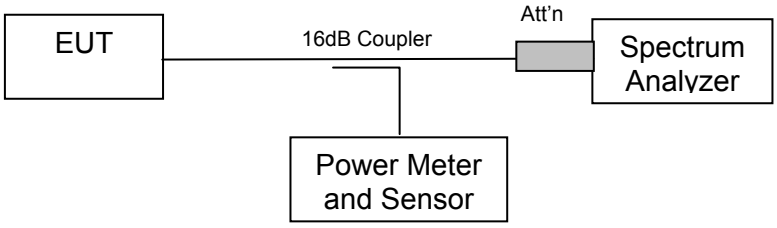
The following spectrum analyzer settings were used:

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

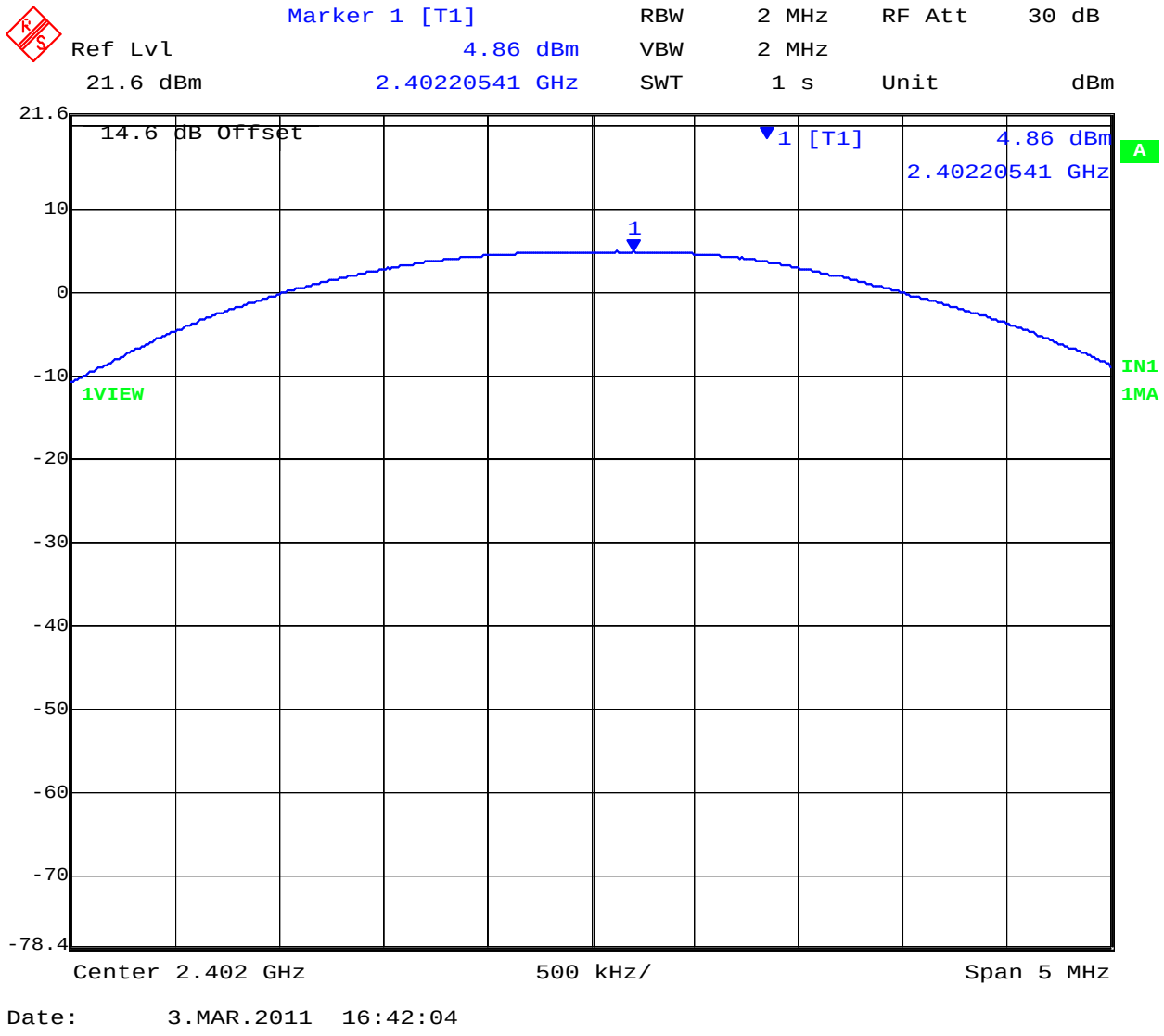
Ambient conditions.

TABLE OF RESULTS

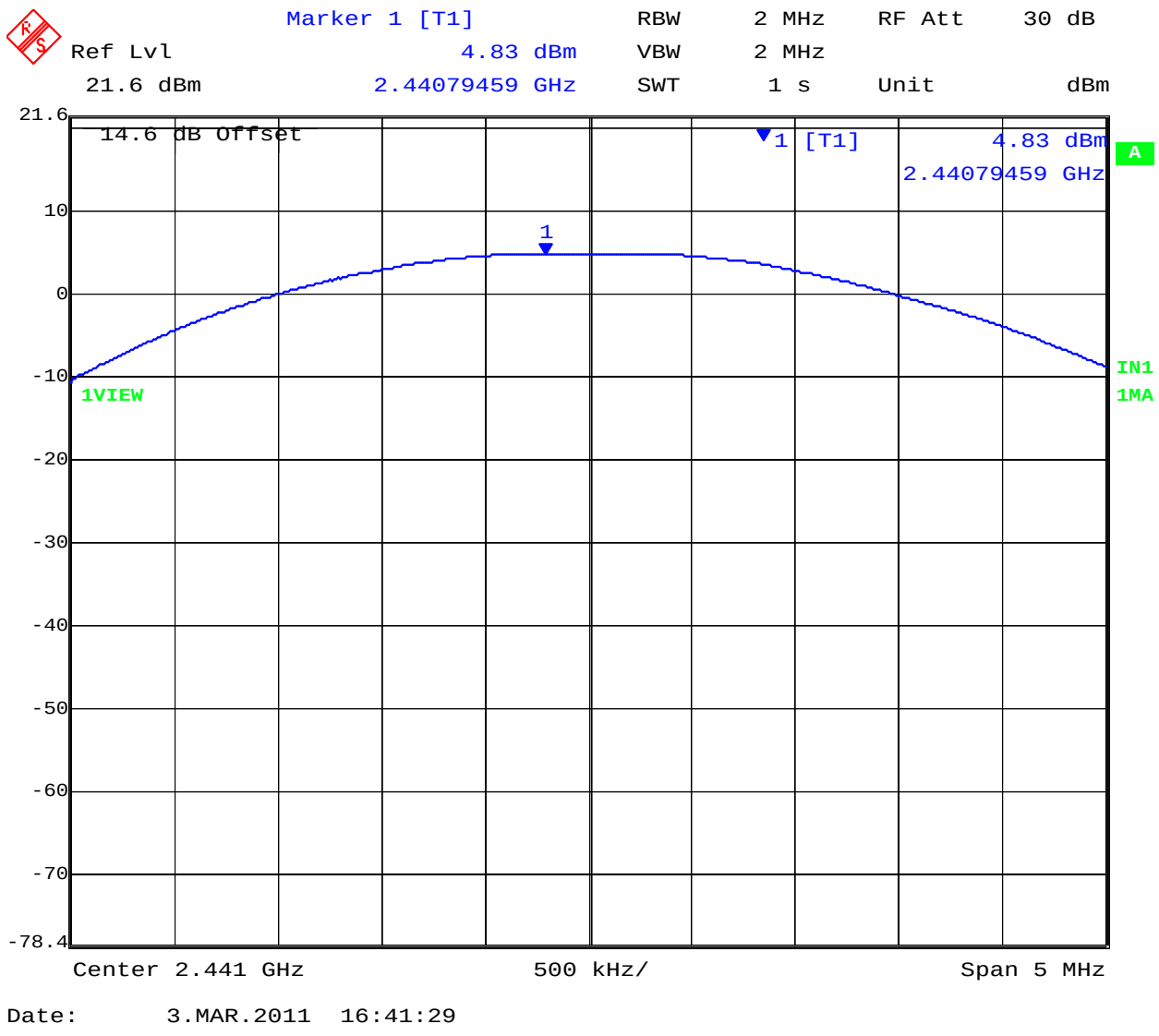
Maximum Conducted Power – 1 MBit/s

Center Frequency (MHz)	Peak Power (dBm)	EIRP (dBm) 0.5 dBi Antenna
2402	+4.86	+5.36
2441	+4.83	+5.33
2480	+4.14	+4.64

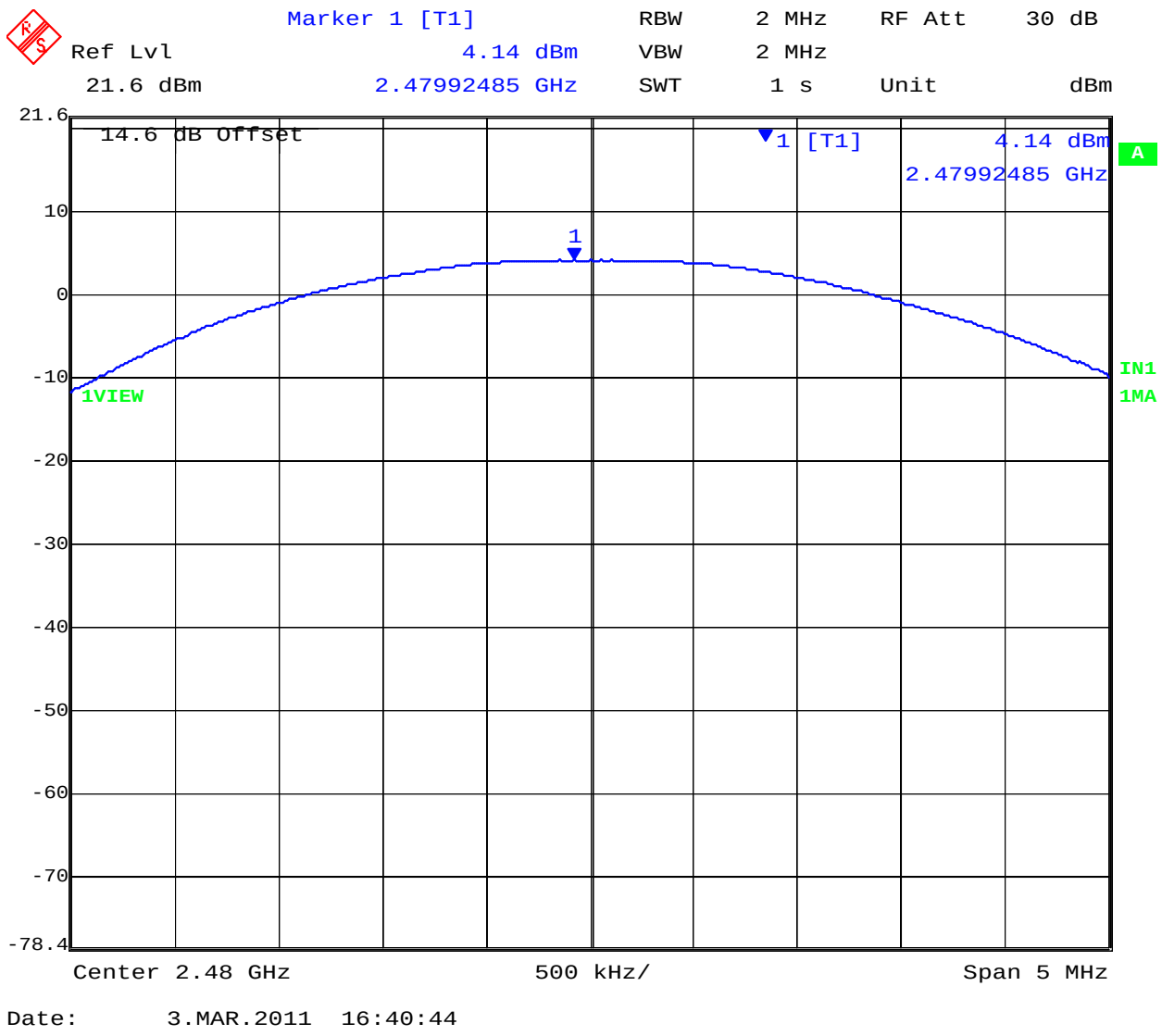
2402 MHz DH1, 1 MBit/s Peak Power (dBm)



2441 MHz DH1, 1 MBit/s Peak Power (dBm)



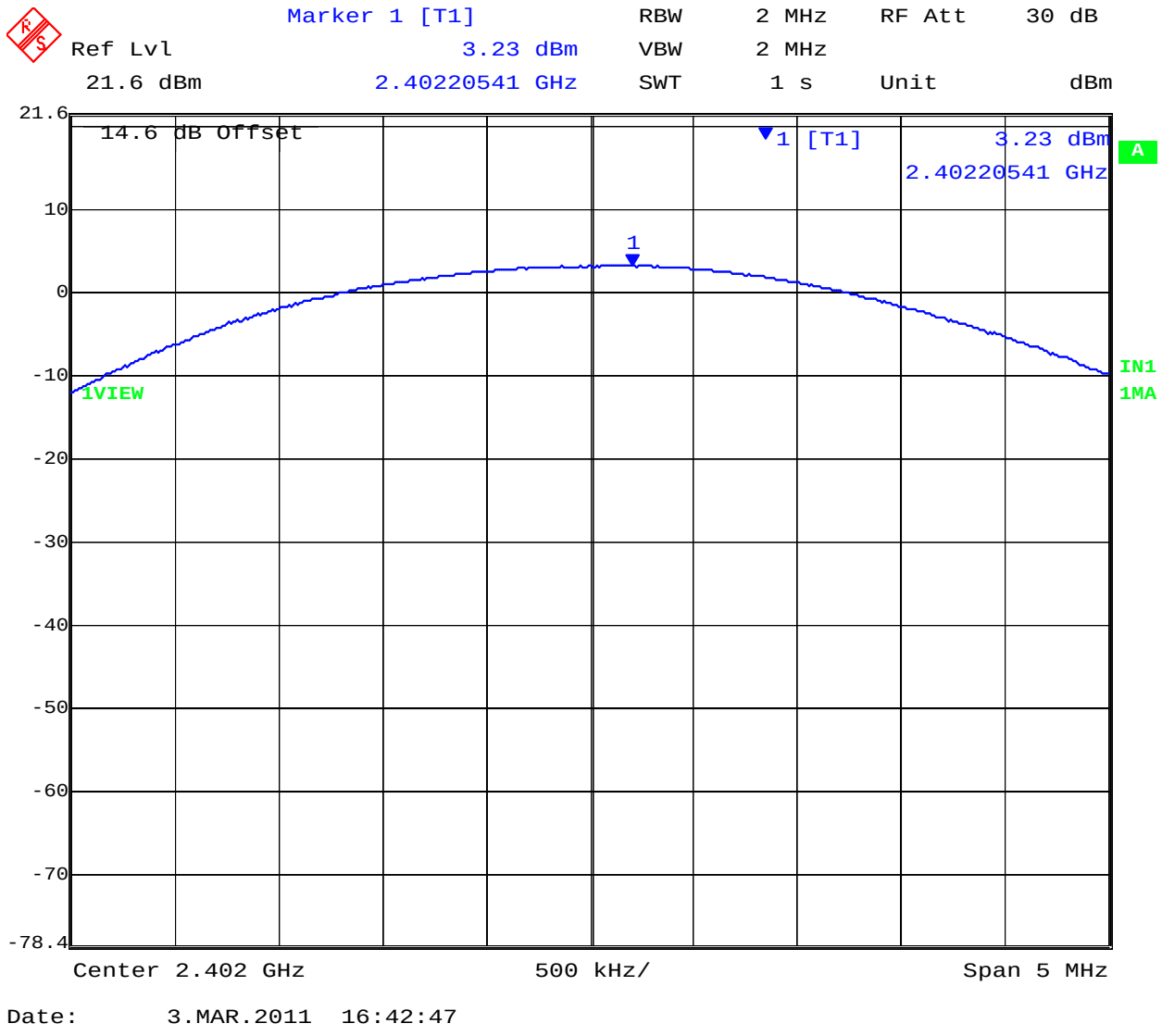
2480 MHz DH1, 1 MBit/s Peak Power (dBm)



