ENGINEERING TEST REPORT

DORIN Module
Model: ASYDORINWLAN
FCC ID: 2AC9T-DORIN16MB

Applicant:

BSM Wireless Inc.
75 International Blvd, Suite 100
Toronto, ON, M9W 6L9

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.: HGI-010Q_F15C247

This Test report is Issued under the Authority of Tri M. Luu Vice President of Engineering UltraTech Group of Labs Date: September 29, 2014	
Report Prepared by: Dharmajit Solanki Issued Date: September 29, 2014	Tested by: Hung Trinh Test Dates: Aug 11 & Sept 02 to 09, 2014

- *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

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

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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:	Limited Modular Approval 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 Measurement Guidance v03r02
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	2013	Code of Federal Regulations (CFR), Title 47 – Telecommunication
ANSI C63.4	2009	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	2009	American National Standard for Testing Unlicensed Wireless Devices
CISPR 22 & EN 55022	2008-09, Ed 6 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 # 558074 D01, DTS Meas. Guidance v03r02	2014	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

Applicant	
Name:	BSM Wireless Inc.
Address:	75 International Blvd, Suite 100 Toronto, ON, M9W 6L9 CANADA
Contact Person:	Isaac Kuruvilla Phone #: 416-675-1201 Fax #: 416-679-8992 Email Address: ikuruvilla@bsmwireless.com

Manufacturer	
Name:	BSM Wireless Inc.
Address:	75 International Blvd, Suite 100 Toronto, ON, M9W 6L9 CANADA
Contact Person:	Isaac Kuruvilla Phone #: 416-675-1201 Fax #: 416-679-8992 Email Address: ikuruvilla@bsmwireless.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:	BSM Wireless Inc.
Product Name:	DORIN Module
Model Name or Number:	ASYDORINWLAN
Serial Number:	Test Sample
Type of Equipment:	Digital Transmission System (DTS)
Input Power Supply Type:	External DC Power Supply
Primary User Functions of EUT:	WLAN device operating on IEEE 802.11n & compatible with 802.11b/g with a maximum data rate up to 150Mbps

2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Module (Limited Modular Approval)
Intended Operating Environment:	▪ Commercial, industrial or business environment ▪ Residential environment
Power Supply Requirement:	3.3 VDC, Max 5A
RF Output Power Rating:	+21.3 dBm Max
Operating Frequency Range:	2412 – 2462 MHz (20 MHz Ch Spacing) 2422 – 2452 MHz (40 MHz Ch Spacing)
RF Output Impedance:	50 Ω
Channel Spacing:	20 & 40 MHz
Duty Cycle:	100%
Modulation Types:	OFDM (BPSK 1/2, QPSK 3/4, 16-QAM 3/4, 64-QAM 5/6)
Oscillator Frequency(ies):	24 MHz
Antenna Connector Type:	RPSMA (using 5" U.FL to SMA cable with a cable loss of 0.82dB)

2.4. ASSOCIATED ANTENNA DESCRIPTION

Antenna Type	Maximum Gain (dBi)
Monopole (Quarter-Wave) antenna	1.6

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 (N/A for integral antenna)
2	DC supply and I/O port	1	Pin header	Direct connection (no cable)

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:	BSM Wireless
Model Name or Number:	N/A
Serial Number:	N/A
Connected to EUT's Port:	Module pin signals

Ancillary Equipment # 2	
Description:	Laptop Computer
Brand name:	HP
Model Name or Number:	Elite Book 8440p
Serial Number:	CND051129W
Connected to Test Jig's:	USB Power

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 via USB Power from Laptop

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:	Special 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 was tested with the antenna fitted in a manner typical of normal intended use as integral / non-integral antenna equipment as described with the test results.

Transmitter Test Signals	
Frequency Band(s):	2412 – 2462 MHz (20 MHz Ch Spacing) 2422 – 2452 MHz (40 MHz Ch Spacing)
Frequency(ies) Tested:	2412, 2437 and 2462 MHz (20 MHz Ch Spacing) 2422, 2437 and 2452 MHz (40 MHz Ch Spacing)
RF Power Output: (measured maximum output power at antenna terminals)	21.31 dBm (135.21mW) Peak
Normal Test Modulation:	OFDM 20 MHz Ch Spacing – (BPSK ½ 6.5 Mbps, QPSK ¾ 19.5 Mbps, 16-QAM ¾ 39 Mbps, 64-QAM 5/6 65 Mbps) 40 MHz Ch Spacing – (BPSK ½ 13.5 Mbps, QPSK ¾ 40.5 Mbps, 16-QAM ¾ 81 Mbps, 64-QAM 5/6 135 Mbps)
Modulating Signal Source:	Internal

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

* The EUT complies with the requirement; it employs a unique (non-standard) antenna connector or integral antenna.

