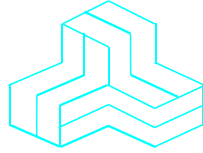# ENGINEERING TEST REPORT

Pico 2.4GHz 1W Digital Data Link Module
Model: pDDL2450
FCC ID: NS916PDDL2450

Applicant:

Microhard Systems Inc.
150 Country Hills Landing NW
Calgary, Alberta
Canada T3K 5P3

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Systems (DTS) Operating in 2400 – 2483.5 MHz Band

UltraTech's File No.: 16MCRS085_FCC15C247DTS

This Test report is Issued under the Authority of Tri M. Luu Vice President of Engineering UltraTech Group of Labs Date: April 13, 2016	
Report Prepared by: Dan Huynh Issued Date: April 13, 2016	Tested by: Hung Trinh Test Dates: January 23 – April 11, 2016

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Tel.: (905) 829-1570   Fax.: (905) 829-8050
Website: www.ultratech-labs.com, Email: vic@ultratech-labs.com, Email: tri@ultratech-labs.com

91038	1309	46390-2049	NVLAP LAB CODE 200093-0	AT-1945	SL2-IN-E-1119R	CA2049	TL363_B	TPTDP DA1300

TABLE OF CONTENTS

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

EXHIBIT 1.   INTRODUCTION

1.1.   SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 – Radio Frequency Devices
Purpose of Test:	Equipment Certification for Digital Modulation Systems (DTS) Transmitter Operating in the Frequency Band 2400-2483.5 MHz.
Test Procedures:	▪ ANSI C63.4 ▪ ANSI C63.10 ▪ FCC KDB Publication No. 558074 D01 DTS Meas Guidance v03r04
Environmental Classification:	[x] Commercial, industrial or business environment [x] Residential environment

1.2.   RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3.   NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2015	Code of Federal Regulations (CFR), Title 47 – Telecommunication
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
CISPR 22 & EN 55022	2008-09, Edition 6.0 2006	Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement
CISPR 16-1-1 +A1 +A2	2006 2006 2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-1-2 +A1 +A2	2003 2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Conducted disturbances
FCC, KDB Publication No. 558074 D01 DTS Meas Guidance v03r04	2016	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

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EXHIBIT 2.   PERFORMANCE ASSESSMENT

2.1.   CLIENT INFORMATION

APPLICANT	
Name:	Microhard Systems Inc.
Address:	150 Country Hills Landing NW Calgary, Alberta Canada T3K 5P3
Contact Person:	Mr. Hany Shenouda Phone #: 403 248-0028 Fax #: 403 248 2762 Email Address: shenouda@microhardcorp.com

MANUFACTURER	
Name:	Microhard Systems Inc.
Address:	150 Country Hills Landing NW Calgary, Alberta Canada T3K 5P3
Contact Person:	Mr. Hany Shenouda Phone #: 403 248-0028 Fax #: 403 248-2762 Email Address: shenouda@microhardcorp.com

2.2.   EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Microhard Systems Inc.
Product Name:	Pico 2.4GHz 1W Digital Data Link Module
Model Name or Number:	pDDL2450
Serial Number:	Test Sample
Type of Equipment:	Digital Transmission System (DTS)
Input Power Supply Type:	External DC Power Supply
Primary User Functions of EUT:	The pDDL2450 is a high-performance embedded wireless data transceiver module capable of providing reliable wireless data transfer between almost any type of equipment which uses an asynchronous serial interface. The small-size and superior RF performance of this module make it ideal for many applications.

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2.3.   EUT'S TECHNICAL SPECIFICATIONS

Transmitter			
Equipment Type:	• Mobile • Base Station (fixed use)		
Intended Operating Environment:	▪ Commercial, industrial or business environment ▪ Residential environment		
Power Supply Requirement:	3.3 VDC		
RF Output Power Rating:	16 – 30 dBm typical		
[1]**Tx Gain Setting:**	0-70		
Operating Frequency Range:	Bandwidth	[2]Data Rate 1, 2, 3	[2]Data Rate 4, 5, 6, 7
	1 MHz and 2 MHz 4 MHz 8 MHz	2402 - 2482 MHz 2402 - 2477 MHz 2407 - 2477 MHz	2402 - 2482 MHz 2403 - 2480 MHz 2407 - 2477 MHz
RF Output Impedance:	50 Ω		
Duty Cycle:	Continuous		
Modulation Type:	COFDM		
Antenna Connector Types:	U.FL		

[1]TX gain setting is a factory tune-up parameter, not available to end users
[2]Refer to operational description exhibit for more information on data rates and operational restrictions, 1MHz bandwidth at data rate 3 shall be disabled.

2.4.   ASSOCIATED ANTENNA DESCRIPTIONS

Antenna Type	Maximum Gain (dBi)
Rubber Ducky	2
Patch Antenna	14
Yagi Antenna	14.5
Omni Directional Antenna	15

2.5.   LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RF port	1	U.FL	Shielded cable
2	DC supply and I/O port	1	Pin header	Direct connection (no cable)

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2.6.   ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	Test Jig
Brand name:	Microhard Systems Inc.
Model Name or Number:	N/A
Connected to EUT's Port:	I/O Port

Ancillary Equipment # 2	
Description:	AC/DC Adapter
Brand name:	BI Switching Power Supply
Model Name or Number:	BI30-120200-AdU
Connected to EUT's Port:	Test Jig of the EUT

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
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EXHIBIT 3.   EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1.   CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21 to 23 ^{o}C
Humidity:	45 to 58%
Pressure:	102 kPa
Power Input Source:	3.3 VDC

3.2.   OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	Test software provided by the Applicant to operate the EUT at each channel frequency continuously and in the range of typical modes of operation.
Special Hardware Used:	Test Jig
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as non-integral antenna equipment as described with the test results.

Transmitter Test Signals	
Frequency Band(s):	2402 - 2482 MHz 2402 - 2477 MHz 2403 - 2480 MHz 2407 - 2477 MHz
Frequency(ies) Tested:	2402 MHz, 2403 MHz, 2407 MHz, 2437 MHz, 2477 MHz, 2480 MHz, 2482 MHz
RF Power Output: (measured maximum output power at antenna terminals)	29.96 dBm Peak
Normal Test Modulation:	COFDM
Modulating Signal Source:	Internal

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EXHIBIT 4.   SUMMARY OF TEST RESULTS

4.1.   LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2017-04-02.

4.2.   APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes
15.207(a)	AC Power Line Conducted Emissions	Yes
15.247(a)(2)	6 dB Bandwidth	Yes
15.247(b)(3)	Peak Conducted Output Power - DTS	Yes
15.247(d)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes
15.247(e)	Power Spectral Density	Yes
15.247(i), 1.1307, 1.1310, 2.1091	RF Exposure	Yes

4.3.   MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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EXHIBIT 5. TEST DATA

5.1. POWER LINE CONDUCTED EMISSIONS [§15.207(a)]

5.1.1. Limit(s)

The equipment shall meet the limits of the following table:

Frequency of emission (MHz)	Conducted Limits (dBμV)	
	Quasi-peak	Average
0.15–0.5 ....…….....	66 to 56*	56 to 46*
0.5–5 ....…….....	56	46
5-30 ……………………..	60 ...……………...	50

*Decreases linearly with the logarithm of the frequency

5.1.2. Method of Measurements

ANSI C63.4-2009

5.1.3. Test Arrangement

ULTRATECH GROUP OF LABS File #: 16MCRS085_FCC15C247DTS
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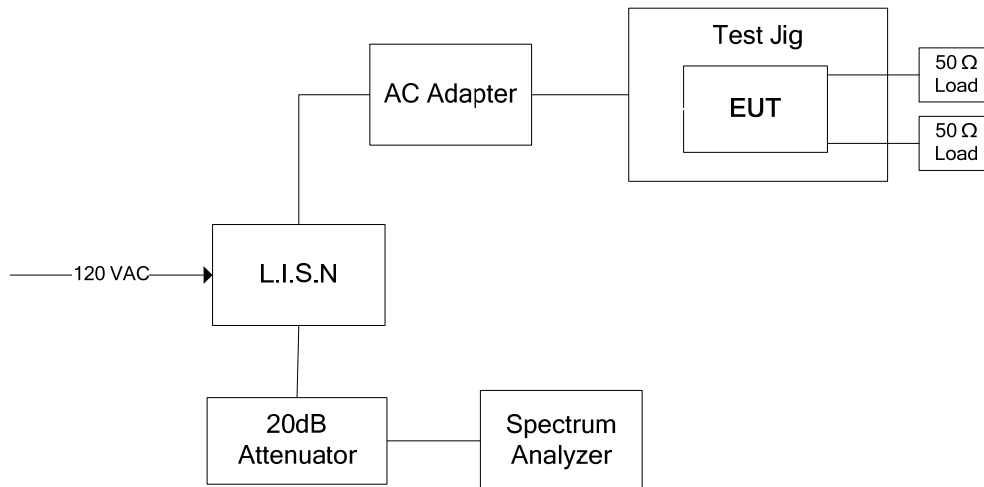
5.1.4. Test Data

Plot 5.1.4.1. Power Line Conducted Emissions; Line Voltage: 120 VAC; Line Tested: Hot

Current Graph

2/16/2016 12:24:33 PM   (Start = 0.15, Stop = 30.00) MHz

Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.246	45.3	41.2	-20.7	32.6	-19.3	Hot
0.520	45.5	44.0	-12.0	42.2	-3.8	Hot
9.730	42.5	38.6	-21.4	30.5	-19.5	Hot
18.803	44.4	41.3	-18.7	36.2	-13.8	Hot

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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Plot 5.1.4.2. Power Line Conducted Emissions; Line Voltage120 VAC; Line Tested: Neutral

Current Graph

dBuV   Neutral

2/16/2016 12:32:46 PM   (Start = 0.15, Stop = 30.00) MHz

Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.176	47.9	42.5	-22.2	30.6	-24.1	Neutral
0.202	44.4	38.9	-24.7	29.4	-24.2	Neutral
0.520	39.5	34.2	-21.8	28.1	-17.9	Neutral
9.595	38.9	34.9	-25.1	28.3	-21.7	Neutral
25.946	39.9	35.8	-24.2	29.6	-20.4	Neutral

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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5.2.   OCCUPIED BANDWIDTH [§ 15.247(a)(2)]

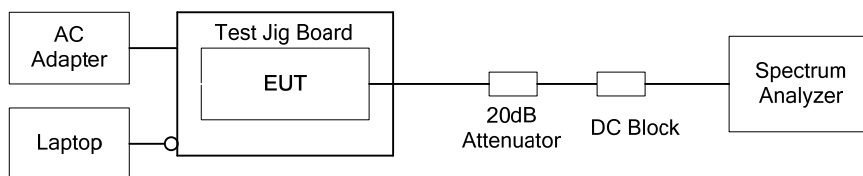### 5.2.1.   Limit(s)

The minimum 6 dB bandwidth shall be at least 500 kHz.

5.2.2.   Method of Measurements

KDB 558074D01 DTS Meas Guidance v03r04, Section 8.1 DTS bandwidth Option 1 or 2 methods

5.2.3.   Test Arrangement

```
┌──────────┐     ┌─────────────────────┐
│    AC    │     │   Test Jig Board    │
│ Adapter  ├─────┤                     │                                      ┌───────────┐
└──────────┘     │       EUT           ├──────┤────┤──┤────┤───────────────────┤ Spectrum  │
                 │                     │     20dB        DC Block              │ Analyzer  │
┌──────────┐     │                     │   Attenuator                         └───────────┘
│  Laptop  ├──o──┤                     │
└──────────┘     └─────────────────────┘
```

5.2.4.   Test Data

Operating Mode	Data Rate	Frequency (MHz)	6dB BW (MHz)	Min. Limit (kHz)
Bandwidth: 1 MHz TX Gain: 5	1	2402	0.5098	500
		2437	0.5098	500
		2482	0.5098	500
	2	2402	0.5170	500
		2437	0.5218	500
		2482	0.5170	500
Bandwidth: 2 MHz TX Gain: 8	1	2402	0.9764	500
		2437	0.9812	500
		2482	0.9715	500
	2	2402	1.0002	500
		2437	1.0002	500
		2482	1.0006	500
	3	2402	0.9178	500
		2437	0.8778	500
		2482	0.8818	500

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Operating Mode	Data Rate	Frequency (MHz)	6dB BW (MHz)	Min. Limit (kHz)
Bandwidth: 4 MHz TX Gain: 18	1	2402	1.8196	500
		2437	1.8277	500
		2477	1.8277	500
	2	2402	1.8918	500
		2437	1.8998	500
		2477	1.8918	500
	3	2402	1.8517	500
		2437	1.8437	500
		2477	1.8277	500
Bandwidth: 8 MHz TX Gain: 23	1	2407	3.5912	500
		2437	3.6072	500
		2477	3.6072	500
	2	2407	3.8156	500
		2437	3.7836	500
		2477	3.7996	500
	3	2407	3.9599	500
		2437	3.5431	500
		2477	3.5110	500

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Operating Mode	Data Rate	Frequency (MHz)	6dB BW (MHz)	Min. Limit (kHz)
Bandwidth: 1 MHz TX Gain: 20	4	2402	1.0421	500
		2437	1.0471	500
		2482	1.0571	500
	5	2402	1.0471	500
		2437	1.0521	500
		2482	1.0571	500
	6	2402	1.0571	500
		2437	1.0621	500
		2482	1.0621	500
	7	2402	1.0671	500
		2437	1.0471	500
		2482	1.0471	500
Bandwidth: 2 MHz TX Gain: 23	4	2402	2.0842	500
		2437	2.0942	500
		2482	2.1042	500
	5	2402	2.0841	500
		2437	2.0842	500
		2482	2.0741	500
	6	2402	2.0942	500
		2437	2.1042	500
		2482	2.1042	500
	7	2402	2.1042	500
		2437	2.1242	500
		2482	2.1042	500

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Operating Mode	Data Rate	Frequency (MHz)	6dB BW (MHz)	Min. Limit (kHz)
Bandwidth: 4 MHz TX Gain: 23	4	2403	4.1683	500
		2437	4.1683	500
		2480	4.1884	500
	5	2403	4.1884	500
		2437	4.1483	500
		2480	4.1483	500
	6	2403	4.1884	500
		2437	4.1683	500
		2480	4.1884	500
	7	2403	4.1683	500
		2437	4.1884	500
		2480	4.2285	500
Bandwidth: 8 MHz TX Gain: 23	4	2407	8.2966	500
		2437	8.3367	500
		2477	8.3367	500
	5	2407	8.3368	500
		2437	8.3367	500
		2477	8.3367	500
	6	2407	8.3768	500
		2437	8.3367	500
		2477	8.3367	500
	7	2407	8.3367	500
		2437	8.3367	500
		2477	8.3768	500

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

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Plot 5.2.4.1. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 5, 2402 MHz, Data Rate 1
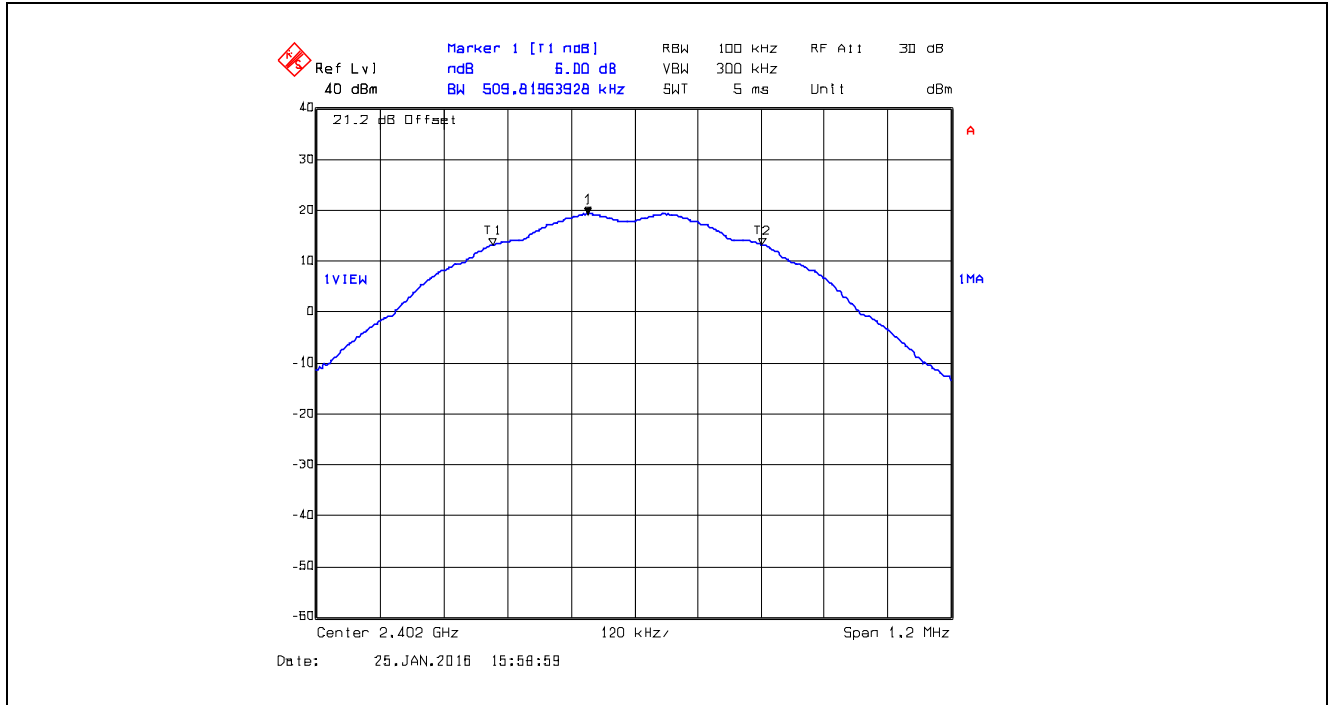
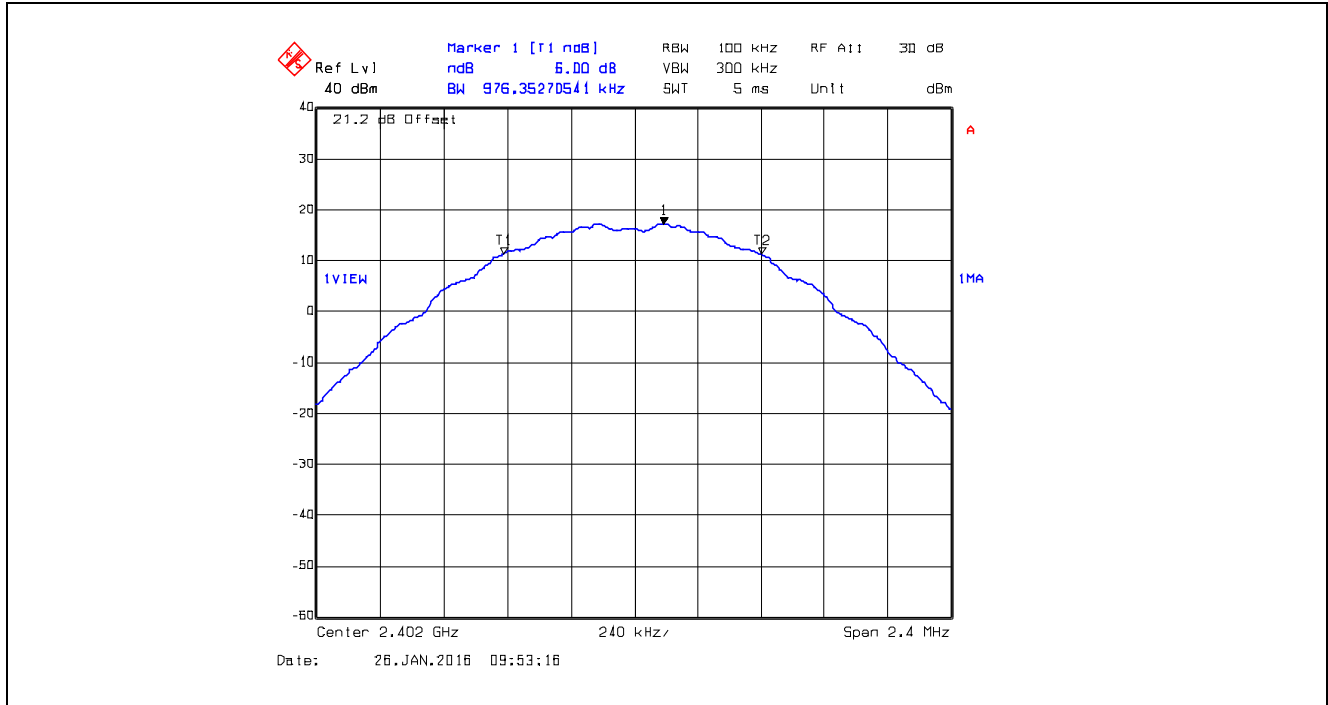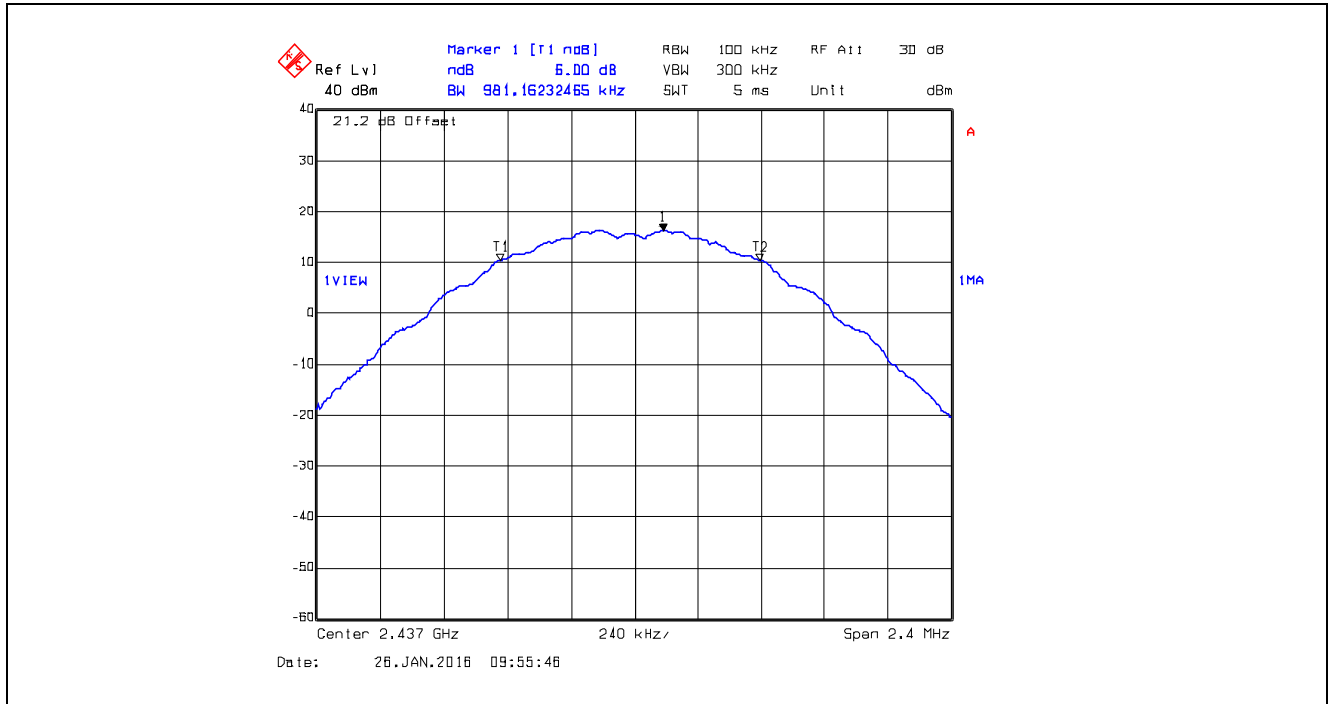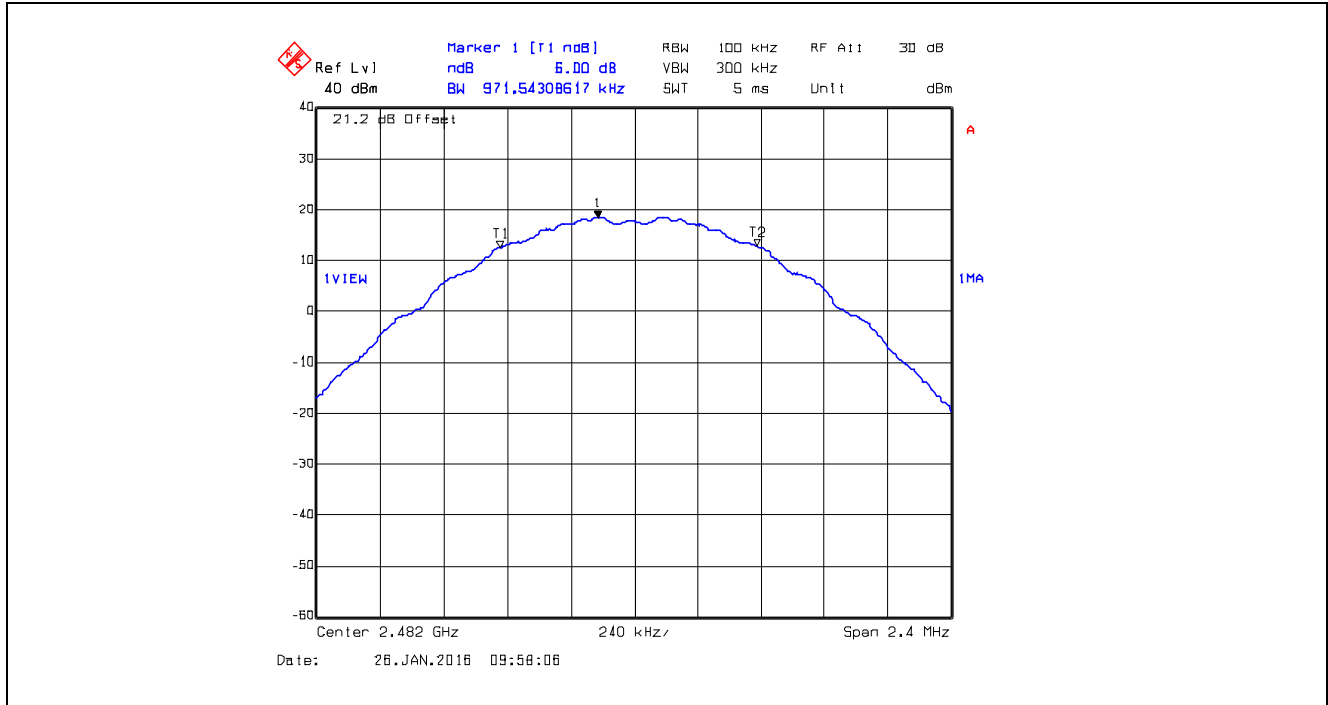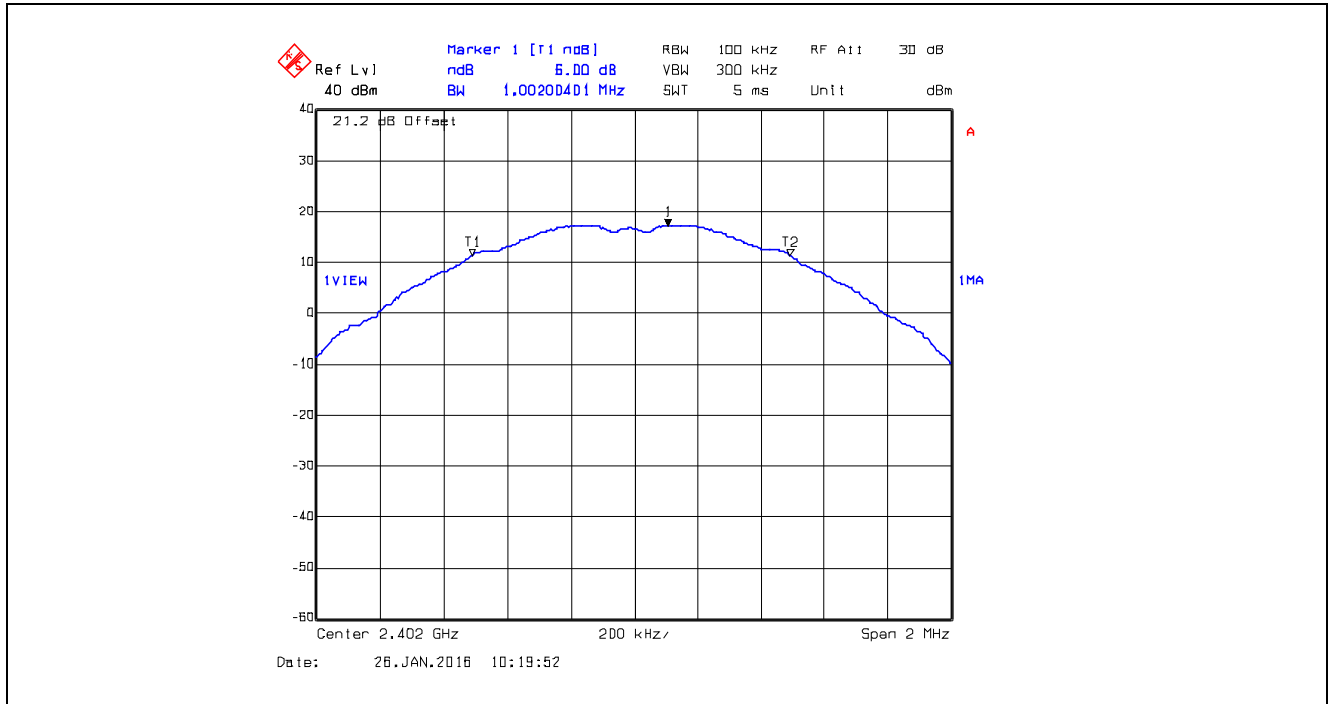**Plot 5.2.4.2.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 5, 2437 MHz, Data Rate 1
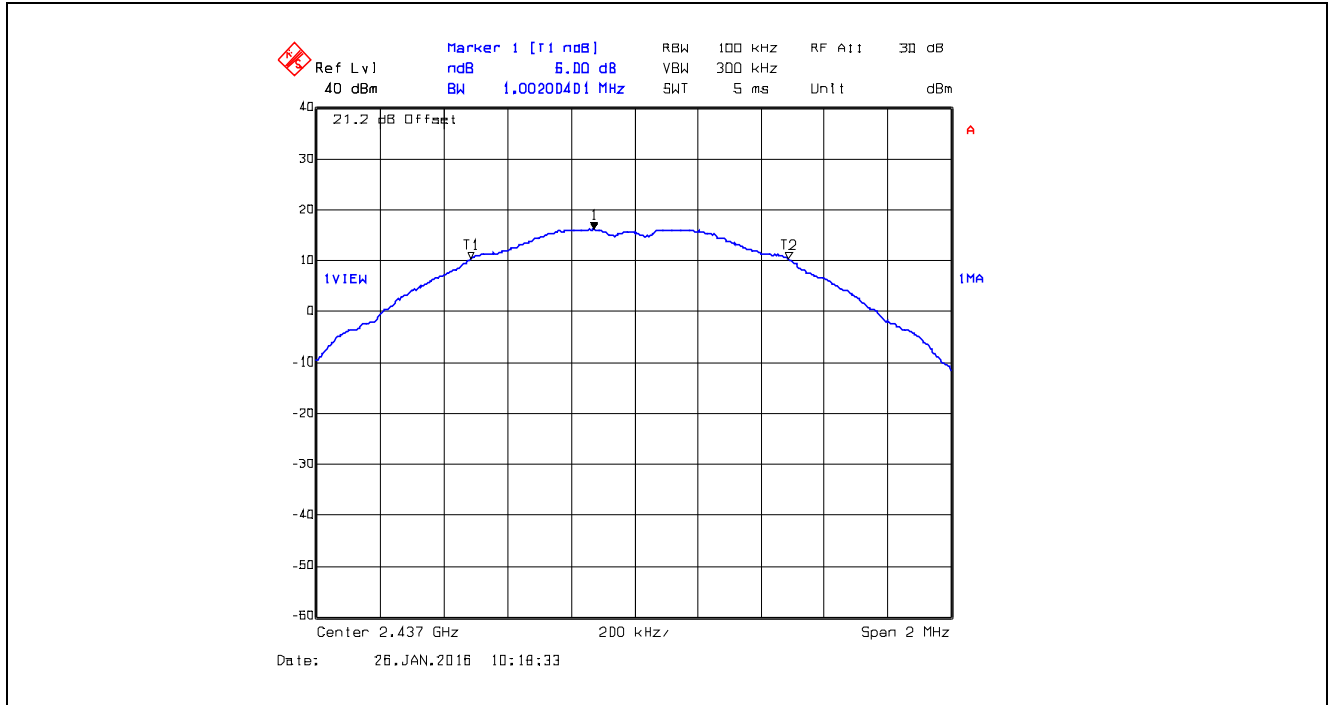
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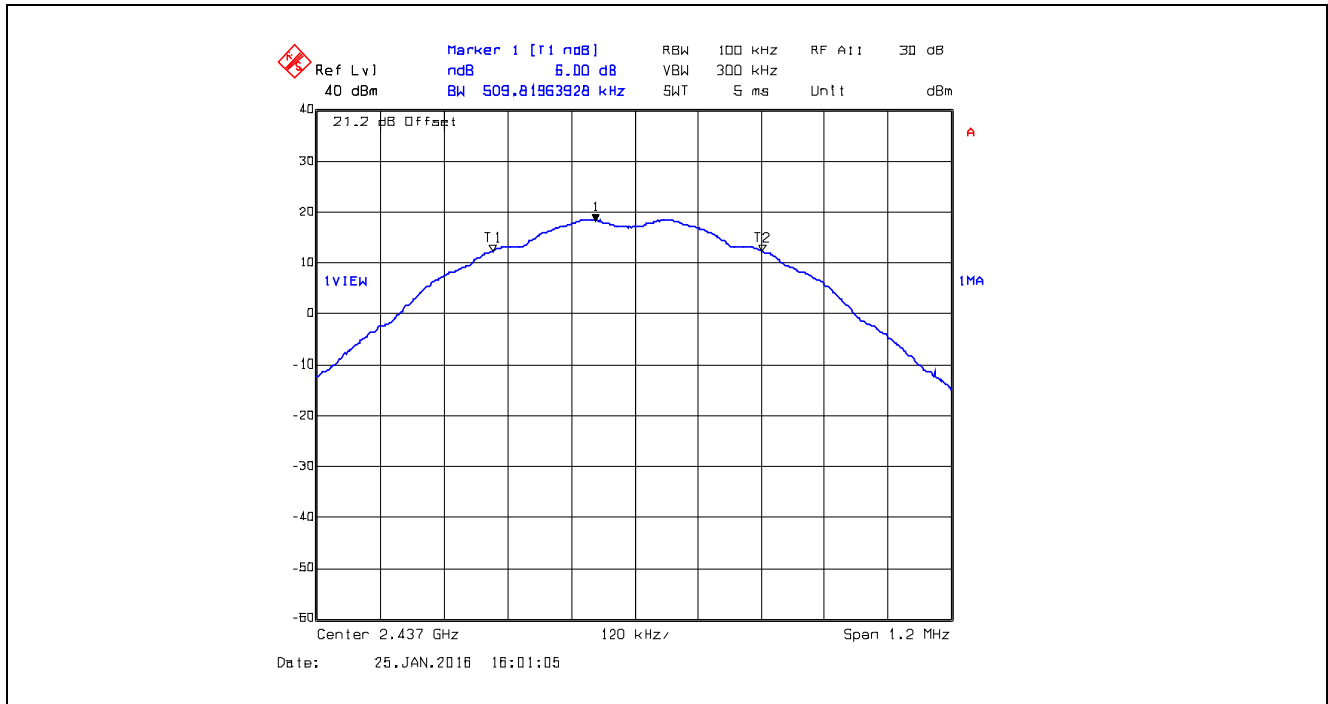
Plot 5.2.4.3. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 5, 2482 MHz, Data Rate 1
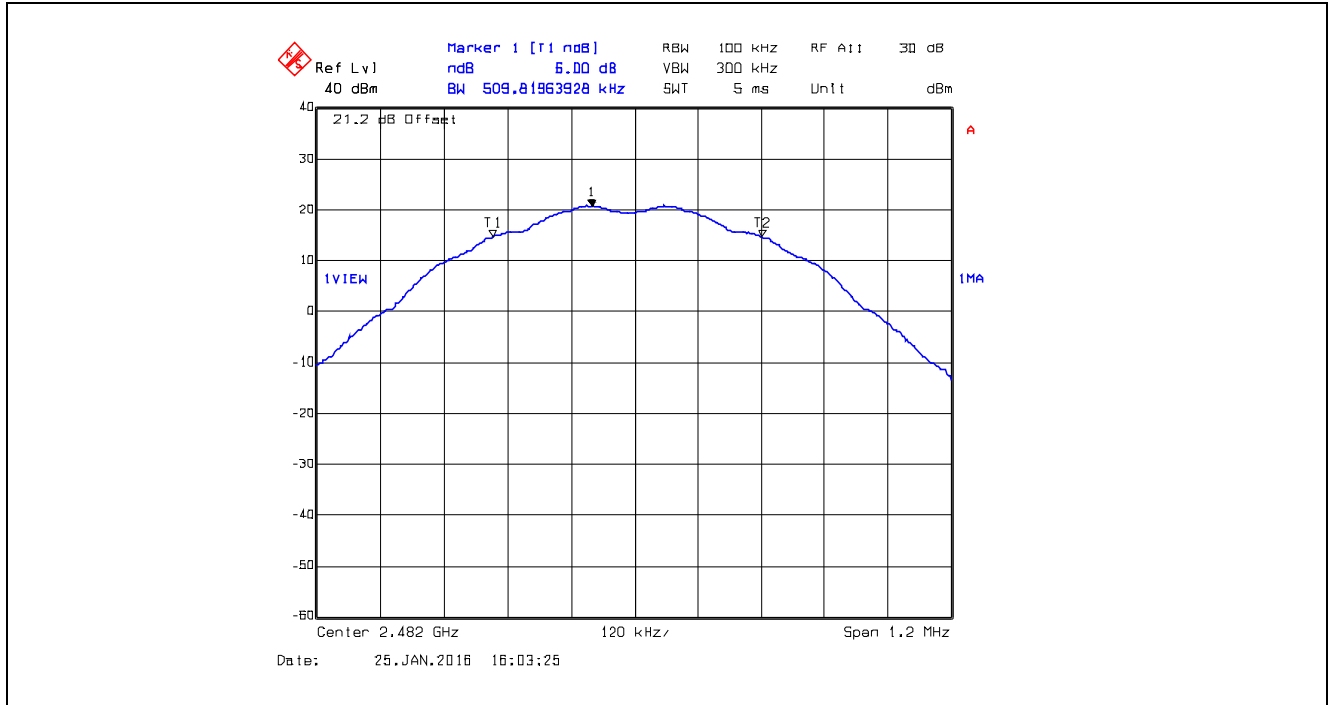
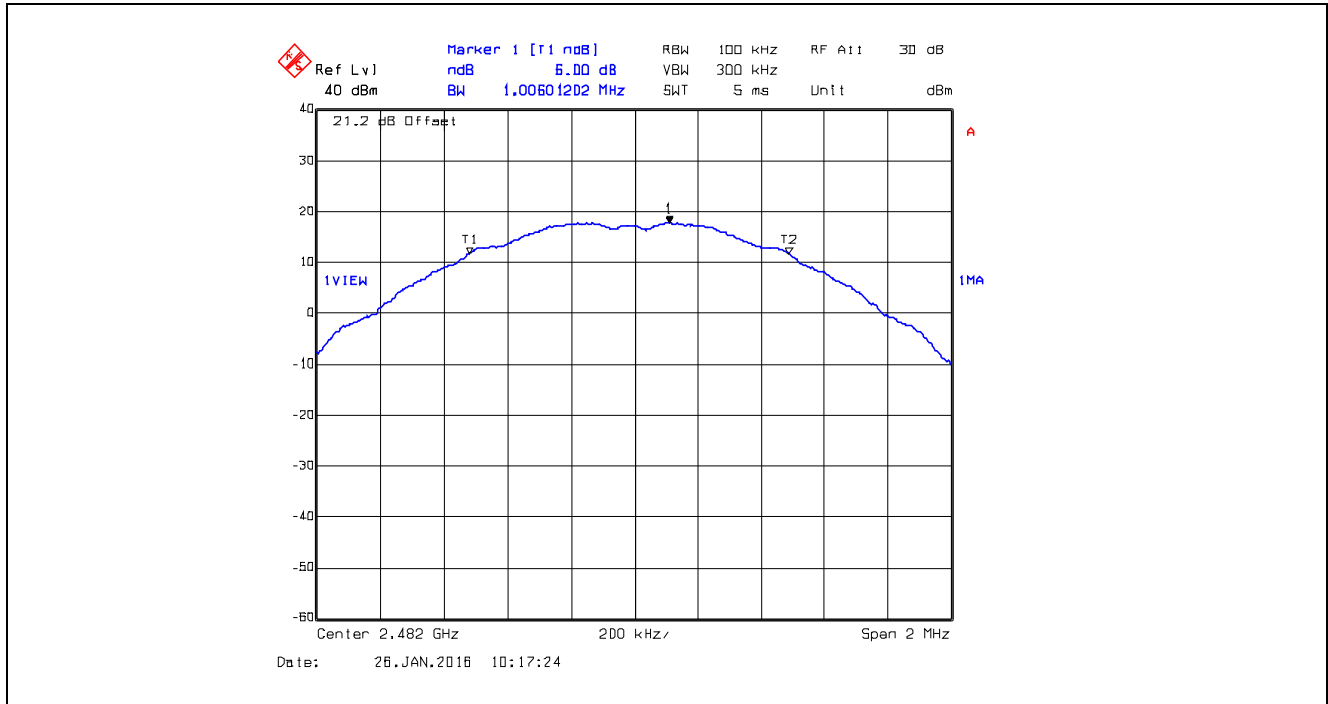**Plot 5.2.4.4.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 5, 2402 MHz, Data Rate 2
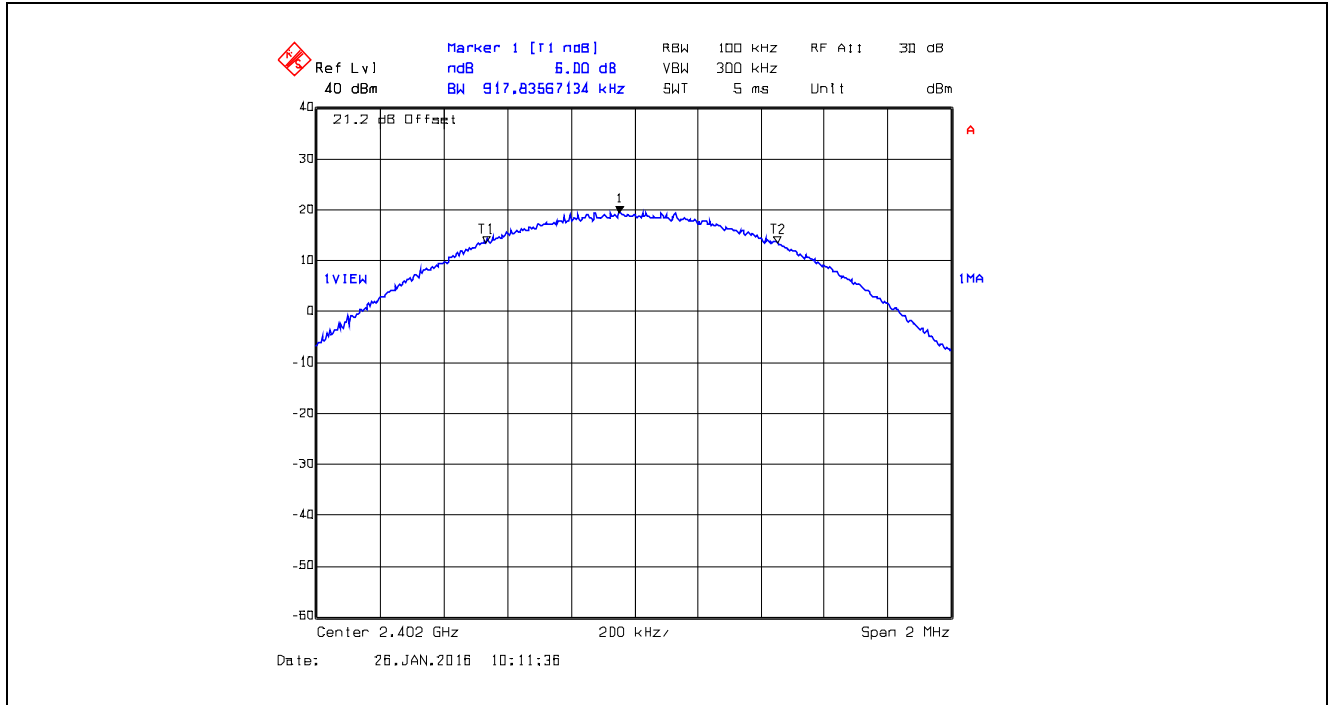
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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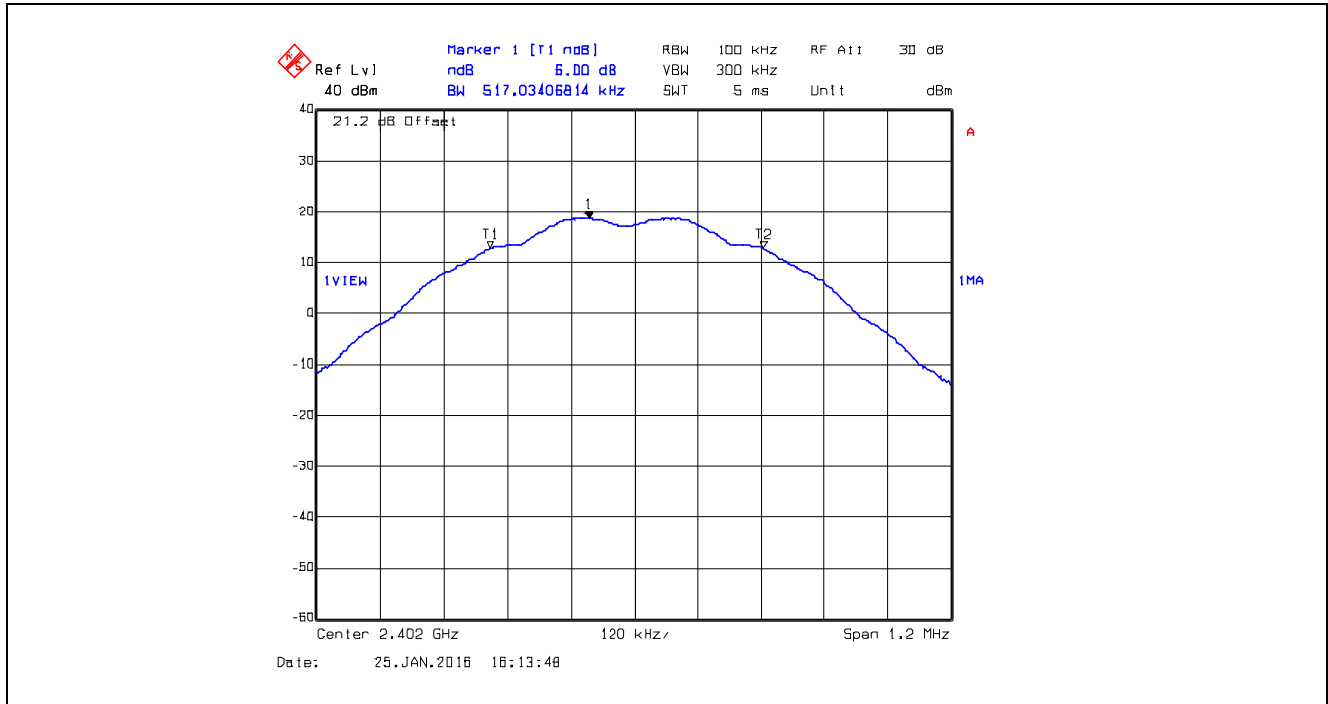
Plot 5.2.4.5. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 5, 2437 MHz, Data Rate 2
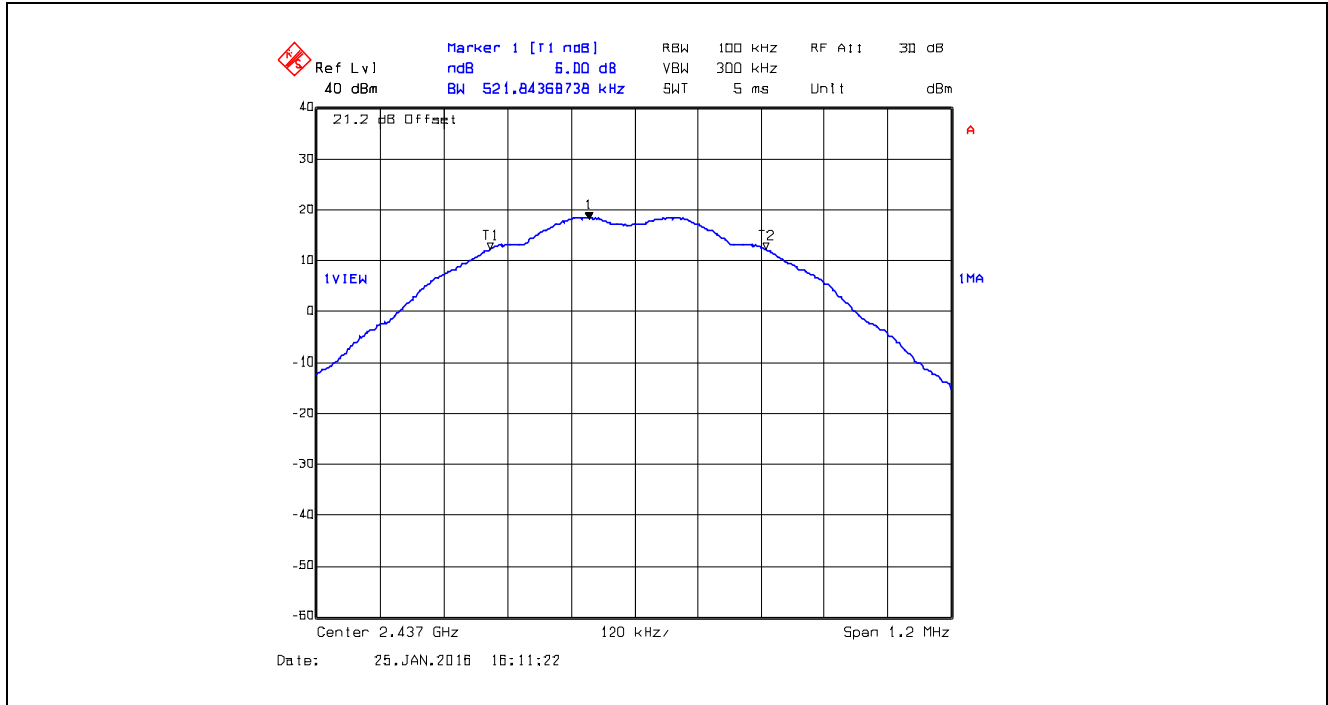
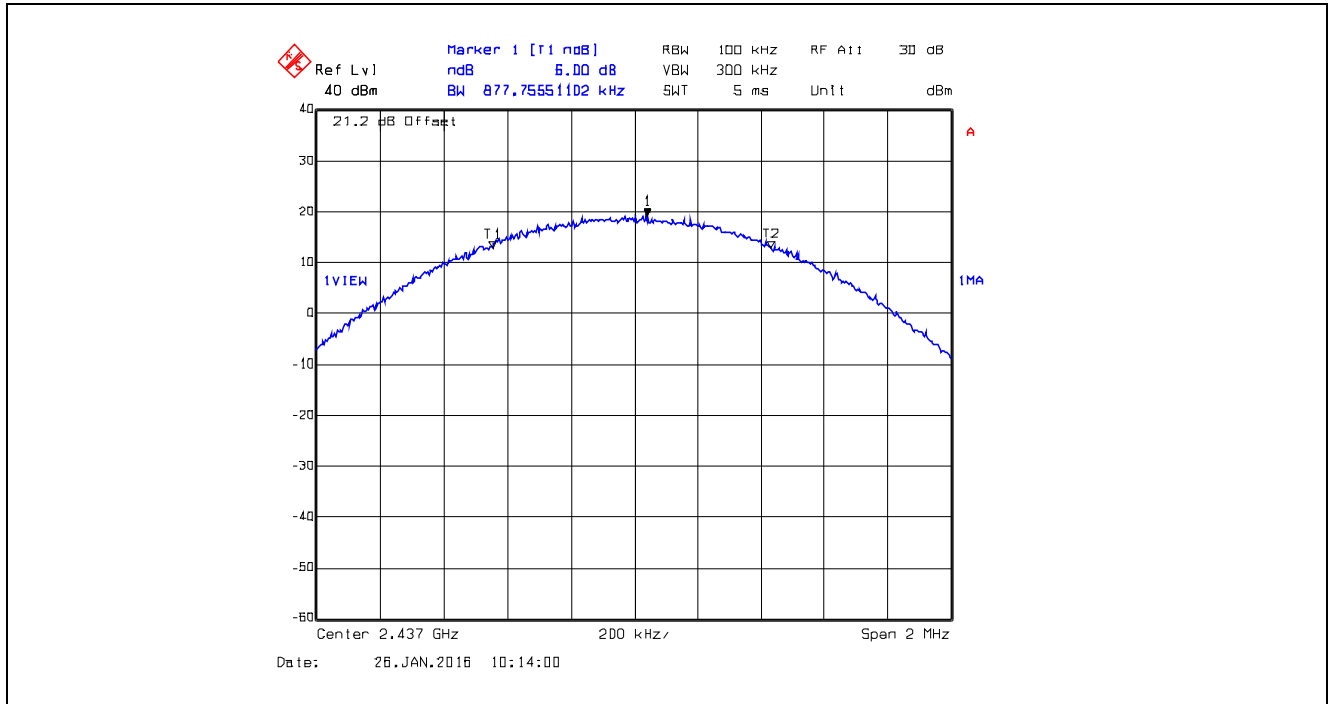**Plot 5.2.4.6.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 5, 2482 MHz, Data Rate 2
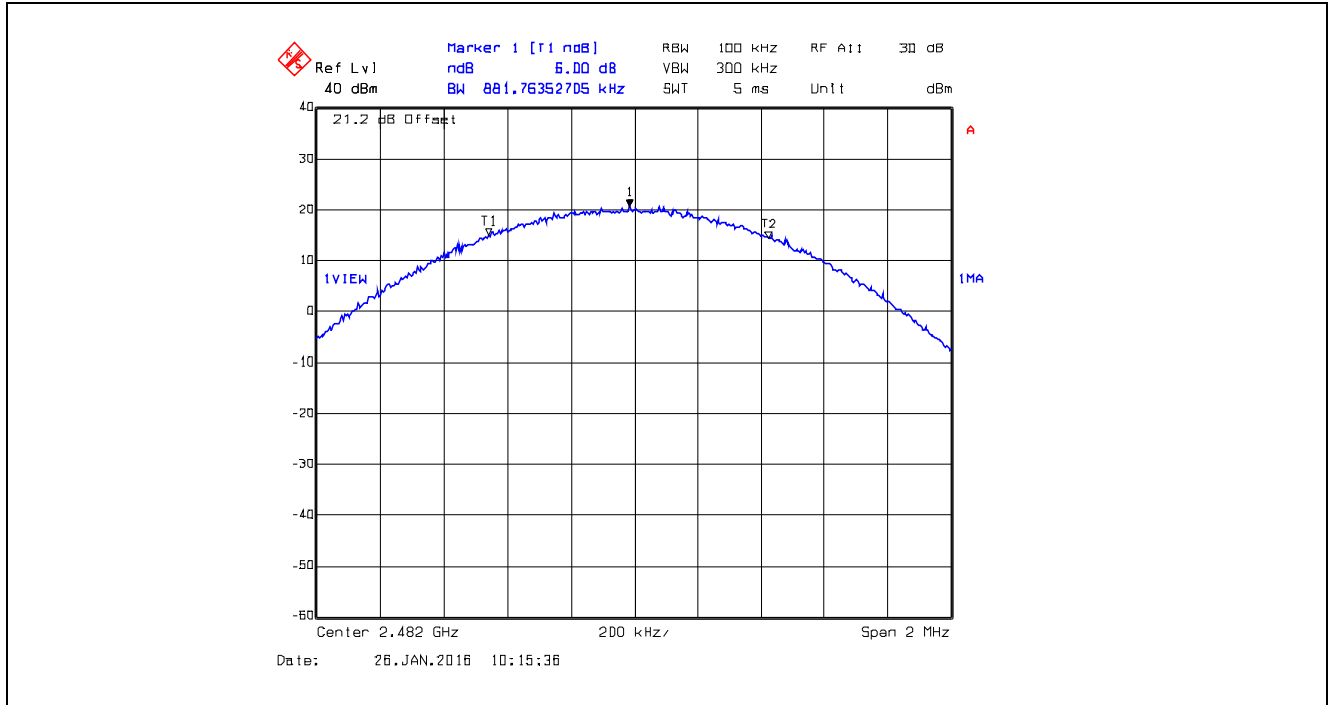
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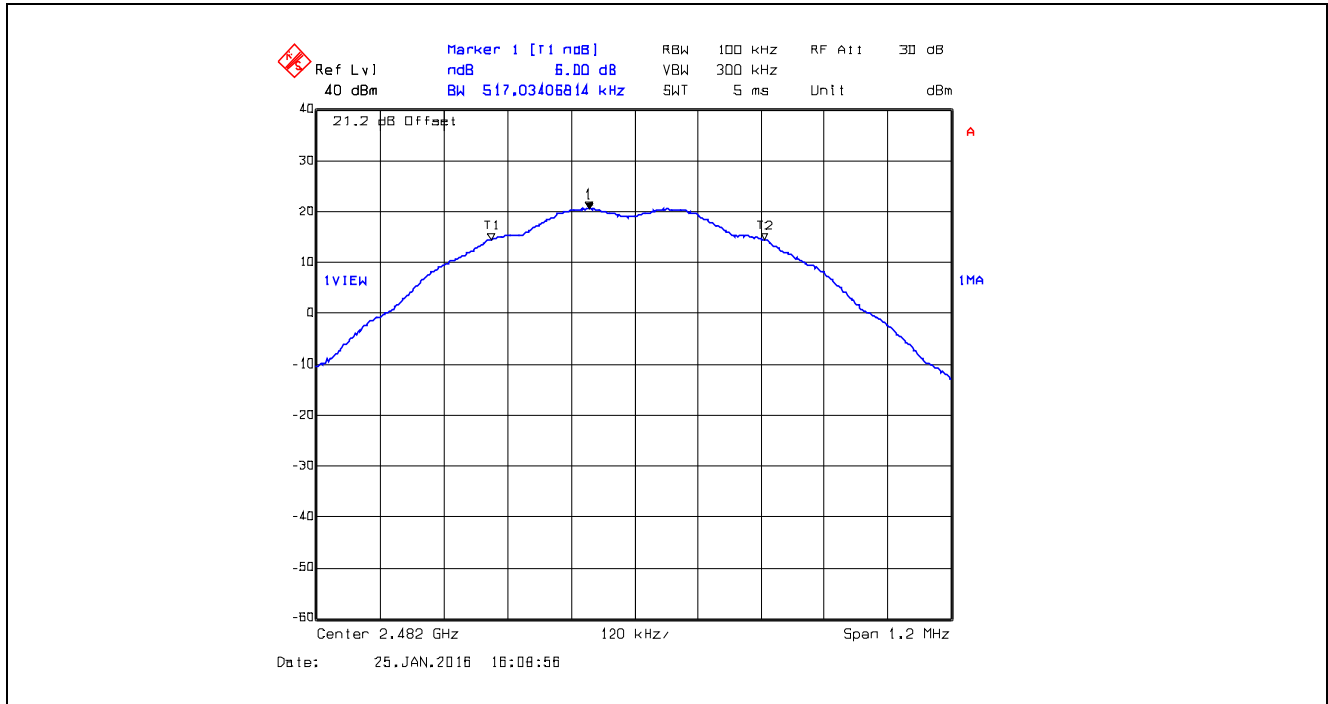
Plot 5.2.4.7. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2402 MHz, Data Rate 1

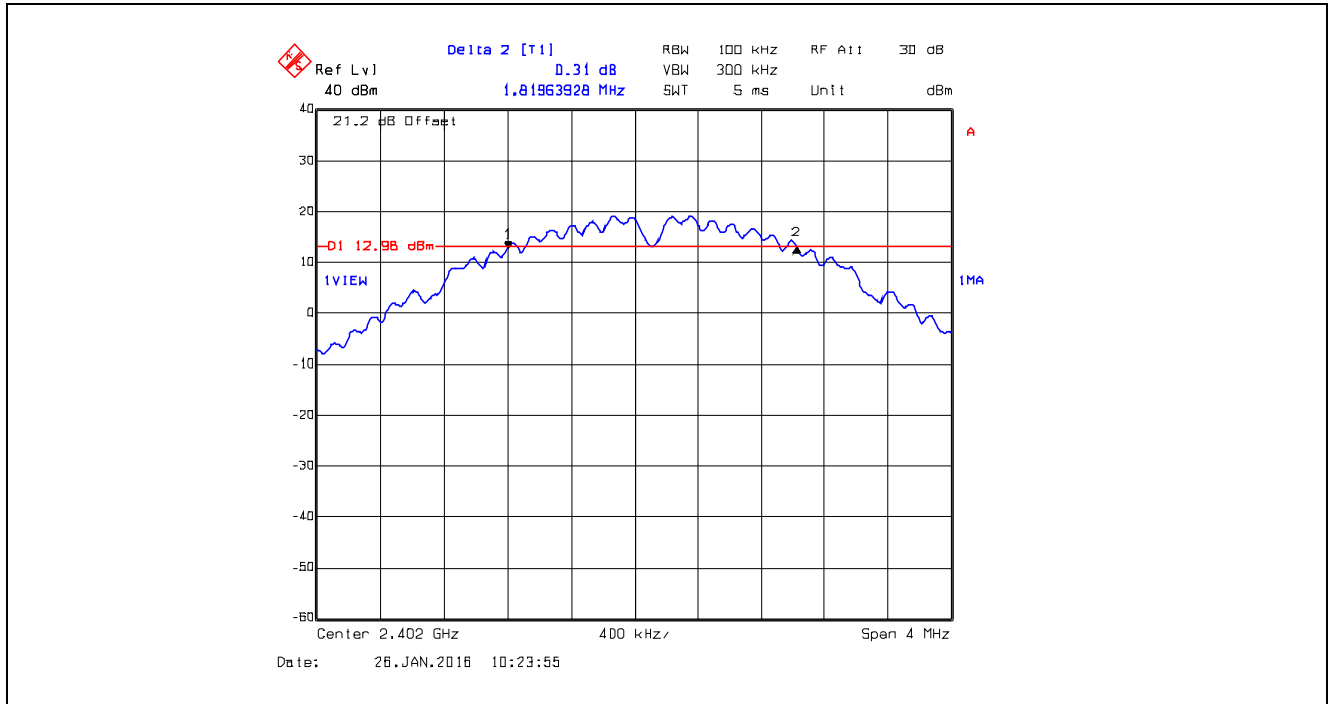**Plot 5.2.4.8.** 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2437 MHz, Data Rate 1
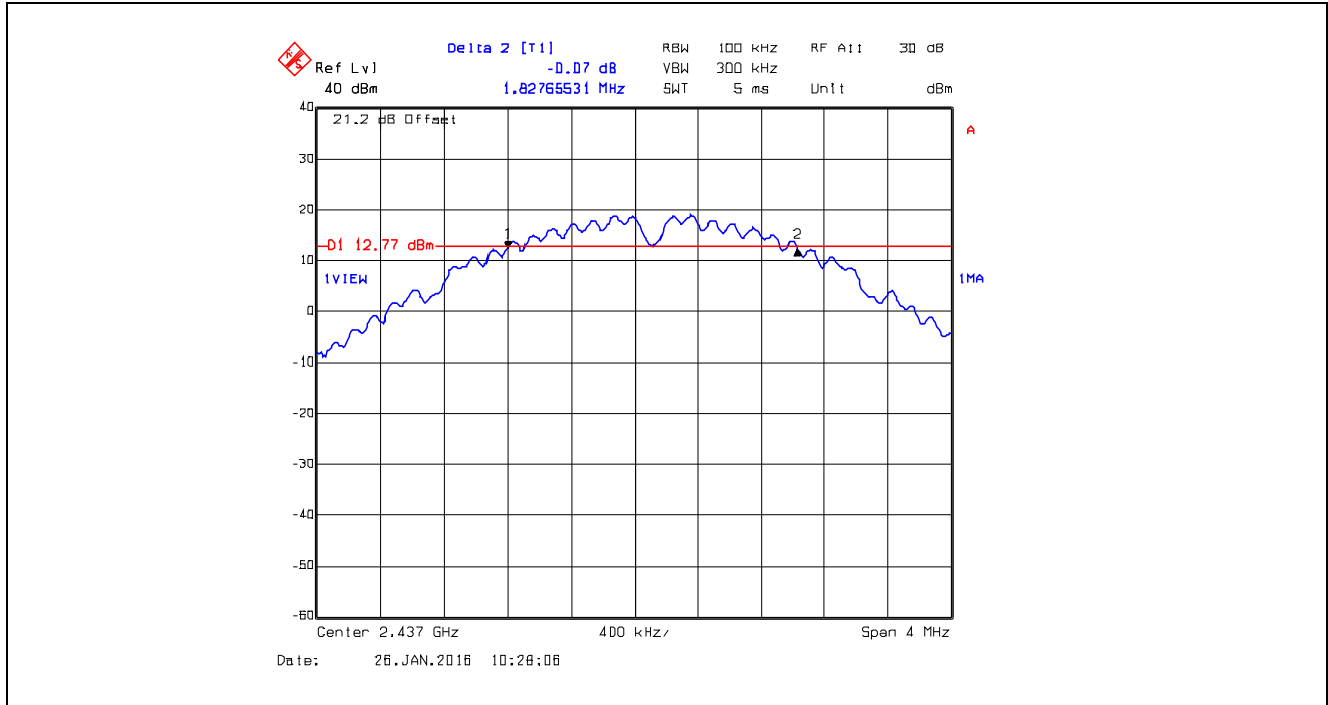
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Plot 5.2.4.9. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2482 MHz, Data Rate 1

Plot 5.2.4.10. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2402 MHz, Data Rate 2
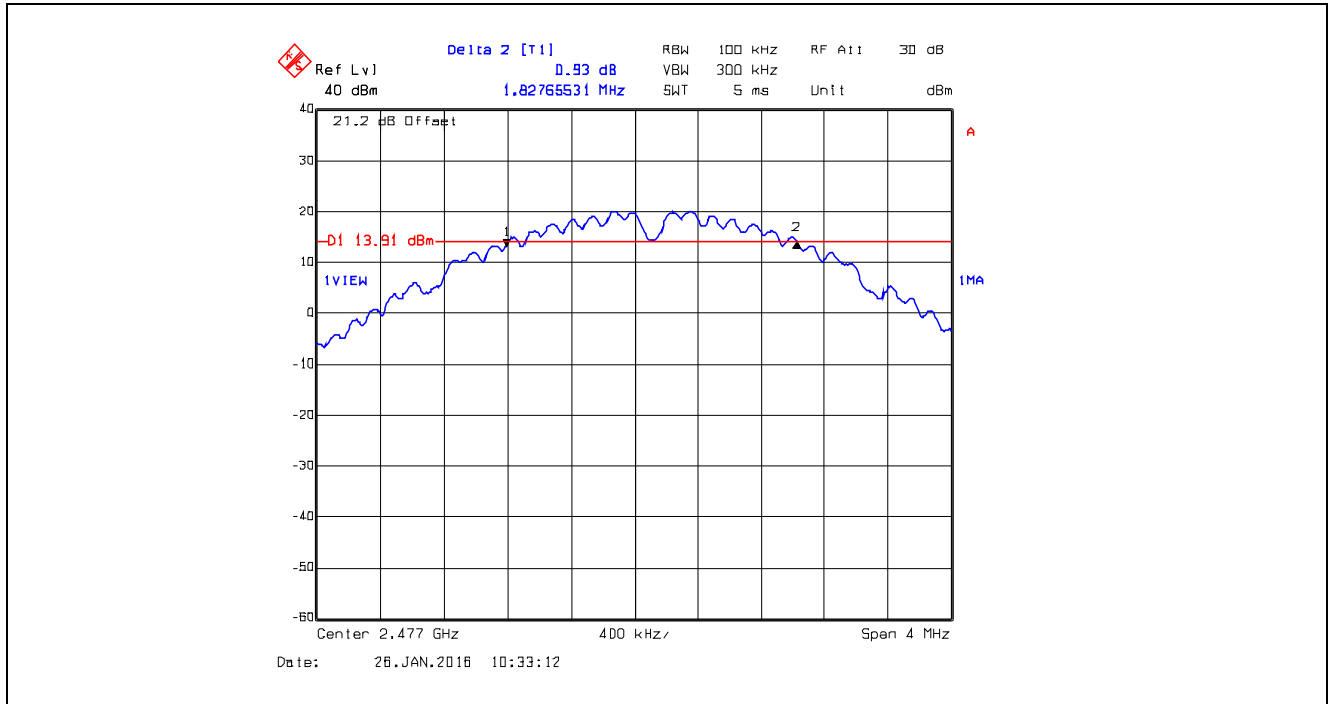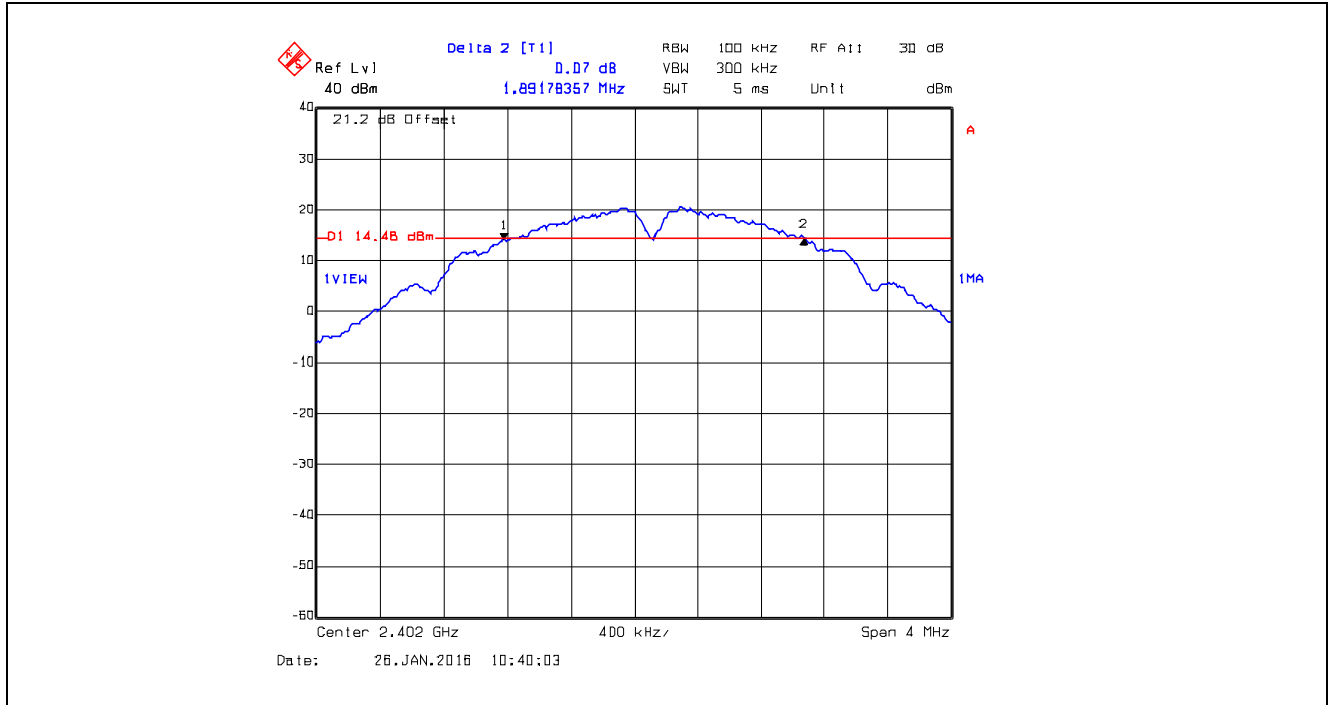
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Plot 5.2.4.11. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2437 MHz, Data Rate 2

Plot 5.2.4.12. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2482 MHz, Data Rate 2
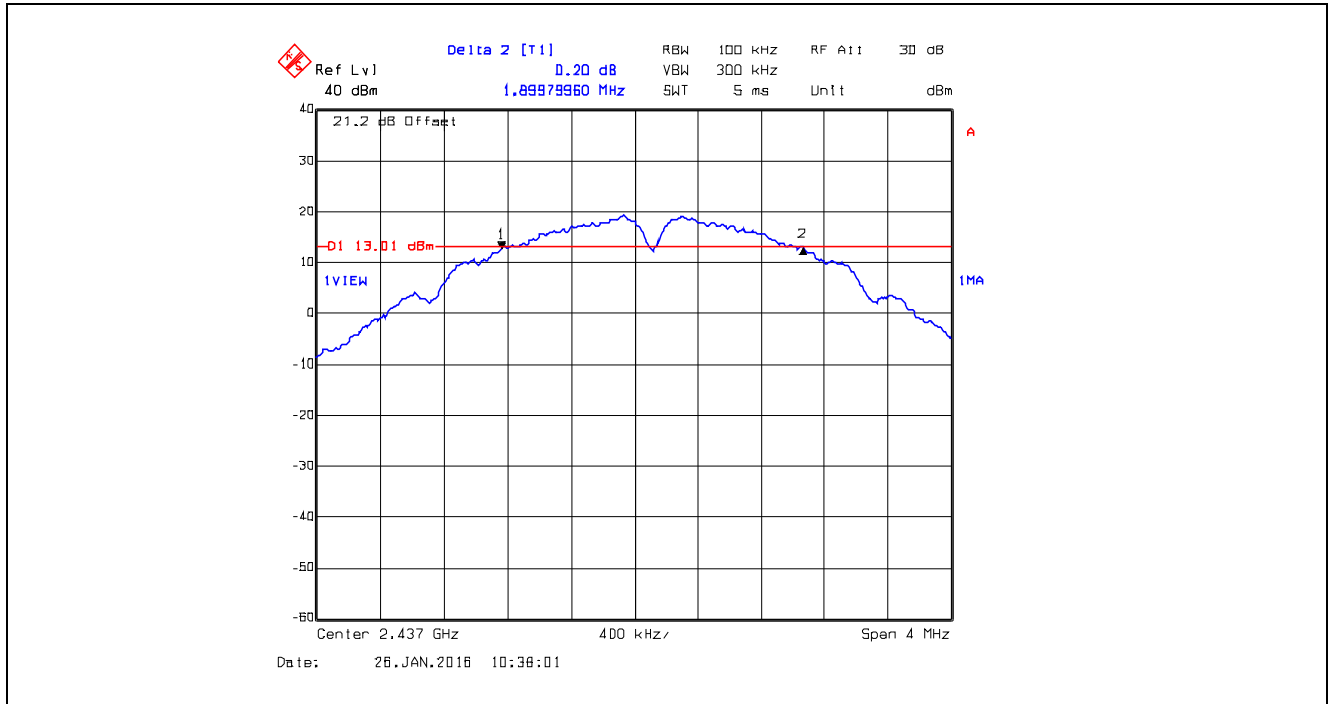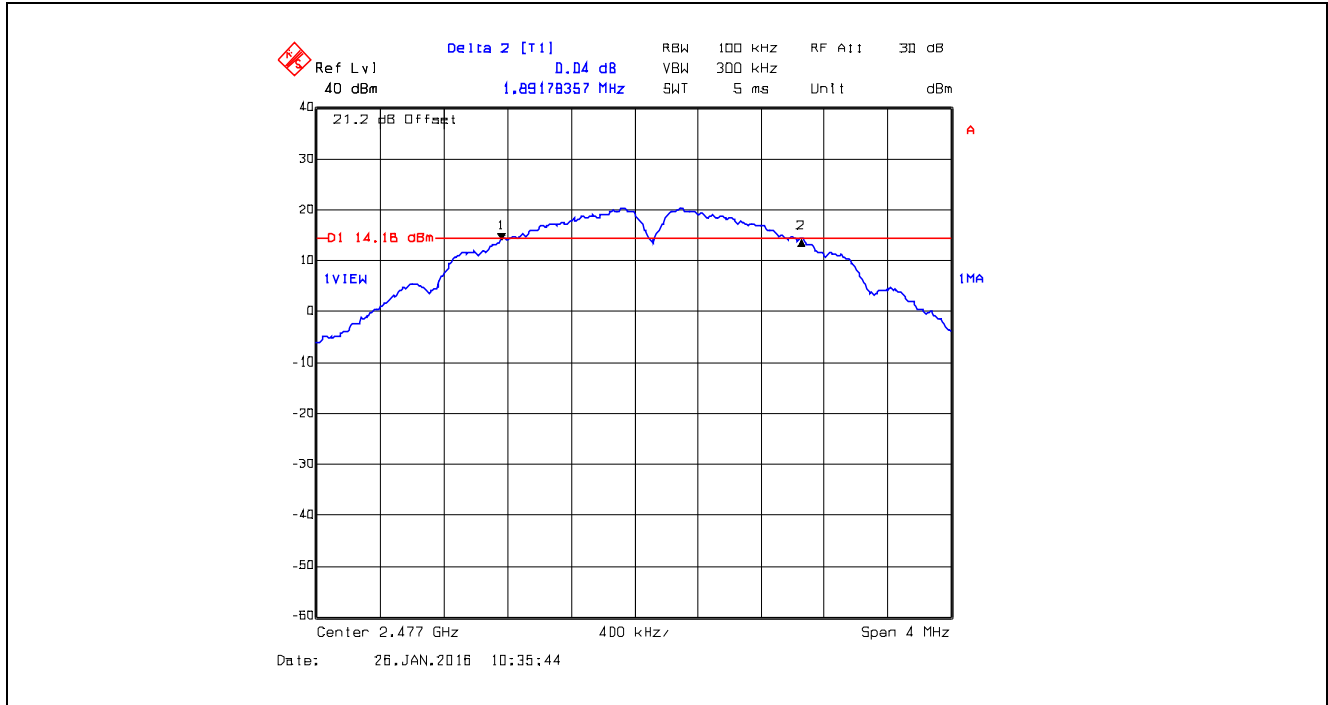
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.2.4.13. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2402 MHz, Data Rate 3

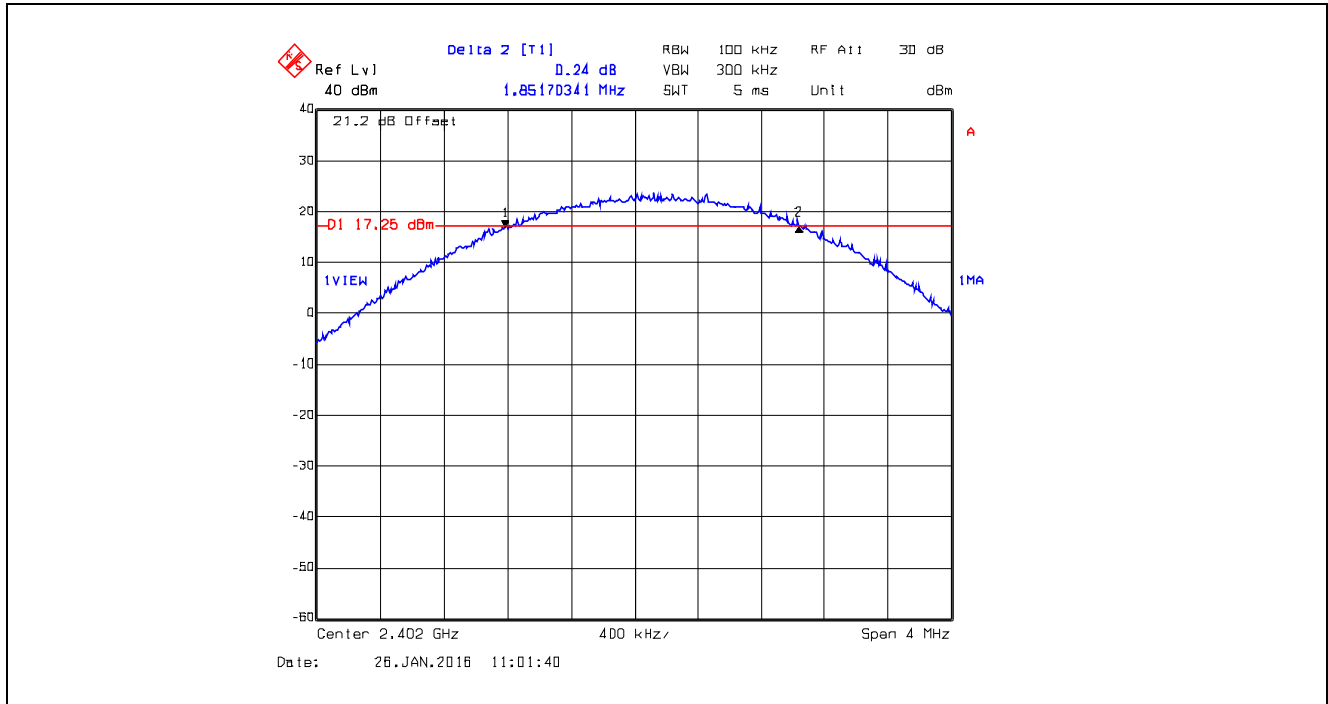**Plot 5.2.4.14.** 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2437 MHz, Data Rate 3
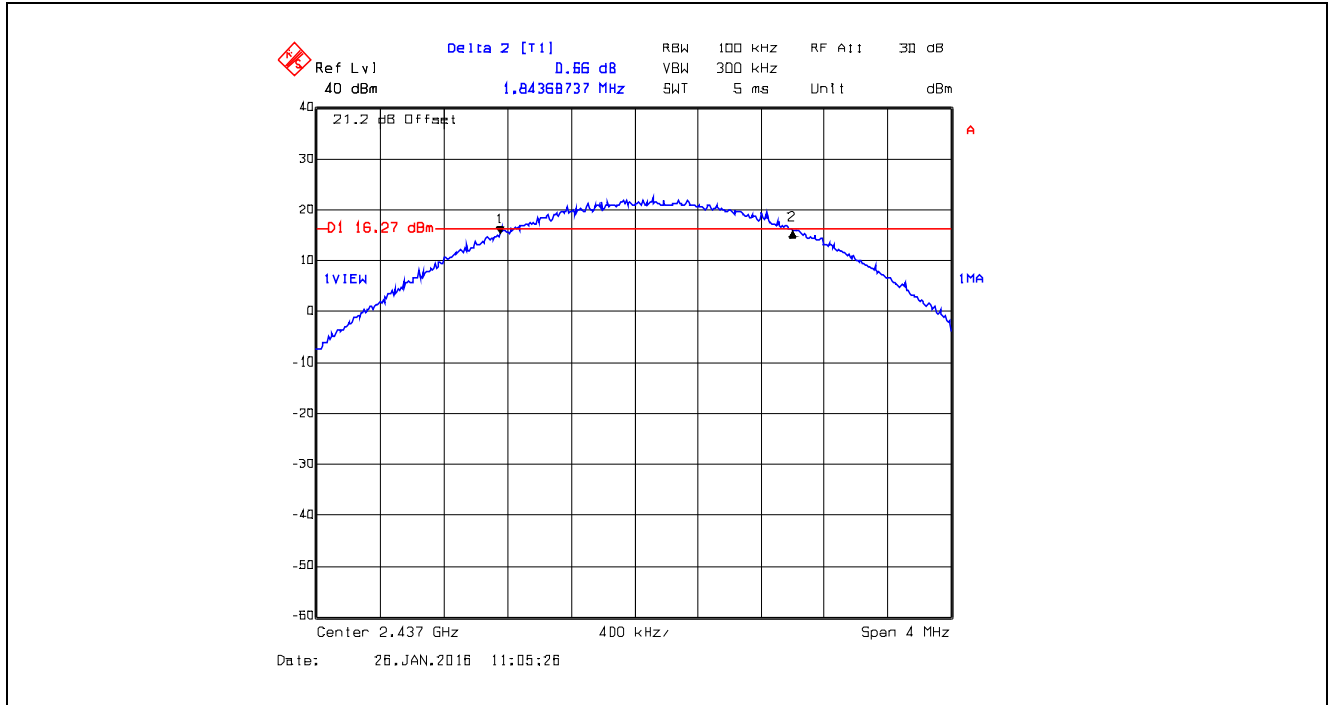
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.2.4.15. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 8, 2482 MHz, Data Rate 3

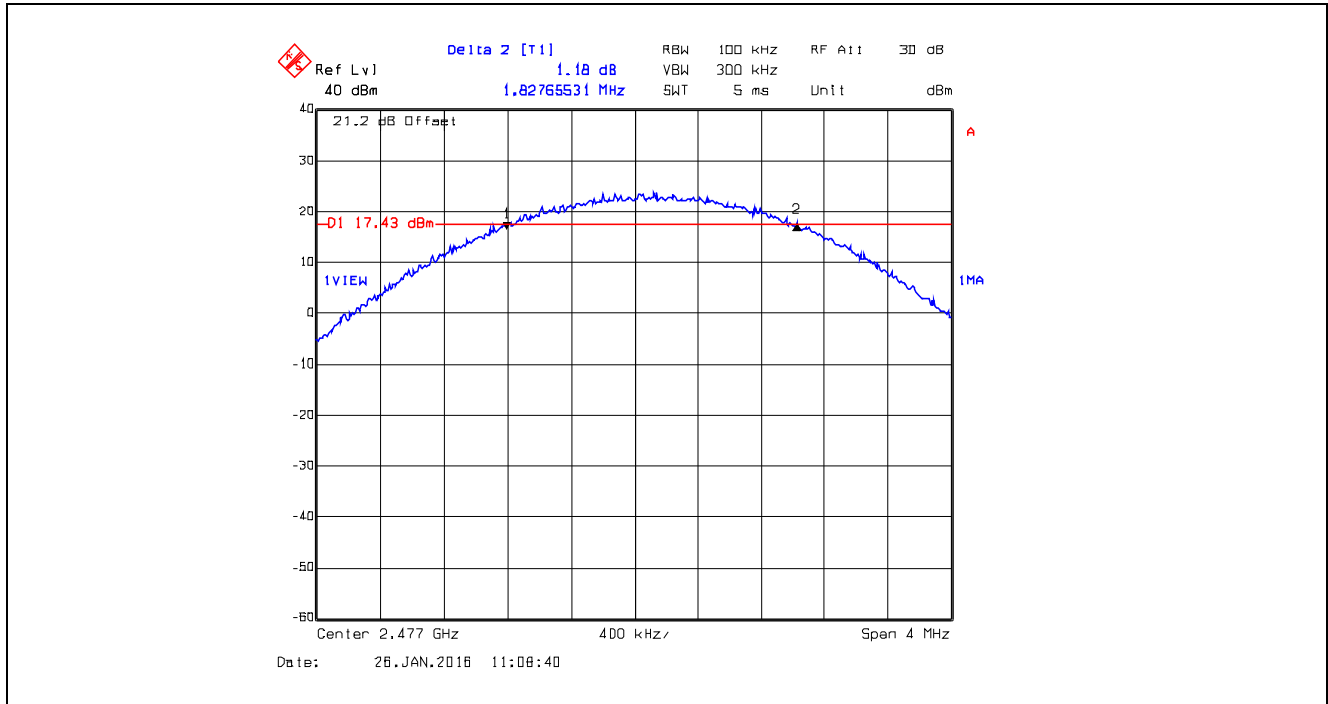**Plot 5.2.4.16.** 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2402 MHz, Data Rate 1
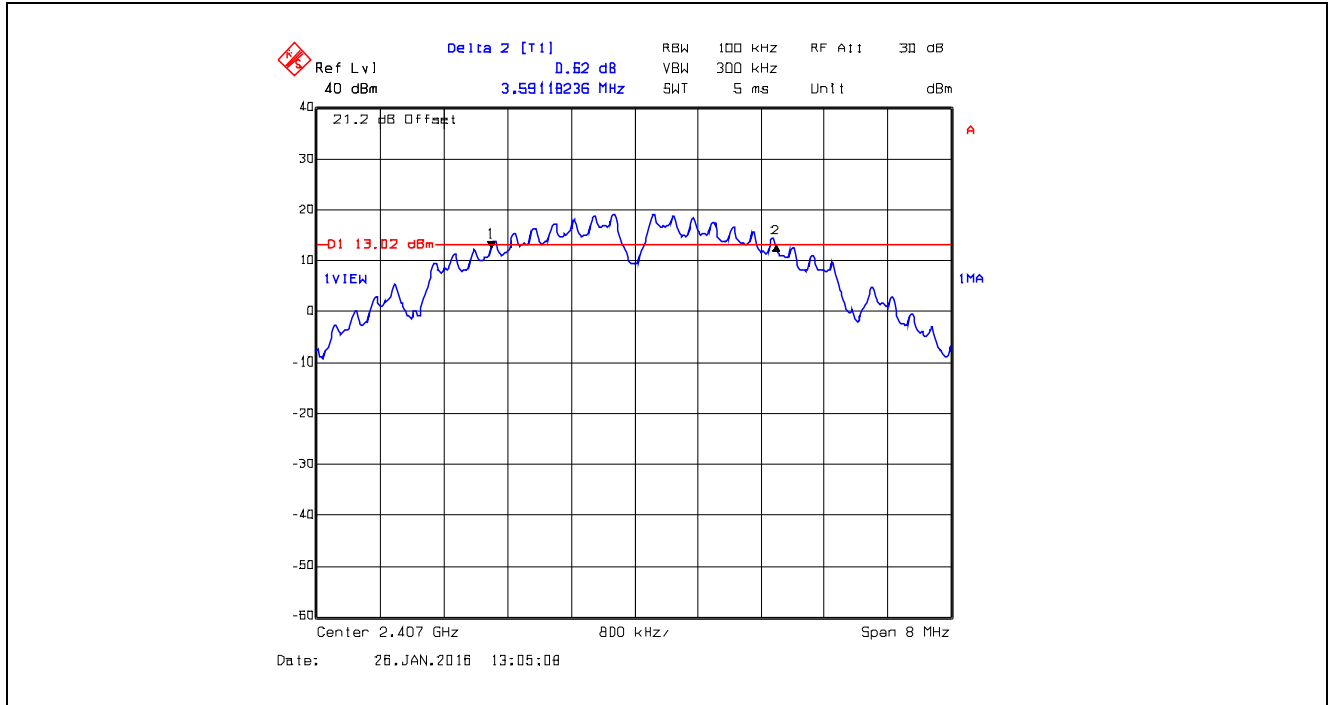
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Plot 5.2.4.17. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2437 MHz, Data Rate 1

Plot 5.2.4.18. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2477 MHz, Data Rate 1
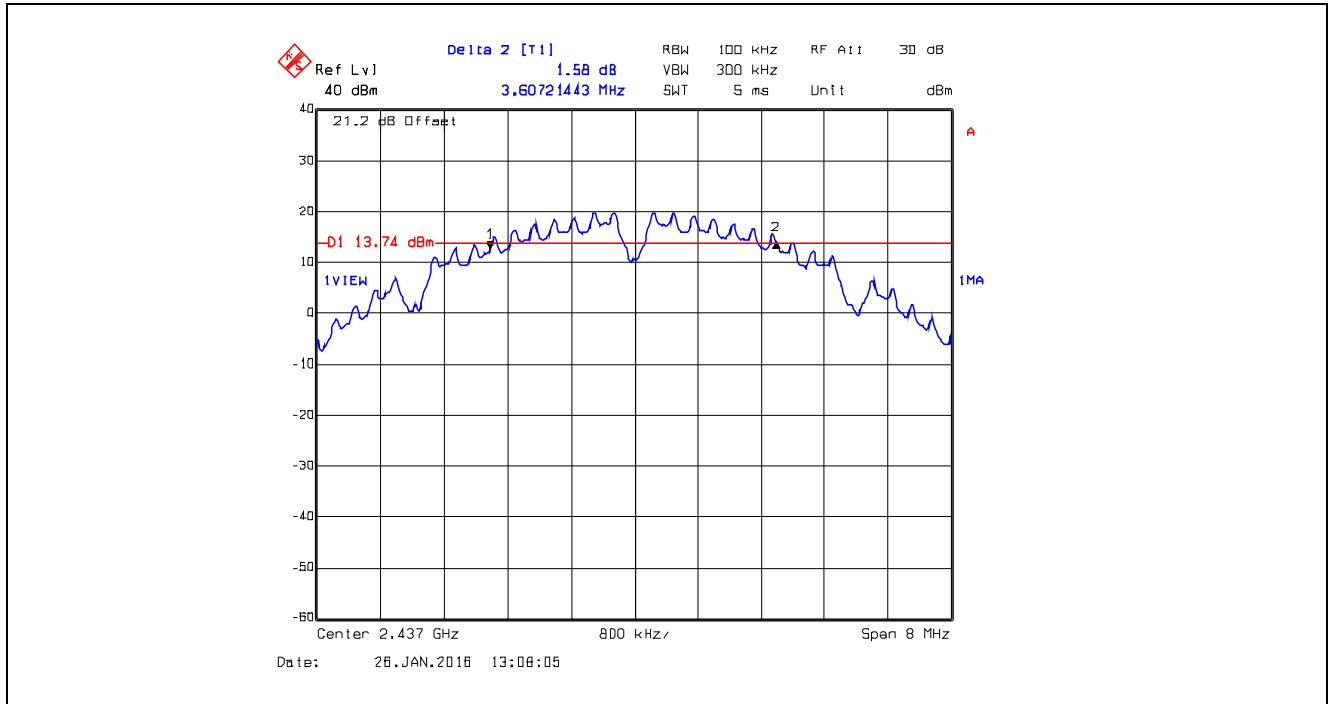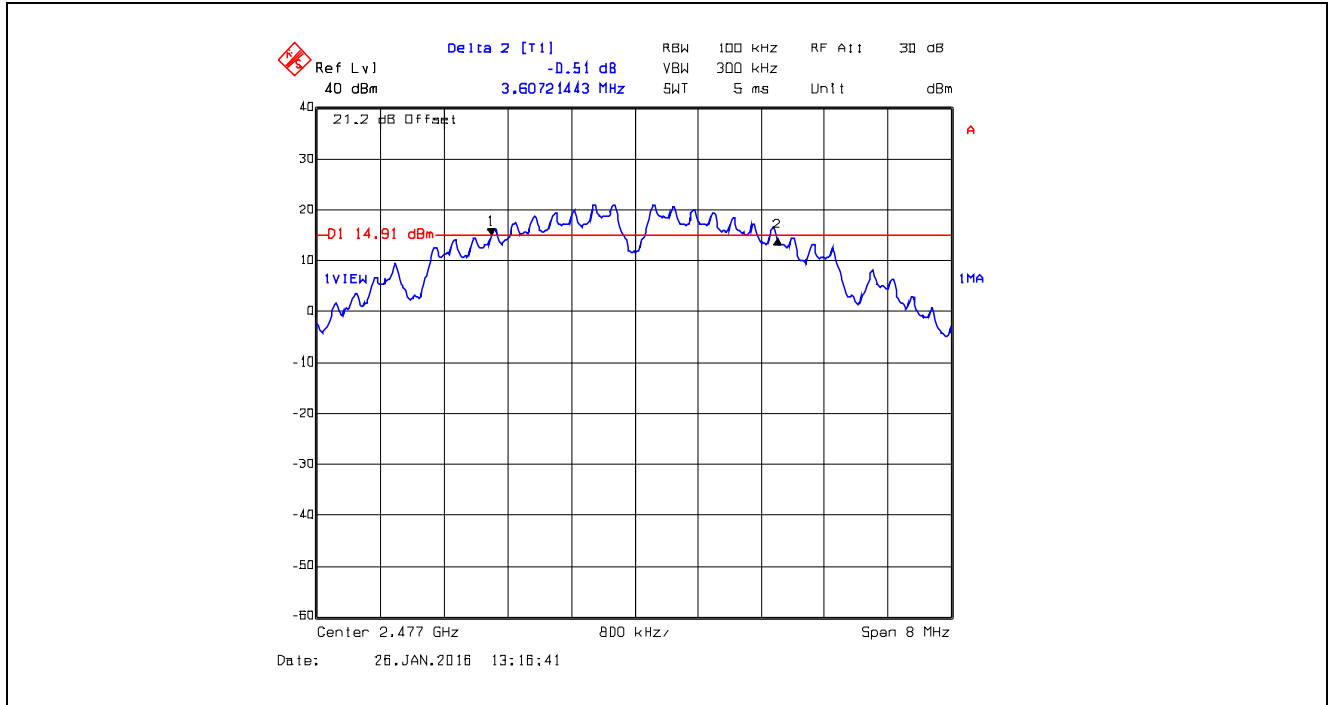
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Plot 5.2.4.19. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2402 MHz, Data Rate 2