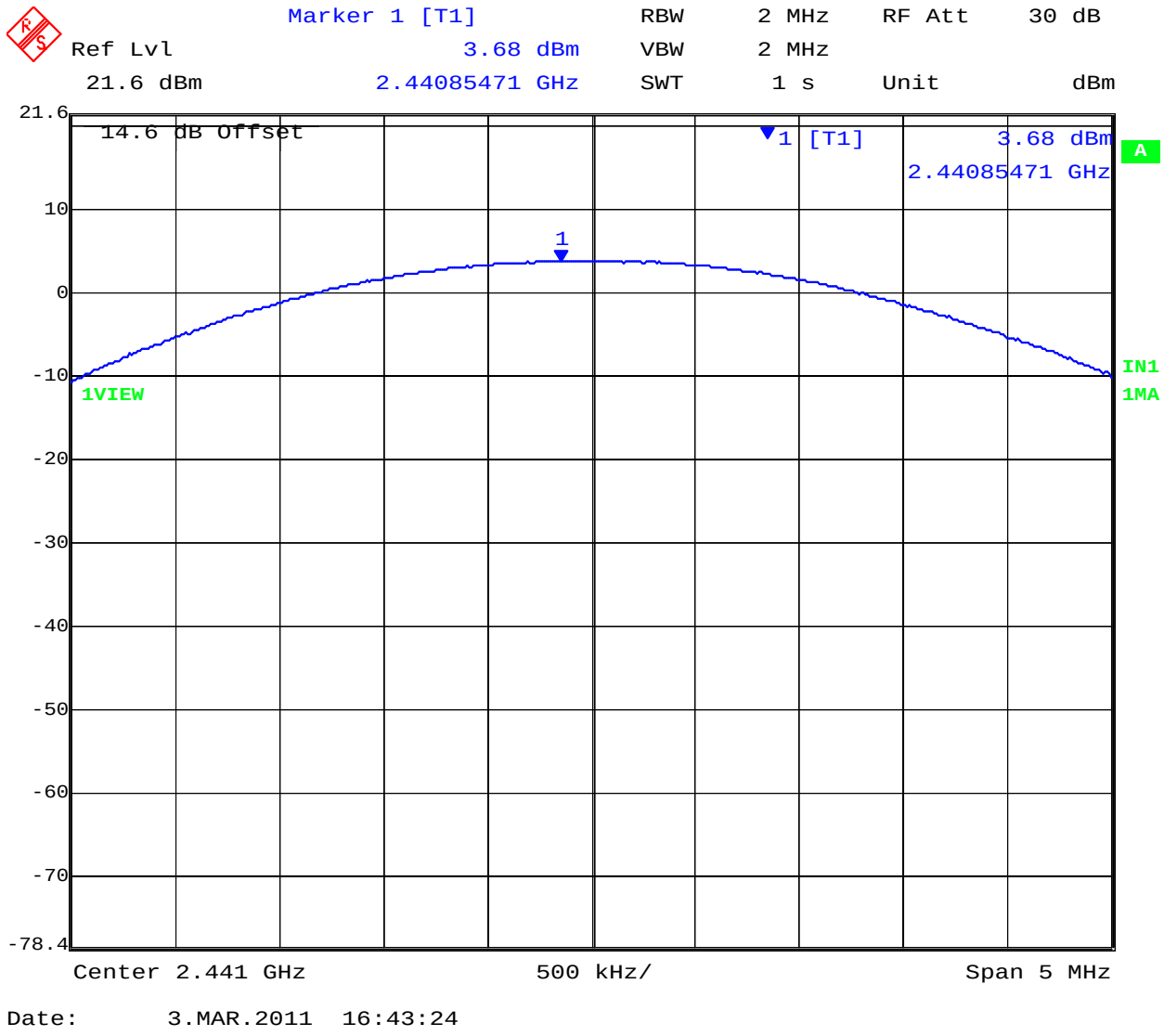
Maximum Conducted Power – 2 MBit/s

Center Frequency (MHz)	Peak Power (dBm)	EIRP (dBm) 0.5 dBi Antenna
2402	+3.23	+3.73
2441	+3.68	+4.18
2480	+2.66	+3.16

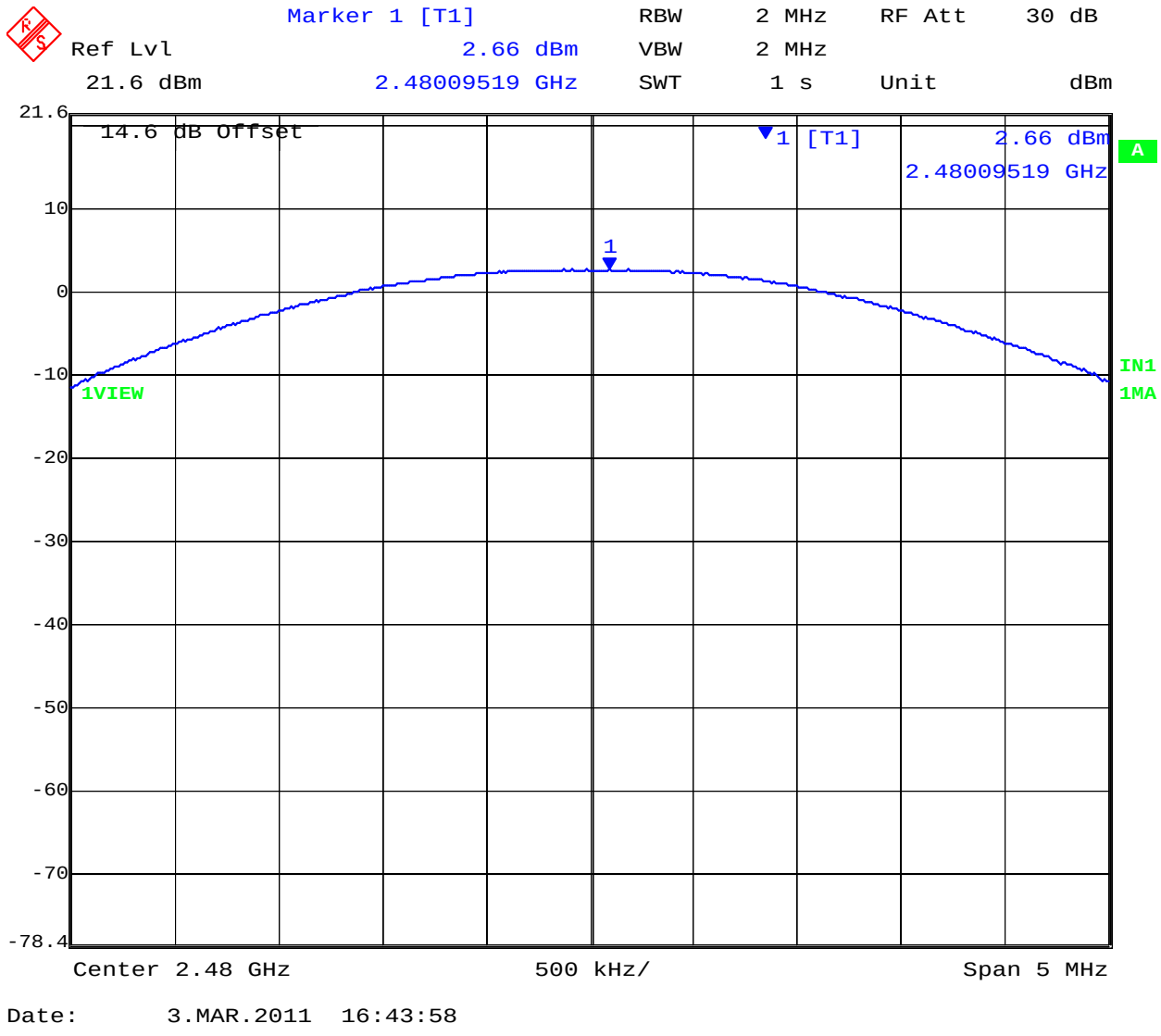
2402 MHz DH2, 2 MBit/s Peak Power (dBm)



2441 MHz DH2, 2 MBit/s Peak Power (dBm)



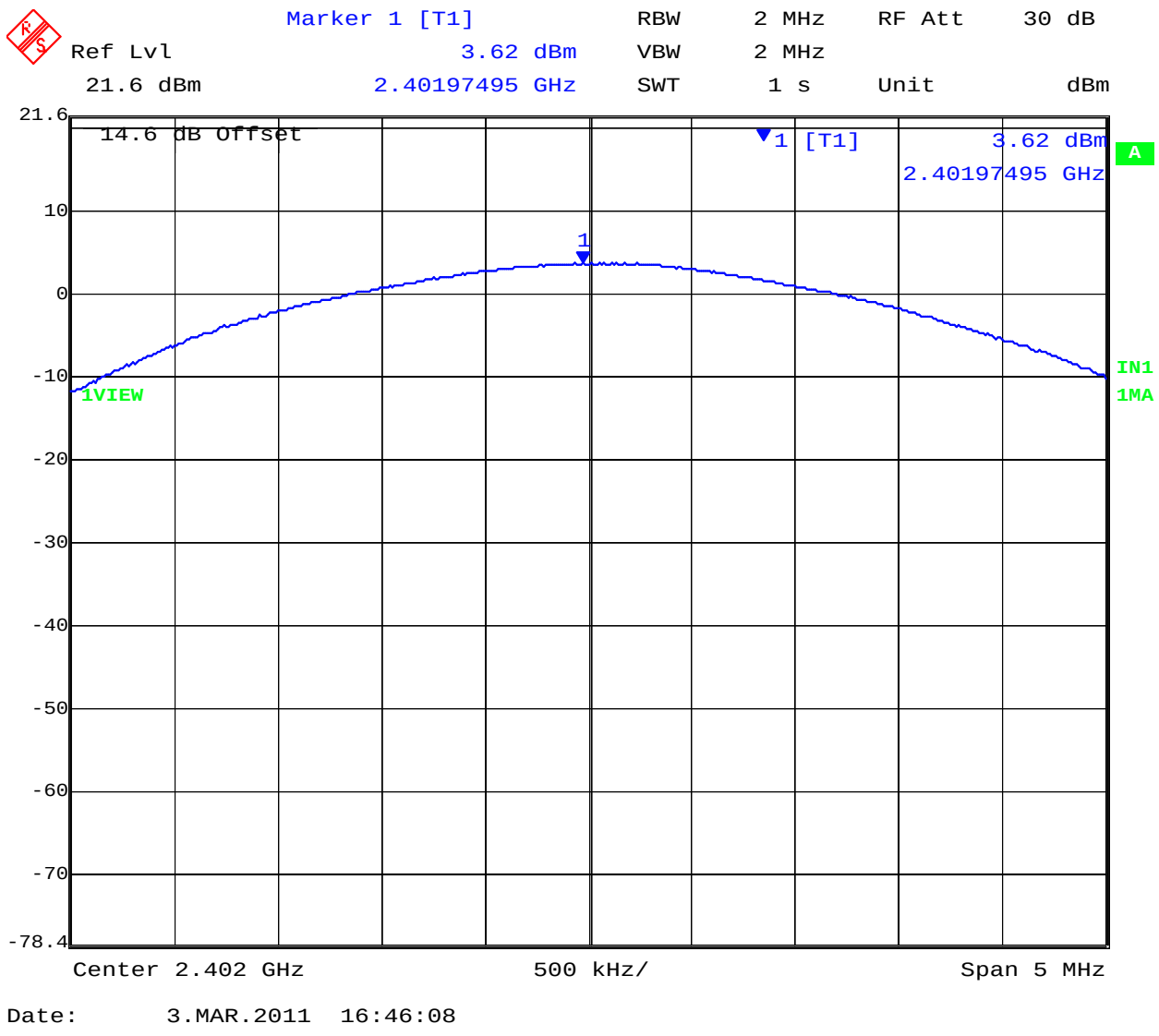
2480 MHz DH2, 2 MBit/s Peak Power (dBm)



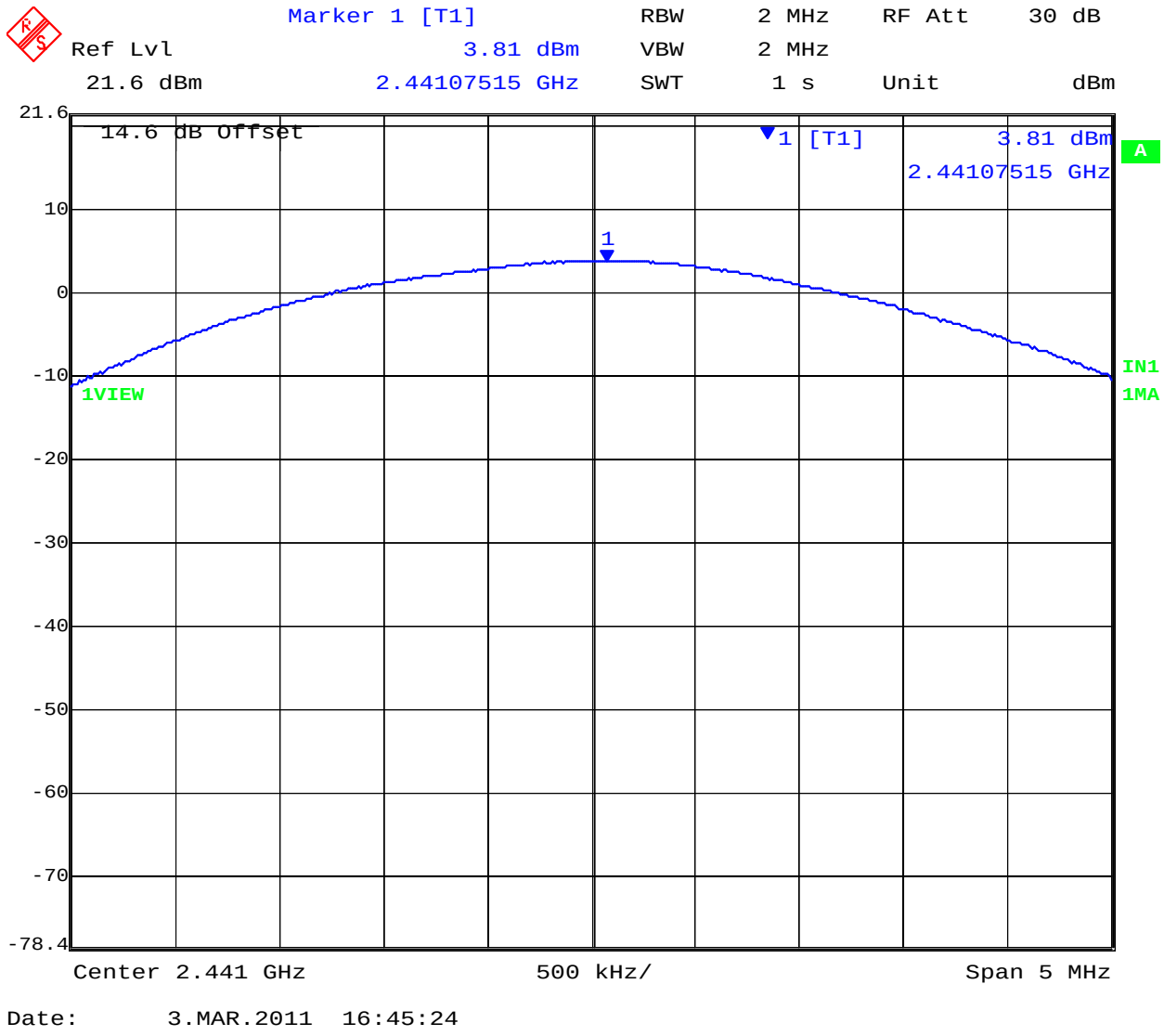
Maximum Conducted Power – 3 MBit/s

Center Frequency (MHz)	Peak Power (dBm)	EIRP (dBm) 0.5 dBi Antenna
2402	+3.62	+4.12
2441	+3.81	+4.31
2480	+3.04	+3.54