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

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:

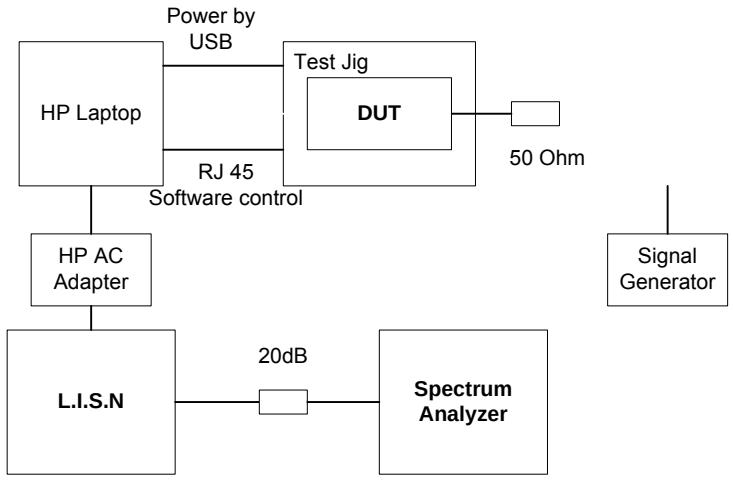
Frequency of emission (MHz)	Conducted Limits (dBμV)	
	Quasi-peak	Average
0.15–0.5 .....……...	66 to 56*	56 to 46*
0.5–5 .....……...	56	46
5-30 ……..	60 ..……..	50