Plot 5.2.4.20. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2437 MHz, Data Rate 2
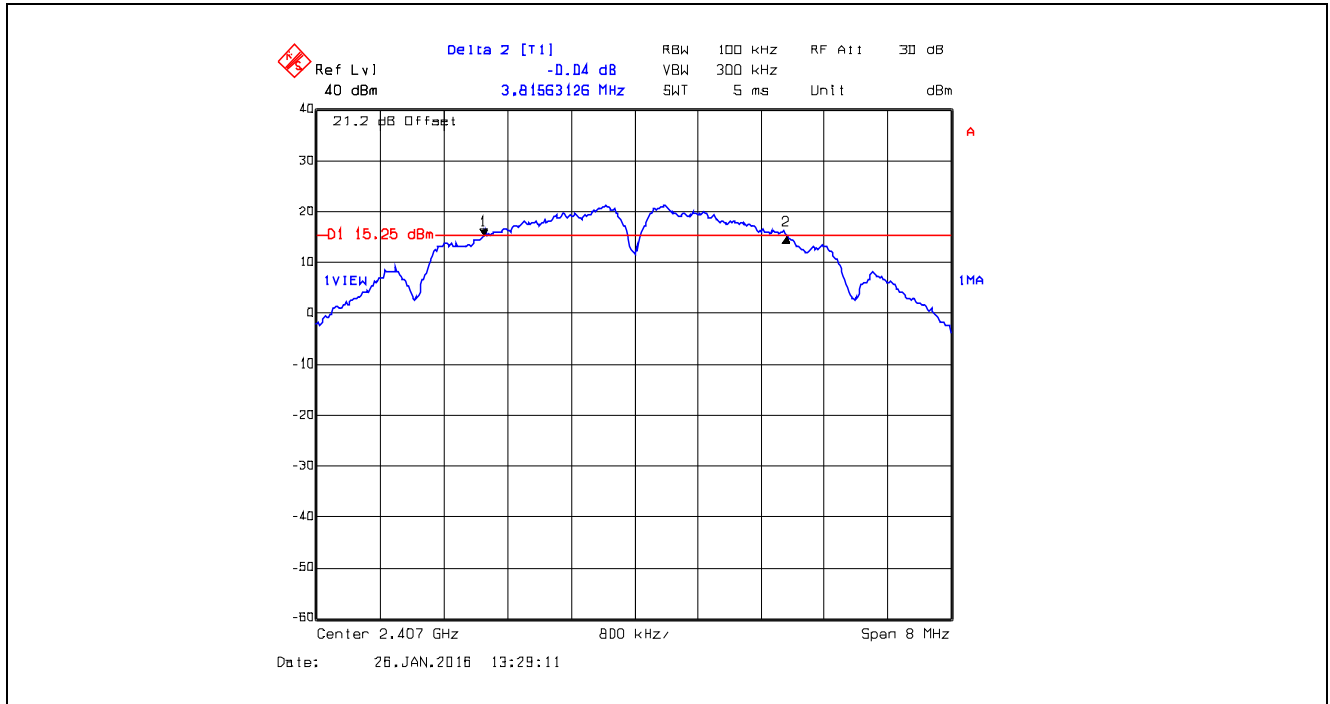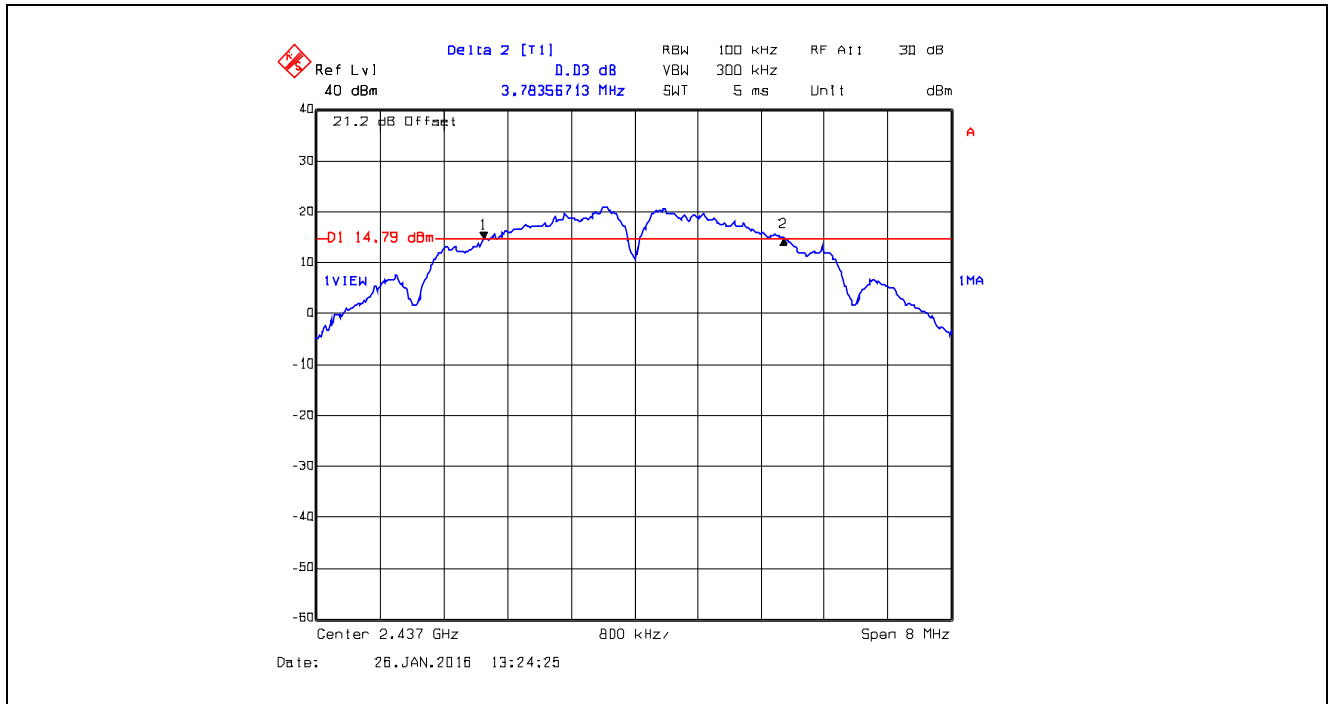
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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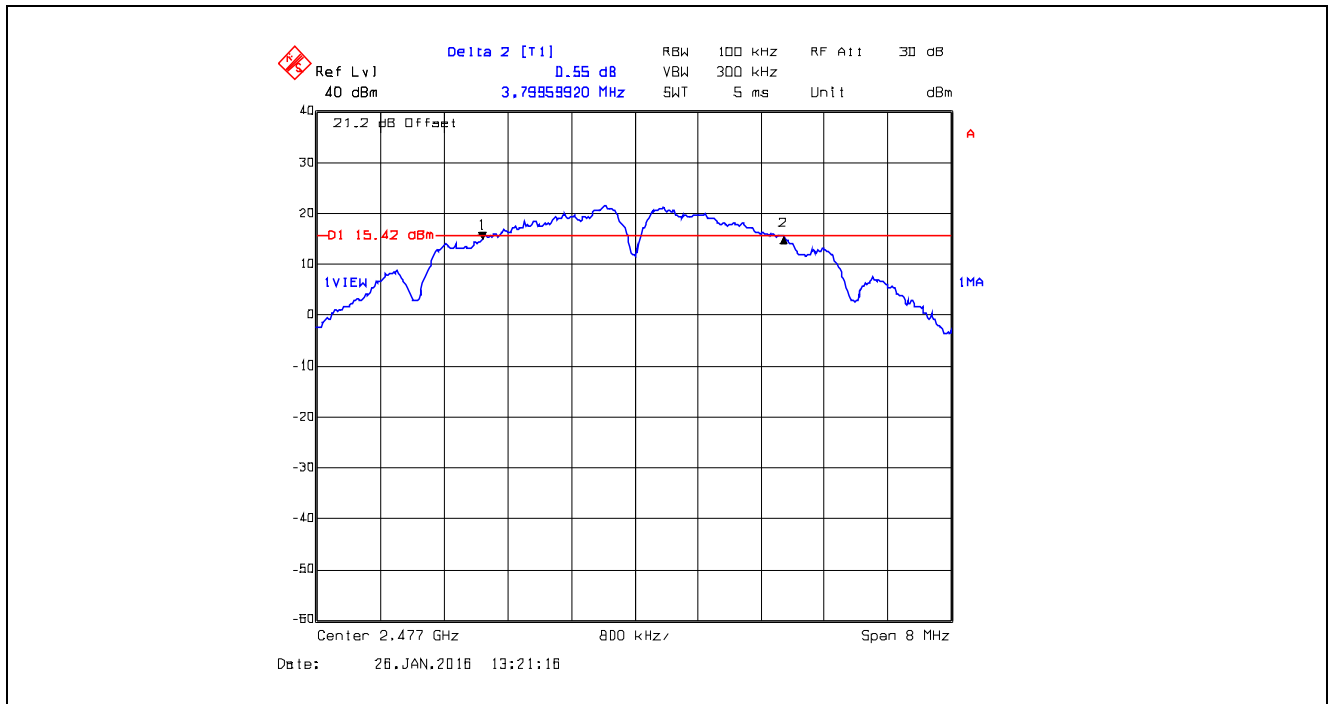
Plot 5.2.4.21. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2477 MHz, Data Rate 2

Plot 5.2.4.22. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2402 MHz, Data Rate 3
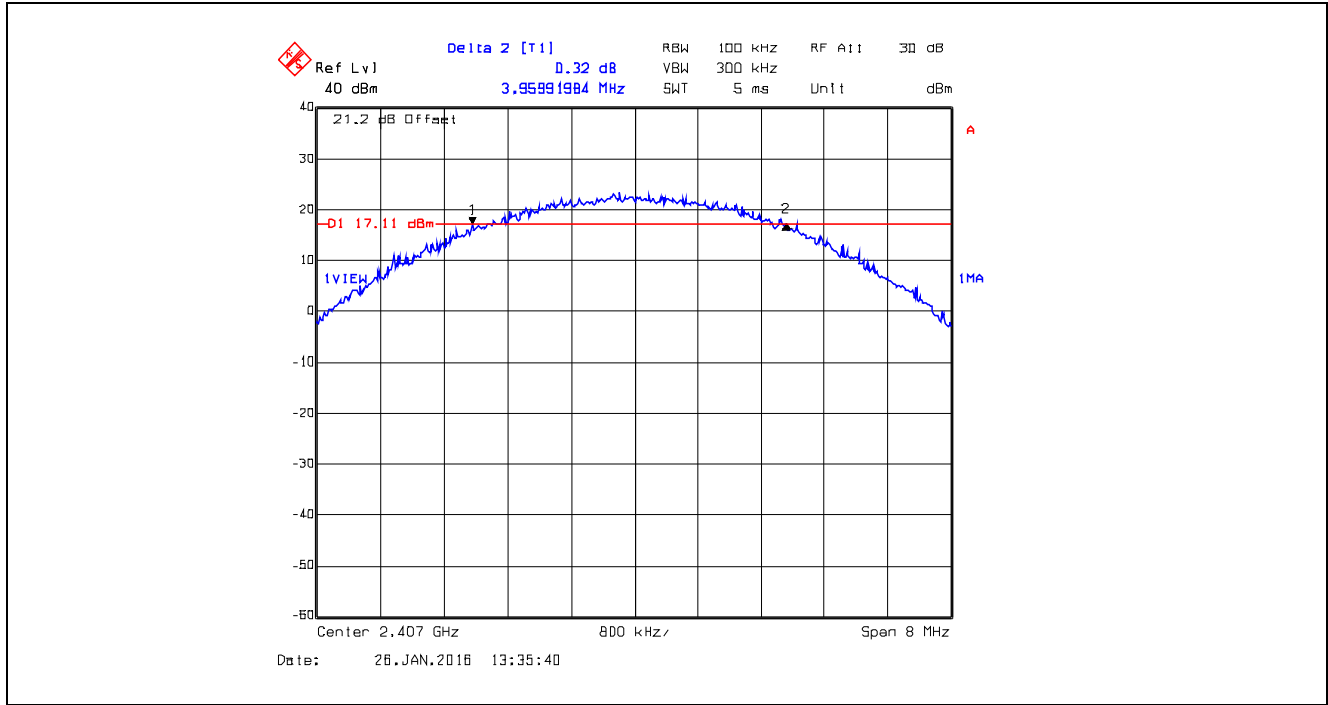

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

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Plot 5.2.4.23. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2437 MHz, Data Rate 3

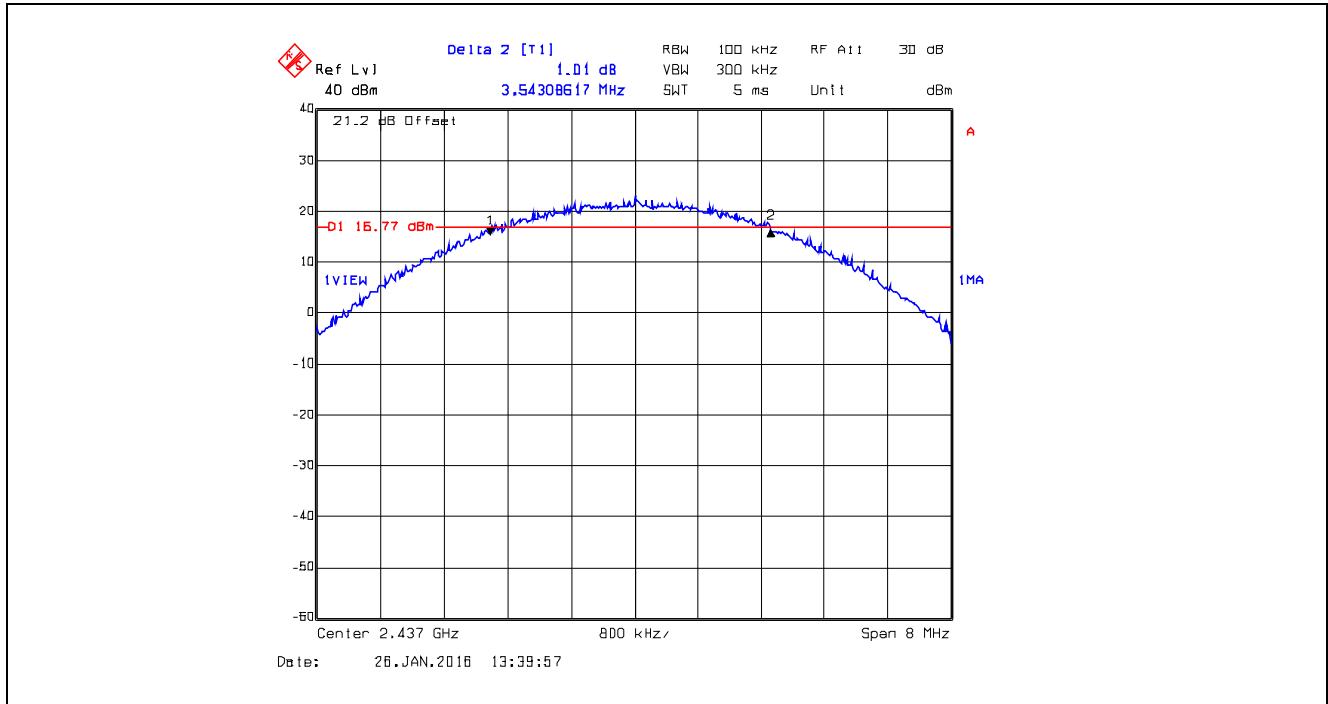**Plot 5.2.4.24.** 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 18, 2477 MHz, Data Rate 3
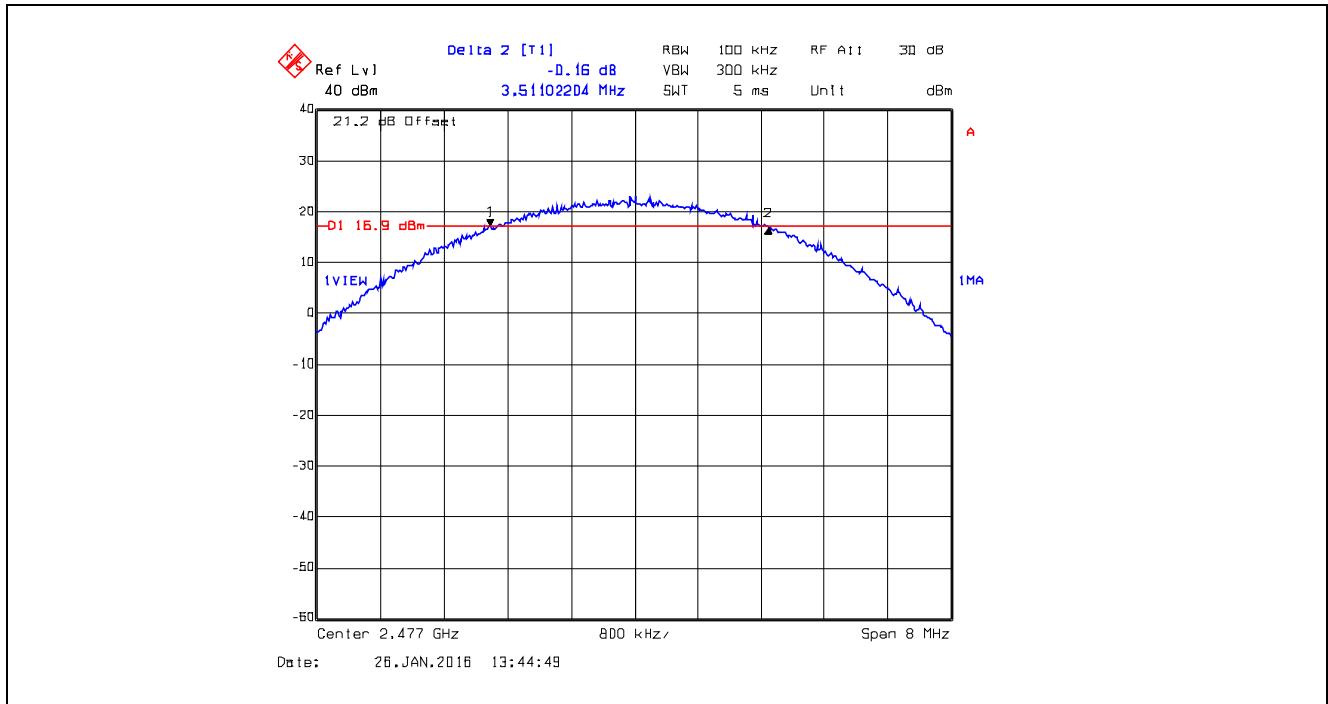
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Plot 5.2.4.25. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 1

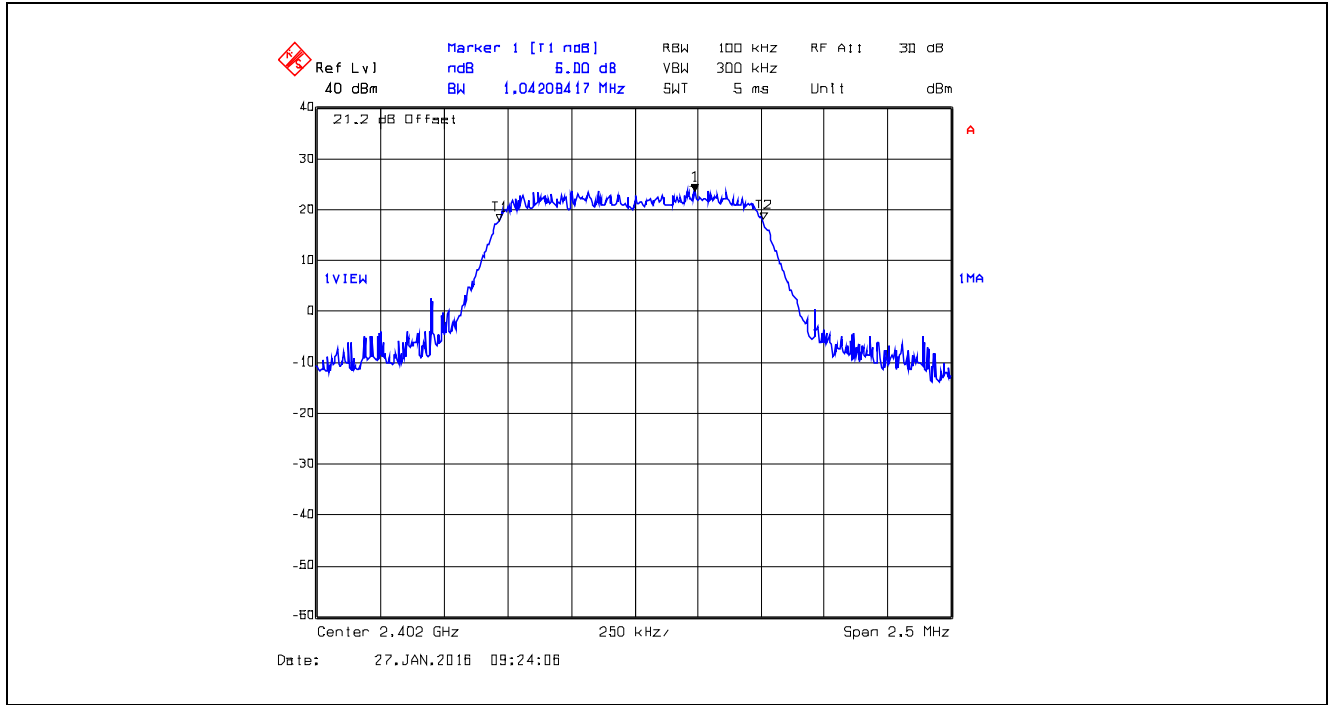**Plot 5.2.4.26.** 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 1
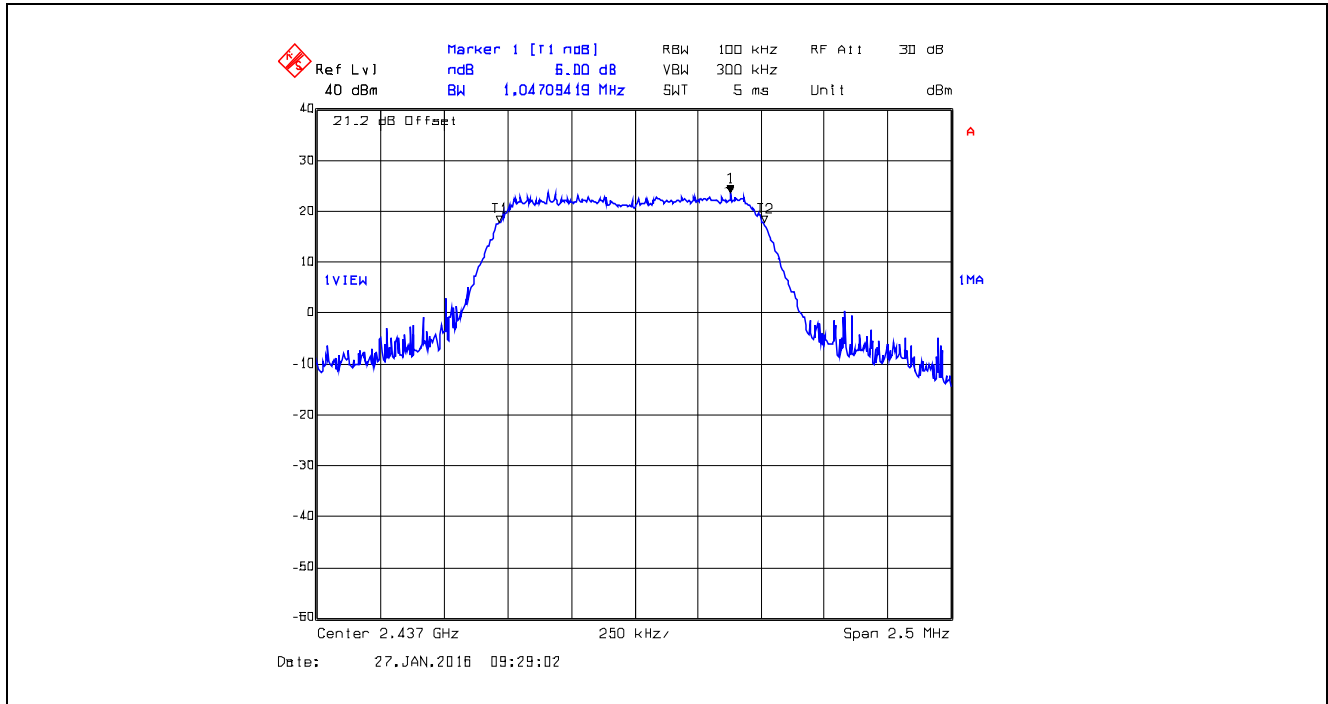
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**

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Plot 5.2.4.27. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 1

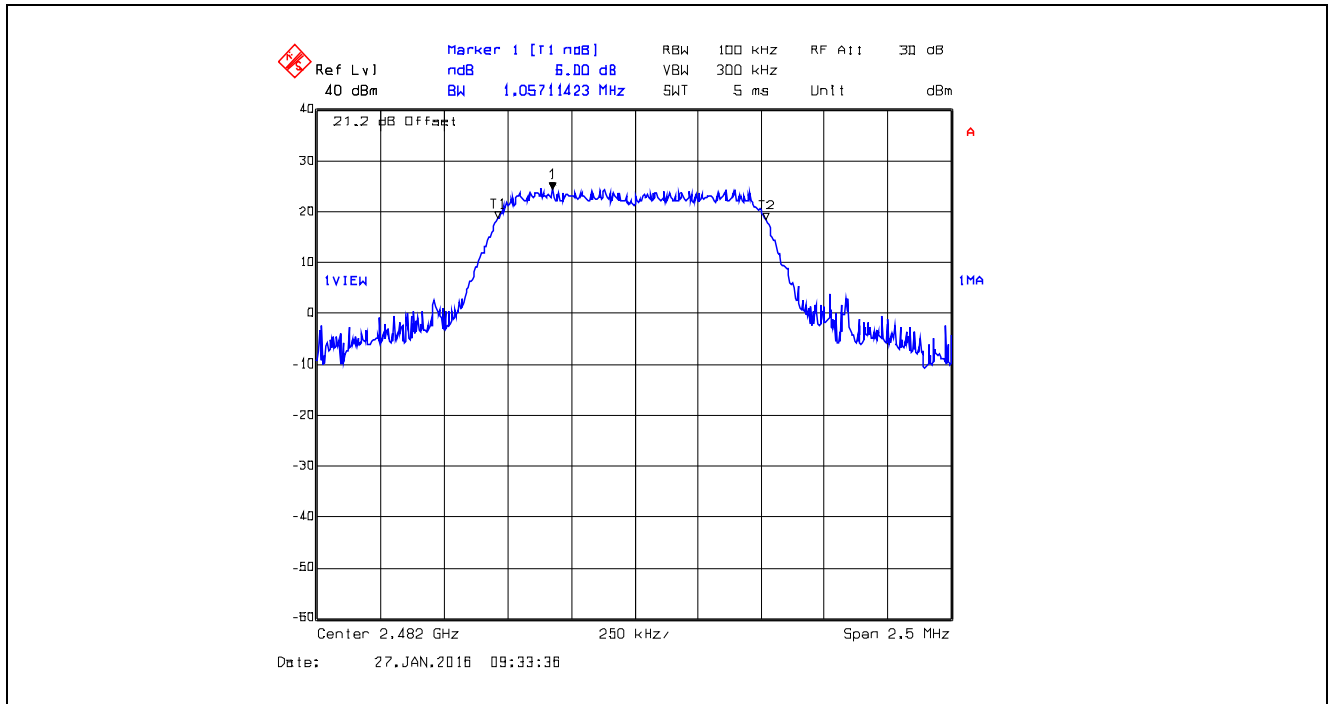**Plot 5.2.4.28.** 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 2
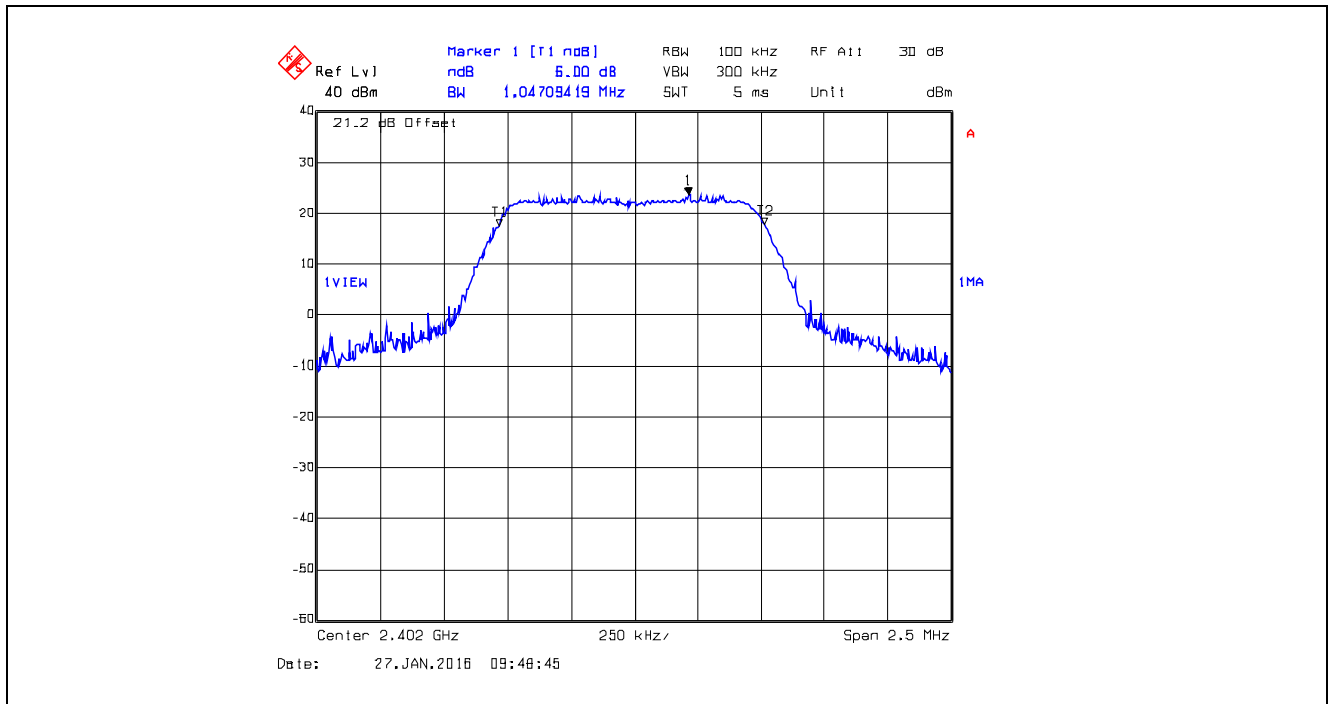
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Plot 5.2.4.29. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 2

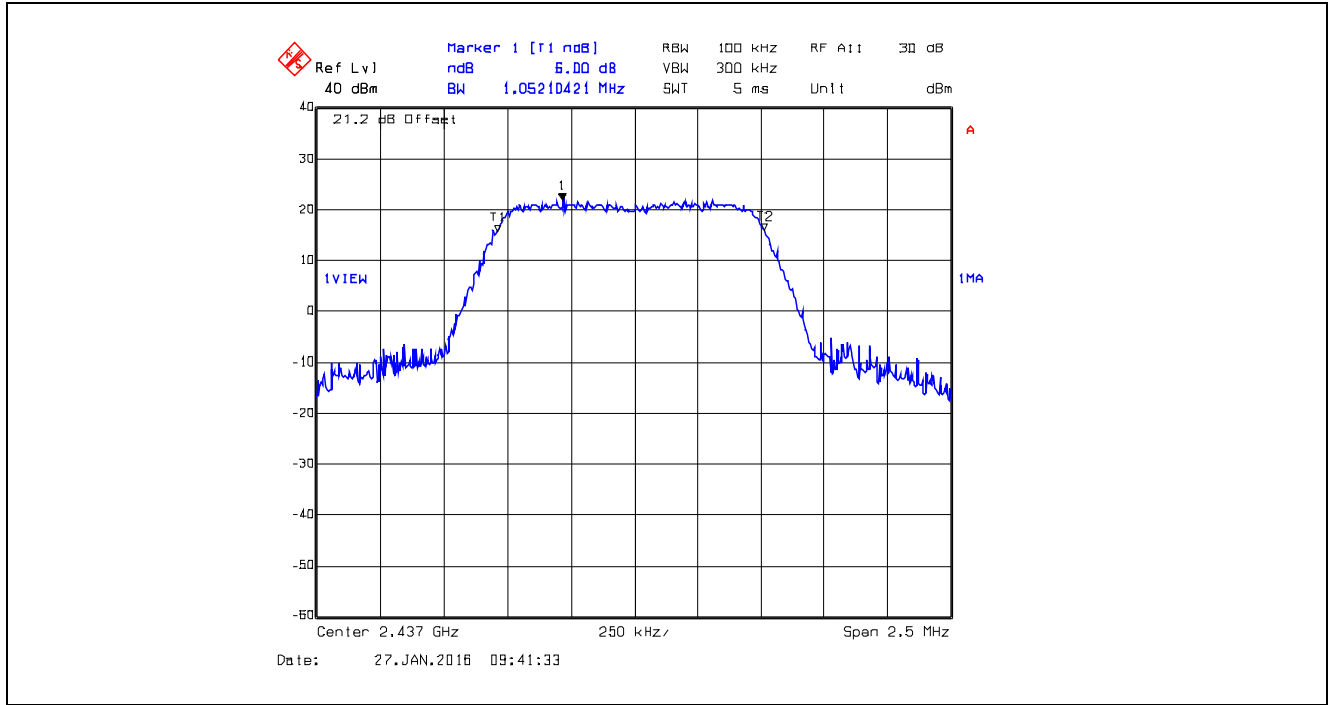**Plot 5.2.4.30.** 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 2
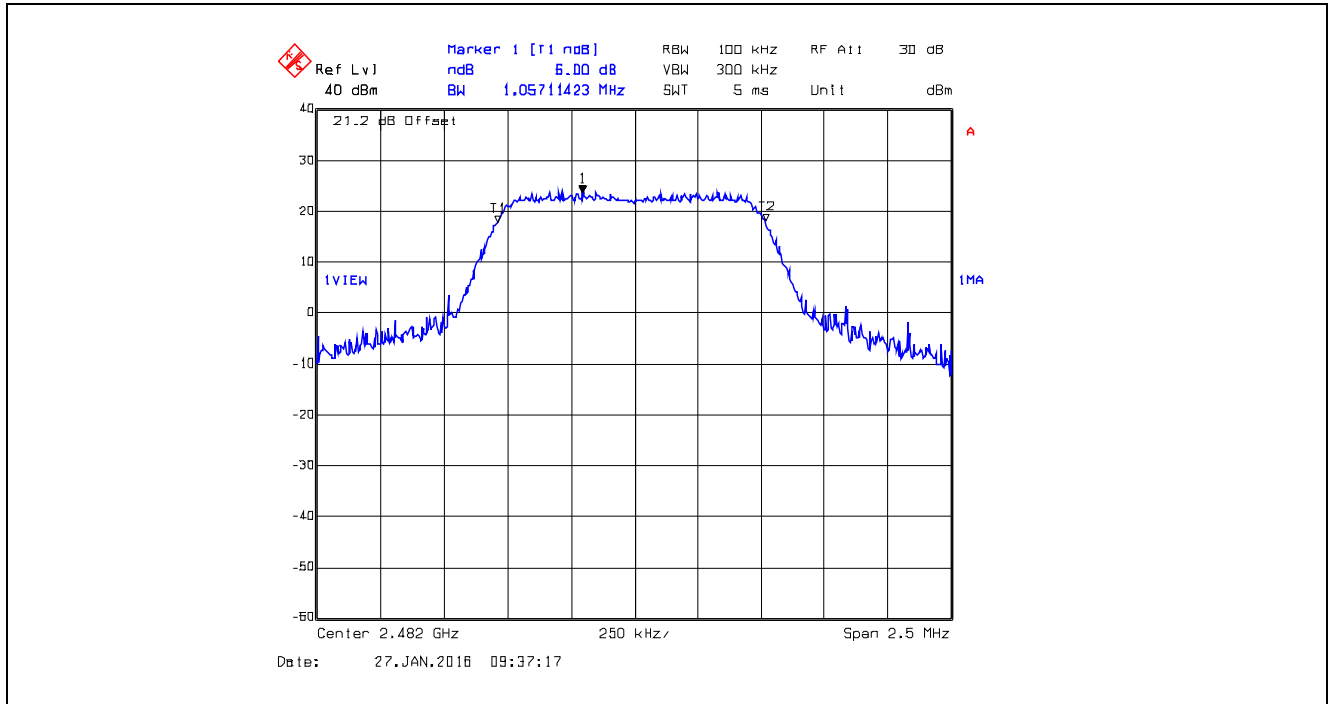
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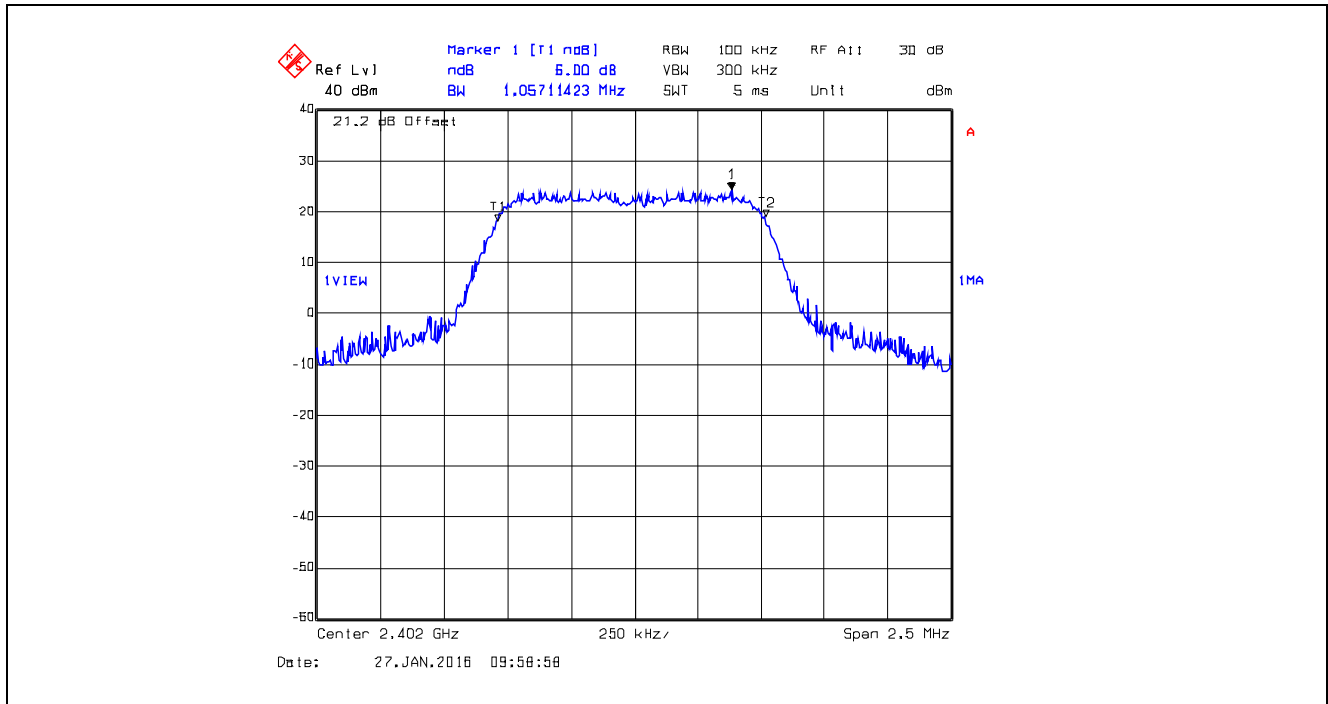
Plot 5.2.4.31. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 3

Plot 5.2.4.32. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 3
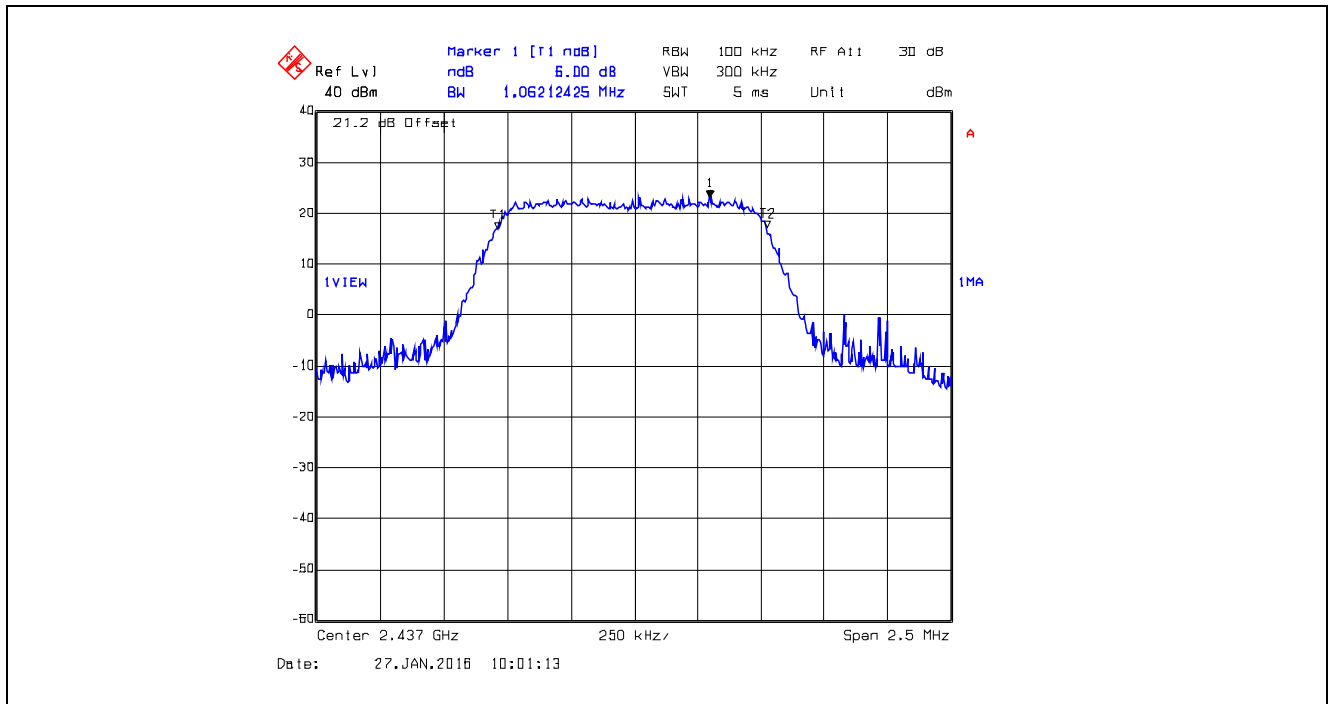
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Plot 5.2.4.33. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 3

ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
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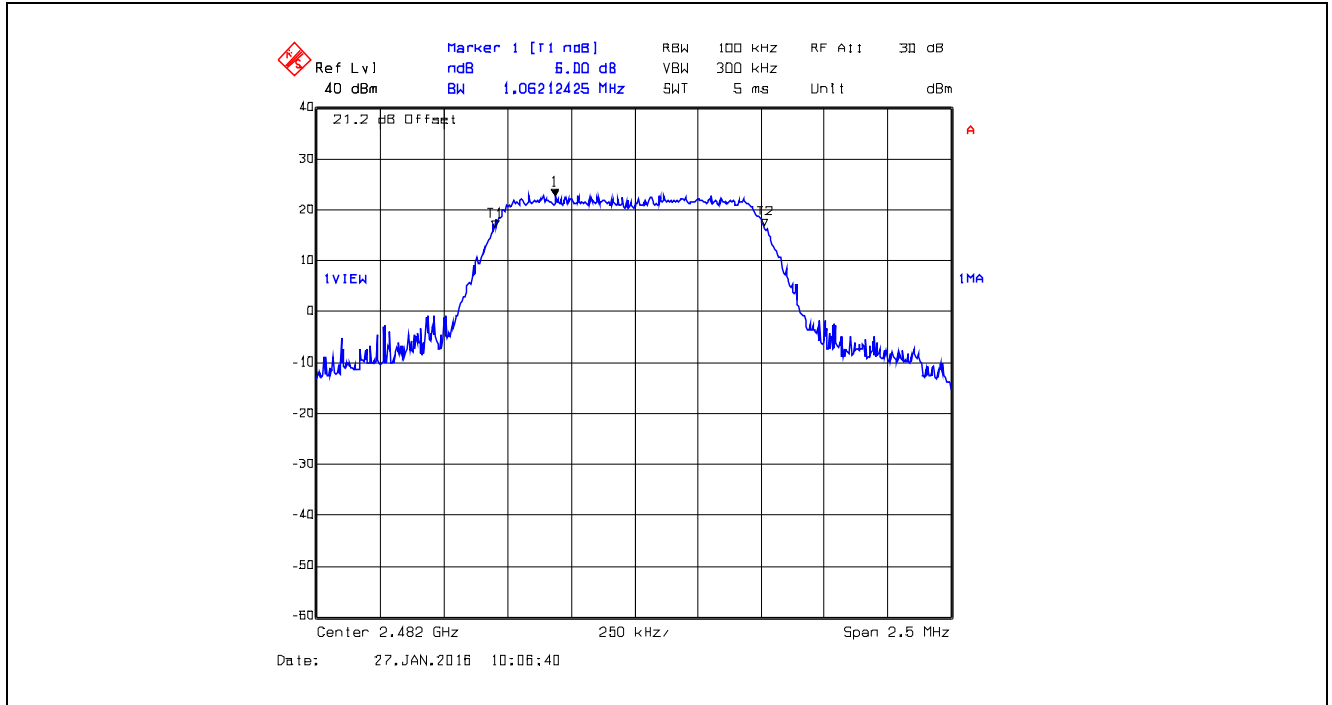
Plot 5.2.4.34. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 4

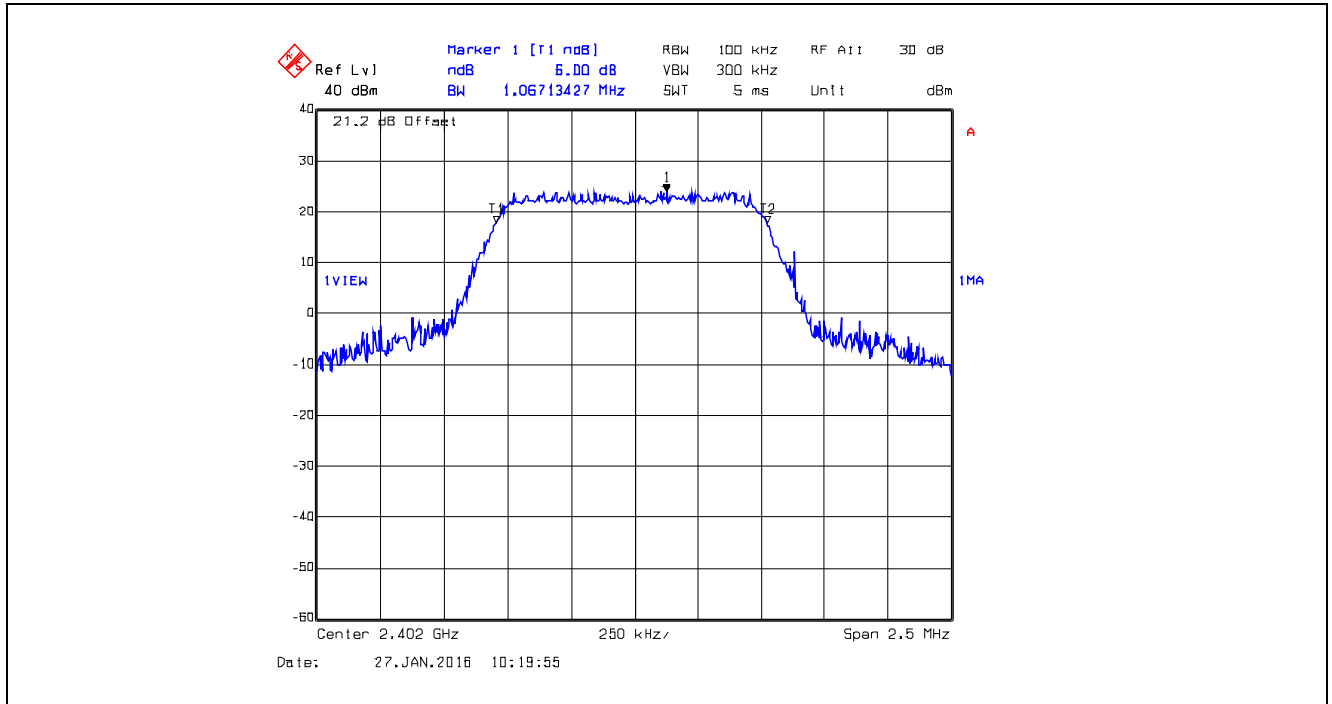**Plot 5.2.4.35.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 4
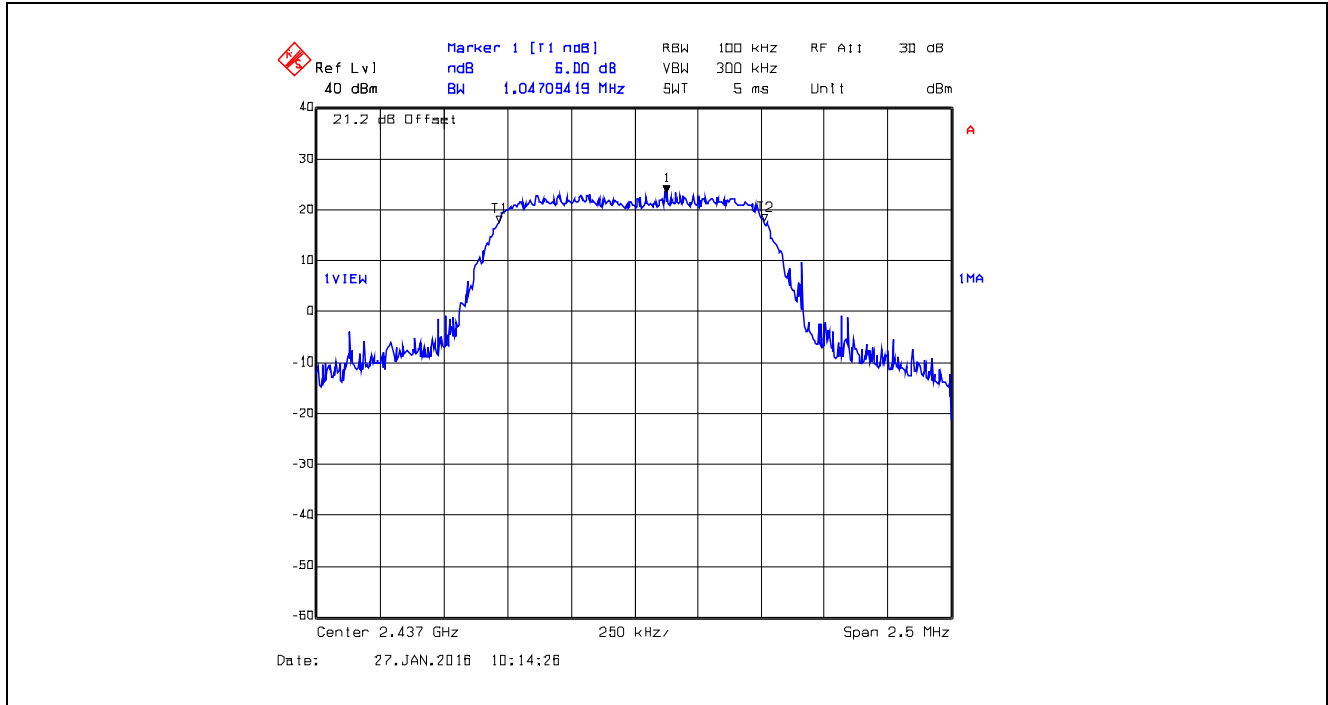
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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
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Plot 5.2.4.36. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 4

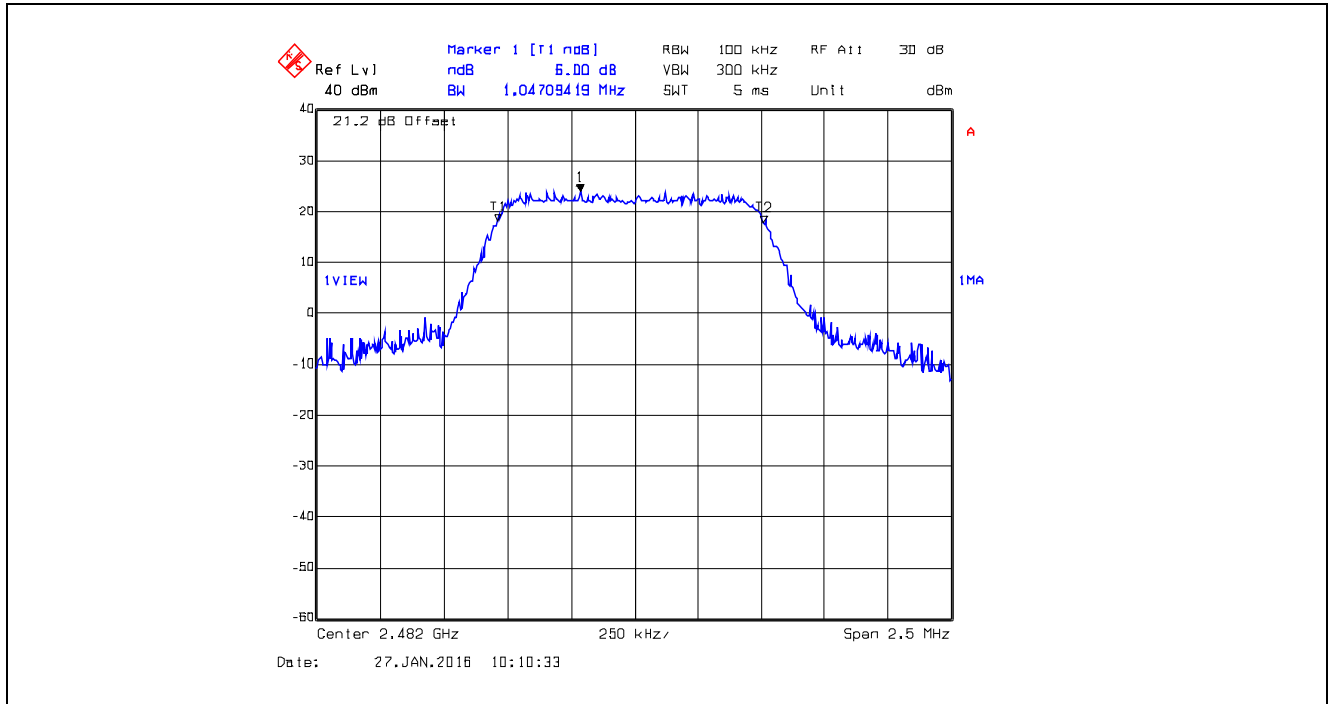**Plot 5.2.4.37.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 5
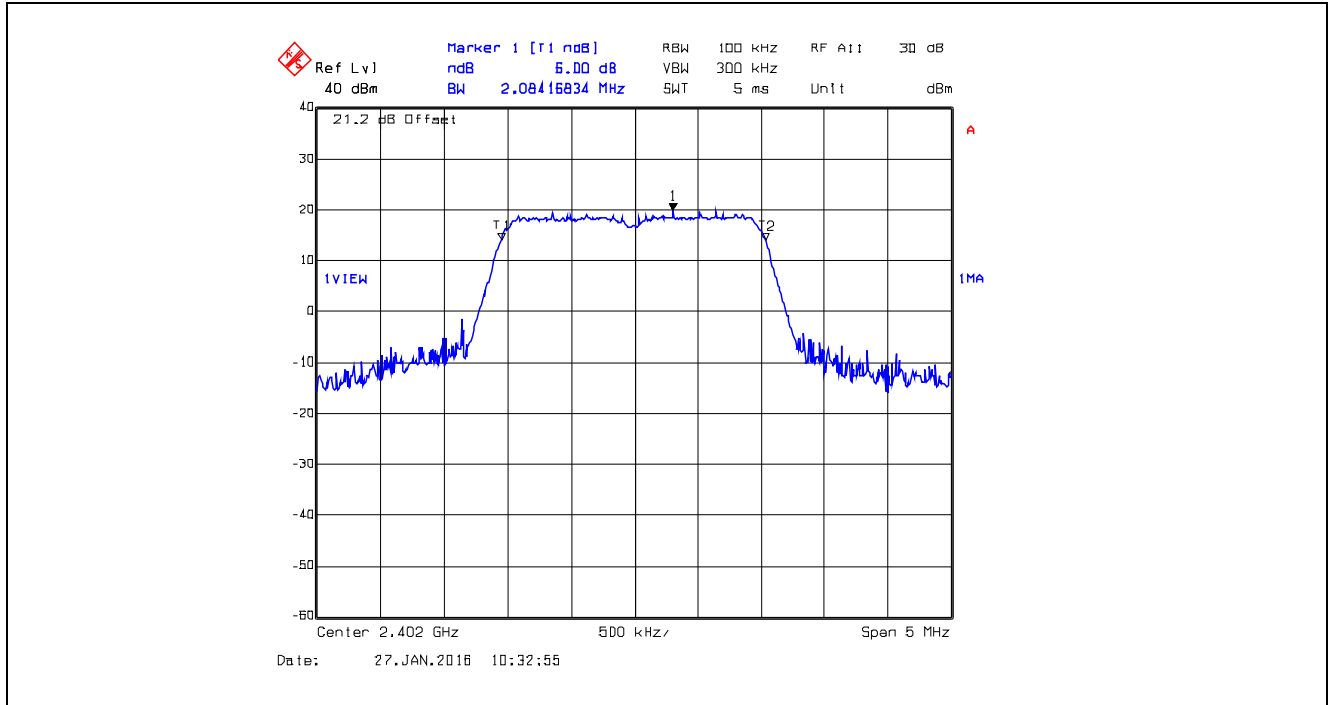

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Plot 5.2.4.38. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 5

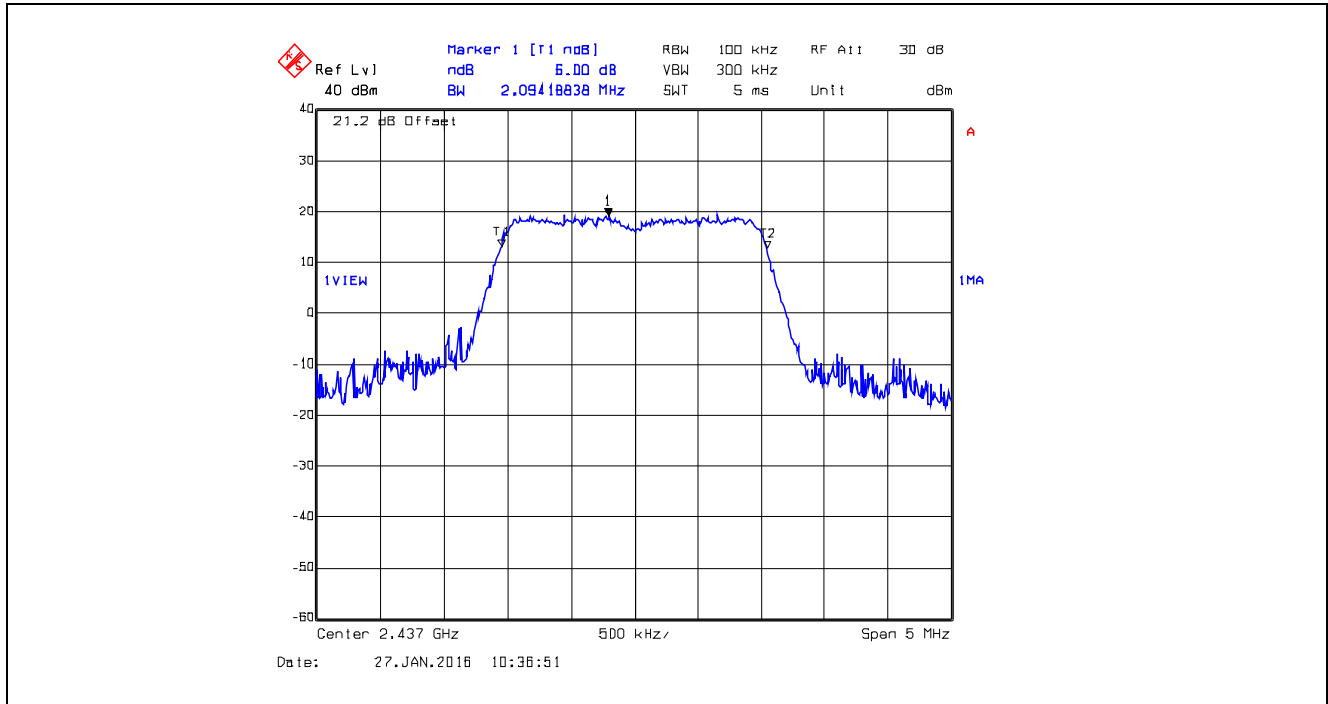**Plot 5.2.4.39.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 5
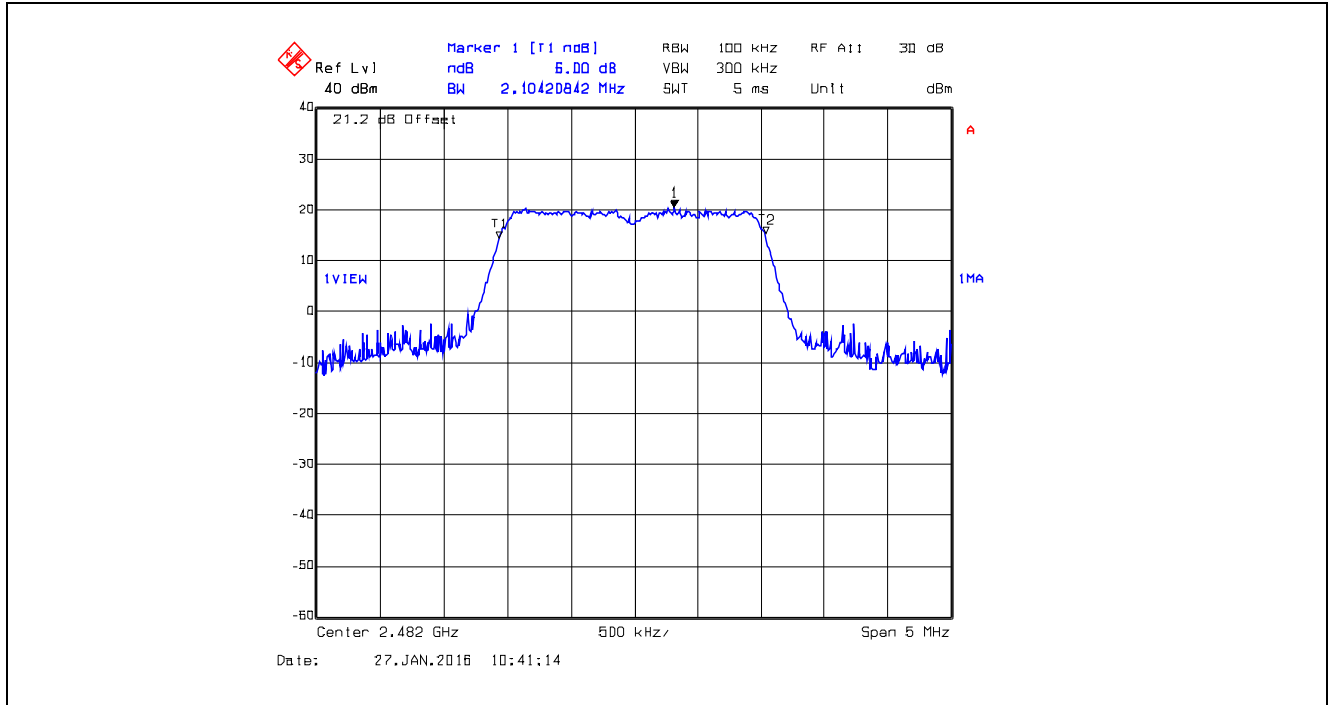

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Plot 5.2.4.40. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 6

Plot 5.2.4.41. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 6
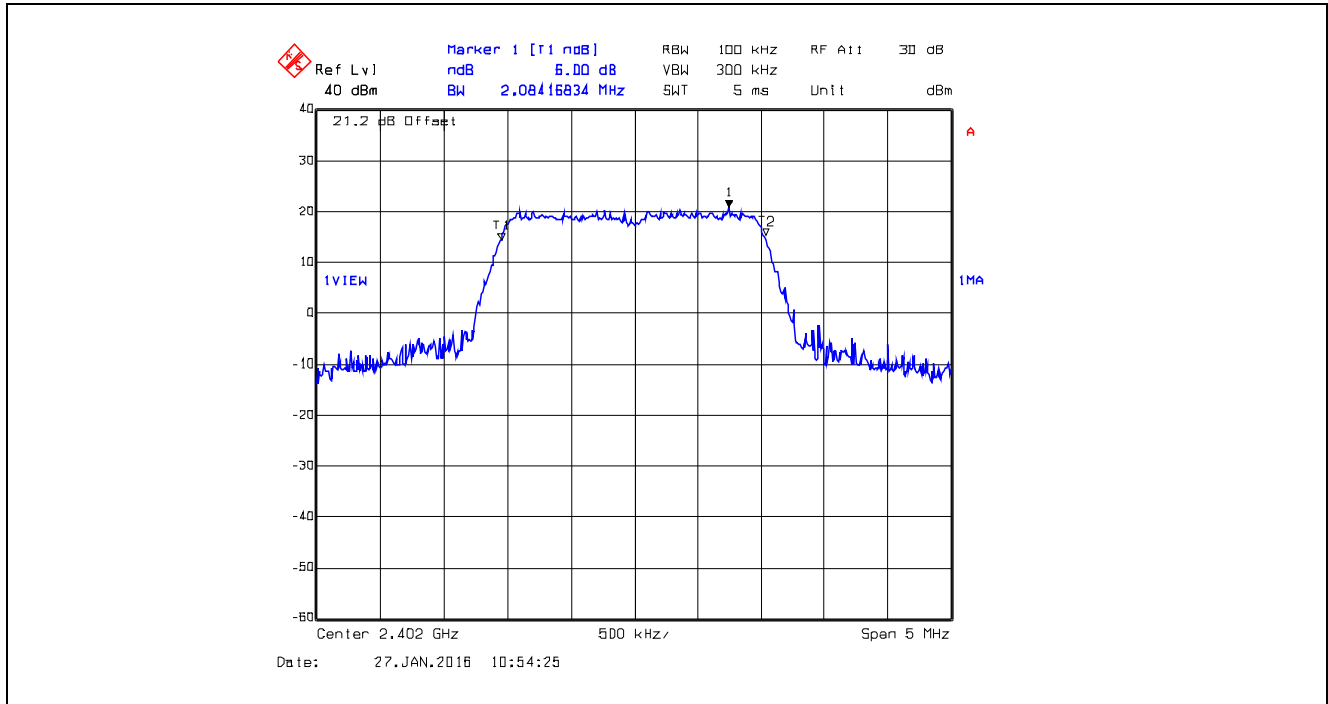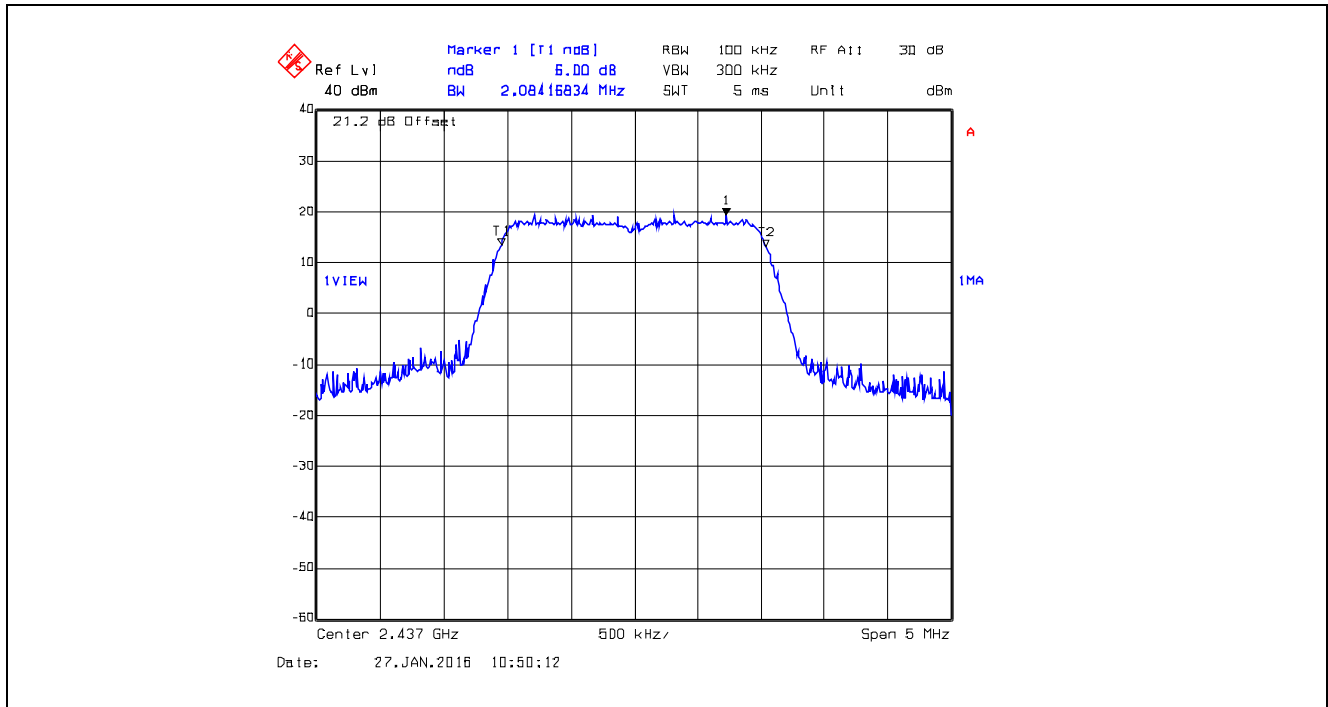
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Plot 5.2.4.42. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 6

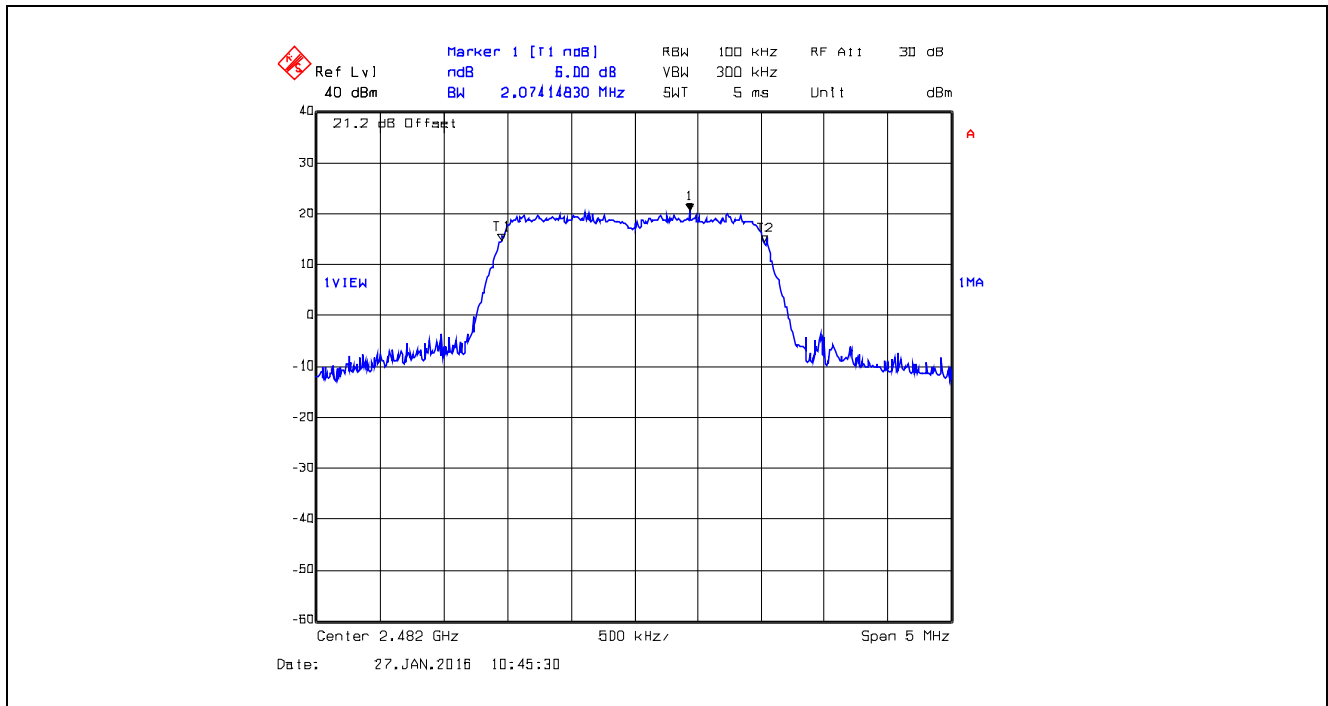**Plot 5.2.4.43.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 7
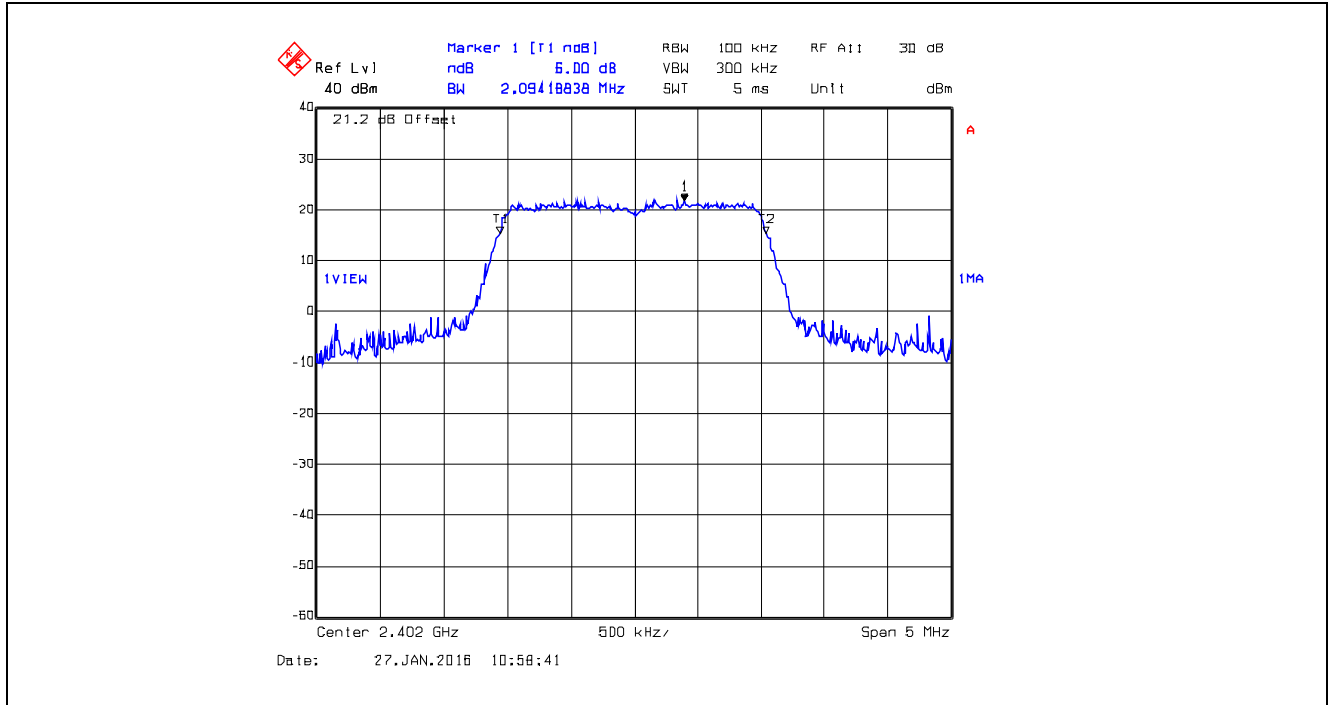
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Plot 5.2.4.44. 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 7

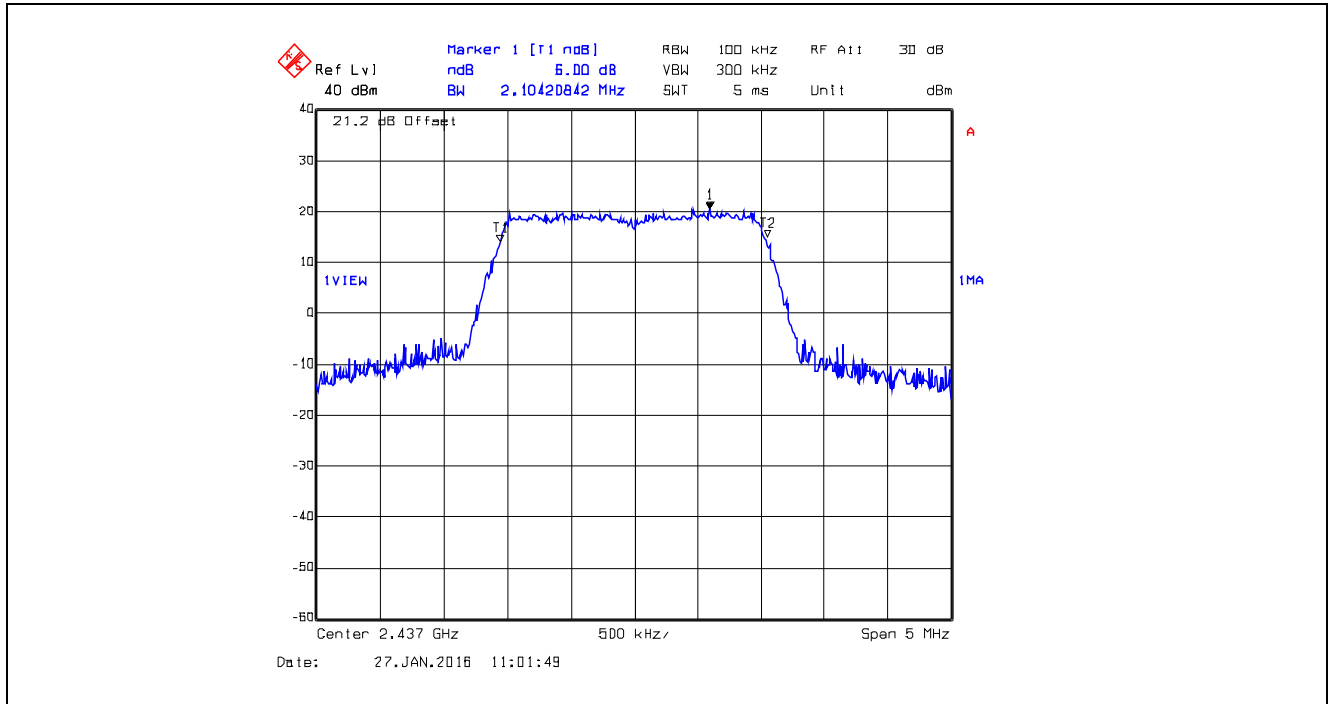**Plot 5.2.4.45.** 6 dB Bandwidth, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 7
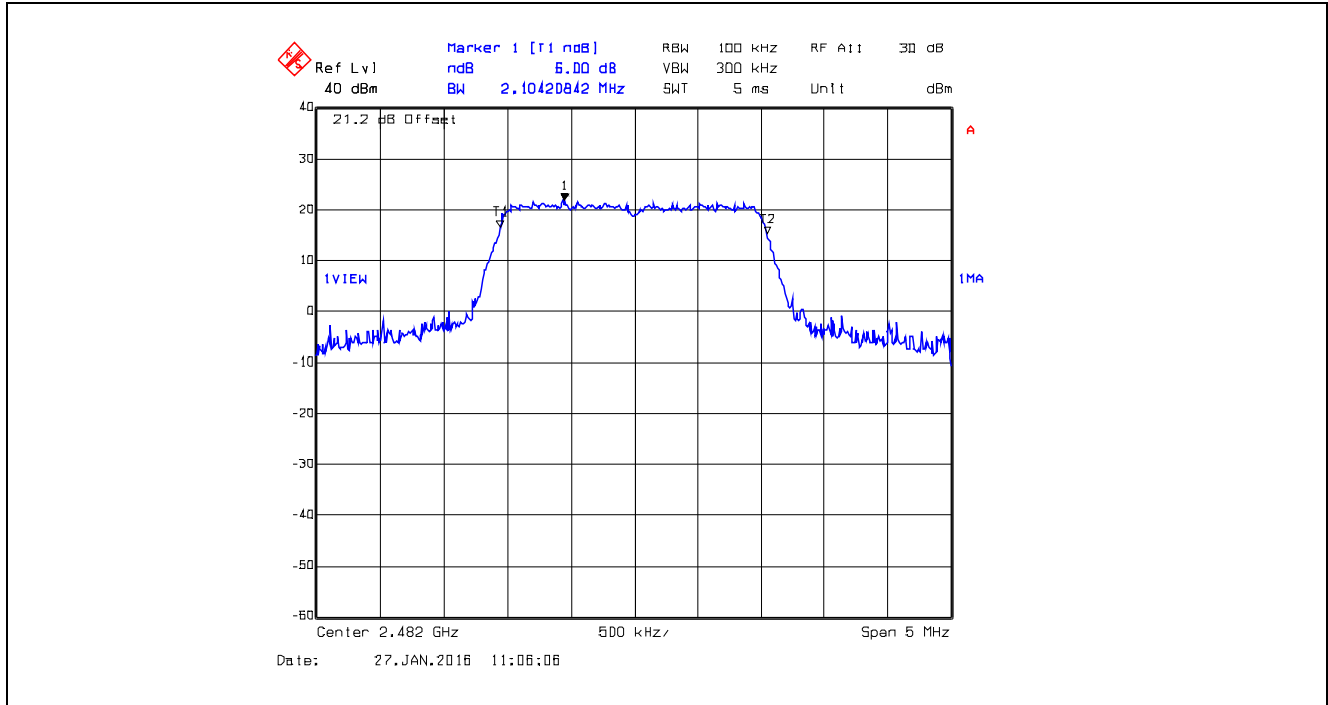
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Plot 5.2.4.46. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 4

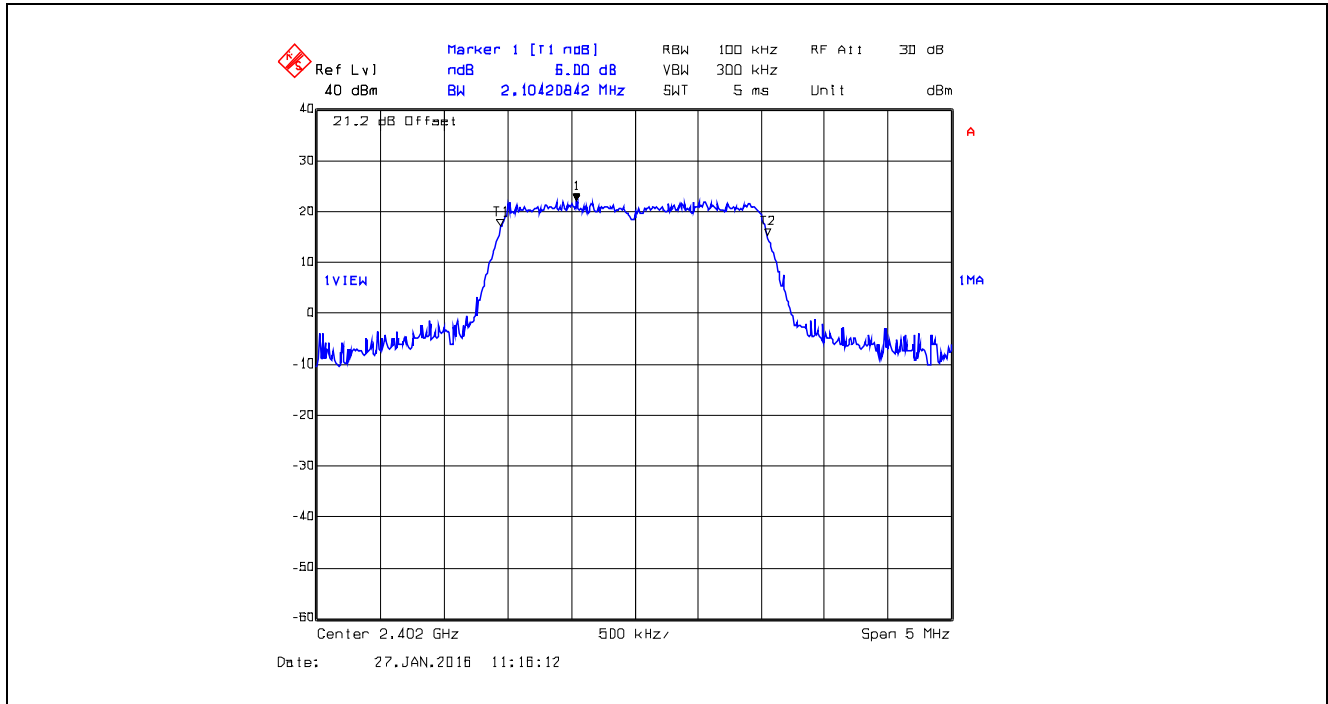**Plot 5.2.4.47.** 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 4
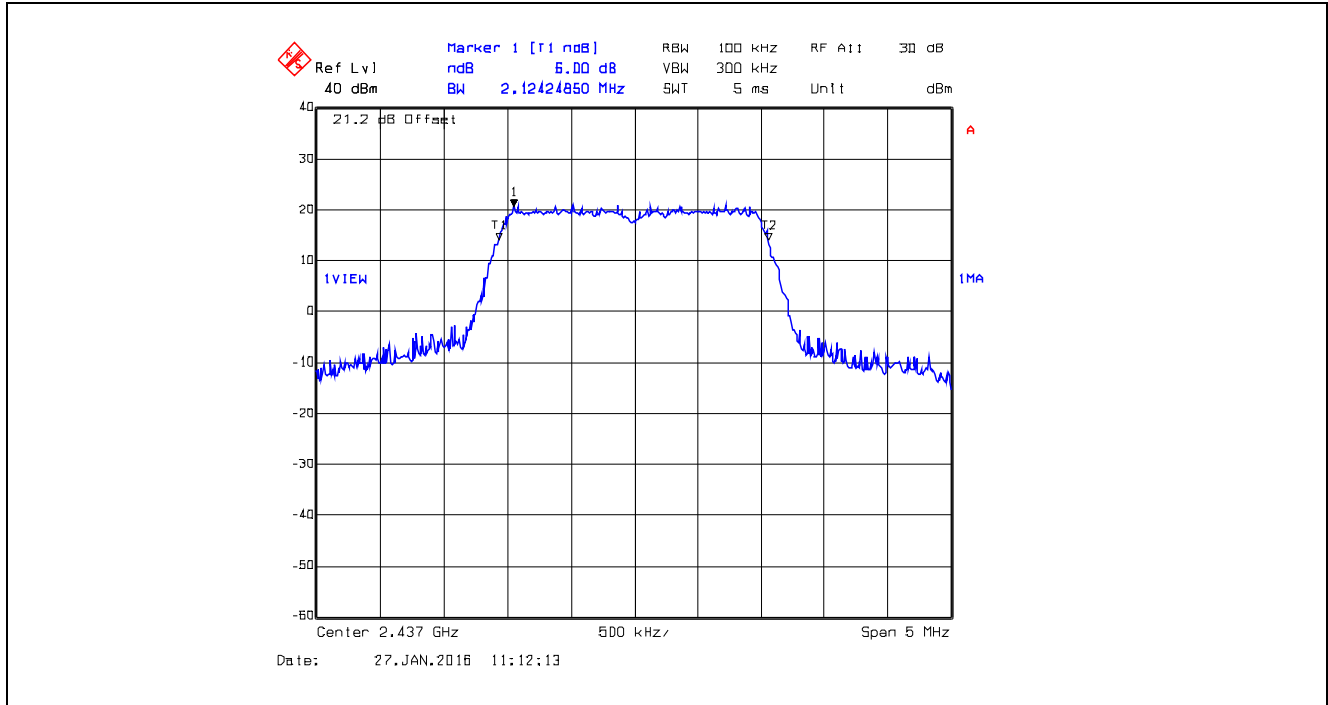
ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
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Plot 5.2.4.48. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 4

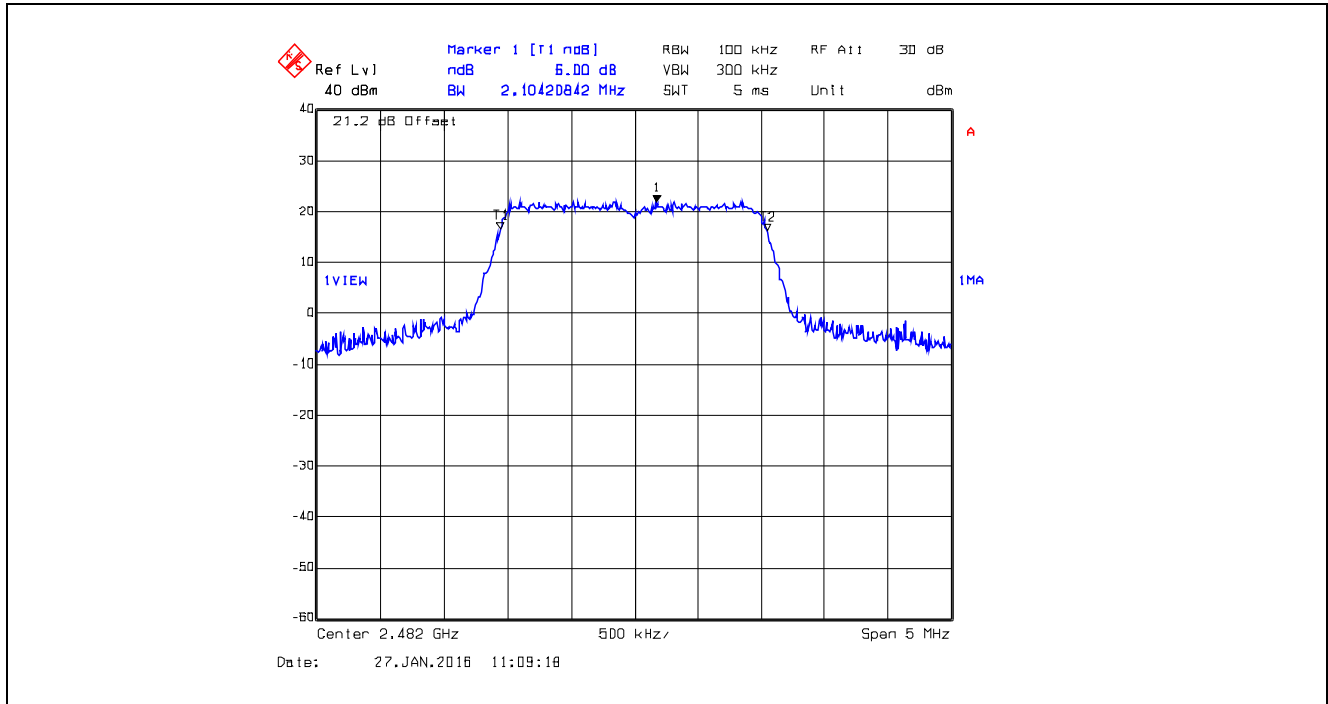**Plot 5.2.4.49.** 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 5
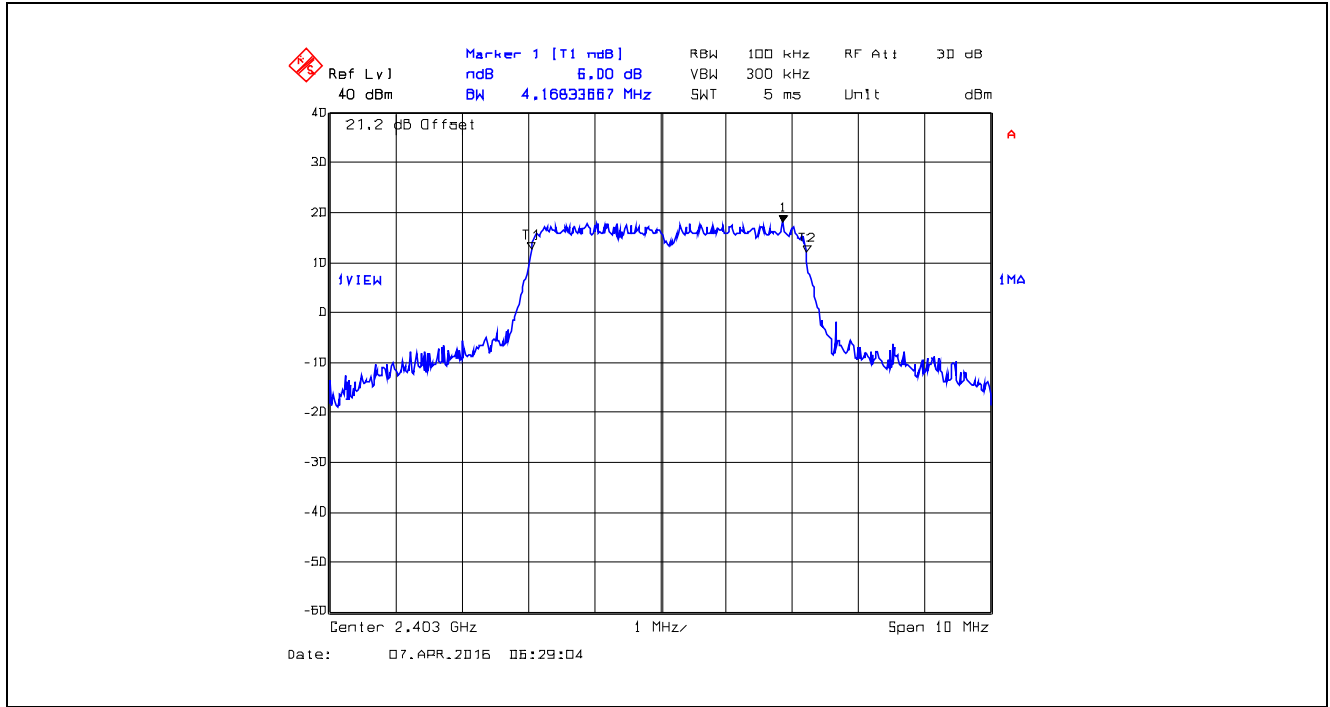
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Plot 5.2.4.50. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 5

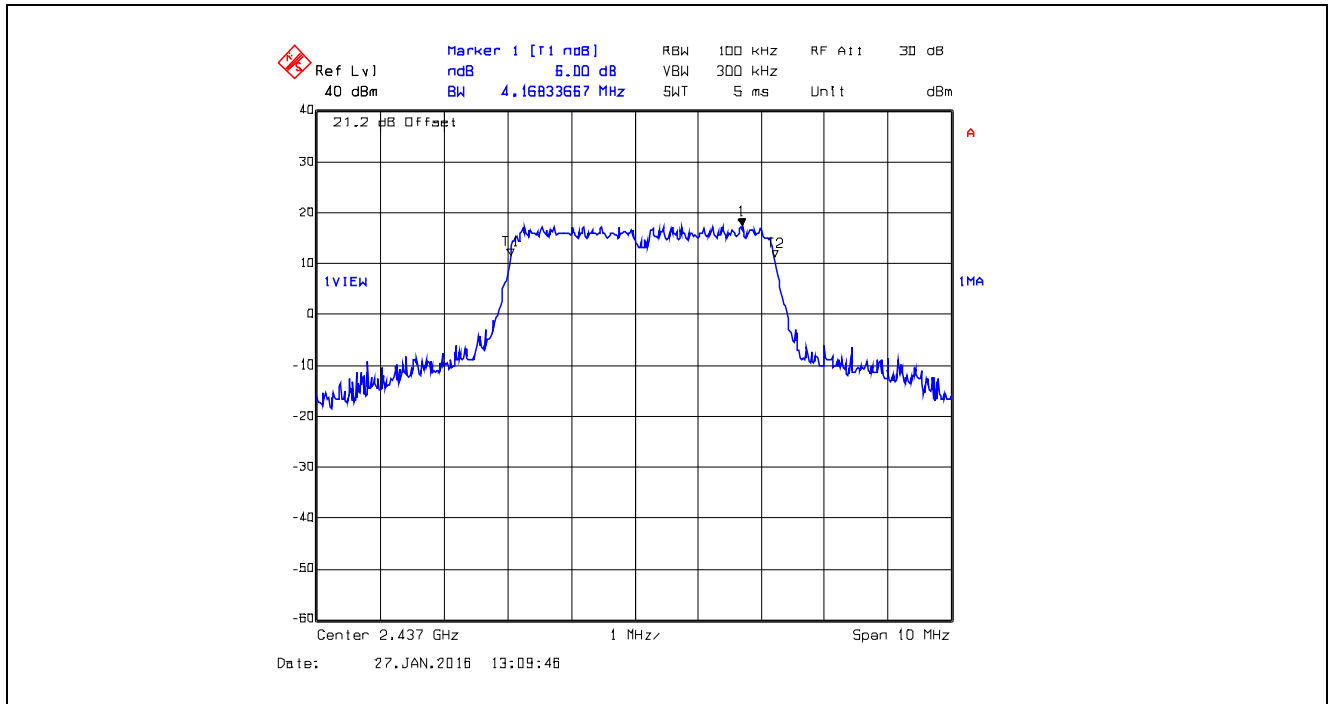**Plot 5.2.4.51.** 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 5
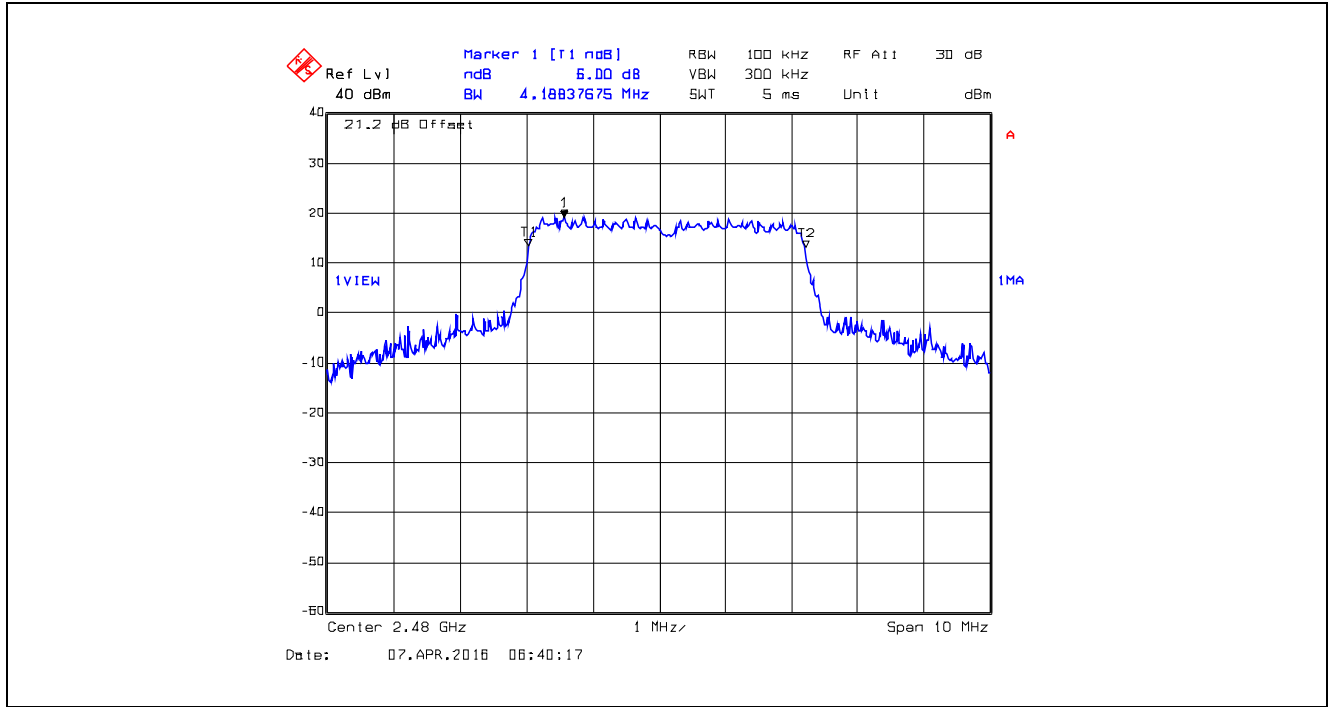
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Plot 5.2.4.52. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 6