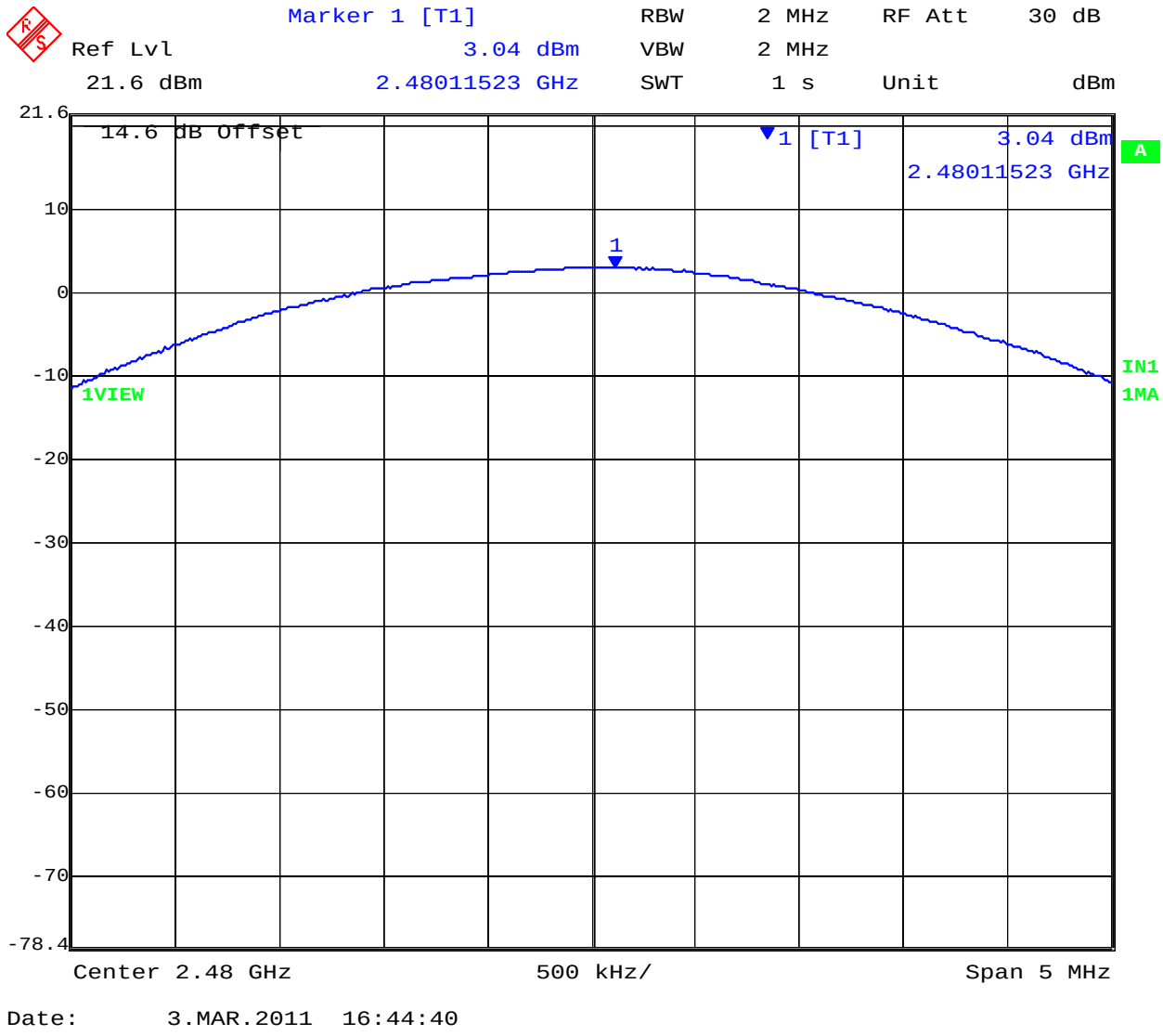
2402 MHz DH3, 3 MBit/s Peak Power (dBm)



2441 MHz DH3, 3 MBit/s Peak Power (dBm)



2480 MHz DH3, 3 MBit/s Peak Power (dBm)



7.1.7 Band-edge Compliance of RF Conducted Emissions

Test Procedure

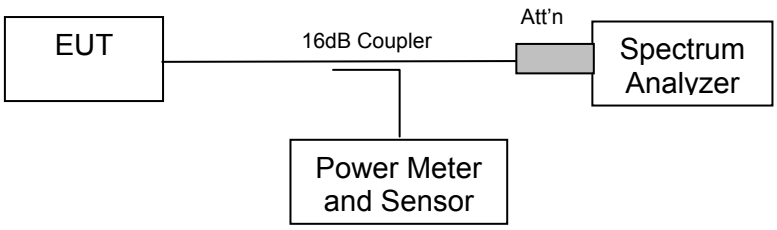
The following spectrum analyzer settings were used:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, 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 band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge. 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

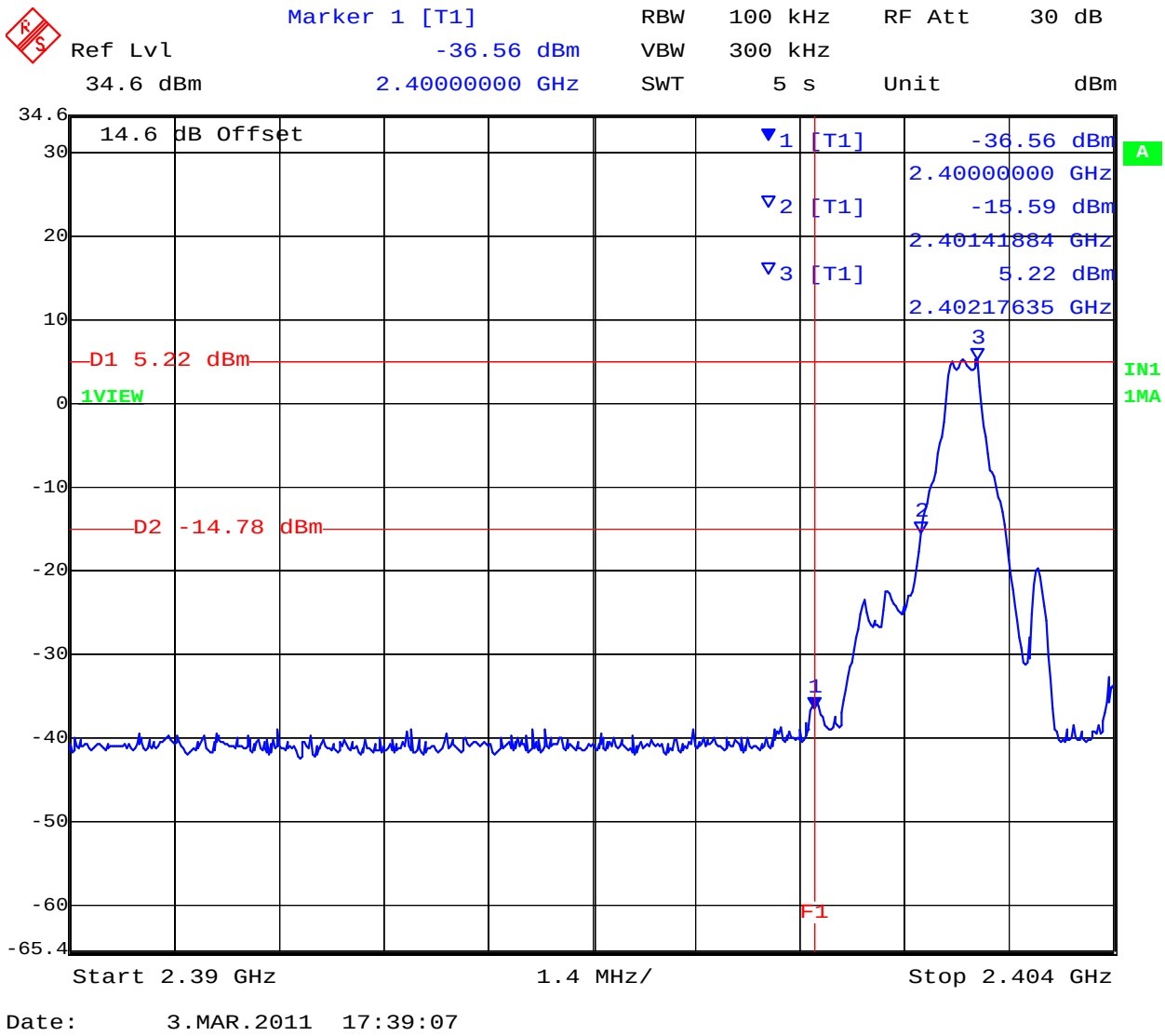
Traceability

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

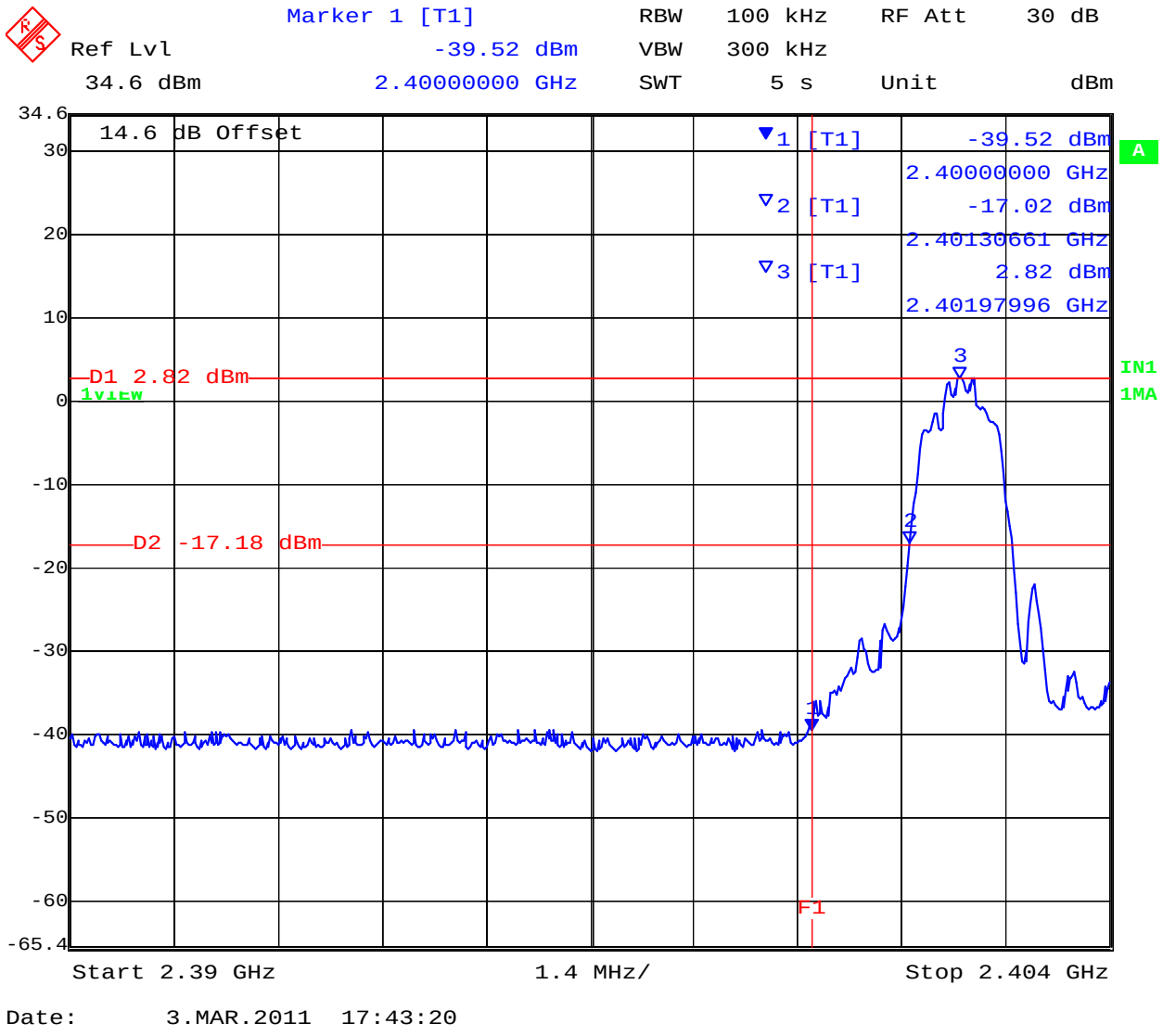
Test Results for Band-edge Compliance of RF Conducted Emissions

Ambient conditions.