*Decreases linearly with the logarithm of the frequency

5.1.2. Method of Measurements

ANSI C63.4-2009

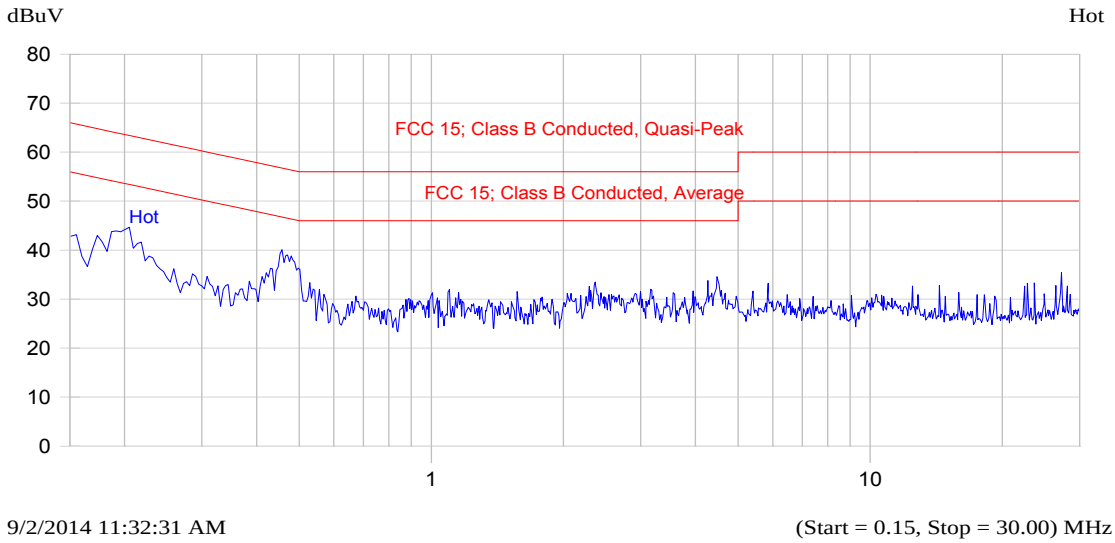
5.1.3. Test Arrangement



5.1.4. Test Data

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

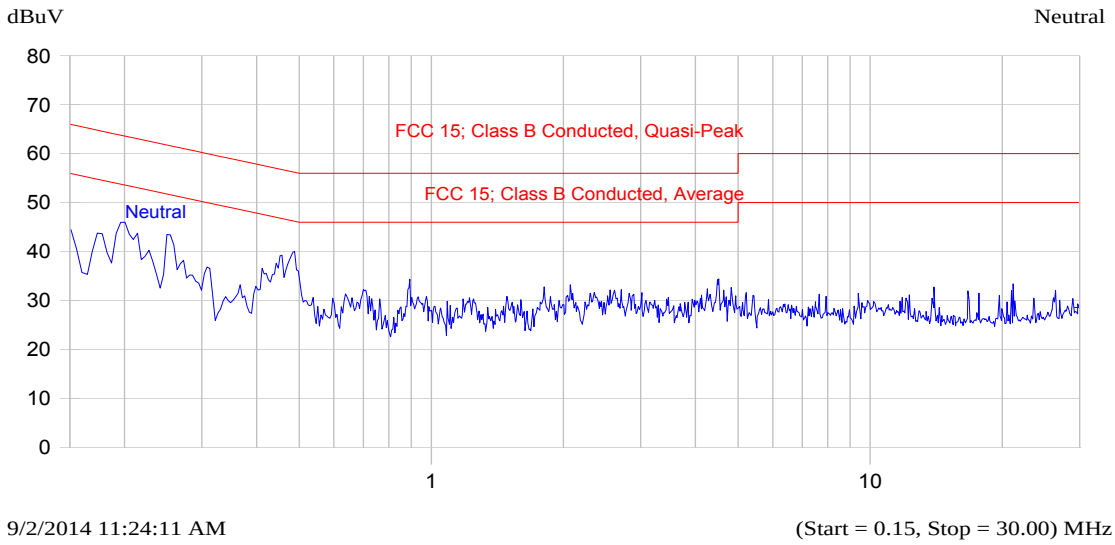
Description: TX mode
Setup Name: FCC 15 Class B
Customer Name: BSM Wireless Inc.
Project Number: HGI-010Q
Operator Name: Hung Trinh
Date Created: 9/2/2014 11:19:51 AM



Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.204	46.4	42.6	-21.9	35.5	-18.9	Hot
0.461	38.9	35.5	-21.6	30.0	-17.0	Hot

Plot 5.1.4.2. Power Line Conducted Emissions; Line Voltage: 120 VAC; Line Tested: Negative

Description: TX mode
Setup Name: FCC 15 Class B
Customer Name: BSM Wireless Inc.
Project Number: HGI-010Q
Operator Name: Hung Trinh
EUT Name: SFM 7000
Date Created: 9/2/2014 11:19:51 AM



Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.194	49.3	43.6	-21.1	36.0	-18.7	Neutral
0.240	45.3	38.5	-24.8	27.0	-26.4	Neutral
0.481	39.8	37.2	-19.4	31.8	-14.7	Neutral

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

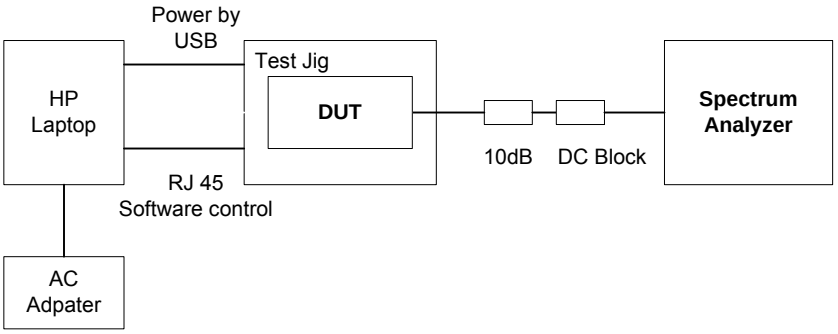
5.2.1. Limit(s)

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

5.2.2. Method of Measurements

KDB Publication No. 558074 D01 DTS Measurement Guidance V03r02, Section 8.1 Option 1

5.2.3. Test Arrangement



5.2.4. Test Data

(a) 20 MHz Channel Spacing Mode:

MCS Index	Modulation	Data Rate (Mbps)	Channel Number	Frequency (MHz)	6 dB BW (MHz)	Min Limit (kHz)
0	BPSK ½	6.5	1	2412	17.37	500
0	BPSK ½	6.5	6	2437	17.18	500
0	BPSK ½	6.5	11	2462	17.24	500
2	QPSK ¾	19.5	1	2412	17.31	500
2	QPSK ¾	19.5	6	2437	17.31	500
2	QPSK ¾	19.5	11	2462	17.31	500
4	16-QAM ¾	39	1	2412	17.63	500
4	16-QAM ¾	39	6	2437	17.69	500
4	16-QAM ¾	39	11	2462	17.69	500
7	64-QAM 5/6	65	1	2412	17.69	500
7	64-QAM 5/6	65	6	2437	17.69	500
7	64-QAM 5/6	65	11	2462	17.69	500