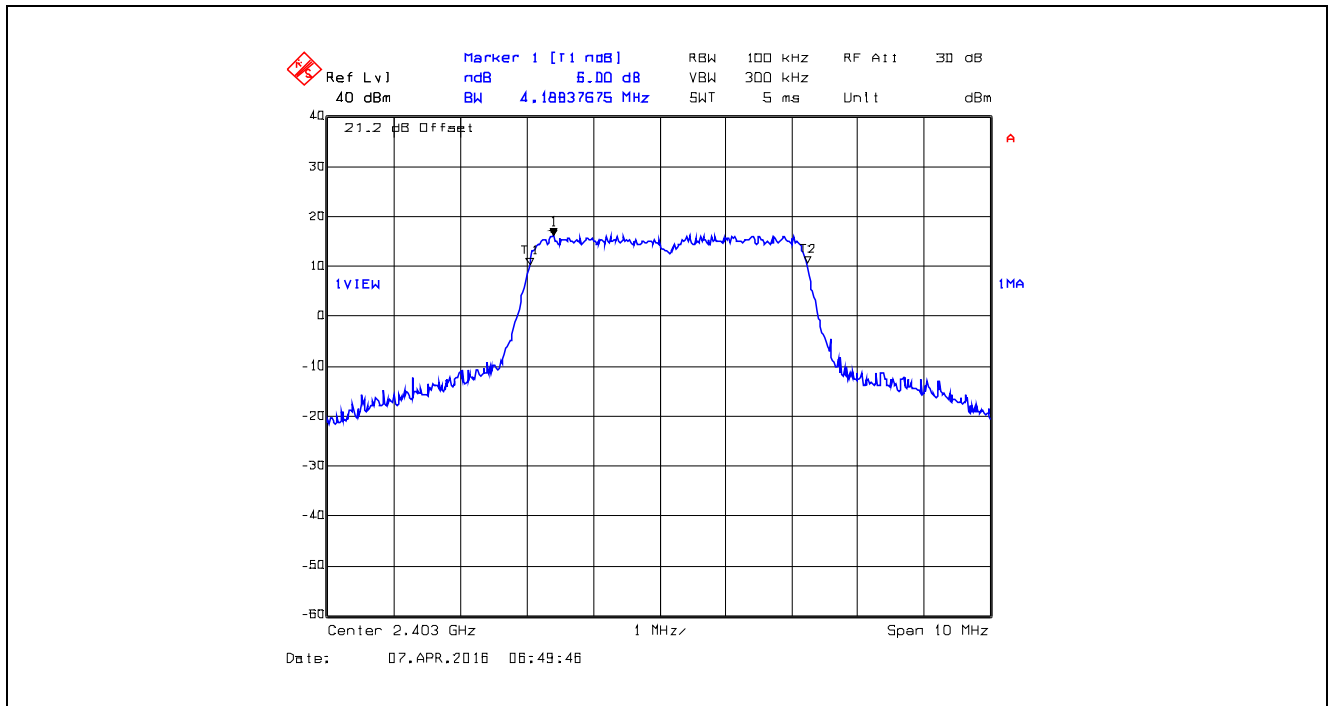**Plot 5.2.4.53.** 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 6
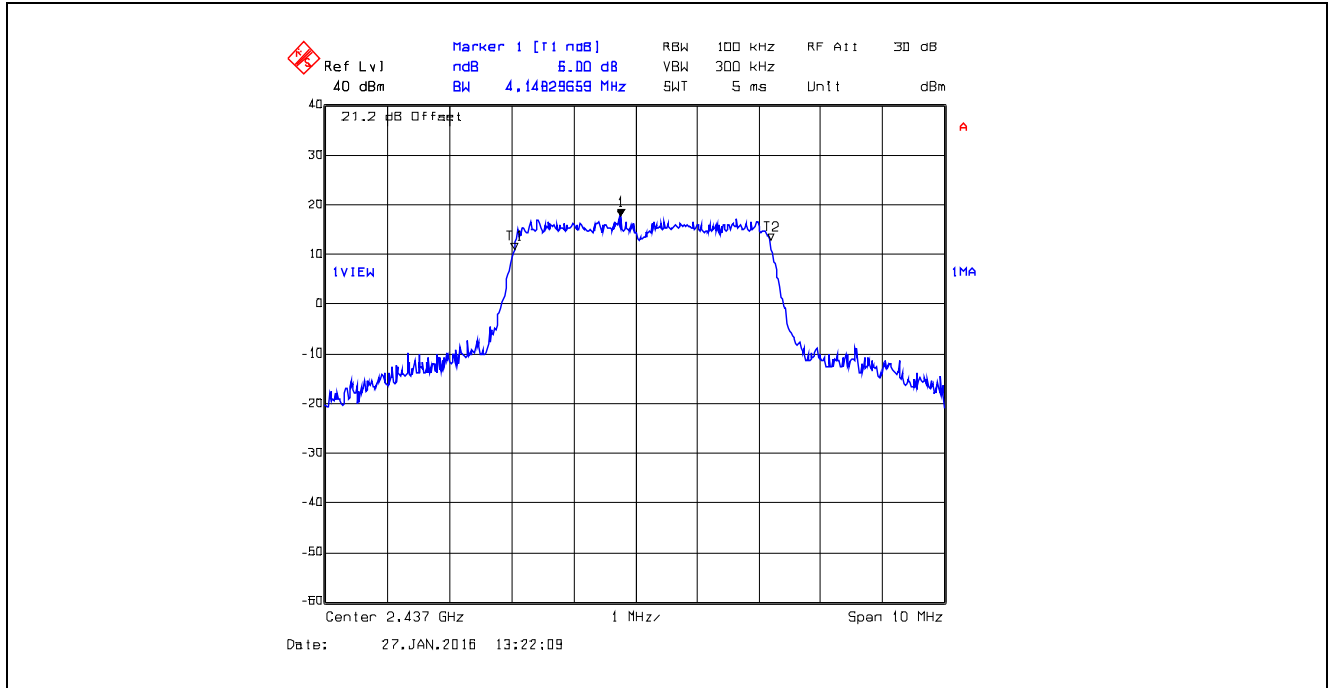
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Plot 5.2.4.54. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 6

Plot 5.2.4.55. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 7
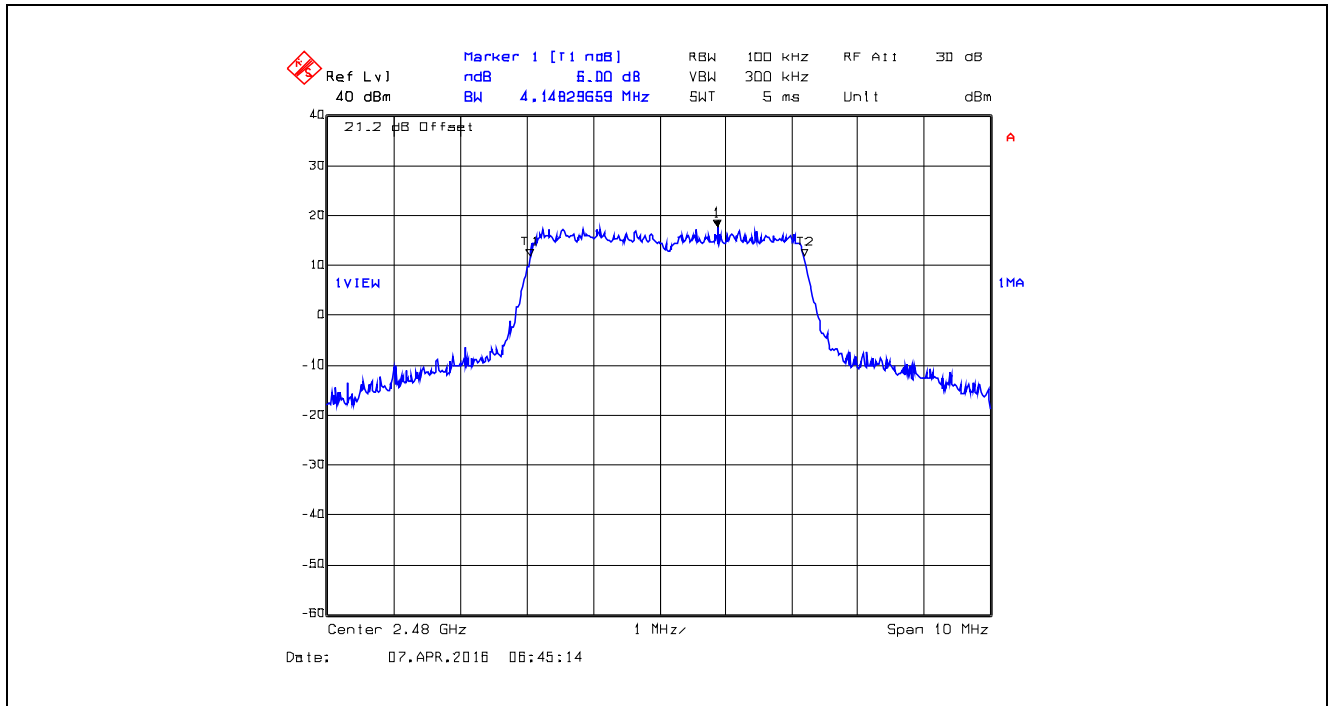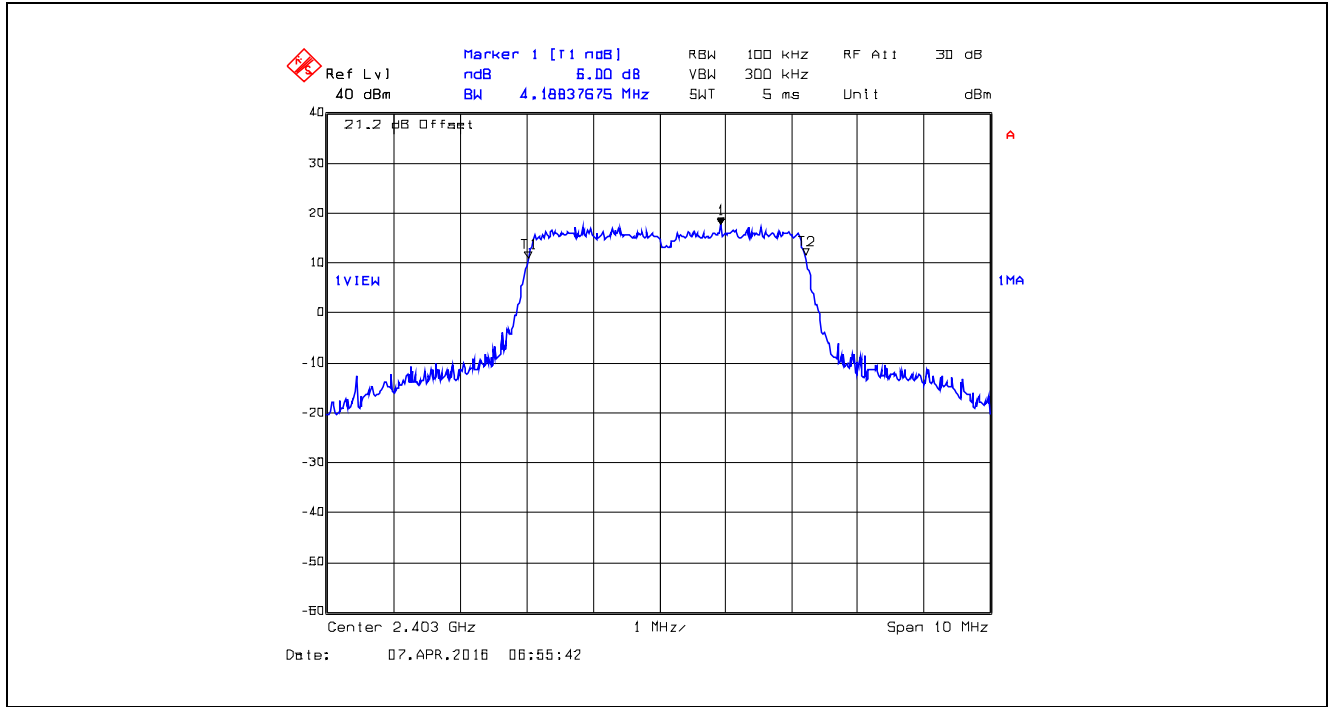
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.2.4.56. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 7

Plot 5.2.4.57. 6 dB Bandwidth, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 7
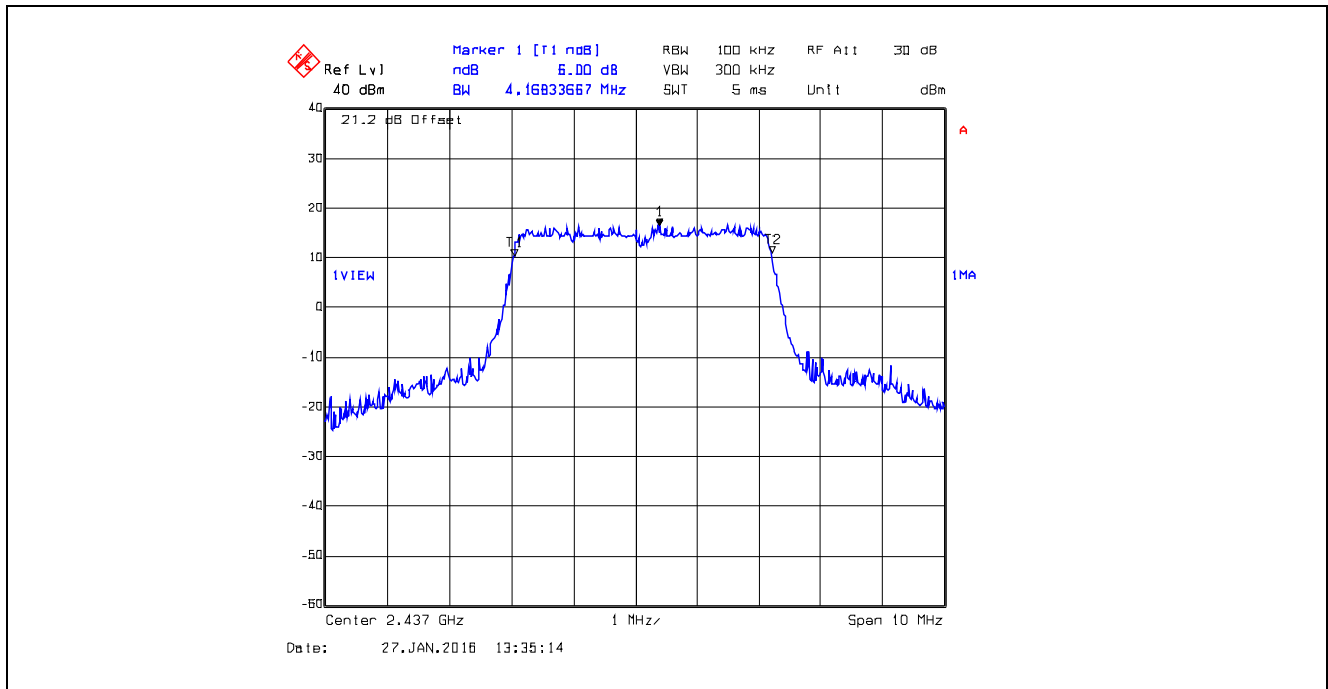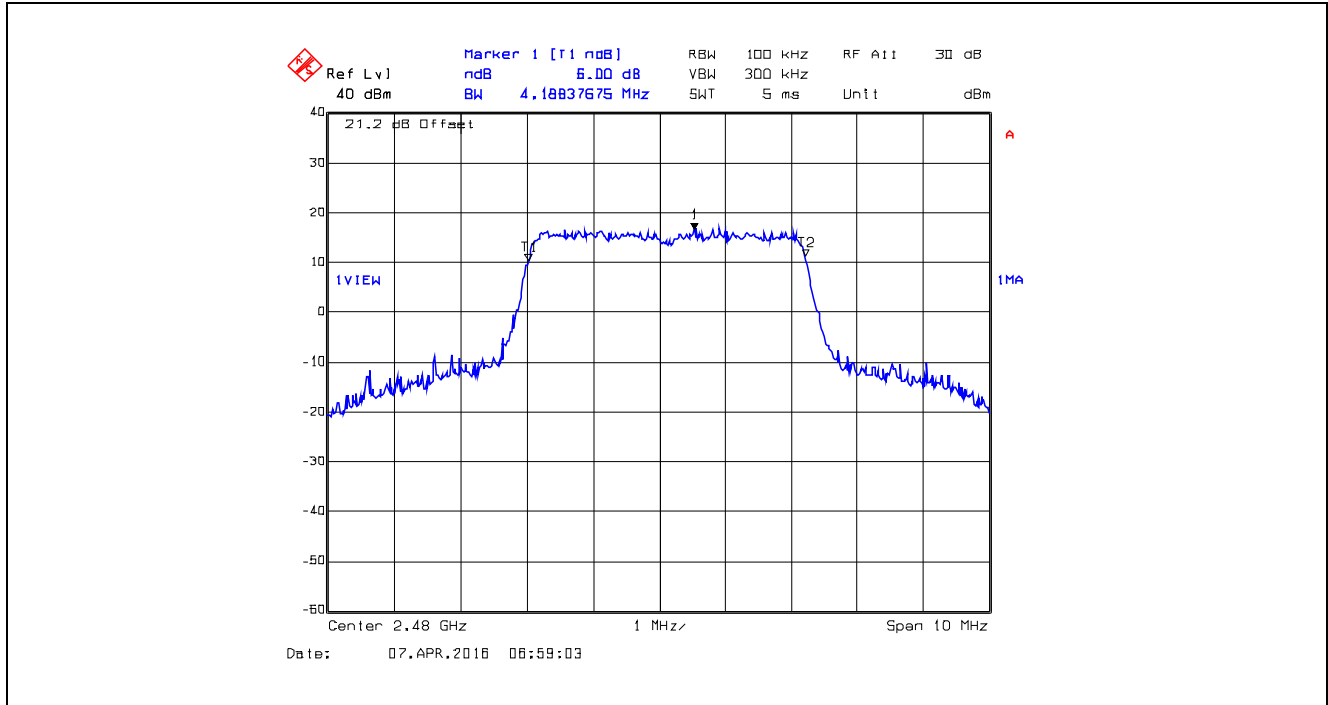
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.2.4.58. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 4

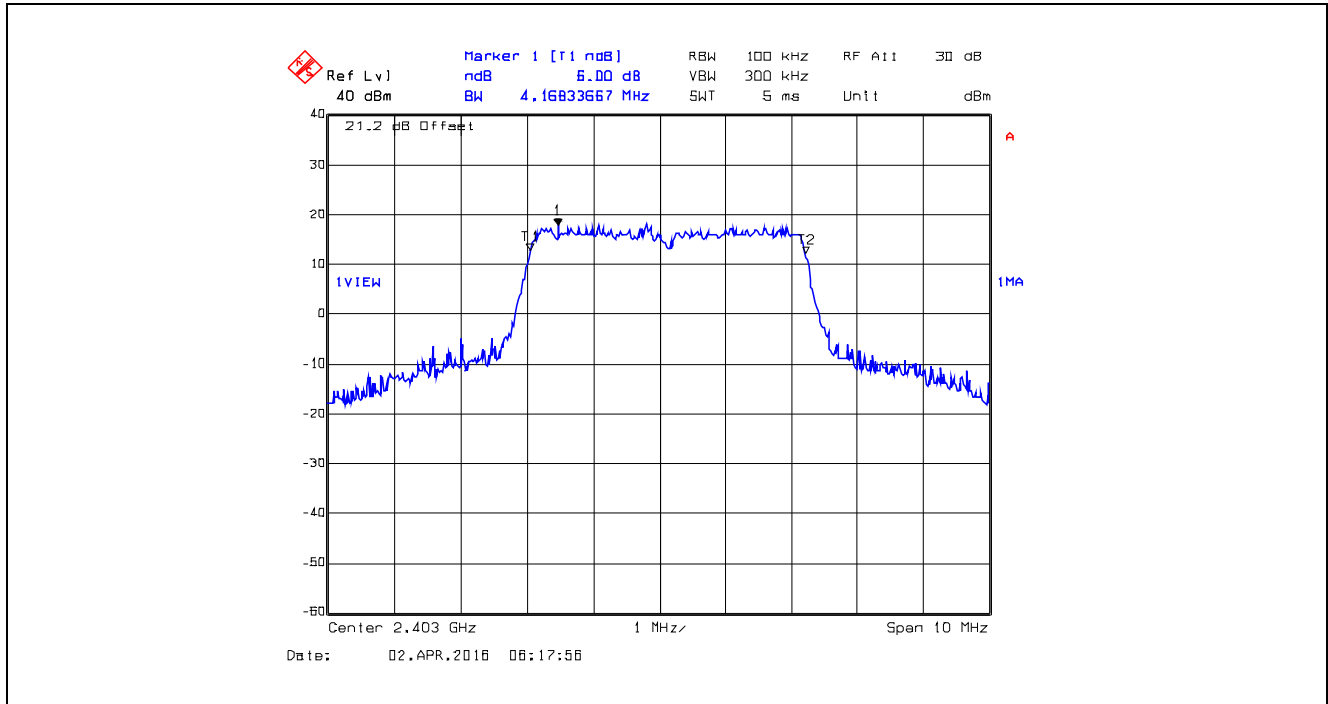**Plot 5.2.4.59.** 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 4
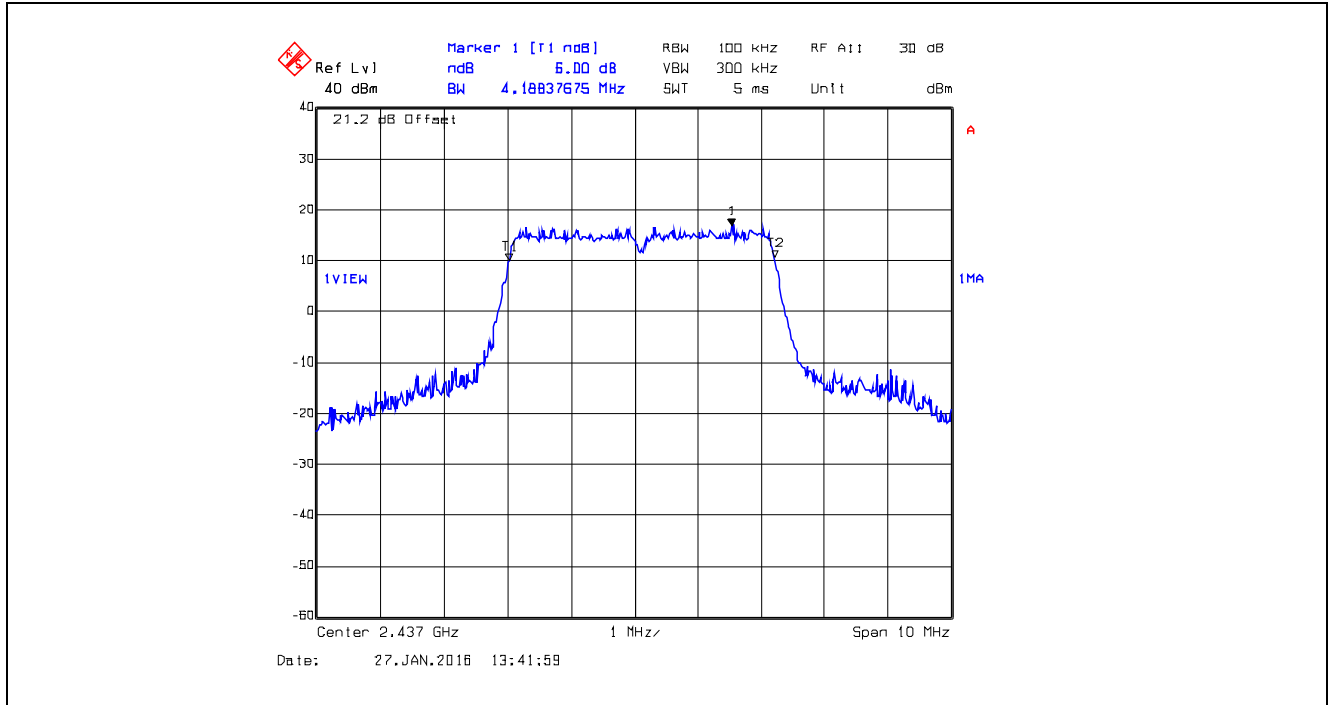
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Plot 5.2.4.60. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 4

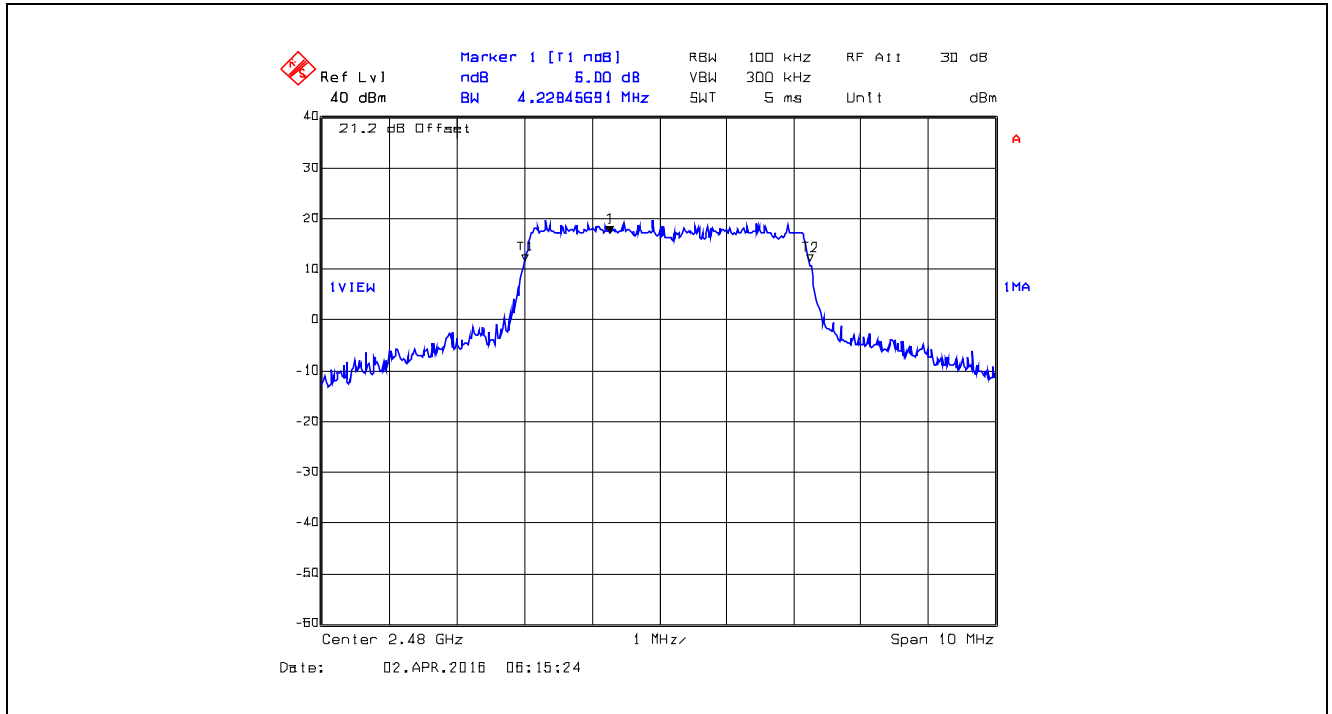**Plot 5.2.4.61.** 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 5
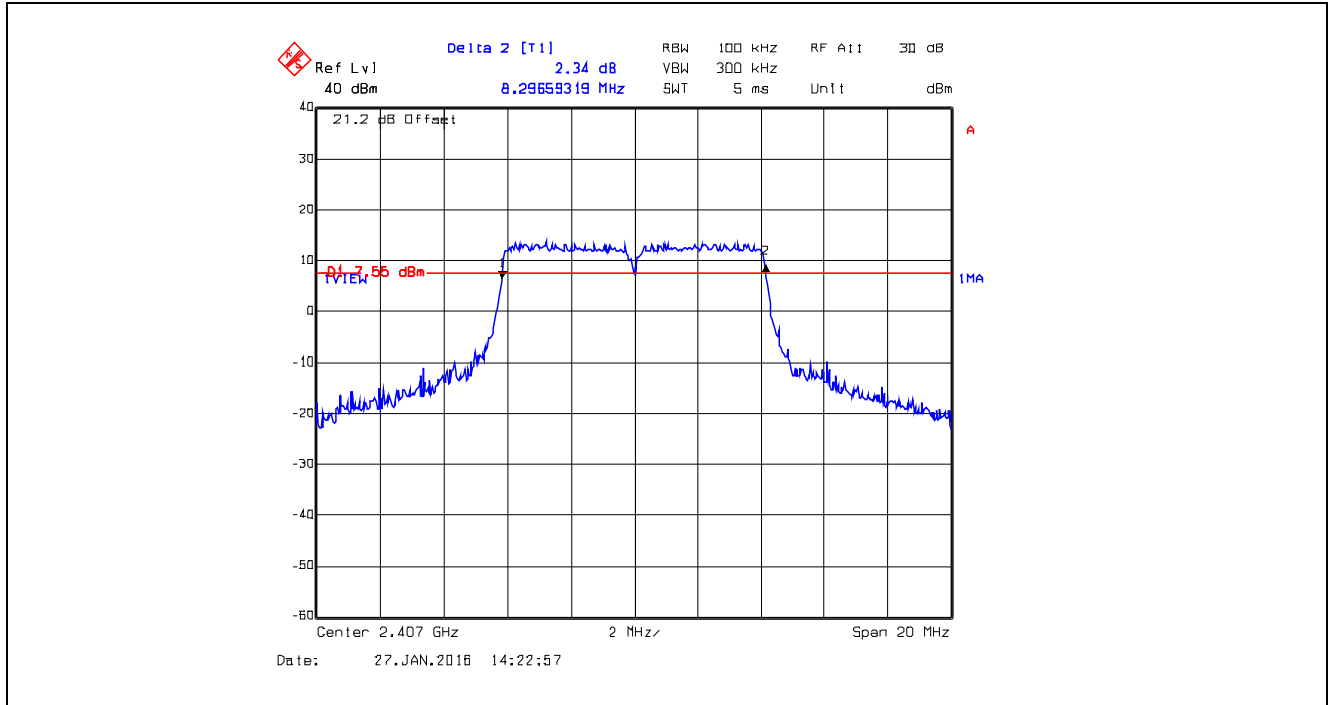
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File #: 16MCRS085_FCC15C247DTS

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April 13, 2016

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Plot 5.2.4.62. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 5

Plot 5.2.4.63. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 5
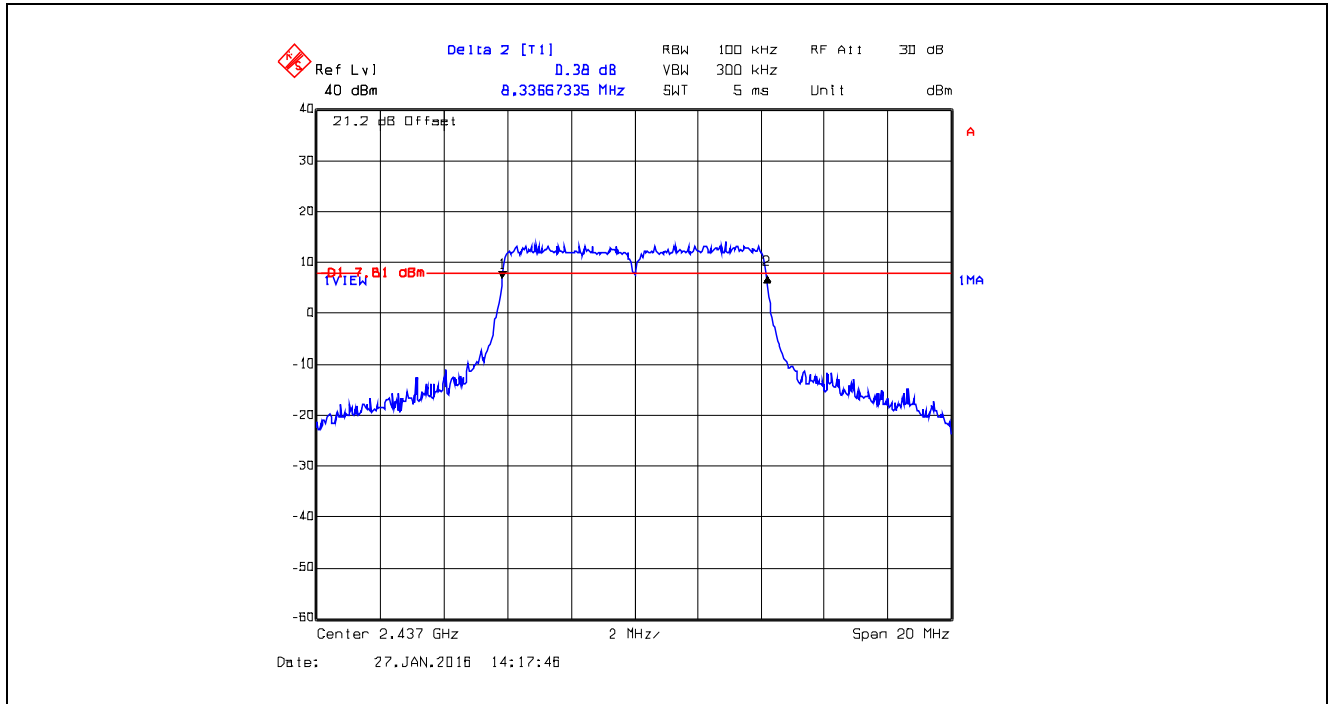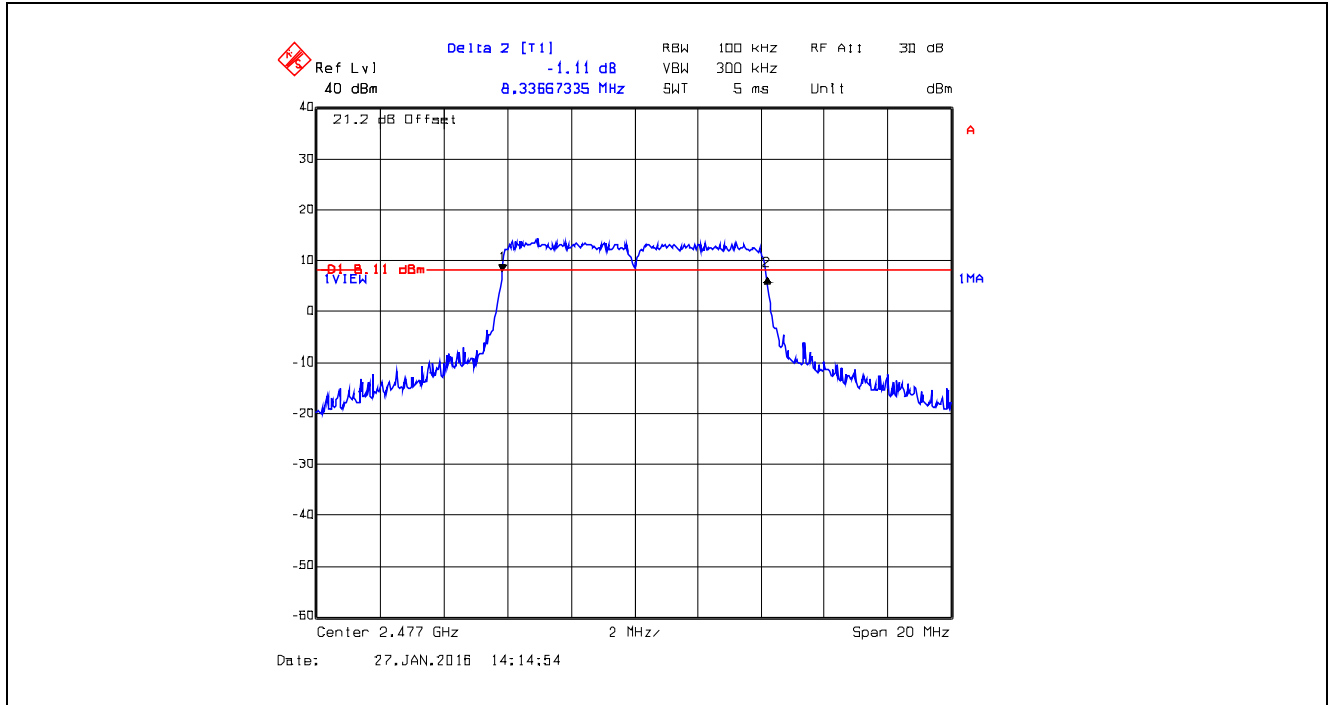
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 5.2.4.64. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 6

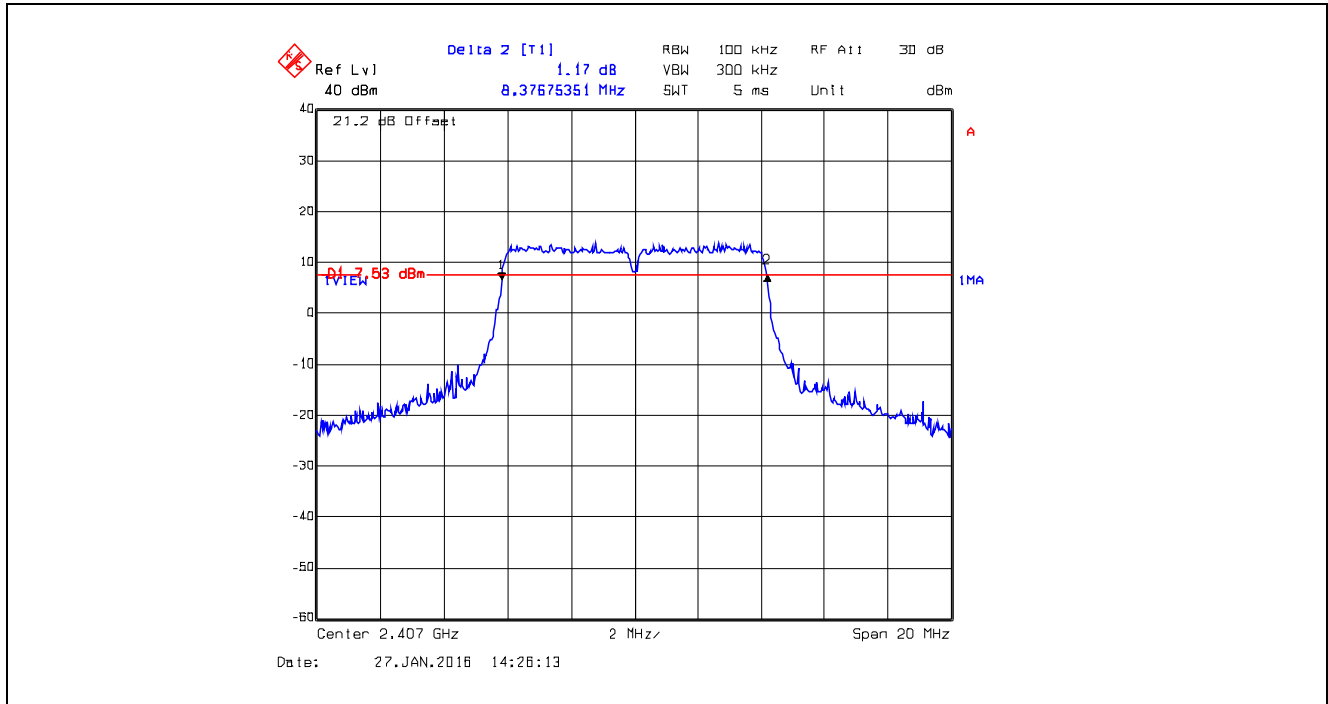**Plot 5.2.4.65.** 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 6
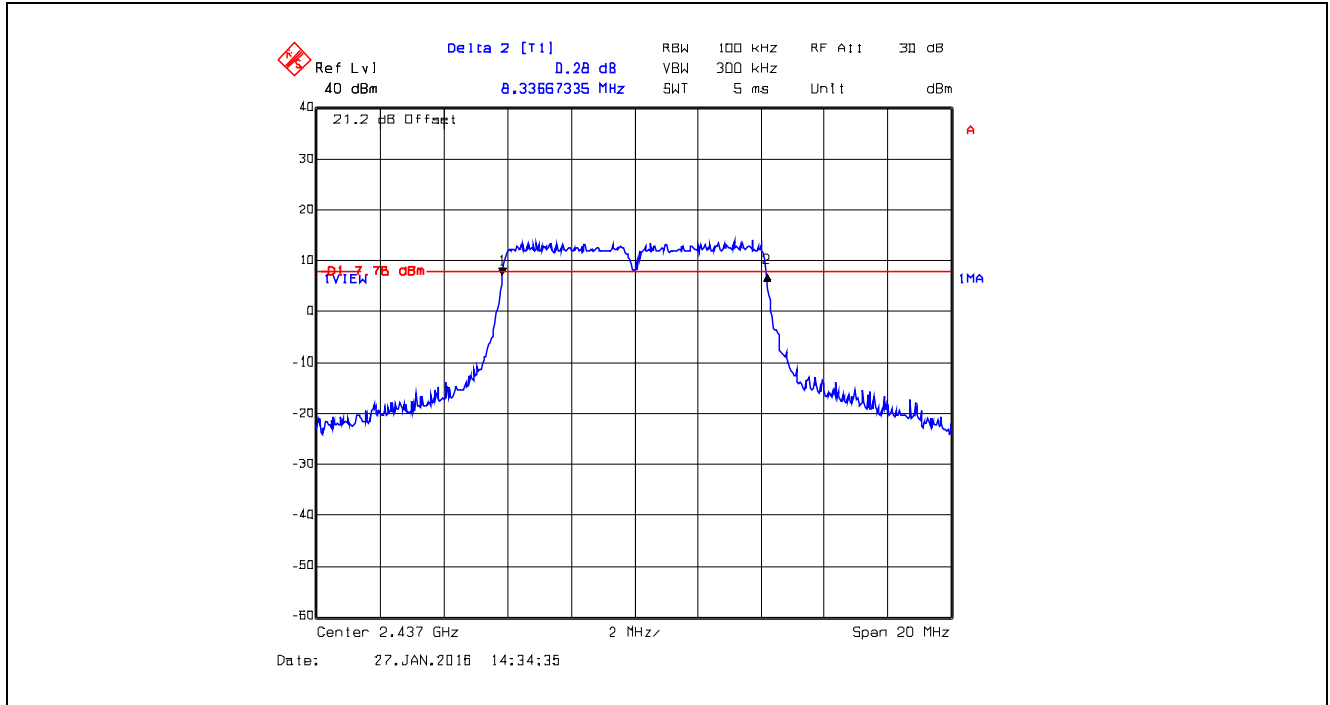
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.2.4.66. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 6

Plot 5.2.4.67. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 7
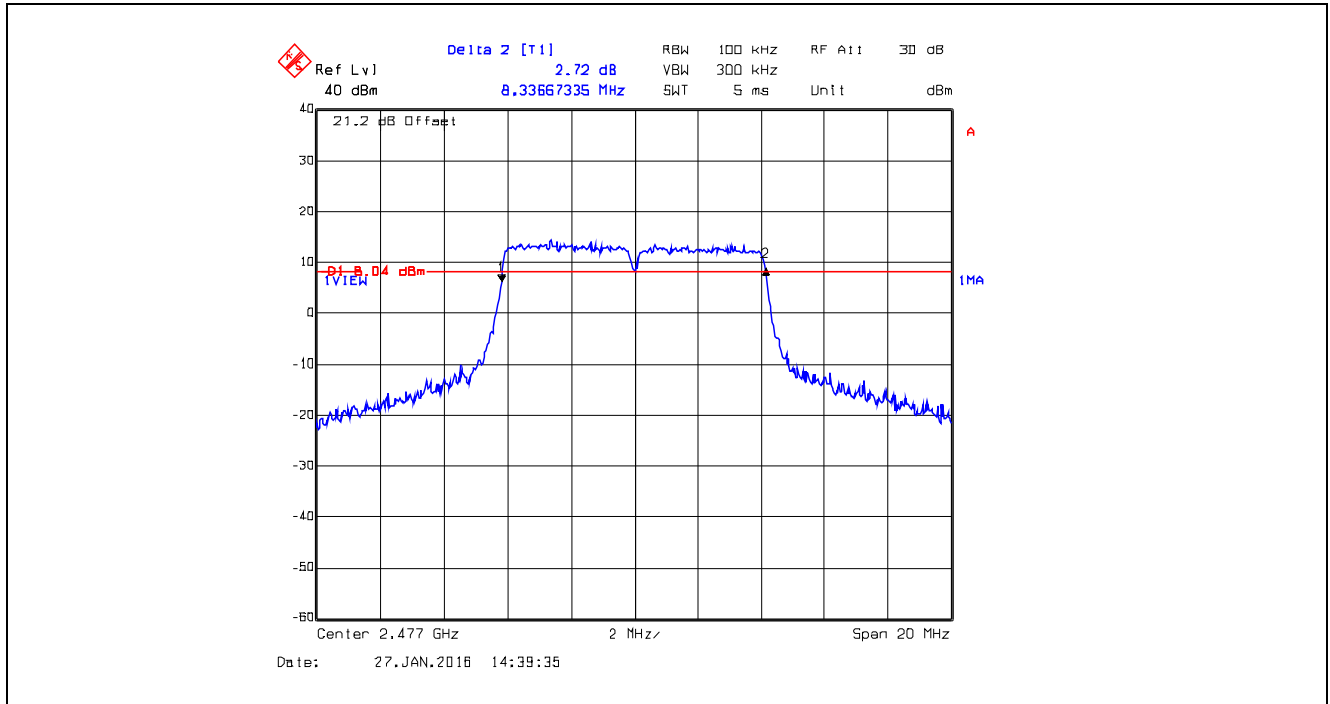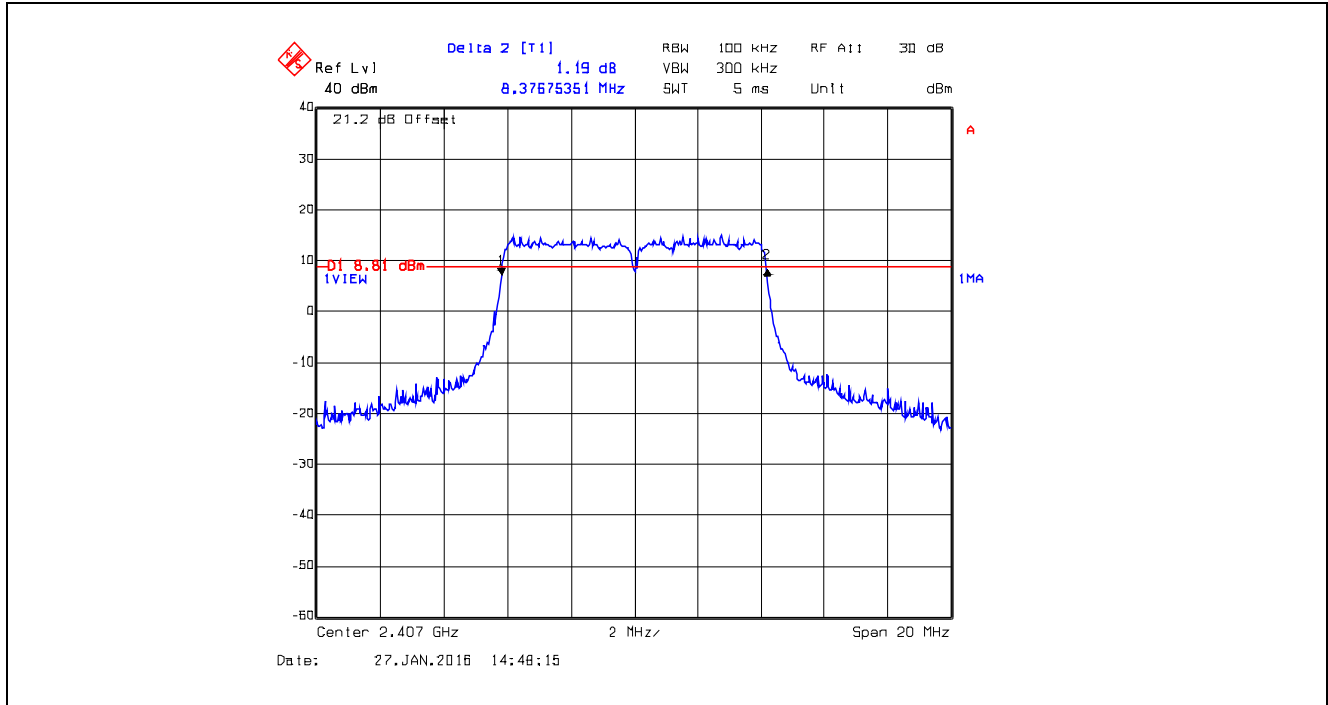
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 5.2.4.68. 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 7

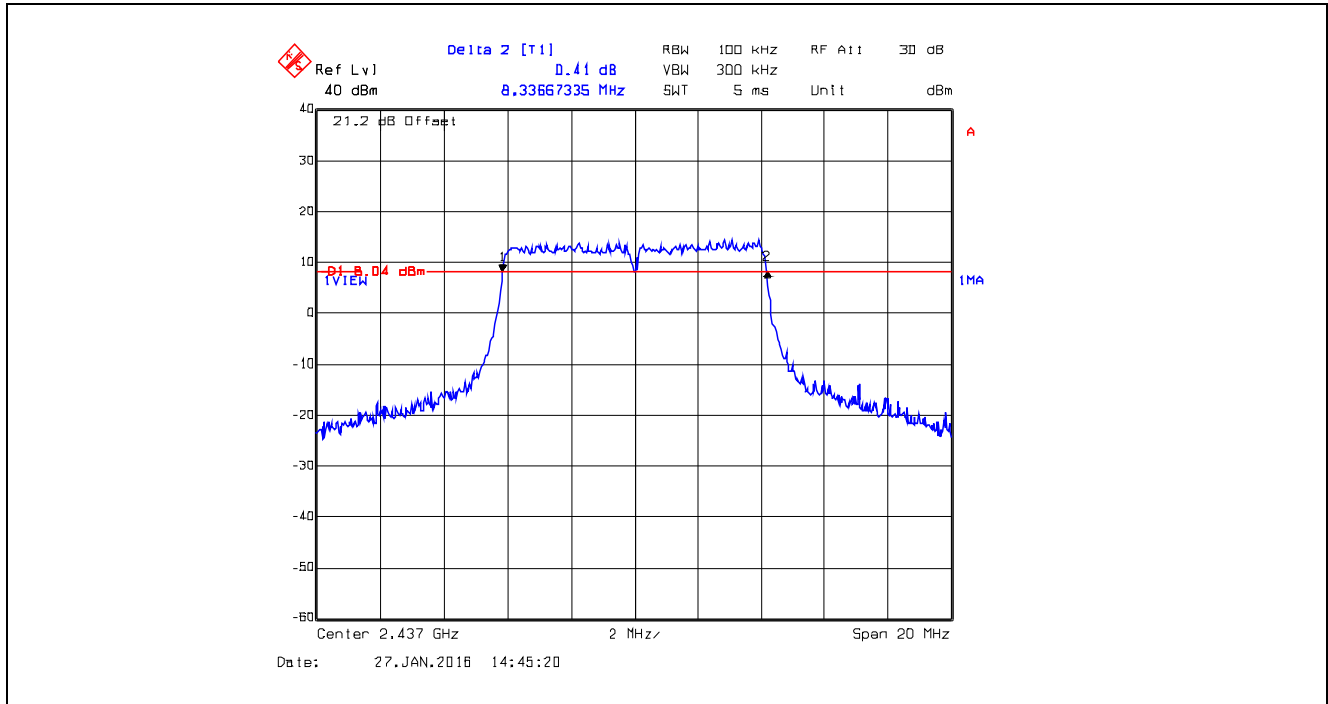**Plot 5.2.4.69.** 6 dB Bandwidth, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 7

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

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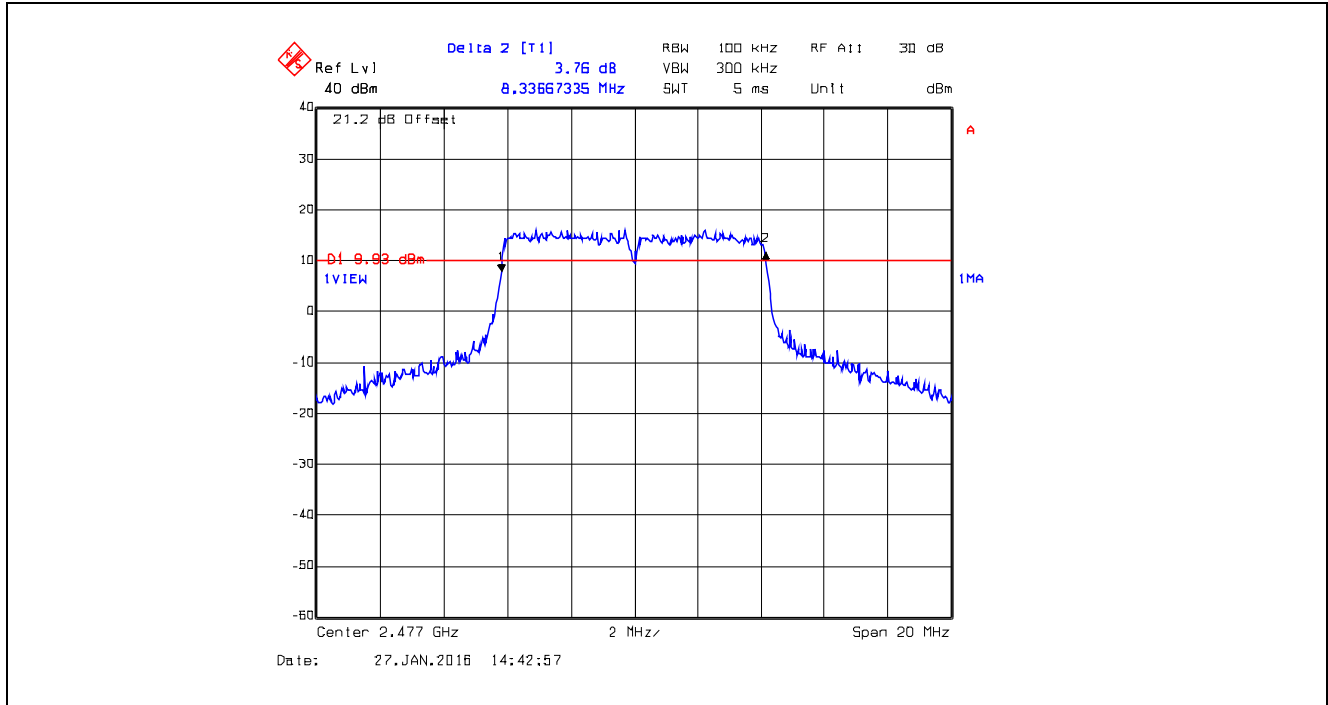
Plot 5.2.4.70. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 4

Plot 5.2.4.71. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 4
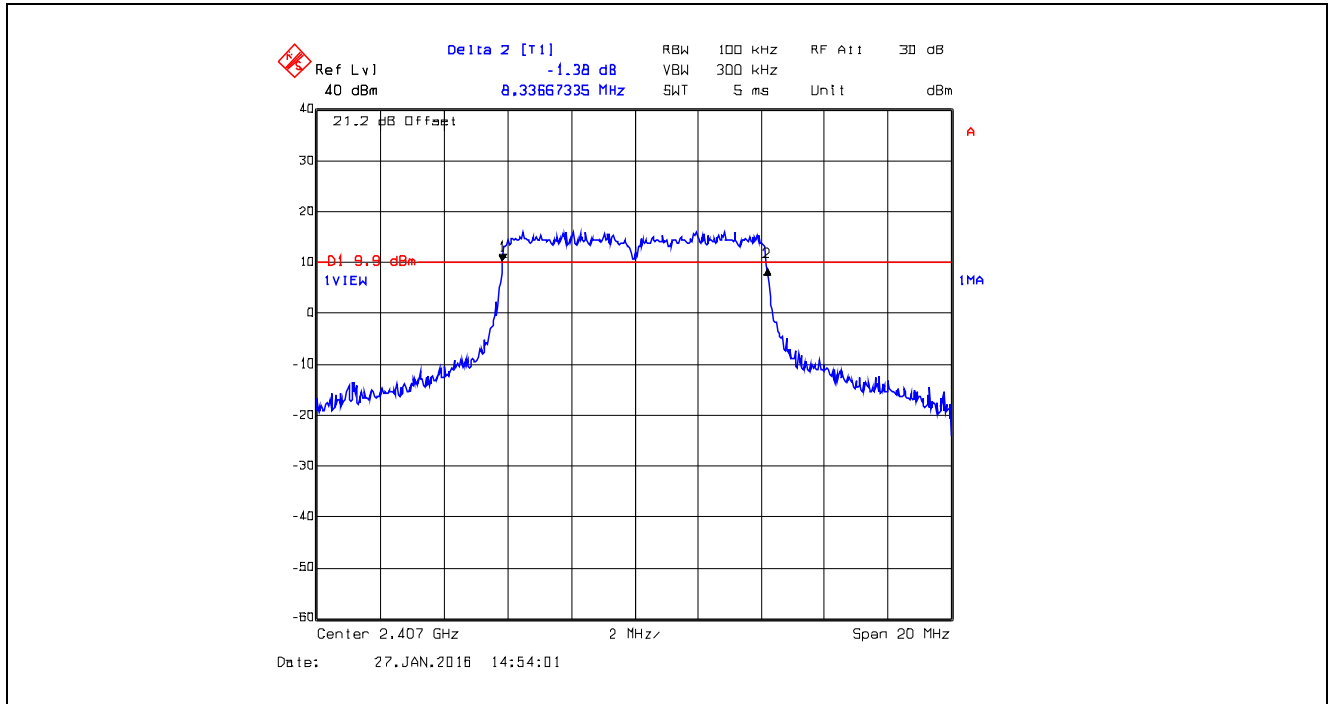
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Plot 5.2.4.72. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 4

Plot 5.2.4.73. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 5
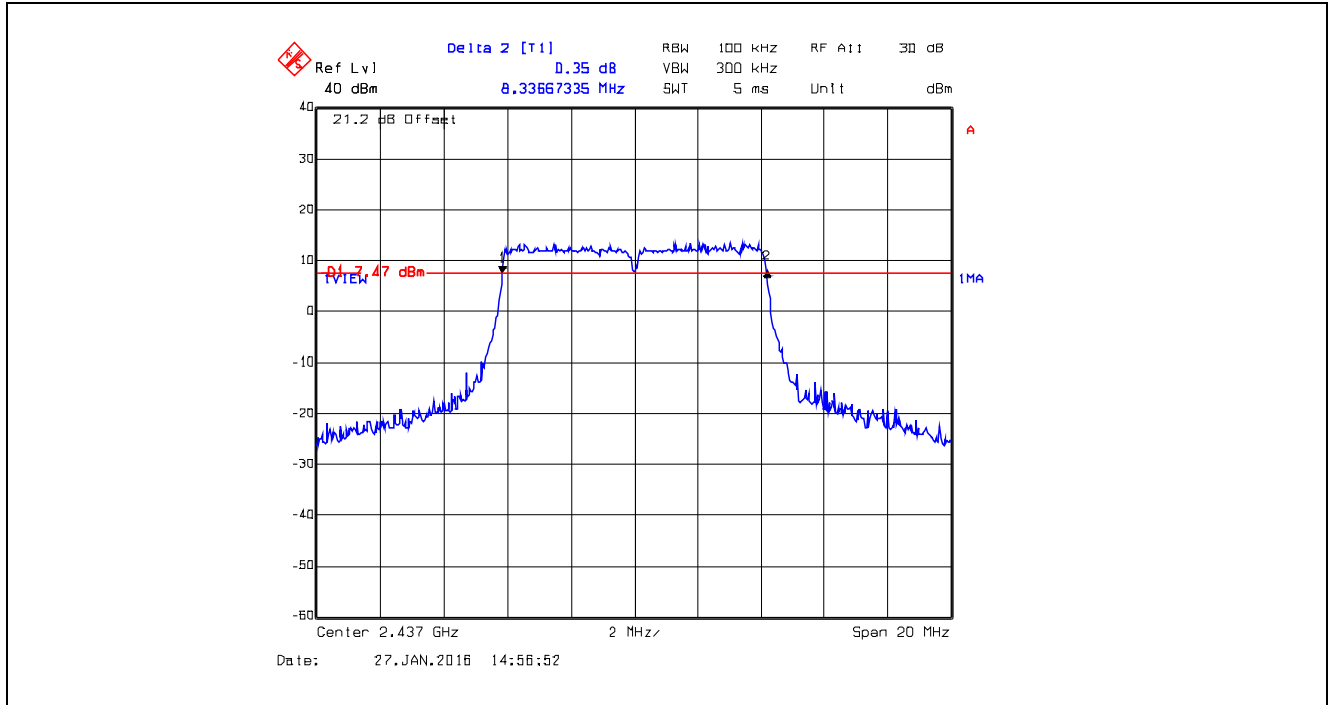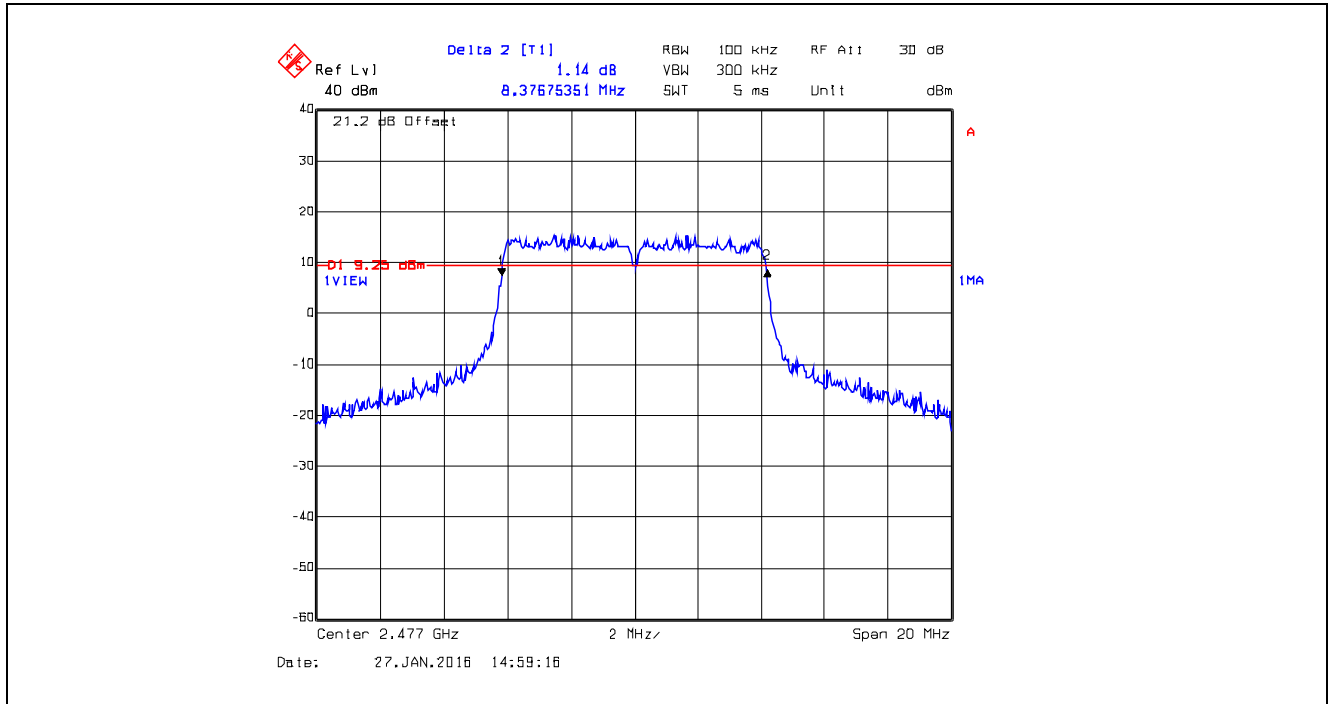
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Plot 5.2.4.74. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 5

Plot 5.2.4.75. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 5

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Plot 5.2.4.76. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 6

Plot 5.2.4.77. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 6

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Plot 5.2.4.78. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 6

Plot 5.2.4.79. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 7

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Plot 5.2.4.80. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 7

Plot 5.2.4.81. 6 dB Bandwidth, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 7

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5.3.   PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)(3)]

5.3.1.   Limit(s)

§ 15.247(b)(3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

§ 15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.3.2.   Method of Measurements & Test Arrangement

KDB 558074 D01 DTS Meas Guidance v03r04, Section 9.1.2 PKPM1 Peak power meter method

5.3.3.   Test Arrangement

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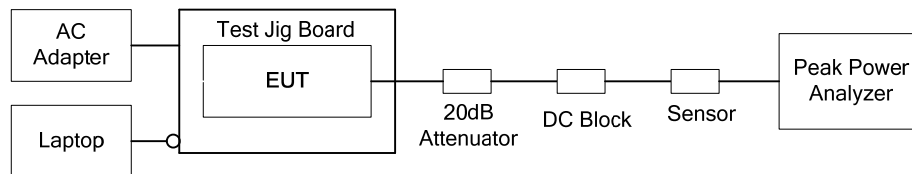
5.3.4. Test Data

Remarks:

1. The EIRP shall be calculated based on the transmitter antenna gain (G_{dBi}), cable loss (CL_{dB}) and peak output power at antenna terminal (P_{dBm}). Calculated EIRP = $P_{dBm} + G_{dBi} - CL_{dB}$

2. EIRP shall not exceed 36 dBm limit (Power Setting = 36 dBm - $G_{dBi} + CL_{dB}$). See Operating Manual for instruction of power setting.

Operating Mode	Data Rate	Frequency (MHz)	Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
Bandwidth: 1 MHz High Power (TX Gain Setting 5)	1	2402	23.55	30	6.45
		2437	22.74	30	7.26
		2482	24.19	30	5.81
	2	2402	23.55	30	6.45
		2437	22.74	30	7.26
		2482	24.19	30	5.81
Bandwidth: 2 MHz High Power (TX Gain Setting 8)	1	2402	25.07	30	-4.93
		2437	23.87	30	-6.13
		2482	26.21	30	-3.79
	2	2402	25.07	30	-4.93
		2437	23.87	30	-6.13
		2482	26.21	30	-3.79
	3	2402	25.07	30	-4.93
		2437	23.87	30	-6.13
		2482	26.21	30	-3.79
Bandwidth: 4 MHz High Power (TX Gain Setting 18)	1	2402	28.98	30	-1.02
		2437	28.14	30	-1.86
		2477	29.18	30	-0.82
	2	2402	28.98	30	-1.02
		2437	28.14	30	-1.86
		2477	29.18	30	-0.82
	3	2402	28.98	30	-1.02
		2437	28.14	30	-1.86
		2477	29.18	30	-0.82

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Operating Mode	Data Rate	Frequency (MHz)	Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
Bandwidth: 8 MHz High Power (TX Gain Setting 23)	1	2407	29.96	30	-0.04
		2437	29.88	30	-0.12
		2477	29.84	30	-0.16
	2	2407	29.72	30	-0.28
		2437	29.87	30	-0.13
		2477	29.91	30	-0.09
	3	2407	29.93	30	-0.07
		2437	29.91	30	-0.09
		2477	29.84	30	-0.16

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
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Operating Mode	Data Rate	Frequency (MHz)	Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
Bandwidth: 1 MHz High Power (TX Gain Setting 20)	4	2402	29.76	30	-0.24
		2437	29.77	30	-0.23
		2482	29.72	30	-0.28
	5	2402	29.76	30	-0.24
		2437	29.67	30	-0.33
		2482	29.58	30	-0.42
	6	2402	29.76	30	-0.24
		2437	29.71	30	-0.29
		2482	29.69	30	-0.31
	7	2402	29.74	30	-0.26
		2437	29.72	30	-0.28
		2482	29.68	30	-0.32
Bandwidth: 2 MHz High Power (TX Gain Setting 23)	4	2402	29.94	30	-0.06
		2437	29.89	30	-0.11
		2482	29.32	30	-0.68
	5	2402	29.78	30	-0.22
		2437	29.91	30	-0.09
		2482	29.78	30	-0.22
	6	2402	29.86	30	-0.14
		2437	29.88	30	-0.12
		2482	29.89	30	-0.11
	7	2402	29.93	30	-0.07
		2437	29.84	30	-0.16
		2482	29.61	30	-0.39

ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Operating Mode	Data Rate	Frequency (MHz)	Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
Bandwidth: 4 MHz High Power (TX Gain Setting 23)	4	2403	29.87	30	-0.13
		2437	29.91	30	-0.09
		2480	29.76	30	-0.24
	5	2403	29.95	30	-0.05
		2437	29.66	30	-0.34
		2480	29.78	30	-0.22
	6	2403	29.95	30	-0.05
		2437	29.47	30	-0.53
		2480	29.33	30	-0.67
	7	2403	29.89	30	-0.11
		2437	29.90	30	-0.10
		2480	29.87	30	-0.13
Bandwidth: 8 MHz High Power (TX Gain Setting 23)	4	2407	29.63	30	-0.37
		2437	29.74	30	-0.26
		2477	29.82	30	-0.18
	5	2407	29.95	30	-0.05
		2437	29.55	30	-0.45
		2477	29.14	30	-0.86
	6	2407	29.47	30	-0.53
		2437	29.56	30	-0.44
		2477	29.89	30	-0.11
	7	2407	29.91	30	-0.09
		2437	29.33	30	-0.67
		2477	29.57	30	-0.43

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Operating Mode	Data Rate	Frequency (MHz)	Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
Bandwidth: 8 MHz Low Power (TX Gain Setting 40)	1	2407	16.14	30	-13.86
		2437	16.11	30	-13.89
		2477	16.13	30	-13.87
	2	2407	16.10	30	-13.90
		2437	16.12	30	-13.88
		2477	16.14	30	-13.86
	3	2407	16.09	30	-13.91
		2437	16.10	30	-13.90
		2477	16.12	30	-13.88
Bandwidth: 8 MHz Low Power (TX Gain Setting 40)	4	2407	16.13	30	-13.87
		2437	16.12	30	-13.88
		2477	16.14	30	-13.86
	5	2407	16.11	30	-13.89
		2437	16.08	30	-13.92
		2477	16.13	30	-13.87
	6	2407	16.14	30	-13.86
		2437	16.11	30	-13.89
		2477	16.10	30	-13.90
	7	2407	16.11	30	-13.89
		2437	16.13	30	-13.87
		2477	16.10	30	-13.90

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5.4. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(d)]

5.4.1. Limit(s)

§ 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 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)).

5.4.2. Method of Measurements

KDB 558074 D01 DTS Meas Guidance V03r04, Sections 11, 12 and 13.

5.4.3. Test Arrangement

ULTRATECH GROUP OF LABS
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April 13, 2016
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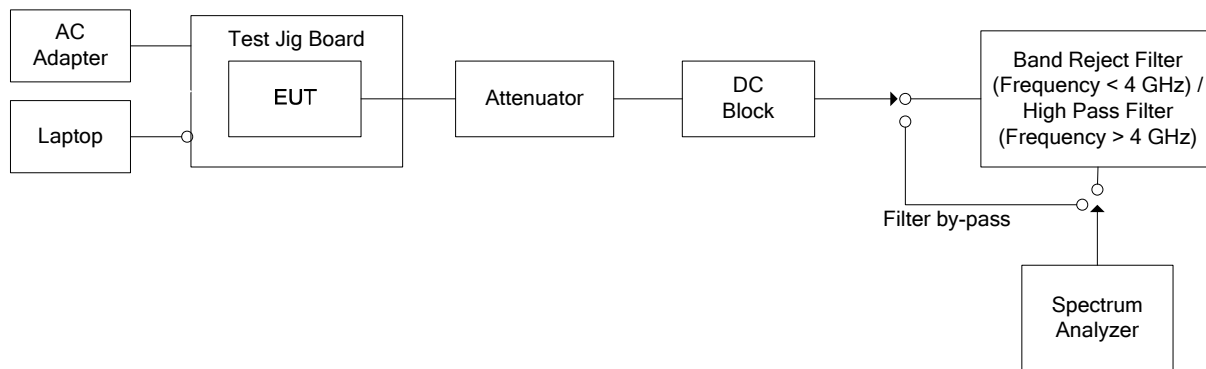
5.4.4. Test Data

Remark(s): Exploratory tests performed to determined worst-case test configurations, the following test results represent the worst-case.
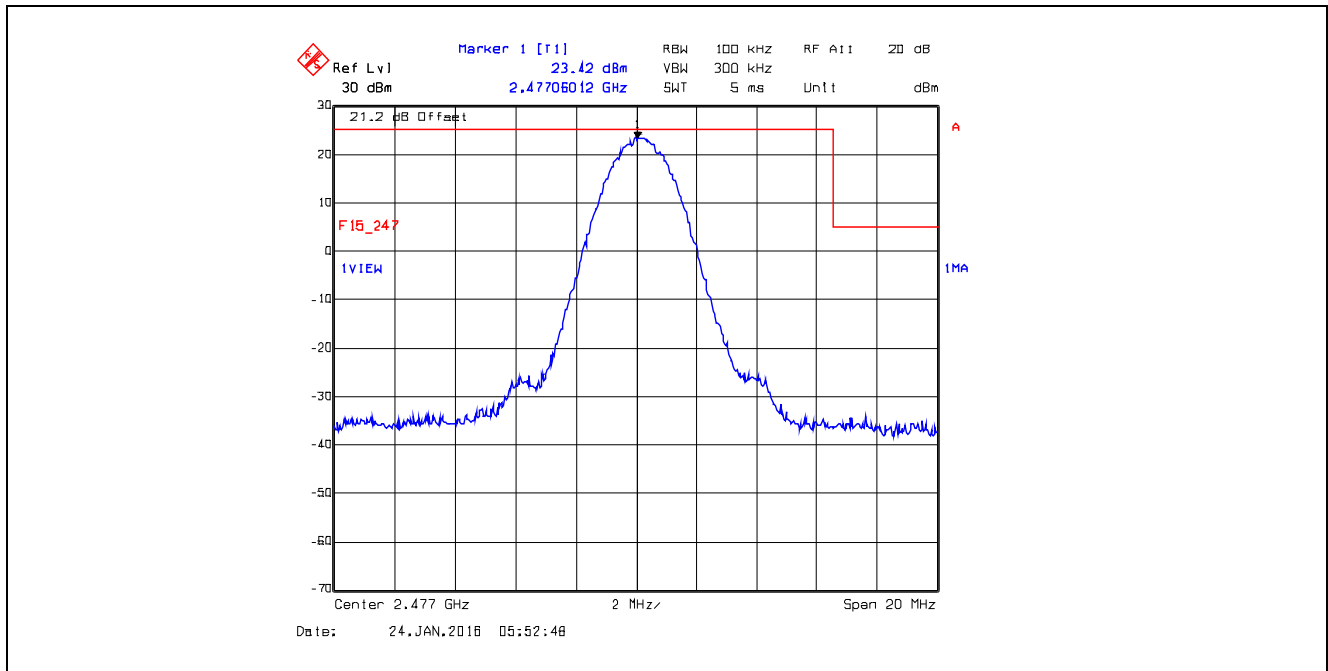
5.4.4.1. Band-Edge RF Conducted Emissions

Plot 5.4.4.1.1. Band-Edge RF Conducted Emissions
Bandwidth: 1 MHz, TX Gain Setting: 5, 2402 MHz, Data Rate 3, Lower Band-edge
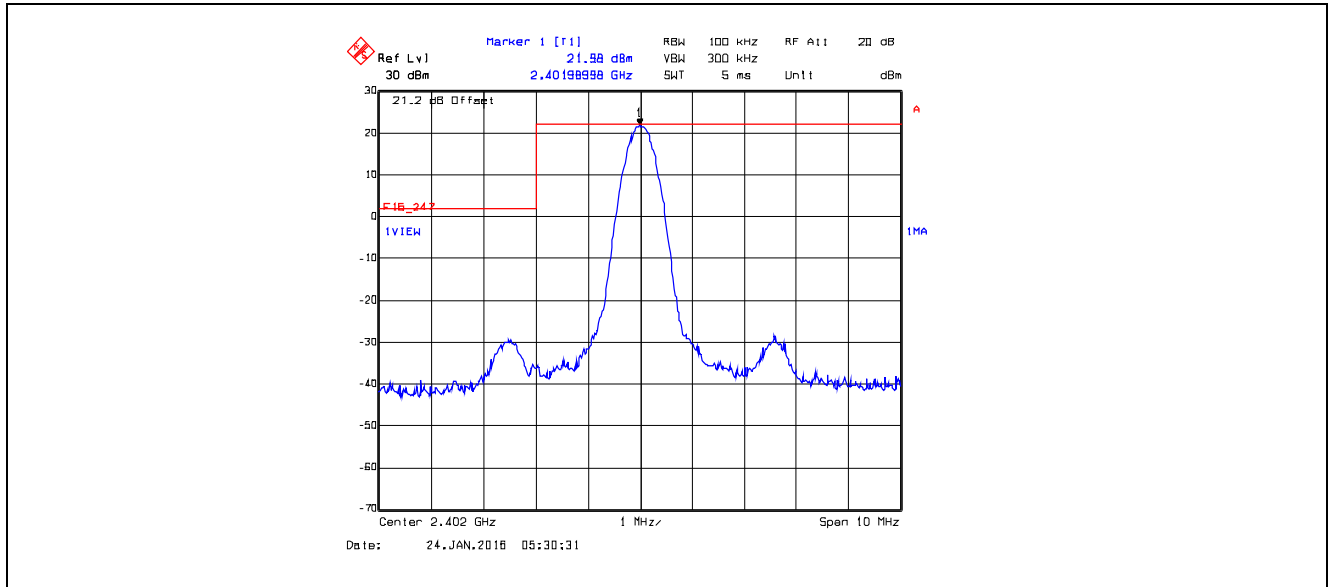
Plot 5.4.4.1.2. Band-Edge RF Conducted Emissions
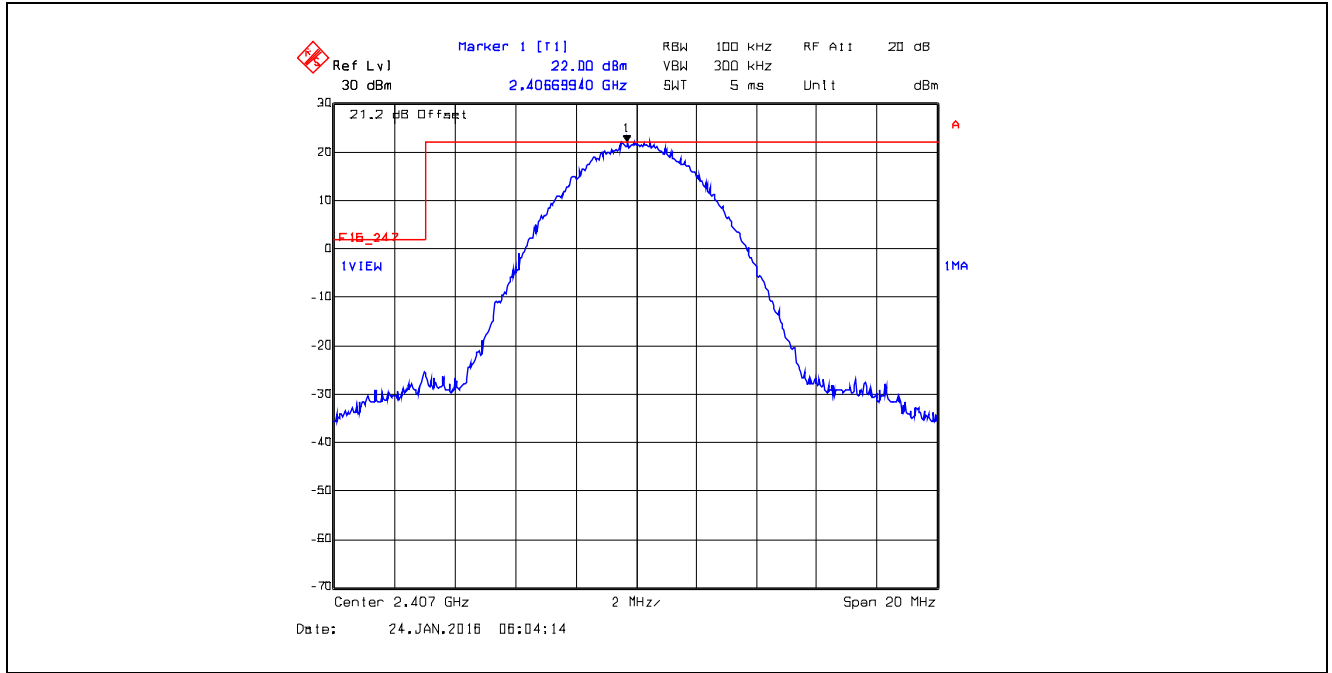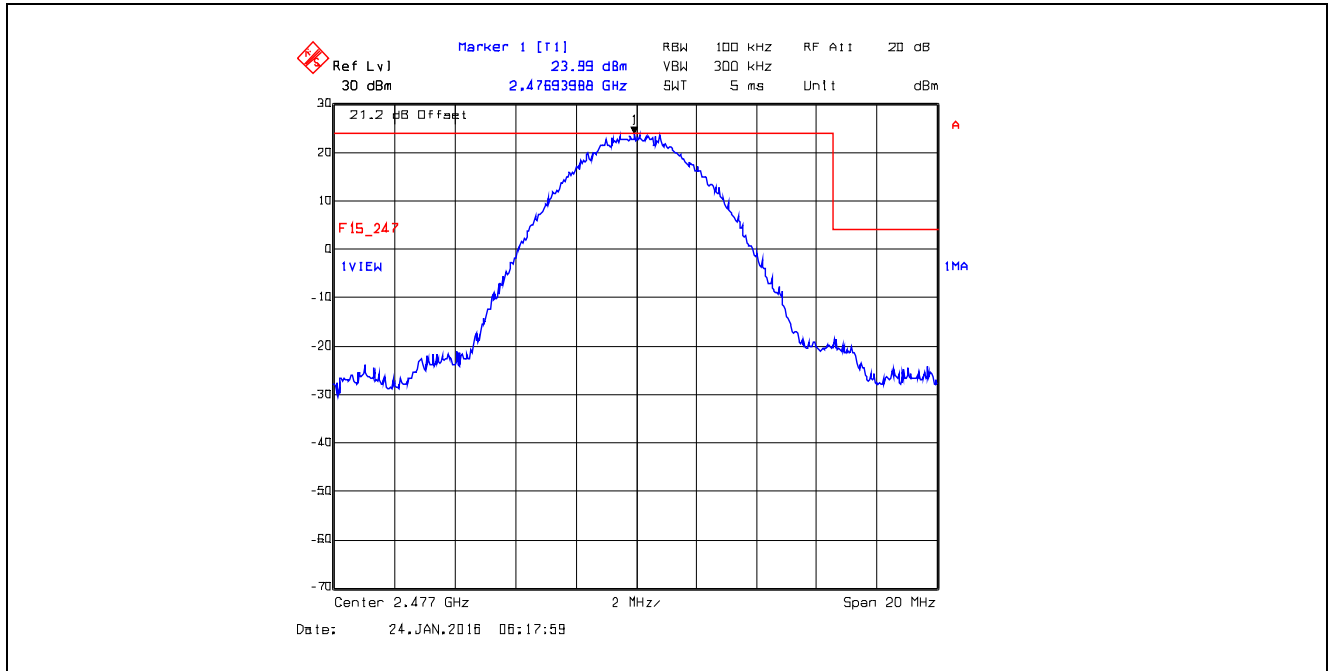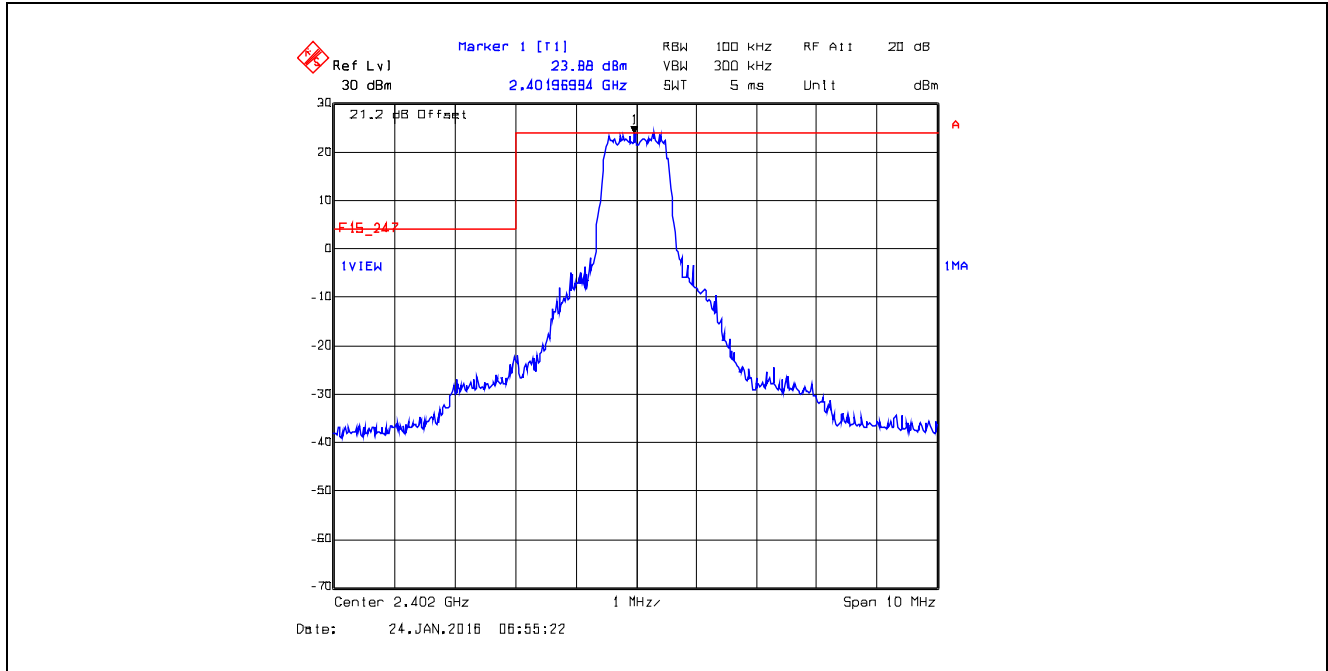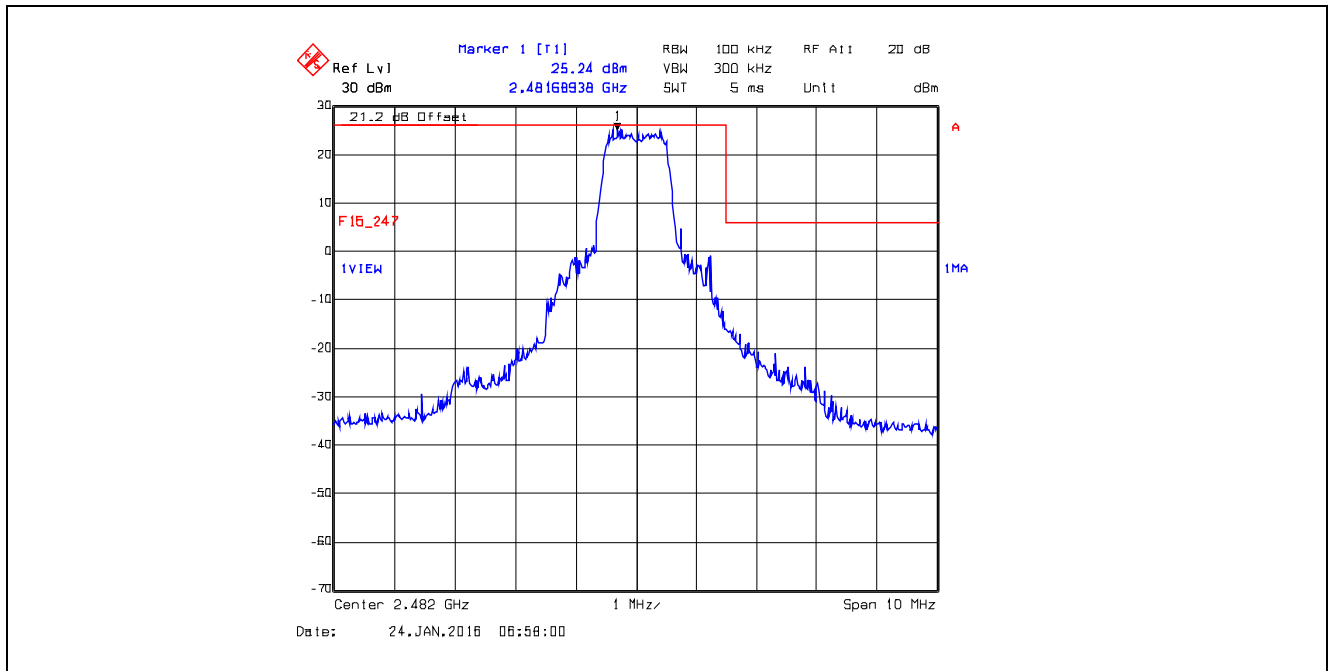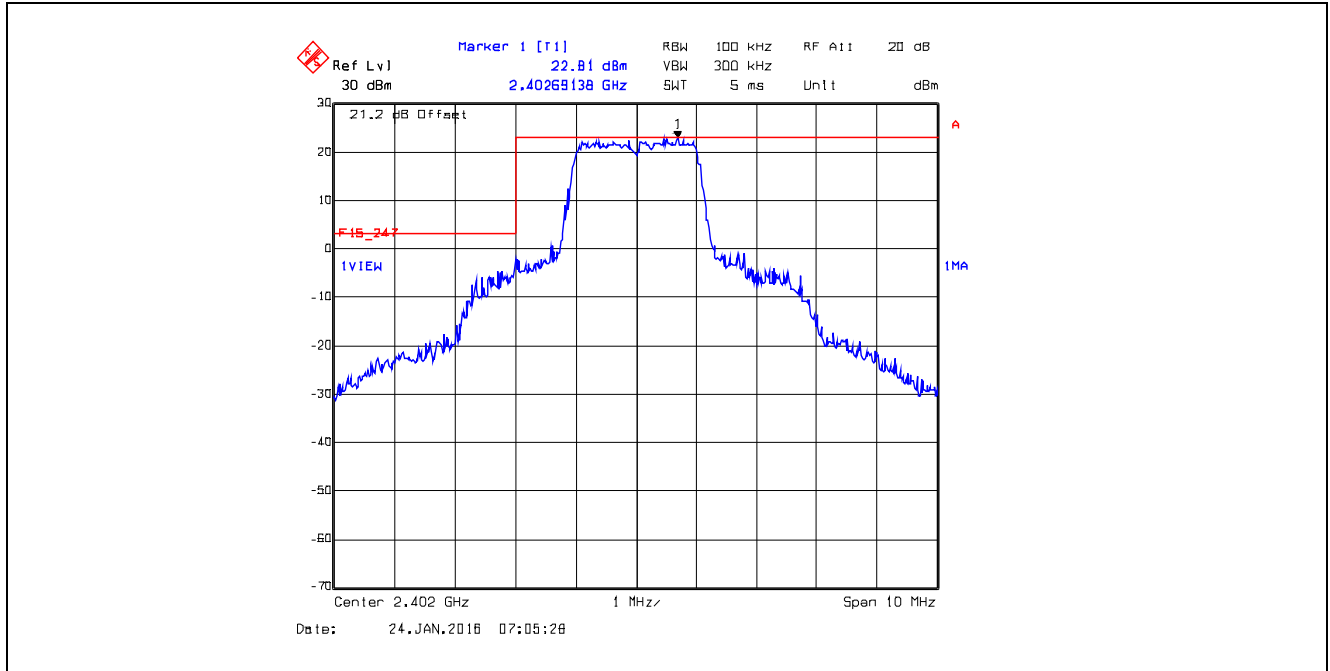Bandwidth: 1 MHz, TX Gain Setting: 5, 2482 MHz, Data Rate 3, Higher Band-edge

ULTRATECH GROUP OF LABS **File #: 16MCRS085_FCC15C247DTS**
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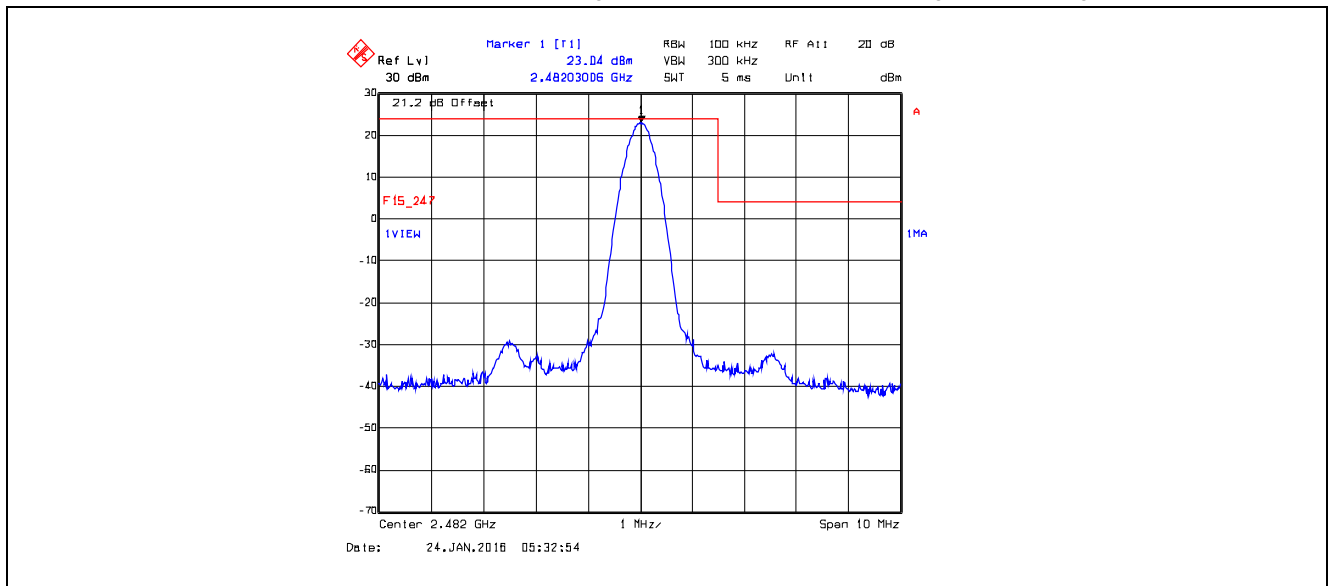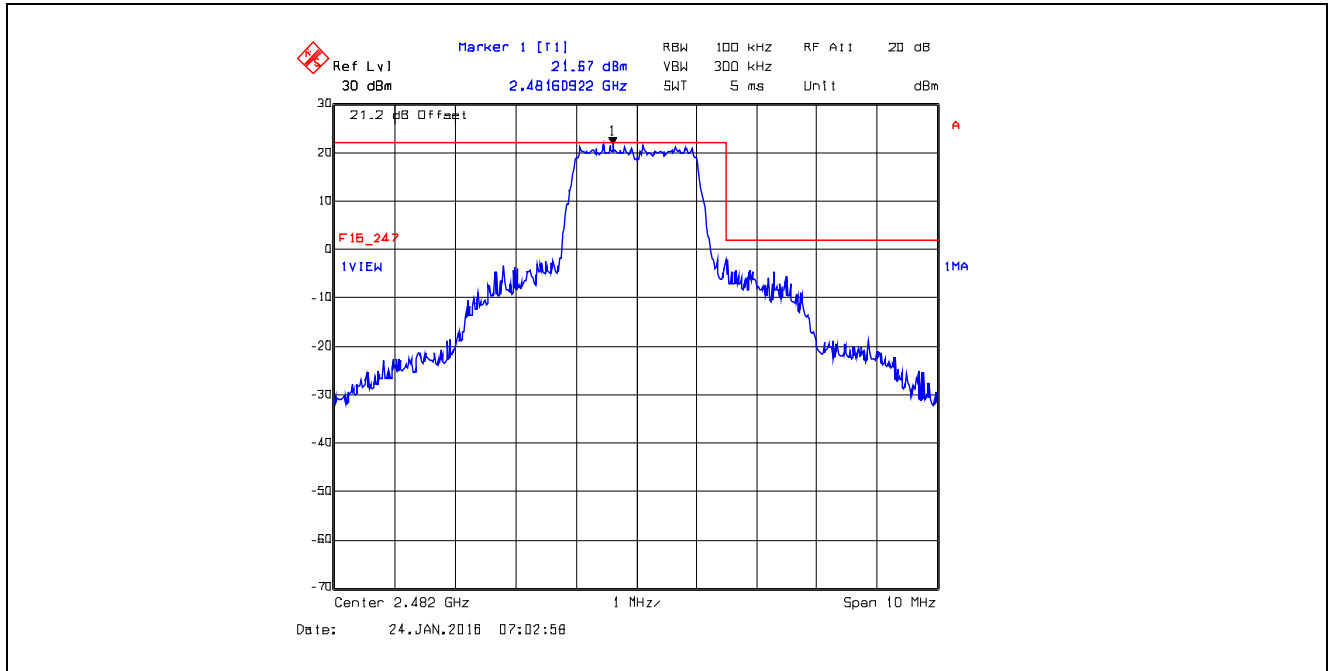
Plot 5.4.4.1.3. Band-Edge RF Conducted Emissions
Bandwidth: 2 MHz, TX Gain Setting: 8, 2402 MHz, Data Rate 3, Lower Band-edge
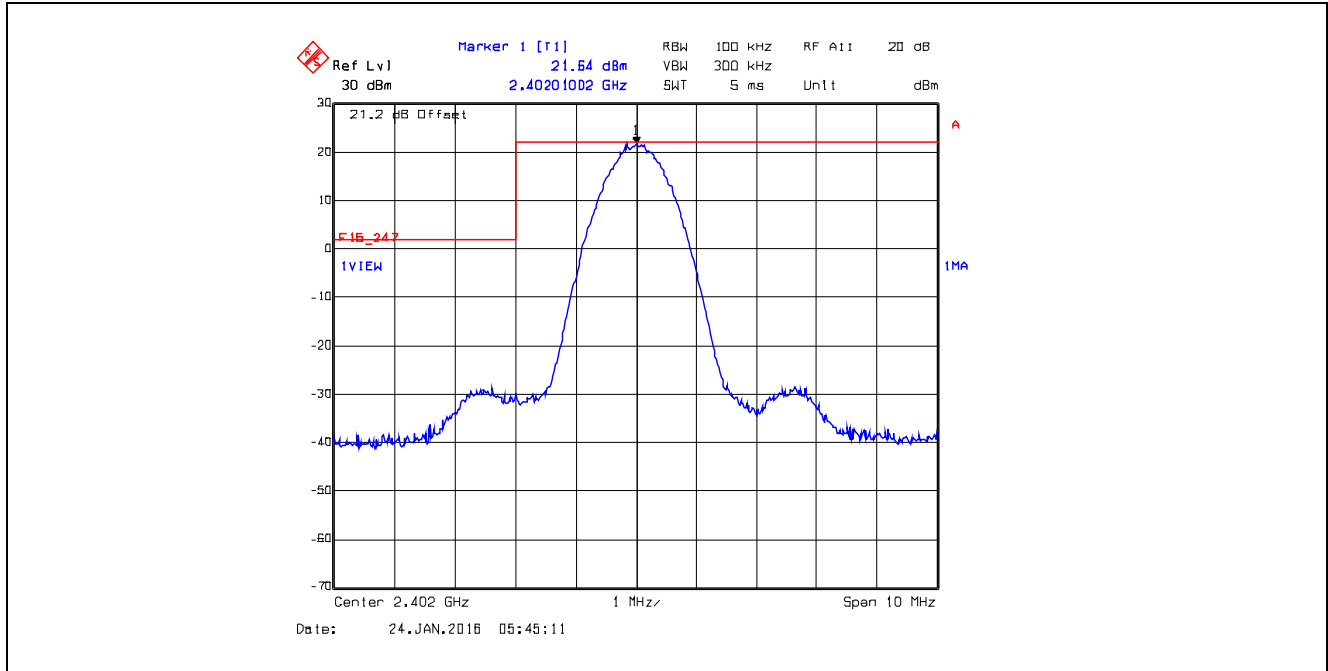
Plot 5.4.4.1.4. Band-Edge RF Conducted Emissions
Bandwidth: 2 MHz, TX Gain Setting: 8, 2482 MHz, Data Rate 3, Higher Band-edge

ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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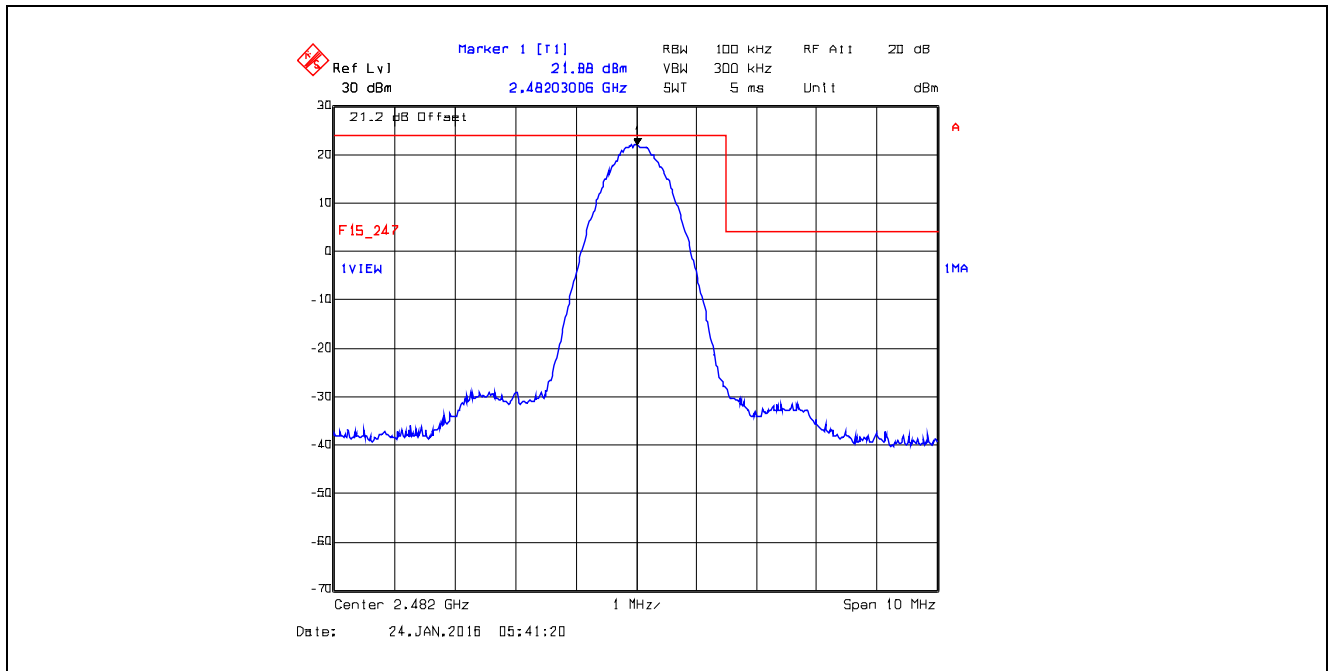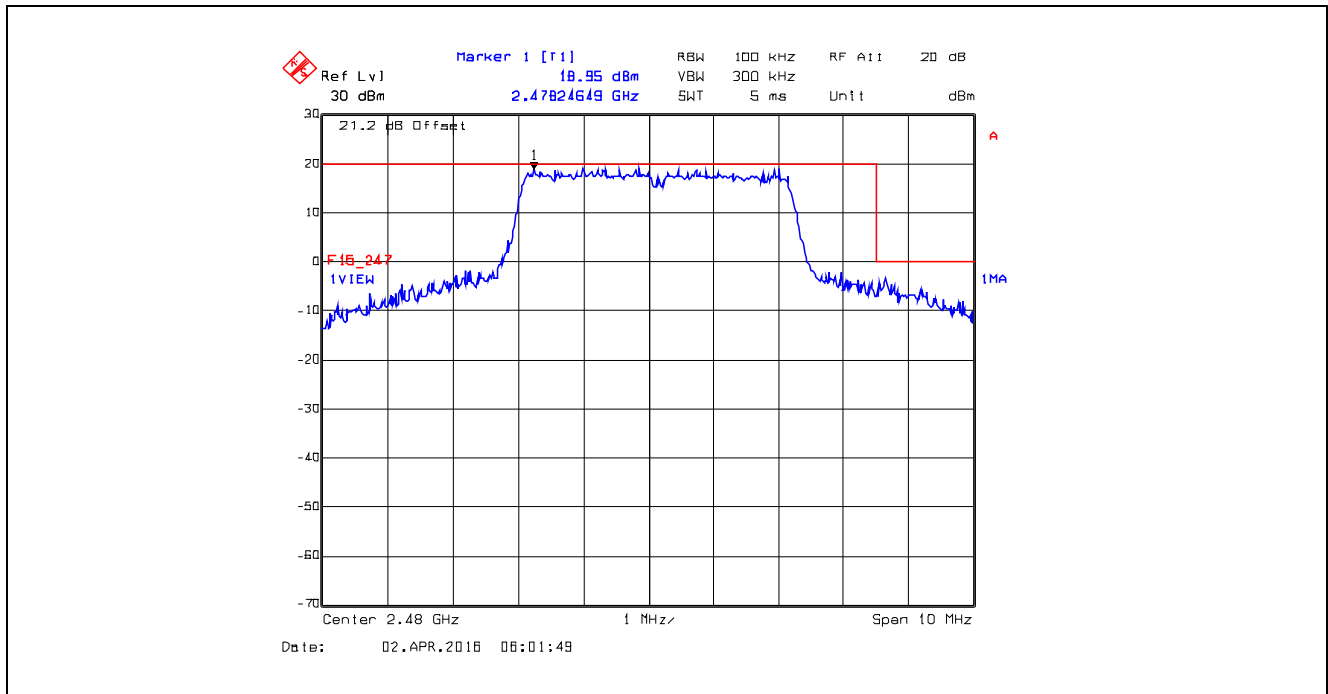
Plot 5.4.4.1.5. Band-Edge RF Conducted Emissions
Bandwidth: 4 MHz, TX Gain Setting: 18, 2402 MHz, Data Rate 3, Lower Band-edge
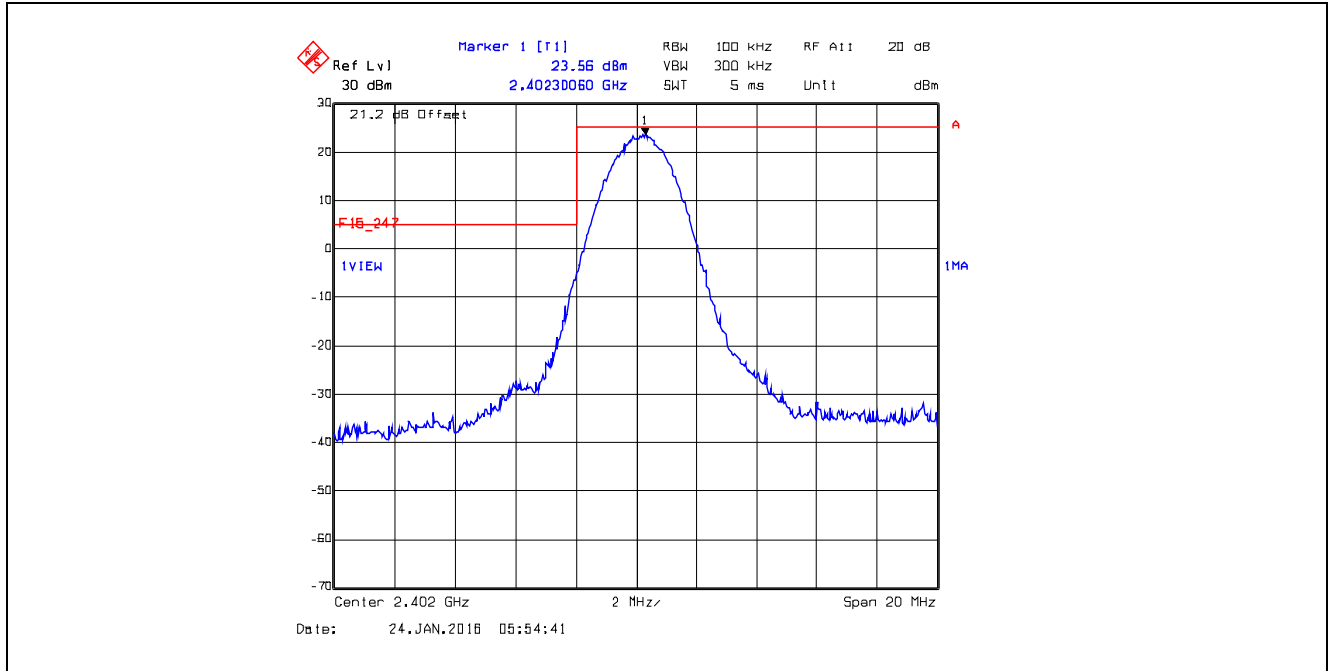
Plot 5.4.4.1.6. Band-Edge RF Conducted Emissions
Bandwidth: 4 MHz, TX Gain Setting : 18, 2477 MHz, Data Rate 3, Higher Band-edge

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Plot 5.4.4.1.7. Band-Edge RF Conducted Emissions
Bandwidth: 8 MHz, TX Gain Setting: 23, 2407 MHz, Data Rate 3, Lower Band-edge

Plot 5.4.4.1.8. Band-Edge RF Conducted Emissions
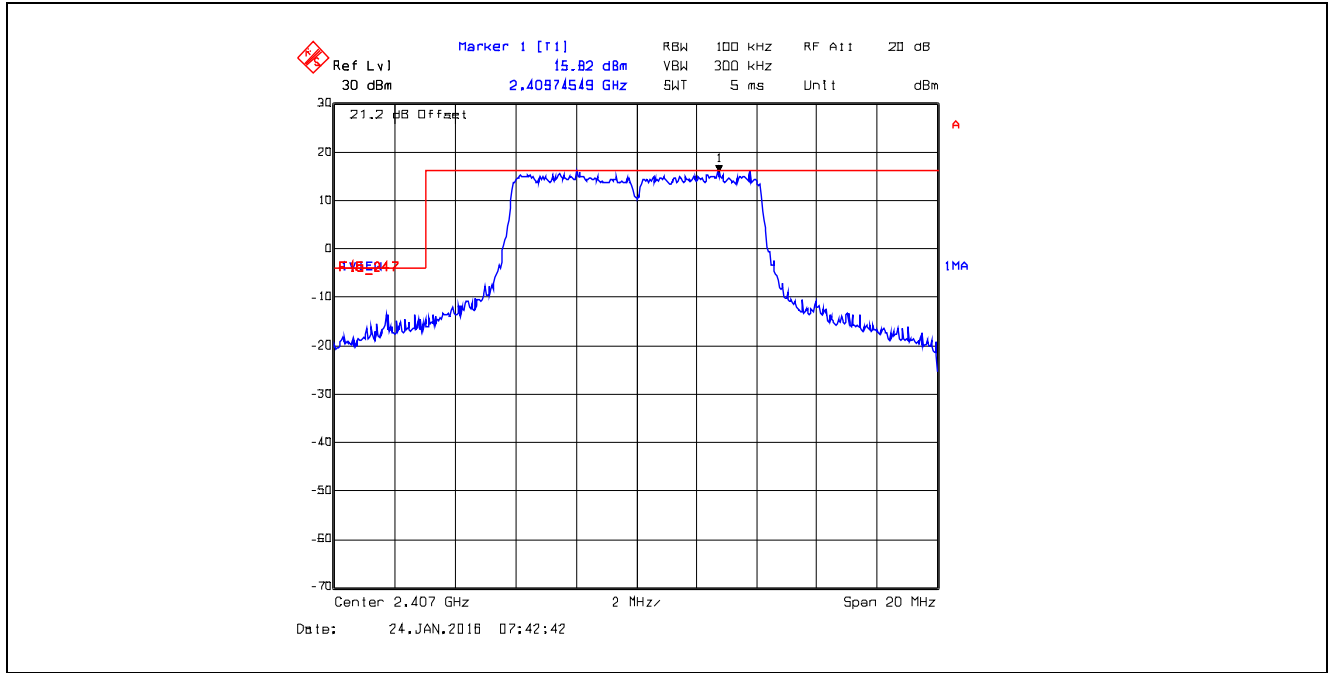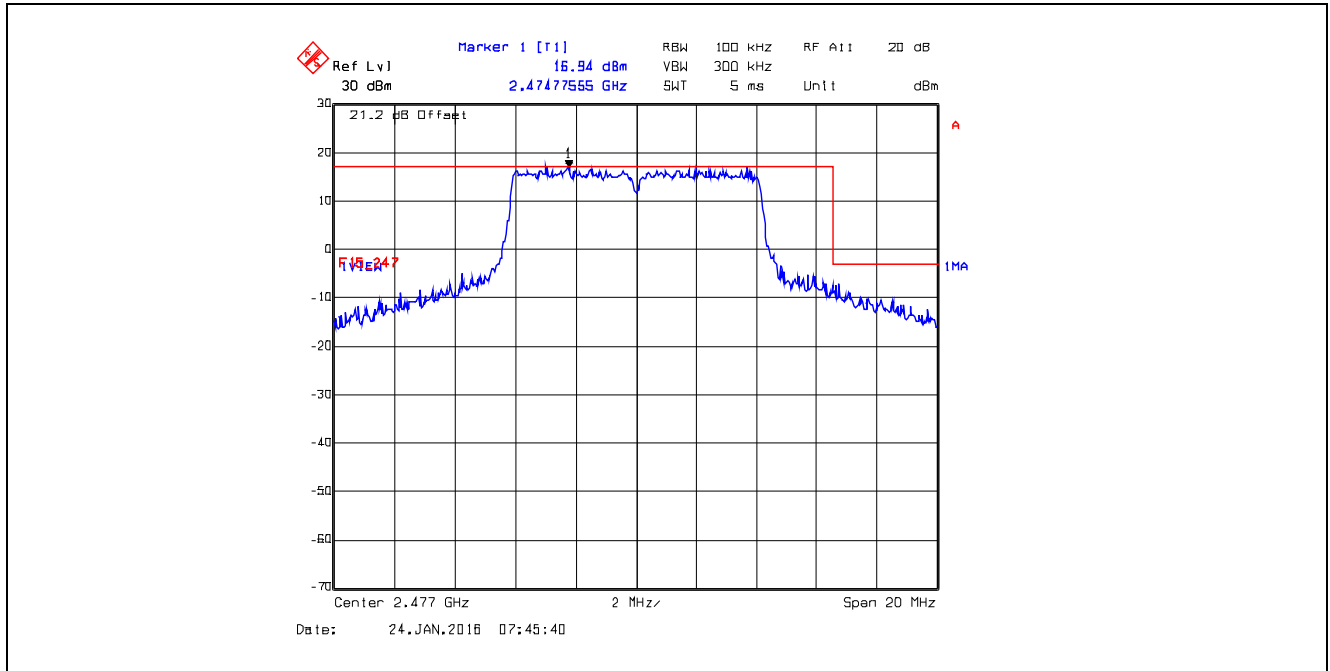Bandwidth: 8 MHz, TX Gain Setting: 23, 2477 MHz, Data Rate 3, Higher Band-edge

ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
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Plot 5.4.4.1.9. Band-Edge RF Conducted Emissions
Bandwidth: 1 MHz, TX Gain Setting: 20, 2402 MHz, Data Rate 7, Lower Band-edge

Plot 5.4.4.1.10. Band-Edge RF Conducted Emissions
Bandwidth: 1 MHz, TX Gain Setting: 20, 2482 MHz, Data Rate 7, Higher Band-edge

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File #: 16MCRS085_FCC15C247DTS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

April 13, 2016

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Plot 5.4.4.1.11. Band-Edge RF Conducted Emissions
Bandwidth: 2 MHz, TX Gain Setting: 23, 2402 MHz, Data Rate 7, Lower Band-edge

Plot 5.4.4.1.12. Band-Edge RF Conducted Emissions
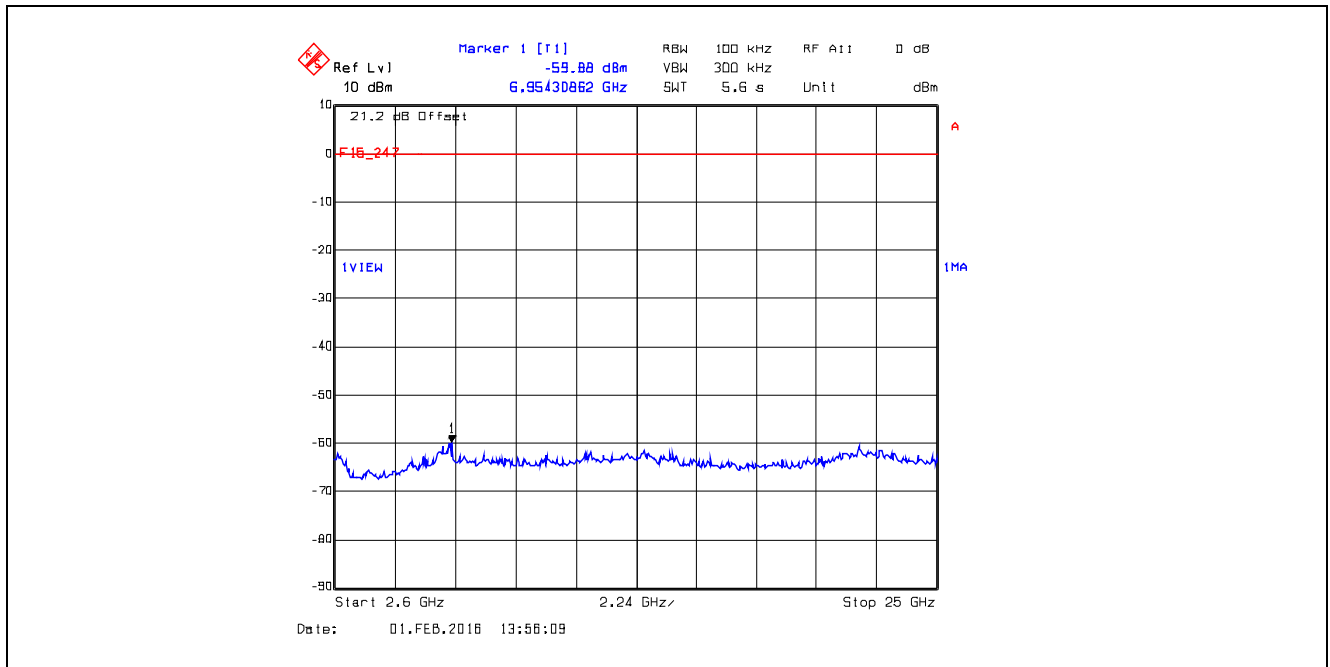Bandwidth: 2 MHz, TX Gain Setting: 23, 2482 MHz, Data Rate 7, Higher Band-edge

ULTRATECH GROUP OF LABS
File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
April 13, 2016
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Plot 5.4.4.1.13. Band-Edge RF Conducted Emissions
Bandwidth: 4 MHz, TX Gain Setting: 23, 2403 MHz, Data Rate 7, Lower Band-edge
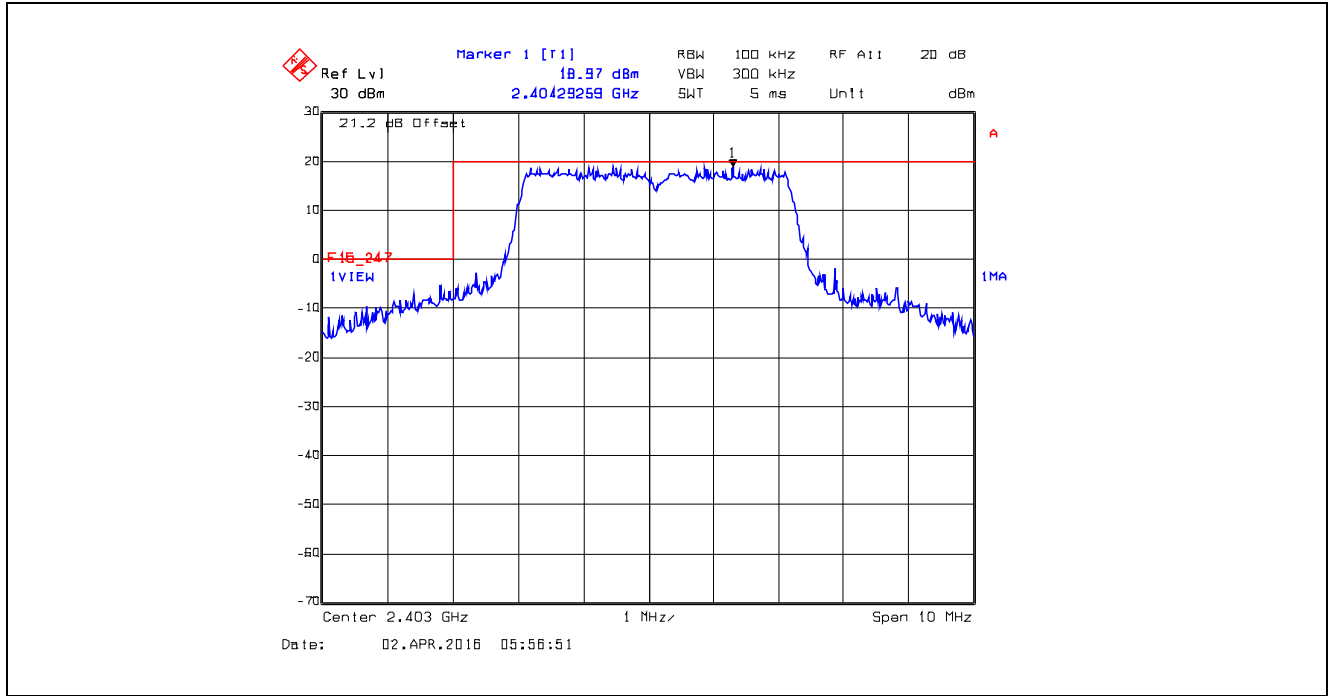
Plot 5.4.4.1.14. Band-Edge RF Conducted Emissions
Bandwidth: 4 MHz, TX Gain Setting: 23, 2480 MHz, Data Rate 7, Higher Band-edge

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Plot 5.4.4.1.15. Band-Edge RF Conducted Emissions
Bandwidth: 8 MHz, TX Gain Setting: 23, 2407 MHz, Data Rate 7, Lower Band-edge

Plot 5.4.4.1.16. Band-Edge RF Conducted Emissions
Bandwidth: 8 MHz, TX Gain Setting: 23, 2477 MHz, Data Rate 7, Higher Band-edge

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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5.4.4.2. Spurious RF Conducted Emissions in Non-restricted Frequency Bands

Plot 5.4.4.2.1. Conducted Spurious Emissions in Non-restricted Frequency Bands
Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 3, 30 MHz – 2.6 GHz
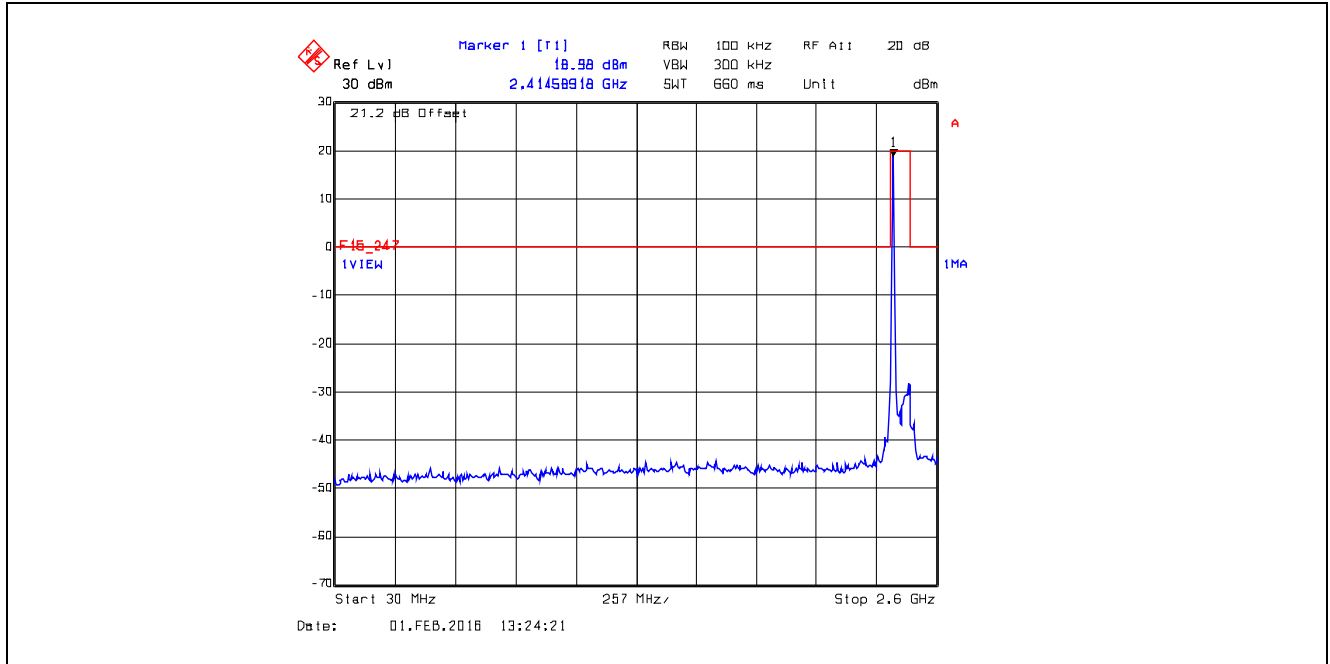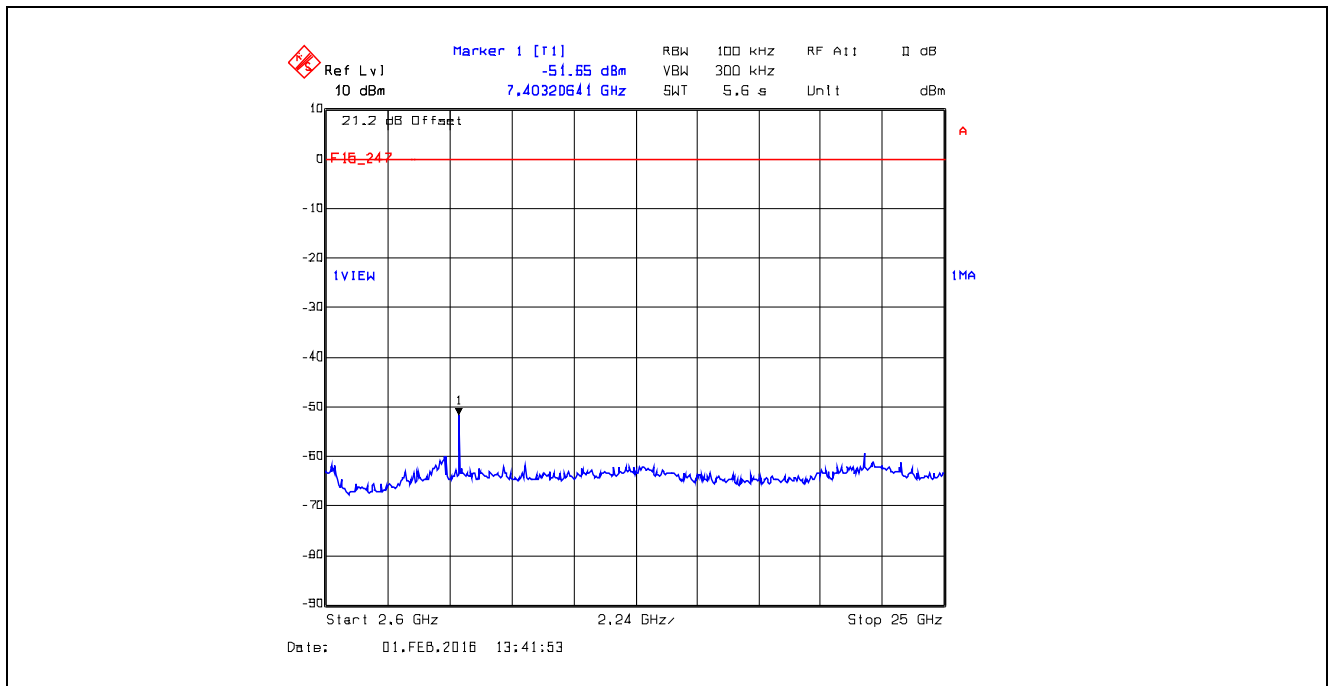

Plot 5.4.4.2.2. Conducted Spurious Emissions in Non-restricted Frequency Bands
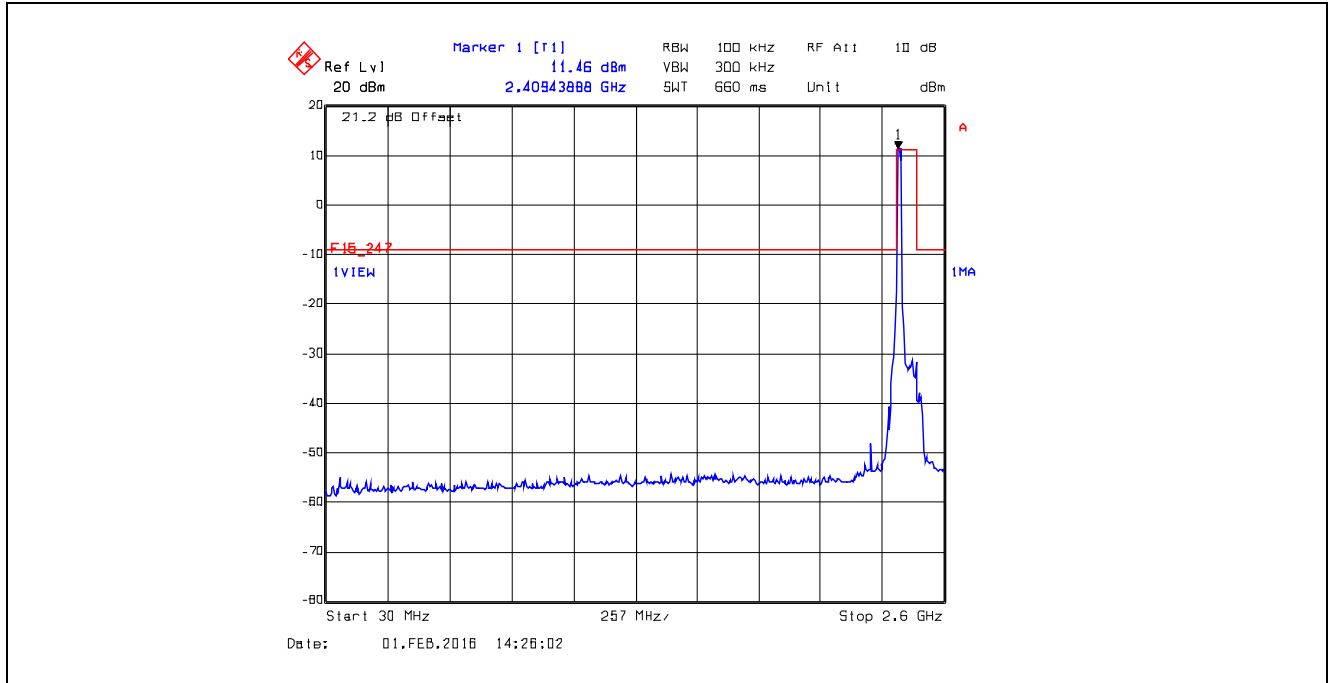Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 3, 2.6 GHz – 25 GHz

ULTRATECH GROUP OF LABS
File #: 16MCRS085_FCC15C247DTS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
April 13, 2016

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Plot 5.4.4.2.3. Conducted Spurious Emissions in Non-restricted Frequency Bands
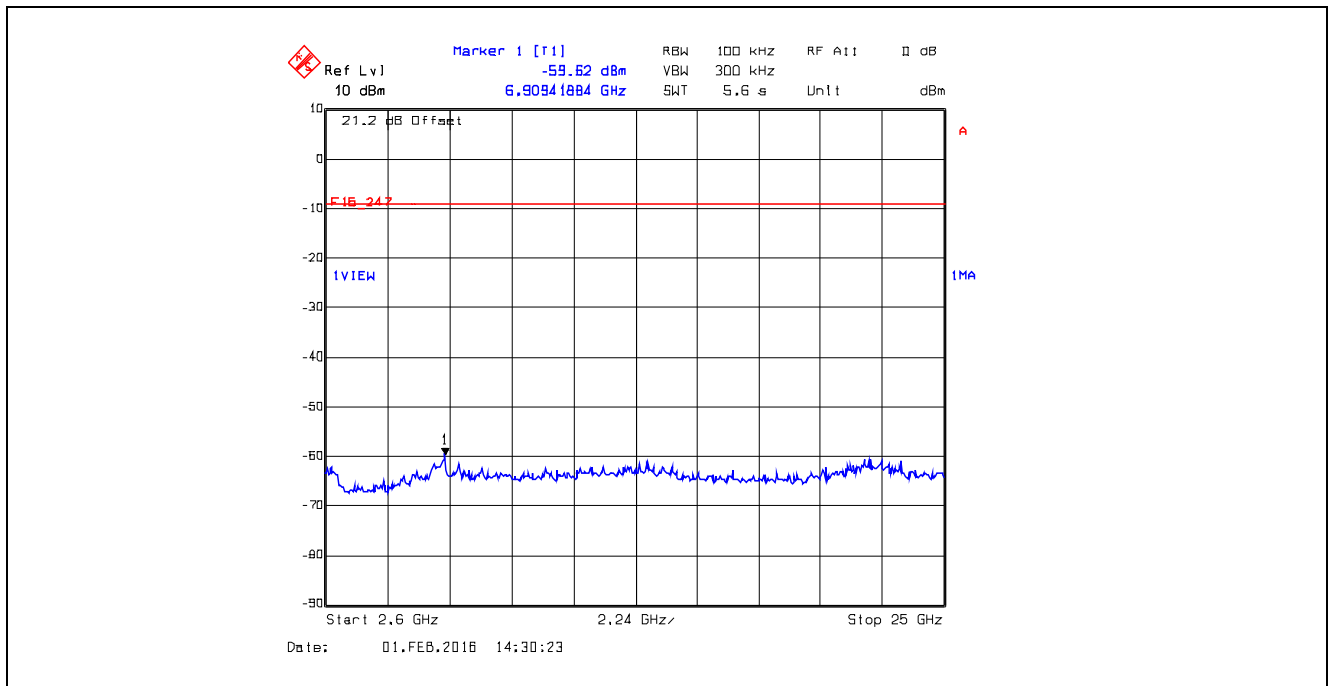Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 3, 30 MHz – 2.6 GHz
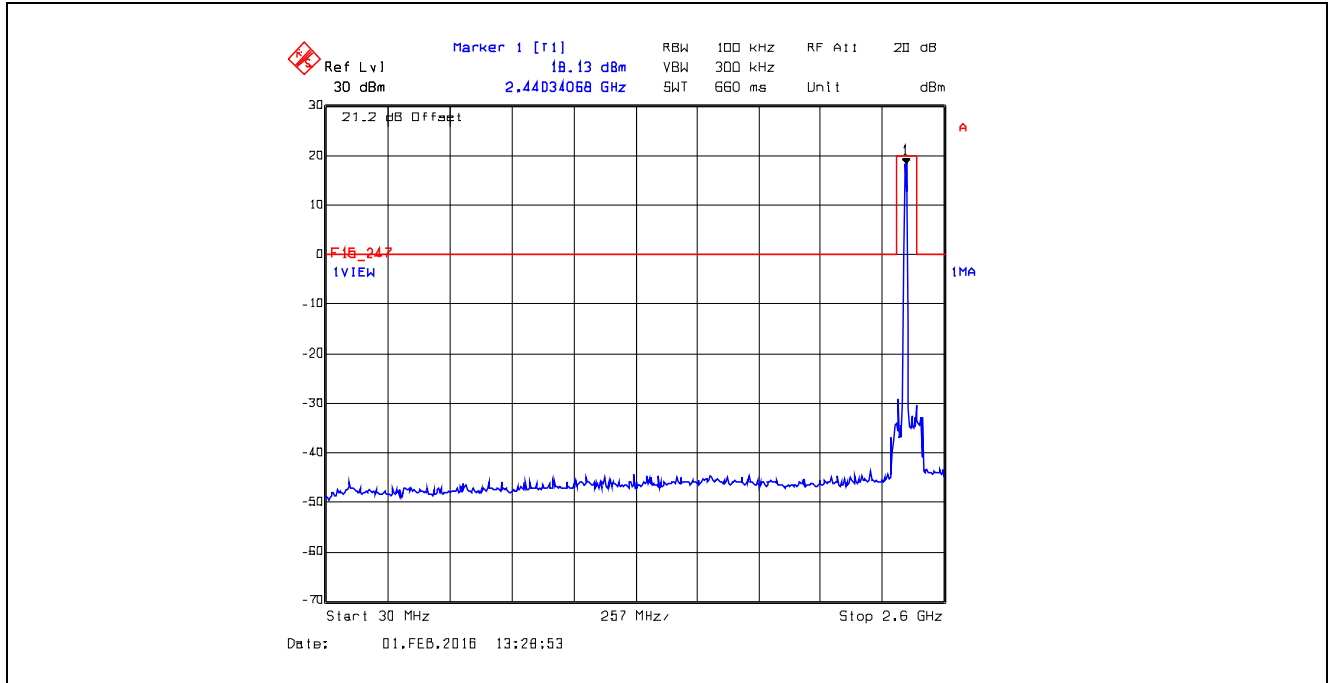
Plot 5.4.4.2.4. Conducted Spurious Emissions in Non-restricted Frequency Bands
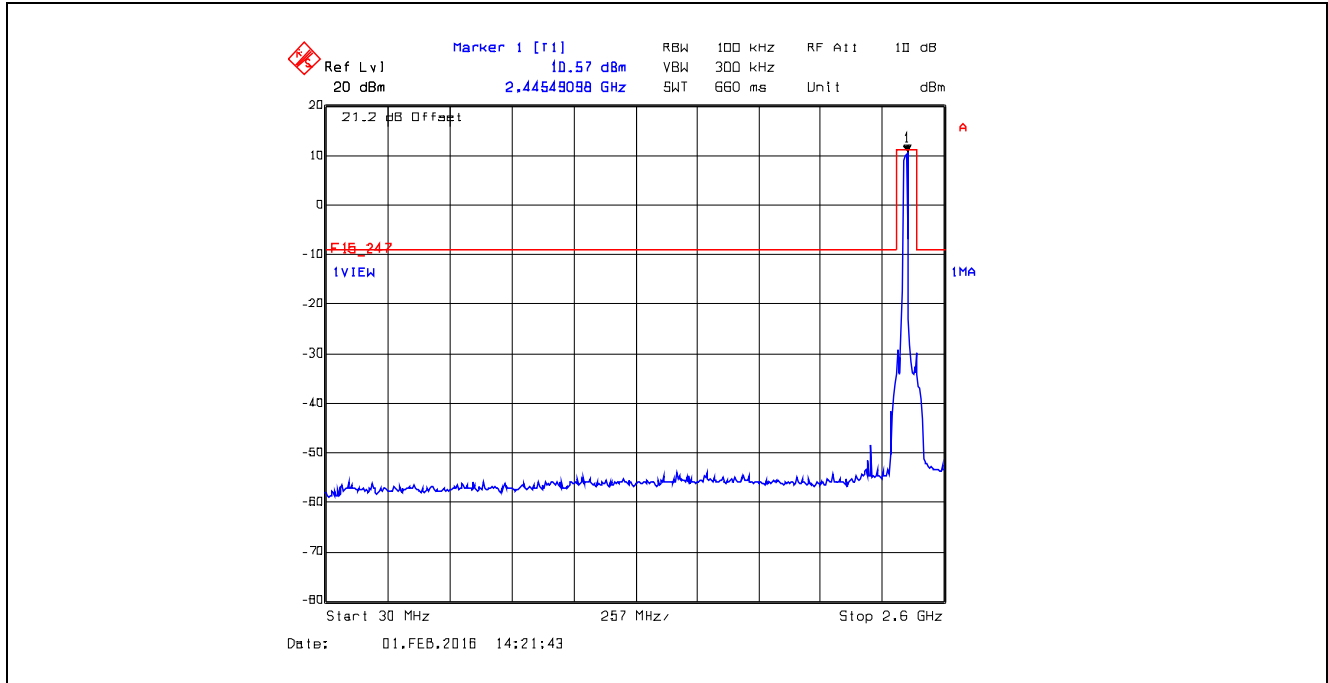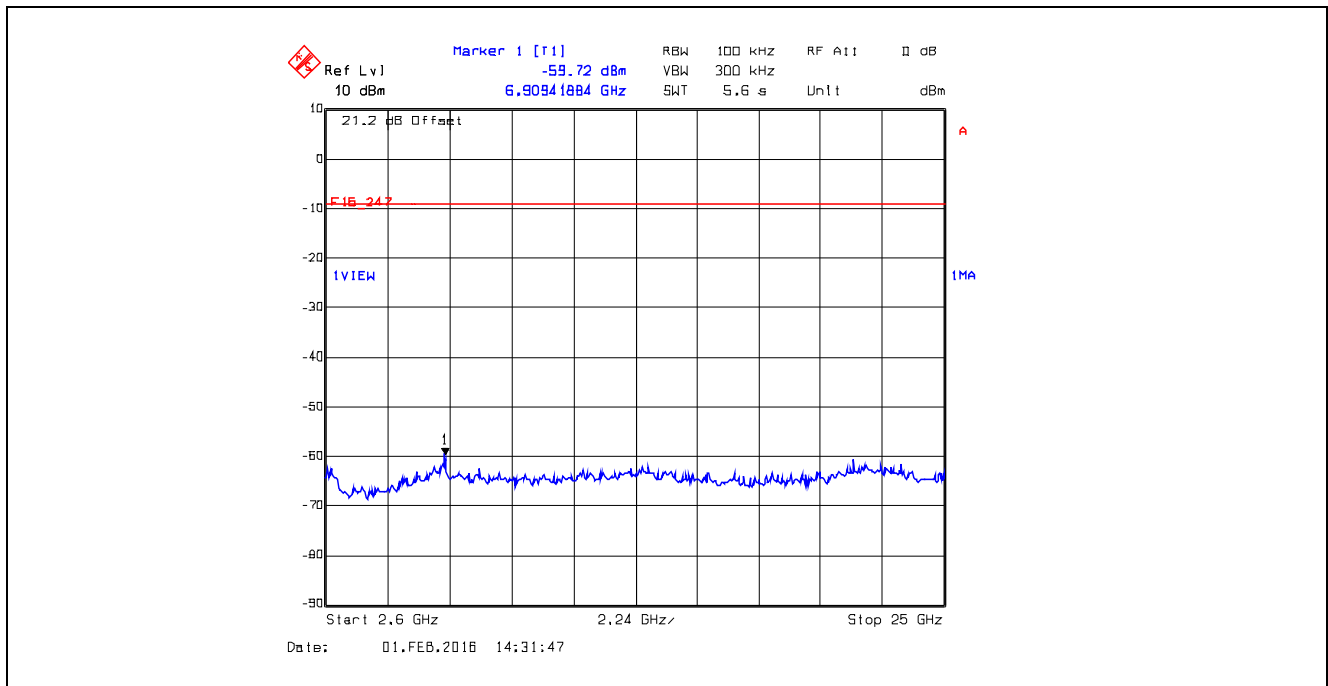Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 3, 2.6 GHz – 25 GHz

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File #: 16MCRS085_FCC15C247DTS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

April 13, 2016

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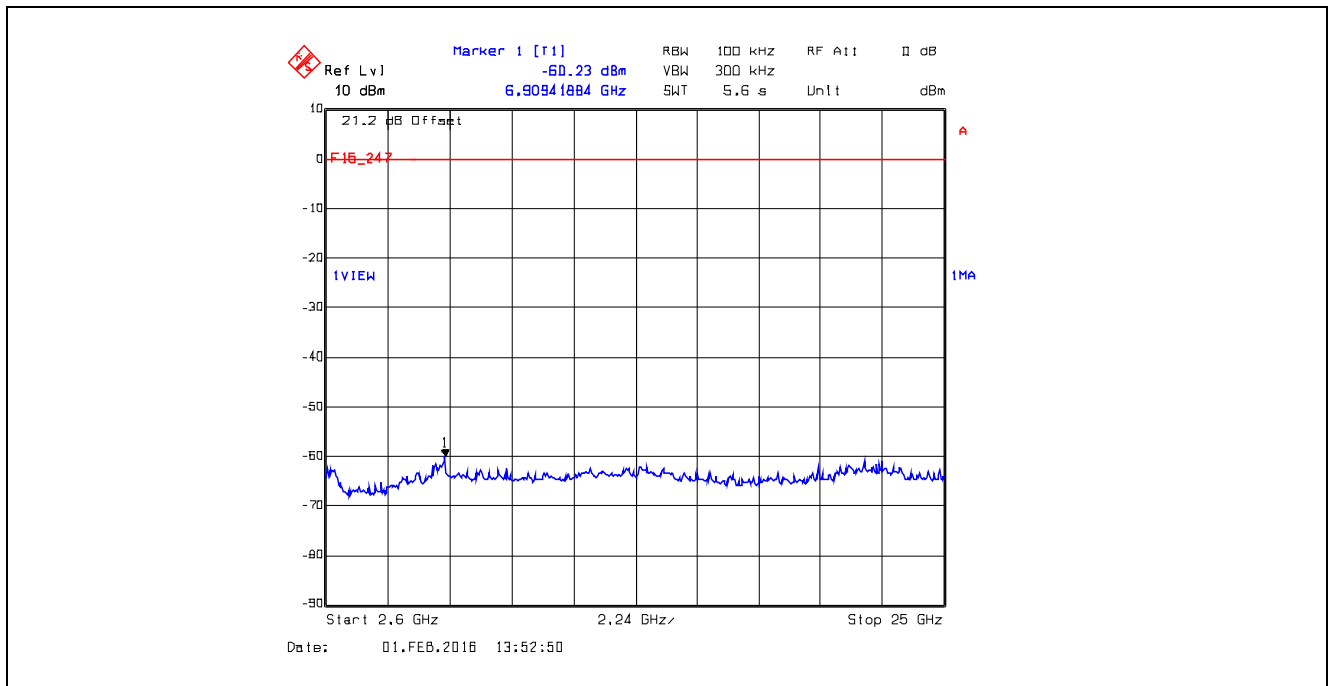
Plot 5.4.4.2.5. Conducted Spurious Emissions in Non-restricted Frequency Bands
Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 3, 30 MHz – 2.6 GHz
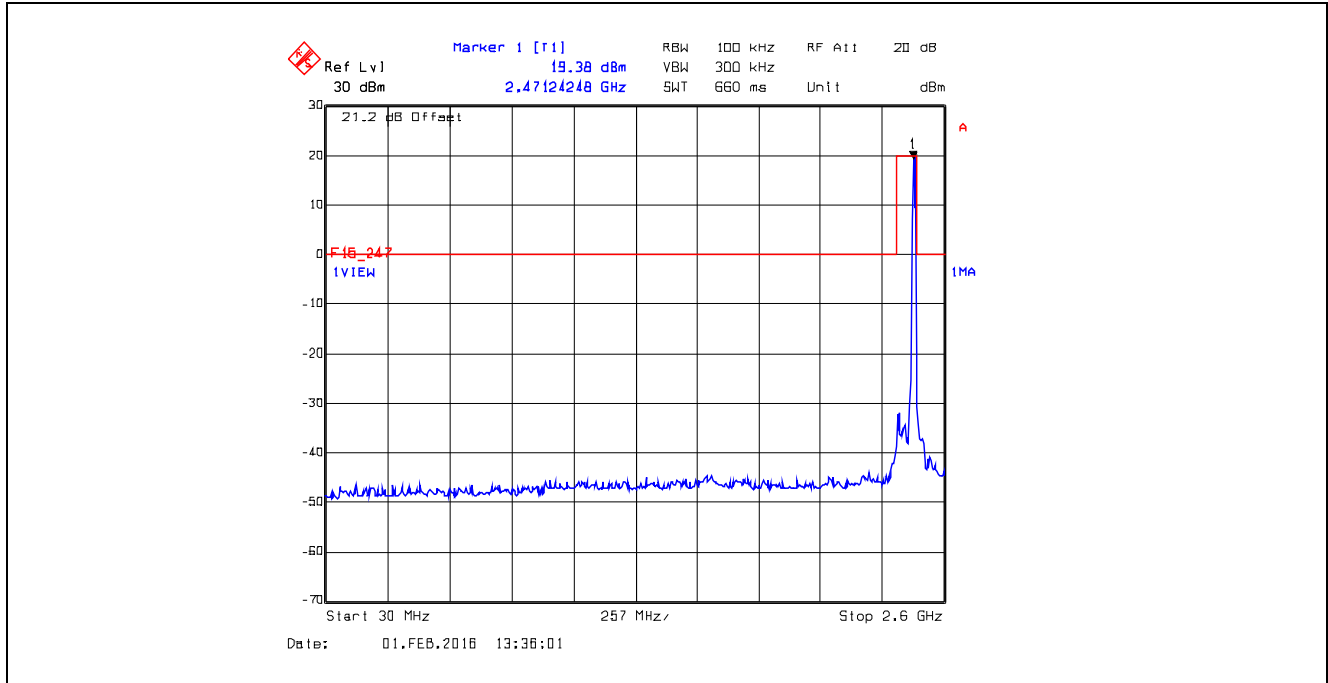
Plot 5.4.4.2.6. Conducted Spurious Emissions in Non-restricted Frequency Bands
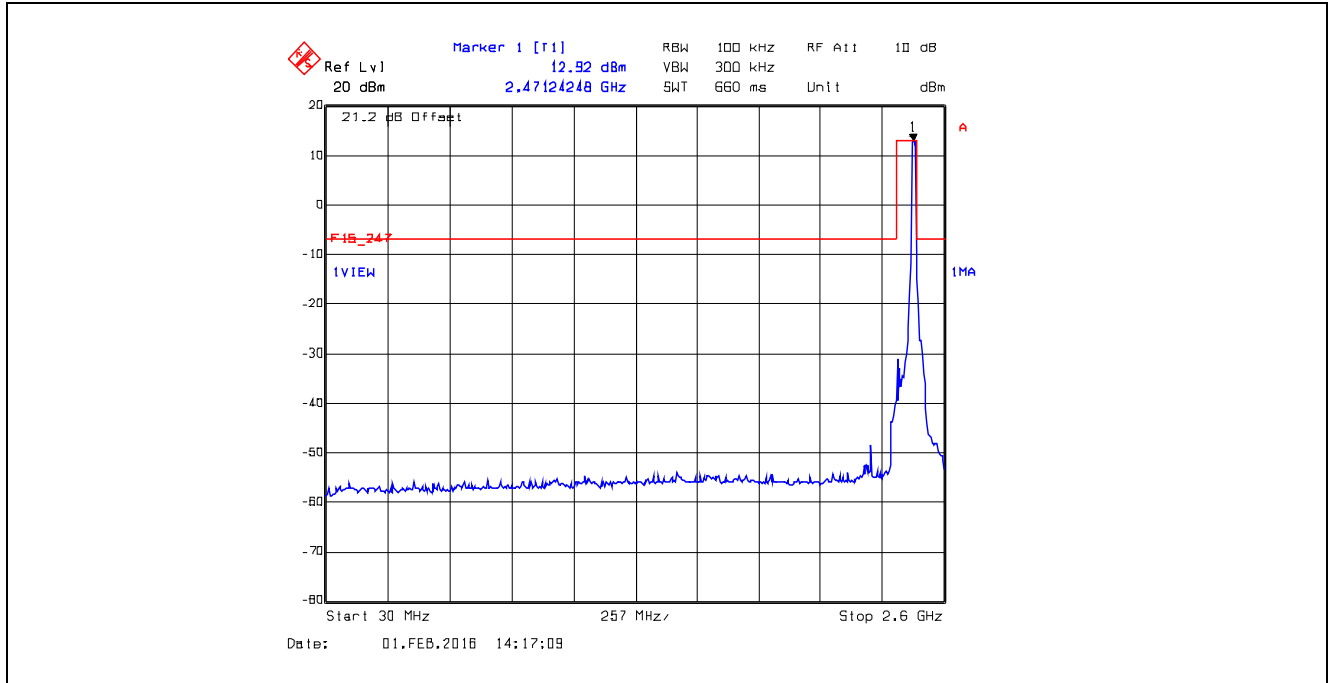Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 3, 2.6 GHz – 25 GHz

Plot 5.4.4.2.7. Conducted Spurious Emissions in Non-restricted Frequency Bands
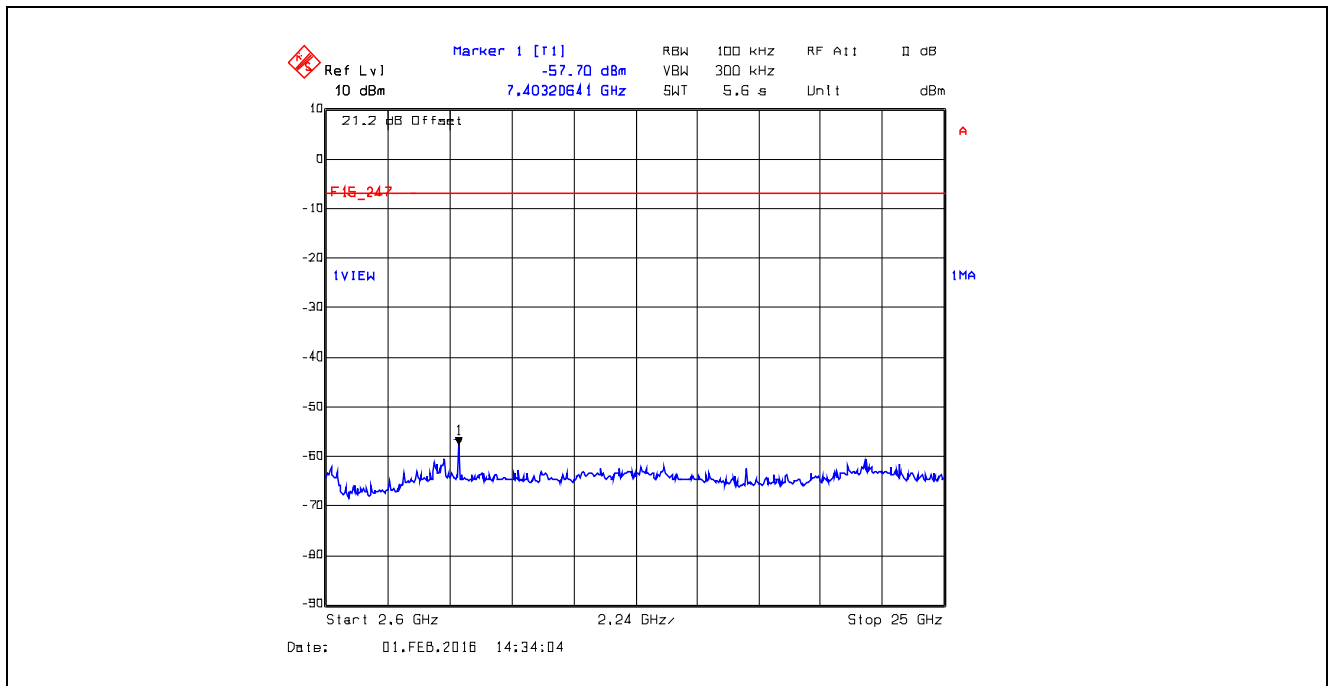Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 7, 30 MHz – 2.6 GHz

Plot 5.4.4.2.8. Conducted Spurious Emissions in Non-restricted Frequency Bands
Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 7, 2.6 GHz – 25 GHz

ULTRATECH GROUP OF LABS **File #: 16MCRS085_FCC15C247DTS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4 **April 13, 2016**

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Plot 5.4.4.2.9. Conducted Spurious Emissions in Non-restricted Frequency Bands
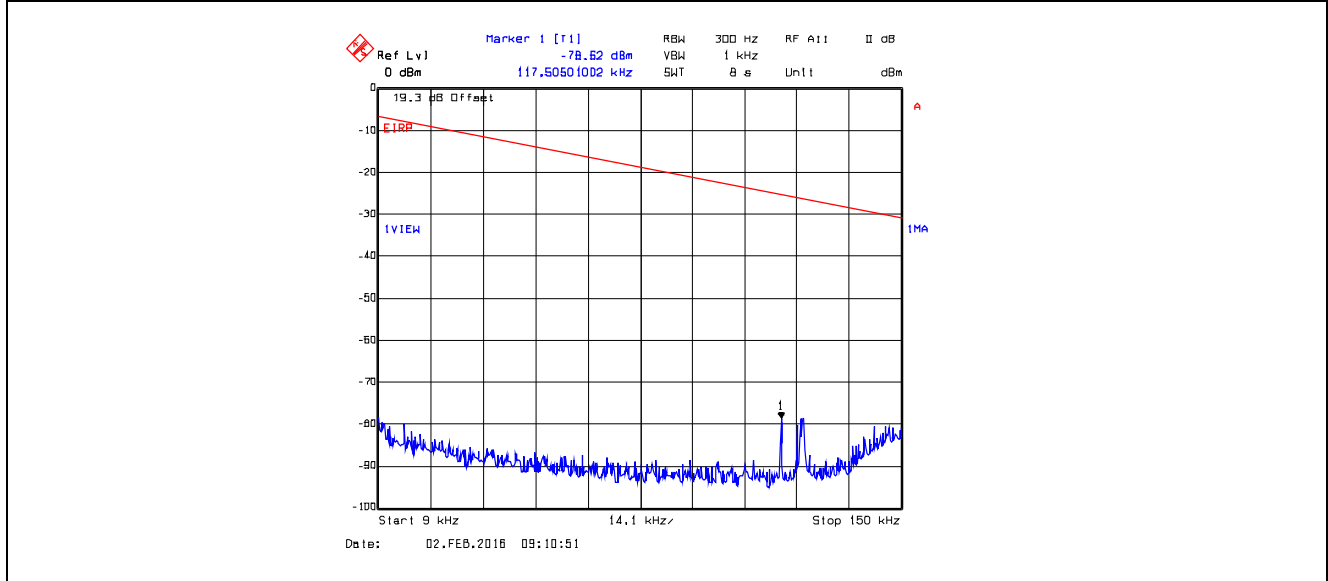Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 7, 30 MHz – 2.6 GHz

Plot 5.4.4.2.10. Conducted Spurious Emissions in Non-restricted Frequency Bands
Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 7, 2.6 GHz – 25 GHz

ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.4.4.2.11. Conducted Spurious Emissions in Non-restricted Frequency Bands
Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 7, 30 MHz – 2.6 GHz

Plot 5.4.4.2.12. Conducted Spurious Emissions in Non-restricted Frequency Bands
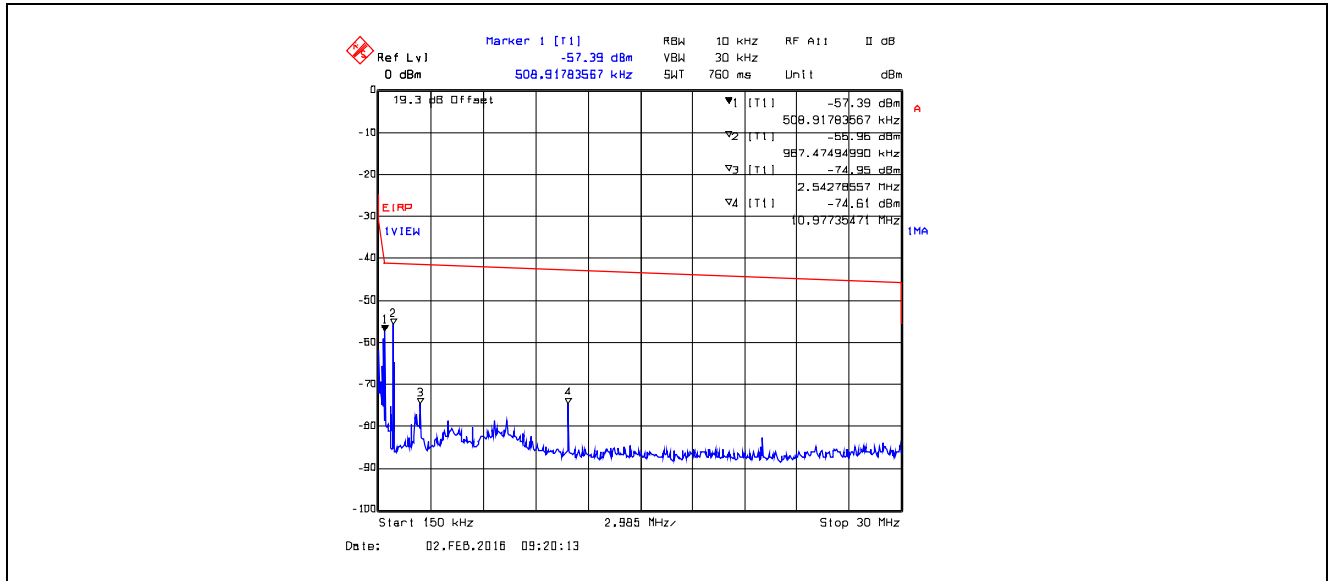Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 7, 2.6 GHz – 25 GHz

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**

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5.4.4.3.   Conducted Spurious Emissions in Restricted Frequency Bands, Highest Power Setting for Lowest Antenna Gain (2 dBi)

Remark: Offset = [Insertion Loss] + [Transmit Antenna Gain (in dBi)] + [Maximum Ground Reflection Factor]
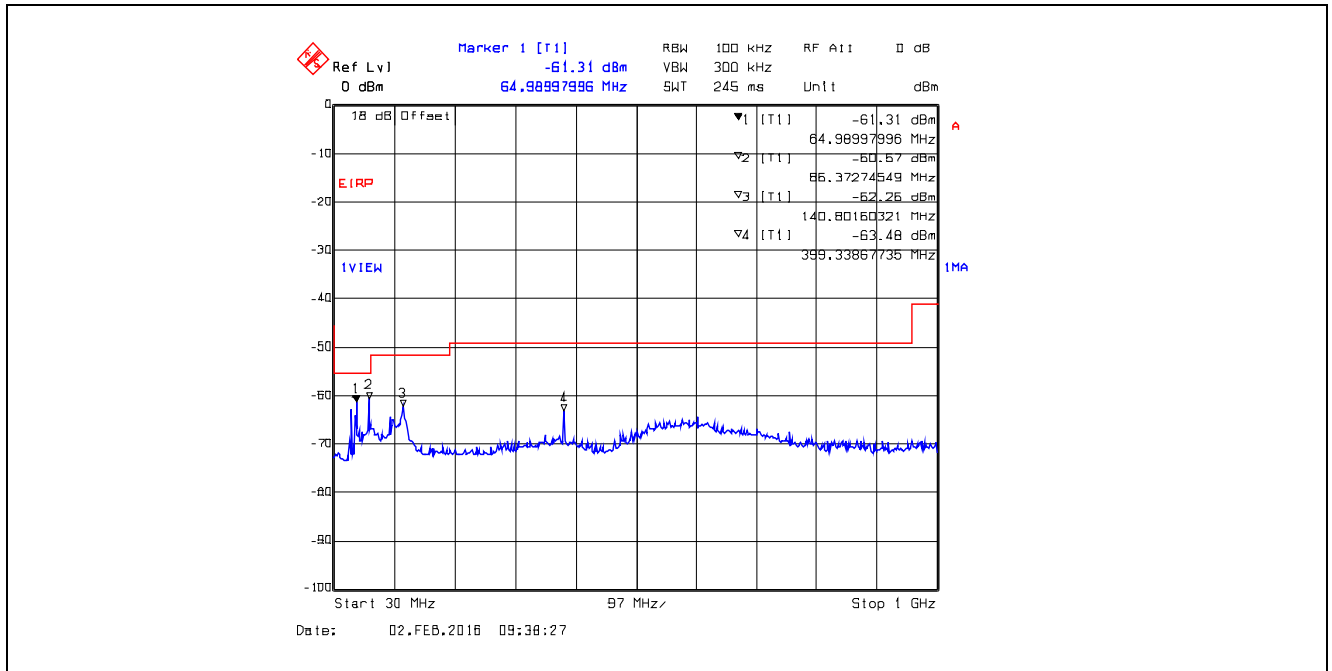
Plot 5.4.4.3.1. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 23, 9 kHz - 150 kHz, Peak Detector
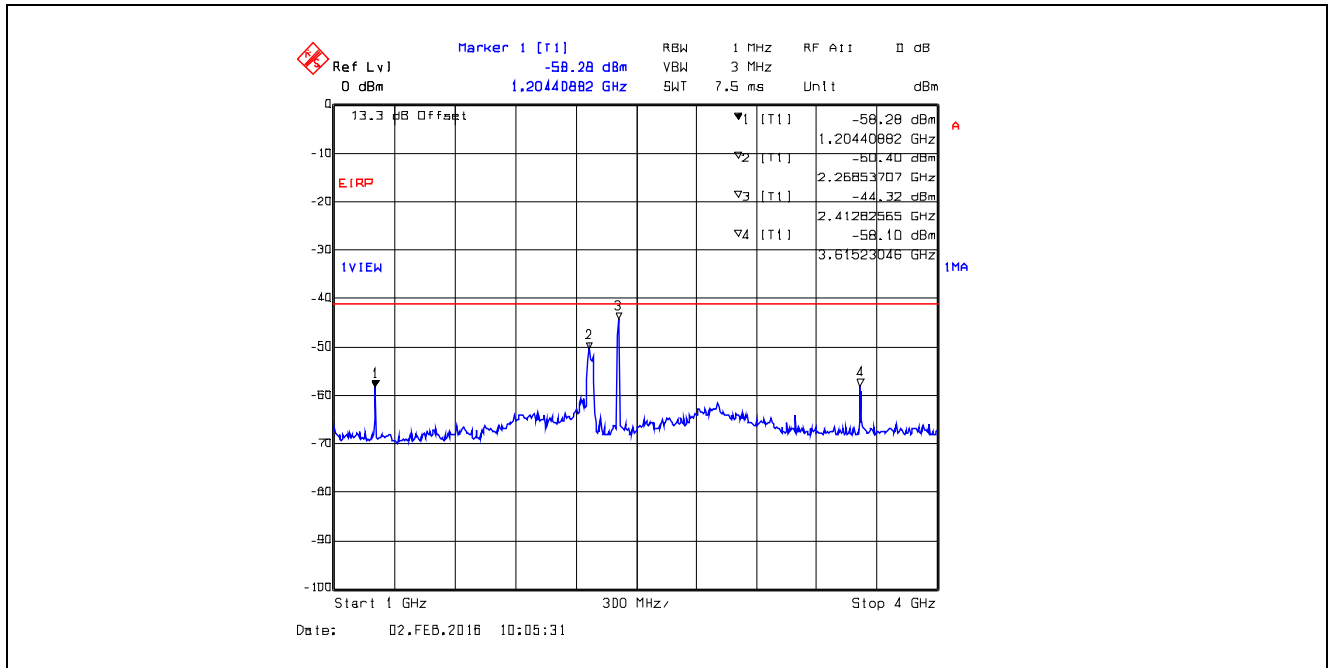

Plot 5.4.4.3.2. Conducted Spurious Emissions in Restricted Frequency Bands
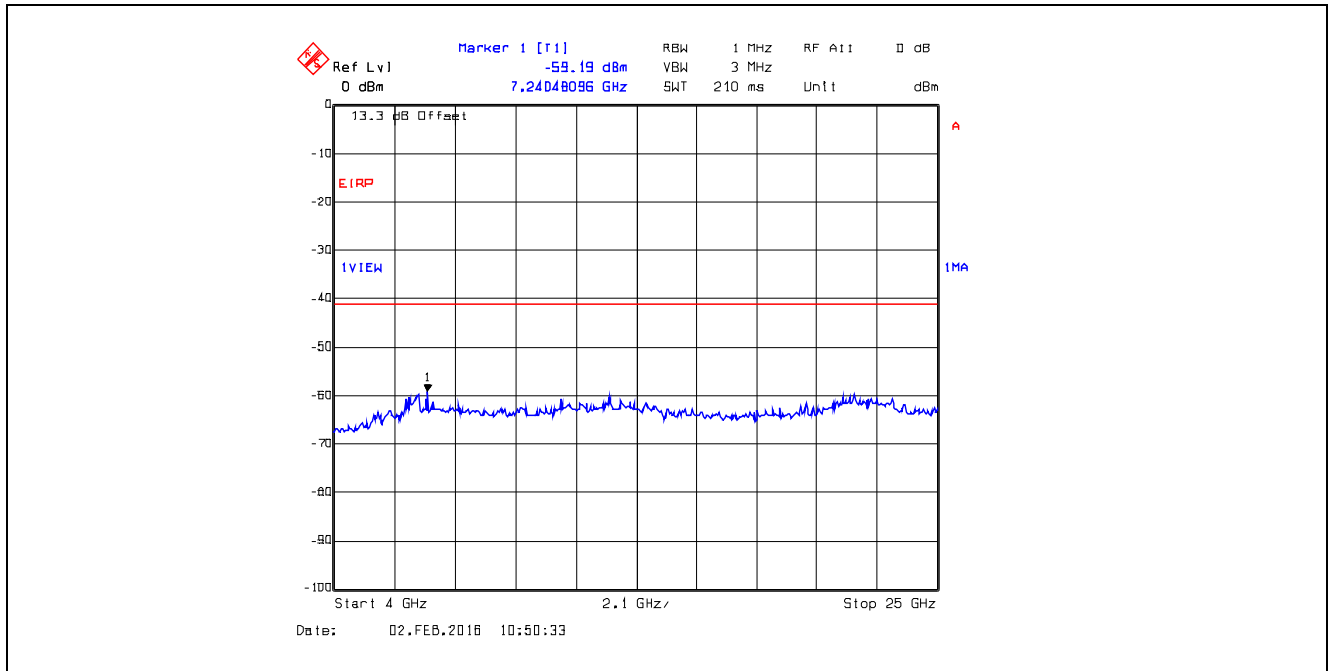Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 23, 150 kHz - 30 MHz, Peak Detector

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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Plot 5.4.4.3.3. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 23, 30 MHz - 1 GHz, Peak Detector
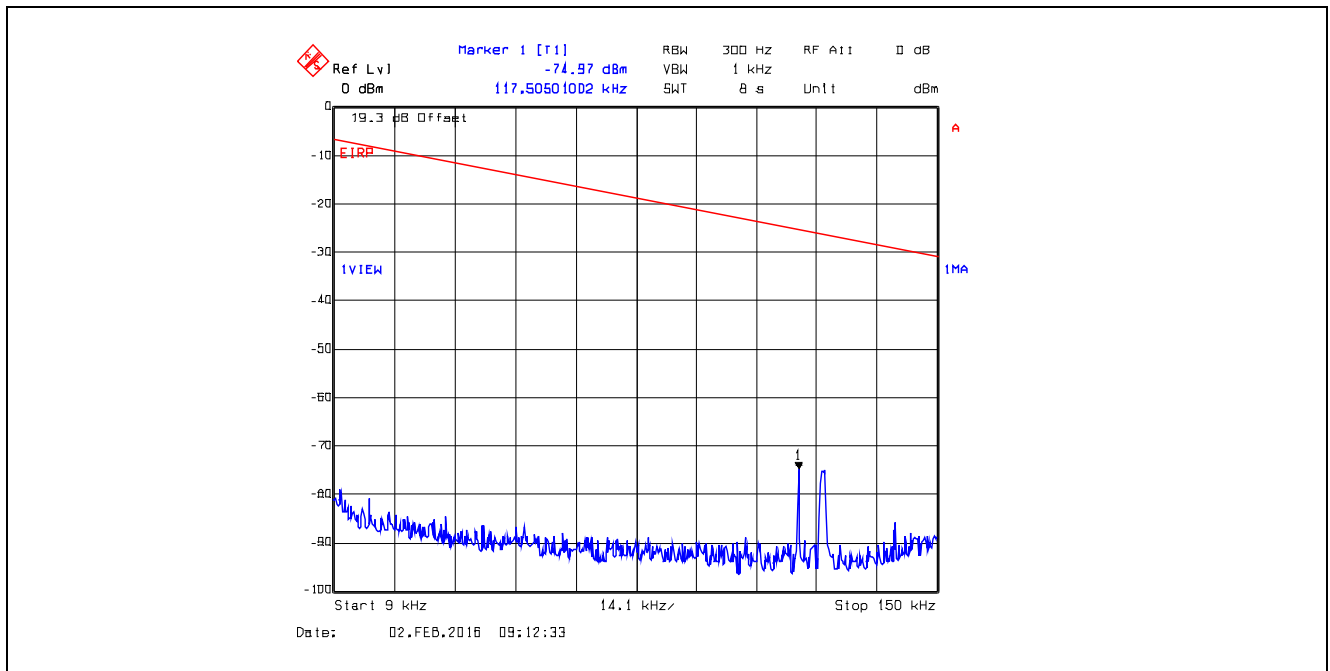

Plot 5.4.4.3.4. Conducted Spurious Emissions in Restricted Frequency Bands
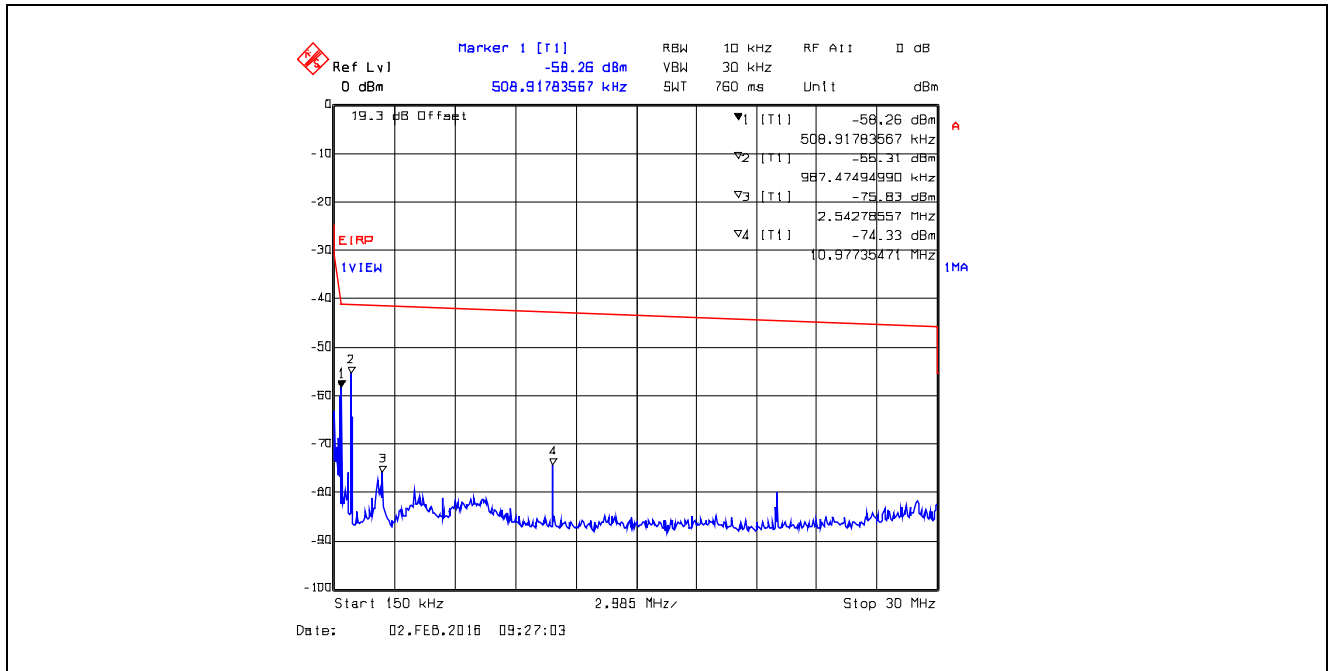Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 23, 1 GHz - 4 GHz, Peak Detector

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**

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Plot 5.4.4.3.5. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 23, 4 GHz - 25 GHz, Peak Detector

Plot 5.4.4.3.6. Conducted Spurious Emissions in Restricted Frequency Bands
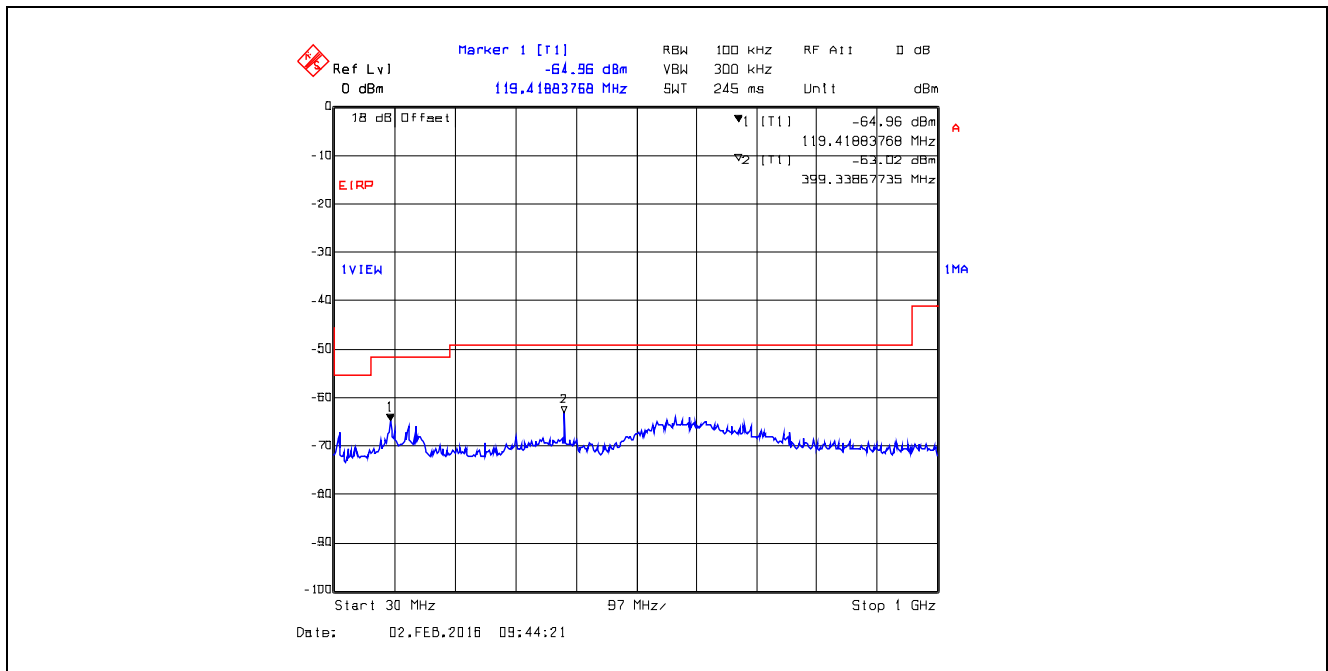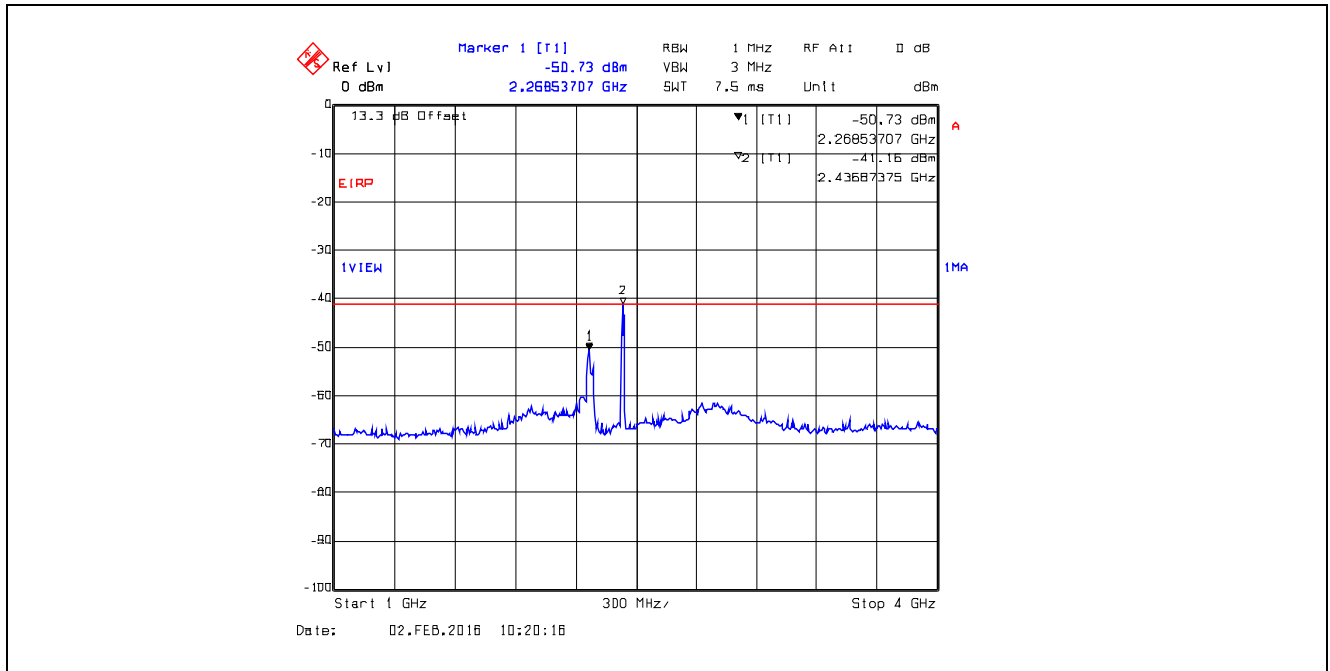Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 23, 9 kHz - 150 kHz, Peak Detector

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**

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Plot 5.4.4.3.7. Conducted Spurious Emissions in Restricted Frequency Bands
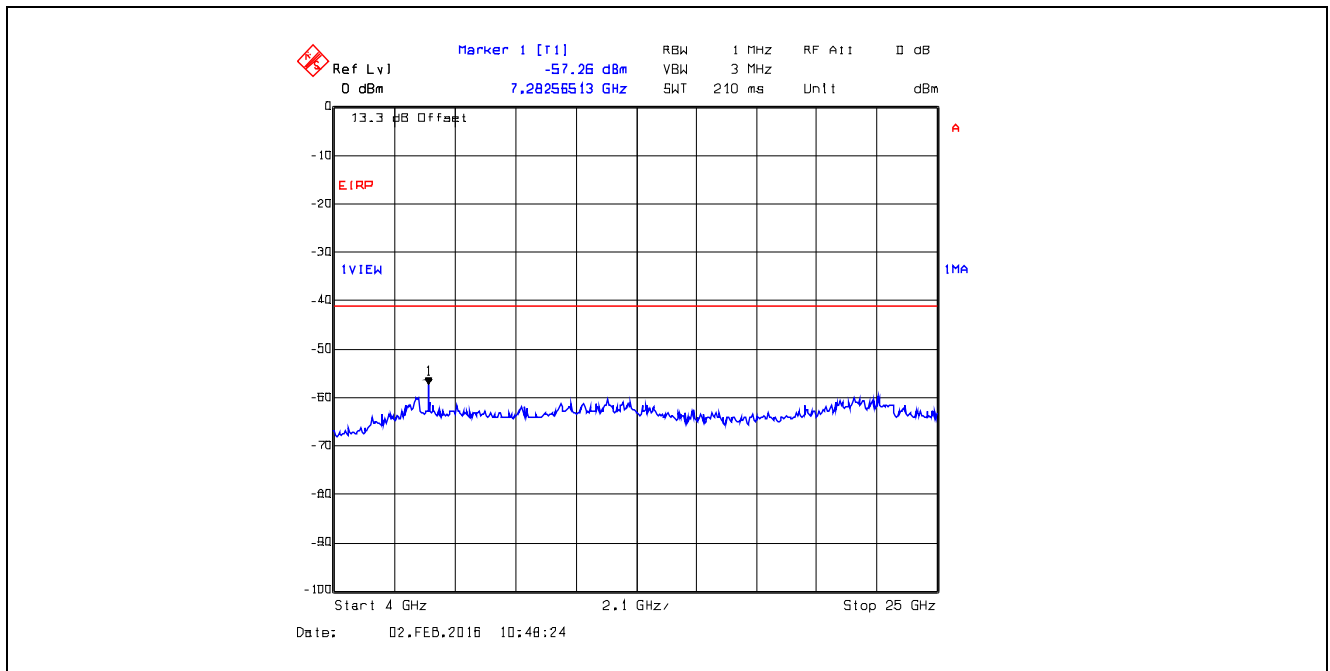Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 23, 150 kHz - 30 MHz, Peak Detector

Plot 5.4.4.3.8. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 23, 30 MHz - 1 GHz, Peak Detector

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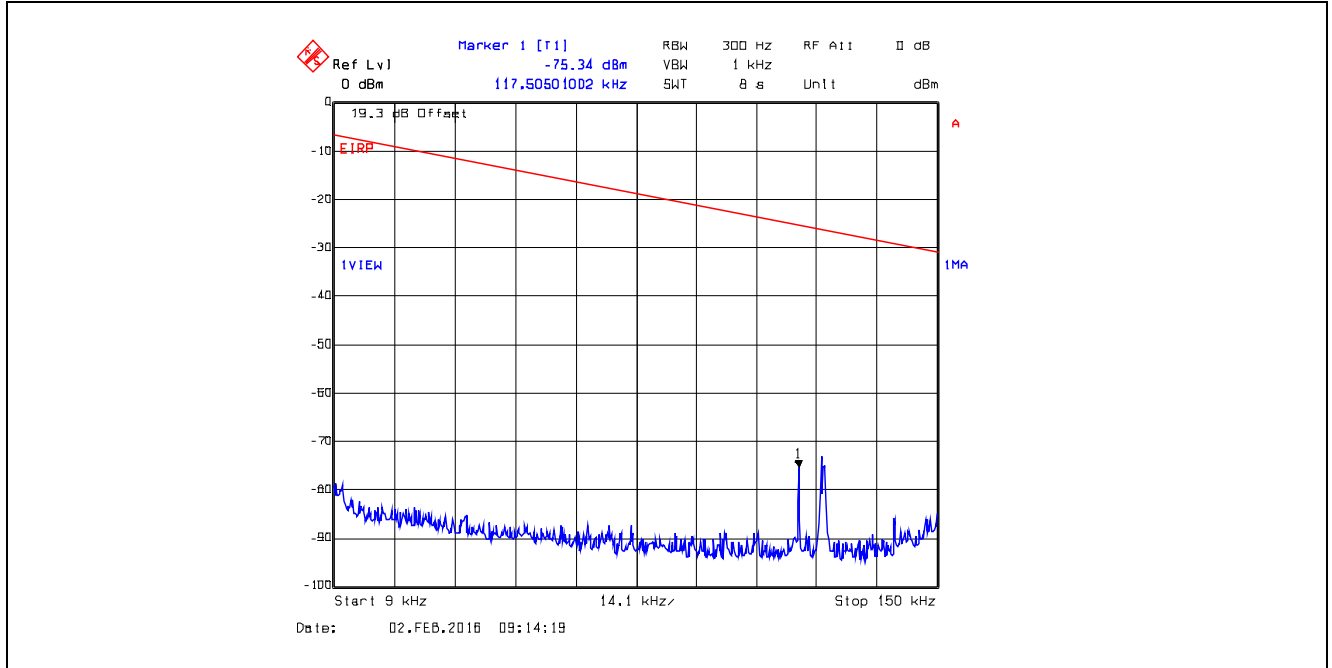
Plot 5.4.4.3.9. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 23, 1 GHz - 4 GHz, Peak Detector
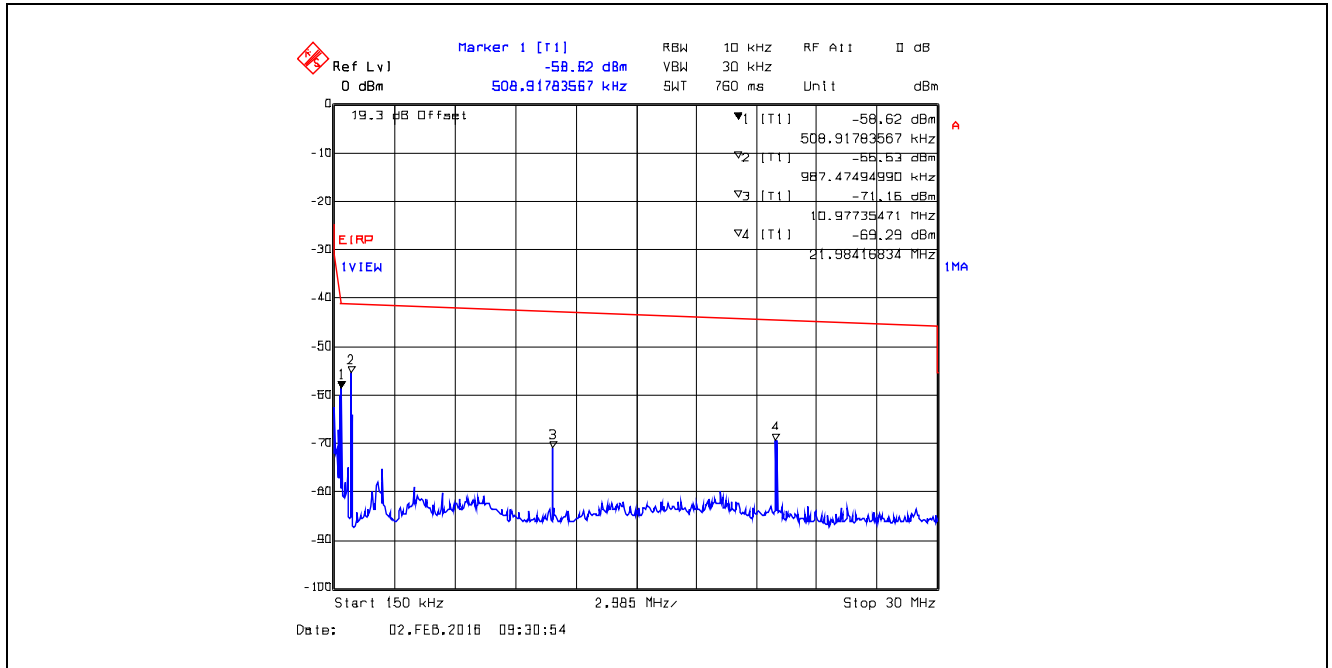

Plot 5.4.4.3.10. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 23, 4 GHz - 25 GHz, Peak Detector

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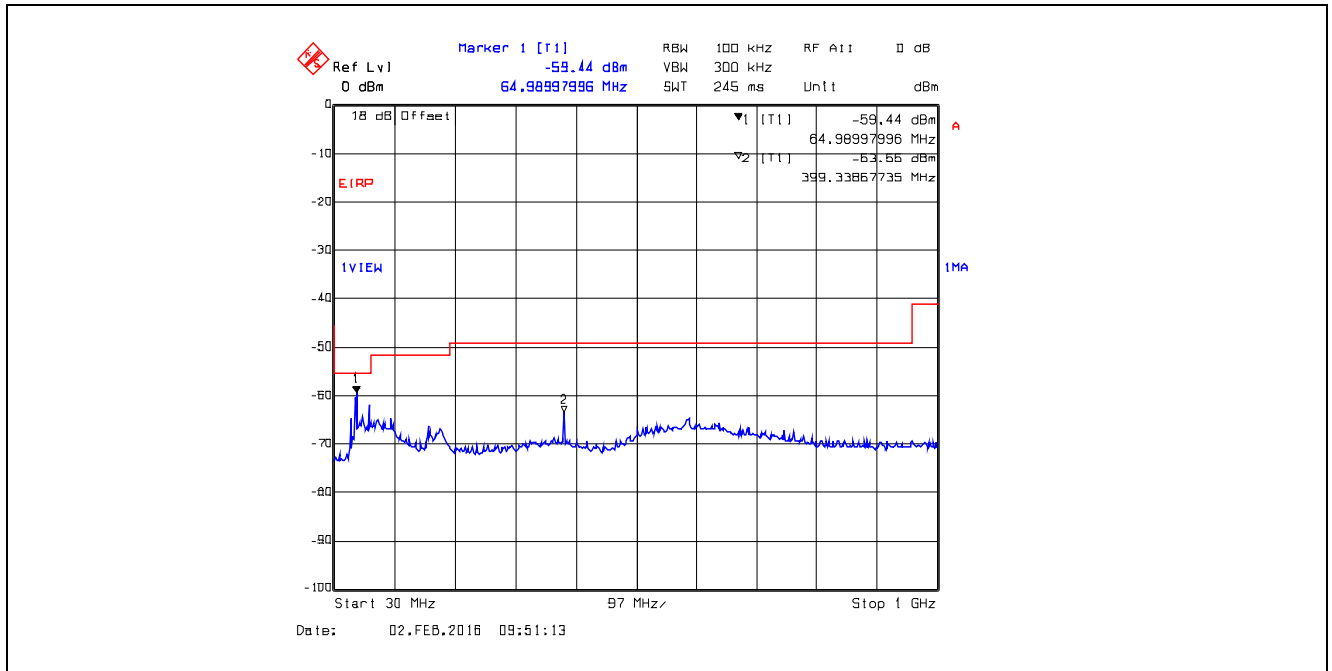
Plot 5.4.4.3.11. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 23, 9 kHz - 150 kHz, Peak Detector

Plot 5.4.4.3.12. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 23, 150 kHz - 30 MHz, Peak Detector