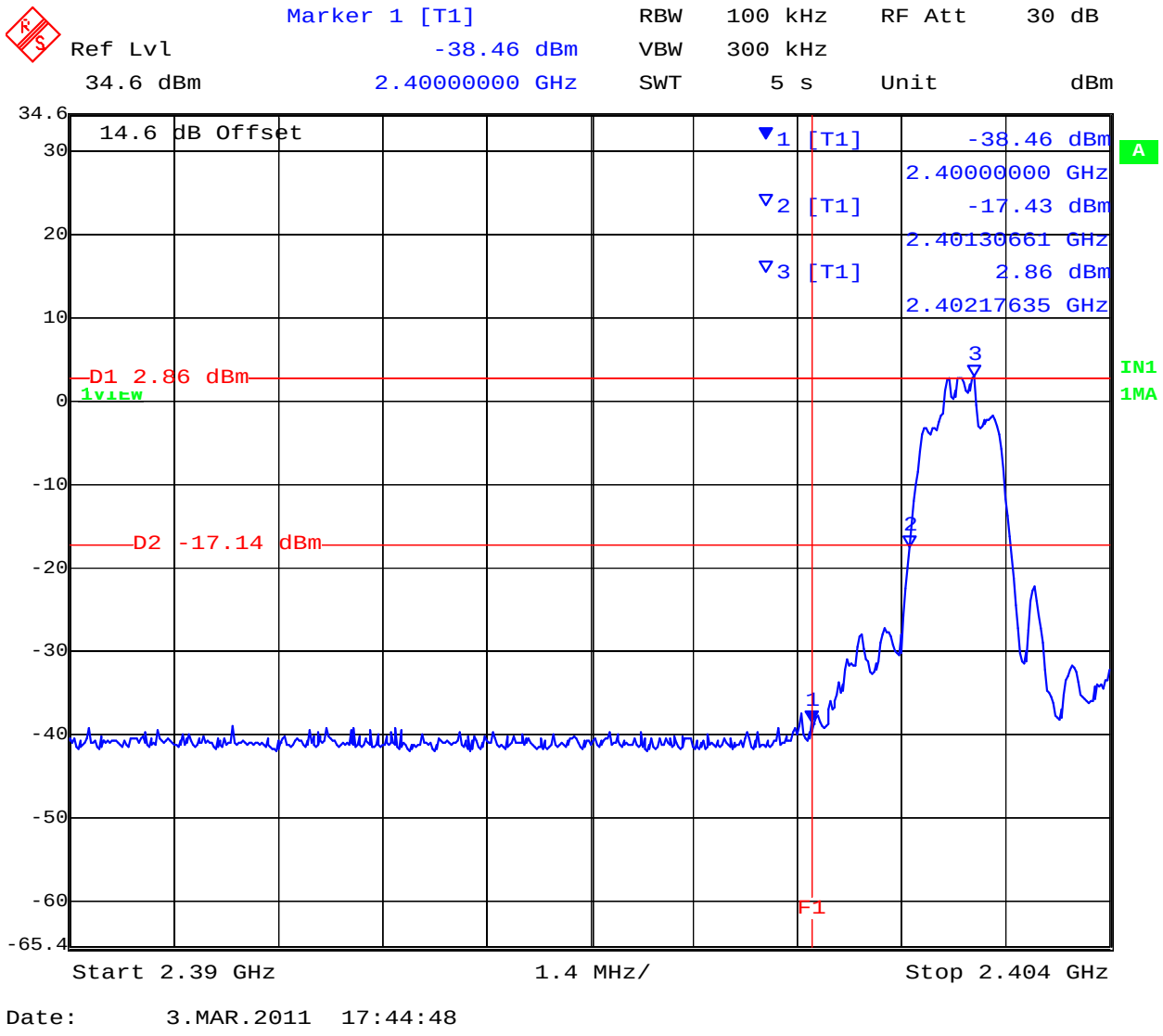
Lower Band-edge; Hopping Off; 1 MBit/s Data Rate



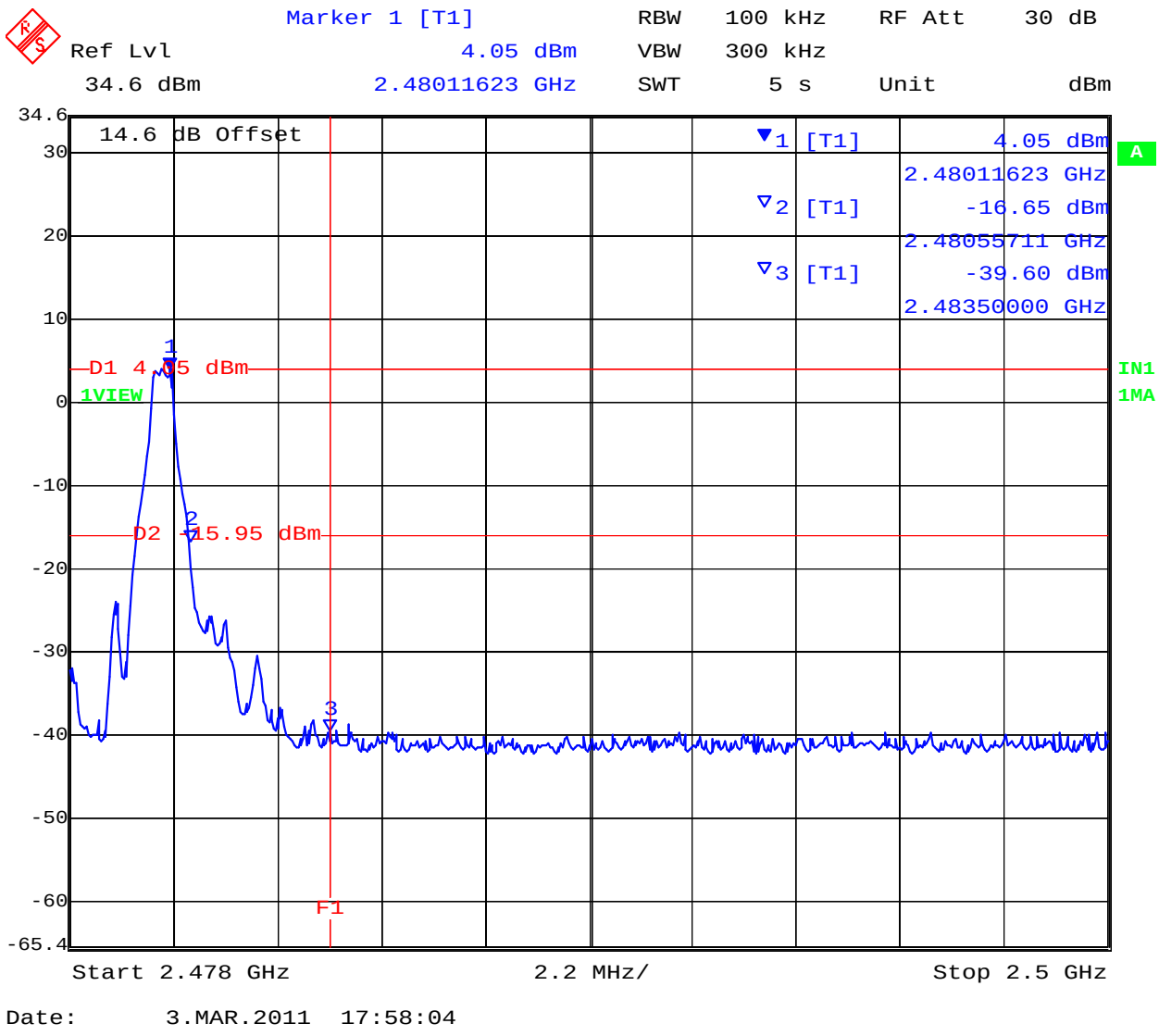
Lower Band-edge; Hopping Off; 2 MBit/s Data Rate



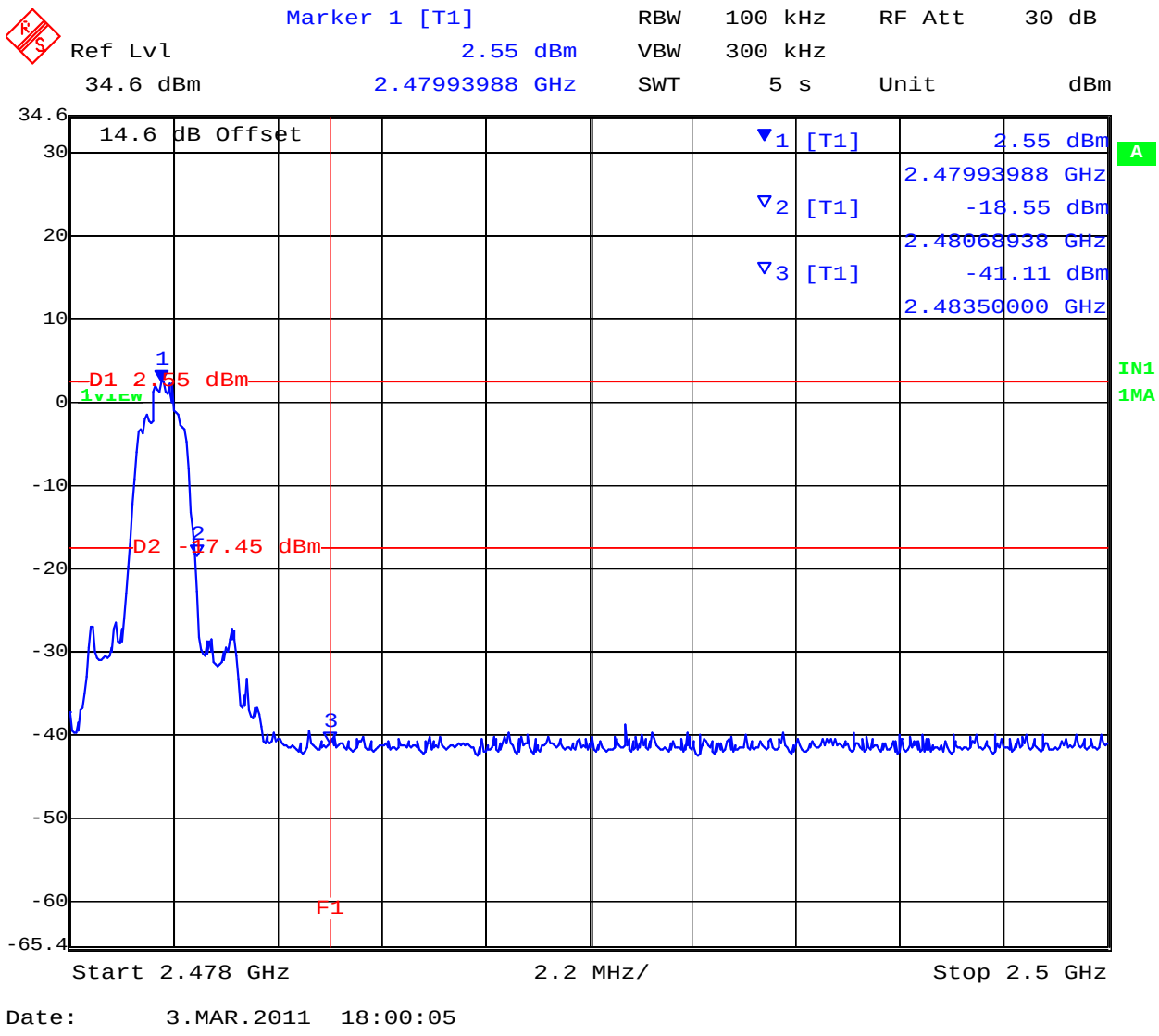
Lower Band-edge; Hopping Off; 3 MBit/s Data Rate



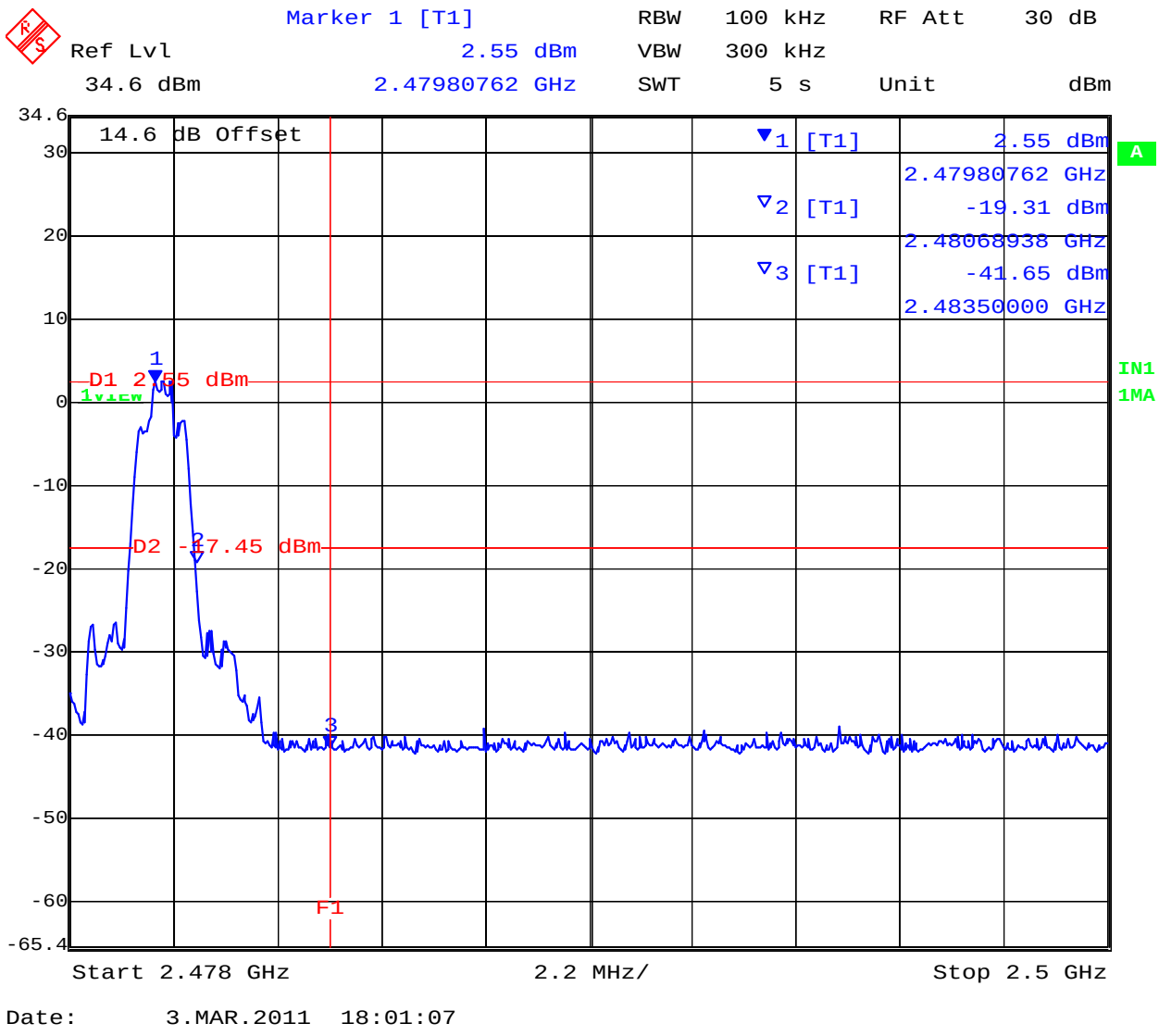
Upper Band-edge; Hopping Off; 1 MBit/s Data Rate



Upper Band-edge; Hopping Off; 2 MBit/s Data Rate



Upper Band-edge; Hopping Off; 3 MBit/s Data Rate



7.1.8 Spurious RF Conducted Emissions - Transmitter

Test Procedure

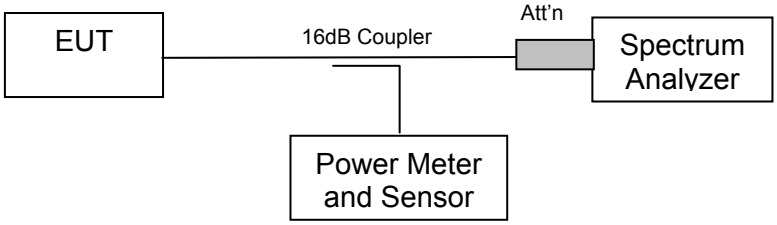
The following spectrum analyzer settings were used:

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

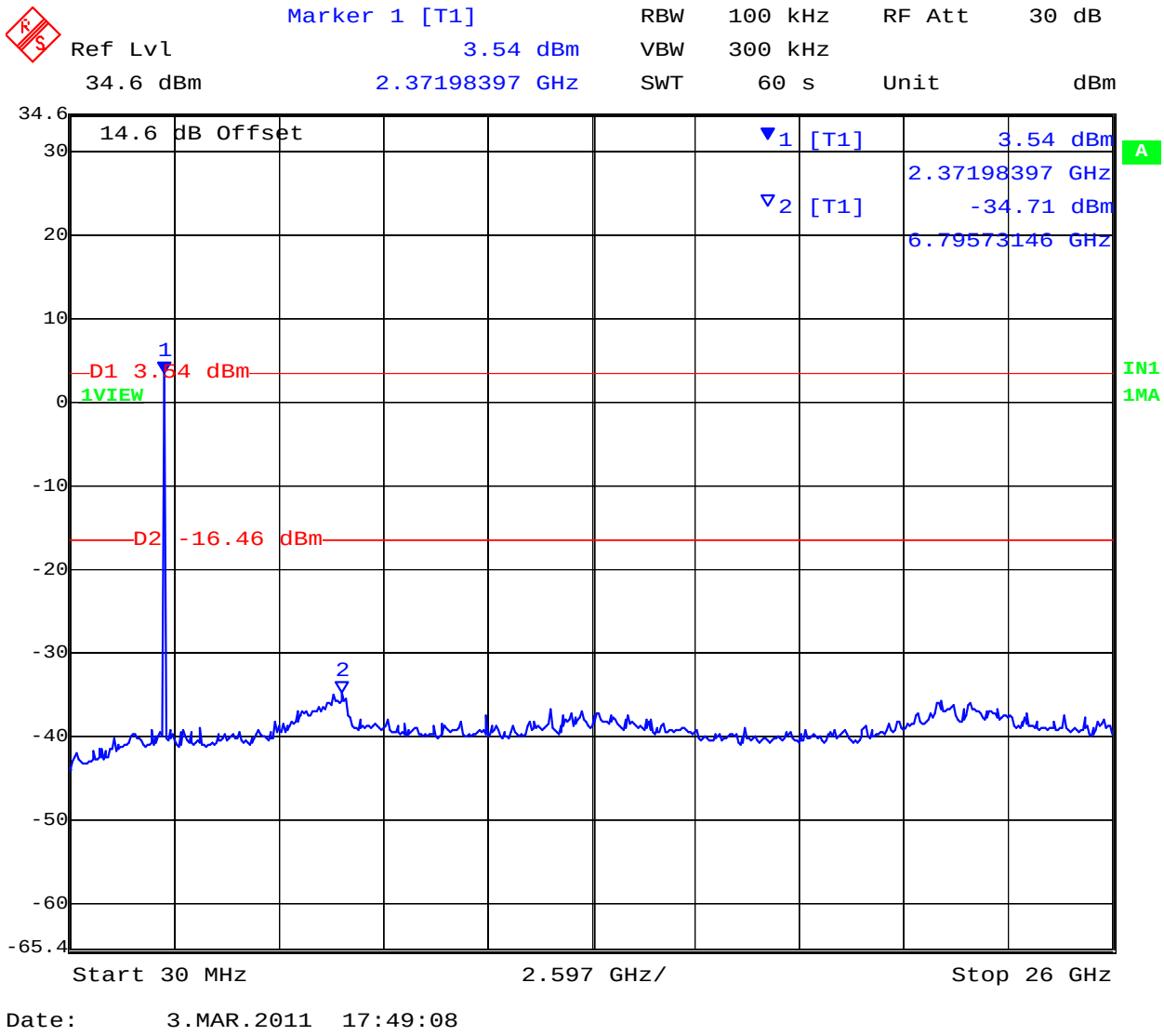
Test Results for Spurious RF Conducted Emissions

Ambient conditions.

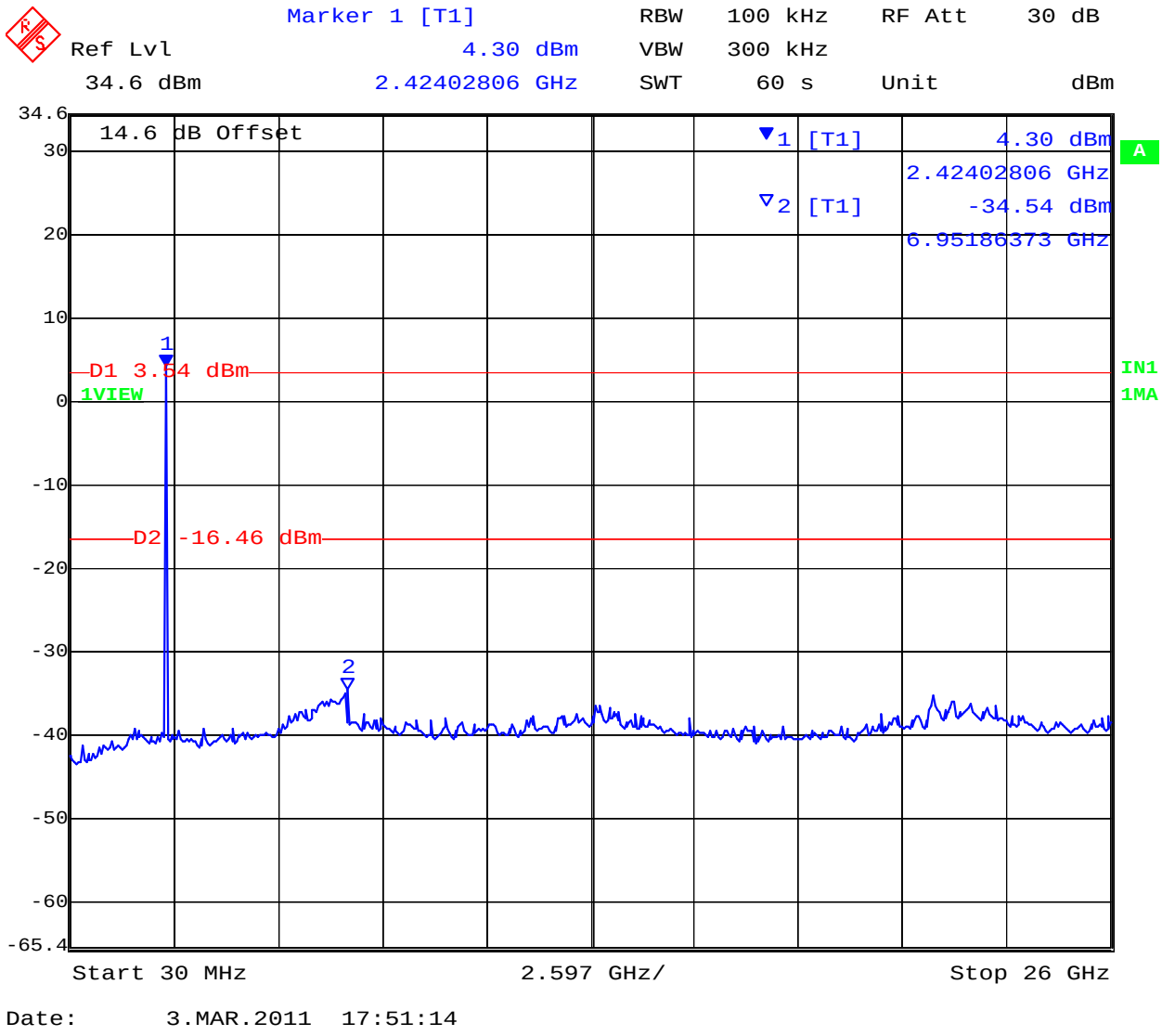
Conducted spurious emissions (30 MHz - 26 GHz) are provided below. The maximum emissions observed are indicated in the table below.

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Date Rate	Limit (dBm)	Margin (dB)
2402	30	26000	-34.71	1 MBit/s	-16.46	-18.25
2441	30	26000	-34.54	1 MBit/s	-16.46	-18.08
2480	30	26000	-33.70	1 MBit/s	-16.46	-17.24
Hopping ON	30	26000	-34.47	1 MBit/s	-15.64	-18.83

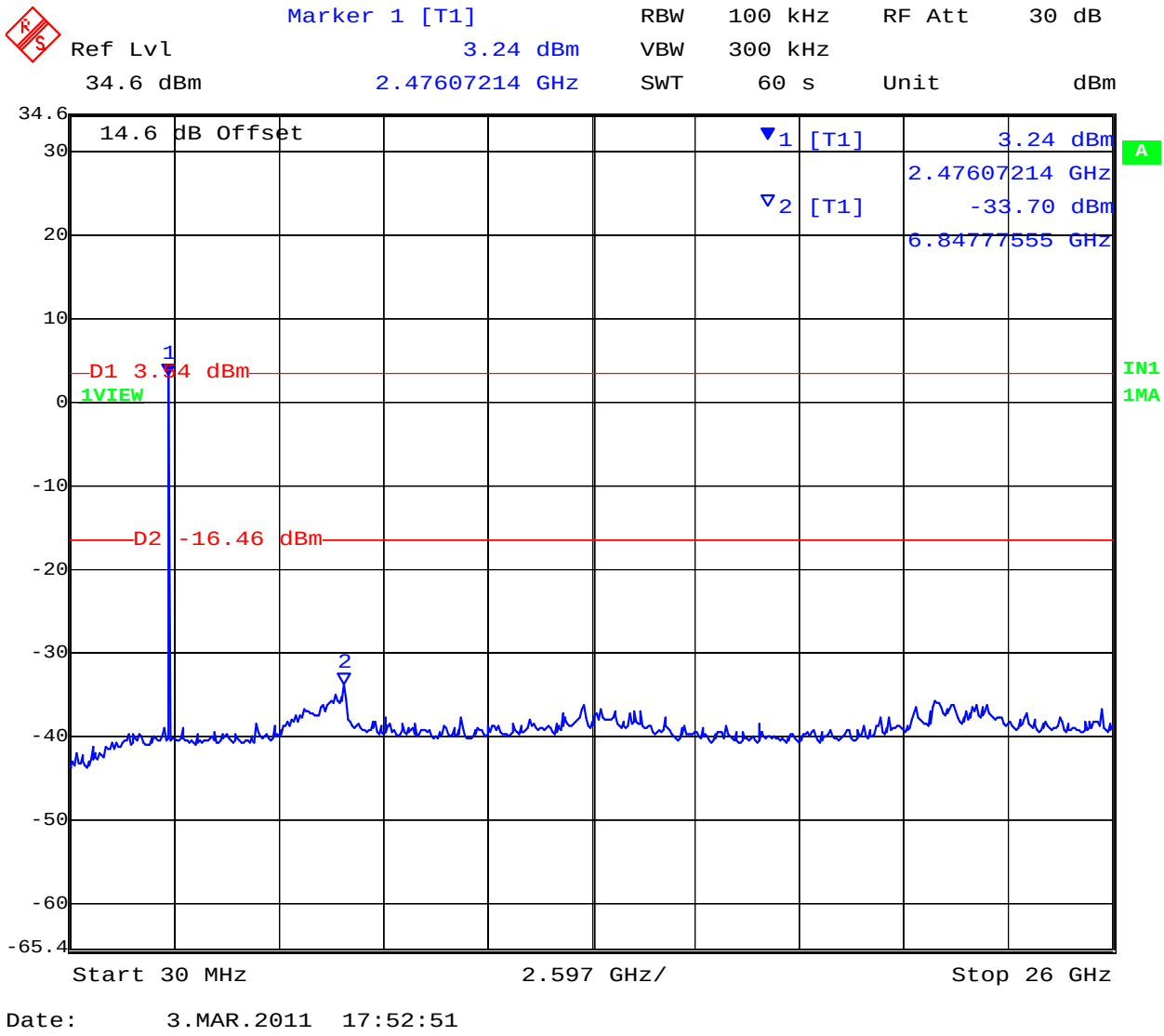
Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 0



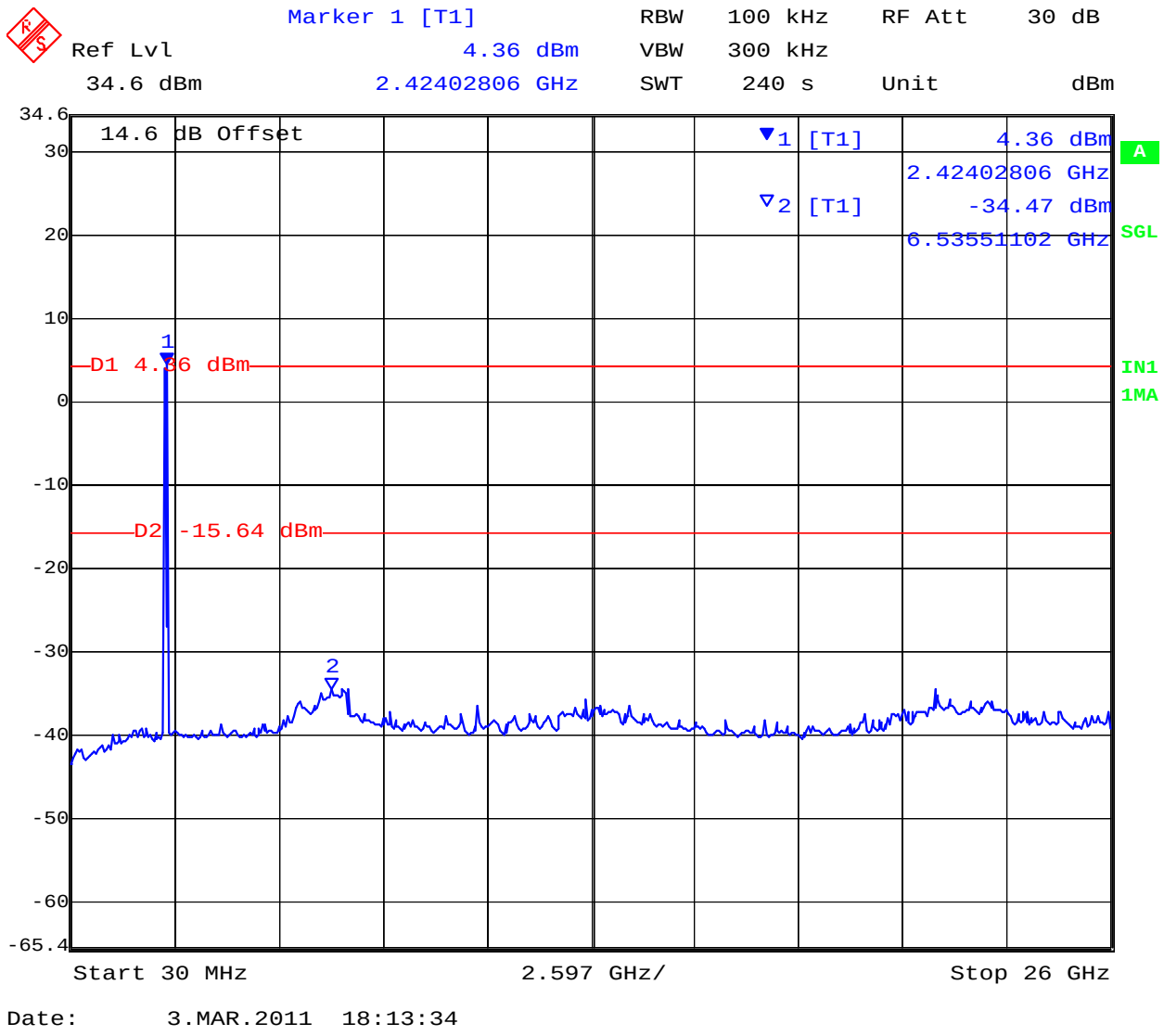
Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 39



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



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



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.