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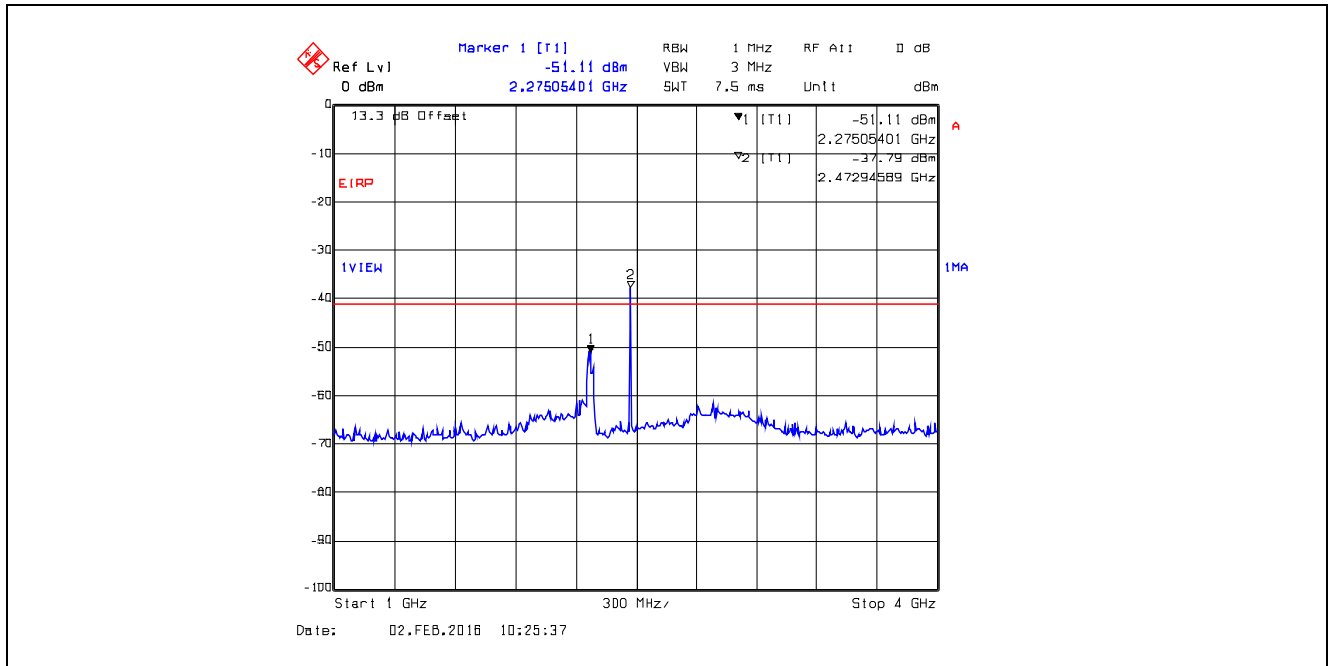
Plot 5.4.4.3.13. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 23, 30 MHz - 1 GHz, Peak Detector
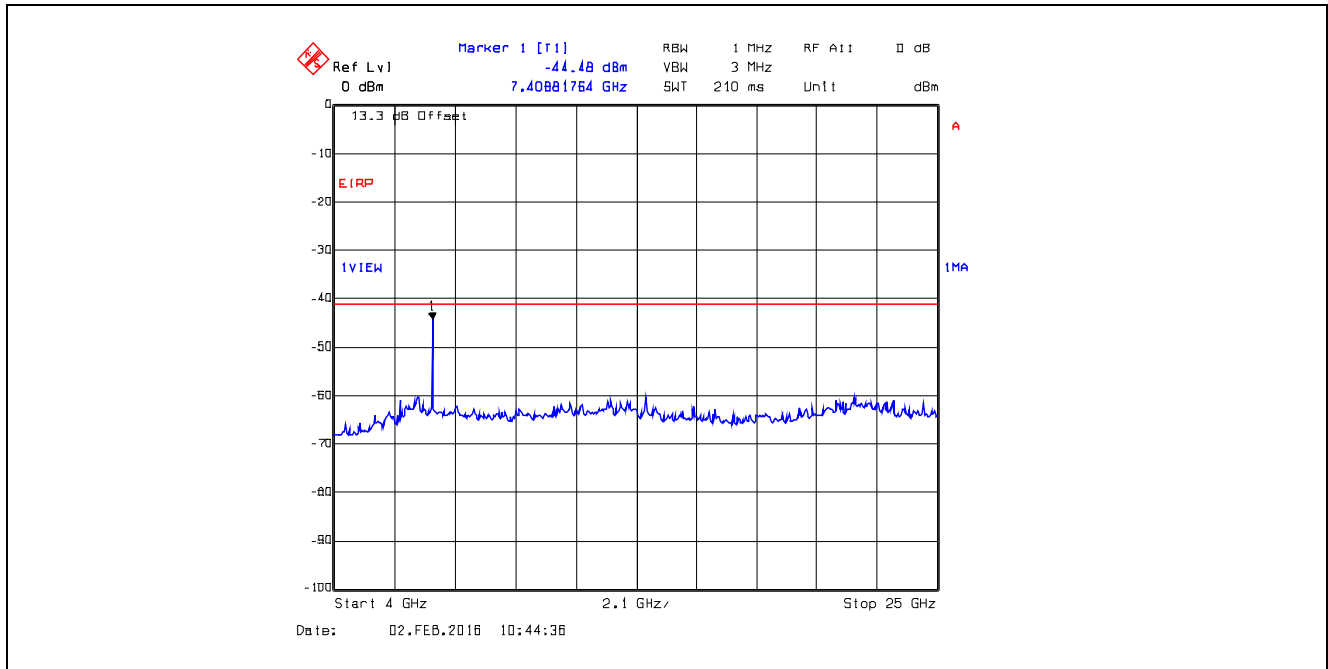

Plot 5.4.4.3.14. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 23, 1 GHz - 4 GHz, Peak Detector
Marker #2 is Fundamental Frequency

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

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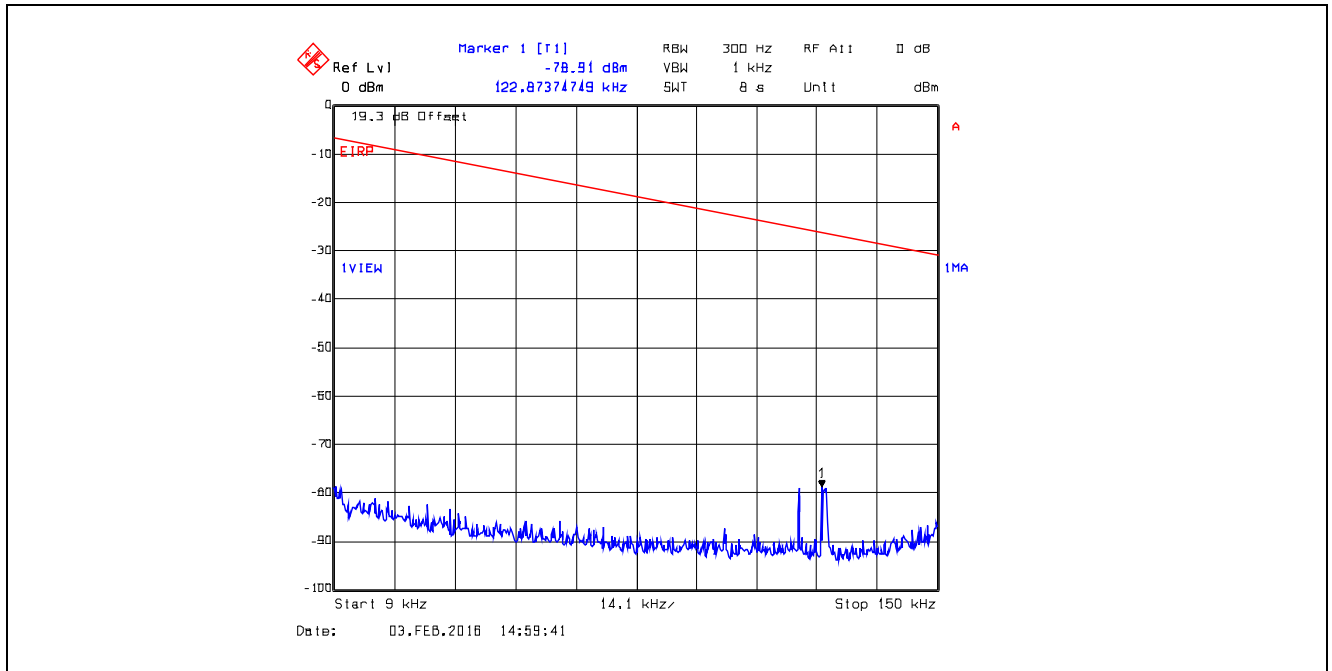
Plot 5.4.4.3.15. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 23, 4 GHz - 25 GHz, Peak Detector

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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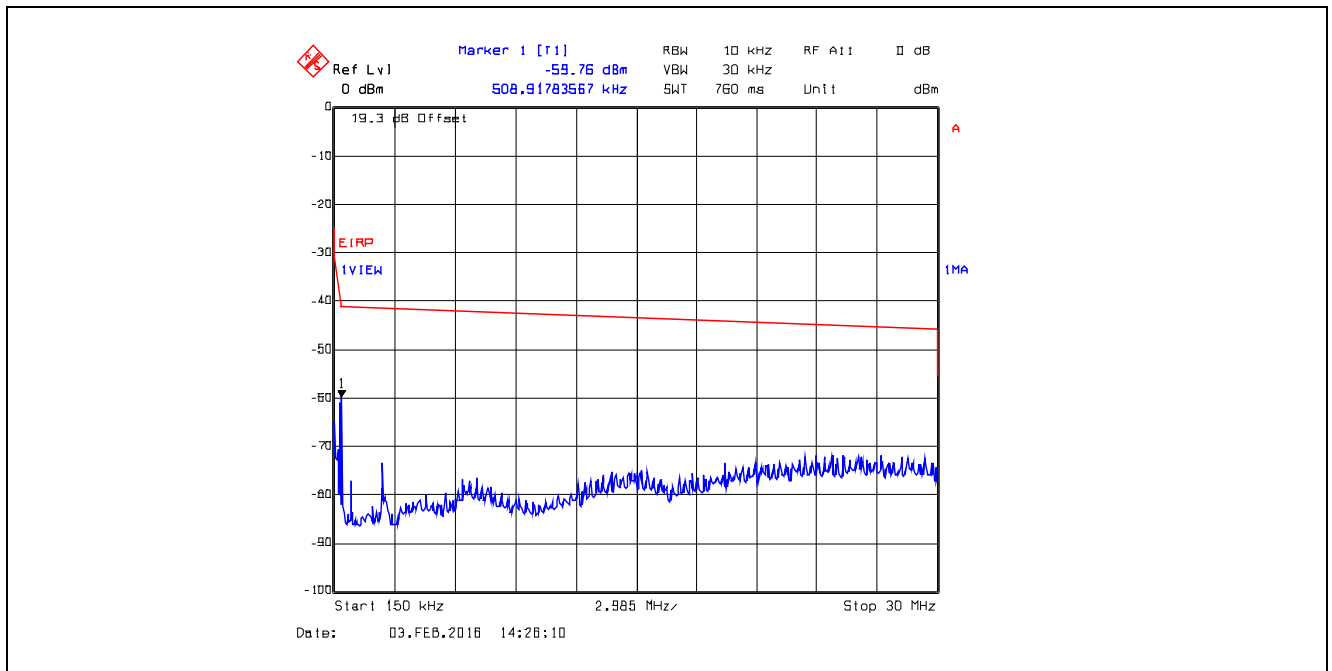
Plot 5.4.4.3.16. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 23, 9 kHz - 150 kHz, Peak Detector
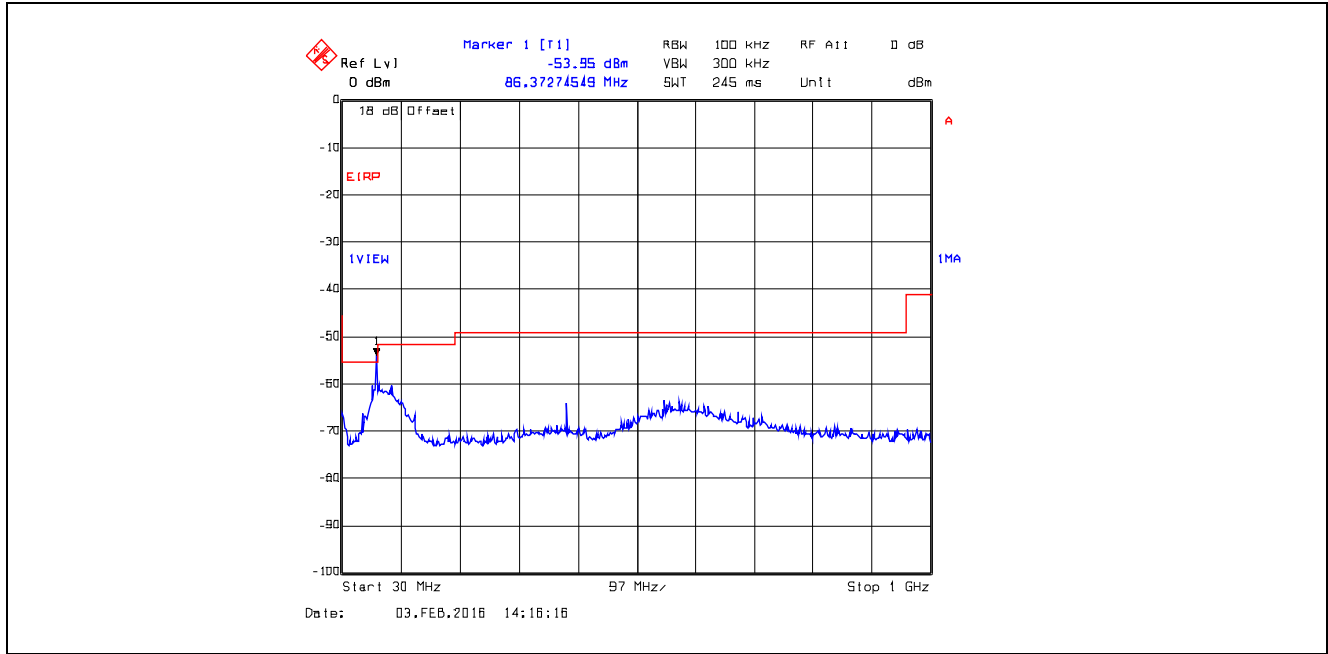

Plot 5.4.4.3.17. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 23, 150 kHz - 30 MHz, Peak Detector

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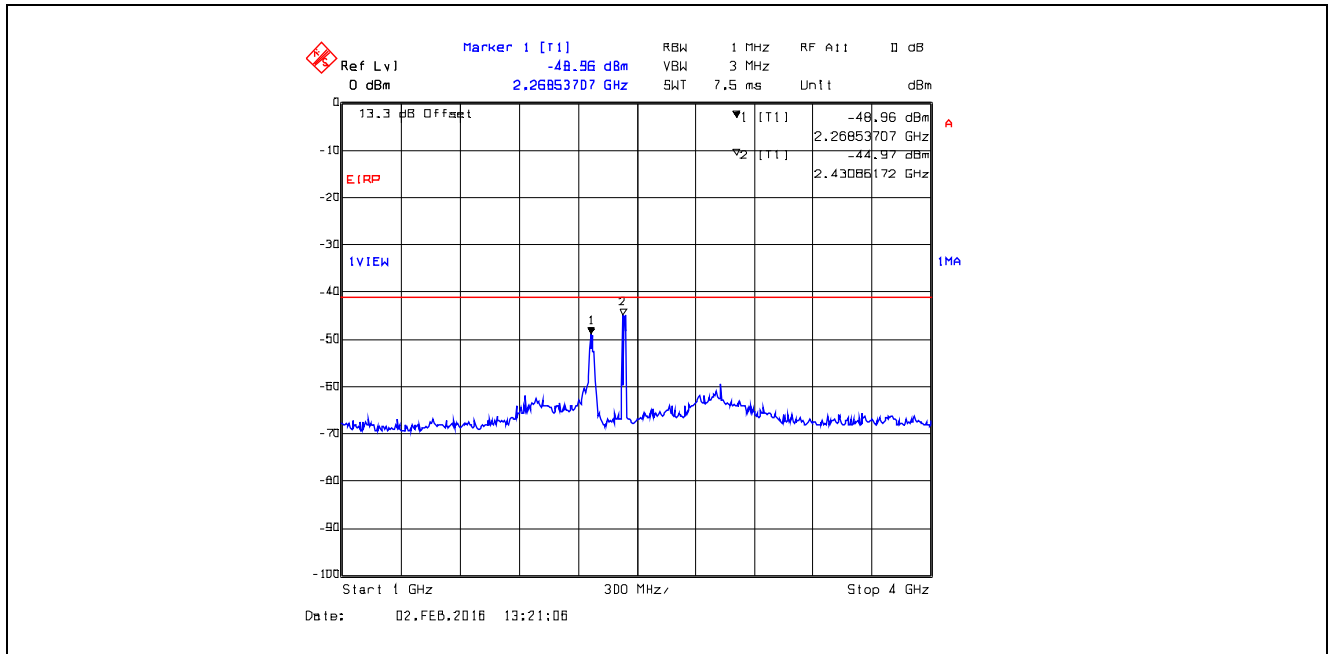
Plot 5.4.4.3.18. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 23, 30 MHz - 1 GHz, Peak Detector
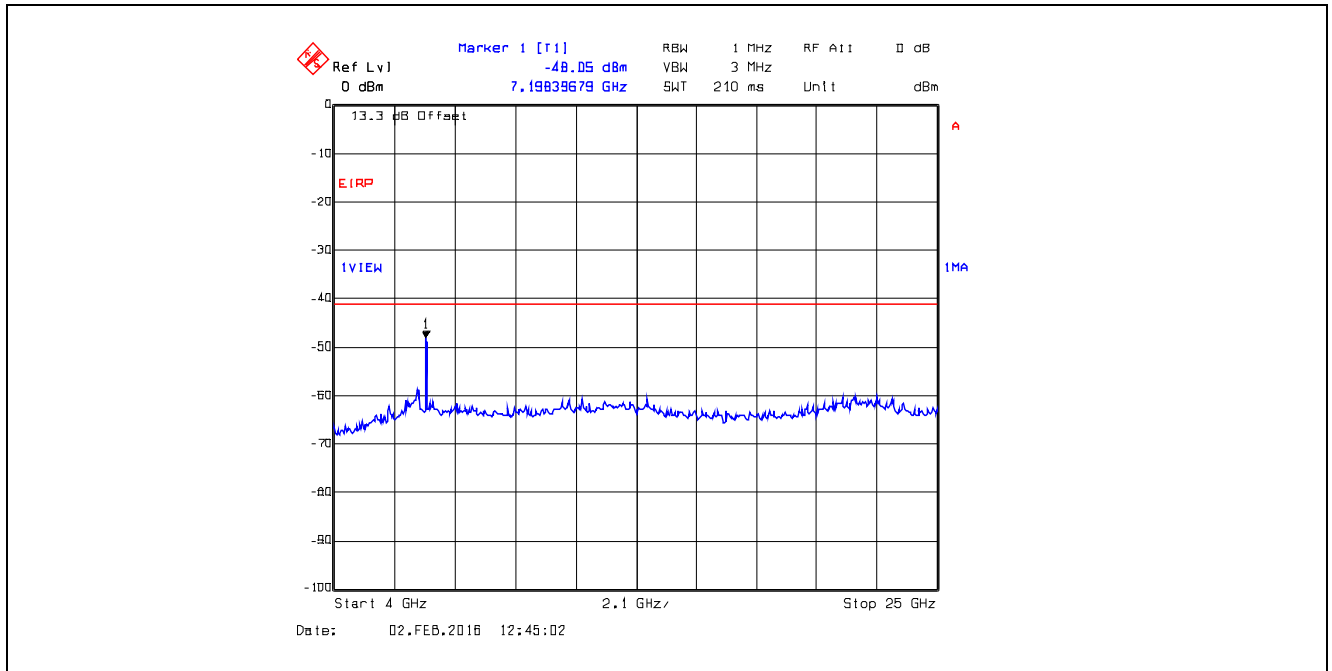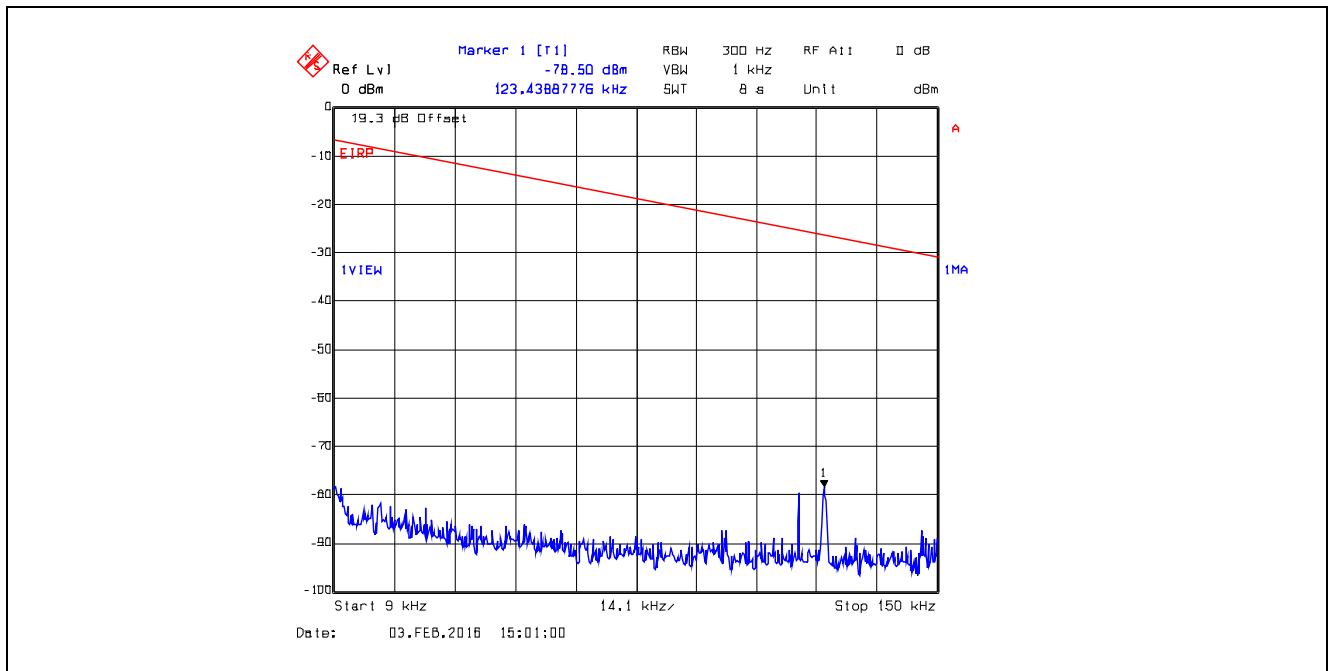Marker 1 is Outside of Restricted Bands

Plot 5.4.4.3.19. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 23, 1 GHz - 4 GHz, Peak Detector

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 5.4.4.3.20. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 23, 4 GHz - 25 GHz, Peak Detector

Plot 5.4.4.3.21. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 23, 9 kHz - 150 kHz, Peak Detector

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File #: 16MCRS085_FCC15C247DTS

April 13, 2016

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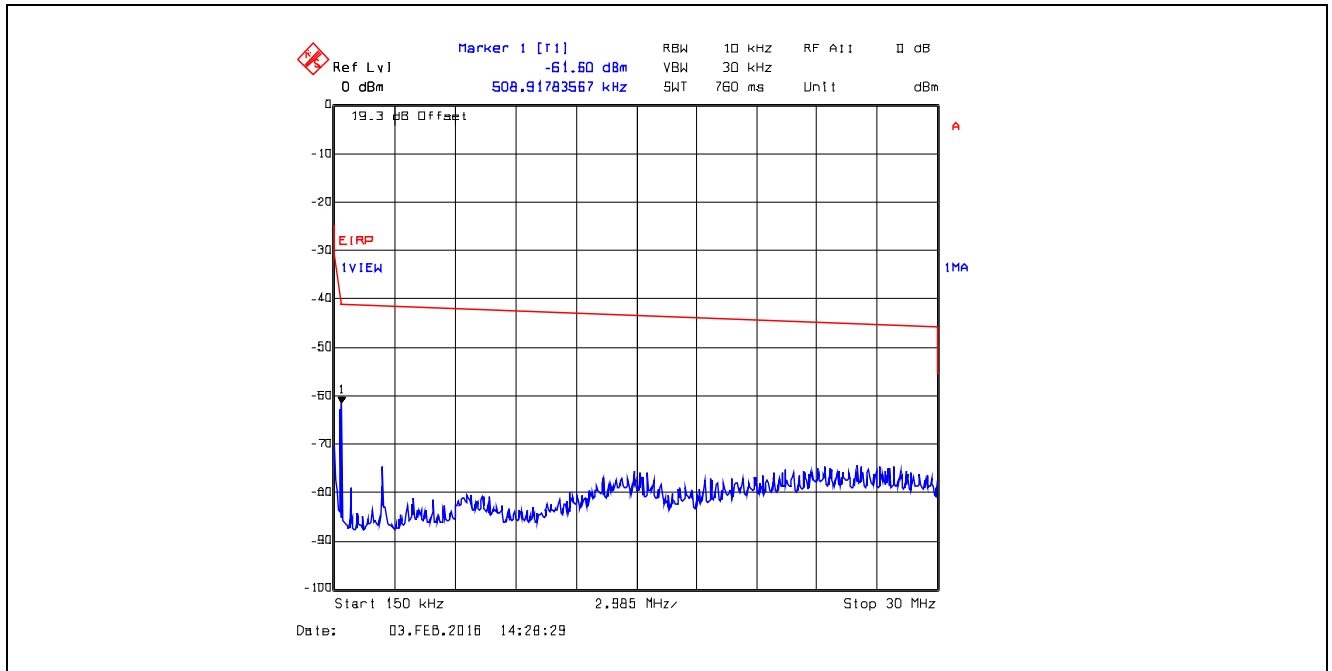
Plot 5.4.4.3.22. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 23, 150 kHz - 30 MHz, Peak Detector
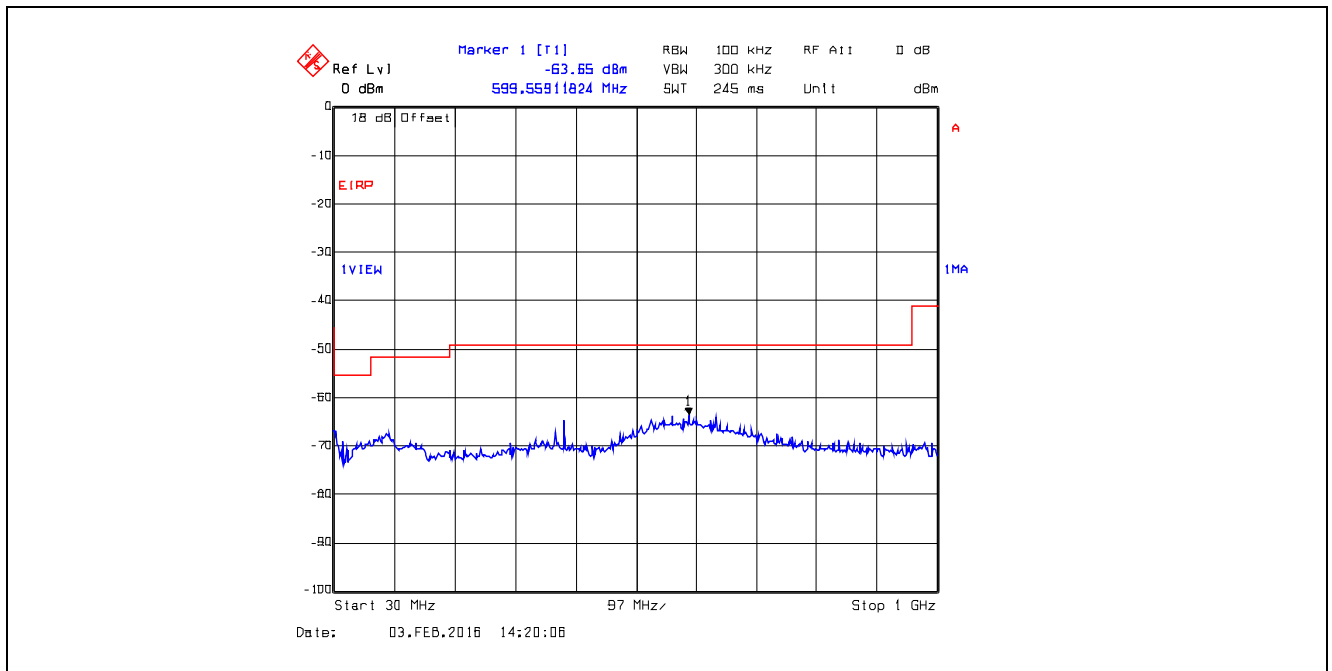

Plot 5.4.4.3.23. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 23, 30 MHz - 1 GHz, Peak Detector

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File #: 16MCRS085_FCC15C247DTS

April 13, 2016

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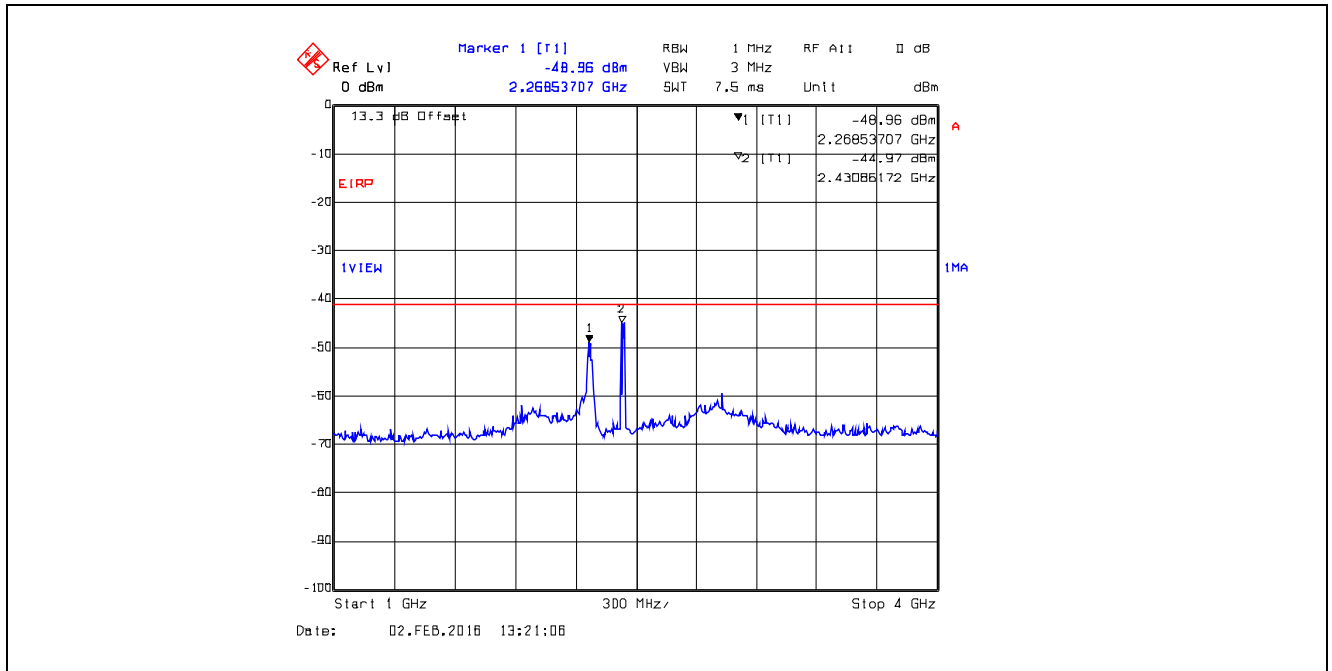
Plot 5.4.4.3.24. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 23, 1 GHz - 4 GHz, Peak Detector

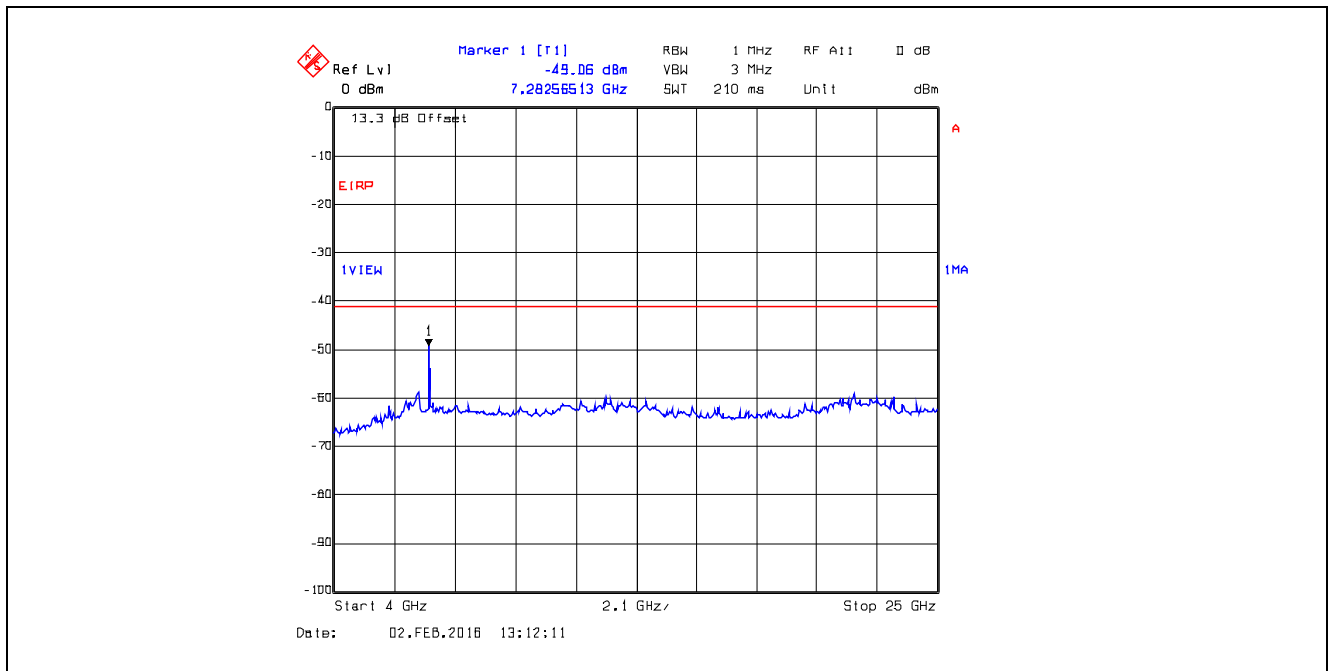

Plot 5.4.4.3.25. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 23, 4 GHz - 25 GHz, Peak Detector

ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
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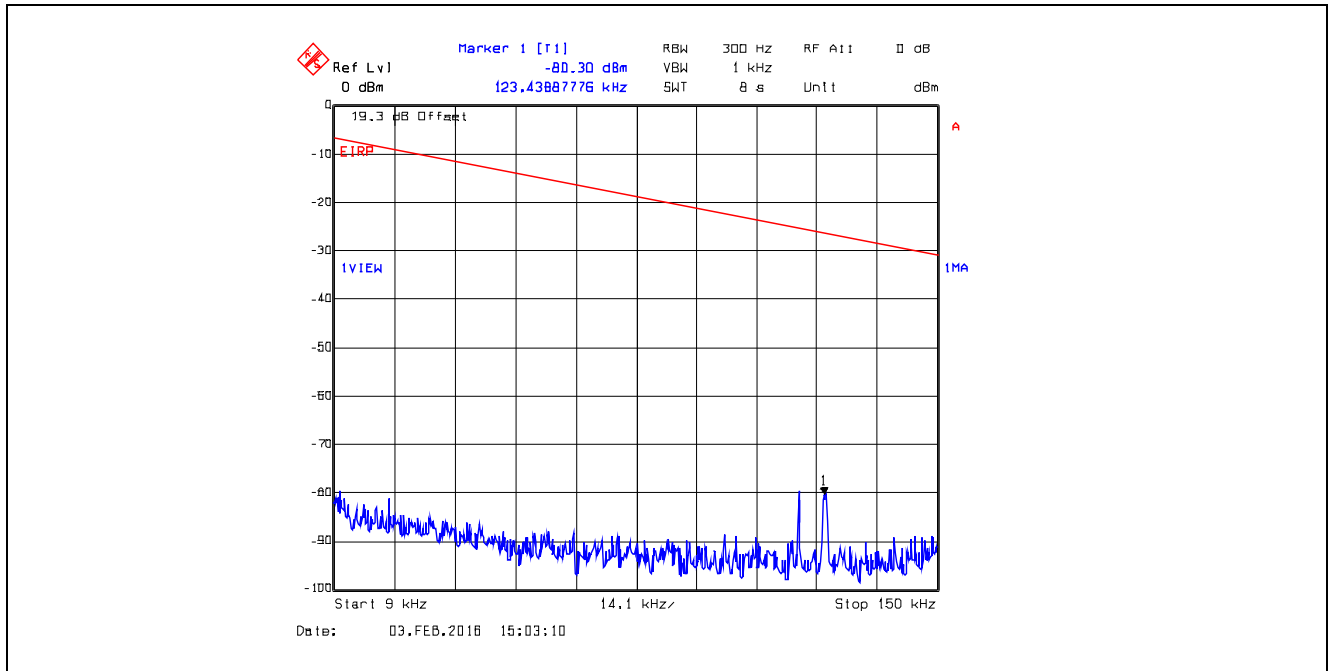
Plot 5.4.4.3.26. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 23, 9 kHz - 150 kHz, Peak Detector
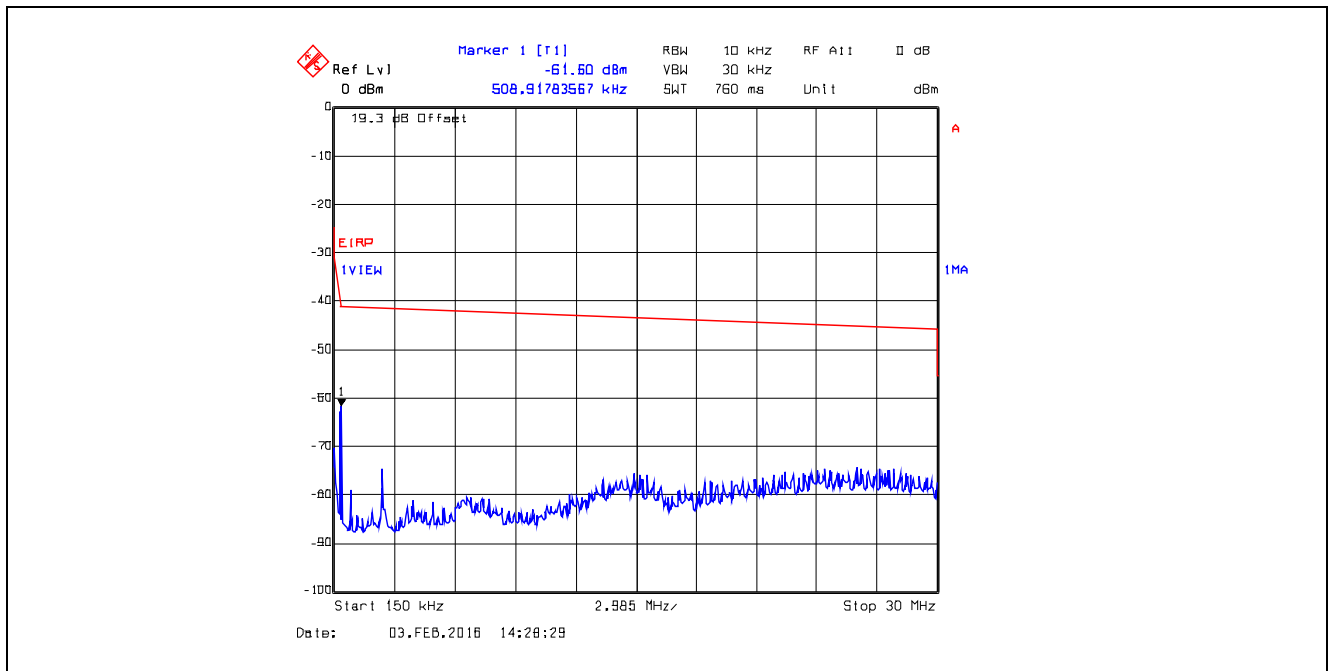

Plot 5.4.4.3.27. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 23, 150 kHz - 30 MHz, Peak Detector

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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Plot 5.4.4.3.28. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 23, 30 MHz - 1 GHz, Peak Detector

Plot 5.4.4.3.29. Conducted Spurious Emissions in Restricted Frequency Bands
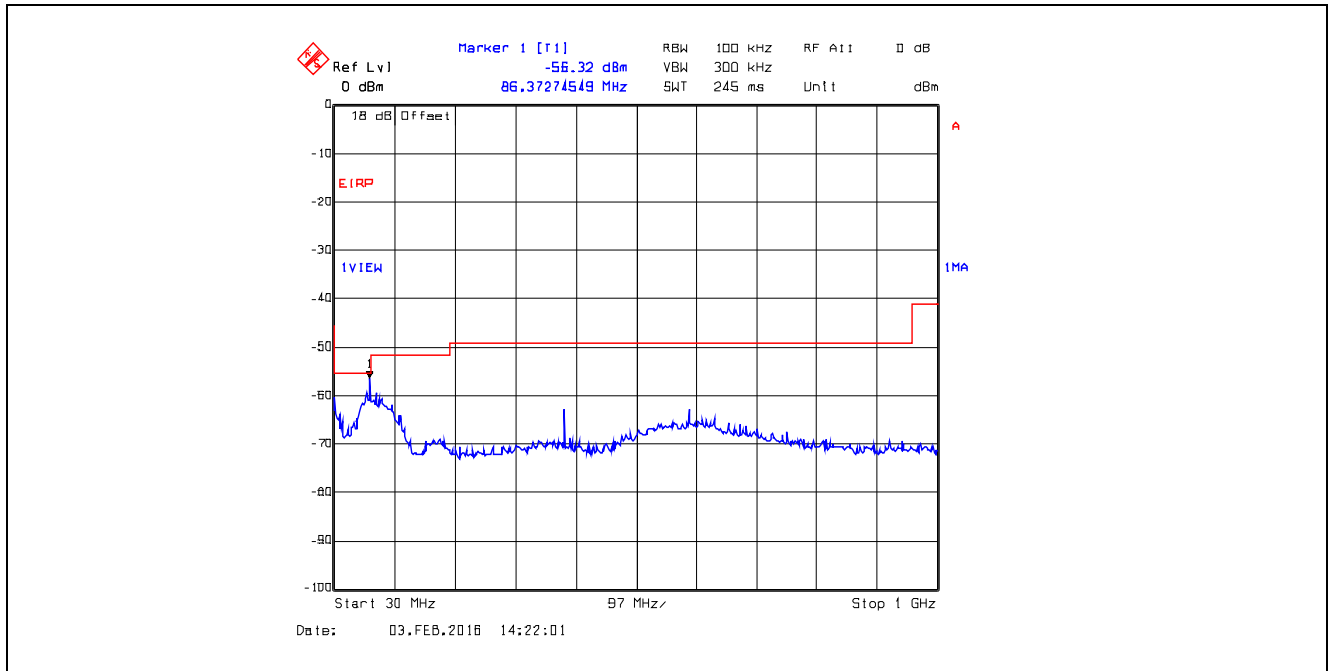Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 23, 1 GHz - 4 GHz, Peak Detector
Marker 2 is Fundamental Frequency

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)
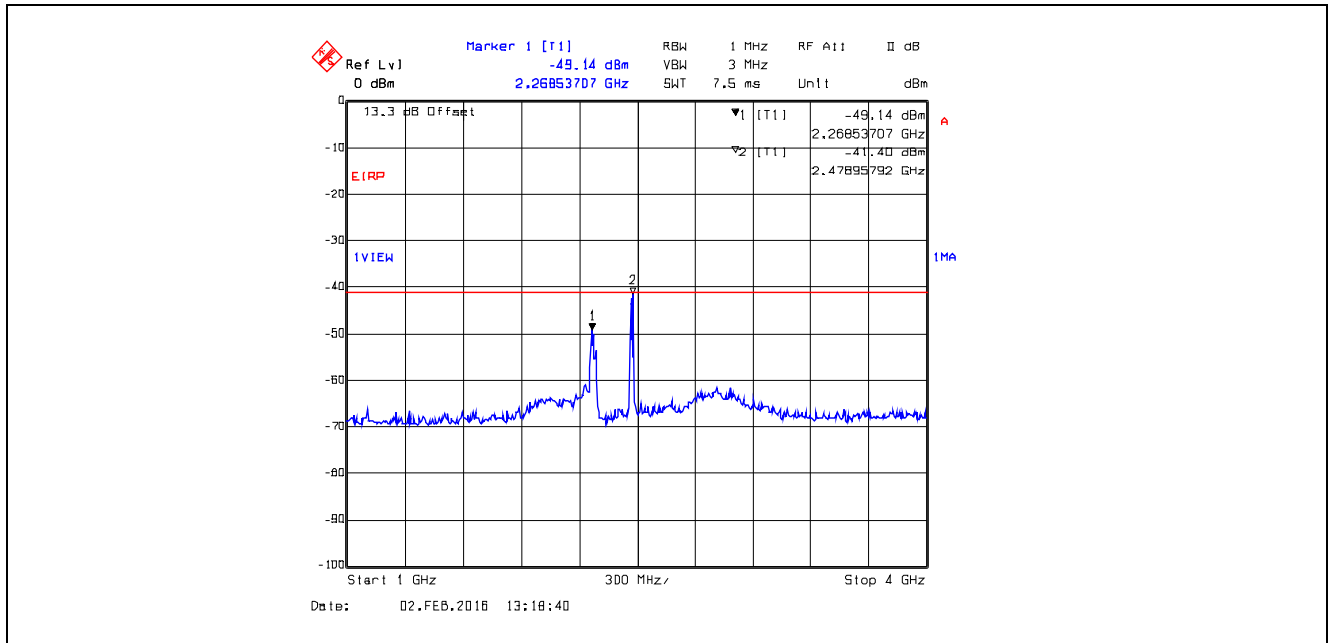
Plot 5.4.4.3.30. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 23, 4 GHz - 25 GHz, Peak Detector

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.4.4.4. Conducted Spurious Emissions in Restricted Frequency Bands, Lower Power Setting for Highest Gain Antenna (15 dBi)

Remark: Offset = [Insertion Loss] + [Transmit Antenna Gain (in dBi)] + [Maximum Ground Reflection Factor]

Plot 5.4.4.4.1. Conducted Spurious Emissions in Restricted Frequency Bands
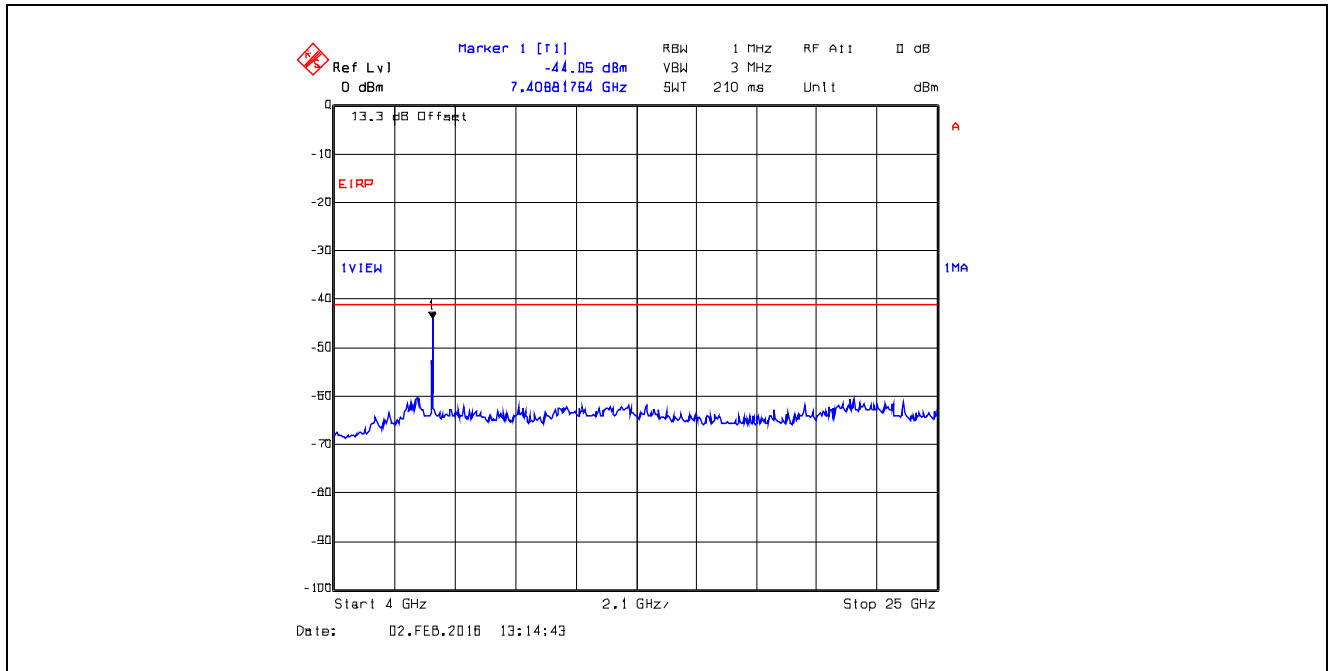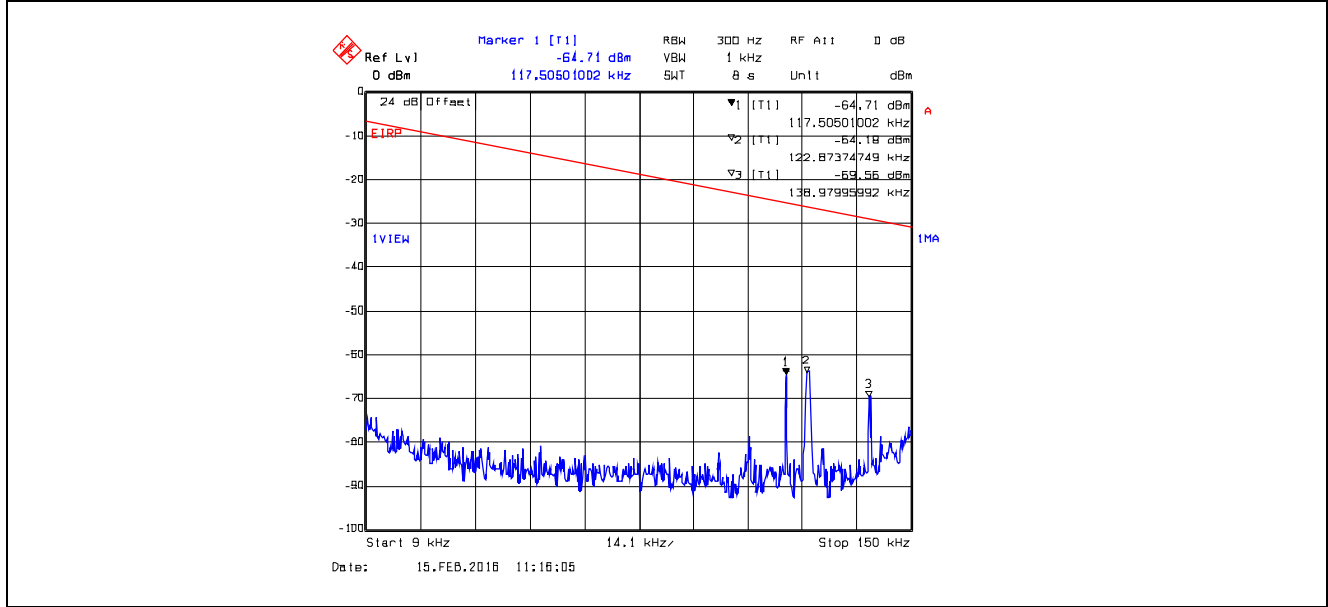Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 2, 9 kHz - 150 kHz, Peak Detector

Plot 5.4.4.4.2. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 2, 150 kHz - 30 MHz, Peak Detector

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Plot 5.4.4.4.3. Conducted Spurious Emissions in Restricted Frequency Bands
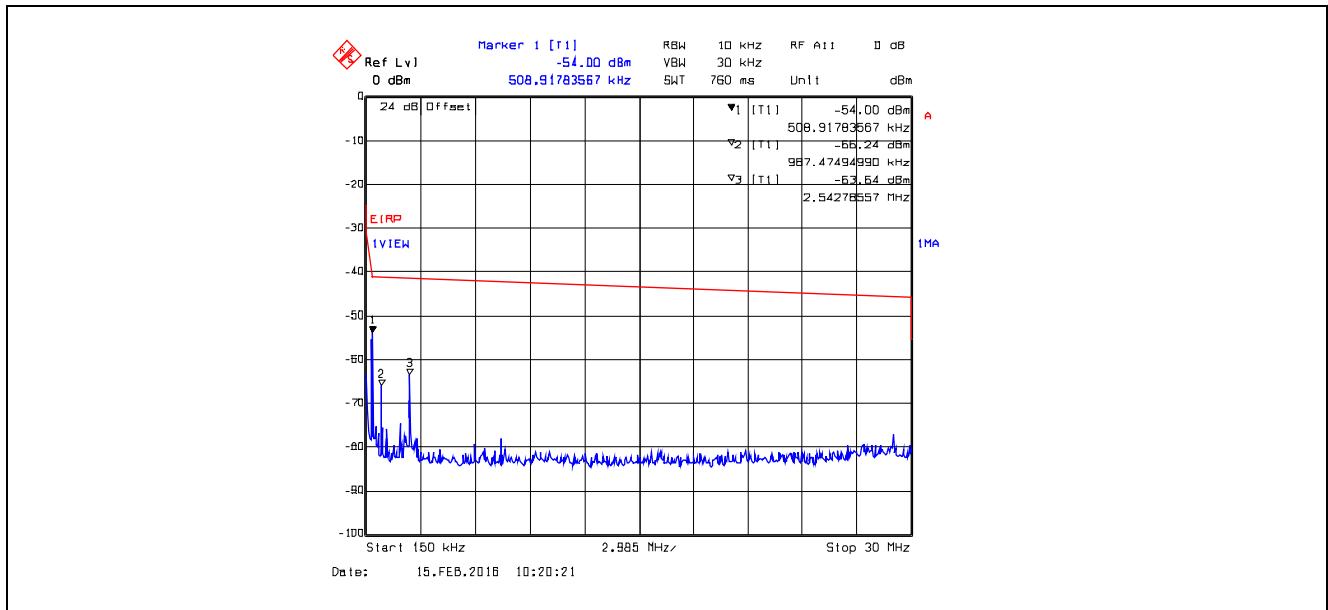Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 2, 30 MHz - 1 GHz, Peak Detector

Plot 5.4.4.4.4. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 2, 74.8-75.2 MHz, Quasi-Peak Detector

ULTRATECH GROUP OF LABS
File #: 16MCRS085_FCC15C247DTS
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April 13, 2016
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Plot 5.4.4.4.5. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 2, 1 GHz - 4 GHz, Peak Detector

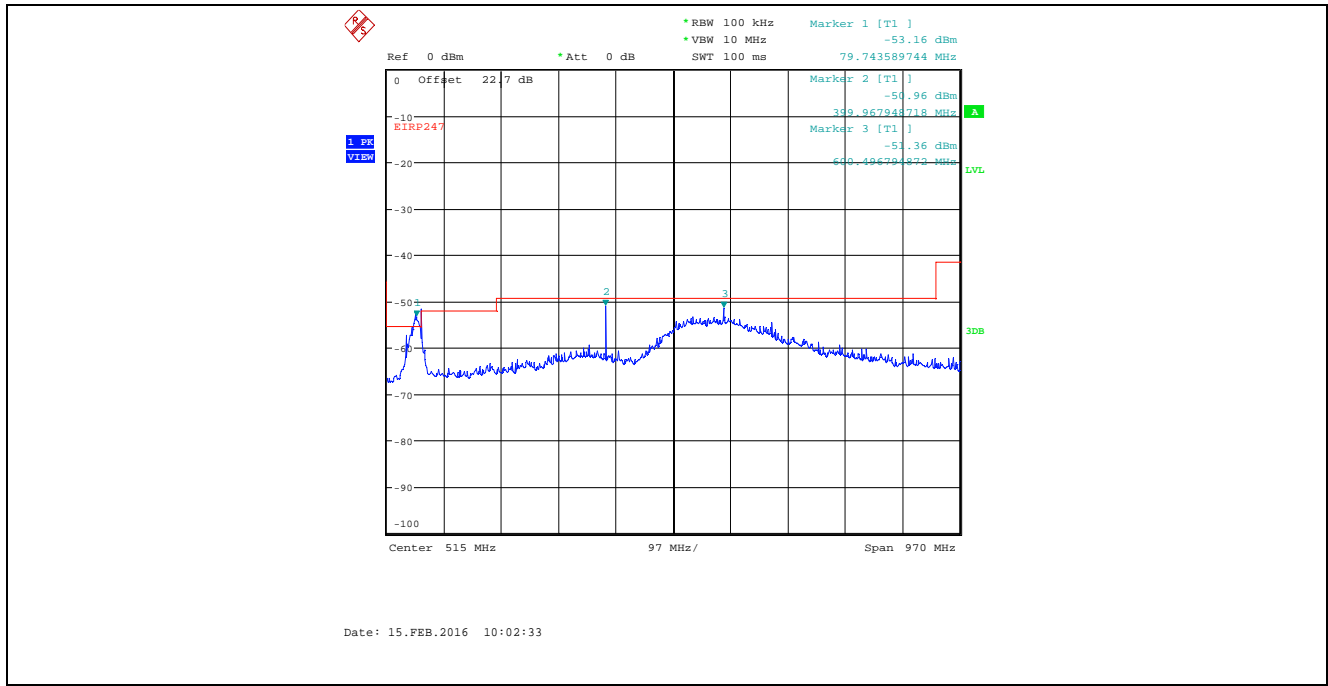

Plot 5.4.4.4.6. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 3, TX Gain Setting 2, 4 GHz - 25 GHz, Peak Detector

ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.4.4.4.7. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 2, 9 kHz - 150 kHz, Peak Detector
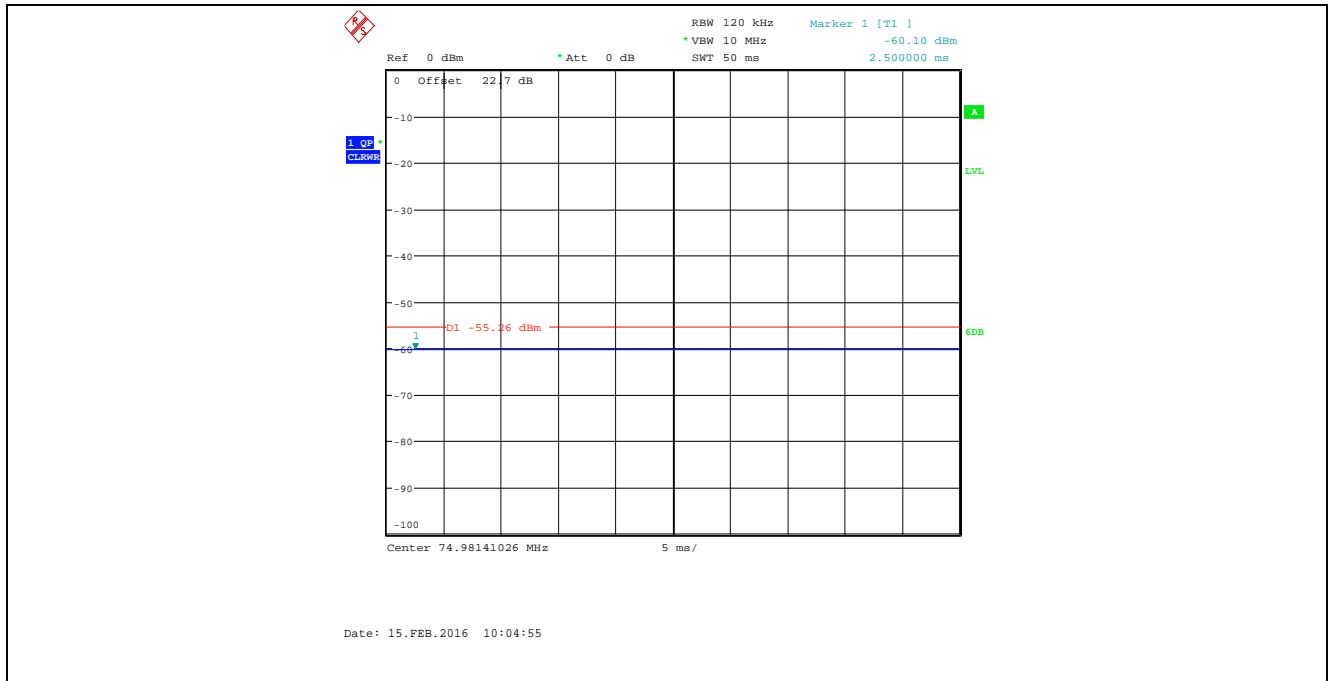

Plot 5.4.4.4.8. Conducted Spurious Emissions in Restricted Frequency Bands
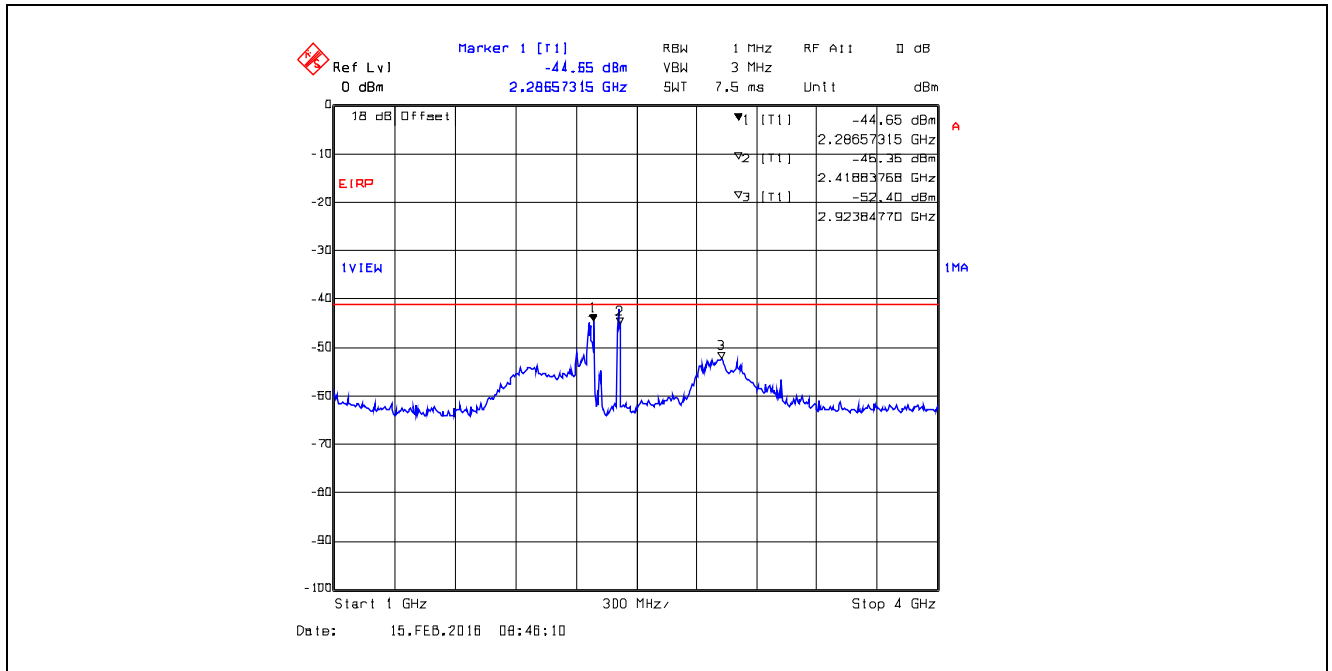Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 2, 150 kHz - 30 MHz, Peak Detector

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

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Plot 5.4.4.4.9. Conducted Spurious Emissions in Restricted Frequency Bands
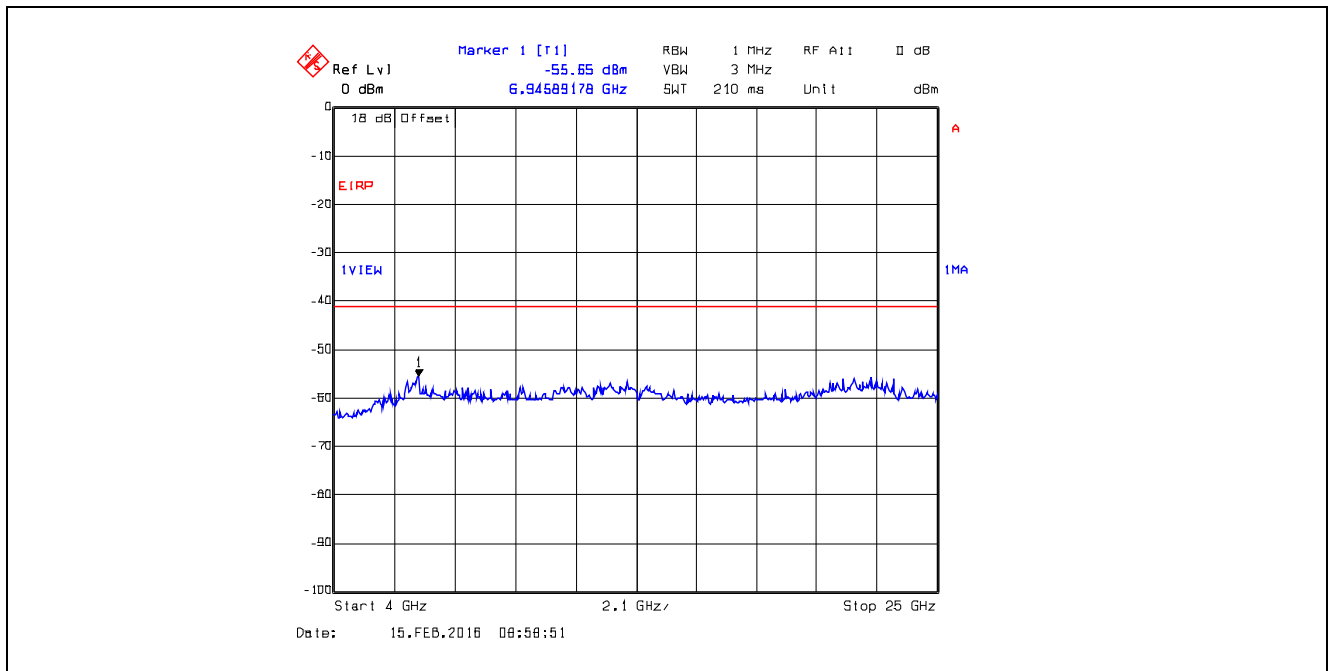Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 2, 30 MHz - 1 GHz, Peak Detector

Plot 5.4.4.4.10. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 2, 1 GHz - 4 GHz, Peak Detector

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)
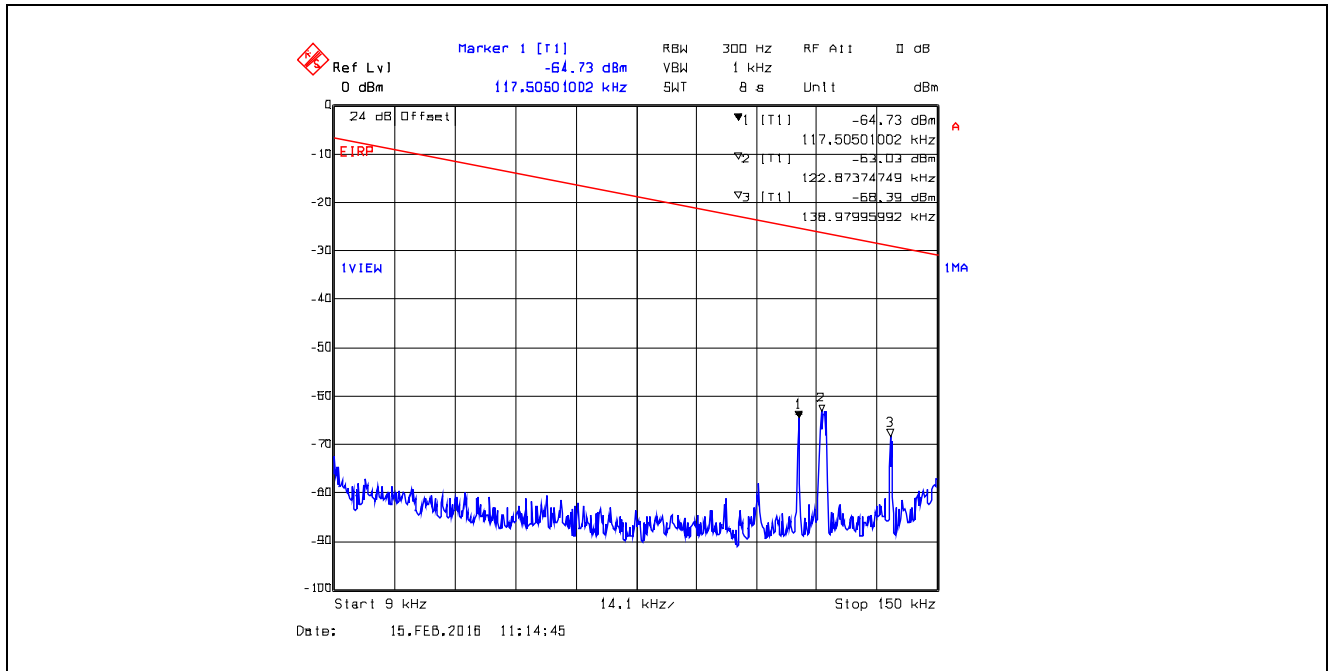
Plot 5.4.4.4.11. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 3, TX Gain Setting 2, 4 GHz - 25 GHz, Peak Detector
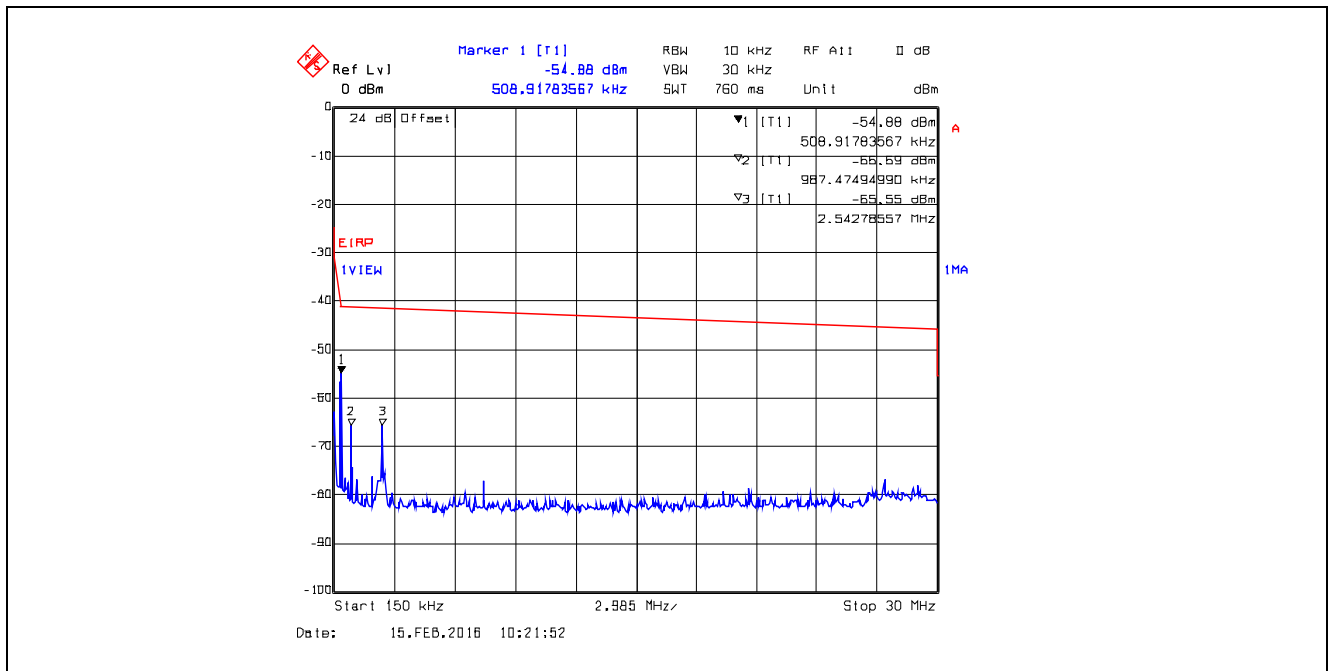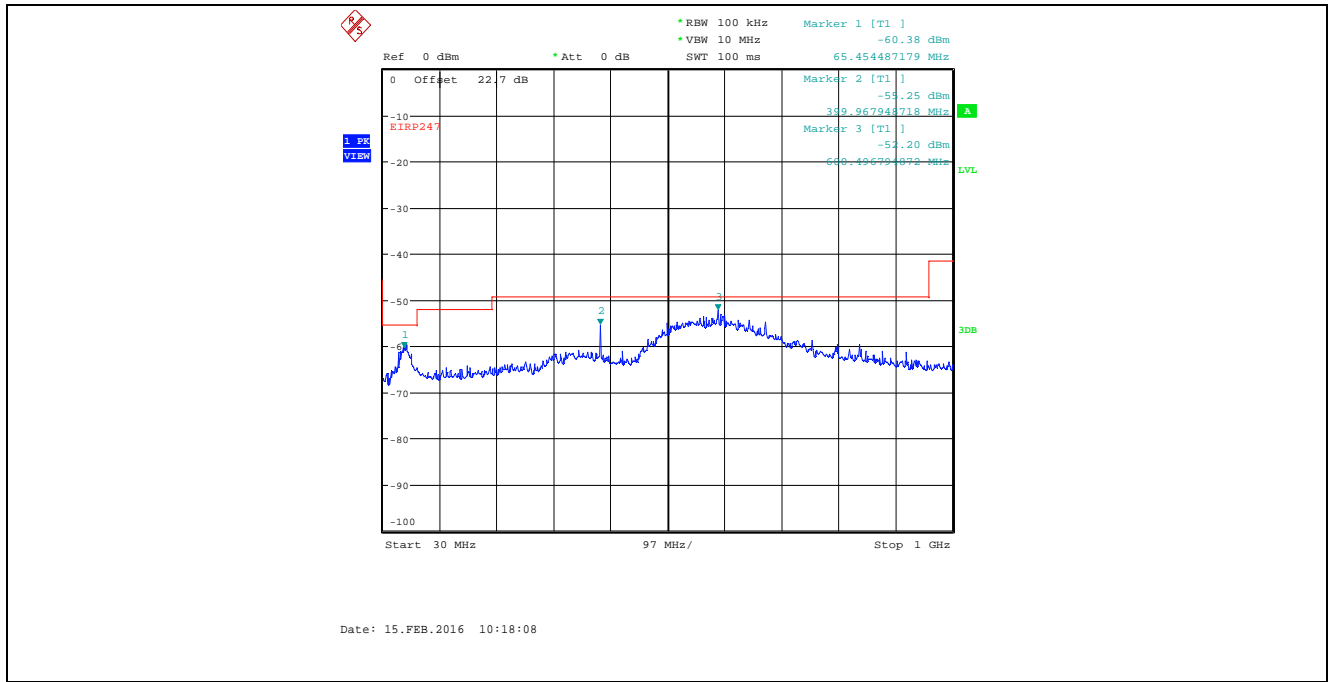

Plot 5.4.4.4.12. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 2, 9 kHz - 150 kHz, Peak Detector

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

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File #: 16MCRS085_FCC15C247DTS

April 13, 2016

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 5.4.4.4.13. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 2, 150 kHz - 30 MHz, Peak Detector
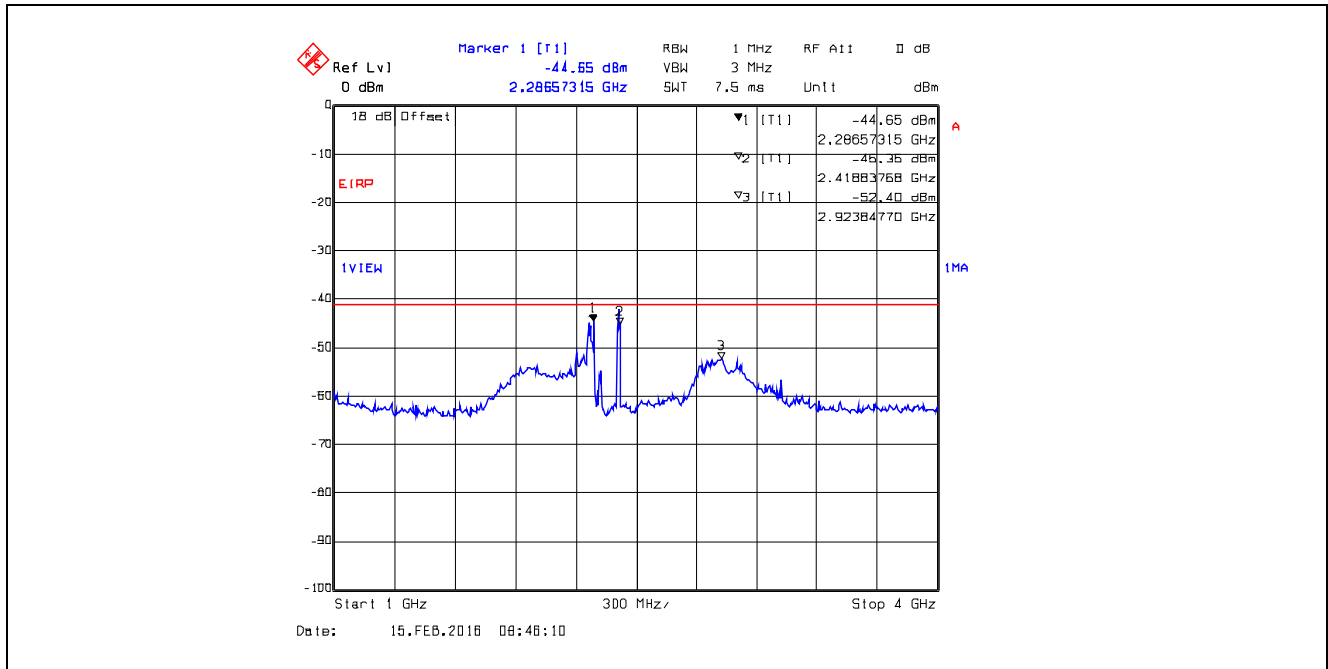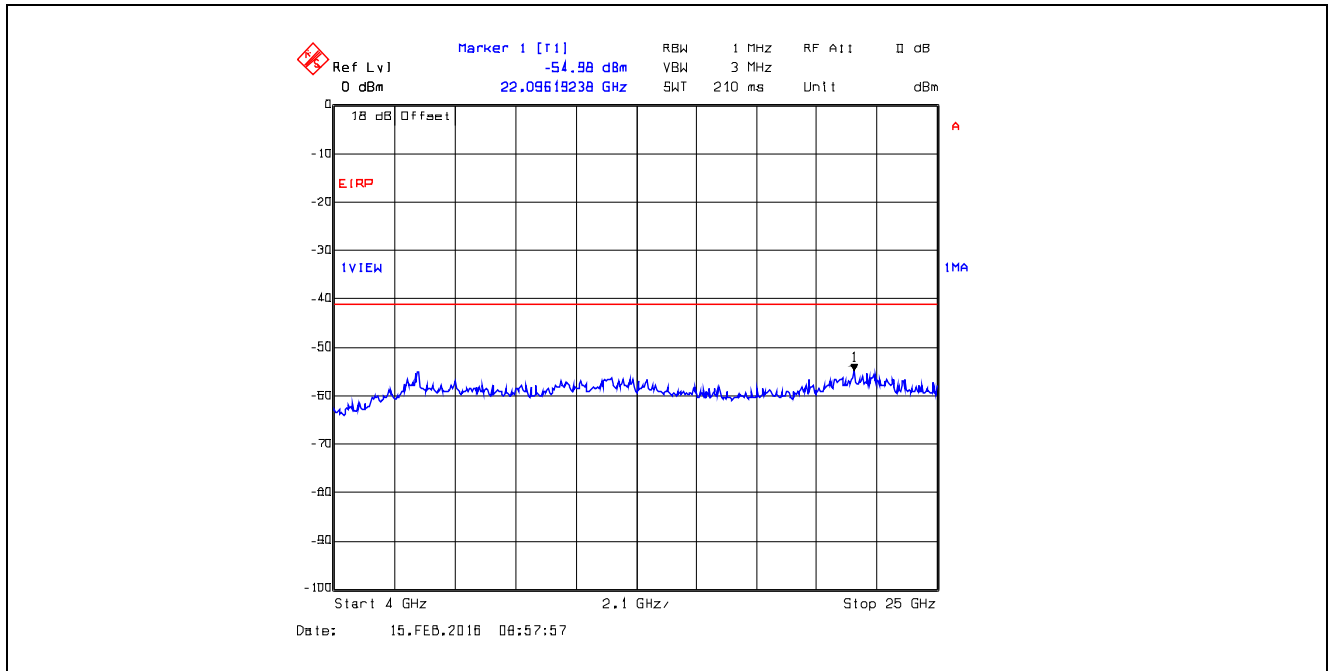

Plot 5.4.4.4.14. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 2, 30 MHz - 1 GHz, Peak Detector

ULTRATECH GROUP OF LABS

File #: 16MCRS085_FCC15C247DTS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

April 13, 2016

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.4.4.4.15. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 2, 74.8-75.2 MHz, Quasi-Peak Detector
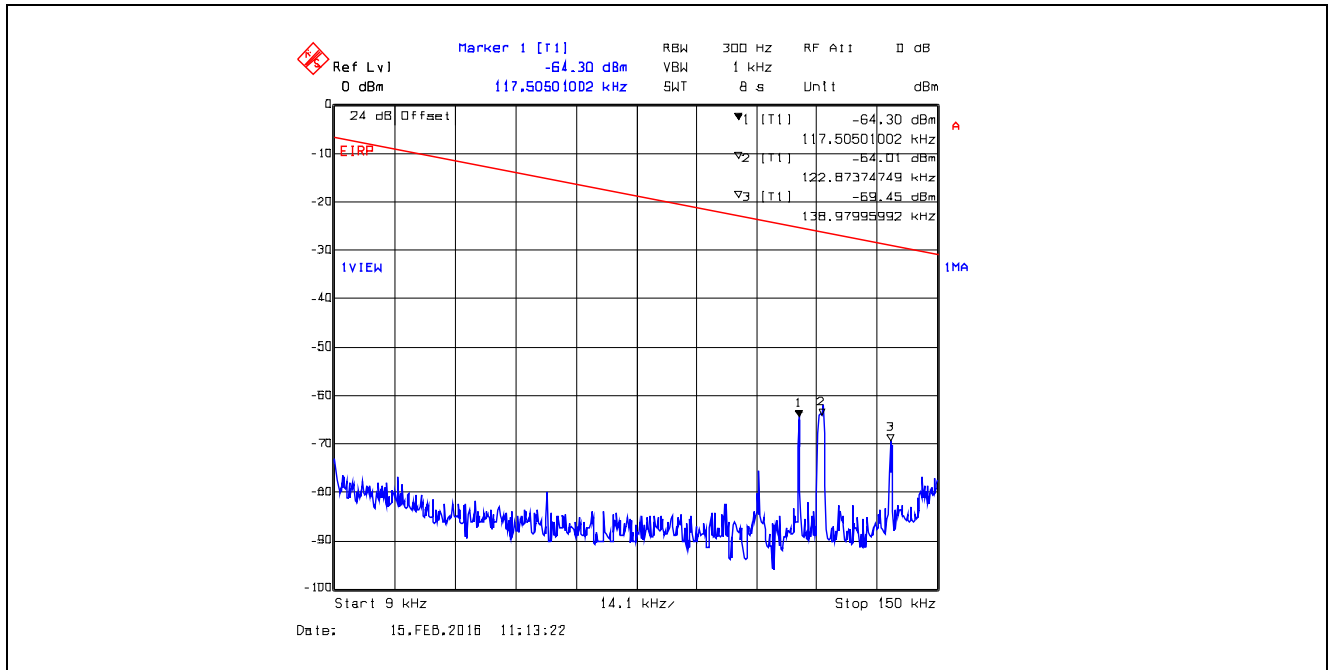

Plot 5.4.4.4.16. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 2, 1 GHz - 4 GHz, Peak Detector
Marker # 2 is fundamental frequency

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)
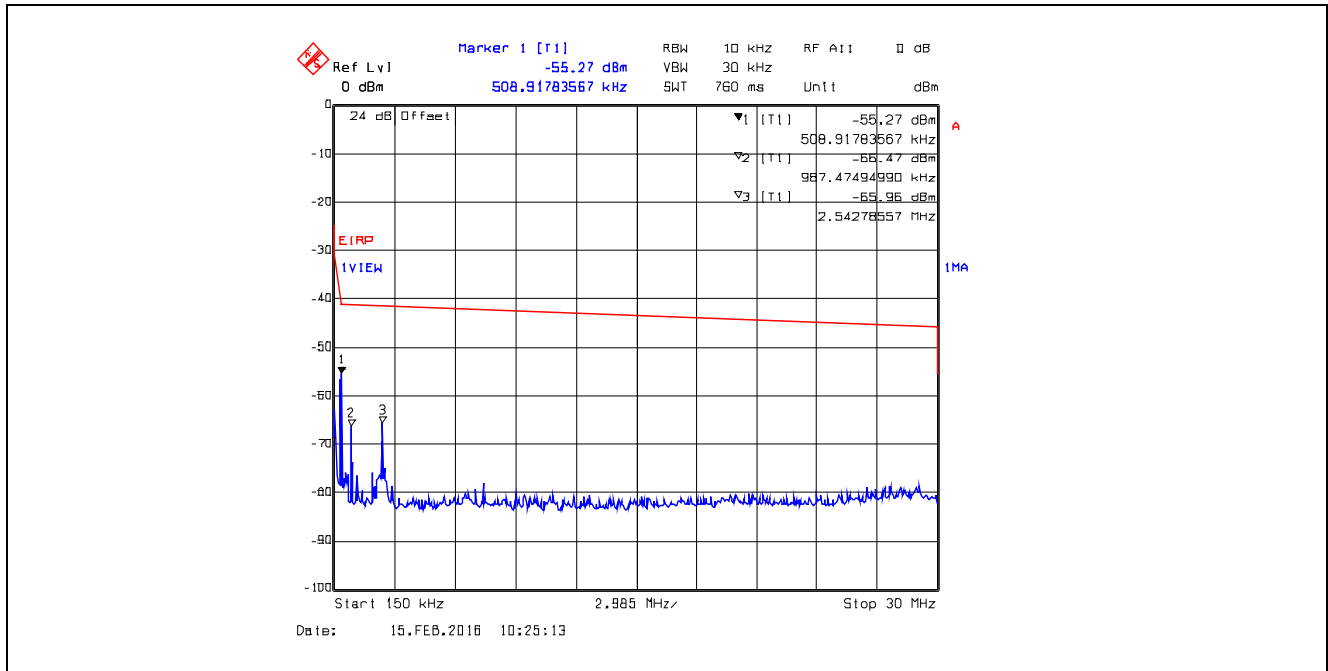
Plot 5.4.4.4.17. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 3, TX Gain Setting 2, 4 GHz - 25 GHz, Peak Detector

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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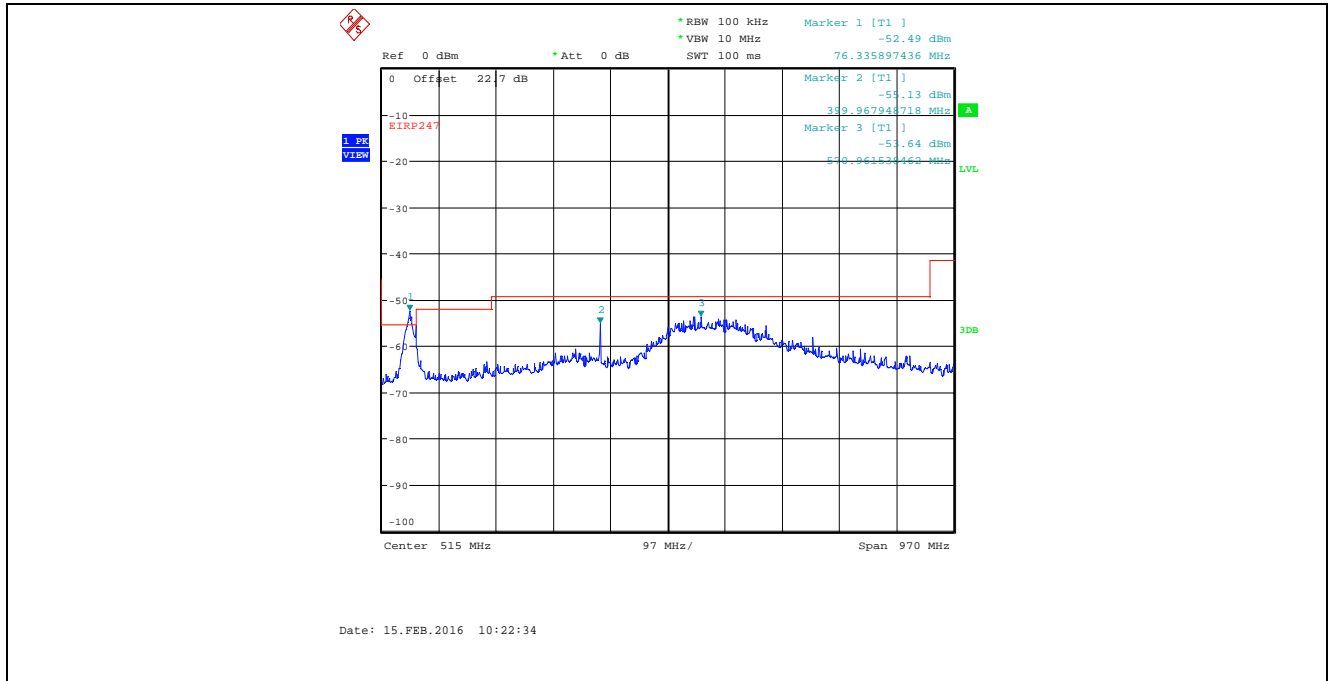
Plot 5.4.4.4.18. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 2, 9 kHz - 150 kHz, Peak Detector
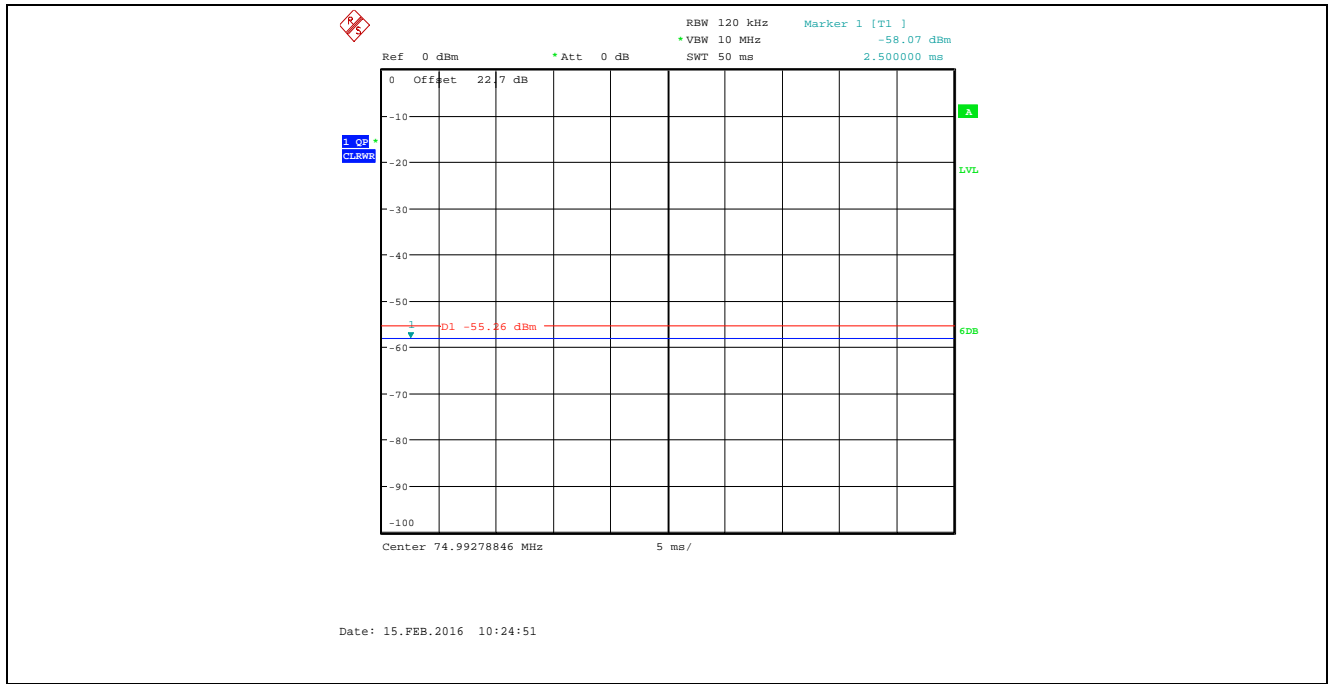

Plot 5.4.4.4.19. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 2, 150 kHz - 30 MHz, Peak Detector

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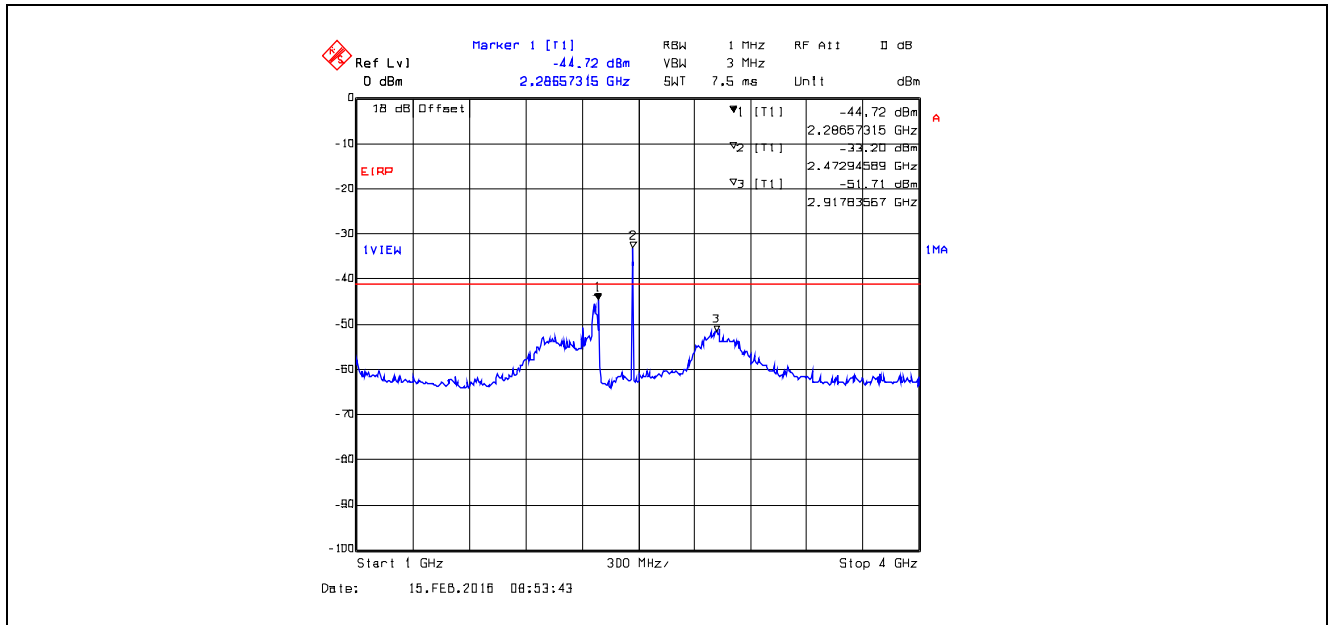
Plot 5.4.4.4.20. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 2, 30 MHz - 1 GHz, Peak Detector

Plot 5.4.4.4.21. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 2, 1 GHz - 4 GHz, Peak Detector

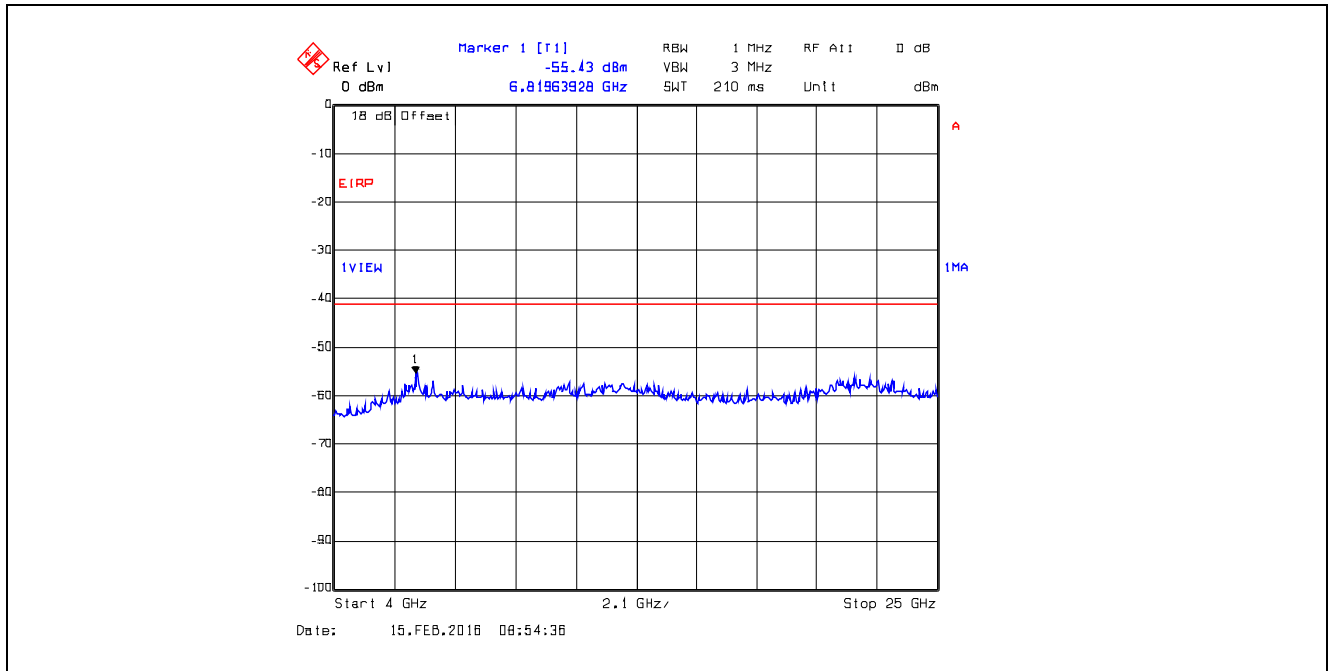**ULTRATECH GROUP OF LABS**
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April 13, 2016