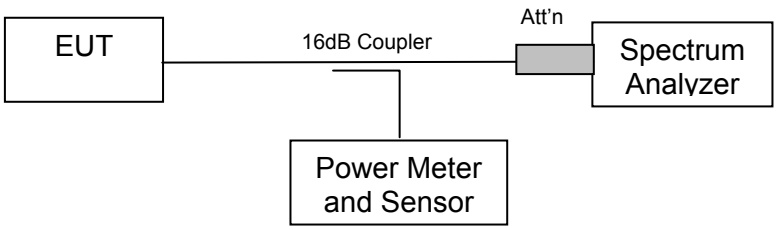
If the receiver is super-regenerative, stabilize it by coupling to it an unmodulated carrier on the receiver frequency (antenna conducted measurement) or by transmitting an unmodulated carrier on the receiver frequency from an antenna in the proximity of the receiver (radiated measurement). Taking care 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 Cambridge Silicon Radio (BlueCore-6) 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.

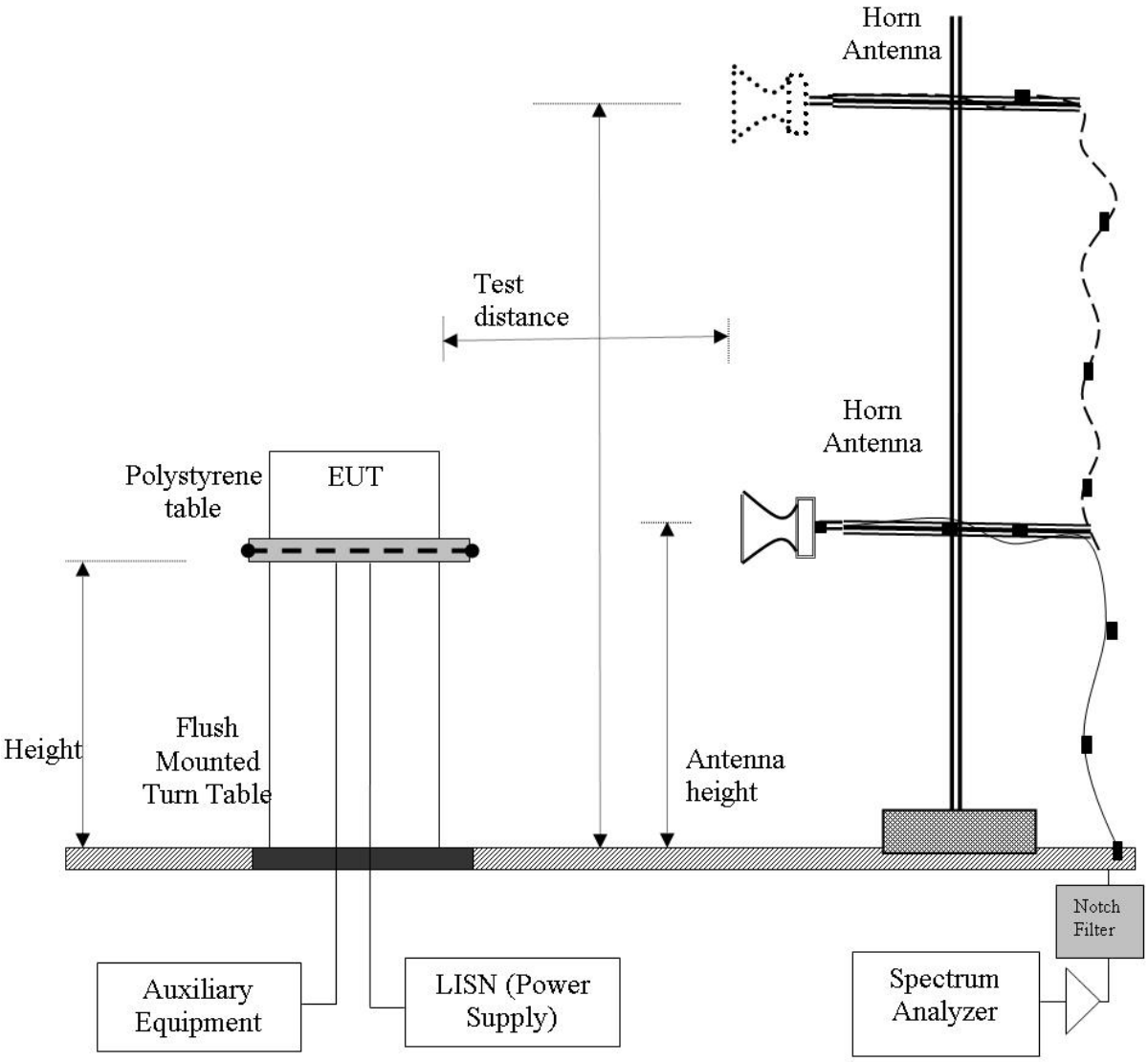
7.2 Radiated Emissions - Radio

Test Procedure

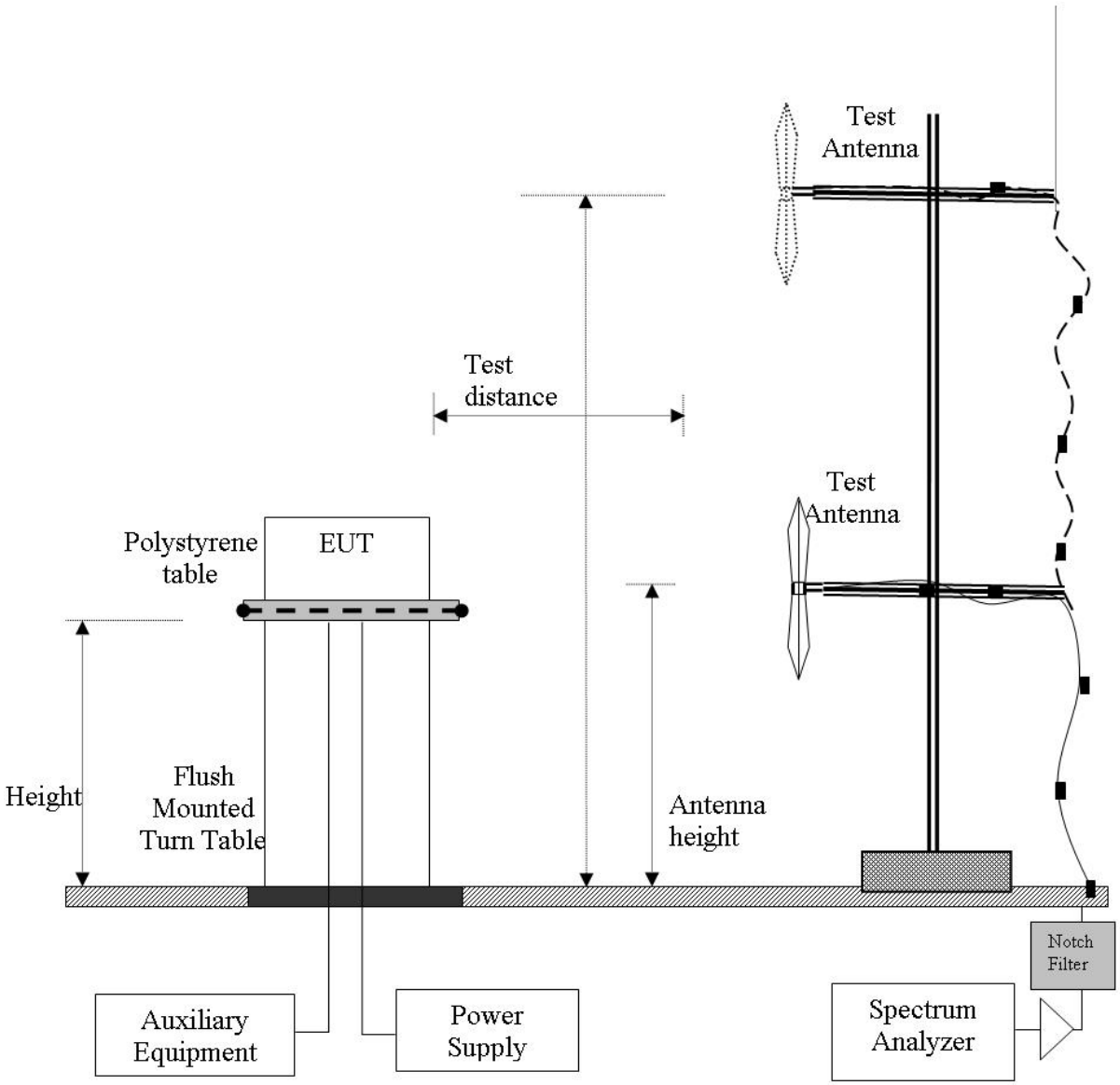
Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak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

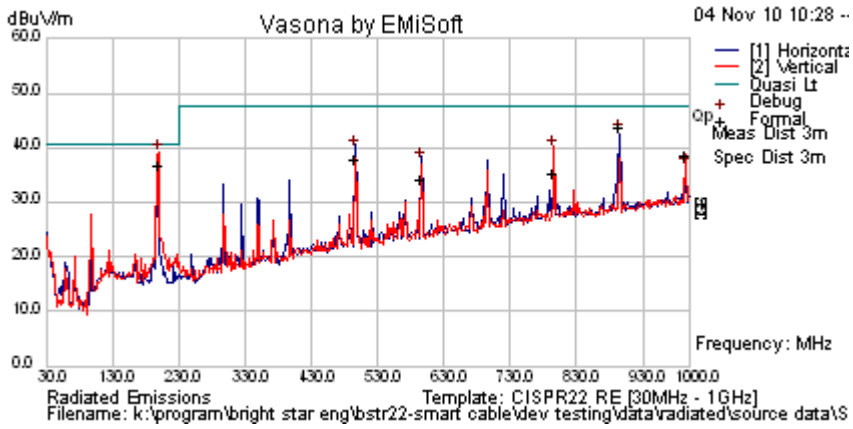
Traceability

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.	2.4 GHz Band	**Engineer**	GMH
Variant	Digital Emissions	**Temp (ºC)**	21.5
Freq. Range	30 MHz - 1000 MHz	**Rel. Hum.(%)**	38
Power Setting	Maximum	**Press. (mBars)**	1004
Antenna	2 dBi Dipole Antenna - Nearson Half-Wave Dipole Swivel Antenna		
Test Notes 1	Test of Emissions from **smartCable**		
Test Notes 2	2.4 GHz Notch Filter on Receiving Amplifier		

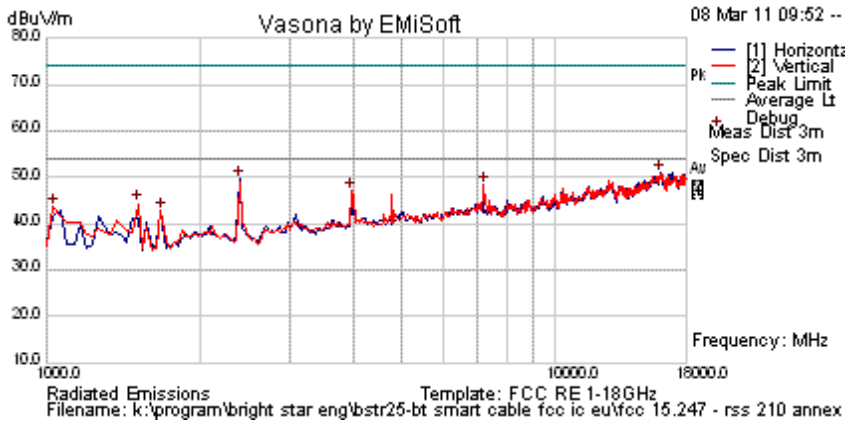


Formally measured emission peaks

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
198.649	50.1	4.7	-18.0	36.9	Quasi Max	V	98	57	40.5	-3.6	Pass	
893.946	43.7	7.3	-7.4	43.6	Quasi Max	H	98	235	47.5	-3.9	Pass	
794.630	36.5	7.2	-8.5	35.2	Quasi Max	H	105	312	47.5	-12.3	Pass	
496.630	44.5	6.0	-12.6	38.0	Quasi Max	H	98	118	47.5	-9.6	Pass	
595.960	39.3	6.4	-11.3	34.4	Quasi Max	V	100	308	47.5	-13.2	Pass	
993.264	37.1	7.7	-6.3	38.6	Quasi Max	V	124	332	47.5	-9.0	Pass	

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.	2402 MHz	**Engineer**	EVF
Variant	Bluetooth	**Temp (ºC)**	20.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	40
Power Setting	max: 255 127	**Press. (mBars)**	1010
Antenna	integral	**Duty Cycle (%)**	100
Test Notes 1	EUT placed on the table along with its peripherals; Fundamental attenuated by band-stop filter.		
Test Notes 2	TXDATA1: Ch.0 1MBits; Transport Type: BCSP/ Serial Port: com 4/ Baud Rate: 57600		

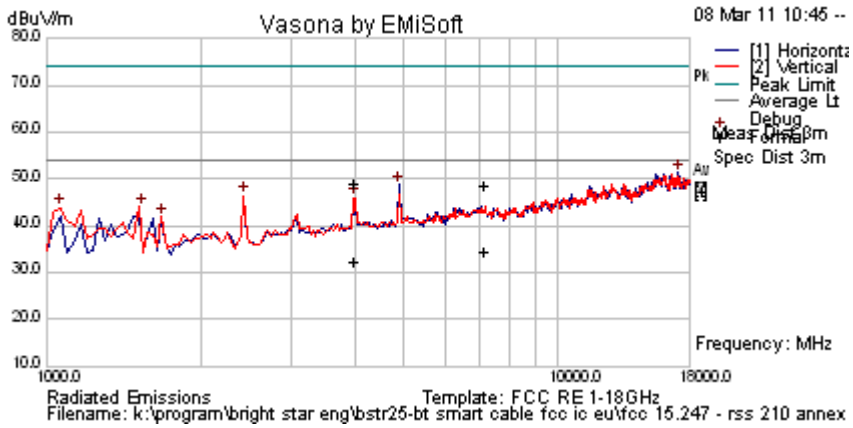


Formally measured emission peaks

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
16058.116	41.3	9	0.7	51	Peak [Scan]	H	100	0	54	-3	Pass	noise floor
2402.034	57.6	3	-11.1	49.5	Peak [Scan]	H	150	0	54	-4.5	Pass	FUND
1536.814	56.3	2.4	-14.5	44.3	Peak [Scan]	V	100	0	54	-9.8	Pass	RB
1092.585	57.8	2	-16.2	43.7	Peak [Scan]	V	100	0	54	-10.4	Pass	RB
1688.477	53.8	2.5	-13.7	42.7	Peak [Scan]	V	100	0	54	-11.3	Pass	RB
7205.591	48.3	5.4	-5.3	48.4	Peak Max	V	117	0	74.0	-25.6	Pass	NRB
3989.739	55.3	3.9	-9.9	49.2	Peak Max	V	164	103	74.0	-24.8	Pass	RB
7205.591	34.5	5.4	-5.3	34.6	Average Max	V	117	0	54	-19.4	Pass	NRB
3989.739	38.6	3.9	-9.9	32.5	Average Max	V	164	103	54	-21.5	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	2441 MHz	**Engineer**	EVF
Variant	Bluetooth	**Temp (ºC)**	20.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	40
Power Setting	max: 255 127	**Press. (mBars)**	1010
Antenna	integral	**Duty Cycle (%)**	100
Test Notes 1	EUT placed on the table along with its peripherals; Fundamental attenuated by band-stop filter.		
Test Notes 2	BT Tx: Ch.39 1MBits		

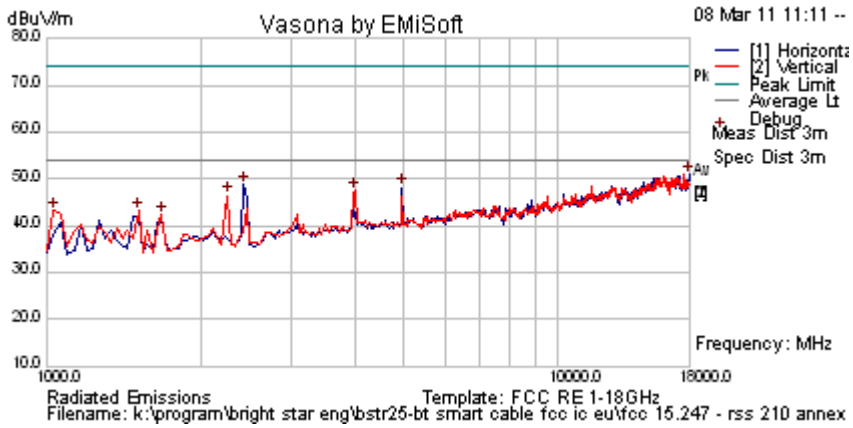


Formally measured emission peaks

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
4881.844	48.6	4.5	-9.3	43.8	Peak Max	H	98	12	74.0	-30.2	Pass	RB
4881.844	35.3	4.5	-9.3	30.5	Average Max	H	98	12	54.0	-23.5	Pass	RB
17148.297	42.3	8.6	0.5	51.3	Peak [Scan]	H	200	0	54.0	-2.7	Pass	noise floor
2441.042	54.5	3.0	-11.0	46.5	Peak [Scan]	H	100	0	54.0	-7.5	Pass	FUND
3988.457	52.0	3.9	-9.9	45.9	Peak [Scan]	V	100	0	54	-8.1	Pass	RB
1536.854	56.2	2.4	-14.5	44.1	Peak [Scan]	V	100	0	54	-9.9	Pass	RB
1063.287	57.8	2.0	-16.1	43.8	Peak [Scan]	V	100	0	54	-10.2	Pass	RB
1688.457	53.1	2.5	-13.7	41.9	Peak [Scan]	V	100	0	54	-12.1	Pass	RB

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	2480 MHz	**Engineer**	EVF
Variant	Bluetooth	**Temp (ºC)**	20.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	40
Power Setting	max: 255 127	**Press. (mBars)**	1010
Antenna	integral	**Duty Cycle (%)**	100
Test Notes 1	EUT placed on the table along with its peripherals; Fundamental attenuated by band-stop filter.		
Test Notes 2	BT Tx: Ch.78 1MBits		



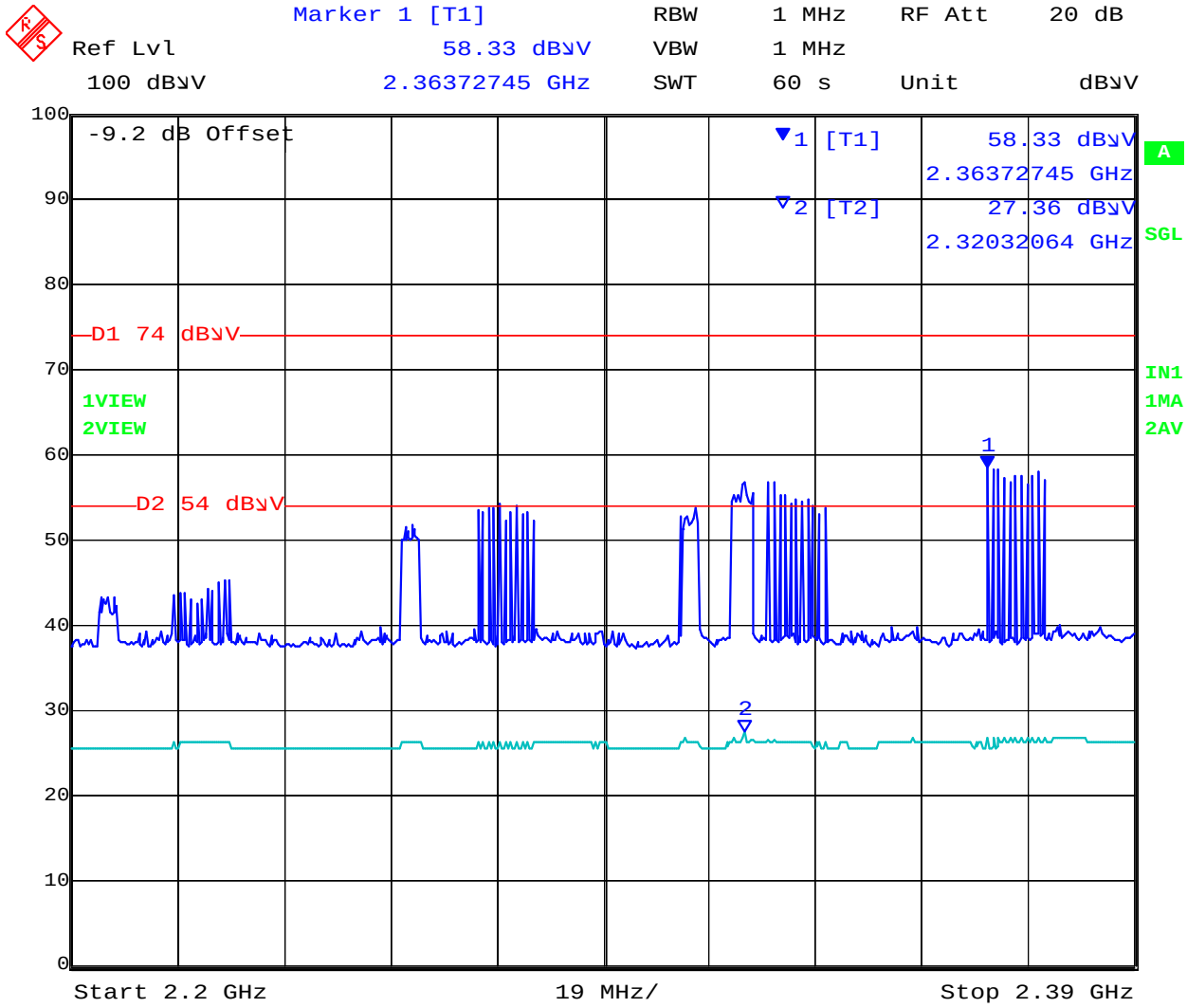
Formally measured emission peaks

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
4959.880	53.5	4.6	-9.1	49.1	Peak Max	H	142	253	74.0	-25.0	Pass	RB
4959.88	37.6	4.6	-9.1	33.2	Average Max	H	142	253	54.0	-20.9	Pass	RB
17965.932	41.1	8.8	0.9	50.8	Peak [Scan]	H	200	0	54.0	-3.2	Pass	noise floor
2479.84	56.7	3.0	-11.0	48.7	Peak [Scan]	H	200	0	54.0	-5.3	Pass	FUND
3990.461	53.5	3.9	-9.9	47.5	Peak [Scan]	V	100	0	54	-6.5	Pass	RB
2261.824	54.9	2.9	-11.3	46.5	Peak [Scan]	V	200	0	54	-7.5	Pass	RB
1537.074	55.3	2.4	-14.5	43.2	Peak [Scan]	V	100	0	54	-10.8	Pass	RB
1092.265	57.3	2.0	-16.2	43.1	Peak [Scan]	V	200	0	54	-10.9	Pass	RB
1688.577	53.6	2.5	-13.7	42.4	Peak [Scan]	V	100	0	54	-11.6	Pass	RB

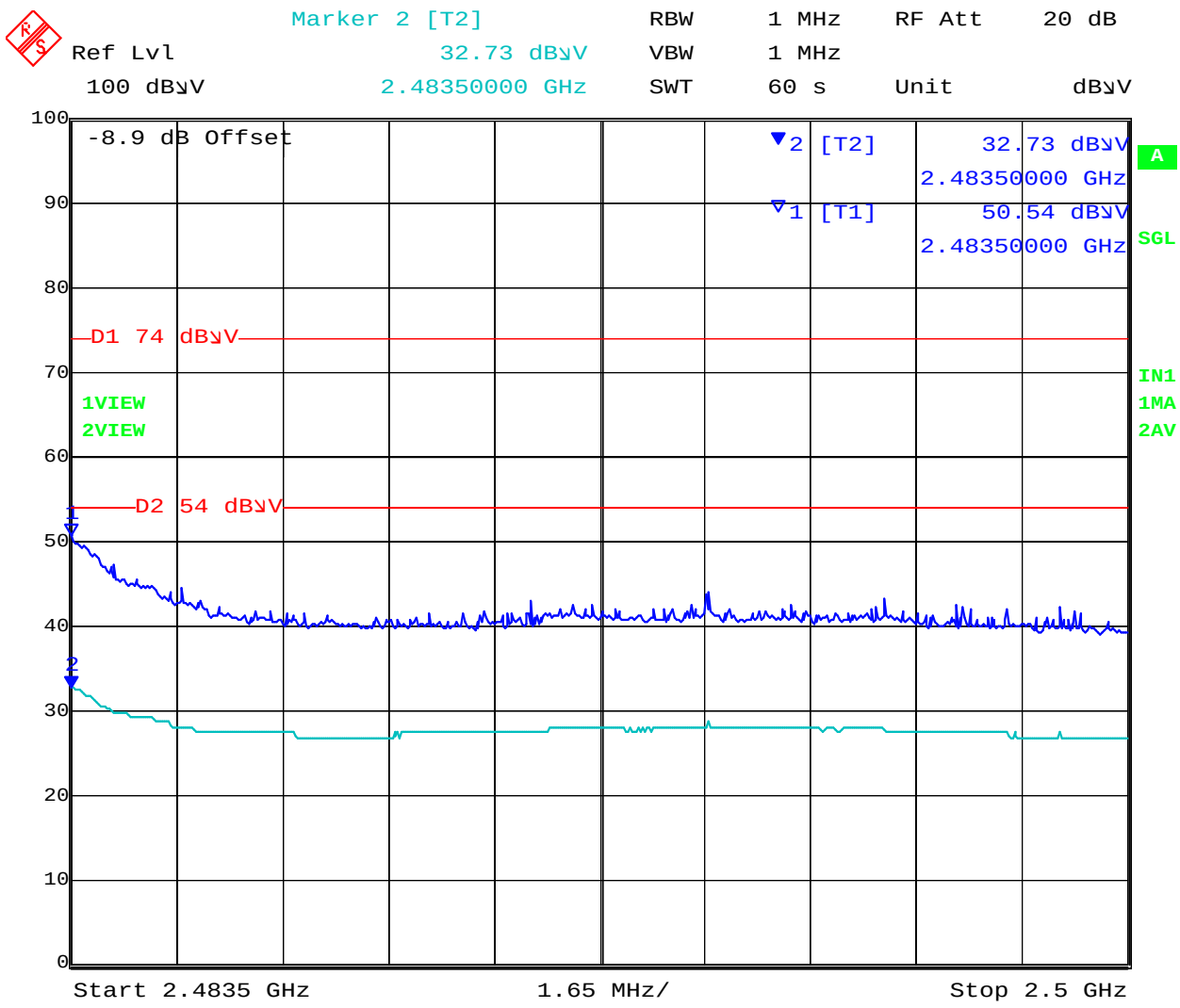
Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

7.2.2 Band-edge Measurements

Band-edge; Channel 0; 1 M/Bit/s Data Rate; 2200-2390 MHz; Vert. Hg=98 Ang=238

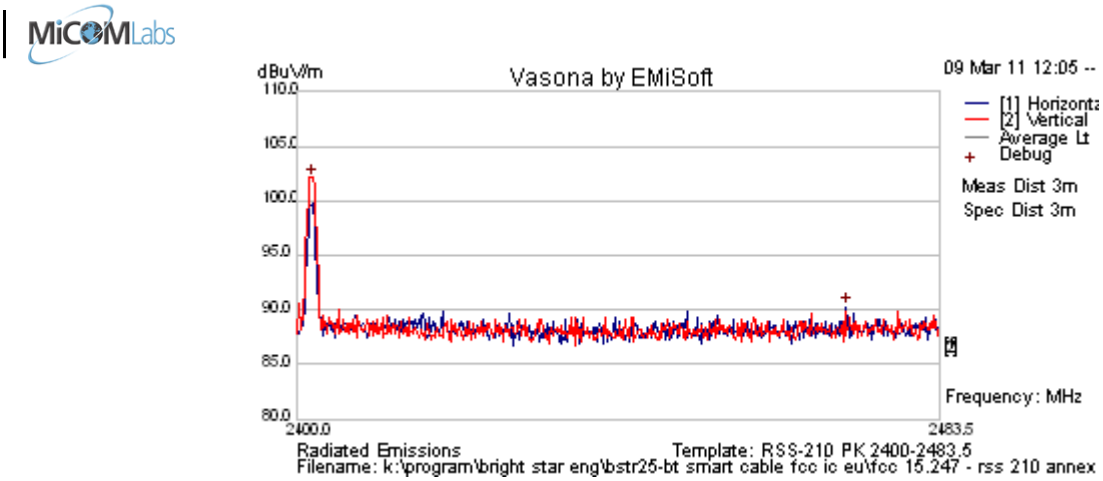


Band-edge; Channel 78; 1 Mbs Data Rate; 2483.5-2500 MHz; Vert. Hg=98 Ang=183



7.2.3 Peak Emissions

Test Freq.	2480 MHz	**Engineer**	EVF
Variant	Bluetooth	**Temp (ºC)**	20.5
Freq. Range	2400 - 2483.5 MHz	**Rel. Hum.(%)**	42
Power Setting	max	**Press. (mBars)**	993
Antenna	integral	**Duty Cycle (%)**	100
Test Notes 1	EUT placed on the table along with its peripherals		
Test Notes 2	TXDATA1: Ch.0 1MBits; Transport Type: BCSP/ Serial Port: com 4/ Baud Rate: 57600		



Formally measured emission peaks

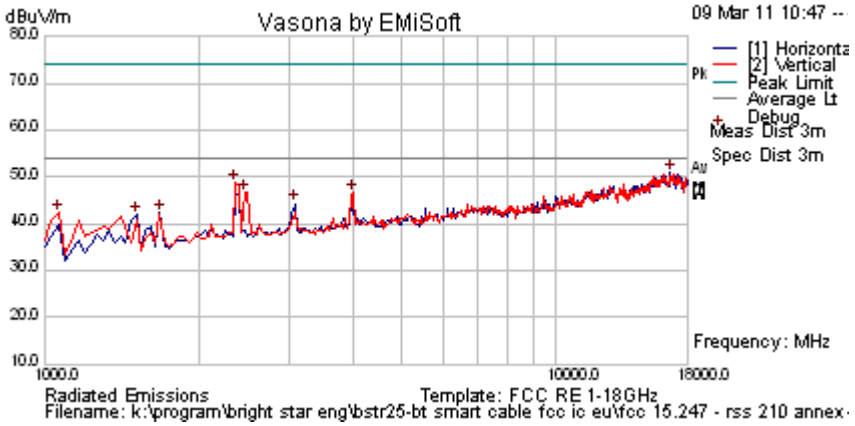
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2402.051	57.0	13.0	32.2	102.1	Peak [Scan]	V						PK

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, modulated. This presents the highest measured peak value transmitted from the EUT.