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Plot 5.4.4.4.22. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2407 MHz, Data Rate 7, TX Gain Setting 2, 4 GHz - 25 GHz, Peak Detector

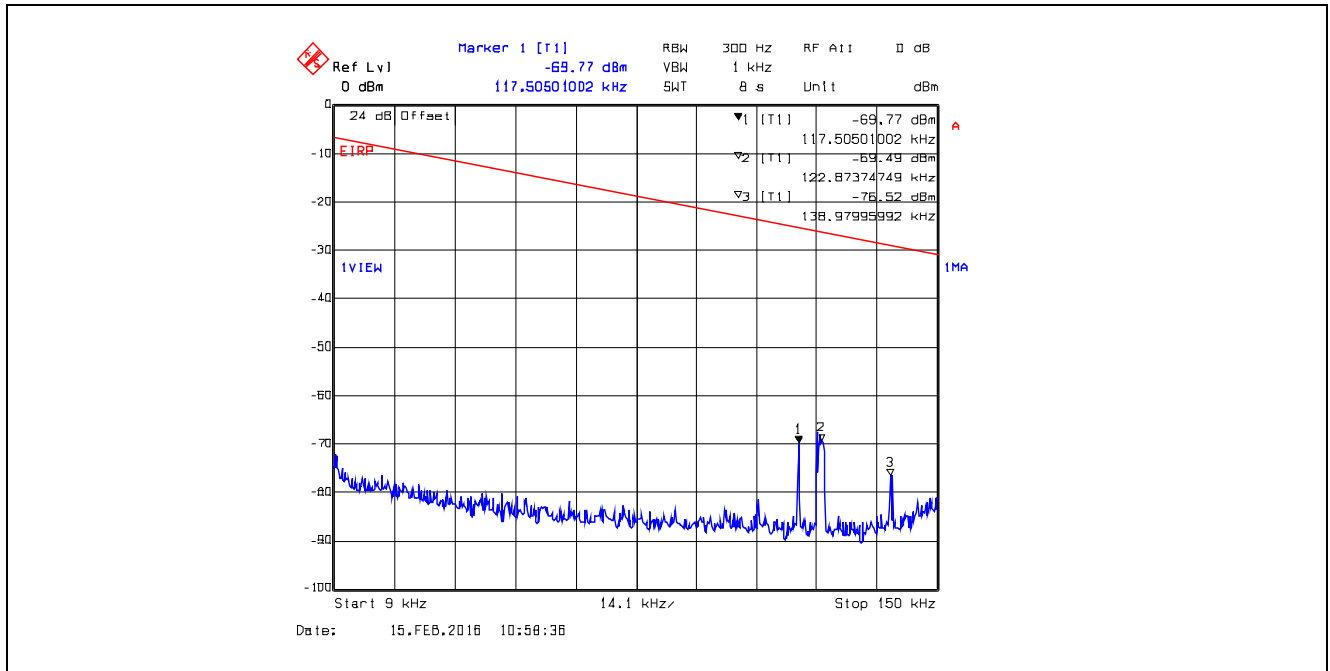

Plot 5.4.4.4.23. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 2, 9 kHz - 150 kHz, Peak Detector

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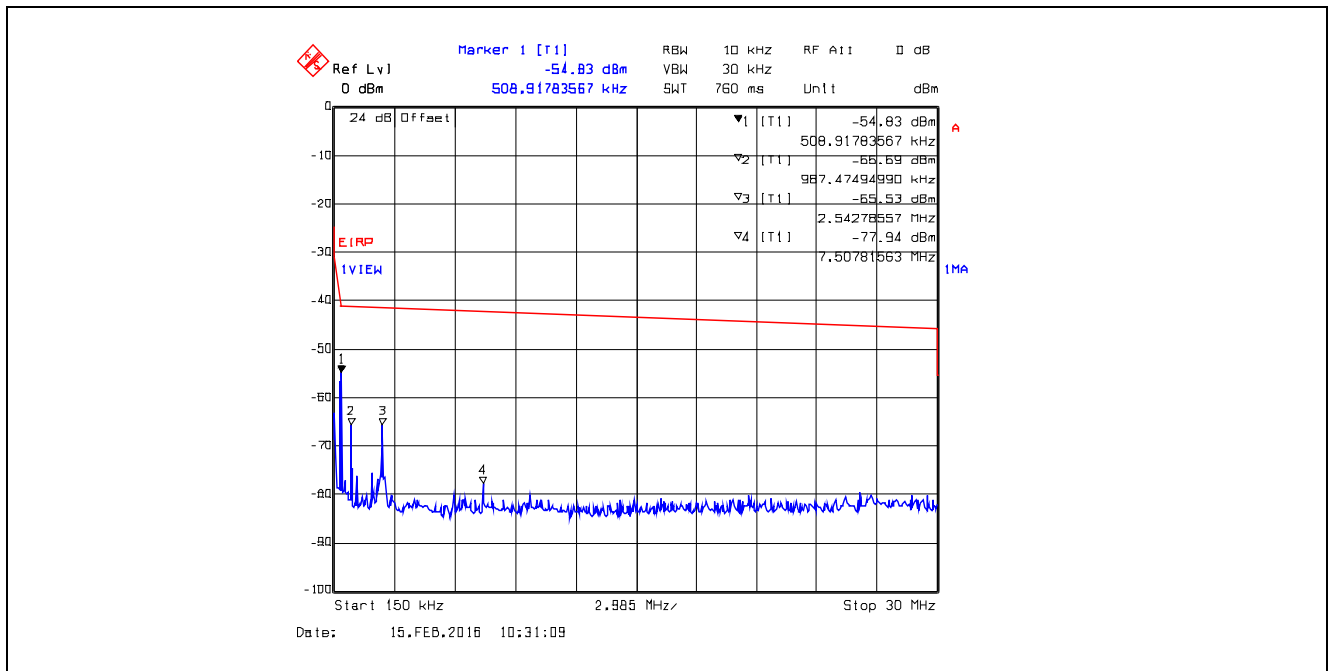
Plot 5.4.4.4.24. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 2, 150 kHz - 30 MHz, Peak Detector

Plot 5.4.4.4.25. Conducted Spurious Emissions in Restricted Frequency Bands
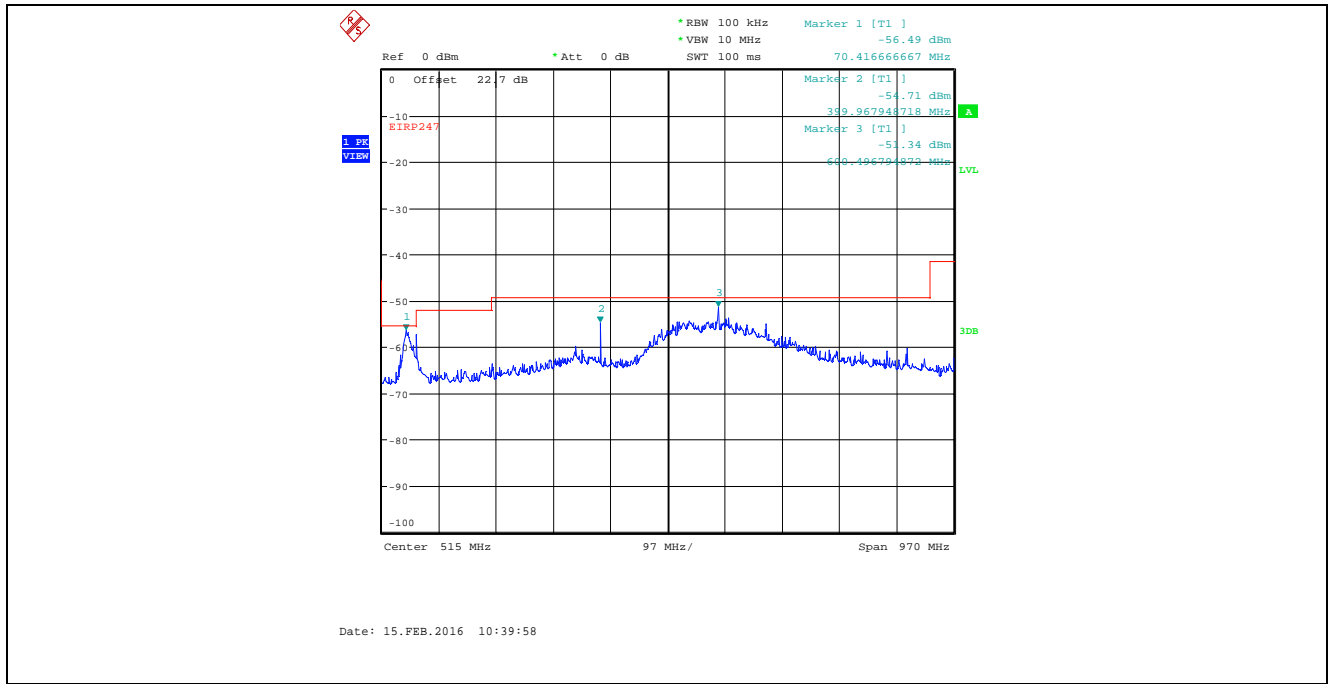Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 2, 30 MHz - 1 GHz, Peak Detector

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Plot 5.4.4.4.26. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 2, 1 GHz - 4 GHz, Peak Detector
Marker # 2 is Fundamental Frequency

Plot 5.4.4.4.27. Conducted Spurious Emissions in Restricted Frequency Bands
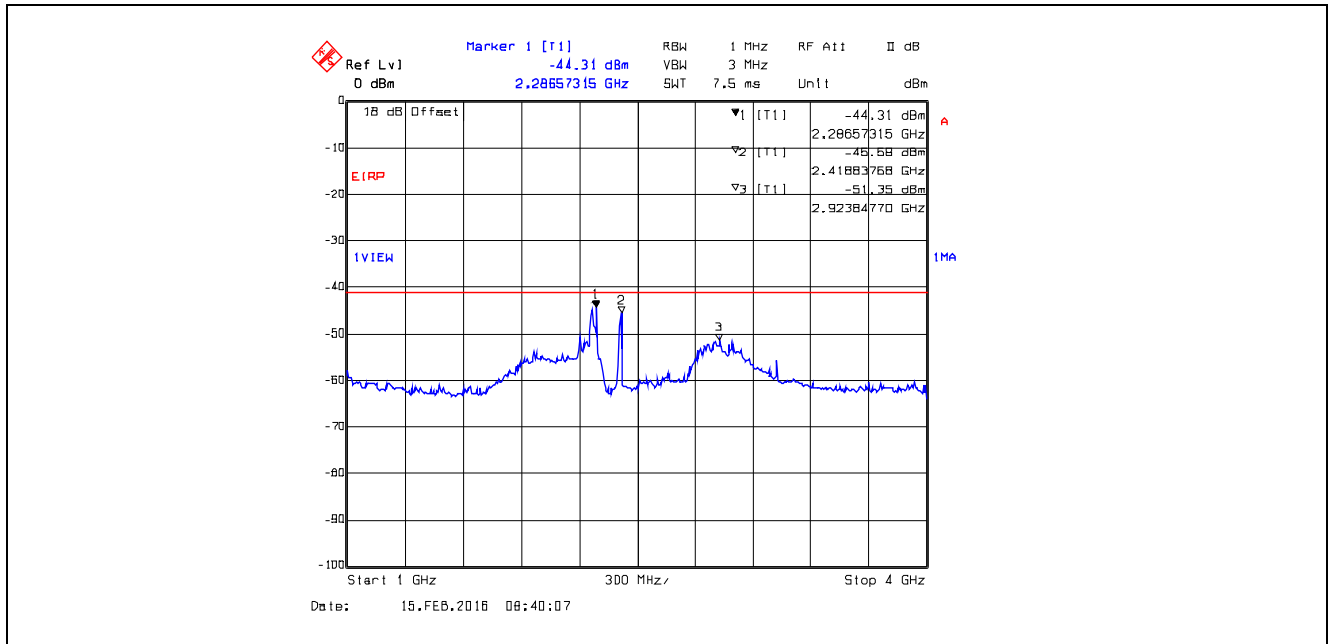Bandwidth: 8 MHz, 2437 MHz, Data Rate 7, TX Gain Setting 2, 4 GHz - 25 GHz, Peak Detector

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Plot 5.4.4.4.28. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 2, 9 kHz - 150 kHz, Peak Detector
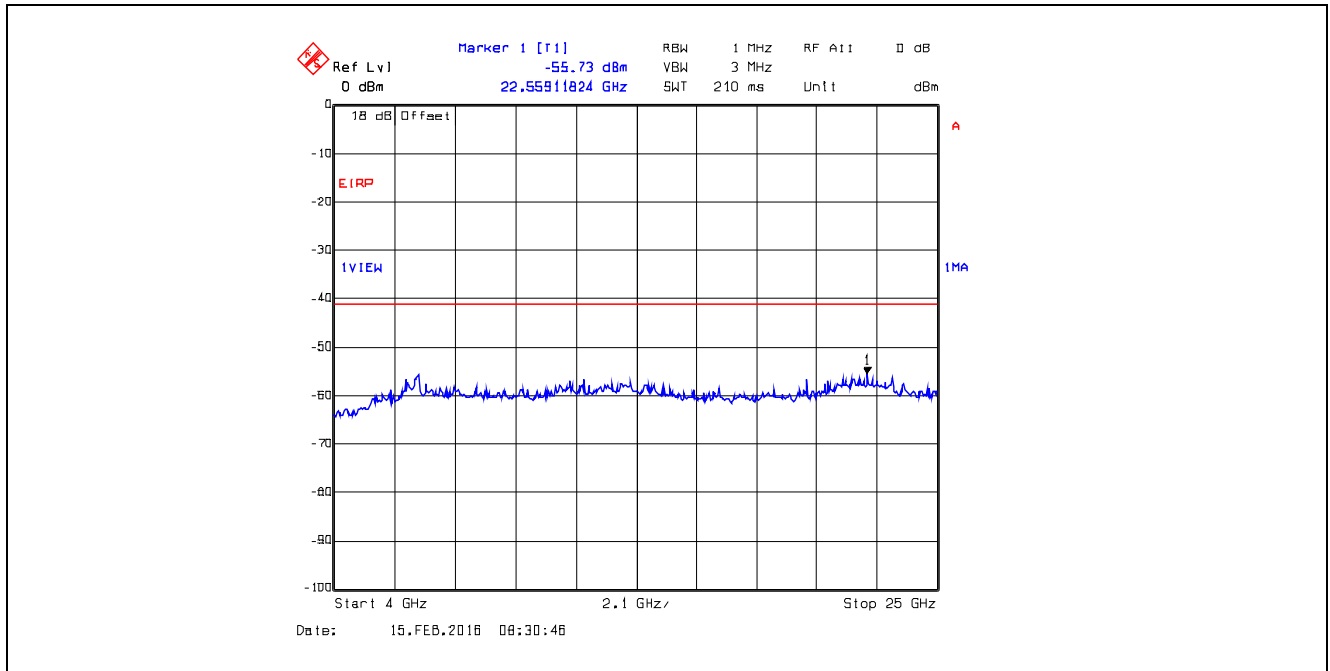

Plot 5.4.4.4.29. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 2, 150 kHz - 30 MHz, Peak Detector
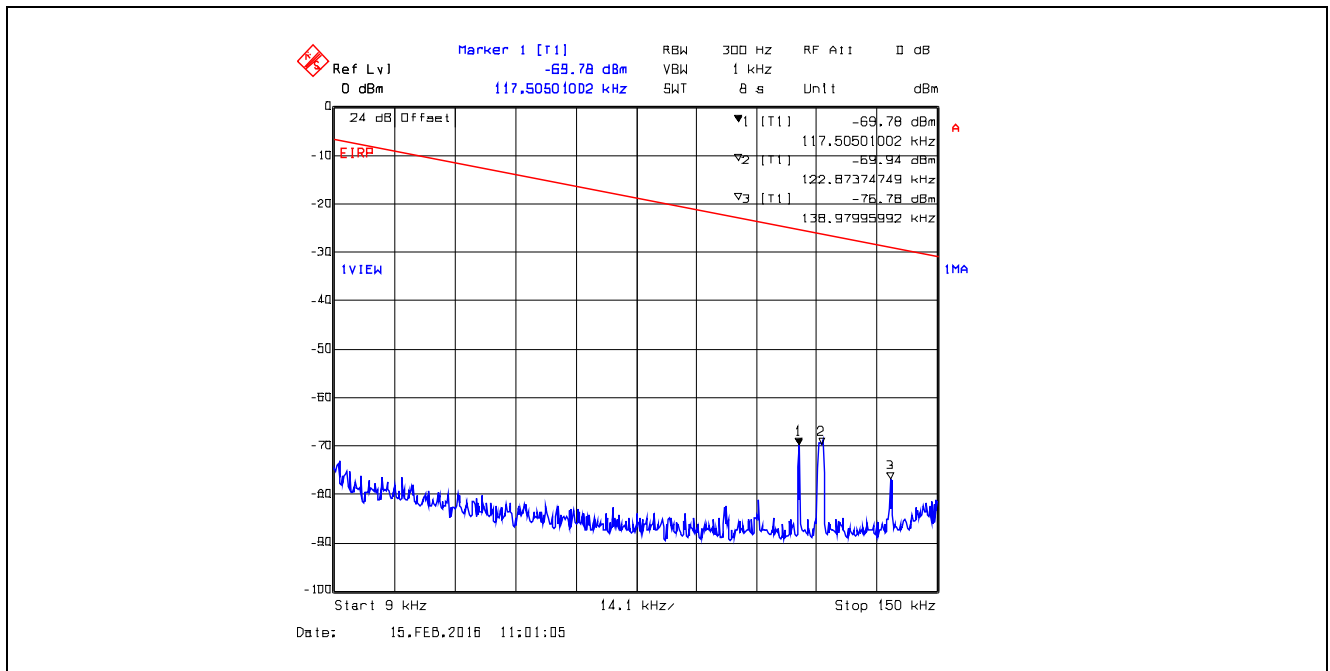
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Plot 5.4.4.4.30. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 2, 30 MHz - 1 GHz, Peak Detector
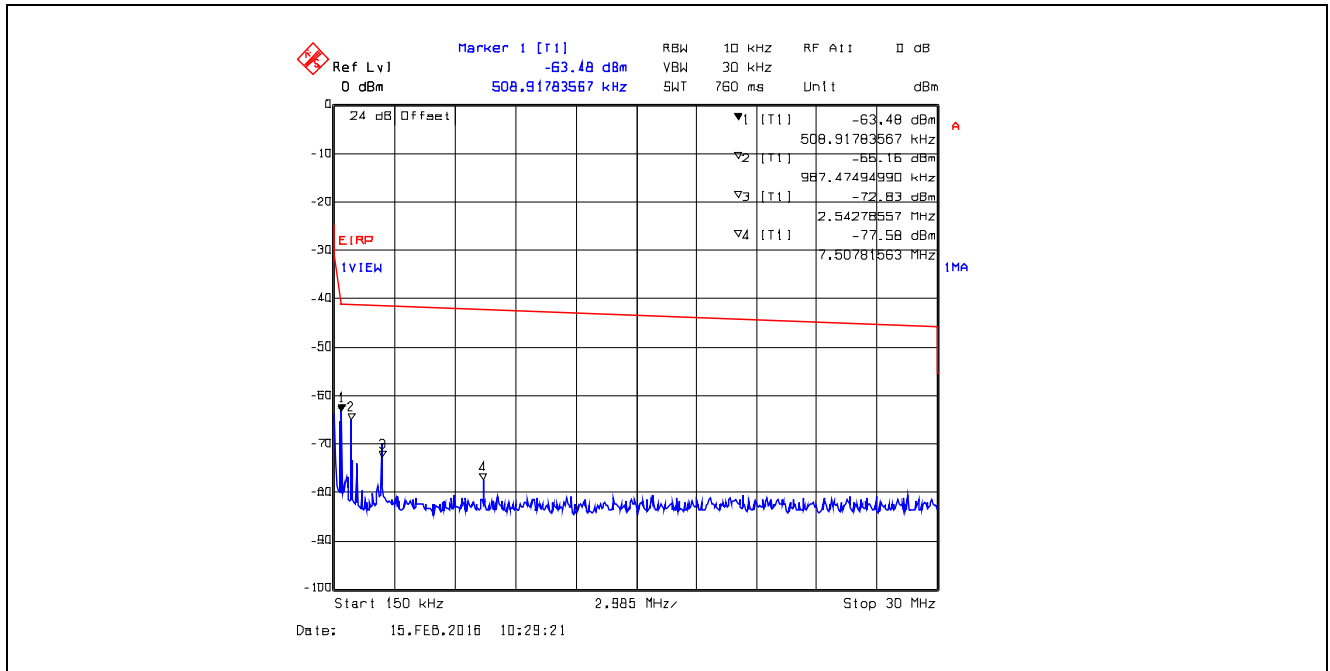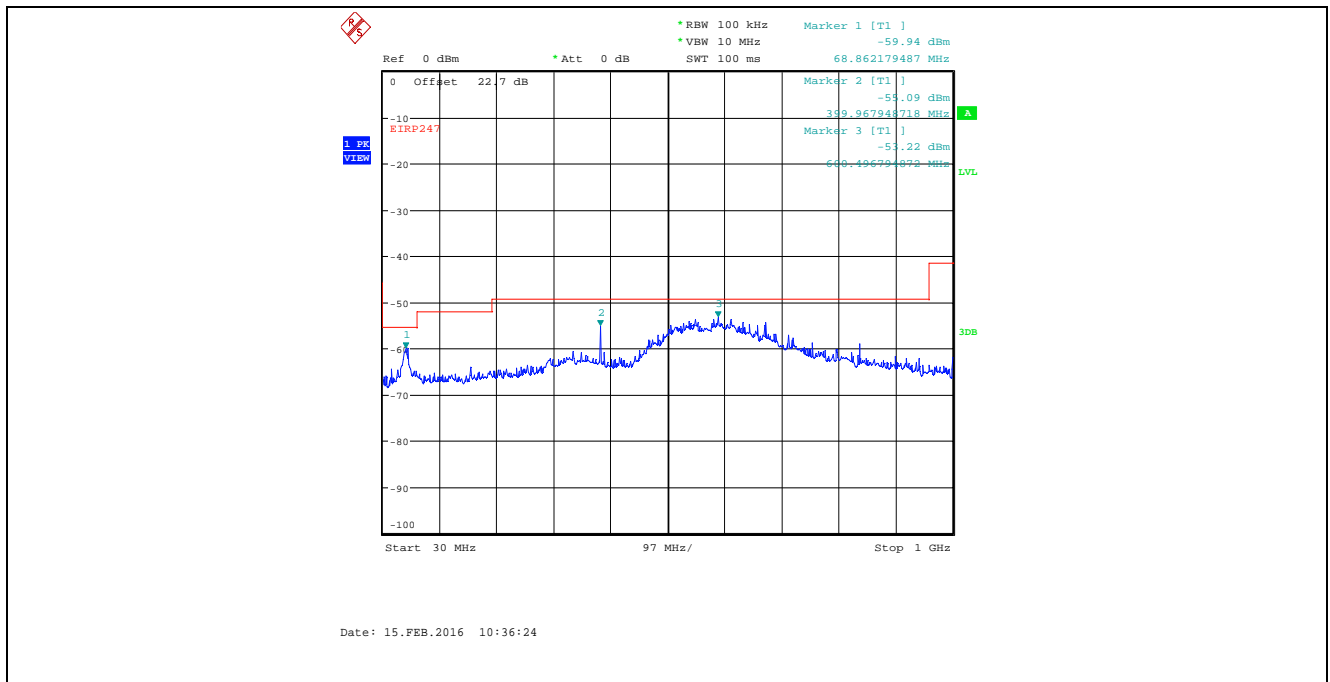

Plot 5.4.4.4.31. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 2, 73-74.6 MHz, Quasi-Peak

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Plot 5.4.4.4.32. Conducted Spurious Emissions in Restricted Frequency Bands
Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 2, 1 GHz - 4 GHz, Peak Detector
Marker # 2 is Fundamental Frequency

Plot 5.4.4.4.33. Conducted Spurious Emissions in Restricted Frequency Bands
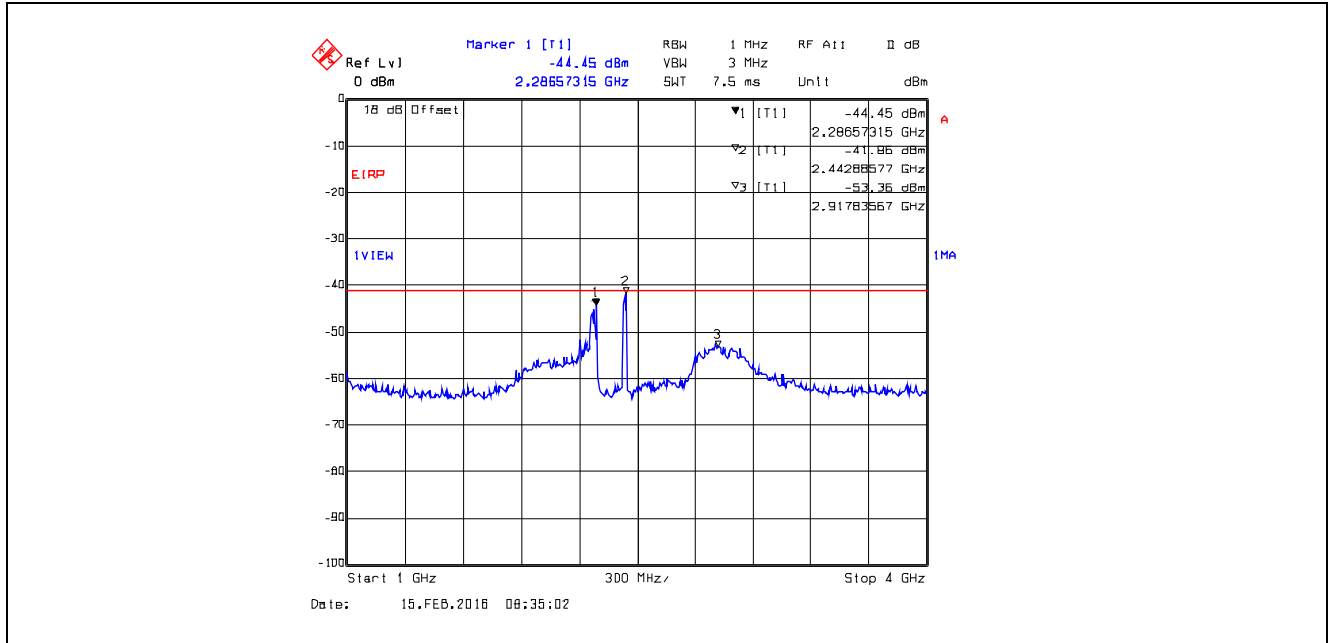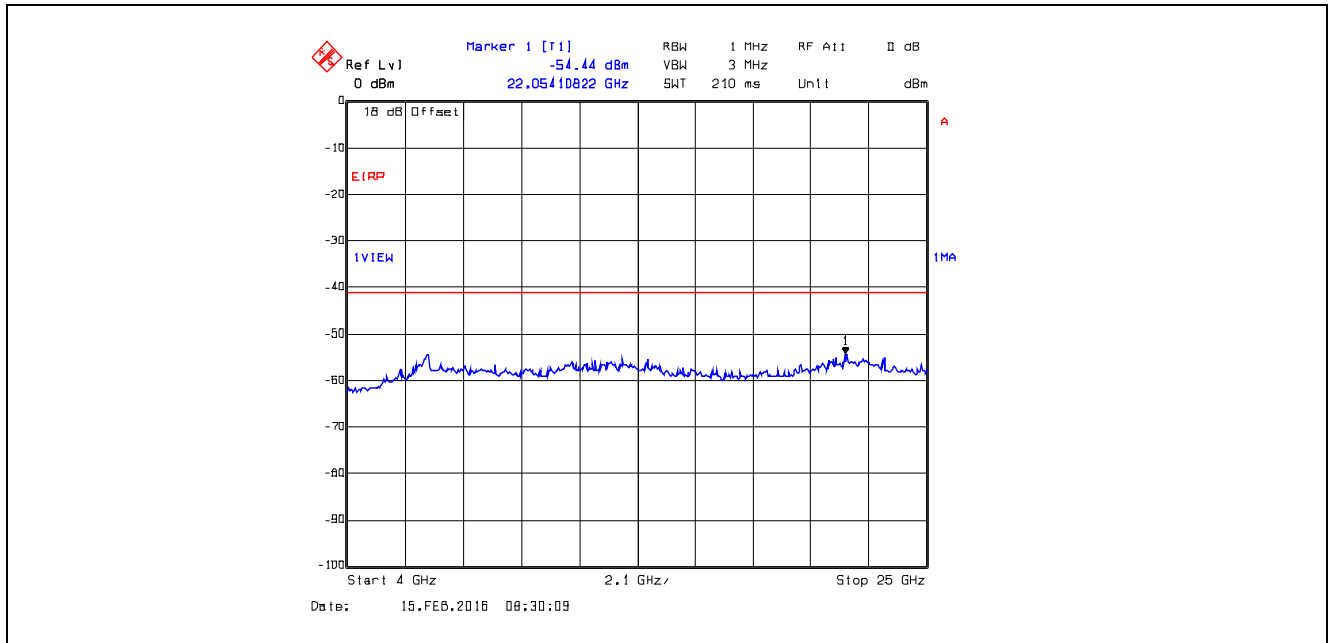Bandwidth: 8 MHz, 2477 MHz, Data Rate 7, TX Gain Setting 2, 4 GHz - 25 GHz, Peak Detector
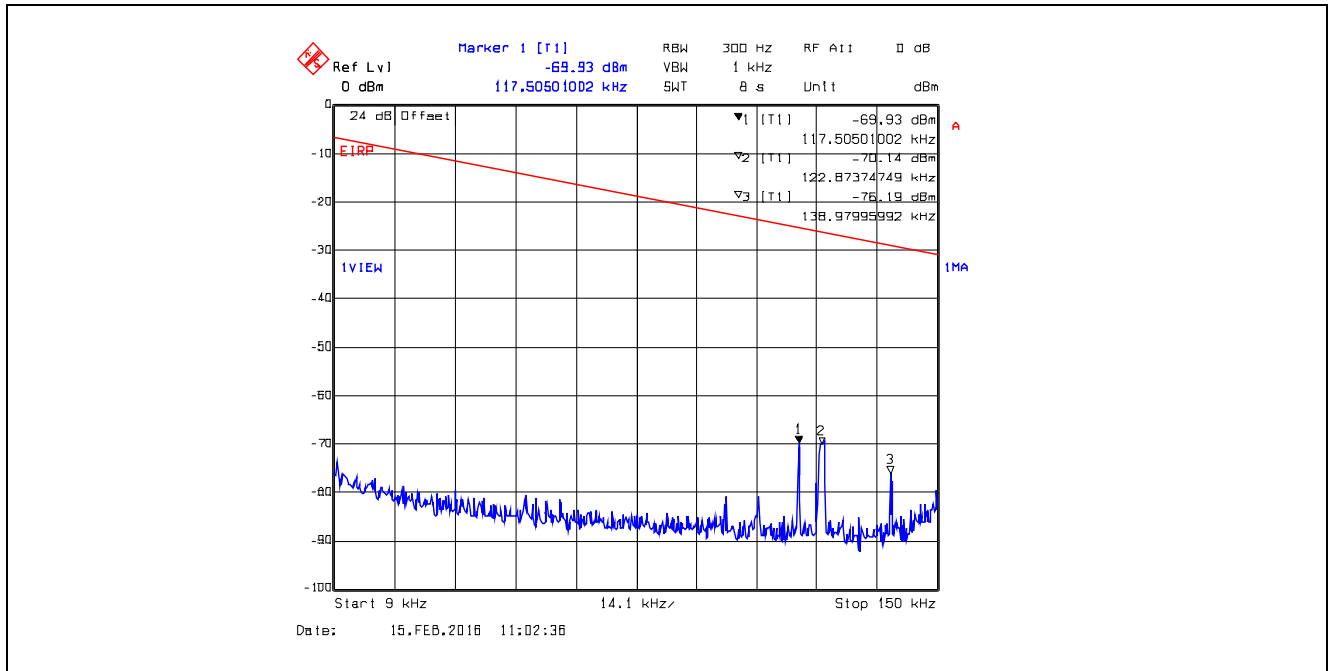
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5.5. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

5.5.1. Limit(s)

§ 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 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 Section 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(c)).

Section 15.205(a) - Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	([2])
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Section 15.209(a) - Field Strength Limits within Restricted Frequency Bands

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

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5.5.2.   Method of Measurements

KDB 558074D01 DTS Meas Guidance v03r04, Section Section 12.2.7 and ANSI C63.10.

5.5.3.   Test Arrangement

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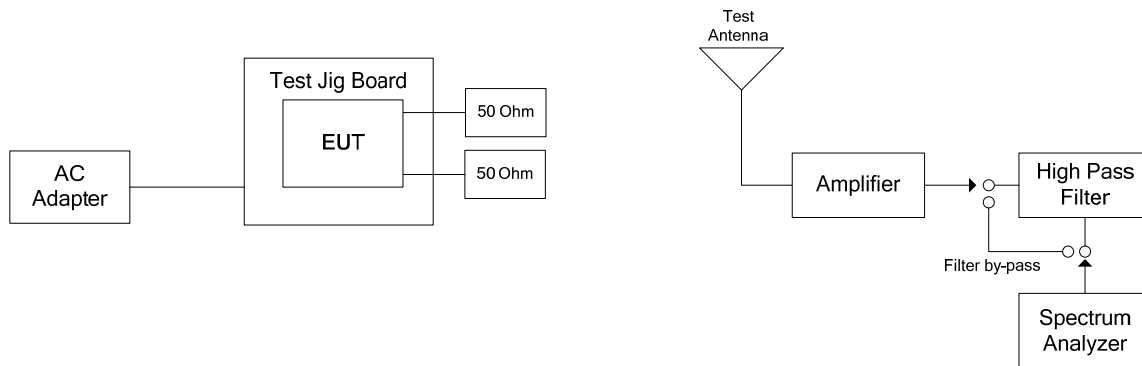
5.5.4. Test Data

Remark(s):
- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT shall be tested in three orthogonal positions.
- § 15.247 (d) spurious emission limit:
    E = (EIRP - 20log(d) + 104.8) – 20 =(36 dBm – 20log(3) + 104.8) – 20 = 111.3 dBµV/m
- Exploratory tests performed to determined worst-case test configurations, the following test results at high power setting represent the worst-case.

5.5.4.1. Bandwidth: 8 MHz, Data Rate 3, High Power, TX Gain Setting 23

Fundamental Frequency:	2407 MHz
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
4814	51.10	37.72	V	54.0	111.3	-16.3	Pass*
4814	50.94	36.77	H	54.0	111.3	-17.2	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:	2437 MHz
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
4874	50.70	37.05	V	54.0	111.3	-16.95	Pass*
4874	50.42	36.87	H	54.0	111.3	-17.13	Pass*
7311	52.30	39.32	V	54.0	111.3	-14.68	Pass*
7311	52.61	40.15	H	54.0	111.3	-13.85	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

| Fundamental Frequency: | 2477 MHz | | | | | | |
| Frequency Test Range: | 30 MHz – 25 GHz | | | | | | |

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
4954	51.75	38.60	V	54.0	111.3	-15.4	Pass*
4954	51.07	36.79	H	54.0	111.3	-17.2	Pass*
7431	55.23	42.22	V	54.0	111.3	-11.8	Pass*
7431	52.49	40.32	H	54.0	111.3	-13.7	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

5.5.4.2.   Bandwidth: 8 MHz, Data Rate 7, High Power, TX Gain Setting 23

| Fundamental Frequency: | 2407 MHz | | | | | | |
| Frequency Test Range: | 30 MHz – 25 GHz | | | | | | |

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
30 - 25000	*	*	H/V	*	111.3	*	*

*All spurious emissions and harmonics are more than 20 dB below the applicable limit.

| Fundamental Frequency: | 2437 MHz | | | | | | |
| Frequency Test Range: | 30 MHz – 25 GHz | | | | | | |

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
30 - 25000	*	*	H/V	*	111.3	*	*

*All spurious emissions and harmonics are more than 20 dB below the applicable limit.

| Fundamental Frequency: | 2477 MHz | | | | | | |
| Frequency Test Range: | 30 MHz – 25 GHz | | | | | | |

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
30 - 25000	*	*	H/V	*	111.3	*	*

*All spurious emissions and harmonics are more than 20 dB below the applicable limit.

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5.6.   POWER SPECTRAL DENSITY [§ 15.247(e)]

5.6.1.   Limit(s)

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

5.6.2.   Method of Measurements

KDB 558074D01 DTS Meas Guidance v03r04, Section 10.2 Peak PSD

5.6.3.   Test Arrangement
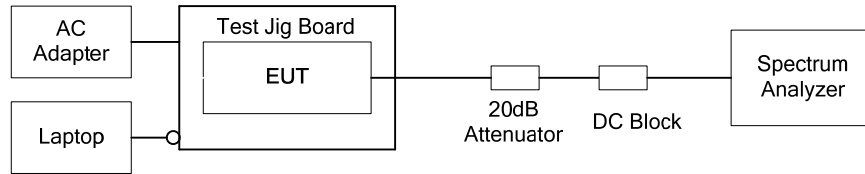
5.6.4.   Test Data

Operating Mode	Data Rate	Frequency (MHz)	PSD (dBm)	Limit (dBm)
Bandwidth: 1 MHz TX Gain: 5	1	2402	7.45	8
		2437	7.80	8
		2482	7.55	8
	2	2402	7.53	8
		2437	7.61	8
		2482	7.41	8
Bandwidth: 2 MHz TX Gain: 8	1	2402	7.56	8
		2437	6.71	8
		2482	7.24	8
	2	2402	7.54	8
		2437	7.06	8
		2482	7.95	8
	3	2402	7.22	8
		2437	6.84	8
		2482	7.71	8

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   April 13, 2016
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Operating Mode	Data Rate	Frequency (MHz)	PSD (dBm)	Limit (dBm)
Bandwidth: 4 MHz TX Gain: 18	1	2402	7.49	8
		2437	7.30	8
		2477	7.86	8
	2	2402	7.35	8
		2437	7.69	8
		2477	7.88	8
	3	2402	7.57	8
		2437	7.57	8
		2477	7.65	8
Bandwidth: 8 MHz TX Gain: 23	1	2407	7.57	8
		2437	7.11	8
		2477	7.56	8
	2	2407	7.49	8
		2437	6.94	8
		2477	7.78	8
	3	2407	7.26	8
		2437	6.87	8
		2477	7.26	8

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**

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Operating Mode	Data Rate	Frequency (MHz)	PSD (dBm)	Limit (dBm)
Bandwidth: 1 MHz TX Gain: 20	4	2402	7.69	8
		2437	7.03	8
		2482	7.39	8
	5	2402	7.40	8
		2437	6.44	8
		2482	7.63	8
	6	2402	7.11	8
		2437	6.74	8
		2482	7.51	8
	7	2402	7.58	8
		2437	6.72	8
		2482	7.67	8
Bandwidth: 2 MHz TX Gain: 23	4	2402	7.58	8
		2437	5.87	8
		2482	7.20	8
	5	2402	7.16	8
		2437	6.42	8
		2482	6.98	8
	6	2402	7.12	8
		2437	6.75	8
		2482	7.59	8
	7	2402	7.25	8
		2437	6.79	8
		2482	7.34	8

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Operating Mode	Data Rate	Frequency (MHz)	PSD (dBm)	Limit (dBm)
Bandwidth: 4 MHz TX Gain: 23	4	2403	2.98	8
		2437	3.90	8
		2480	2.48	8
	5	2403	2.78	8
		2437	3.06	8
		2480	2.96	8
	6	2403	2.32	8
		2437	4.82	8
		2480	2.78	8
	7	2403	2.73	8
		2437	3.46	8
		2480	4.69	8
Bandwidth: 8 MHz TX Gain: 23	4	2407	2.80	8
		2437	0.86	8
		2477	3.68	8
	5	2407	2.60	8
		2437	0.89	8
		2477	2.73	8
	6	2407	2.51	8
		2437	0.88	8
		2477	3.17	8
	7	2407	2.75	8
		2437	1.83	8
		2477	1.92	8

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Plot 5.6.4.1. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 5, 2402 MHz, Data Rate 1
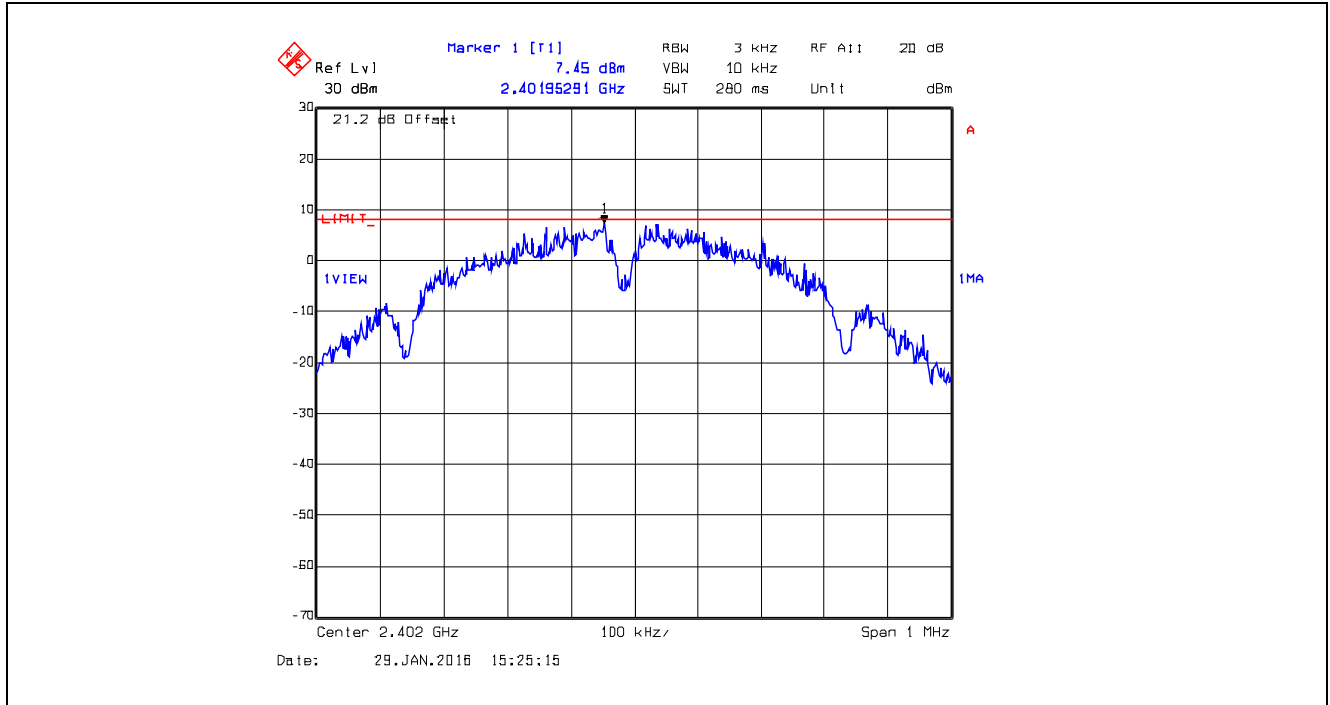
Plot 5.6.4.2. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 5, 2437 MHz, Data Rate 1

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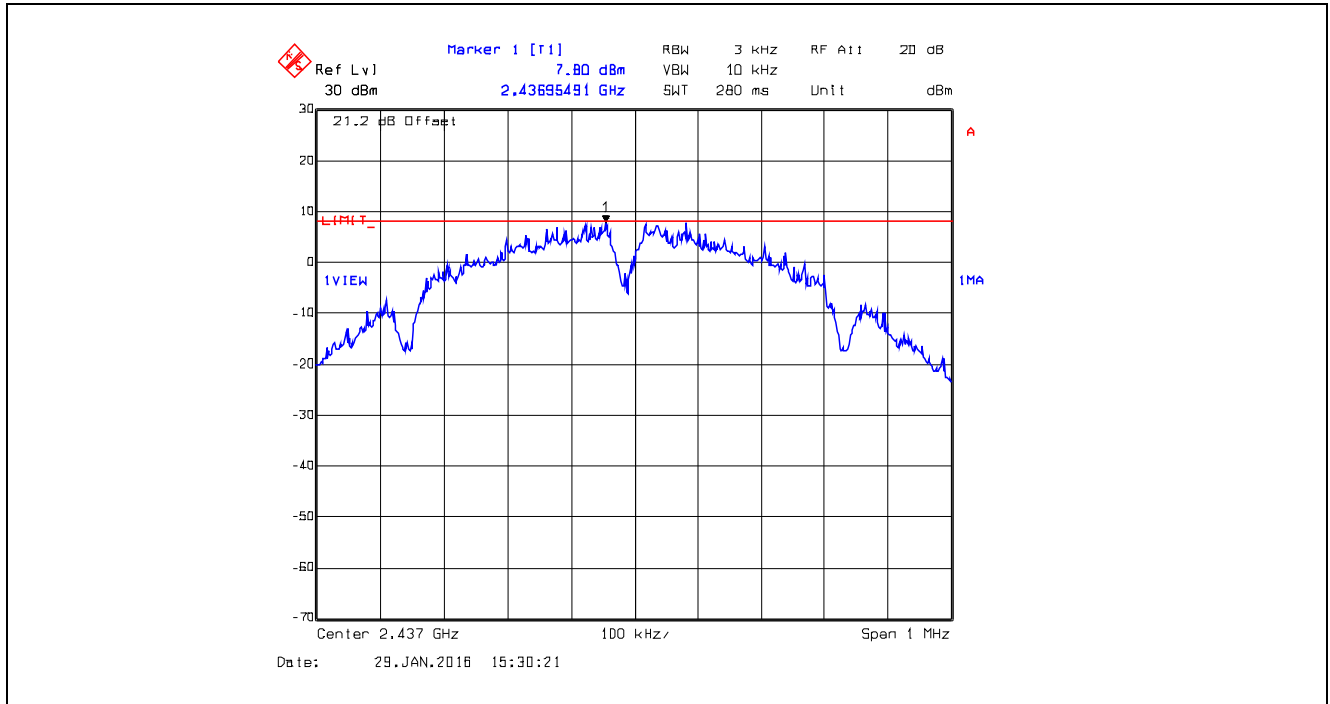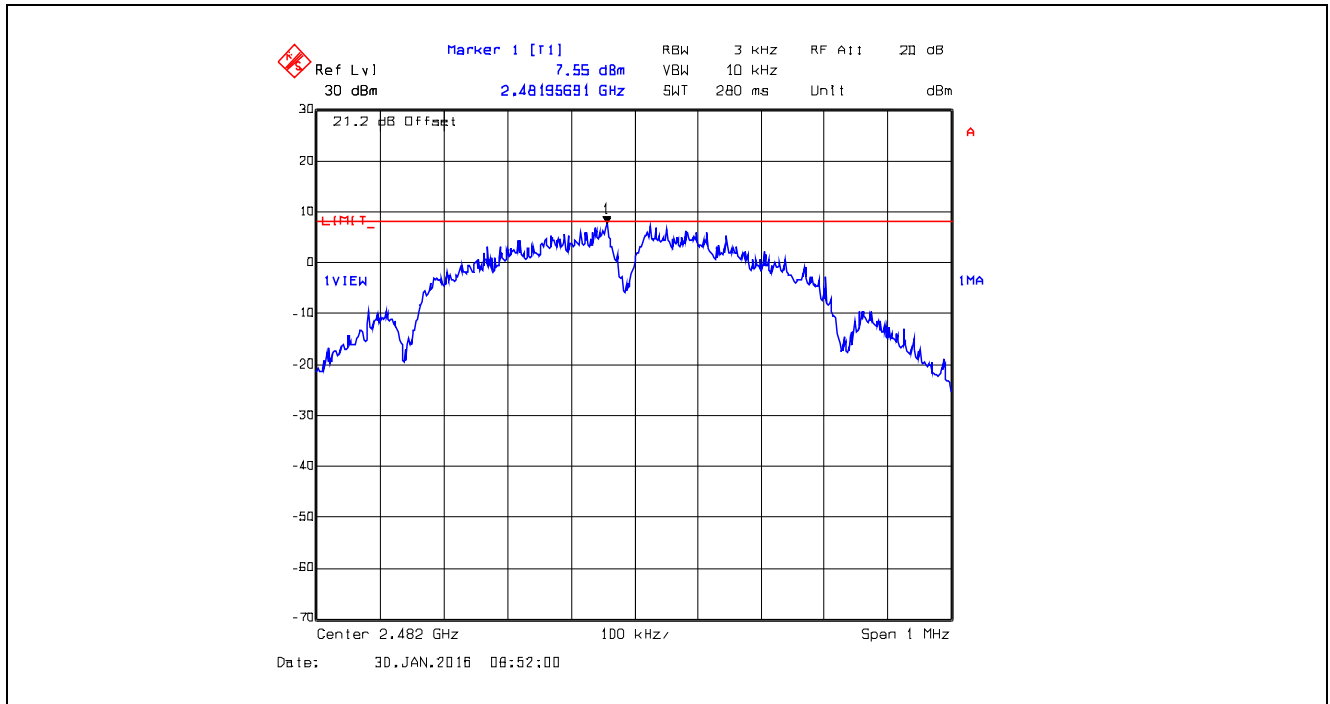
Plot 5.6.4.3. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 5, 2482 MHz, Data Rate 1

Plot 5.6.4.4. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 5, 2402 MHz, Data Rate 2

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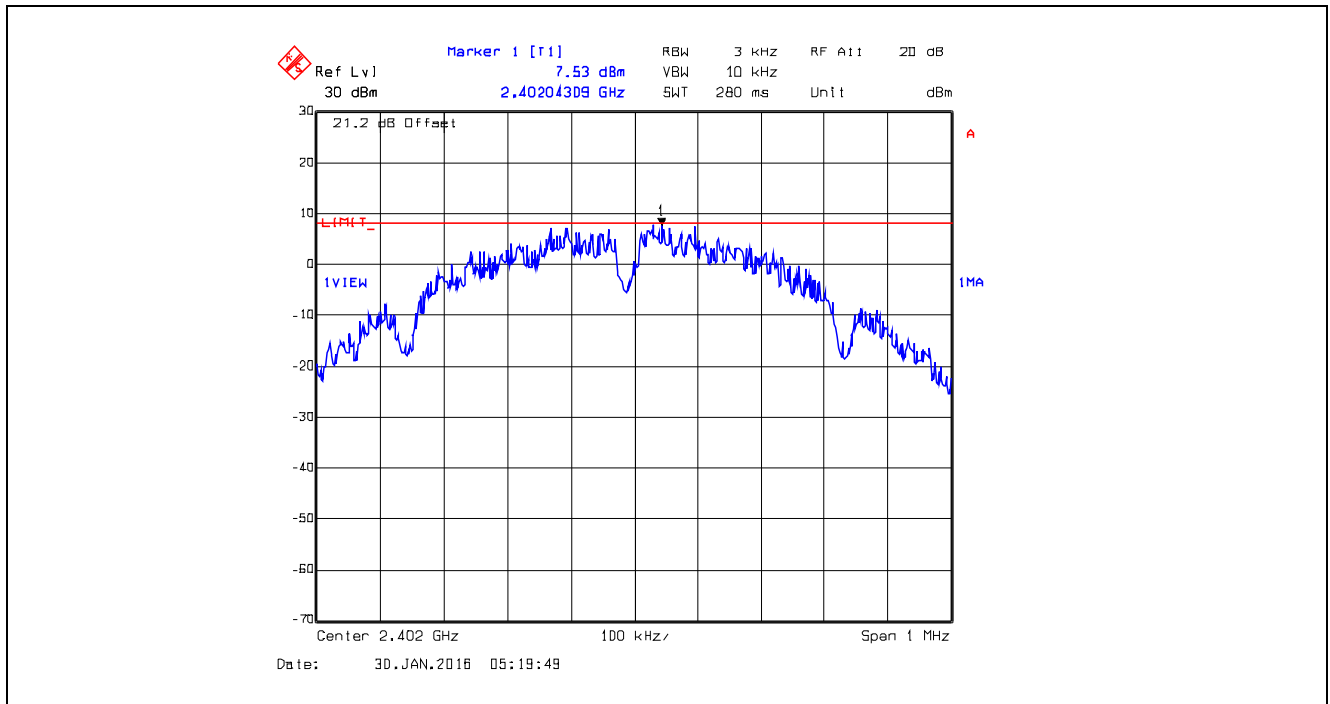
Plot 5.6.4.5. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 5, 2437 MHz, Data Rate 2

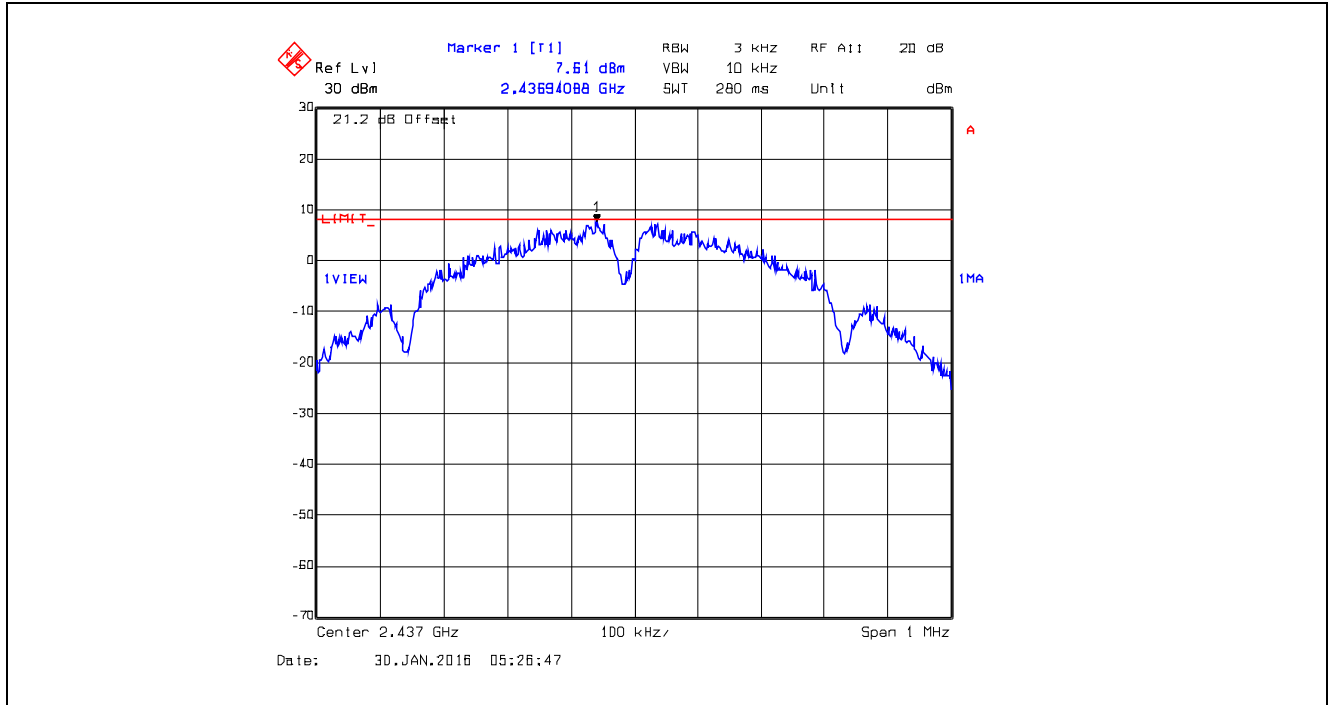**Plot 5.6.4.6.** Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 5, 2482 MHz, Data Rate 2

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Plot 5.6.4.7. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2402 MHz, Data Rate 1

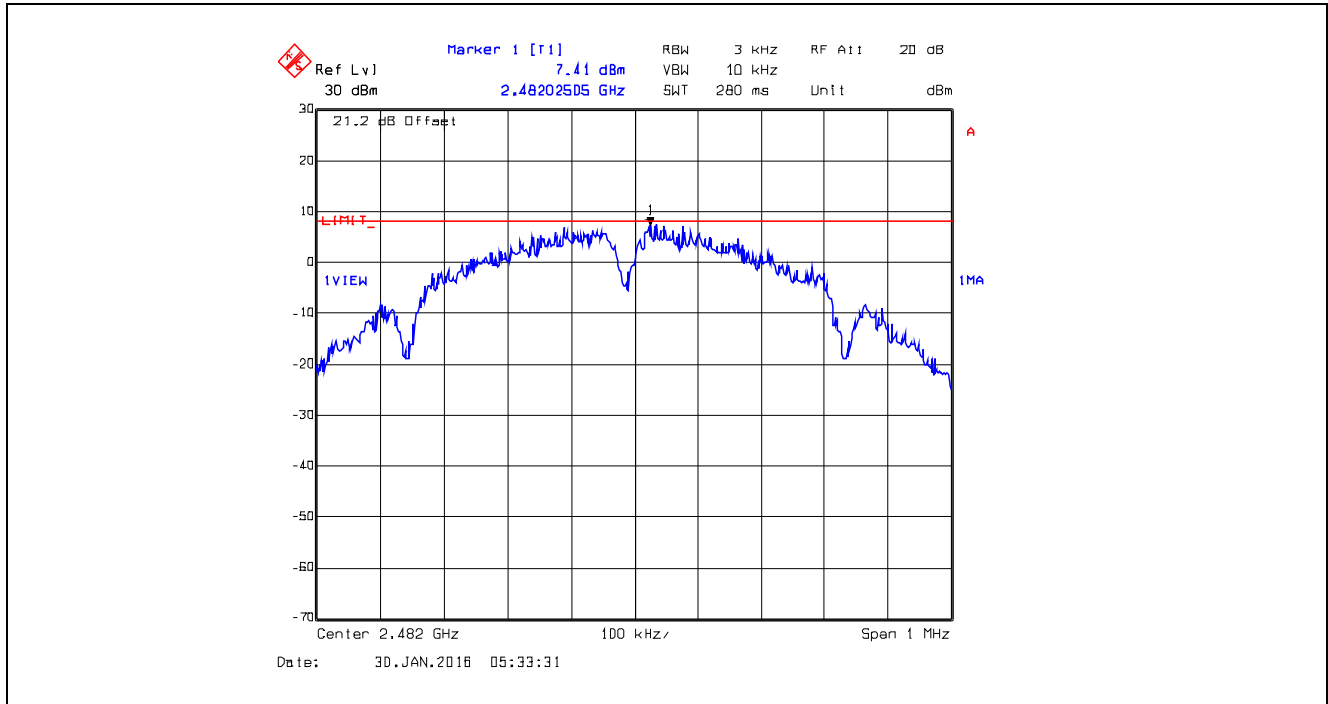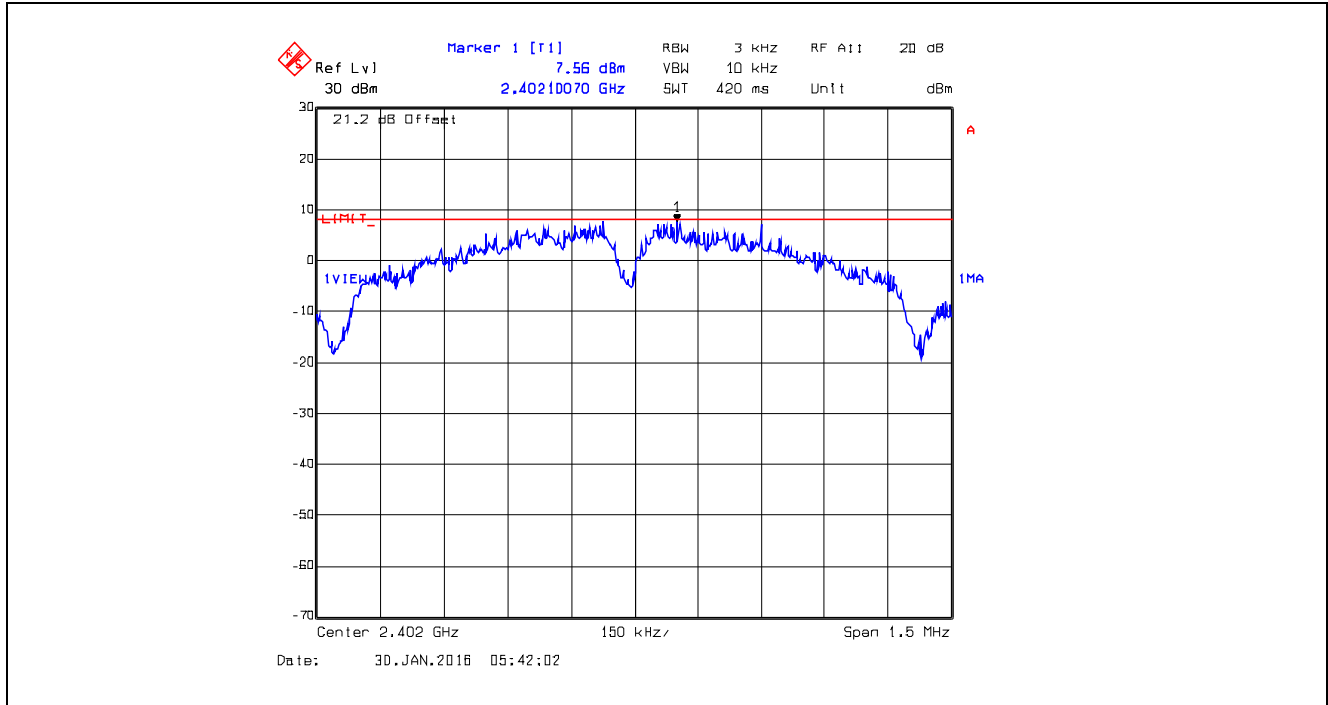**Plot 5.6.4.8.** Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2437 MHz, Data Rate 1

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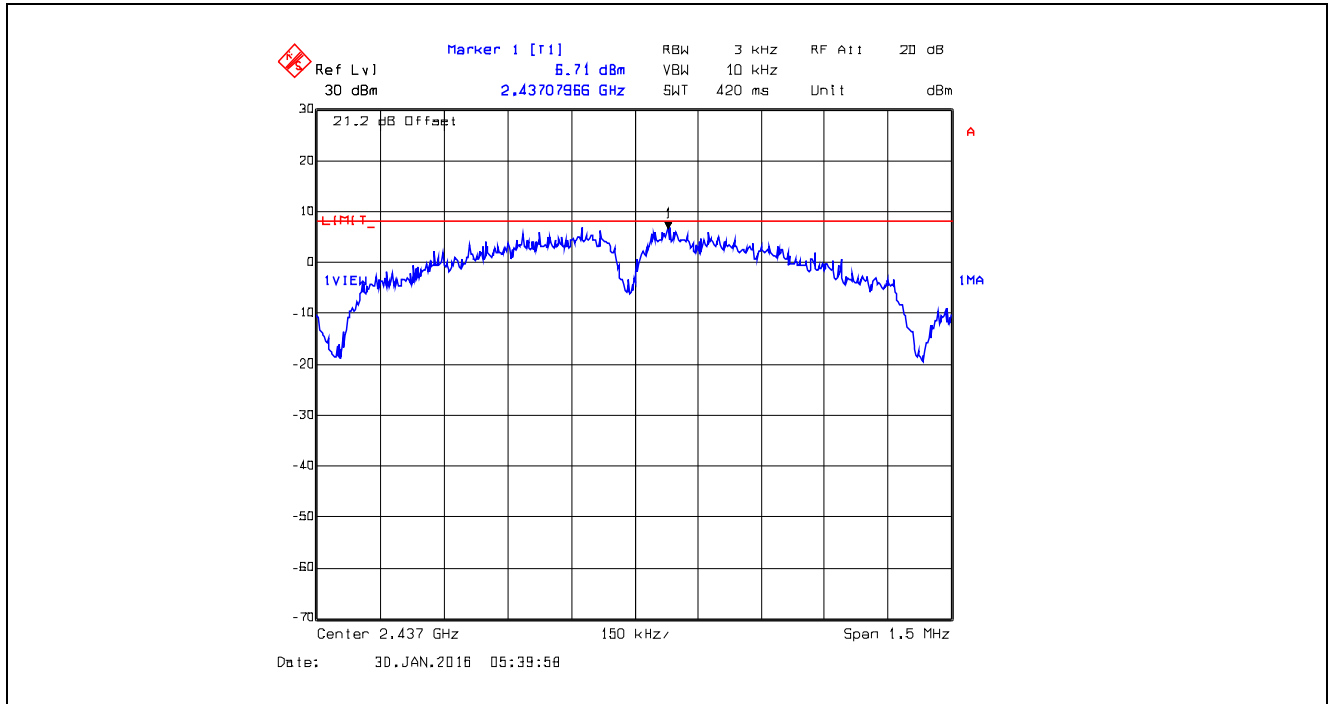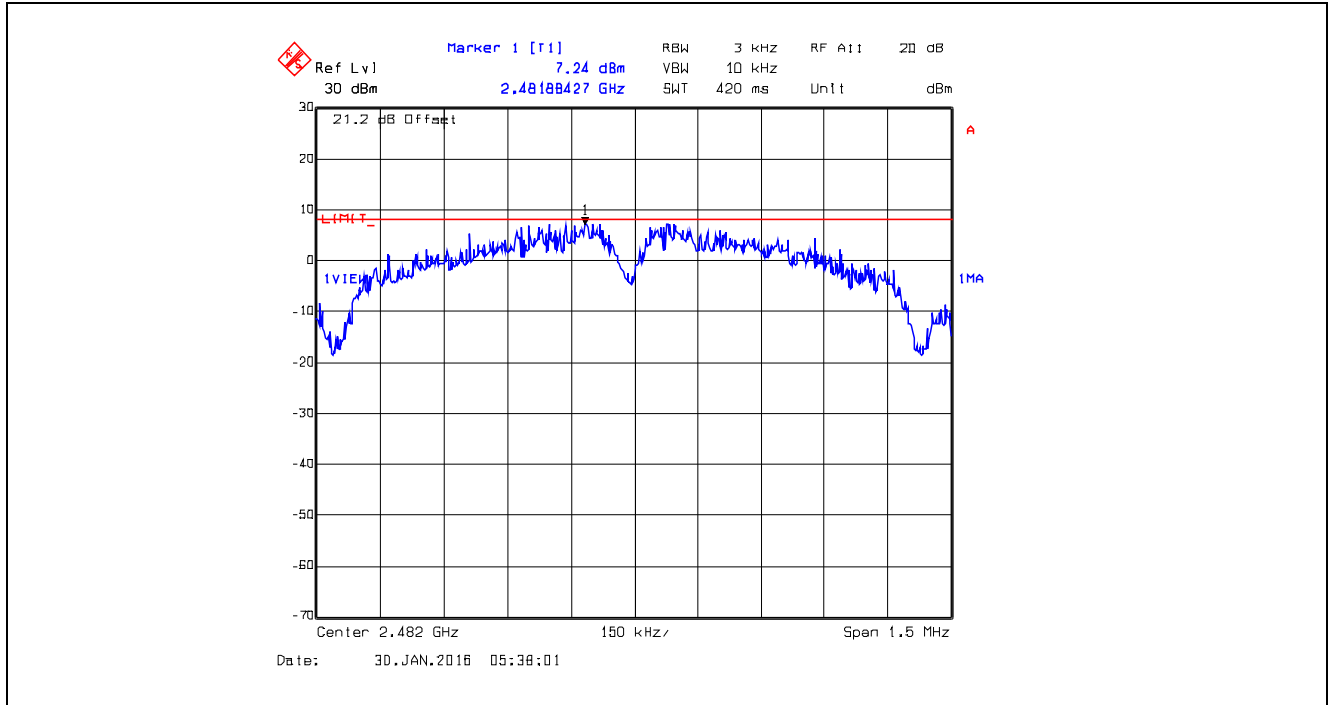
Plot 5.6.4.9. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2482 MHz, Data Rate 1

Plot 5.6.4.10. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2402 MHz, Data Rate 2

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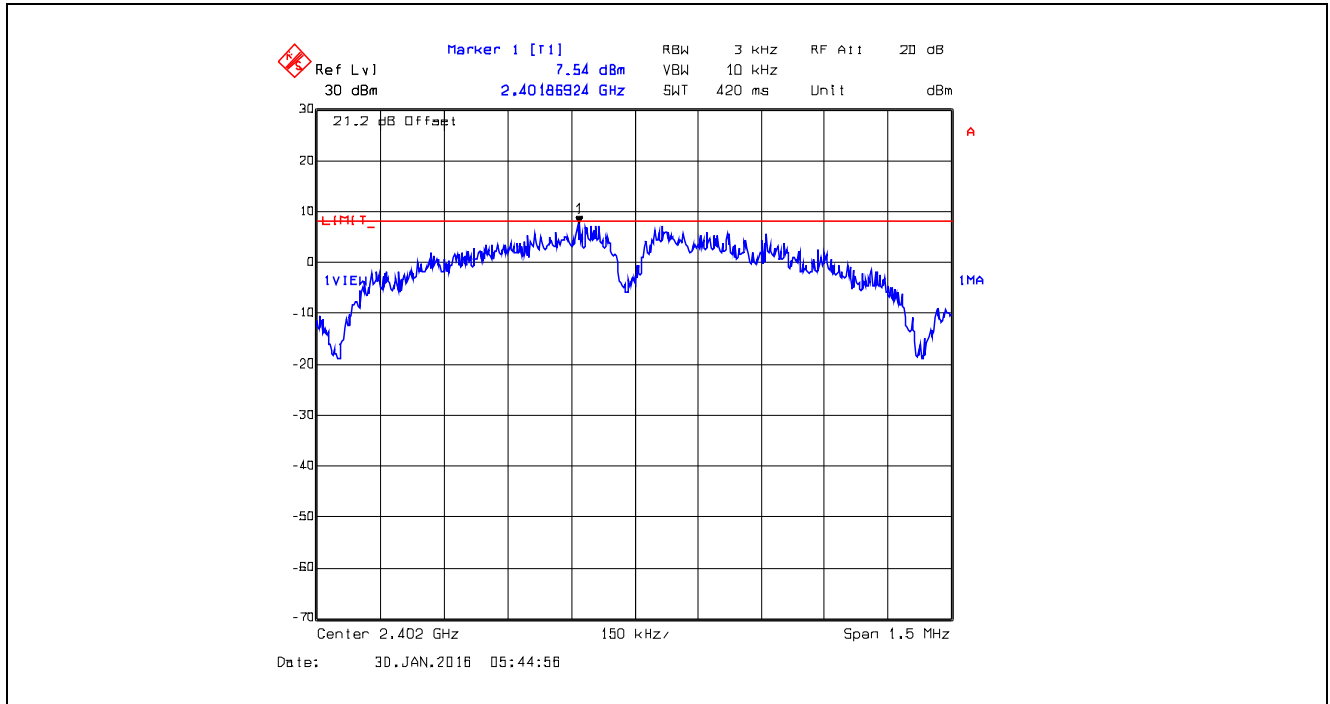
Plot 5.6.4.11. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2437 MHz, Data Rate 2

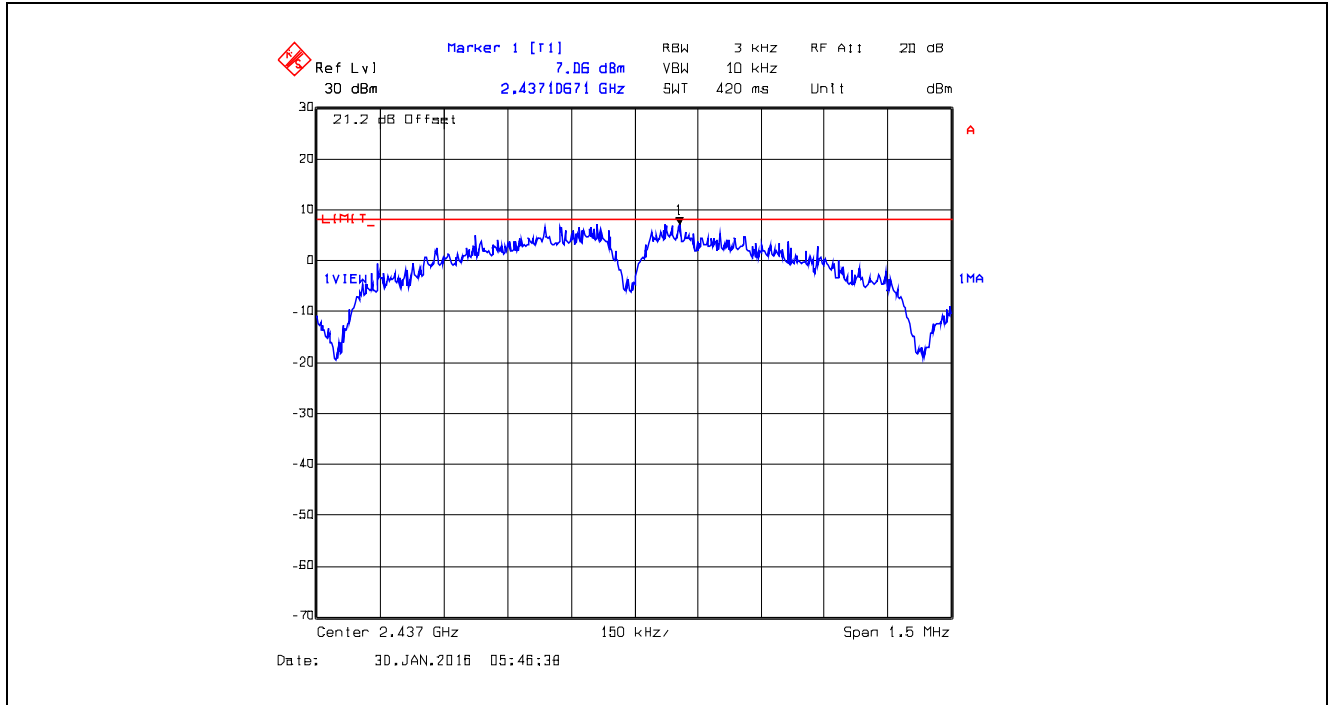**Plot 5.6.4.12.** Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2482 MHz, Data Rate 2

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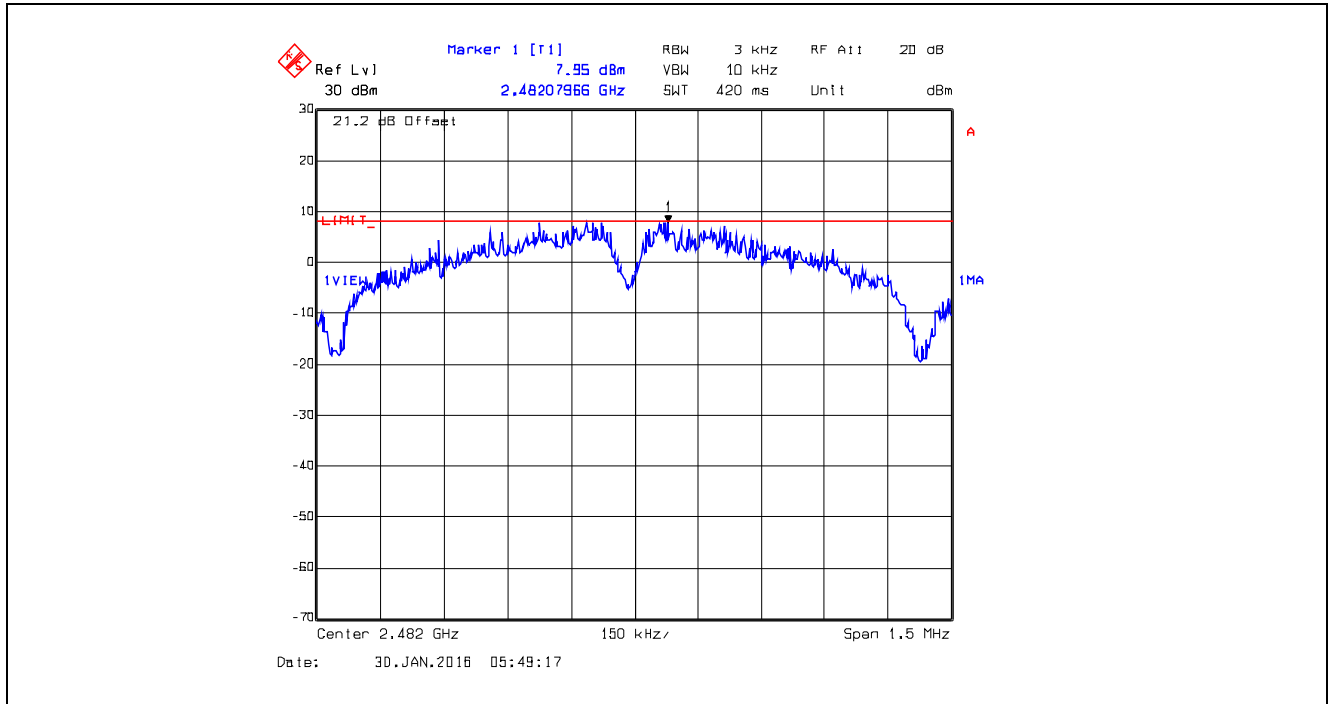
Plot 5.6.4.13. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2402 MHz, Data Rate 3

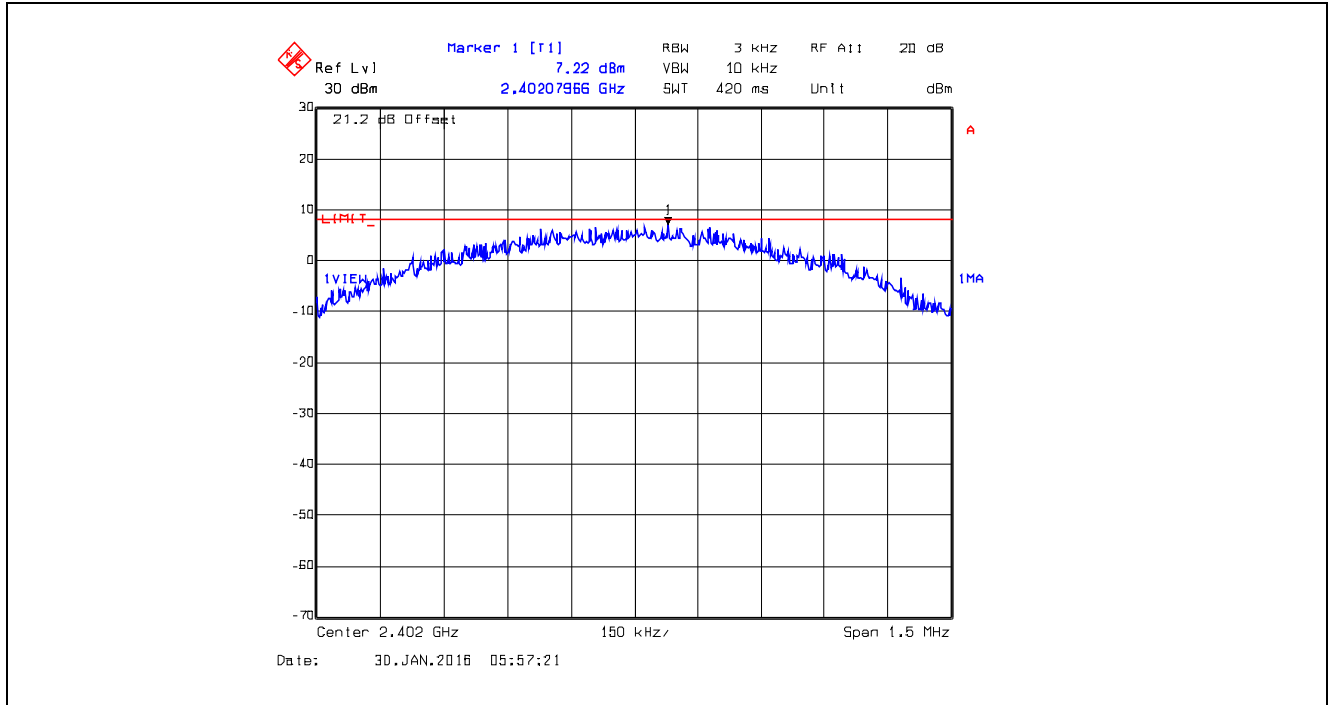**Plot 5.6.4.14.** Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2437 MHz, Data Rate 3

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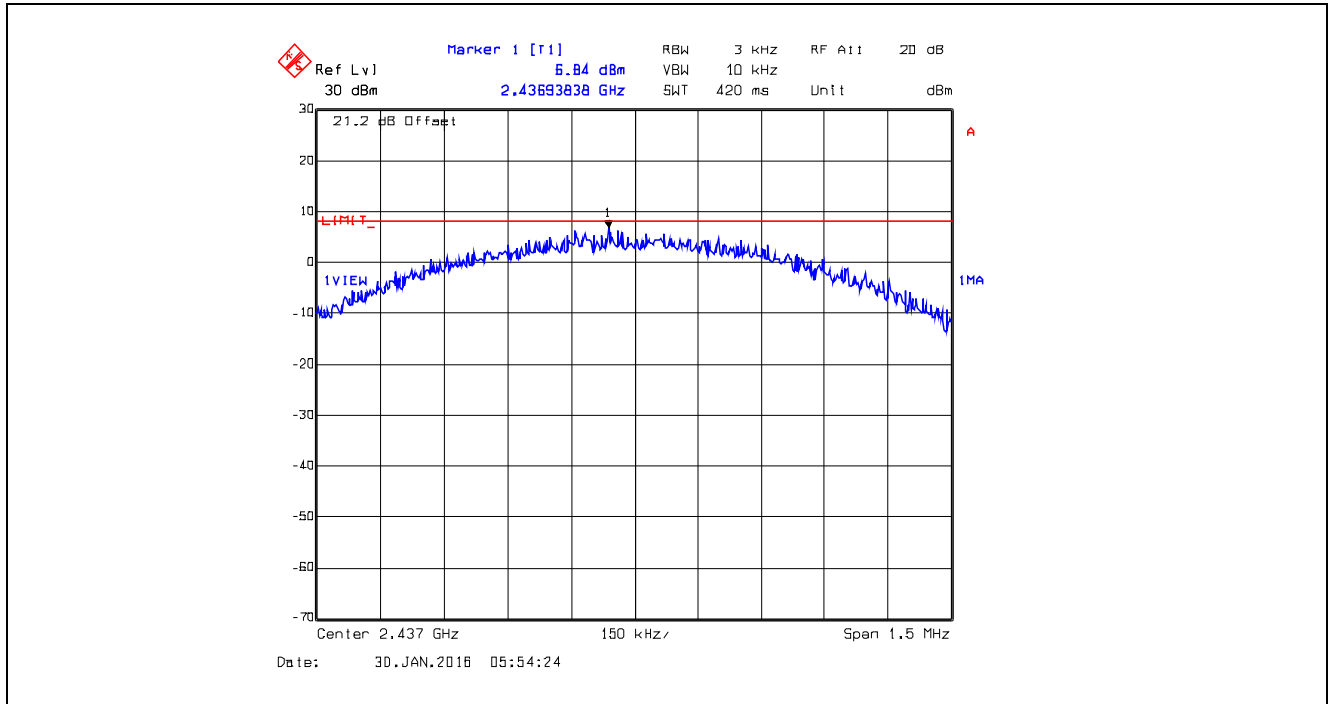
Plot 5.6.4.15. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 8, 2482 MHz, Data Rate 3

Plot 5.6.4.16. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2402 MHz, Data Rate 1

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Plot 5.6.4.17. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2437 MHz, Data Rate 1

Plot 5.6.4.18. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2477 MHz, Data Rate 1
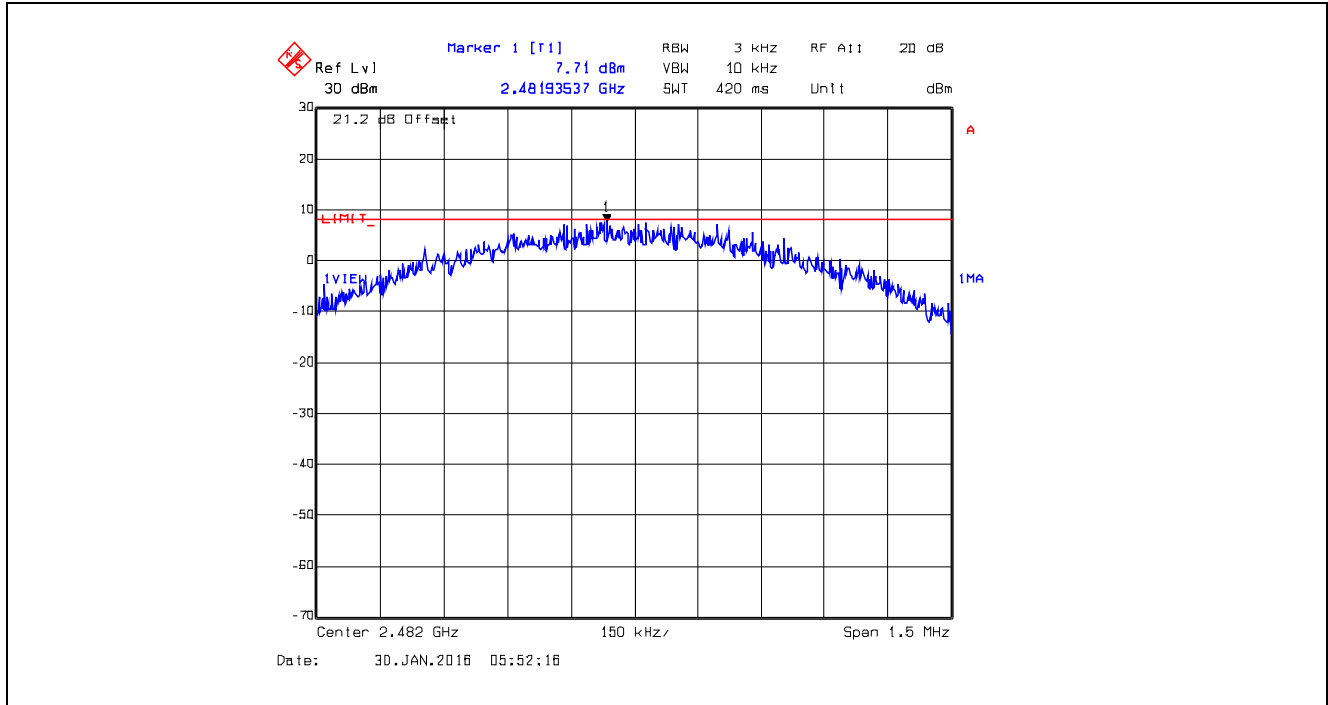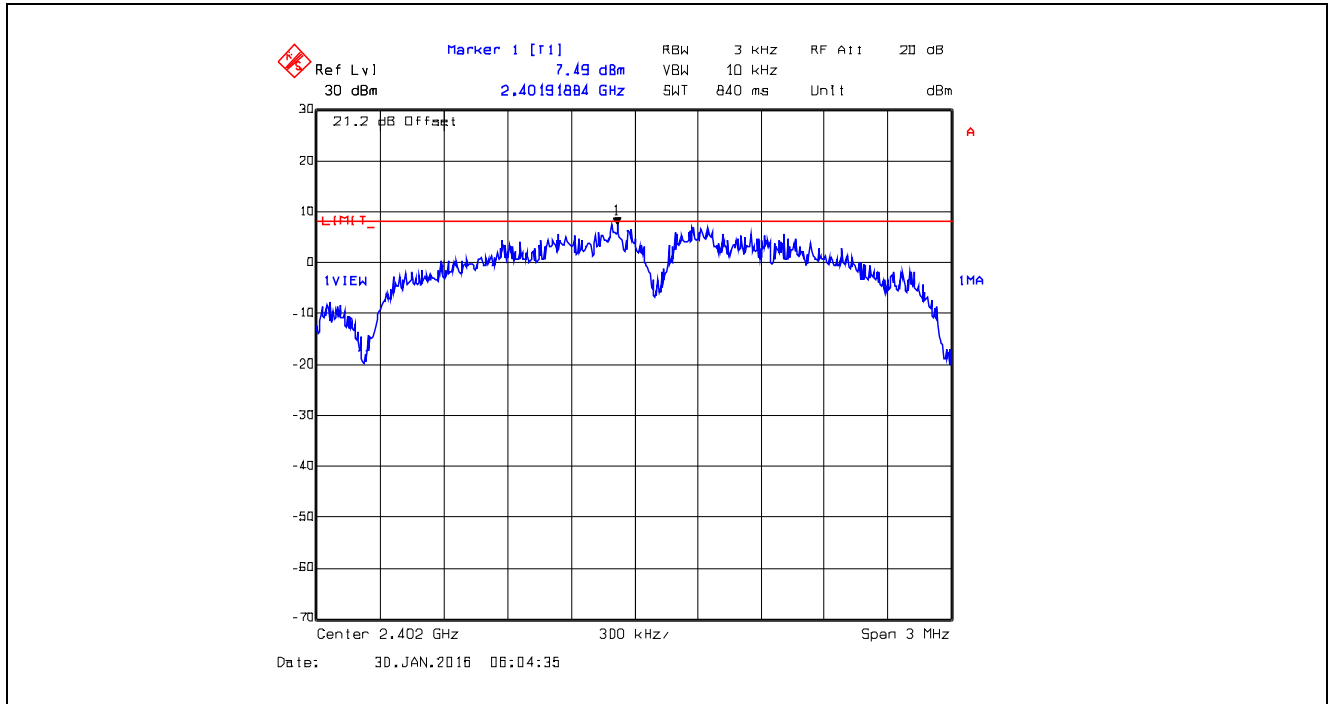
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Plot 5.6.4.19. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2402 MHz, Data Rate 2

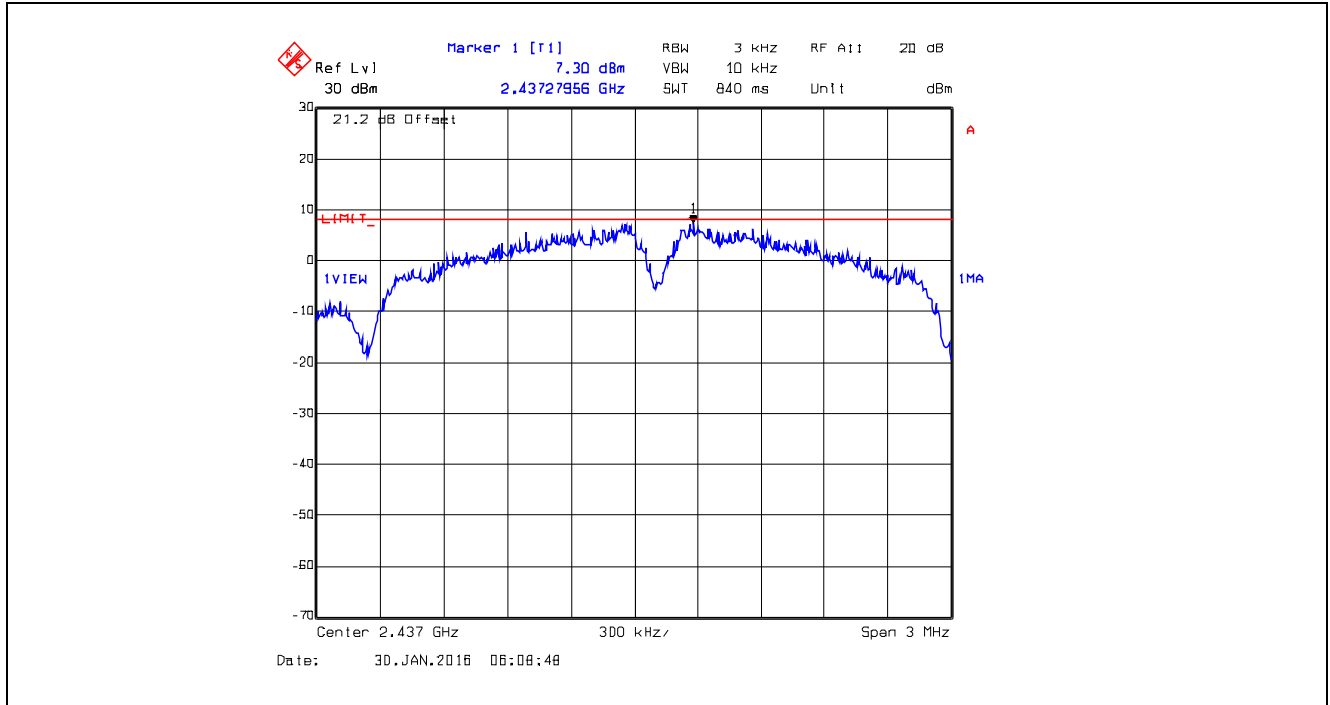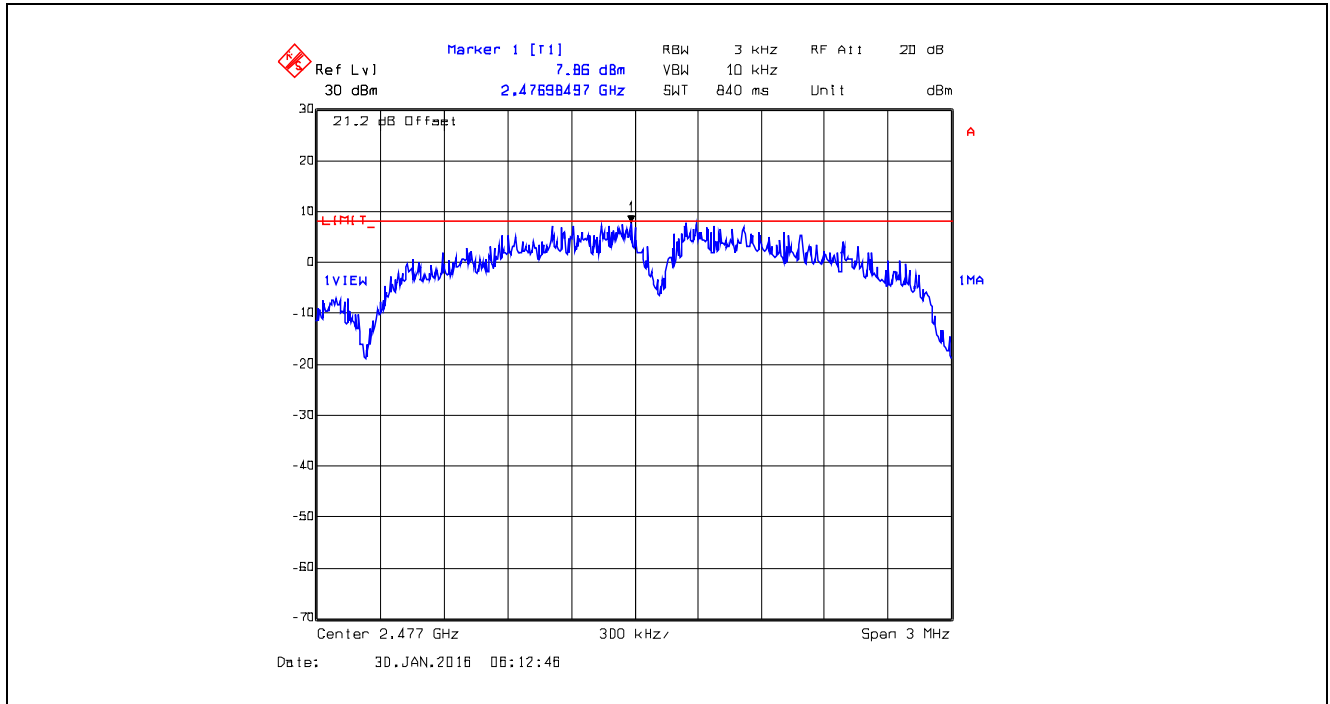**Plot 5.6.4.20.** Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2437 MHz, Data Rate 2

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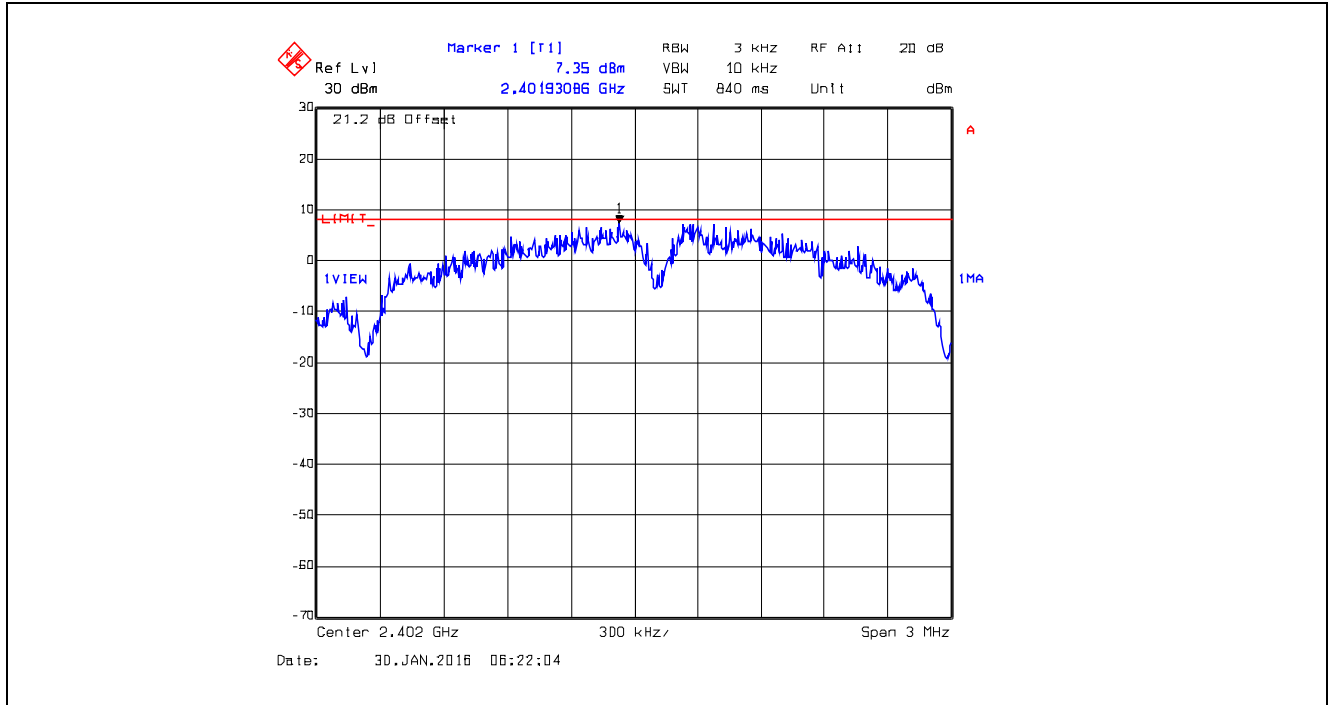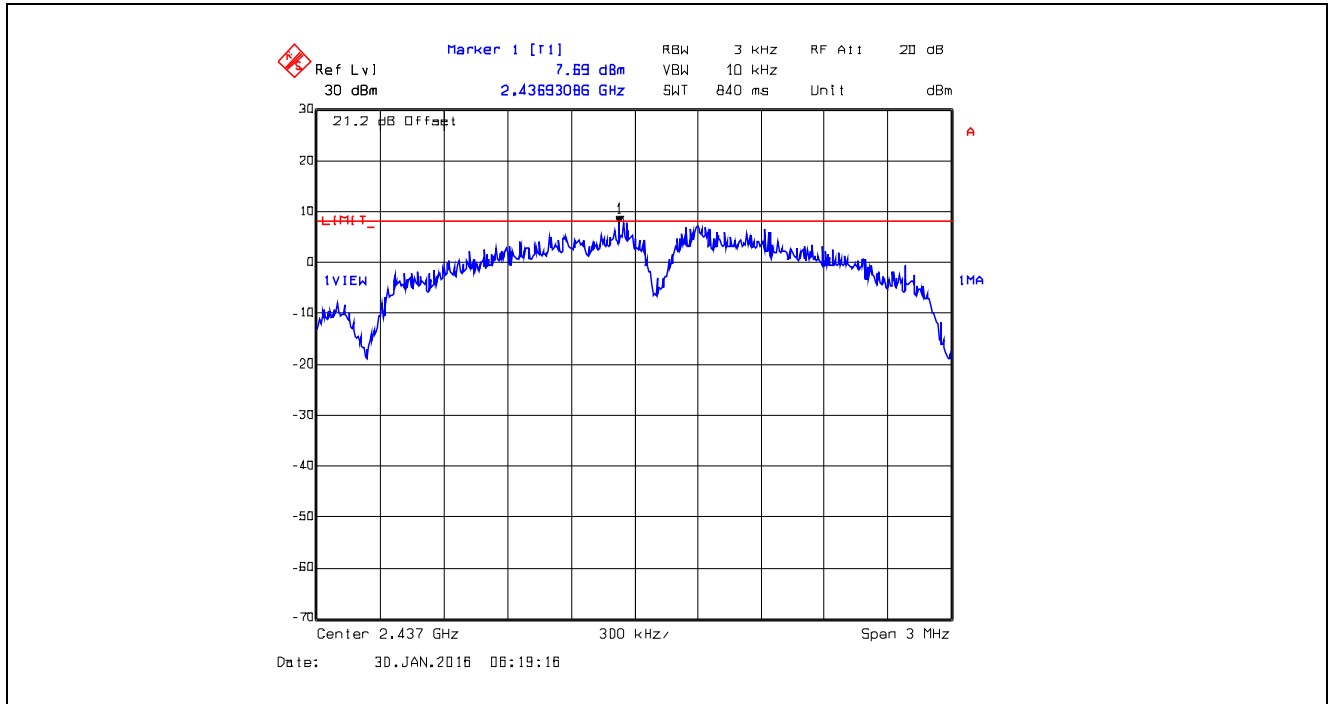
Plot 5.6.4.21. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2477 MHz, Data Rate 2

Plot 5.6.4.22. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2402 MHz, Data Rate 3

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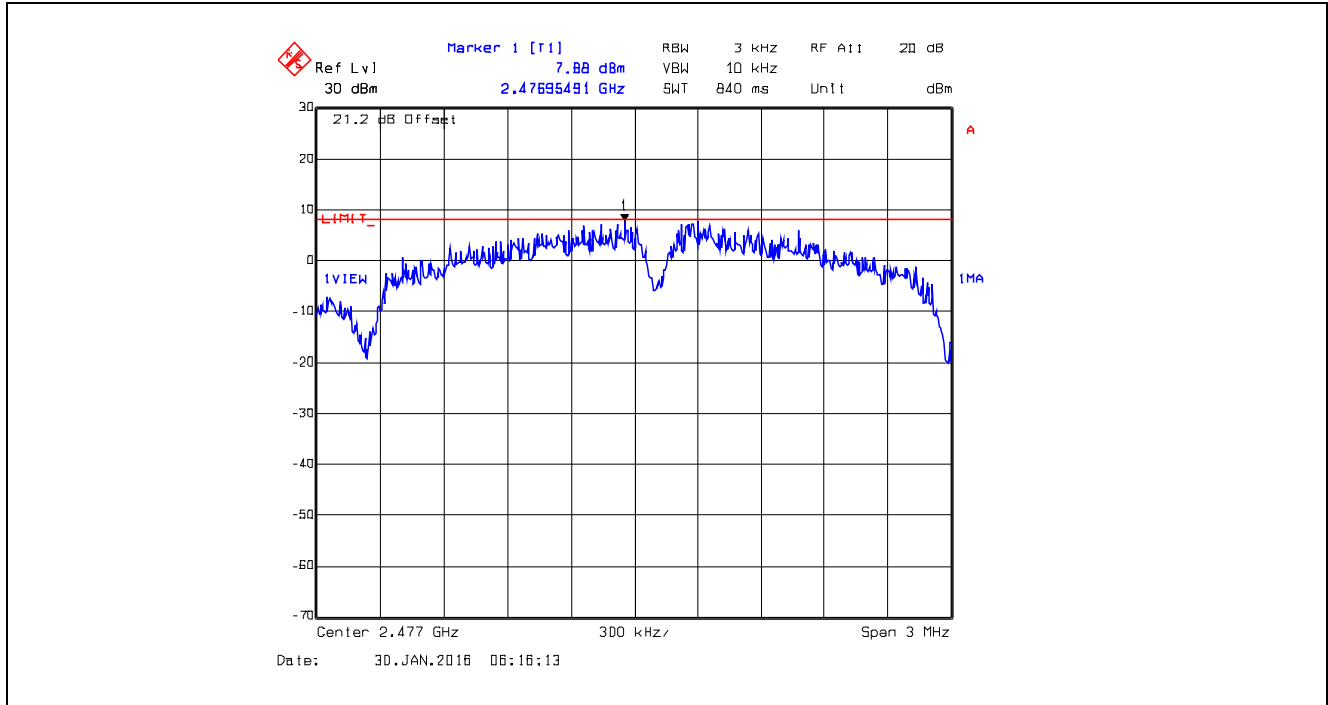
Plot 5.6.4.23. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2437 MHz, Data Rate 3

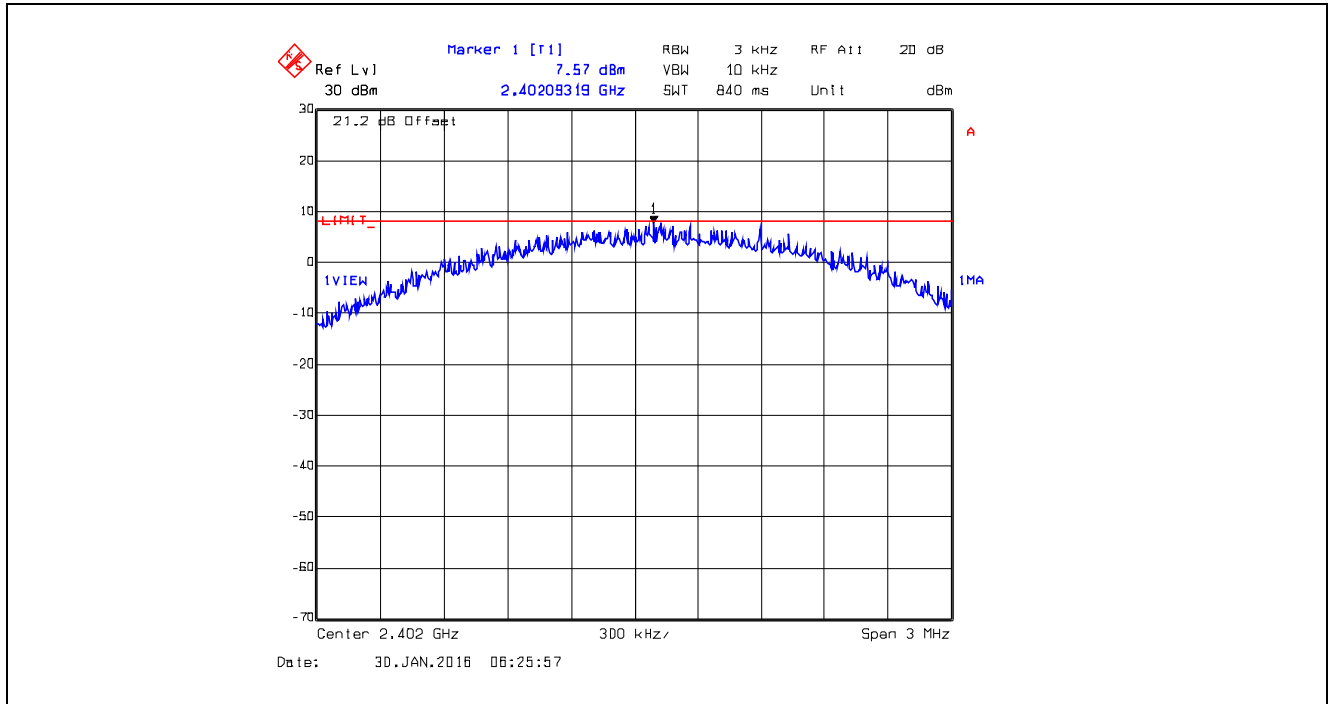**Plot 5.6.4.24.** Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 18, 2477 MHz, Data Rate 3

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Plot 5.6.4.25. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 1

Plot 5.6.4.26. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 1
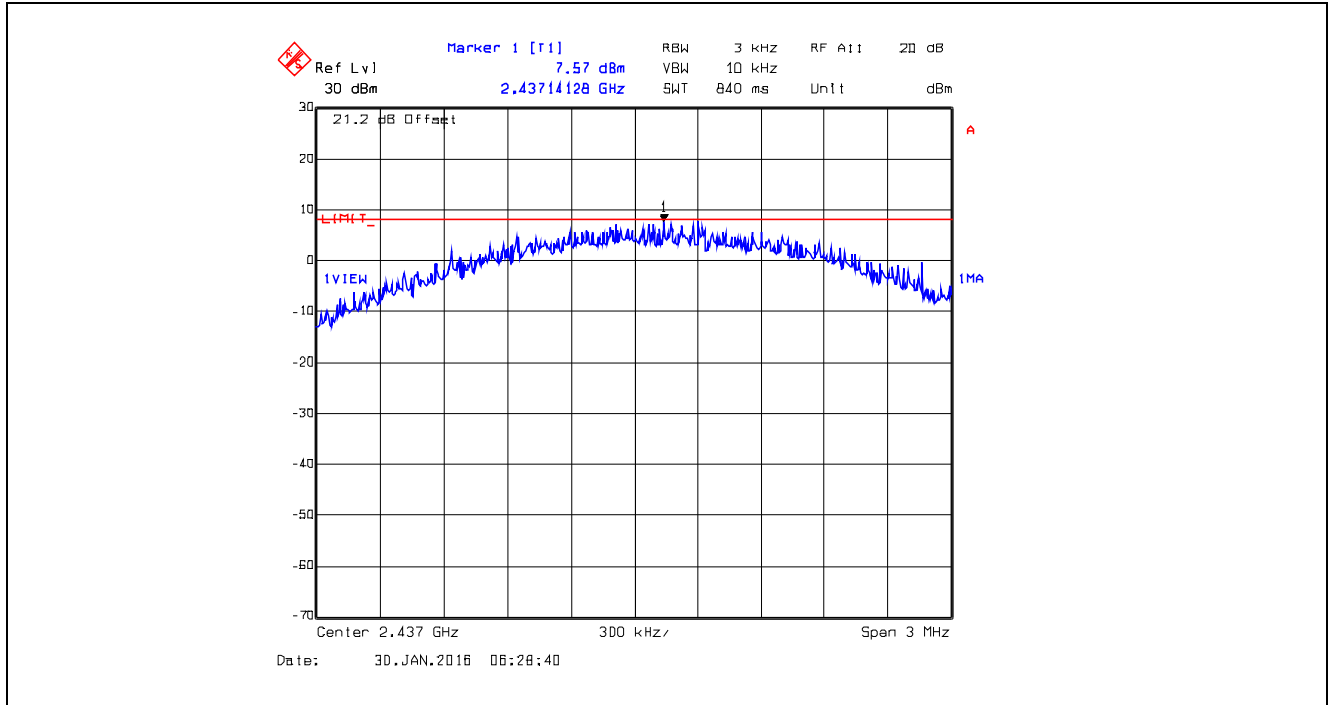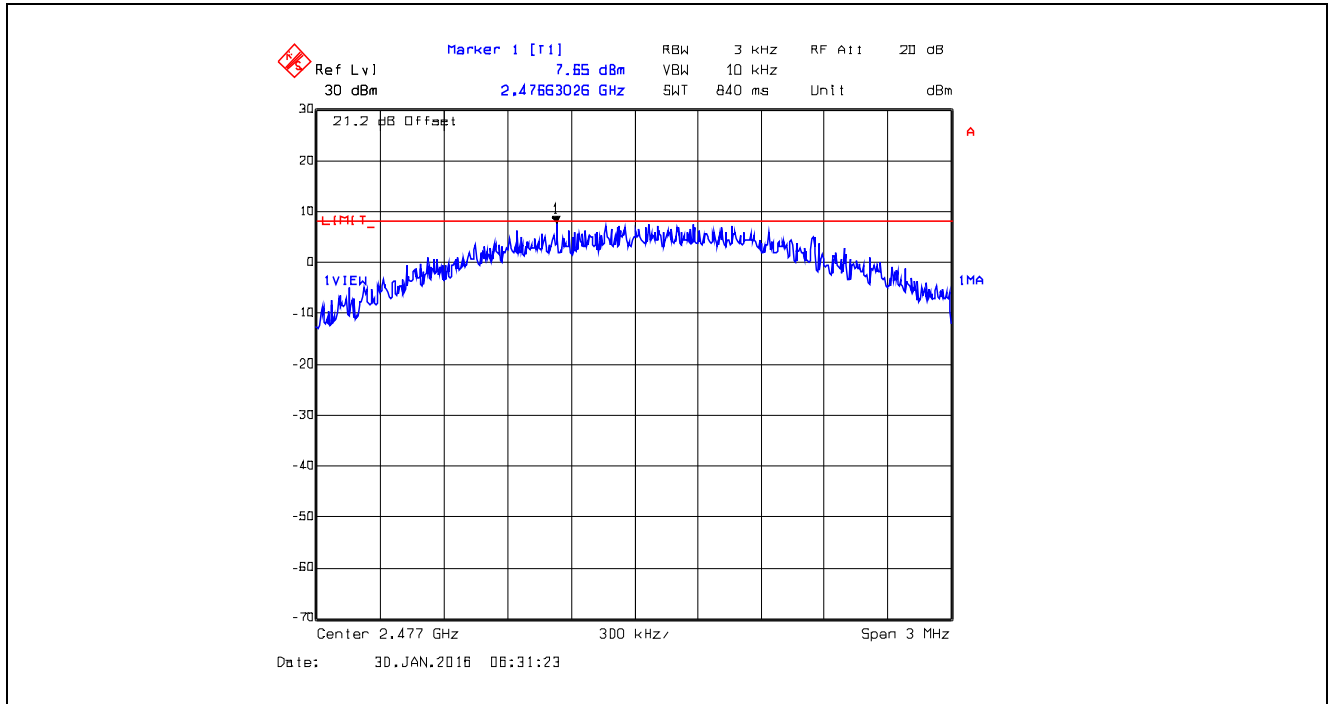
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.6.4.27. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 1

Plot 5.6.4.28. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 2
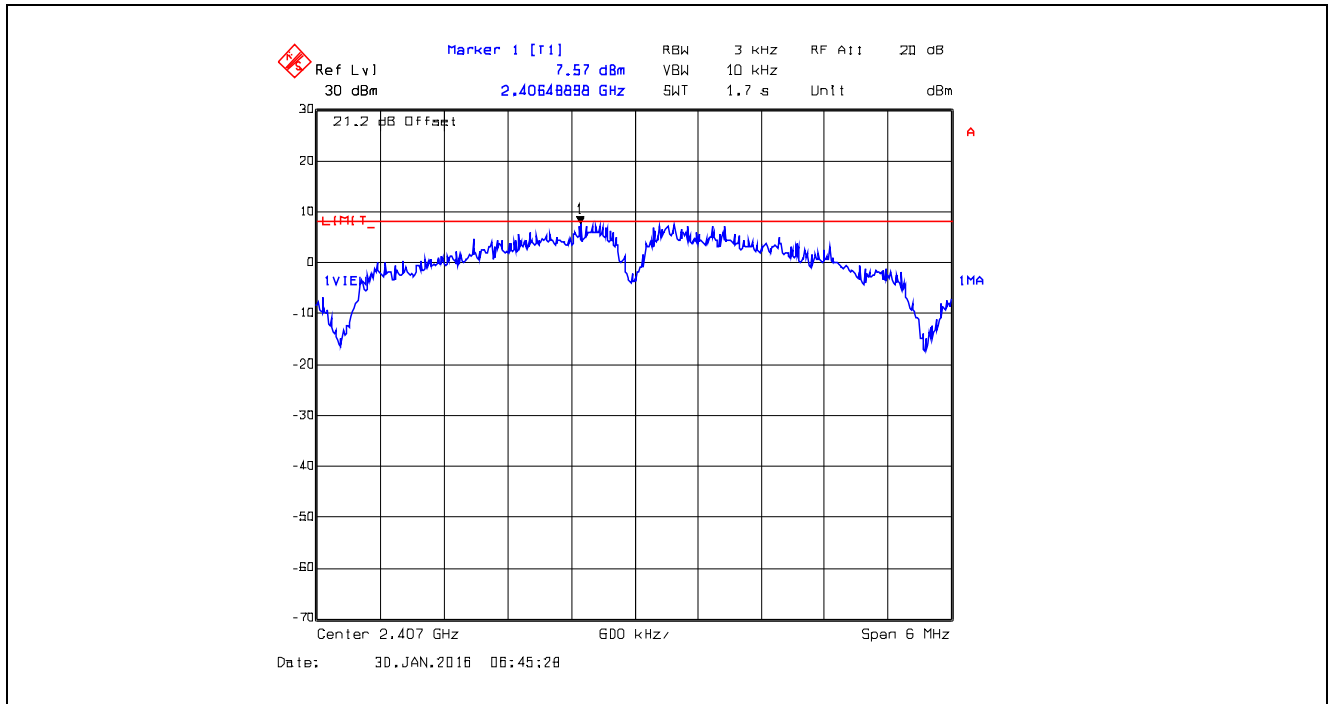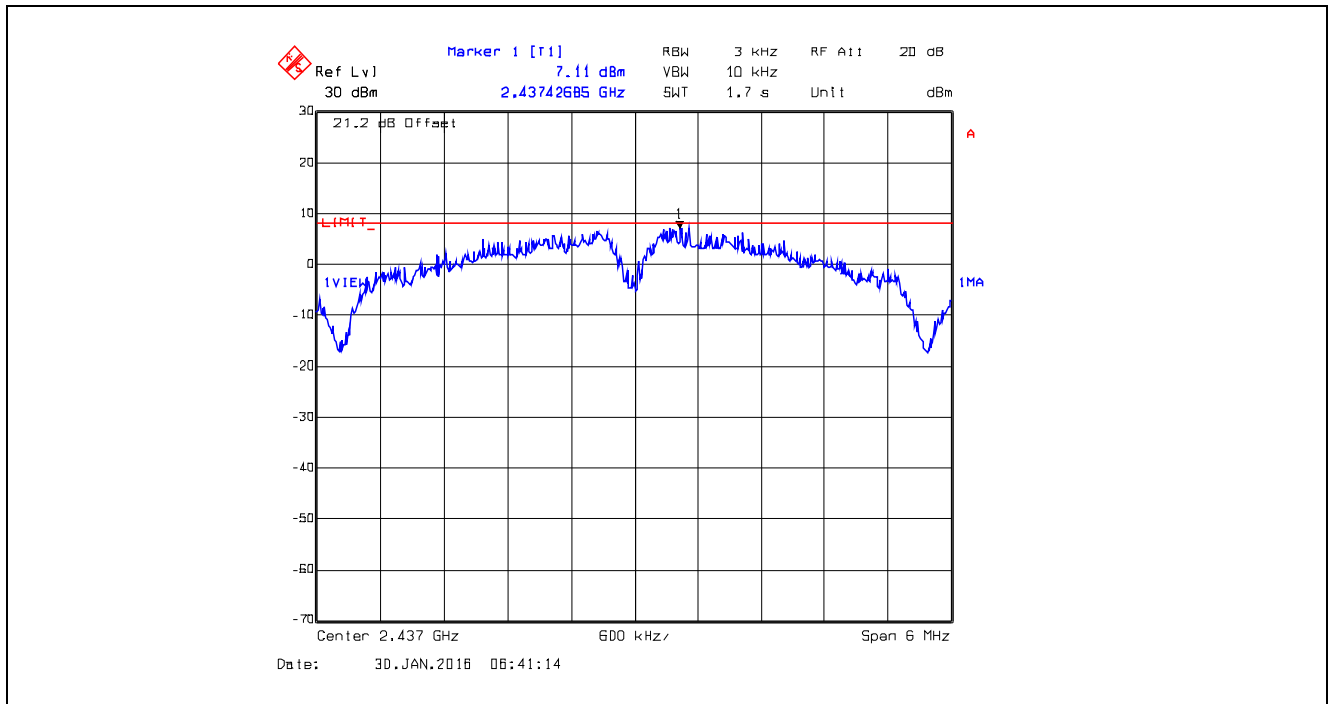
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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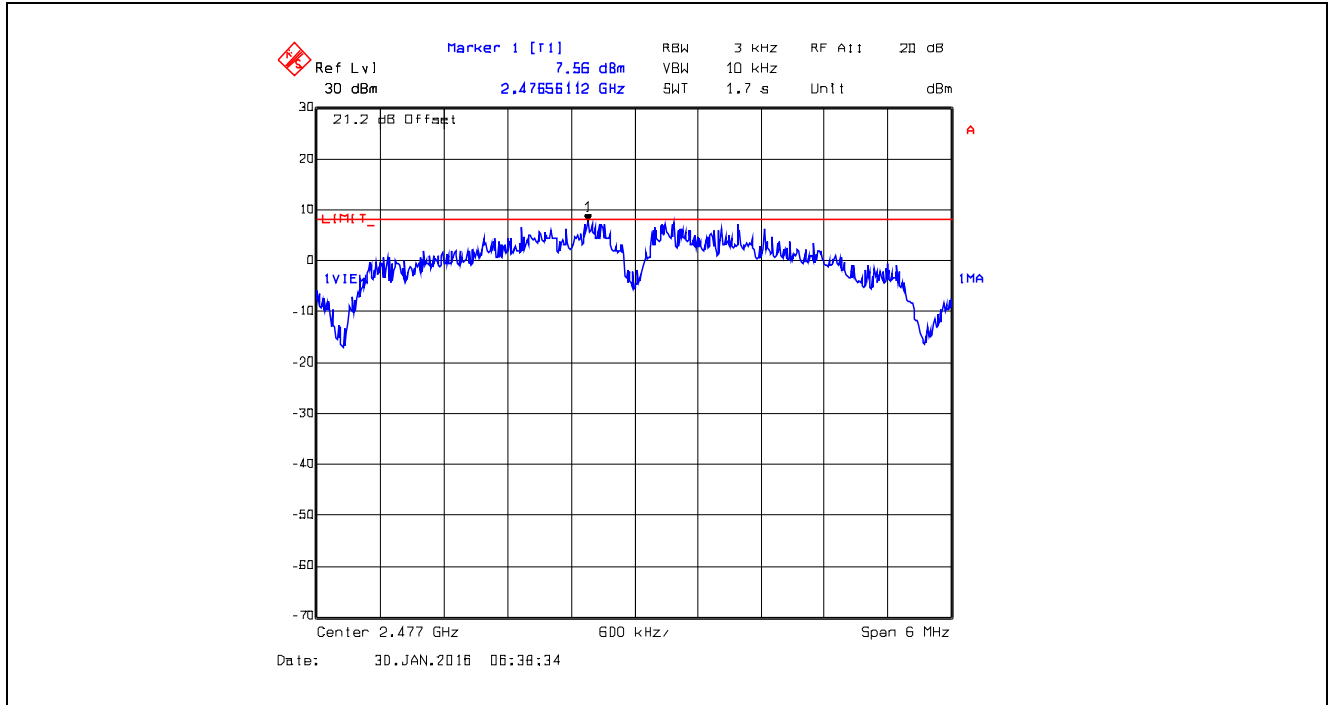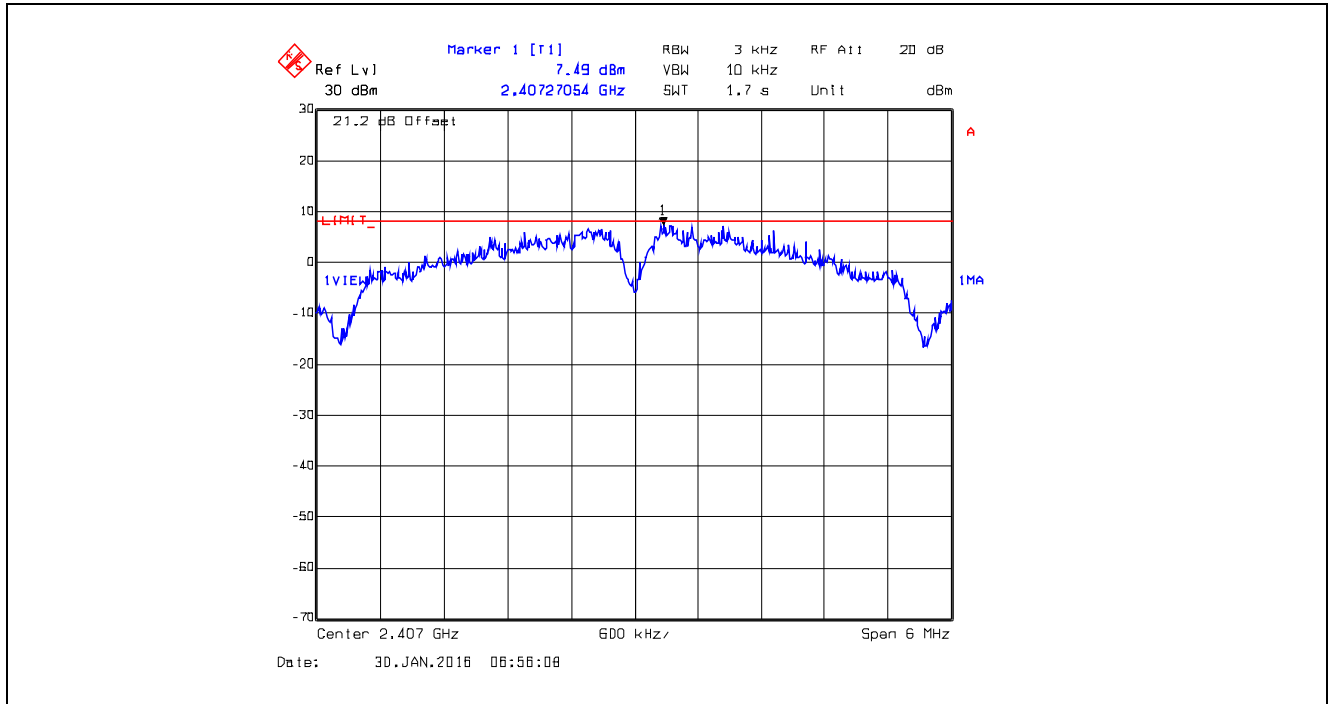
Plot 5.6.4.29. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 2

Plot 5.6.4.30. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 2

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Plot 5.6.4.31. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 3

Plot 5.6.4.32. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 3
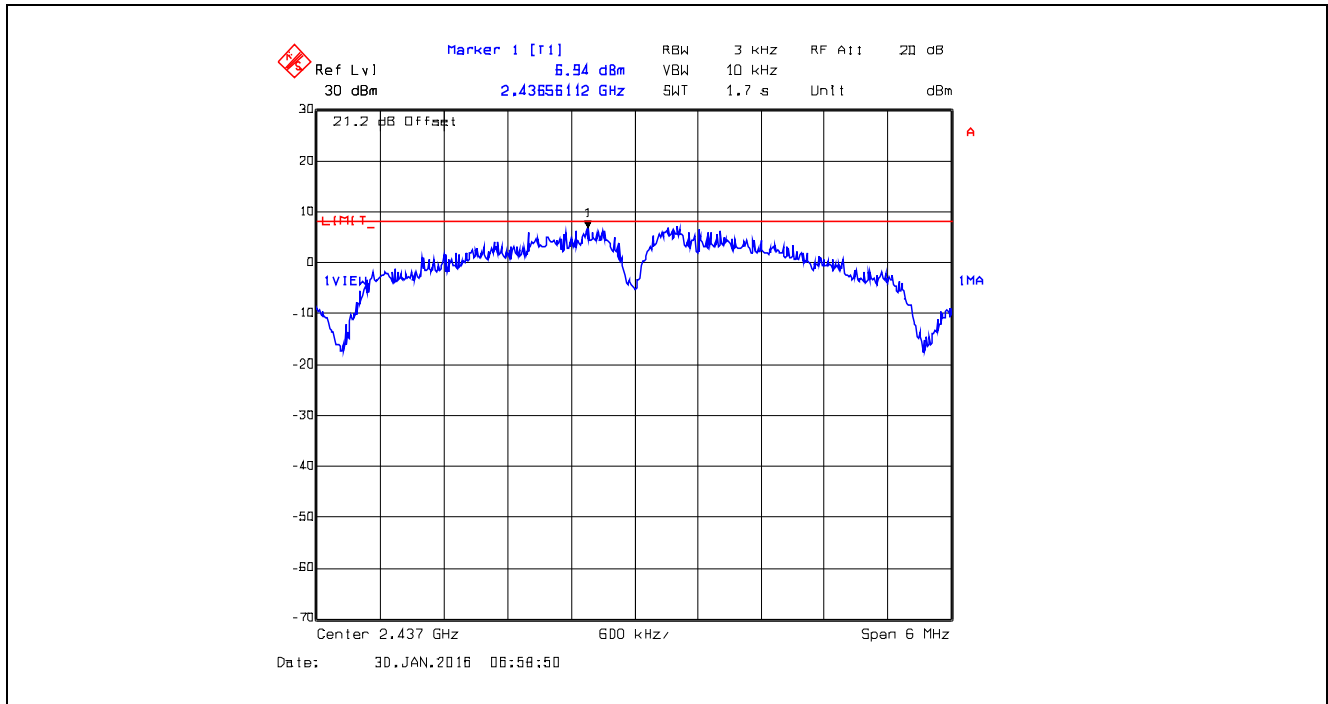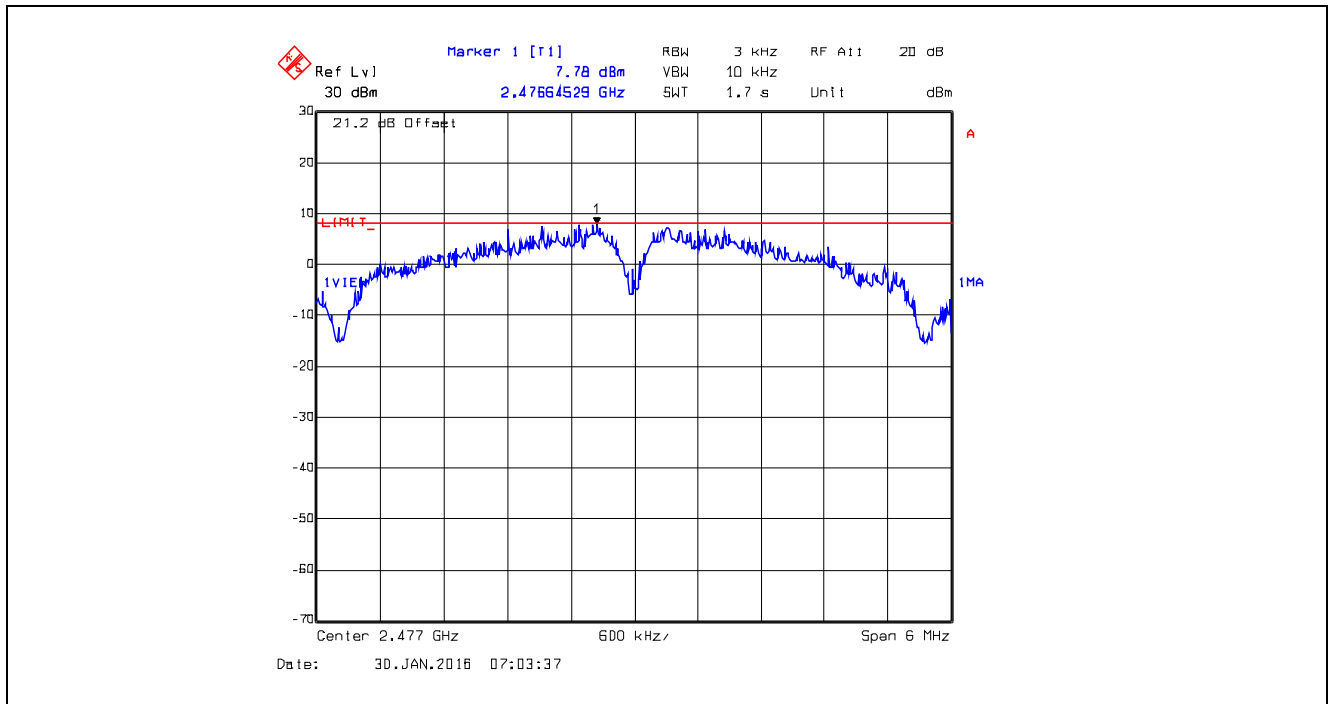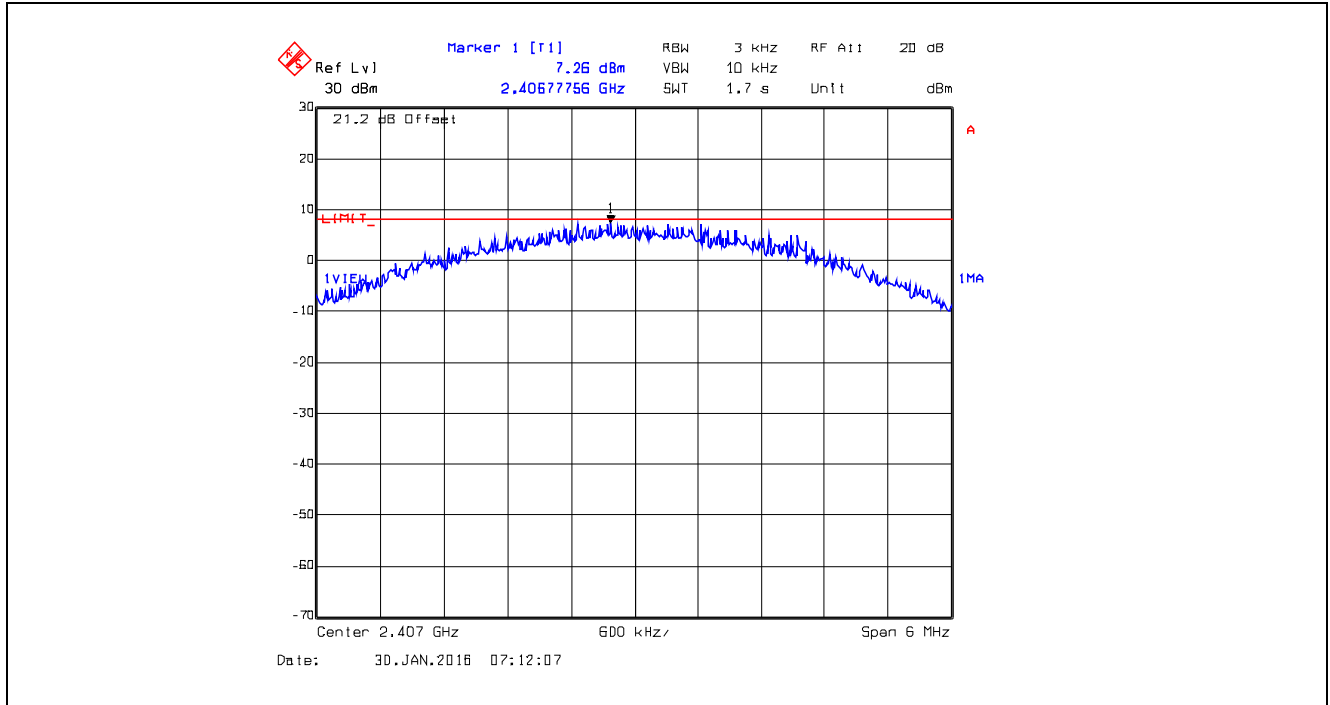
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Plot 5.6.4.33. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 3

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Plot 5.6.4.34. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 4

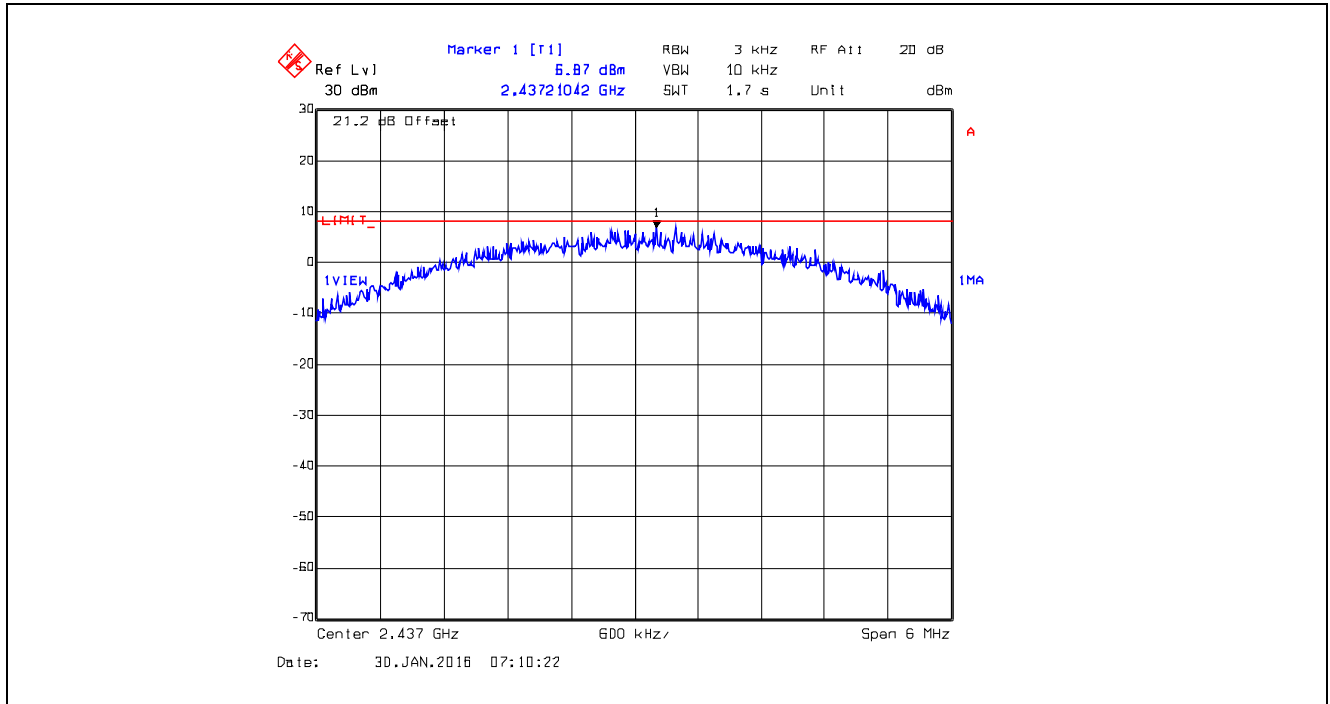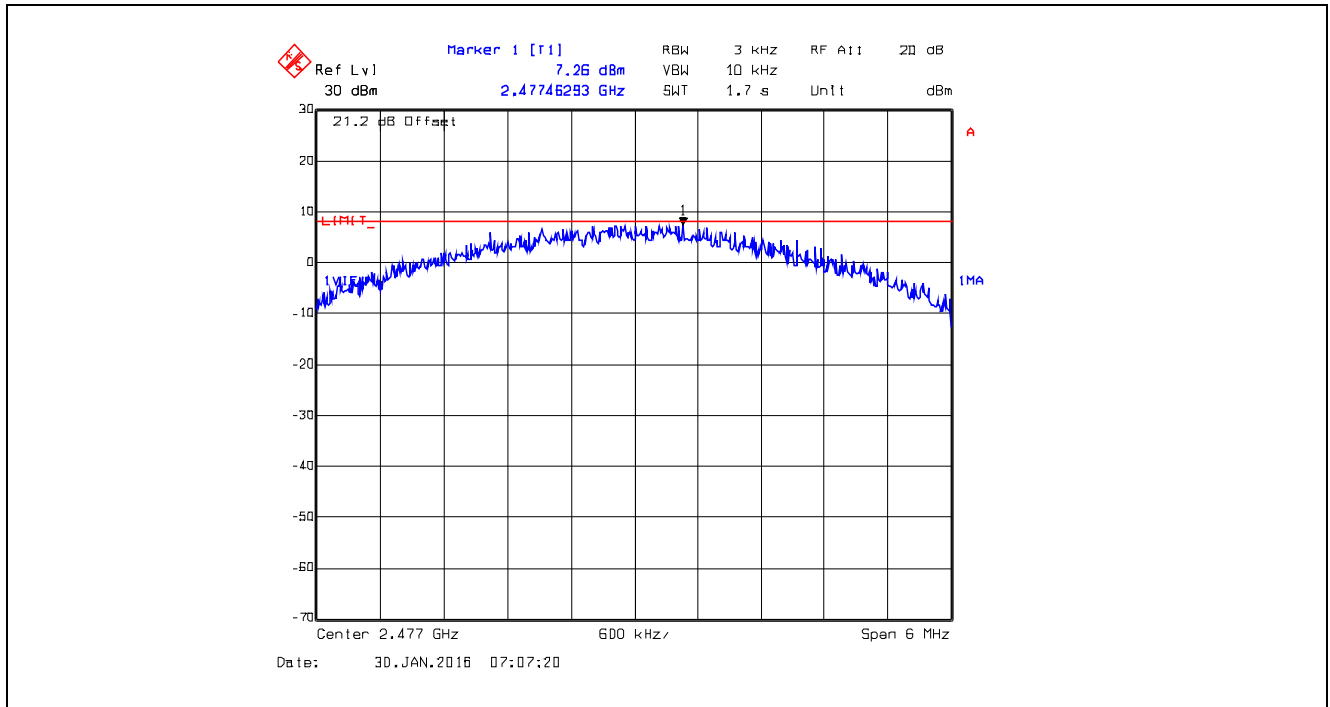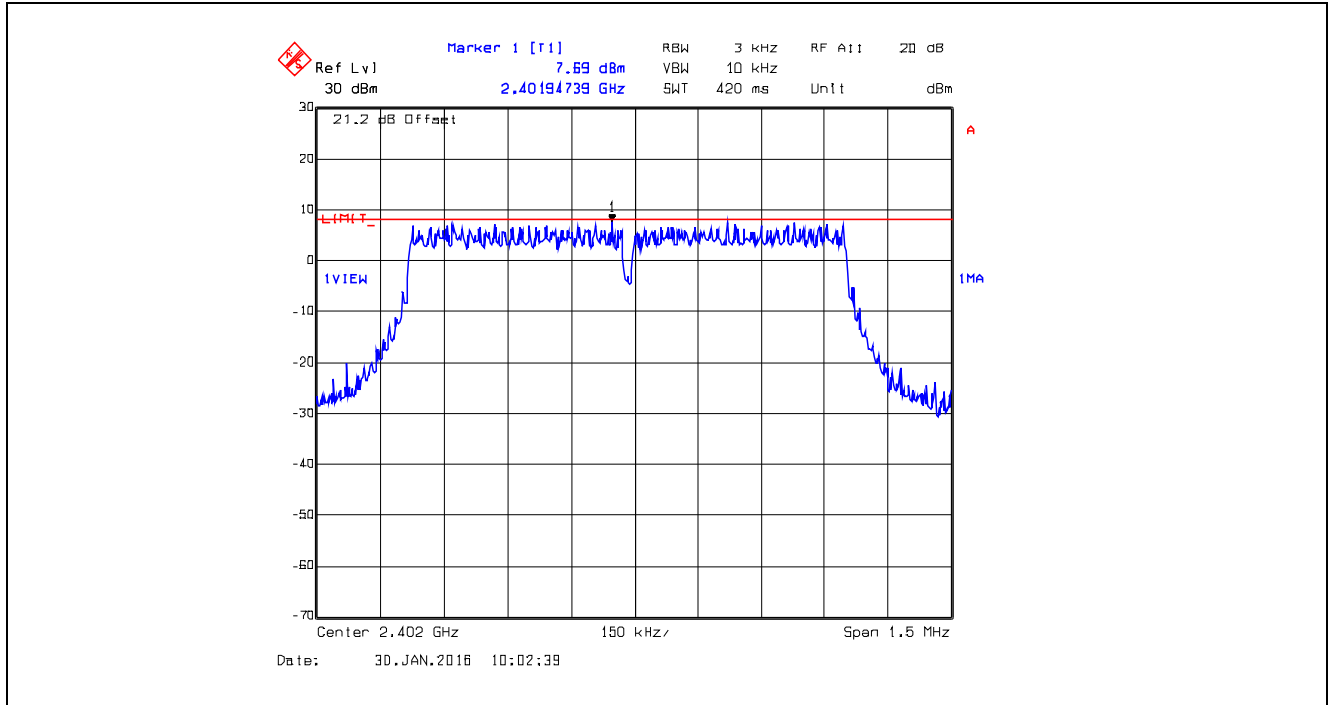**Plot 5.6.4.35.** Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 4

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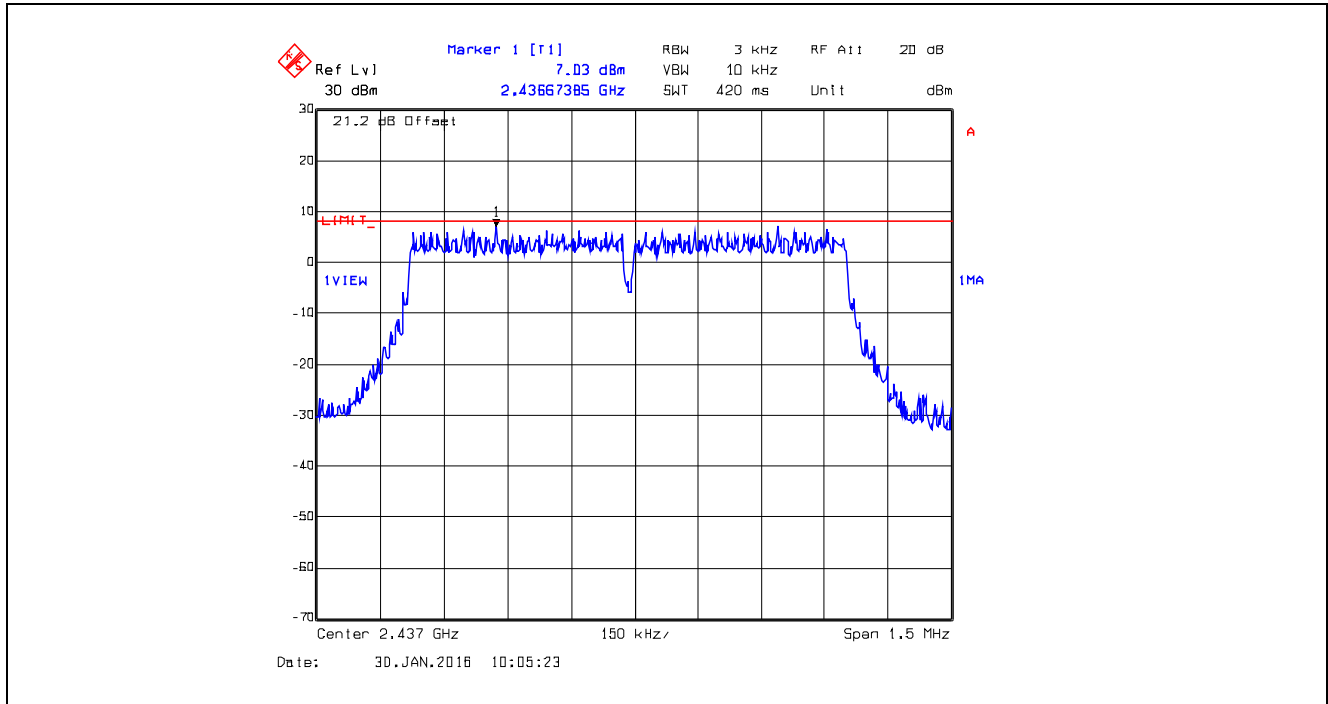
Plot 5.6.4.36. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 4

Plot 5.6.4.37. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 5

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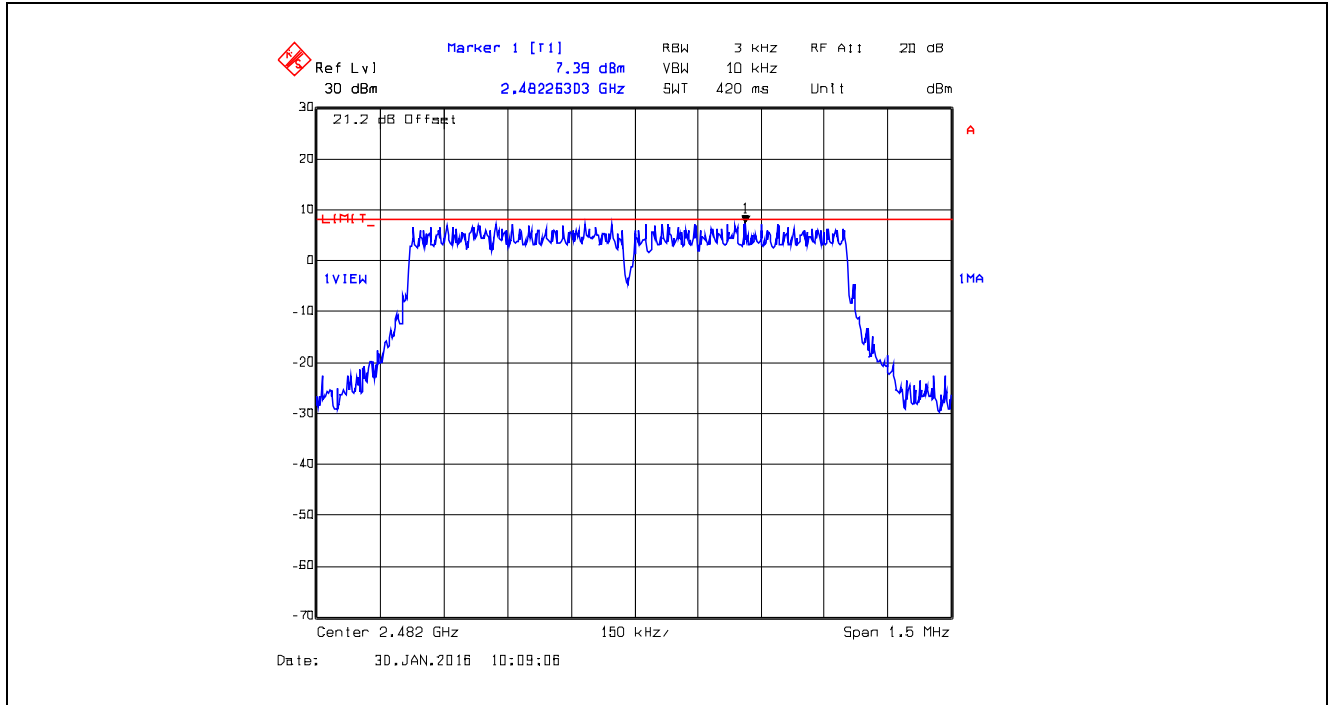
Plot 5.6.4.38. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 5

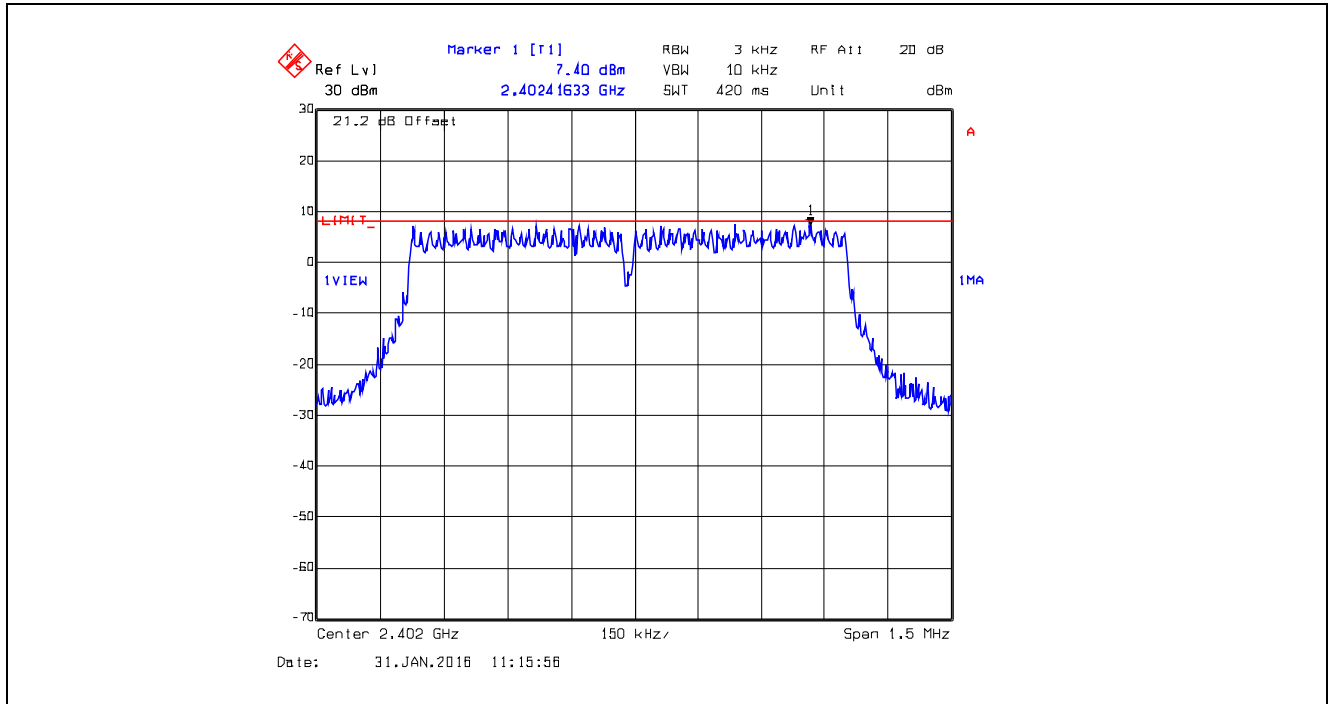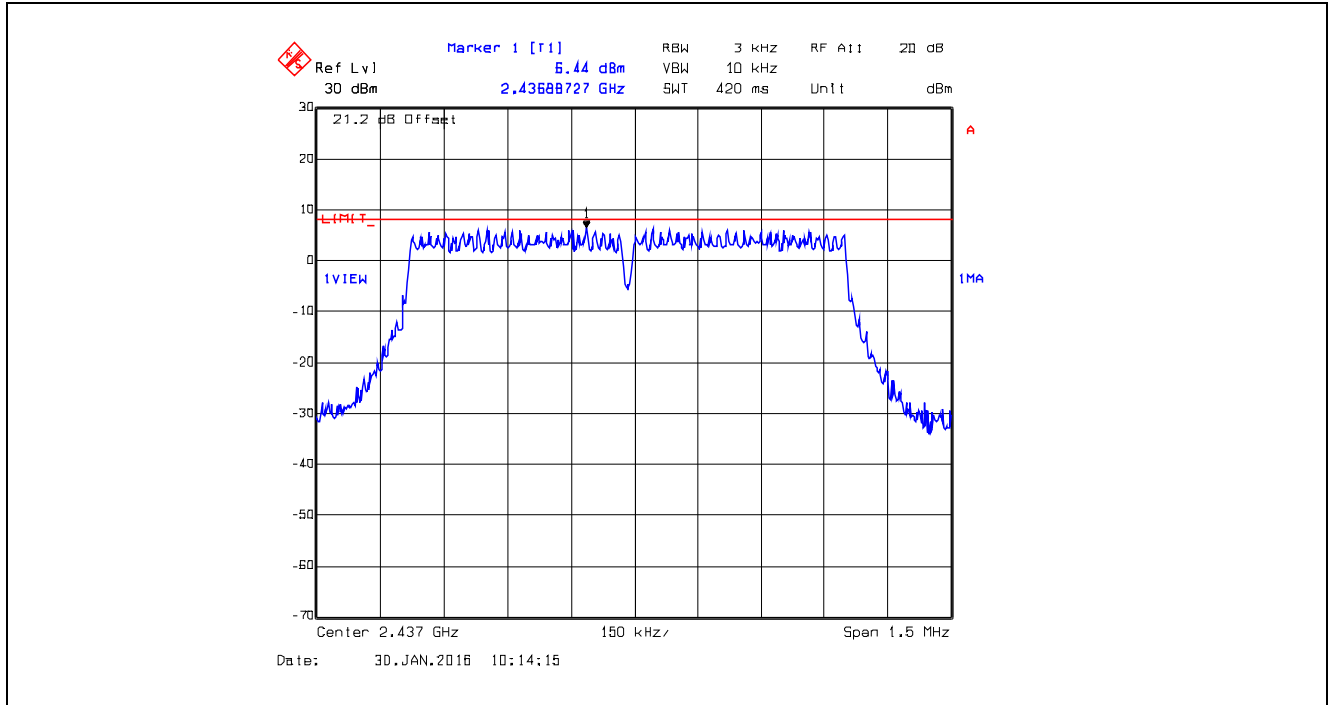**Plot 5.6.4.39.** Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 5

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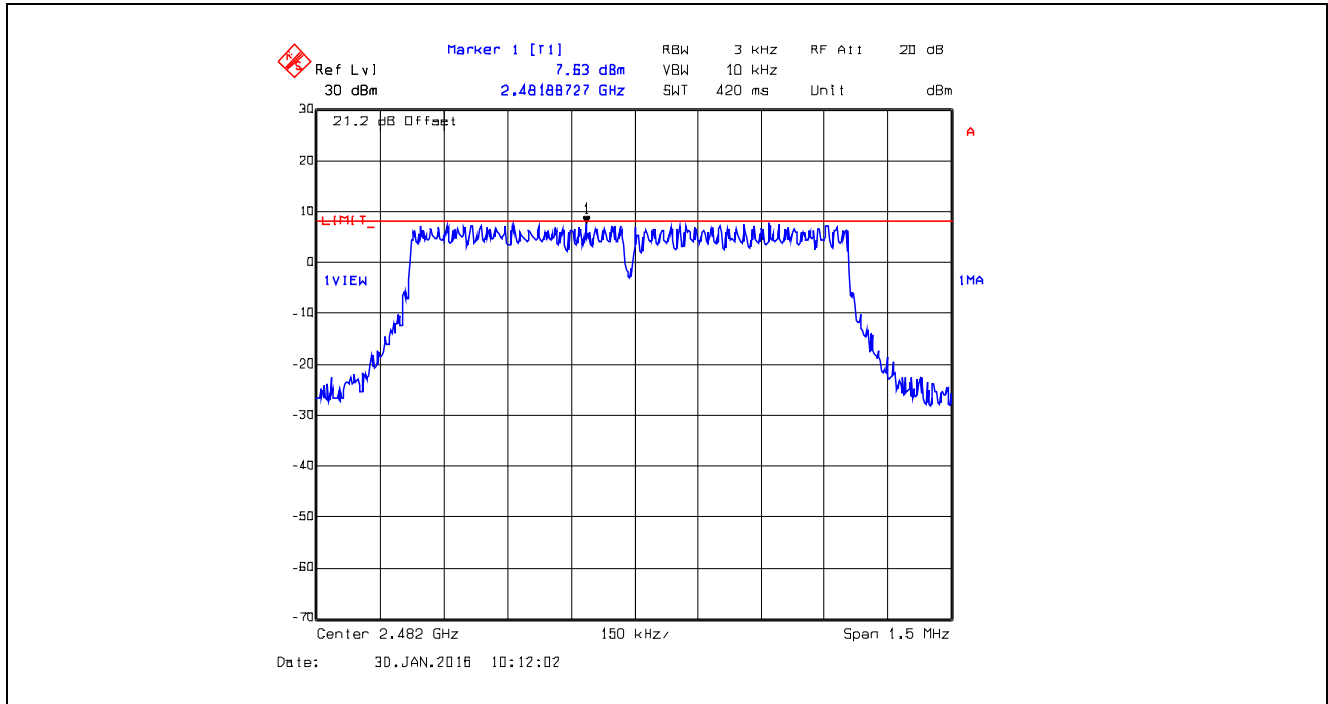
Plot 5.6.4.40. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 6

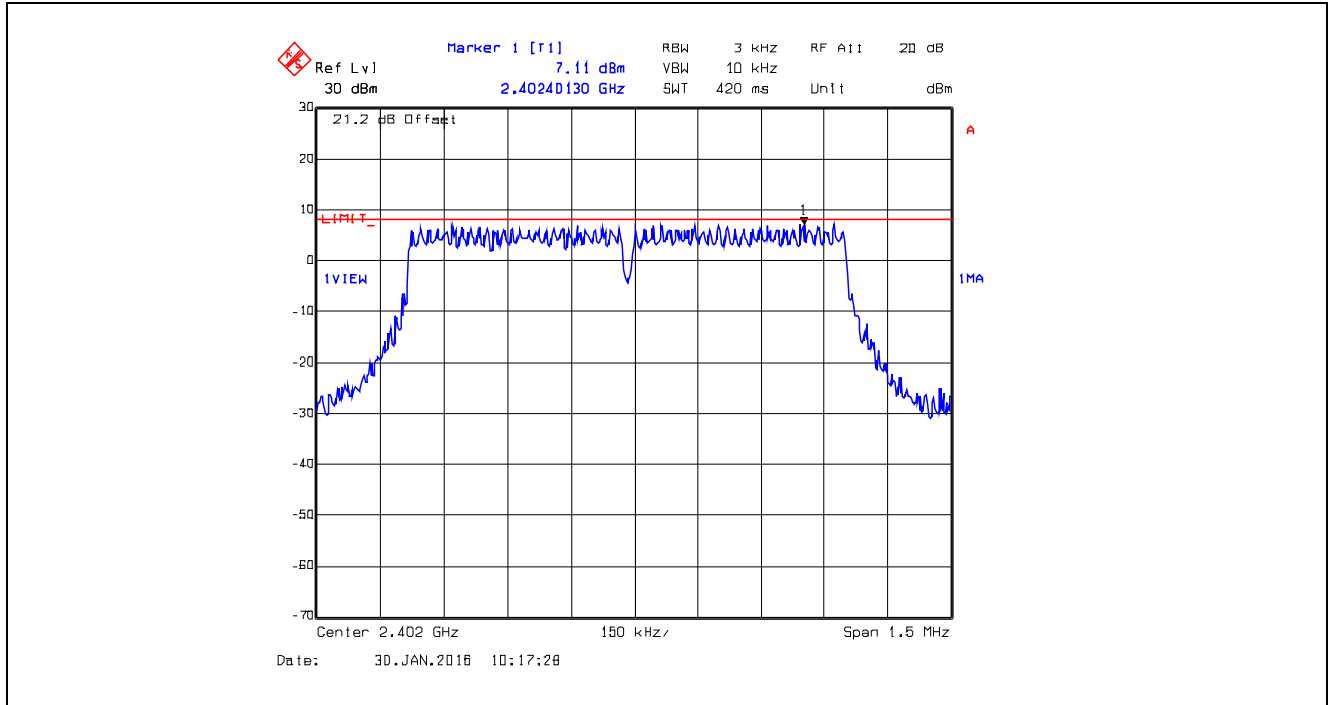**Plot 5.6.4.41.** Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 6

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**

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Plot 5.6.4.42. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 6

Plot 5.6.4.43. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2402 MHz, Data Rate 7
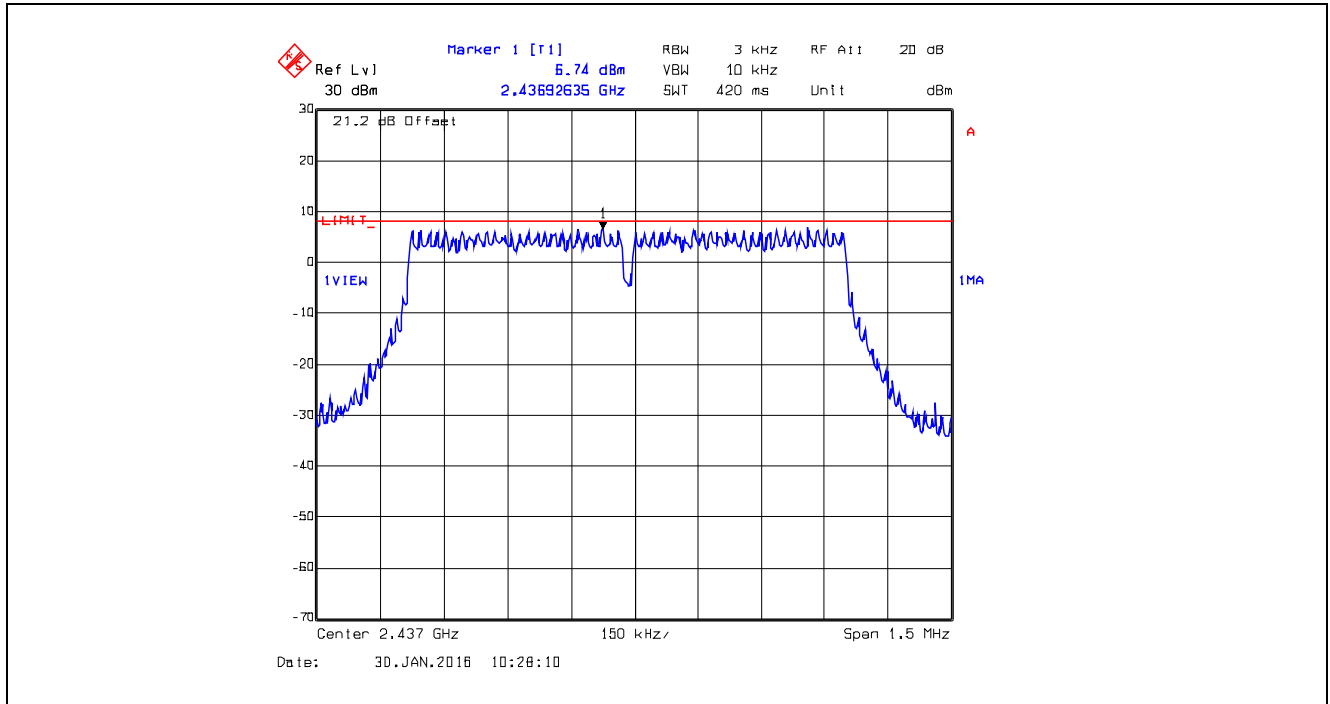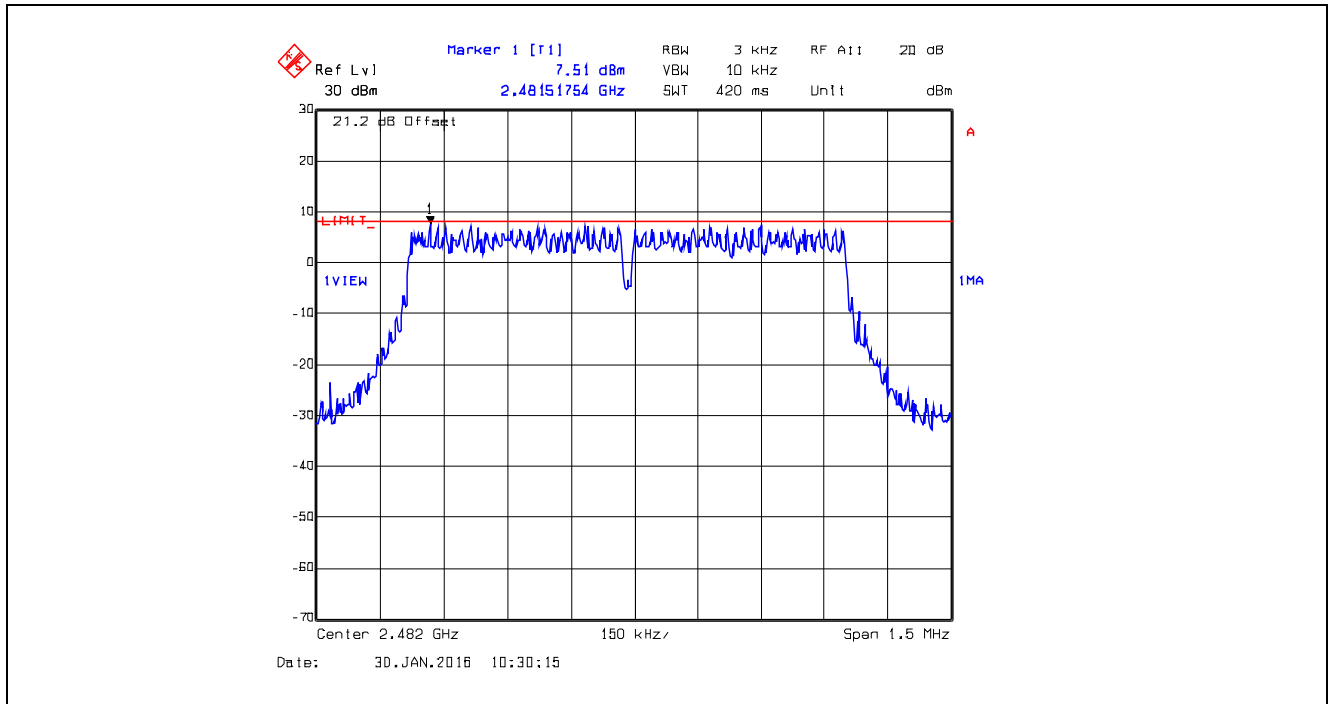
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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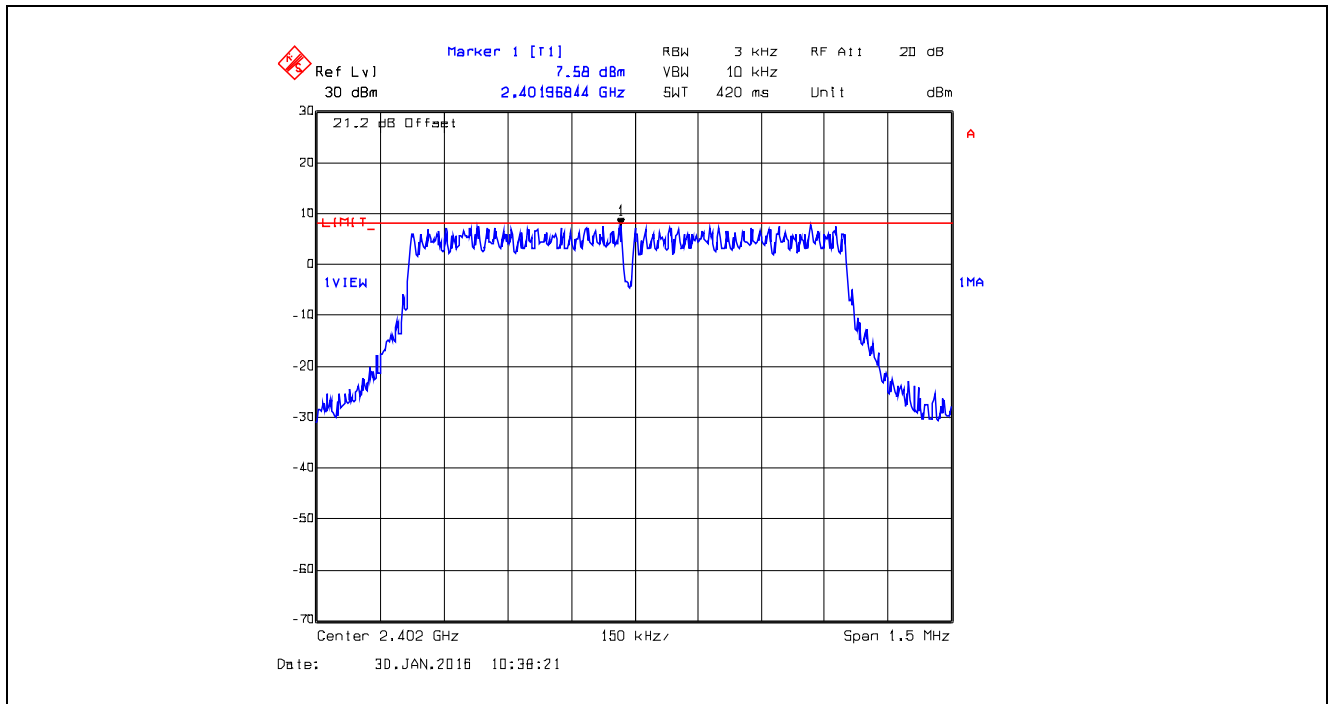
Plot 5.6.4.44. Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2437 MHz, Data Rate 7

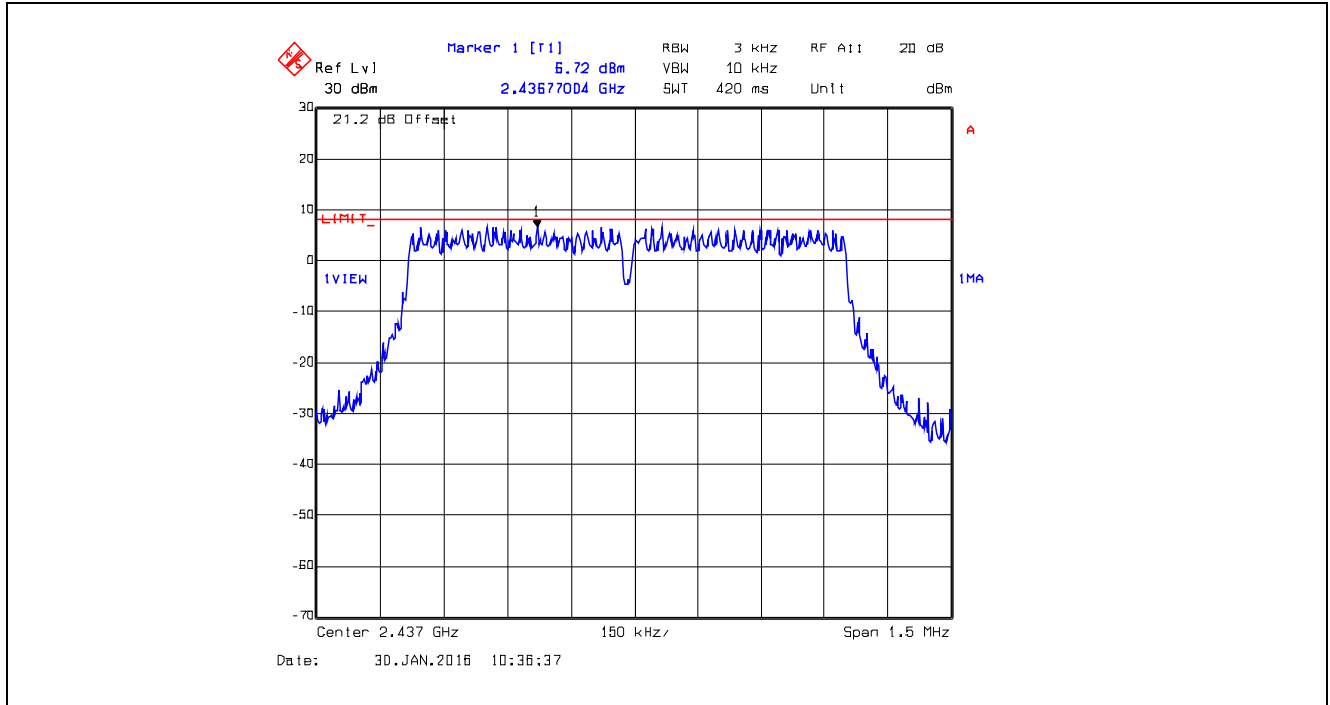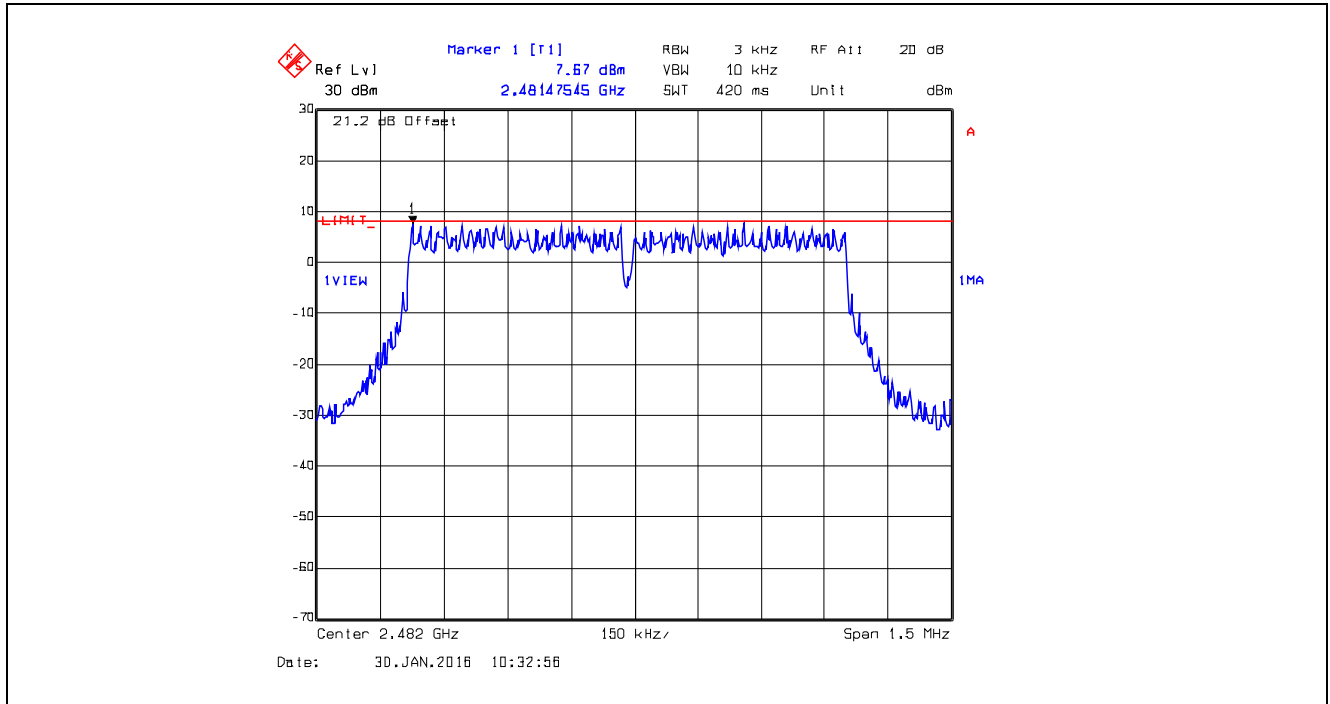**Plot 5.6.4.45.** Power Spectral Density, Bandwidth: 1 MHz, TX Gain: 20, 2482 MHz, Data Rate 7

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Plot 5.6.4.46. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 4

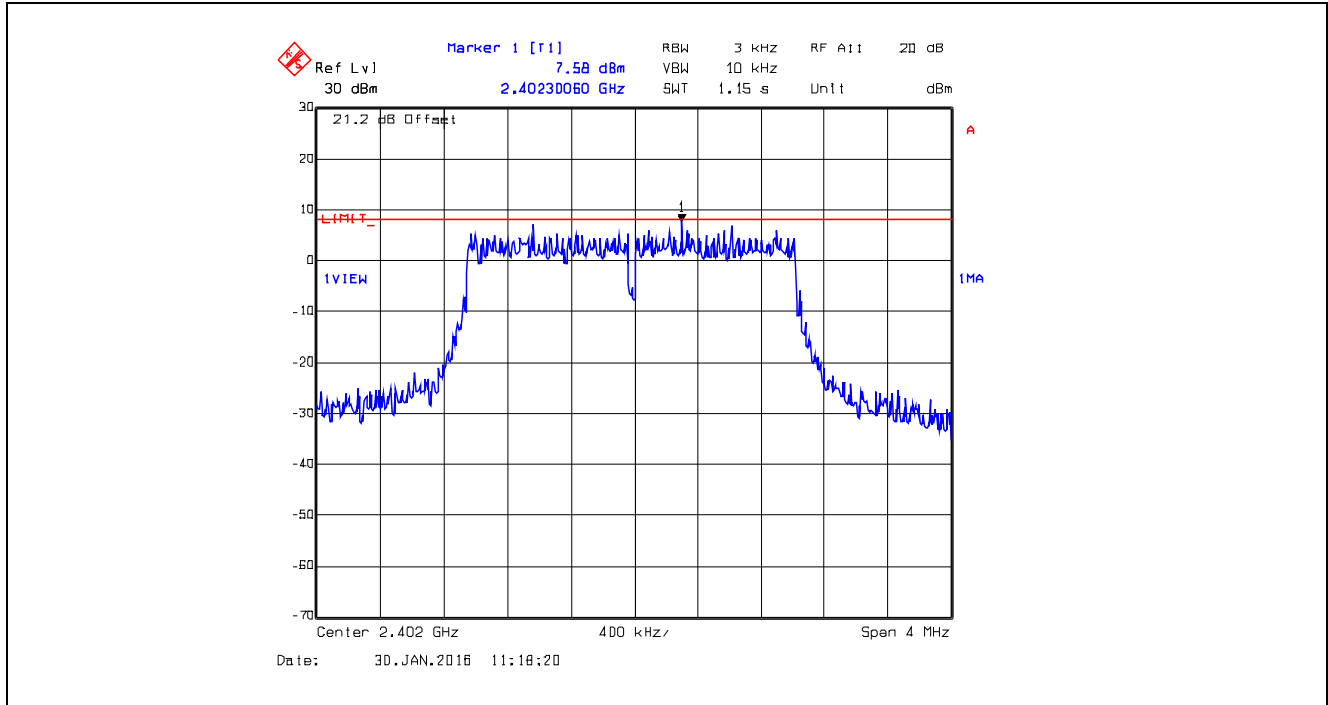**Plot 5.6.4.47.** Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 4

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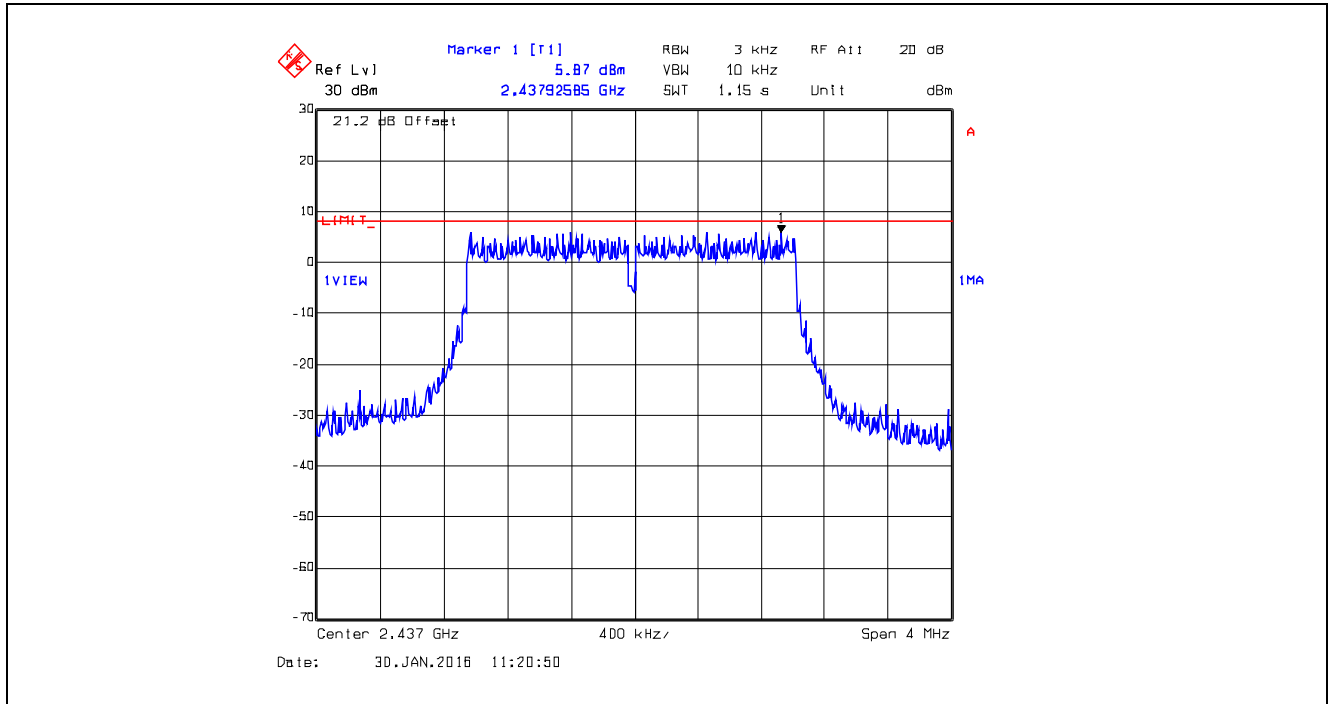
Plot 5.6.4.48. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 4

Plot 5.6.4.49. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 5

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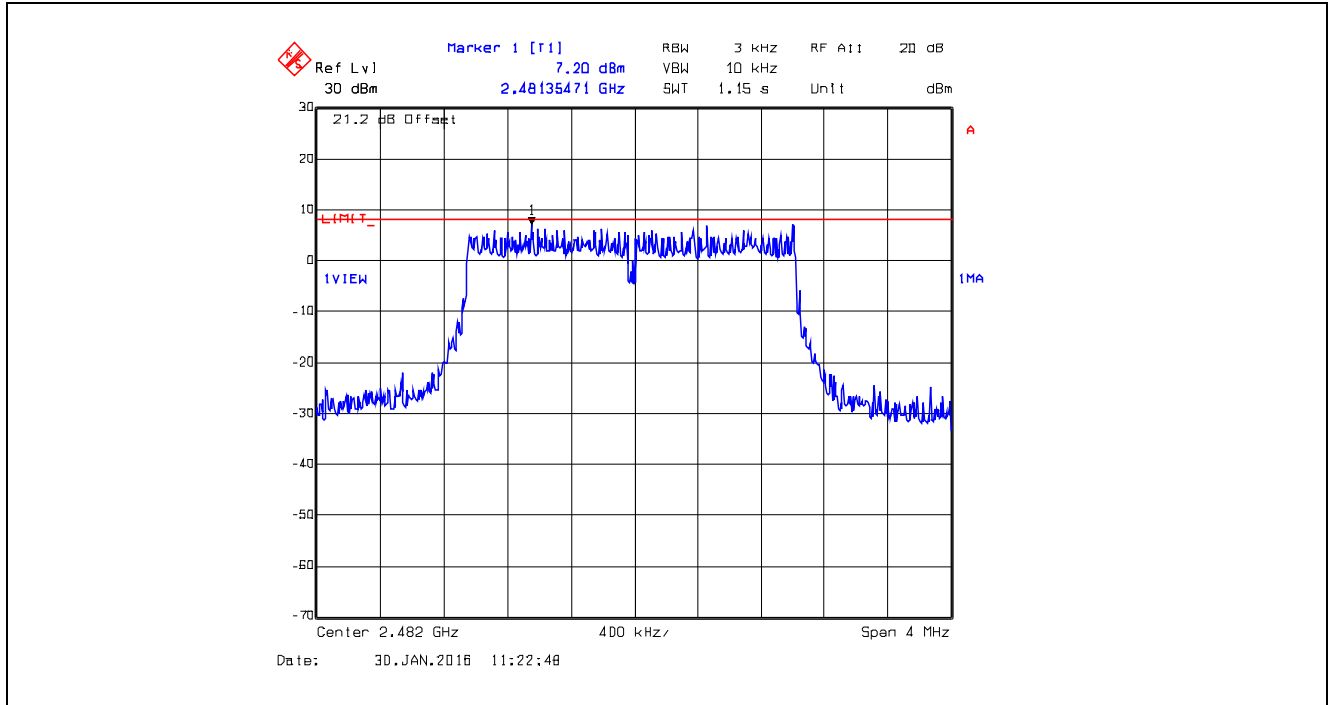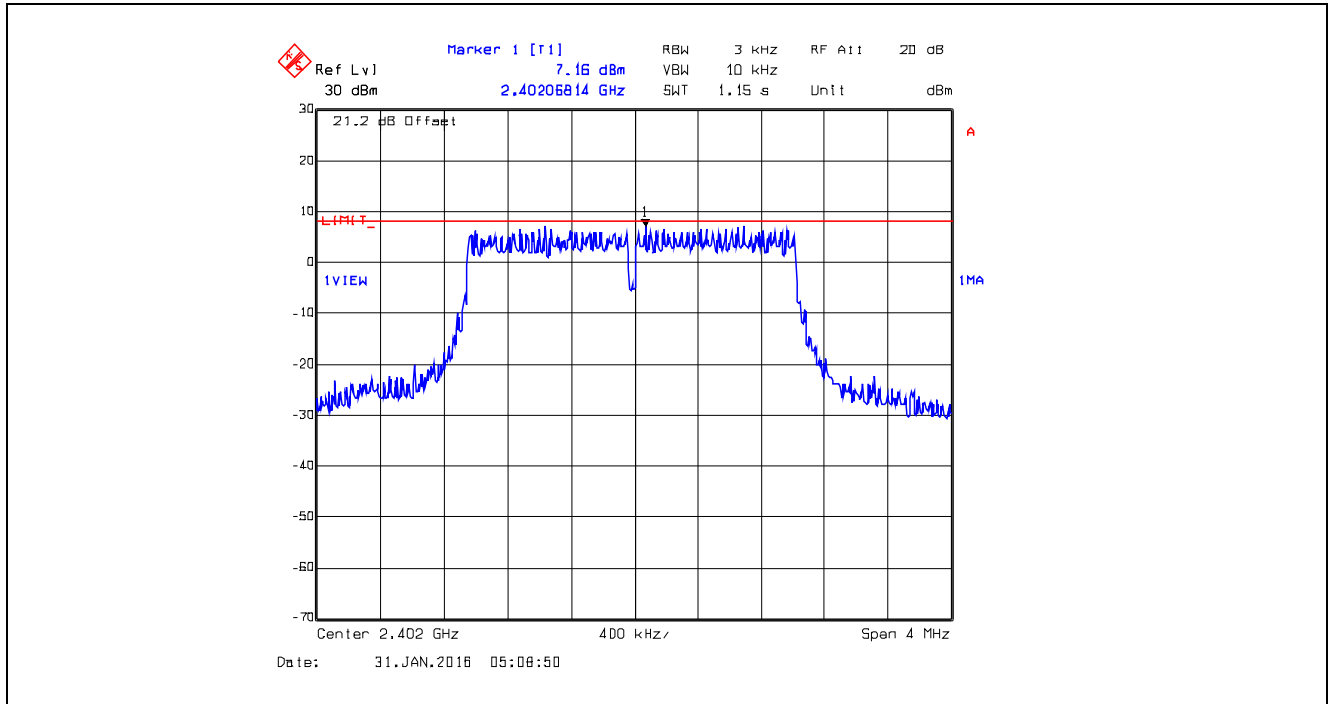
Plot 5.6.4.50. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 5

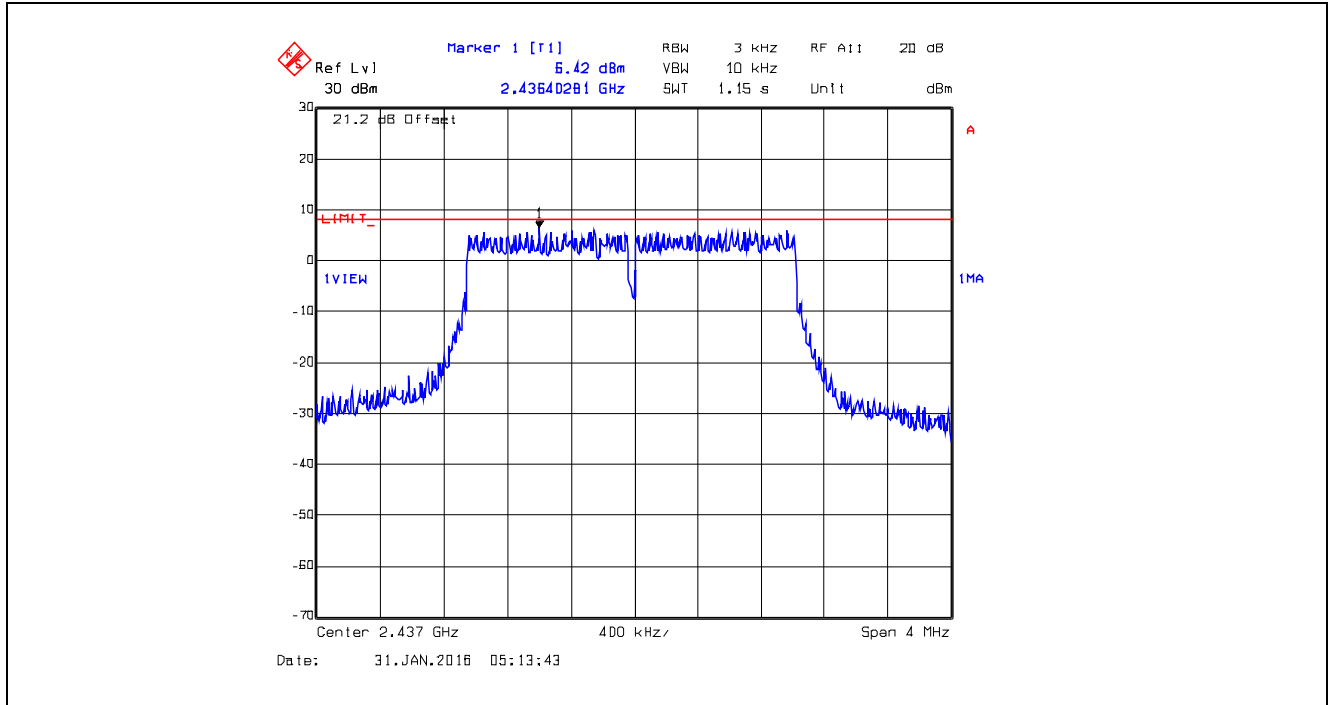**Plot 5.6.4.51.** Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 5

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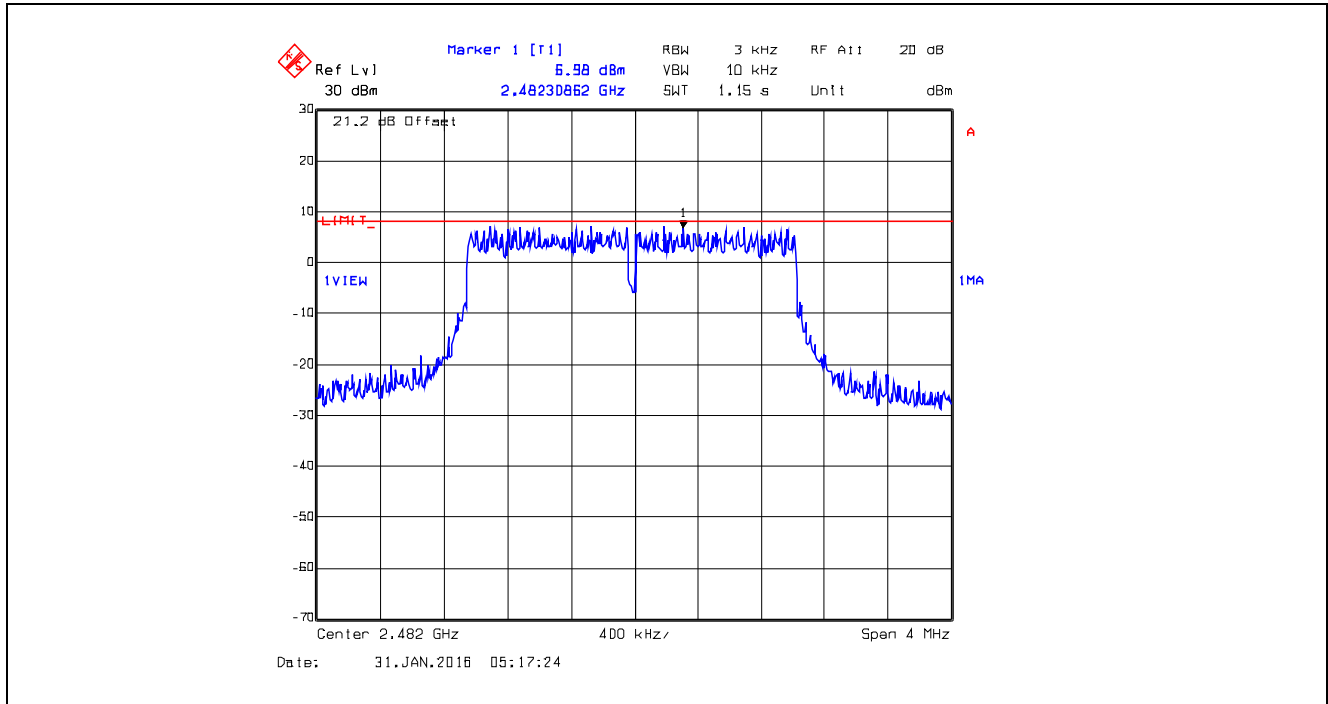
Plot 5.6.4.52. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 6