7.2.4 Receiver Radiated Emissions

Test Freq.	2441 MHz	**Engineer**	EVF
Variant	BT: Receive in Test Utility	**Temp (ºC)**	19.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	41
Power Setting	Not Applicable in Receive Mode	**Press. (mBars)**	1013
Antenna	Integral		
Test Notes 1	EUT placed on the table along with its peripherals		
Test Notes 2	RXSTART1: Ch.39; Transport Type: BCSP/ Serial Port: com 4/ Baud Rate: 57600; antenna on VCI Pod is removed and replaced with 50 Ohm termination		



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
2392.786	59.1	3.0	-11.2	50.9	Peak Max	V	182	68	74	-23.1	Pass	
2392.786	43.3	3.0	-11.2	35.1	Average Max	V	182	68	54	-18.9	Pass	
16705.411	40.81	8.67	1.39	50.88	Peak [Scan]	H	200	0	54	-3.12	Pass	noise floor
3988.297	52.65	3.89	-9.93	46.61	Peak [Scan]	V	150	0	54	-7.39	Pass	
2496.673	54.7	3.0	-11.1	46.6	Peak [Scan]	V	200	0	54	-7.4	Pass	
3073.868	51.8	3.4	-11.0	44.2	Peak [Scan]	H	150	0	54	-9.8	Pass	
1688.557	53.5	2.5	-13.7	42.3	Peak [Scan]	H	100	0	54	-11.7	Pass	

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

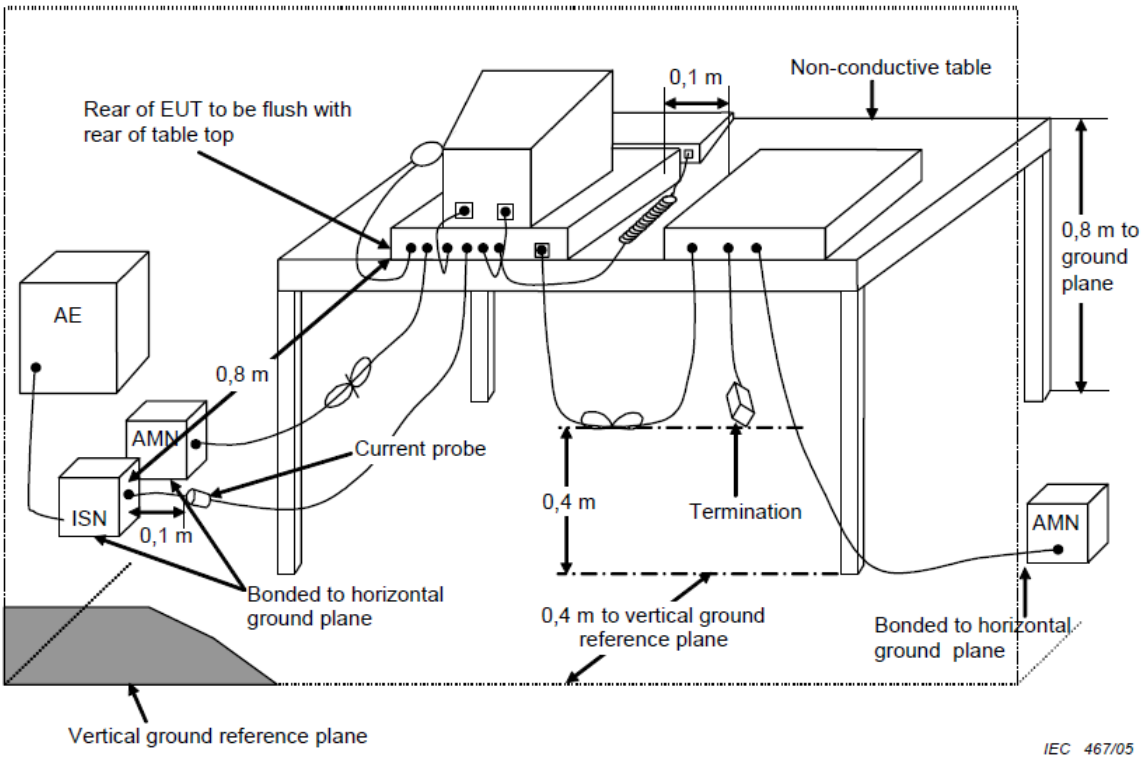
The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions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

No Conducted Disturbance at Mains Terminal was performed at the device was powered via 12 Vdc (vehicle battery power)

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

7.4 Maximum Permissible Exposure

Calculations for Maximum Permissible Exposure Levels

Power Density = Pd (mW/cm^2) = EIRP/(4πd^2)

EIRP = P * G

P = Peak output power (mW)

G = Antenna numeric gain (numeric)

d = Separation distance (cm)

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

The peak power in the table below is calculated by assuming a worst case scenario where all of the EUT transmitters are operating simultaneously in the same band. The Peak Power in mW is the highest transmitter power measured and summed across all transmitters.

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

Freq. Band (GHz)	Antenna Gain (dBi)	Numeric Gain (numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Calculated Safe Distance @ 1mW/cm^2 Limit(cm)	Minimum Separation Distance (cm)
2.4	0.5	3.16	+4.86	3.06	0.88	20

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

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.

FCC §1.1310 Limit = 1mW / cm^2 from 1.310 Table 1

RSS-Gen §5.5 Before equipment certification is granted, the applicable requirements of RSS-102 shall be met.

Laboratory Measurement Uncertainty for Power Measurements

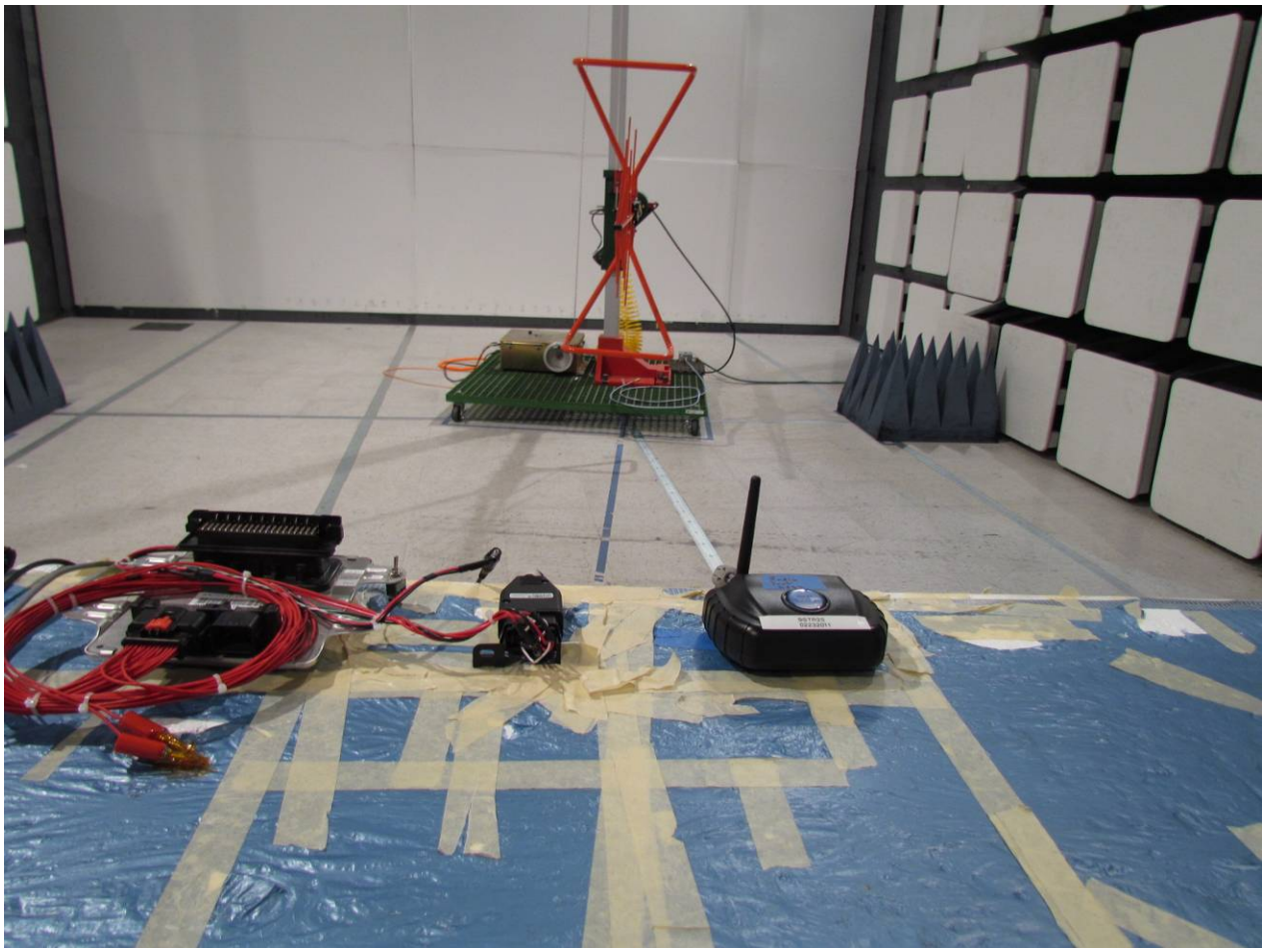
Measurement uncertainty	±1.33 dB

8 PHOTOGRAPHS

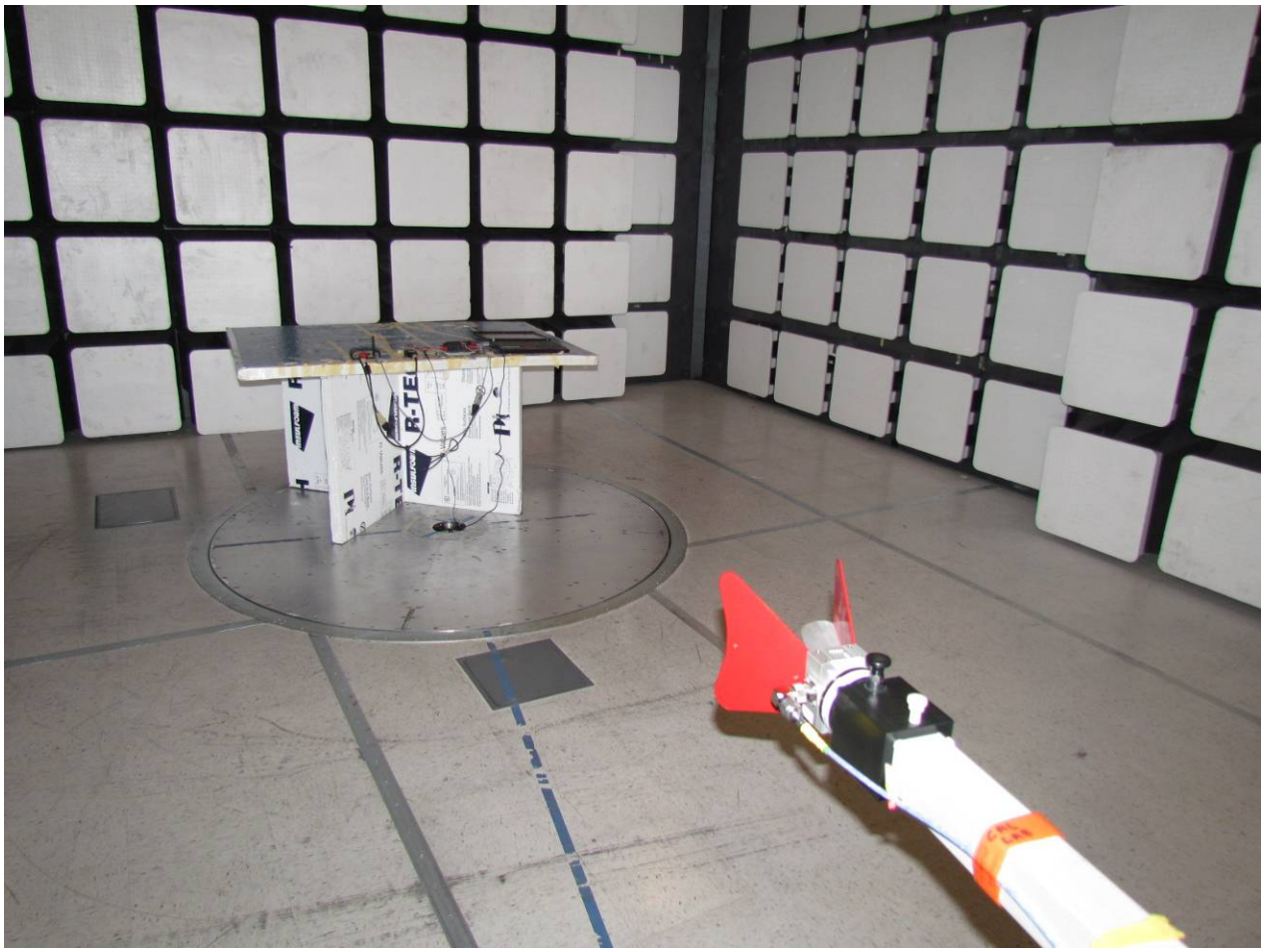
8.1 Conducted RF Emissions - EUT

8.2 Conducted RF Emissions - Test Equipment

8.3 Transmitter Radiated Spurious Emission below 1 GHz



8.4 Receiver Radiated Emissions above 1 GHz



9 TEST EQUIPMENT

Asset #	Instrument	Manufacturer	Part #	Serial #
0116	Power Sensor	Hewlett Packard	8485A	3318A19694
0117	Power Sensor	Hewlett Packard	8487D	3318A00371
0158	Barometer /Thermometer	Control Co.	4196	E2846
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	357.8810.52
0287	EMI Receiver	Rhode & Schwartz	ESIB40	100201
0223	Power Meter	Hewlett Packard	EPM-442A	US37480256
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
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
0190	LISN	Rhode & Schwartz	ESH3Z5	836679/006
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002

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