Plot 5.6.4.53. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 6

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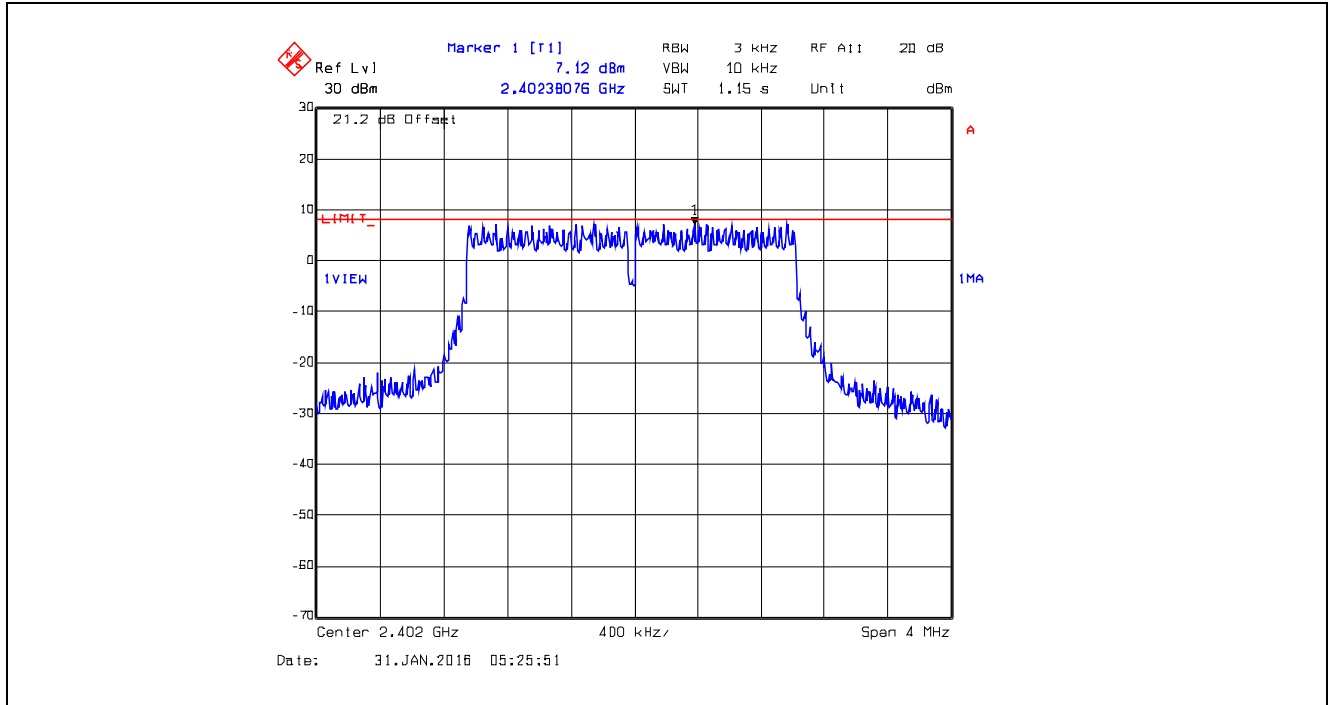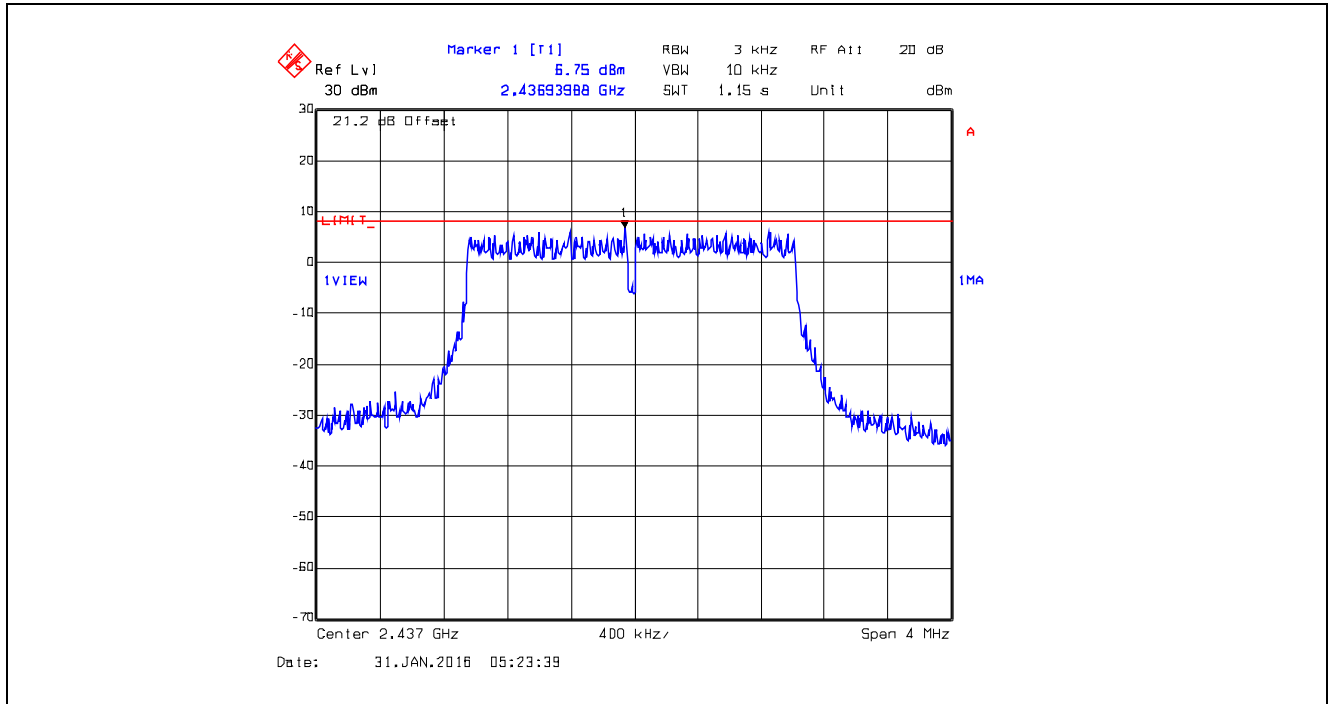
Plot 5.6.4.54. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 6

Plot 5.6.4.55. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2402 MHz, Data Rate 7

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Plot 5.6.4.56. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2437 MHz, Data Rate 7

Plot 5.6.4.57. Power Spectral Density, Bandwidth: 2 MHz, TX Gain: 23, 2482 MHz, Data Rate 7
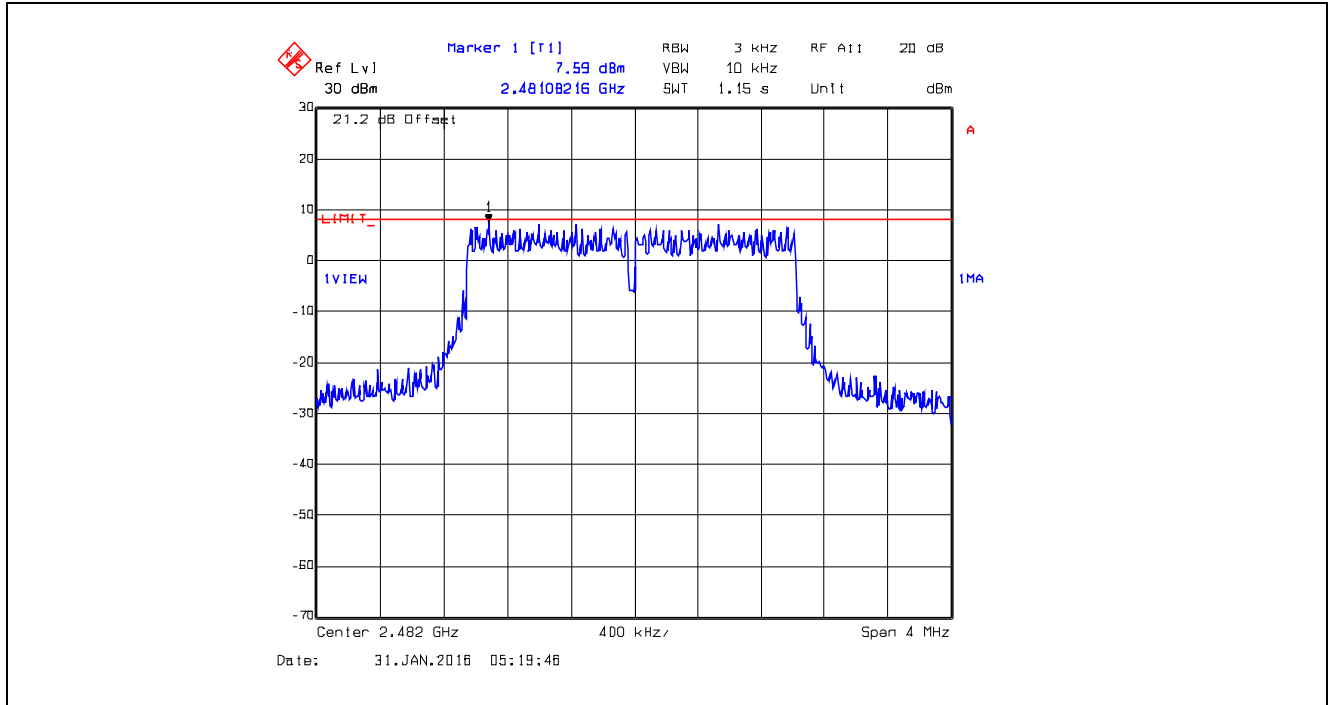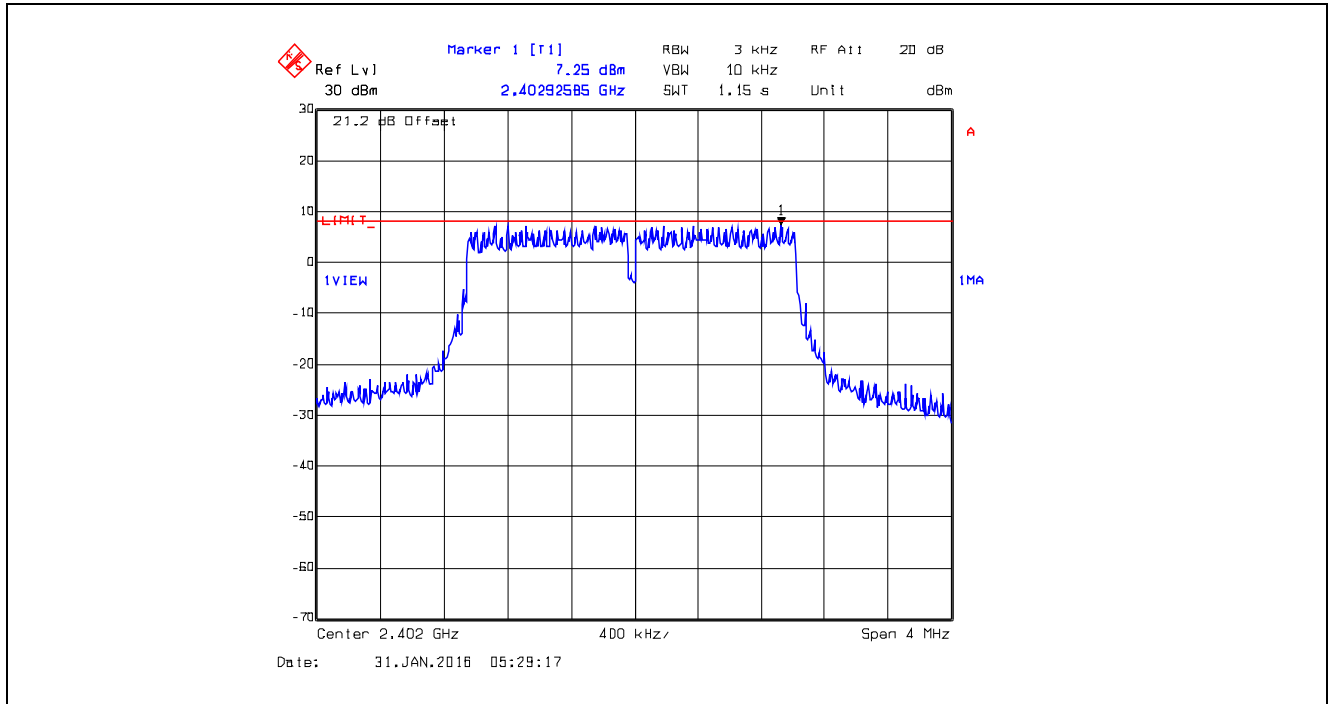
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Plot 5.6.4.58. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 4

Plot 5.6.4.59. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 4
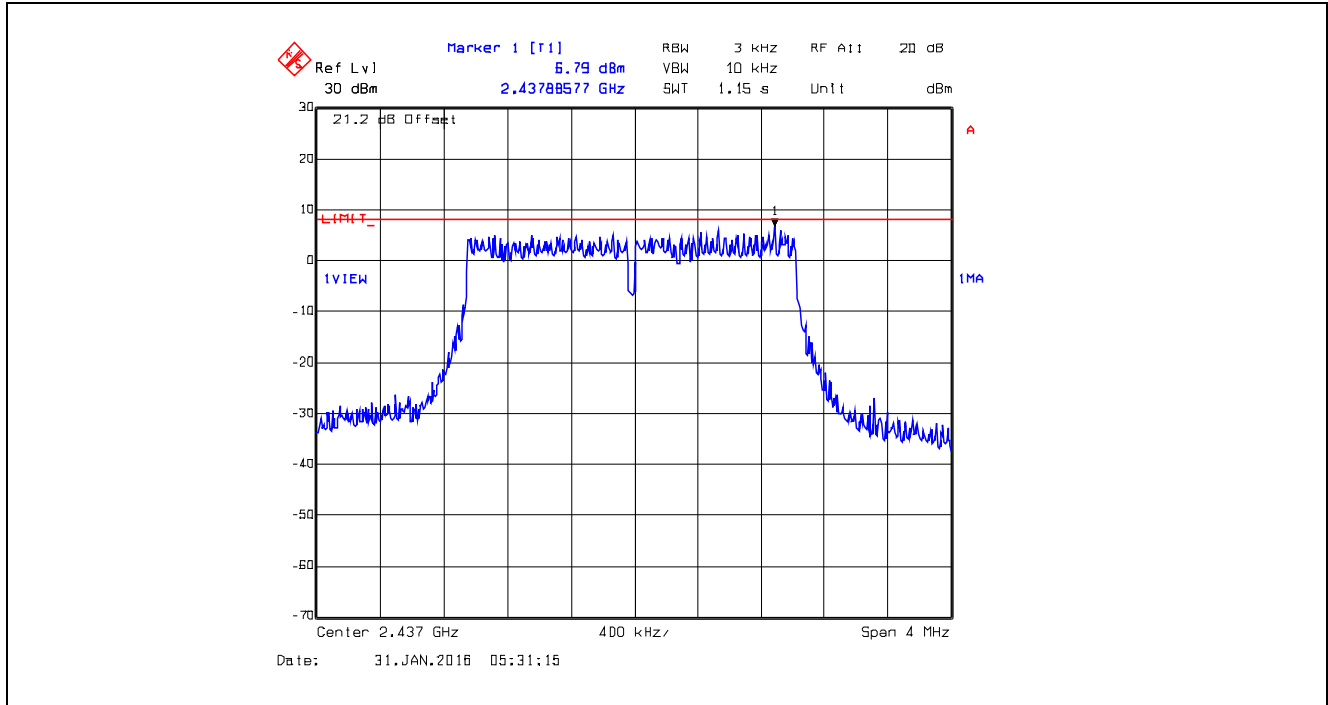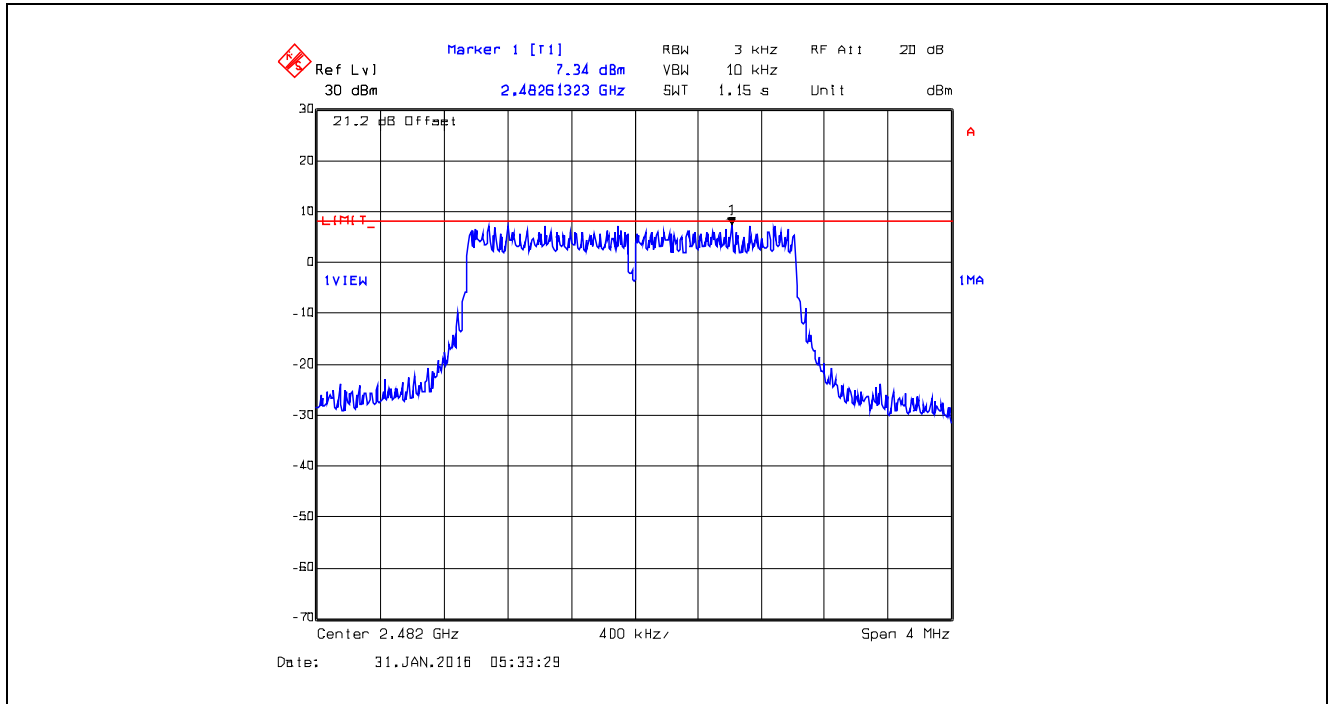
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Plot 5.6.4.60. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 4

Plot 5.6.4.61. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 5
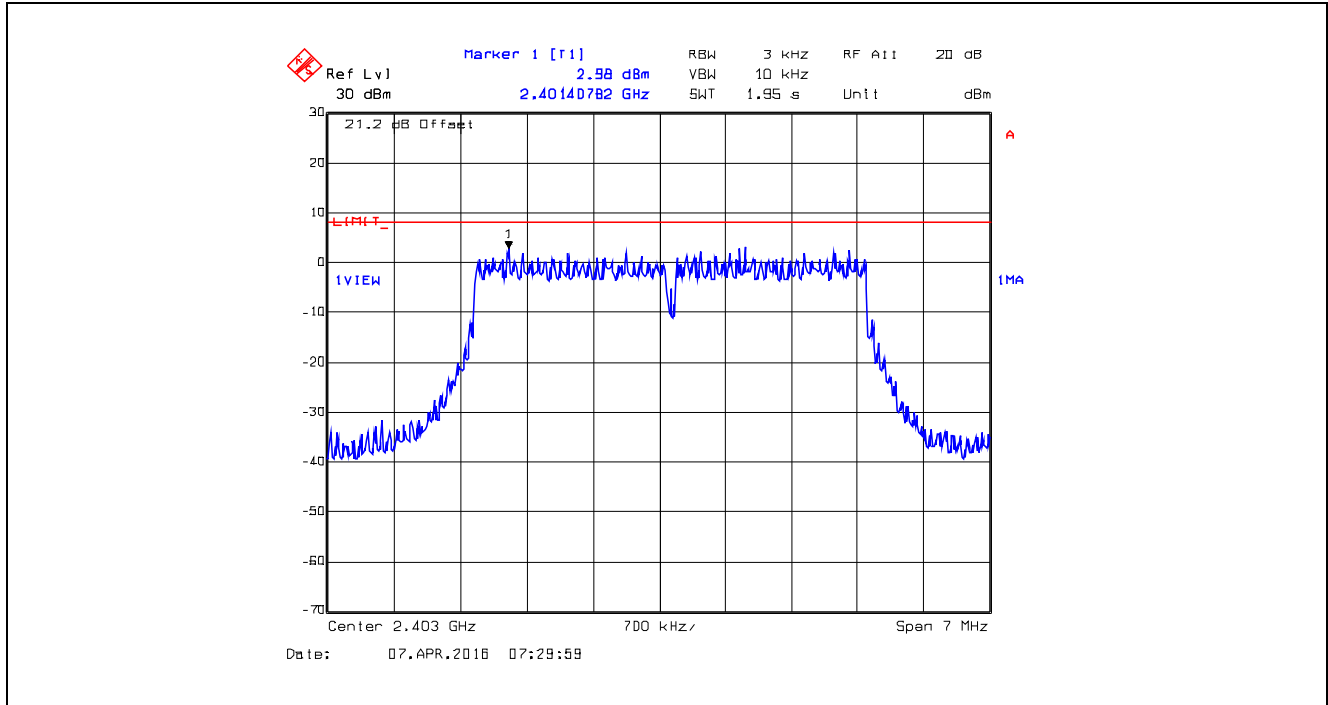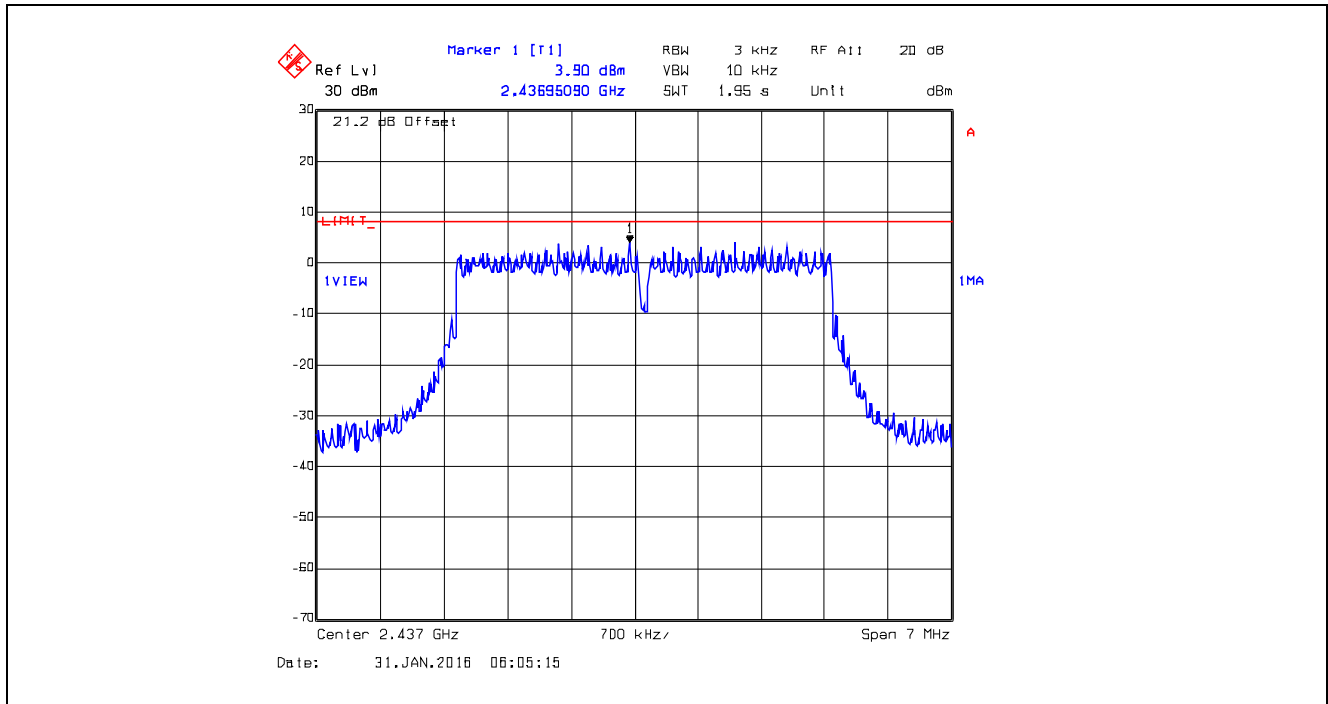
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Plot 5.6.4.62. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 5

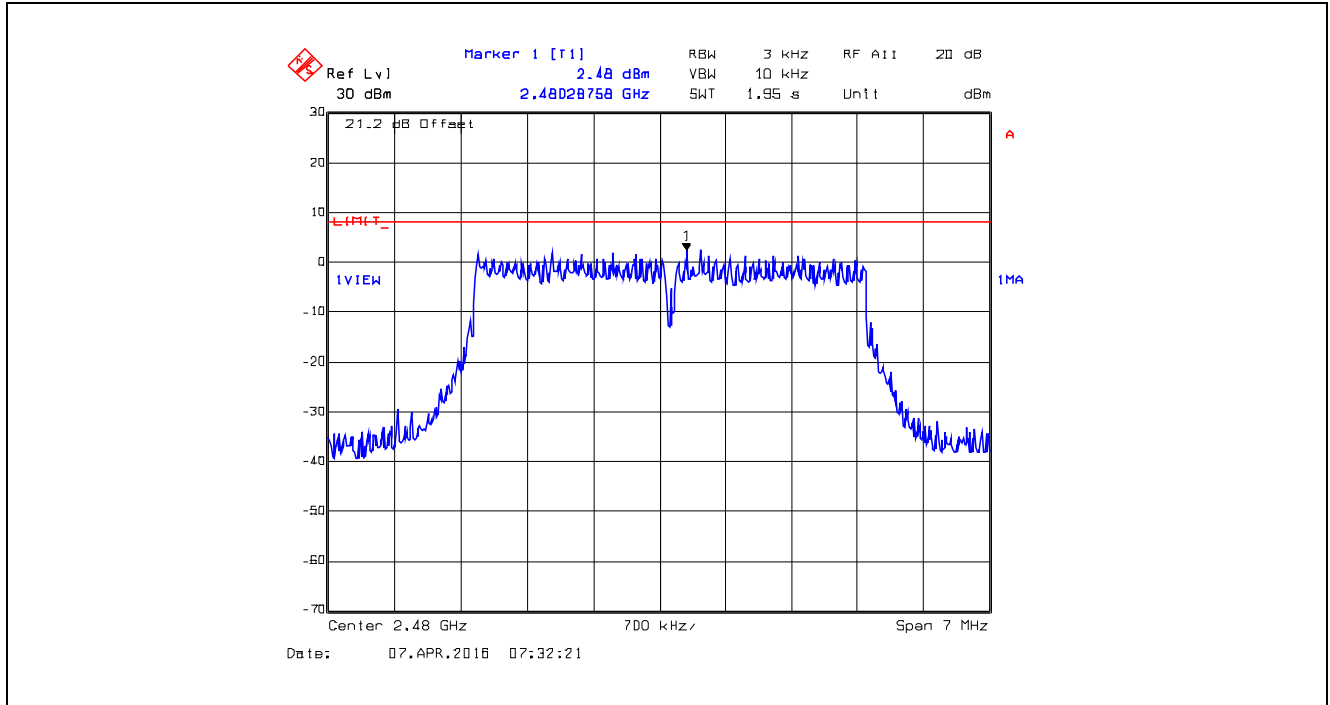**Plot 5.6.4.63.** Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 5

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File #: 16MCRS085_FCC15C247DTS

April 13, 2016

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Plot 5.6.4.64. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 6

Plot 5.6.4.65. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 6
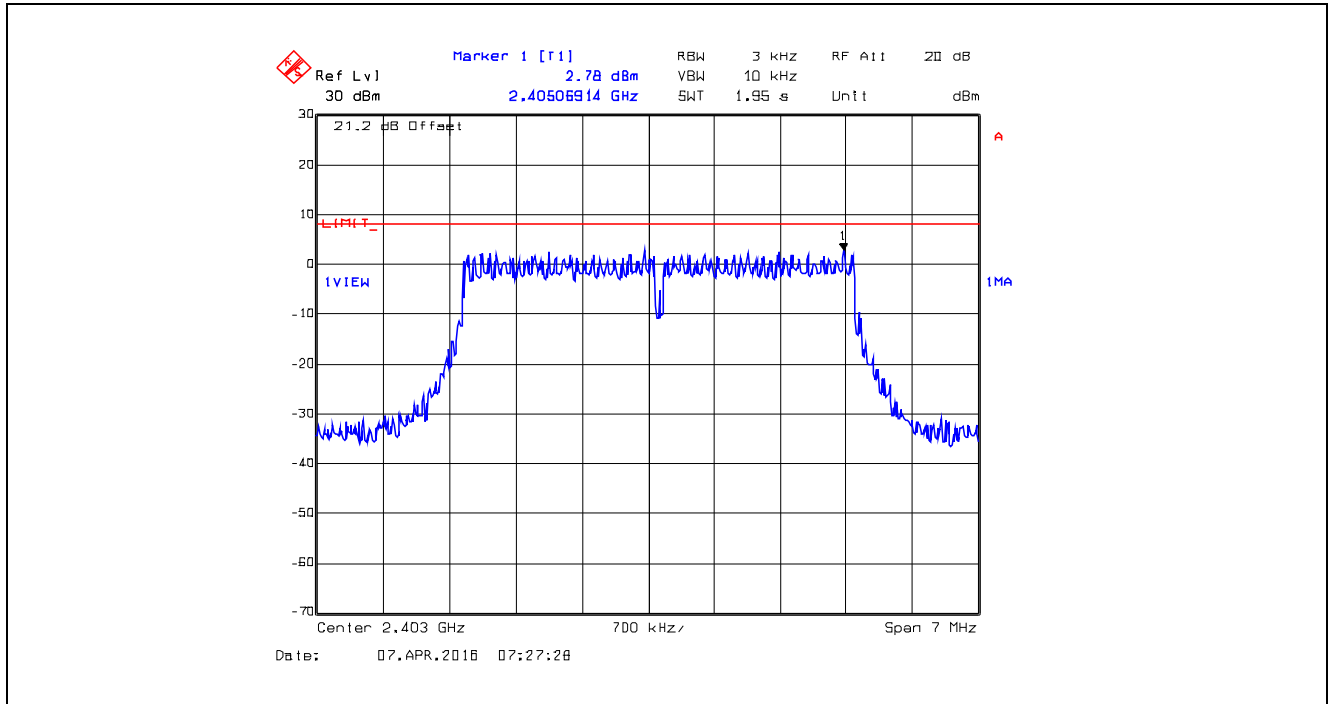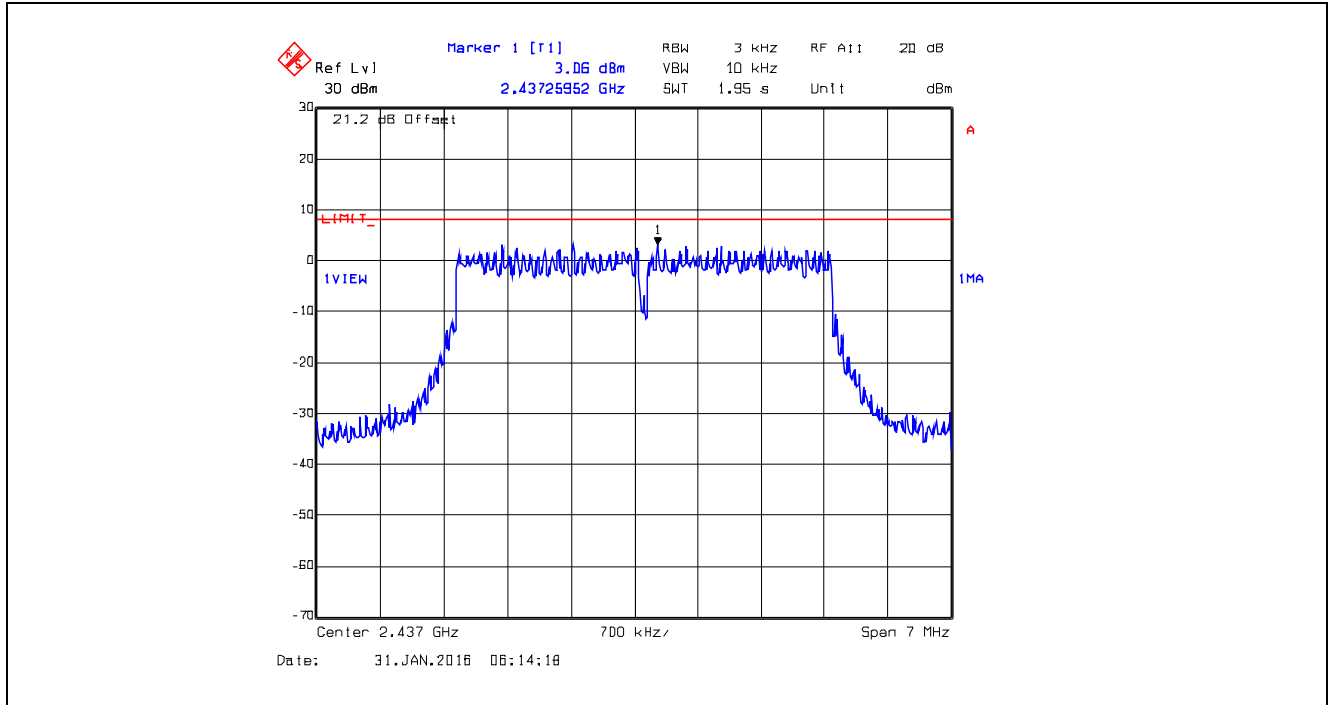
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Plot 5.6.4.66. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 6

Plot 5.6.4.67. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2403 MHz, Data Rate 7
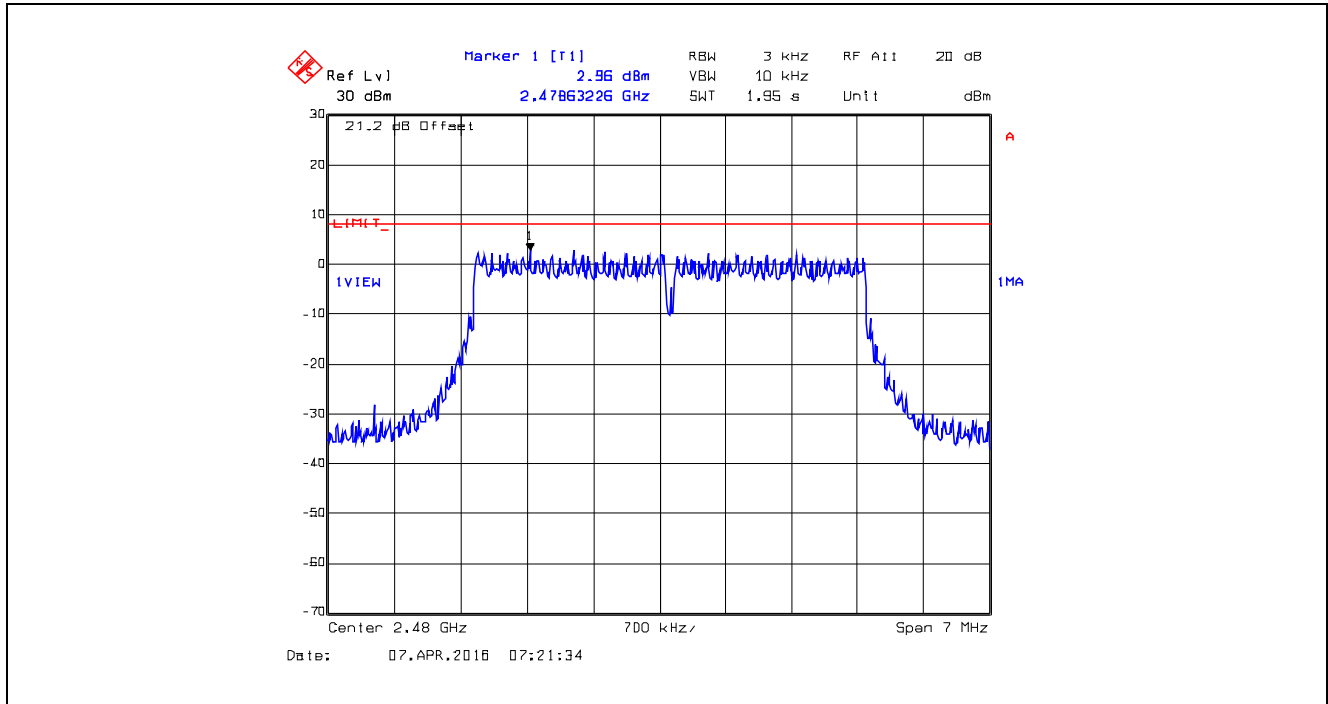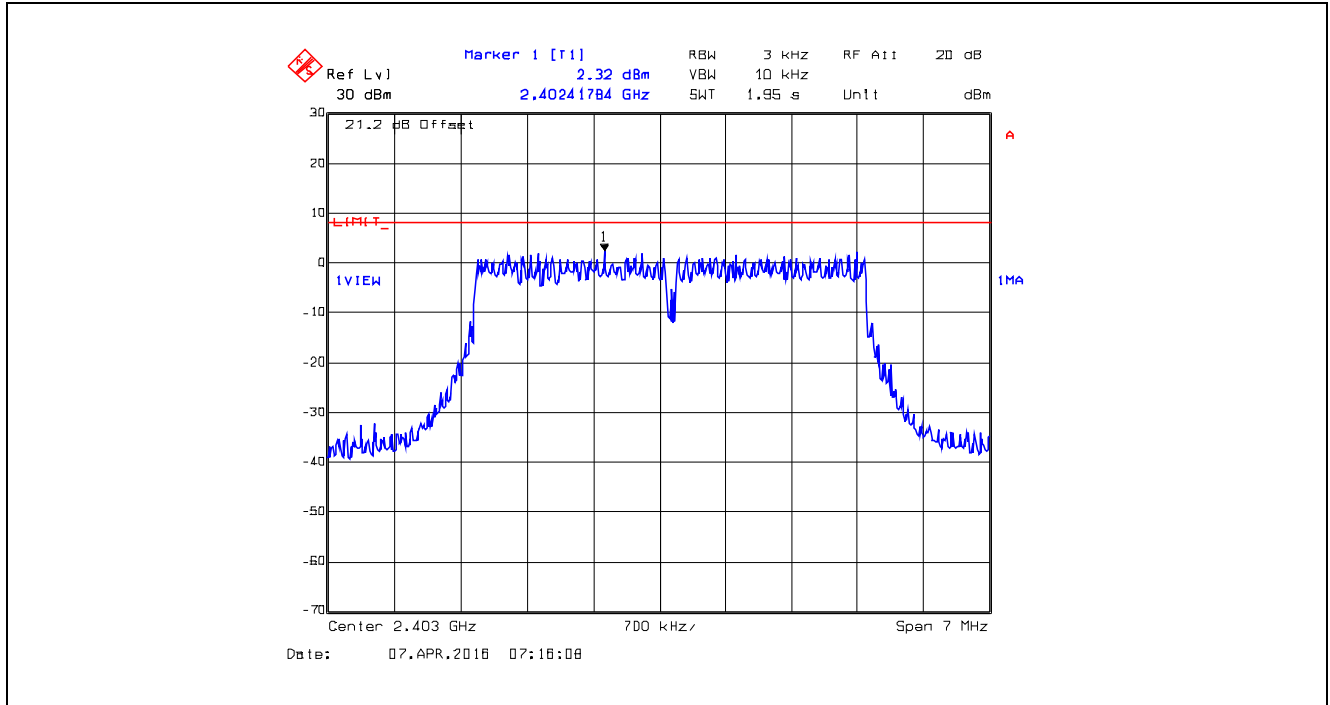
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Plot 5.6.4.68. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2437 MHz, Data Rate 7

Plot 5.6.4.69. Power Spectral Density, Bandwidth: 4 MHz, TX Gain: 23, 2480 MHz, Data Rate 7
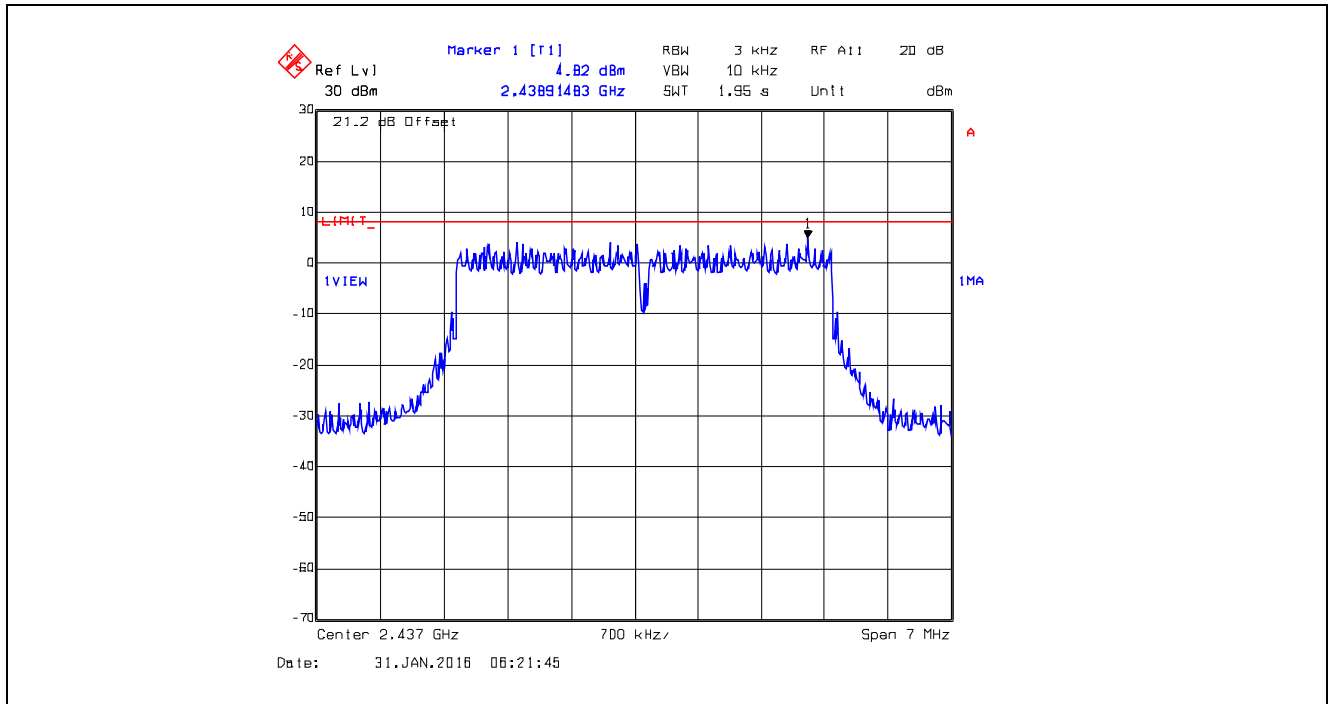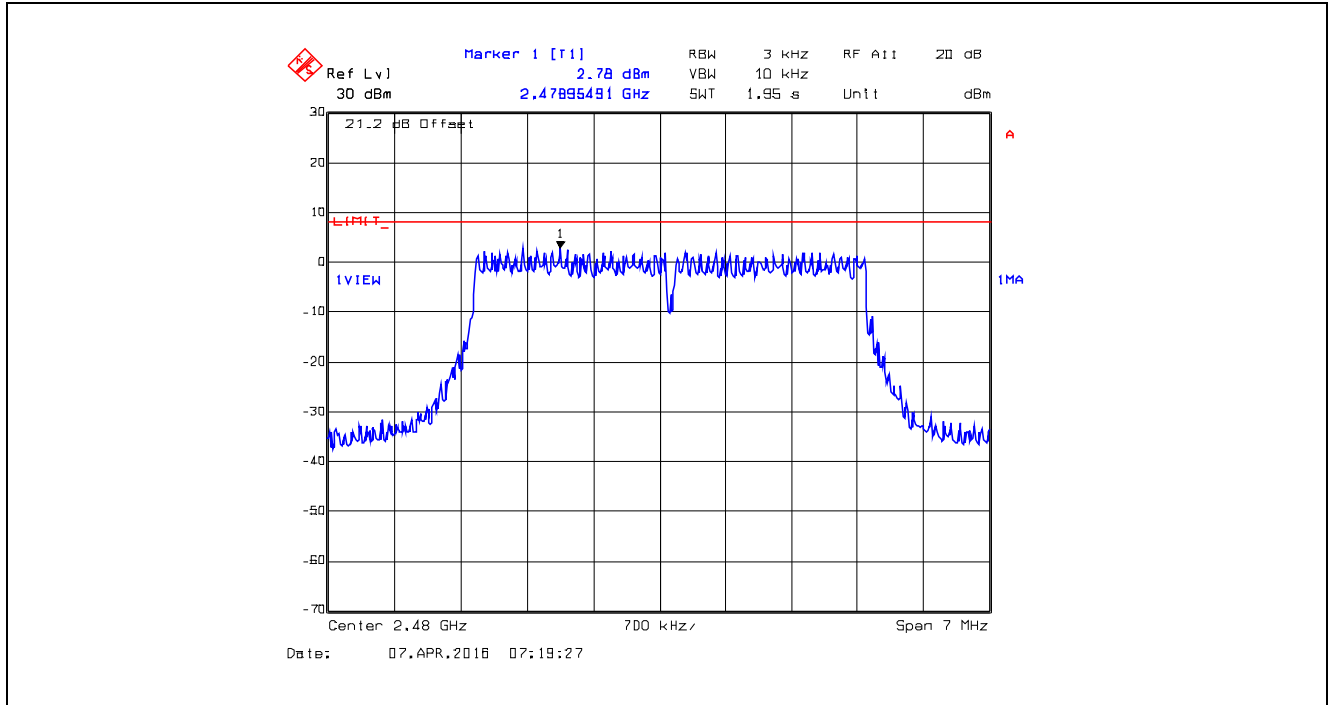
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Plot 5.6.4.70. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 4

Plot 5.6.4.71. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 4
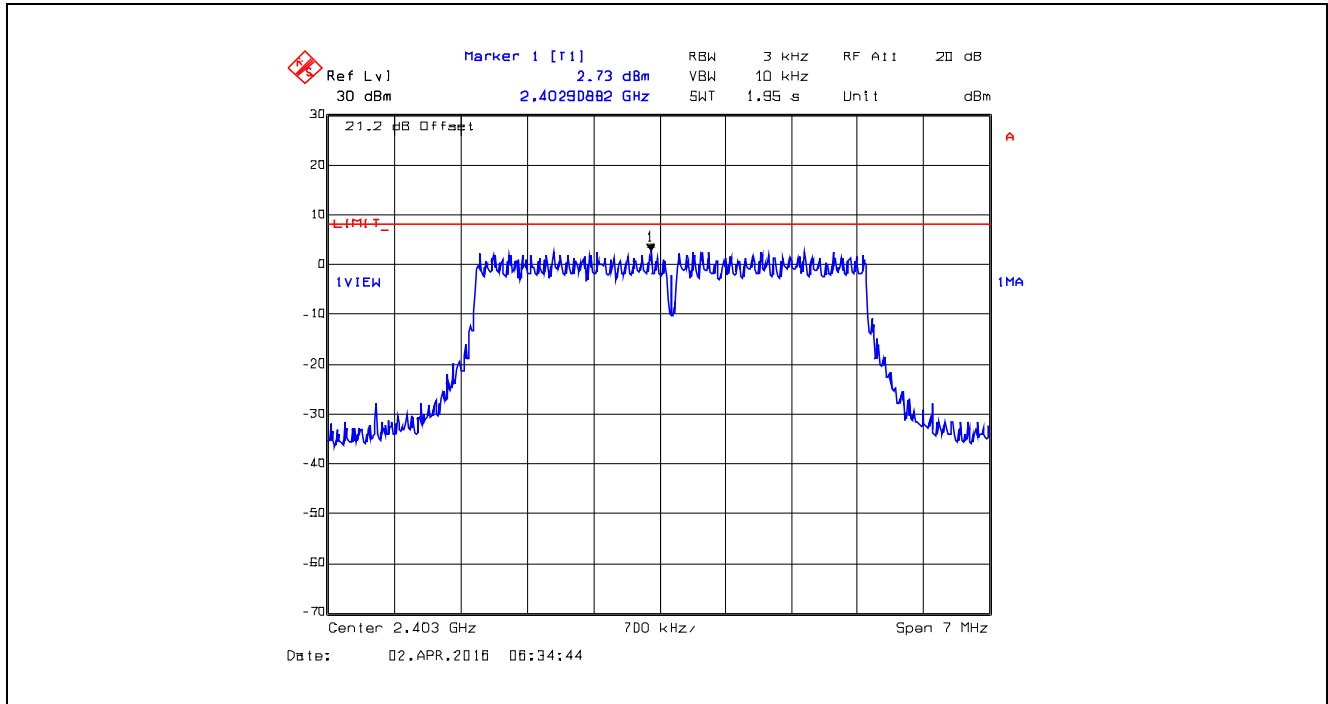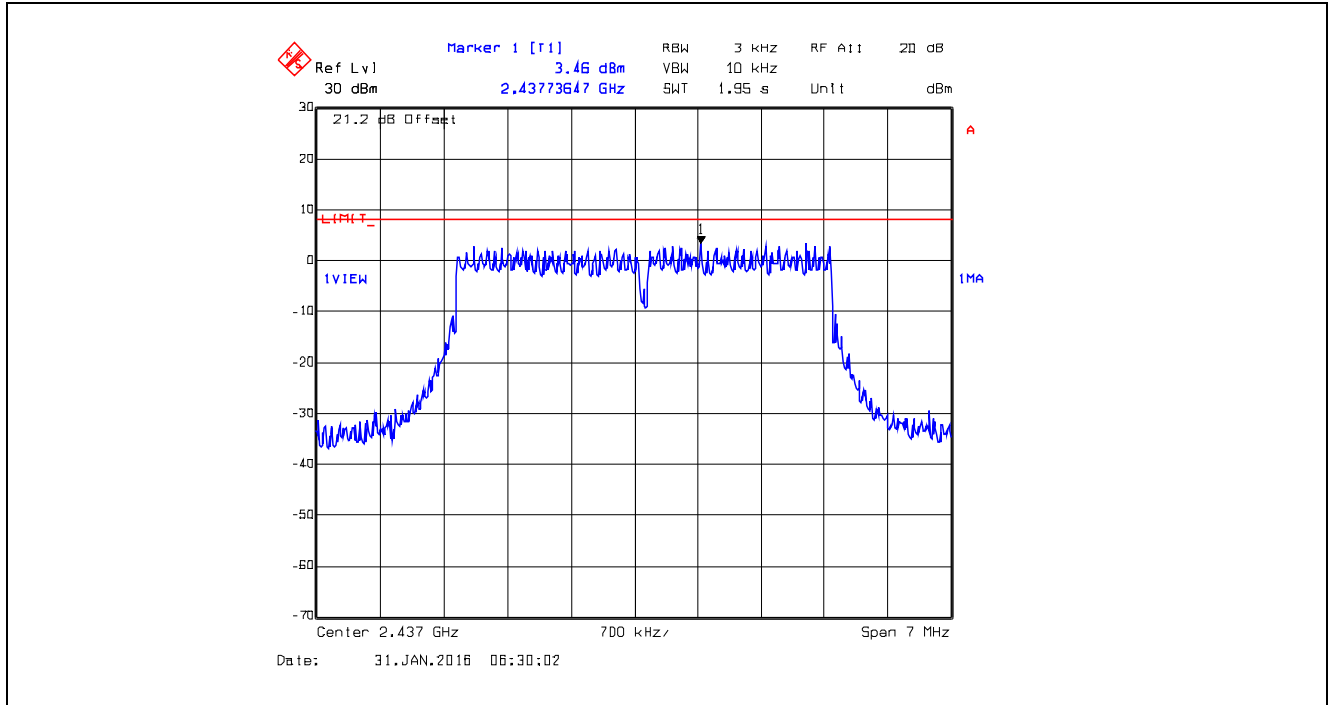
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.6.4.72. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 4

Plot 5.6.4.73. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 5
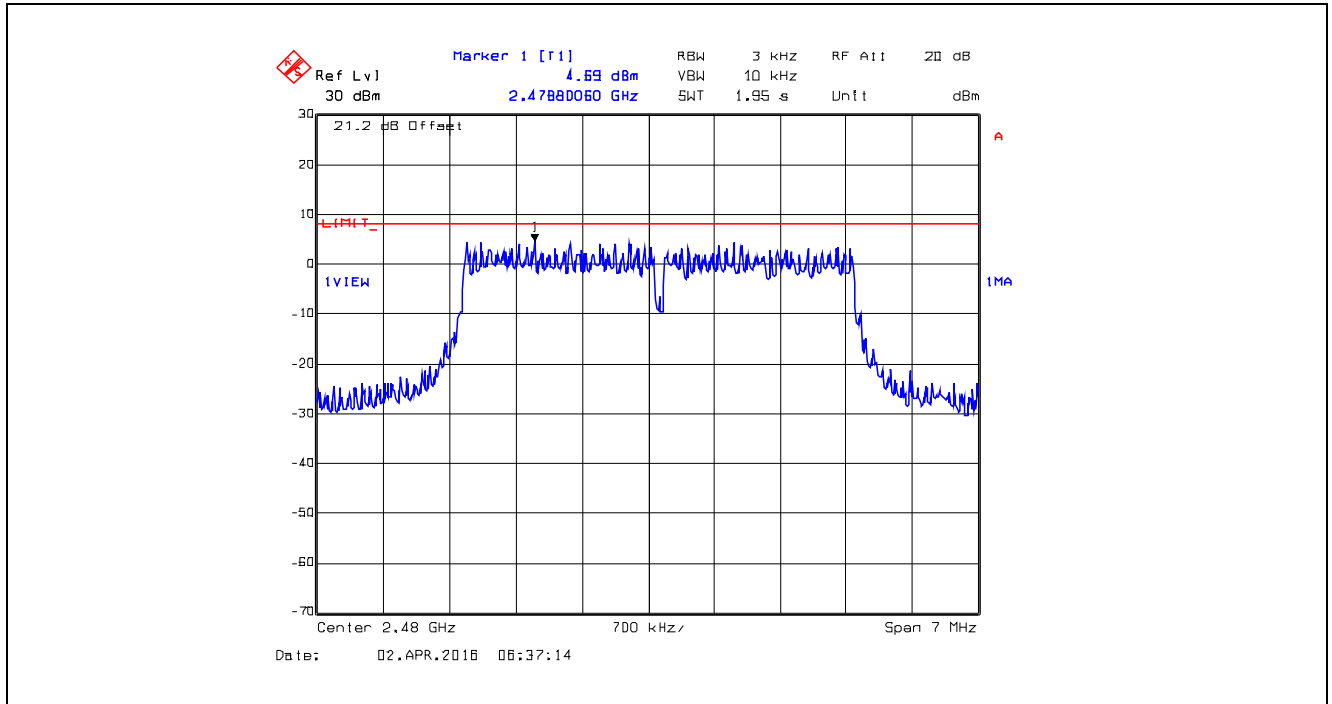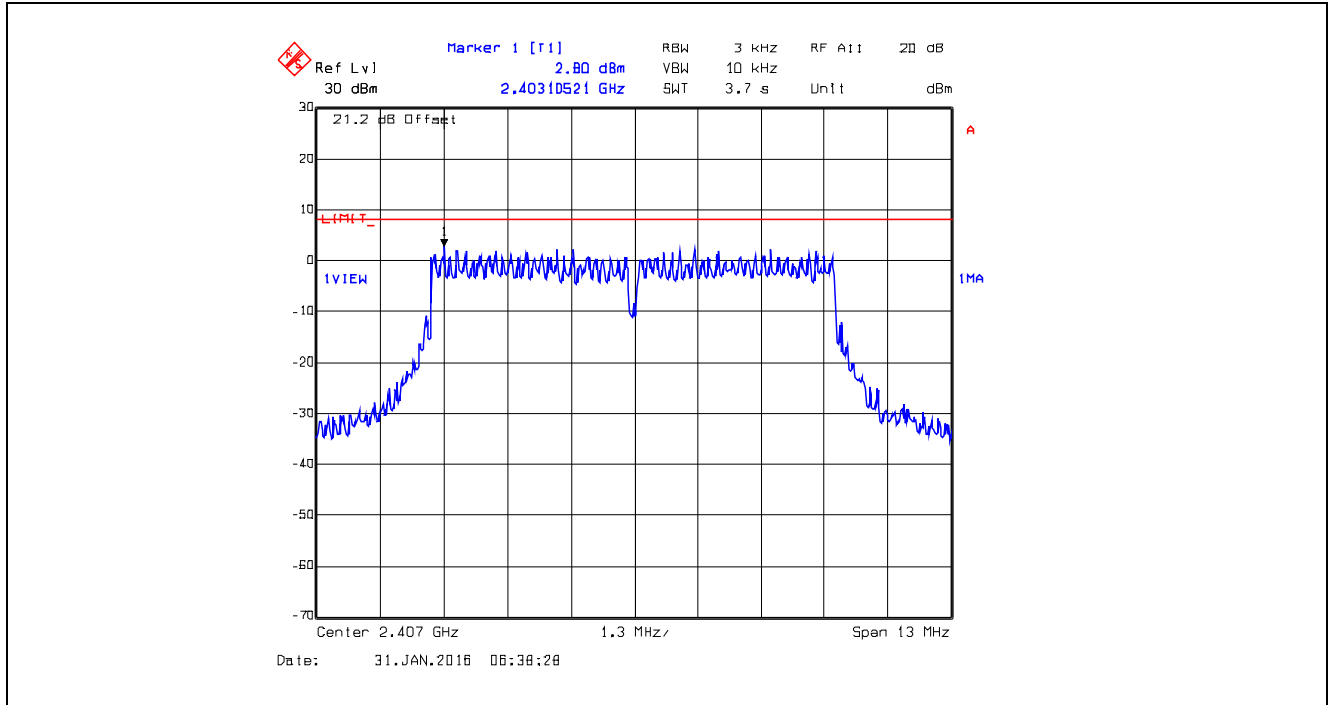
ULTRATECH GROUP OF LABS   File #: 16MCRS085_FCC15C247DTS
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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Plot 5.6.4.74. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 5

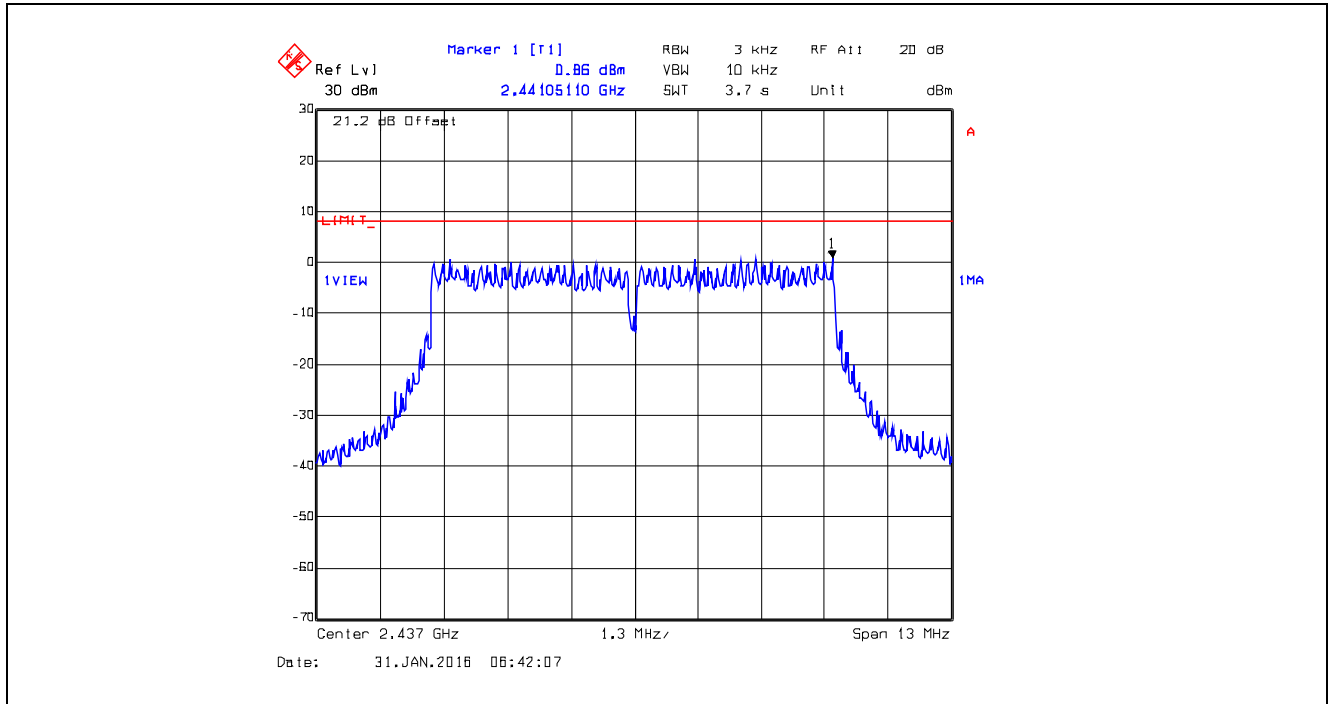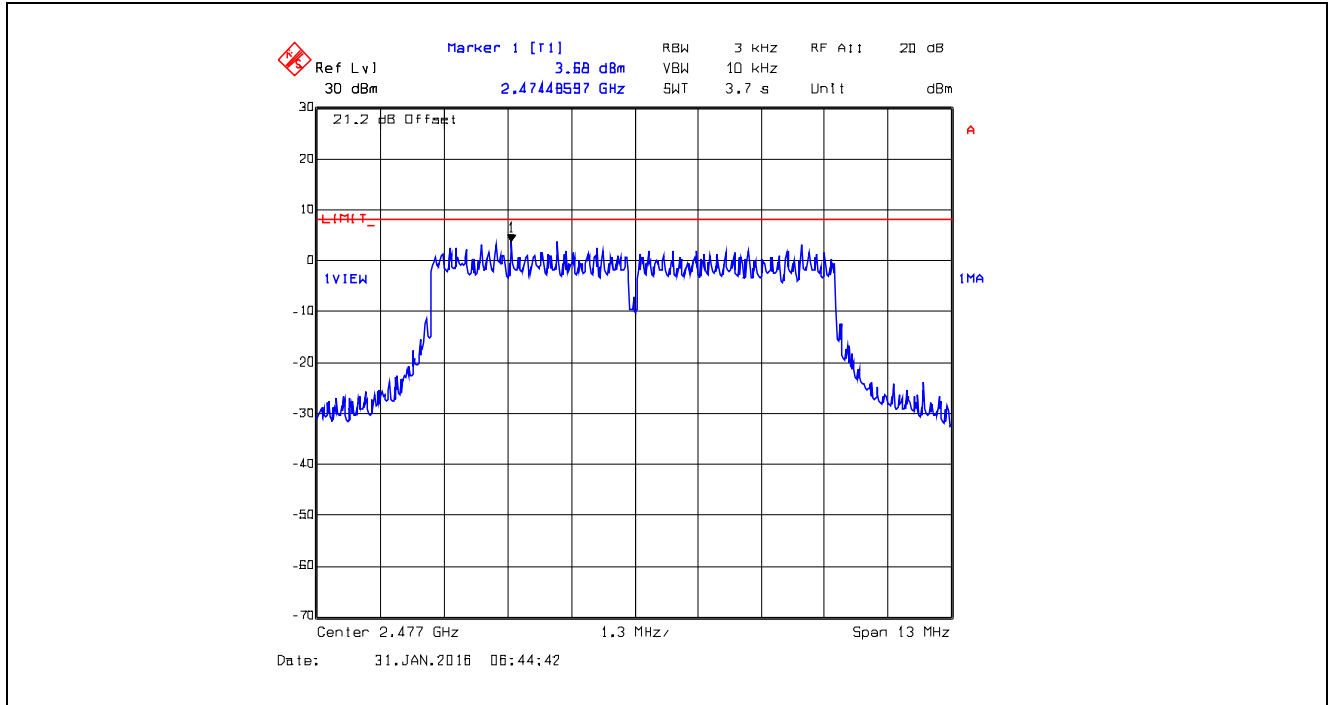**Plot 5.6.4.75.** Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 5

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Plot 5.6.4.76. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 6

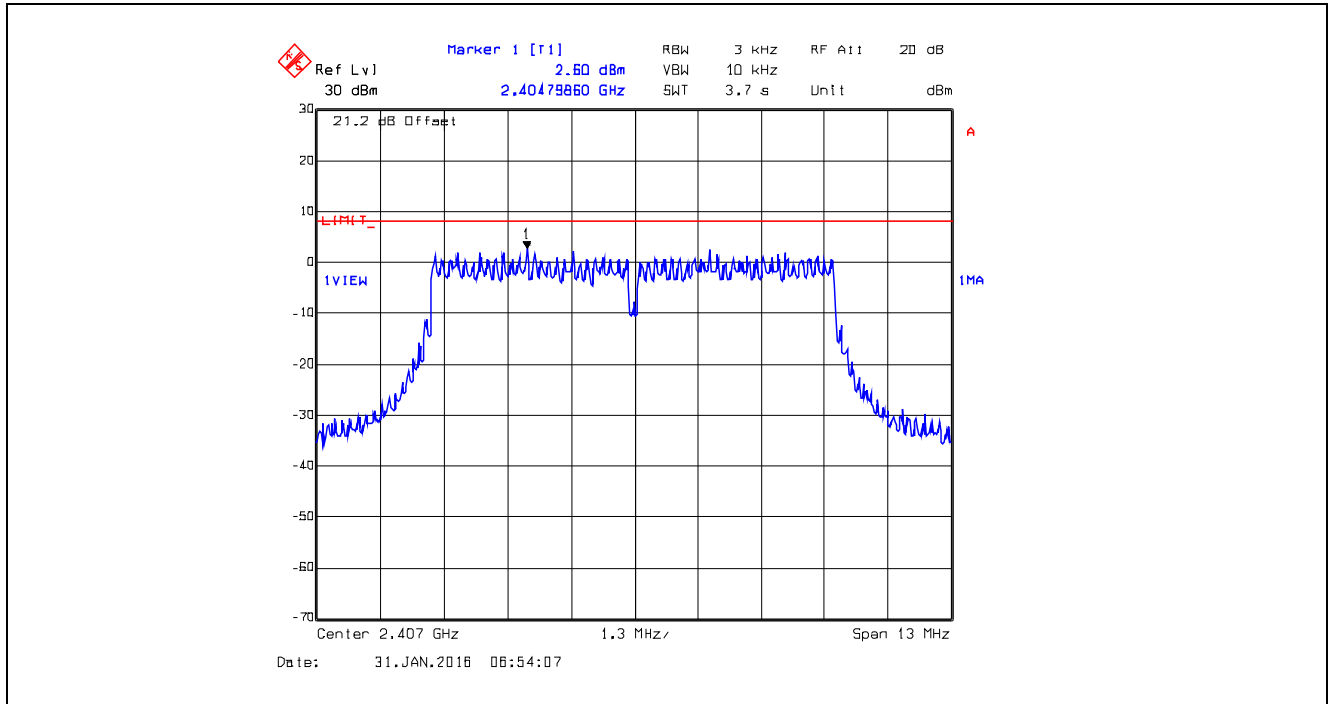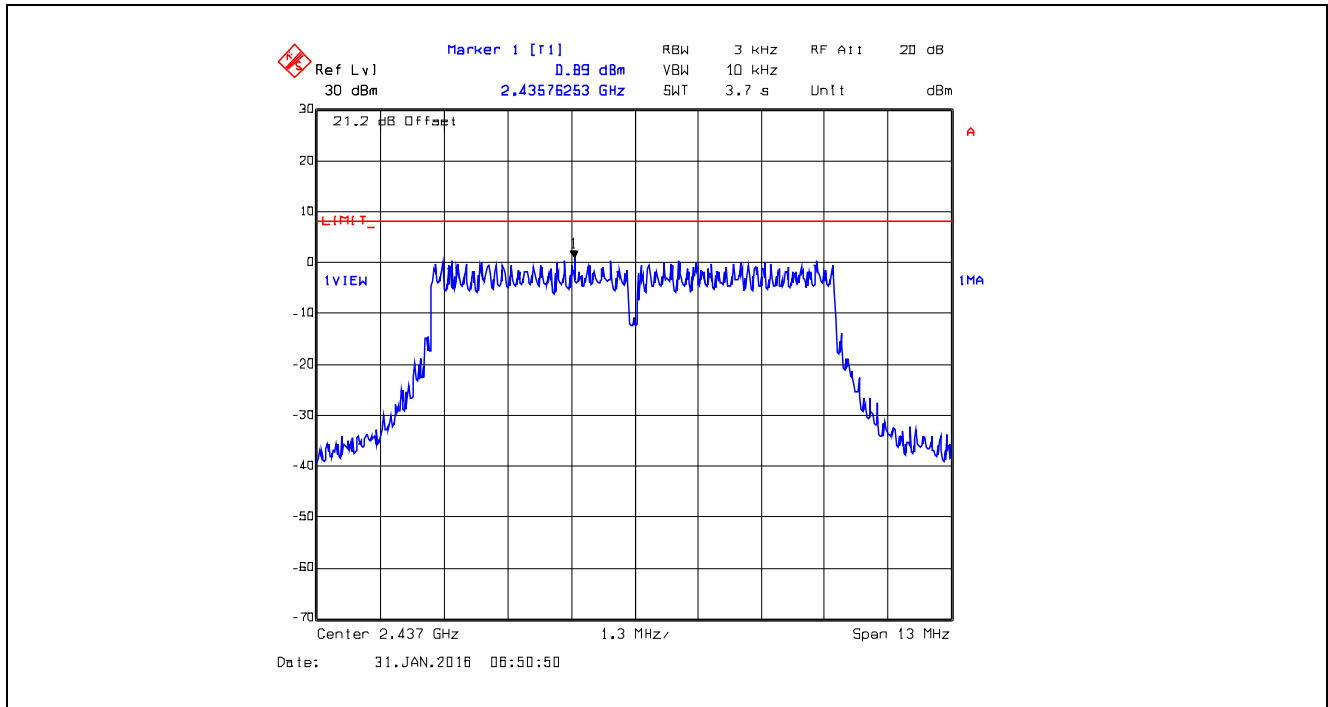**Plot 5.6.4.77.** Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 6

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Plot 5.6.4.78. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 6

Plot 5.6.4.79. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2407 MHz, Data Rate 7
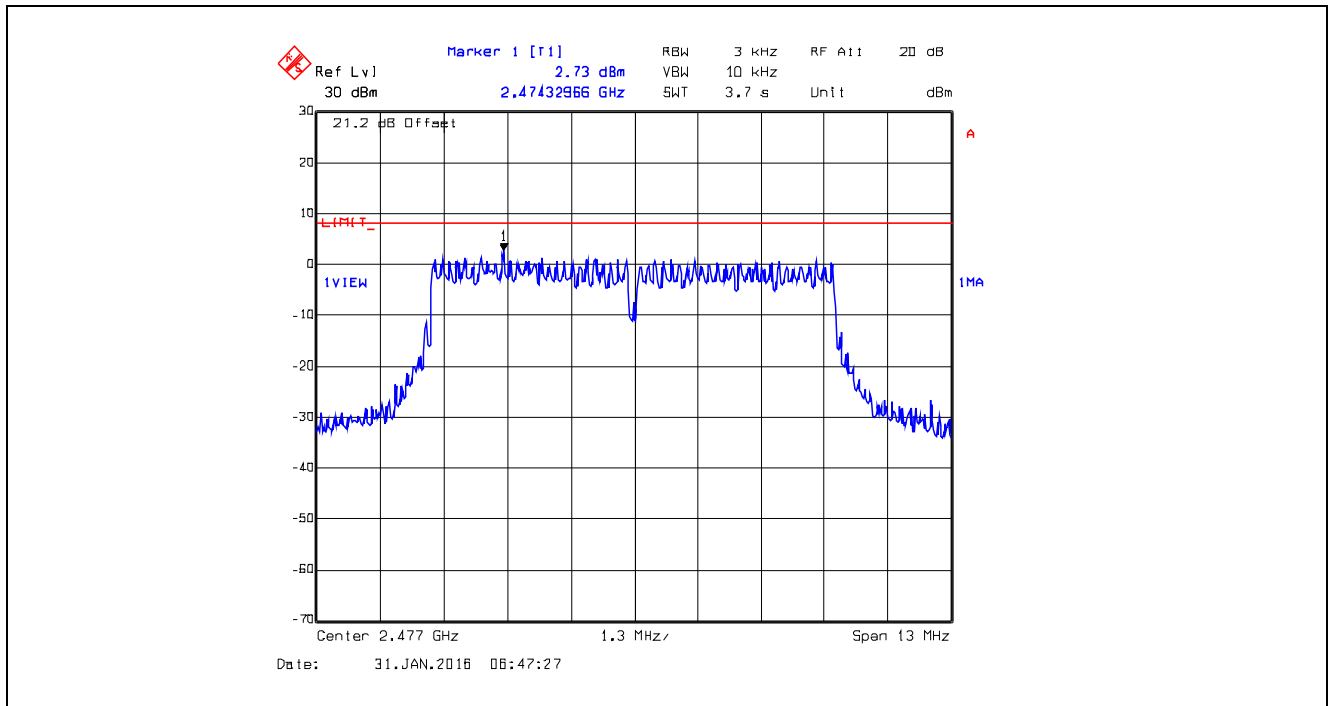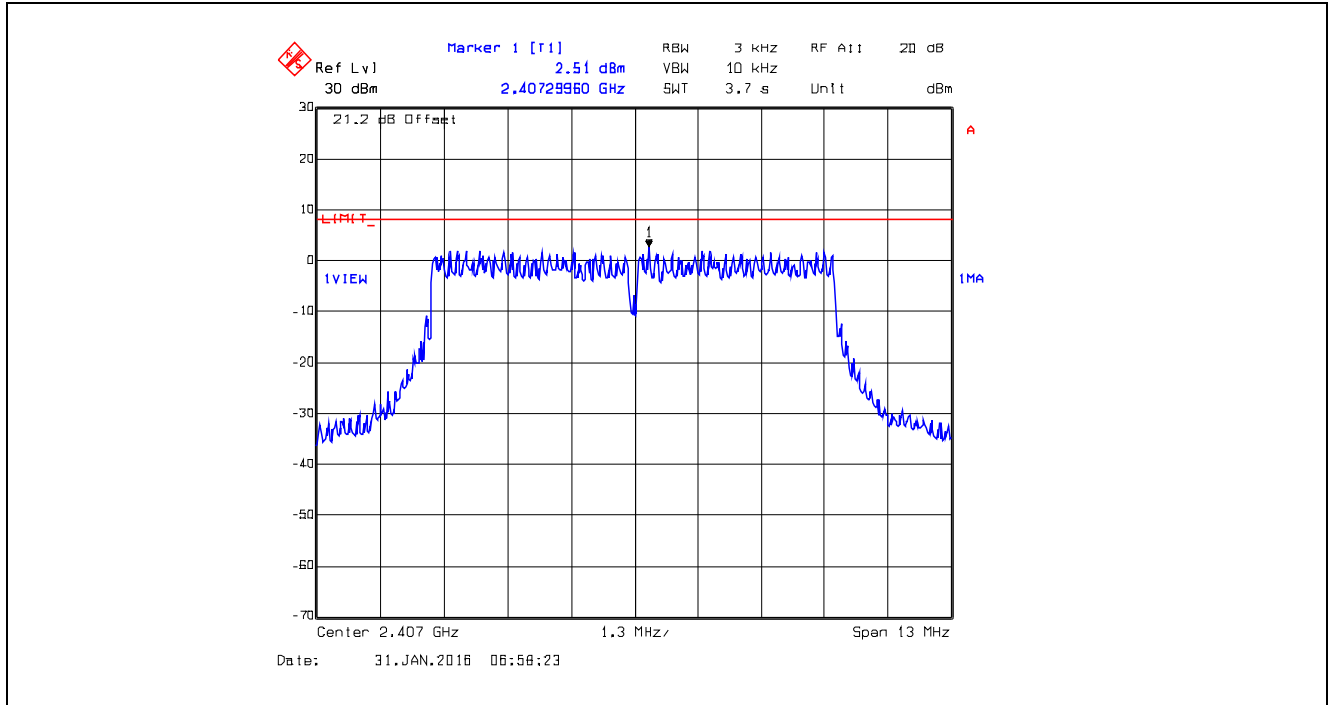
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Plot 5.6.4.80. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2437 MHz, Data Rate 7
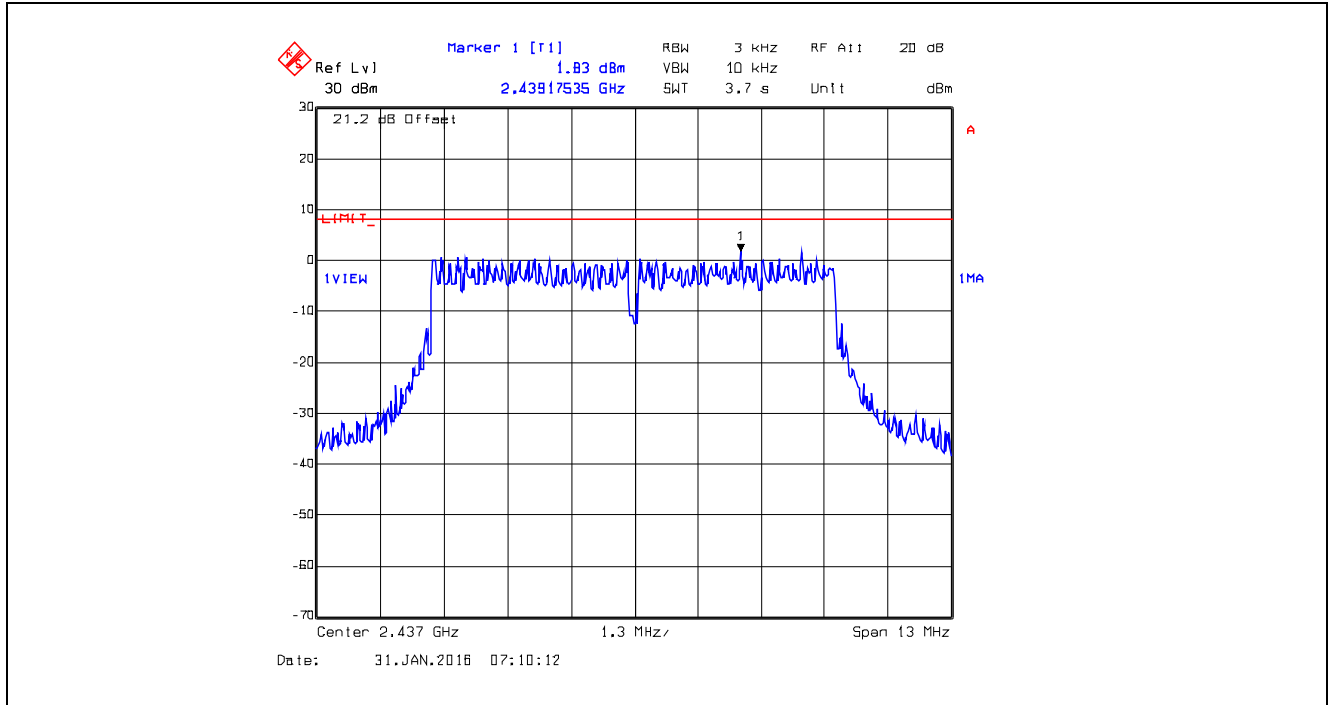
Plot 5.6.4.81. Power Spectral Density, Bandwidth: 8 MHz, TX Gain: 23, 2477 MHz, Data Rate 7
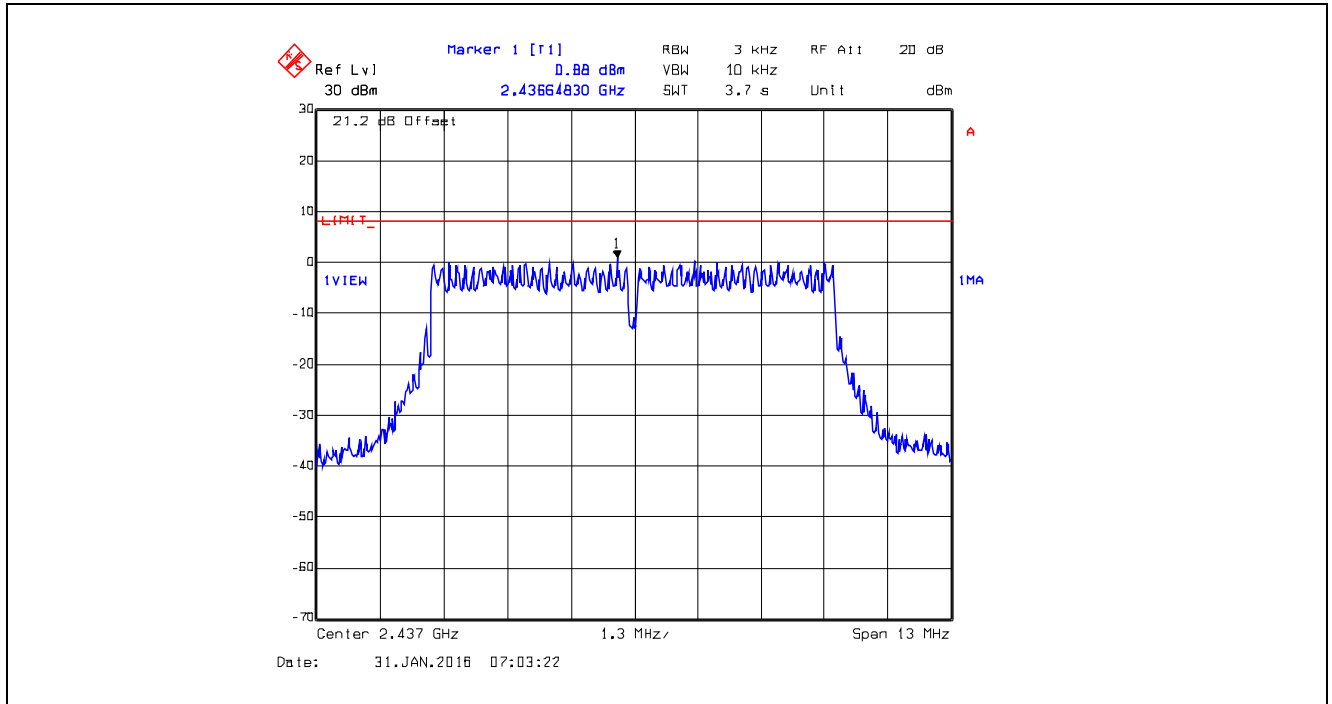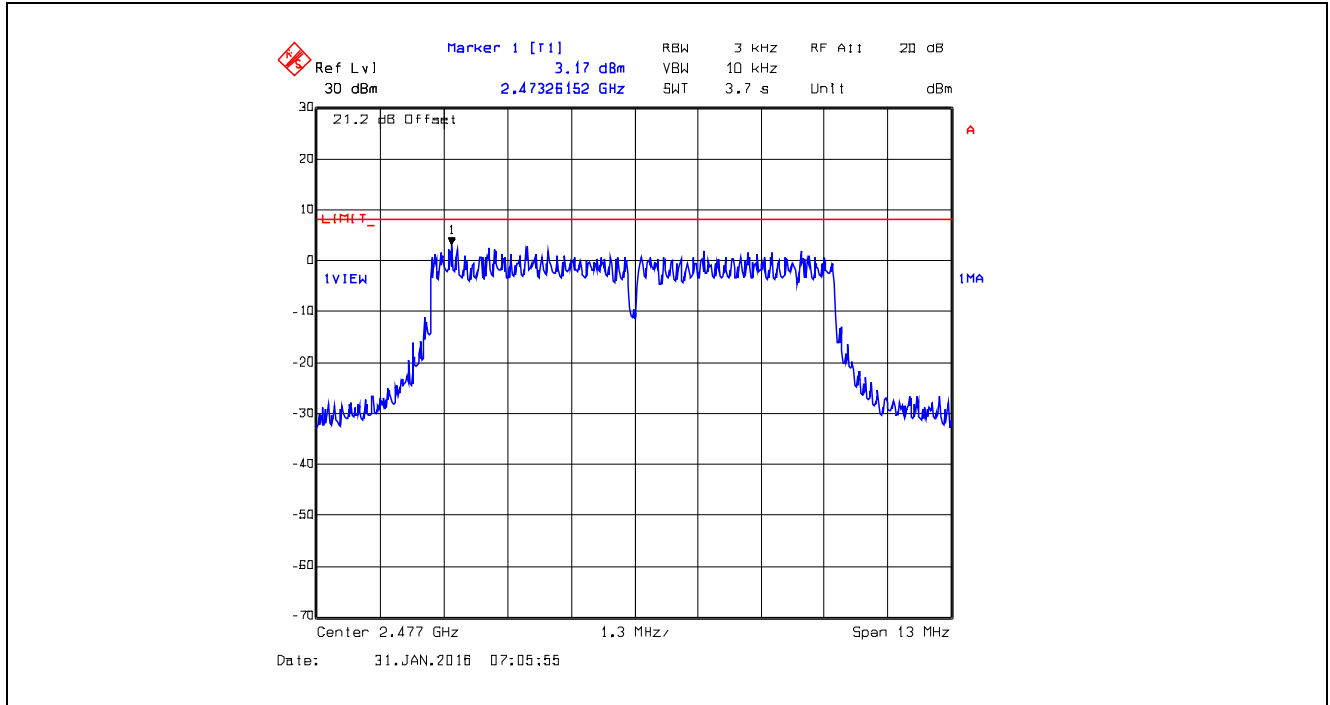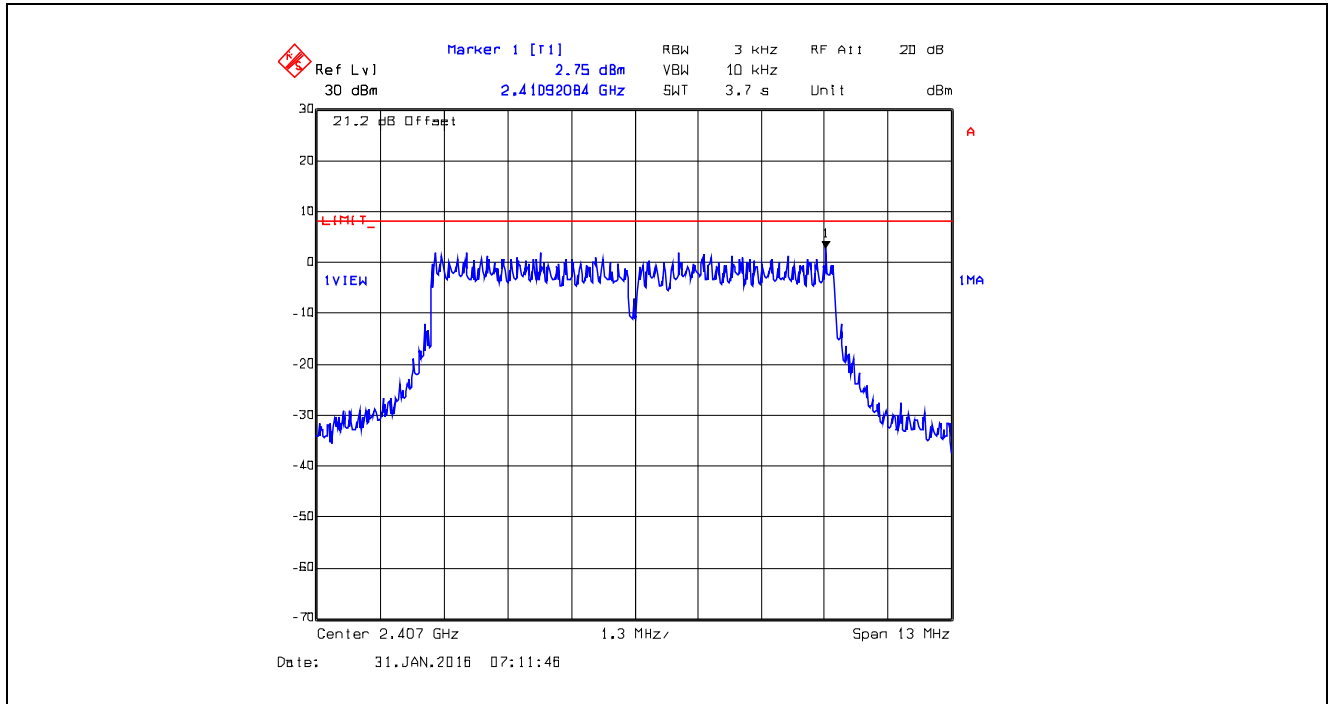
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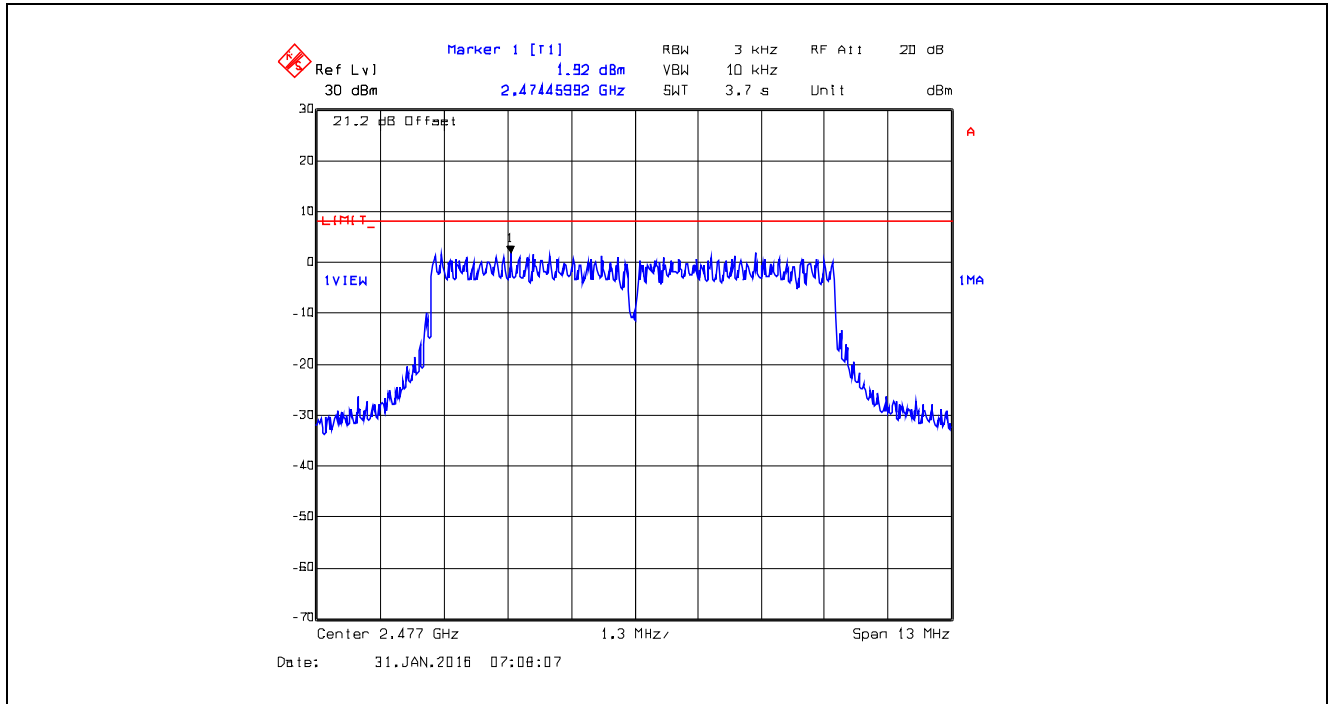
5.7.   RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091]

5.7.1.   Limits

§ **1.1310:** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f^2)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f^2)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

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File #: 16MCRS085_FCC15C247DTS
April 13, 2016

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.7.2.   Method of Measurements

Calculation Method of Power Density/RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where,   P: power input to the antenna in mW
                 EIRP: Equivalent (effective) isotropic radiated power.
                 S: power density mW/cm^2
                 G: numeric gain of antenna relative to isotropic radiator
                 r: distance to centre of radiation in cm

$$r = \sqrt{\frac{PG}{4\pi \cdot S}} = \sqrt{\frac{EIRP}{4\pi \cdot S}}$$

5.7.3.   RF Evaluation

5.7.3.1.   Standalone

Frequency (MHz)	EIRP (dBm)	EIRP (mW)	Evaluation Distance, r (cm)	Power Density, S (mW/cm^2)	MPE Limit (mW/cm^2)	Margin (mW/cm^2)
2402	36	4000	23	0.599	1.0	-0.401

ULTRATECH GROUP OF LABS   **File #: 16MCRS085_FCC15C247DTS**
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   **April 13, 2016**
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5.7.3.2.   Co-location

Pursuant to KDB 447498 D01 General RF Exposure Guidance v06, Section 7.2:

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0, according to calculated/estimated, numerically modeled, or measured field strengths or power density.

Co-location will only applies to EUT with 2 dBi dipole antenna, worst case EIRP of 32 dBm will be used in co-location at the minimum 23 cm evaluation separation distance required by the operating configurations and exposure conditions of the host device.

The maximum calculated MPE ratio of the EUT with 2 dBi dipole antenna

Frequency (MHz)	EUT EIRP (dBm)	EUT EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm^2)	FCC MPE Limit (mW/cm^2)	MPE Ratio
2402	32	1584.893	23	0.238	1.0	0.238

The maximum calculated MPE ratio for the EUT with 2 dBi dipole antenna is 0.238, this configuration can be co-located with other antennas provided the sum of the MPE ratios for all the other simultaneous transmitting antennas incorporated in a host device is ≤ 1.0 - 0.238 ≤ 0.762. The following table addresses the co-location of the EUT with 2 dBi antenna with the specified radio modules.

EUT with 2 dBi dipole antenna co-location with radio module indentified in this table

*Radio Module	Frequency (MHz)	EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm^2)	FCC MPE Limit (mW/cm^2)	MPE Ratio	MPE Ratio of EUT with 2 dBi antenna	Sum of MPE Ratio	Verdict
Data Card Module (FCC ID: RI7LN930, IC: 5131A-LN930)	824.2	2511.890	23	0.378	0.549	0.689	0.238	0.93	Compliant
UMTS/LTE Data Module (FCC ID: XPYTOBYL201, IC: 8595A-TOBYL201)	710.0	2398.833	23	0.361	0.473	0.763	0.238	1.00	Compliant
LE910NA V2 LTE/3G Module (FCC ID: RI7LE910NAV2, IC: 5131A-LE910NAV2)	699.0	1156.112	23	0.174	0.466	0.373	0.238	0.61	Compliant

* The test data of the radio modules represented in this table is the worst-case configuration (maximum MPE ratio) derived from the original radio modules MPE reports. Refer to these reports for details.

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EXHIBIT 6.   TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Hewlett Packard	HP 8593EM	3412A00103	9 kHz–26.5 GHz	9 Apr 2017
Attenuator	Pasternack	PE7010-20	-	DC–2 GHz	3 Feb 2017
L.I.S.N	EMCO	3825/2	2209	0.10 -100 MHz	29 Sep 2016
Peak Power Analyzer	Hewlett Packard	8991A	3342A00657	0.5 - 40 GHz	15 Jul 2016
Peak Power Sensor	Hewlett Packard	84814A	3205A00175	0.5 - 40 GHz	15 Jul 2016
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz	Cal on use
Attenuator	Pasternack	7024-20	6	DC–26.5 GHz	Cal on use
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20Hz–40 GHz	21 Nov 2016
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	14 Jul 2016
Attenuator	Weinschel	3	ES157	DC–26.5 GHz	Cal on use
Band Reject Filter	Micro-Tronics	BRM50701	105	Cut off 2.4-2.483 GHz	Cal on use
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2400 MHz	Cal on use
EMI Receiver	Rohde & Schwarz	ESU40	100037	20Hz–40 GHz	8 May 2017
RF Amplifier	Com-Power	PAM-0118A	551052	0.5 – 18 GHz	13 Jul 2016
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	20 Aug 2016
Biconilog	EMCO	3142C	26873	26-3000 MHz	14 Apr 2016
Horn Antenna	EMCO	3155	6570	1 – 18 GHz	11 Sep 2016
Horn Antenna	EMCO	3160-09	118385	18 – 26.5 GHz	4 Aug 2016

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EXHIBIT 7.   MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

7.1.   LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

	Line Conducted Emission Measurement Uncertainty (9 kHz – 30 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	$\pm$ 1.44	$\pm$ 1.8
U	Expanded uncertainty U: $U = 2u_c(y)$	$\pm$ 2.89	$\pm$ 3.6

7.2.   RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	$\pm$ 2.39	$\pm$ 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	$\pm$ 4.79	$\pm$ 5.2

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	$\pm$ 2.39	$\pm$ 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	$\pm$ 4.78	$\pm$ 5.2

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	$\pm$ 1.87	Under consideration
U	Expanded uncertainty U: $U = 2u_c(y)$	$\pm$ 3.75	Under consideration

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