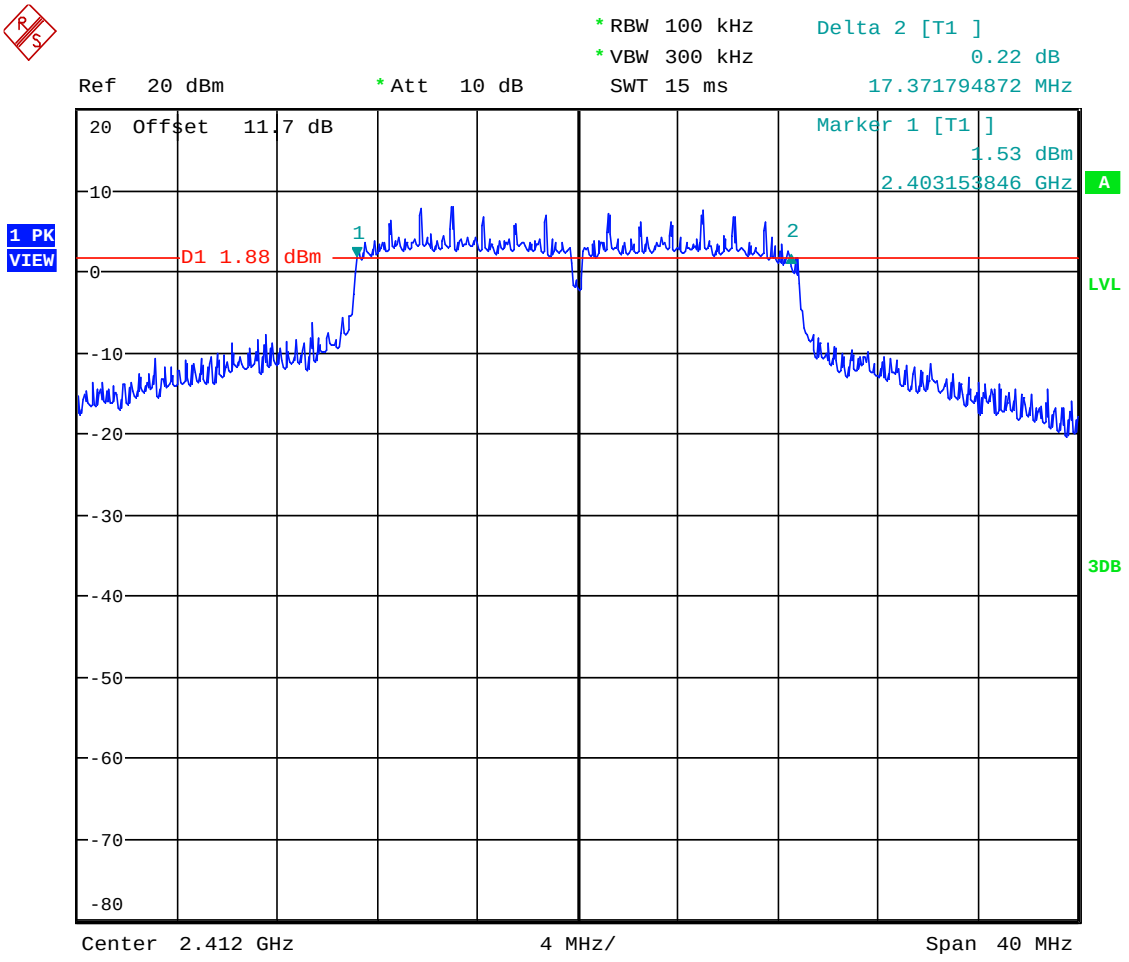
(b) 40 MHz Channel Spacing Mode:

MCS Index	Modulation	Data Rate (Mbps)	Channel Number	Frequency (MHz)	6 dB BW (MHz)	Min Limit (kHz)
0	BPSK ½	13.5	3	2422	36.02	500
0	BPSK ½	13.5	6	2437	36.02	500
0	BPSK ½	13.5	9	2452	36.02	500
2	QPSK ¾	40.5	3	2422	36.02	500
2	QPSK ¾	40.5	6	2437	36.02	500
2	QPSK ¾	40.5	9	2452	36.02	500
4	16-QAM ¾	81	3	2422	36.02	500
4	16-QAM ¾	81	6	2437	36.41	500
4	16-QAM ¾	81	9	2452	36.41	500
7	64-QAM 5/6	135	3	2422	36.02	500
7	64-QAM 5/6	135	6	2437	36.15	500
7	64-QAM 5/6	135	9	2452	36.15	500

See the following plots for detailed measurements.

(a) 20 MHz Channel Spacing Mode:

Plot 5.2.4.1. 6 dB Bandwidth, BPSK Modulation, Channel #1, 2412 MHz



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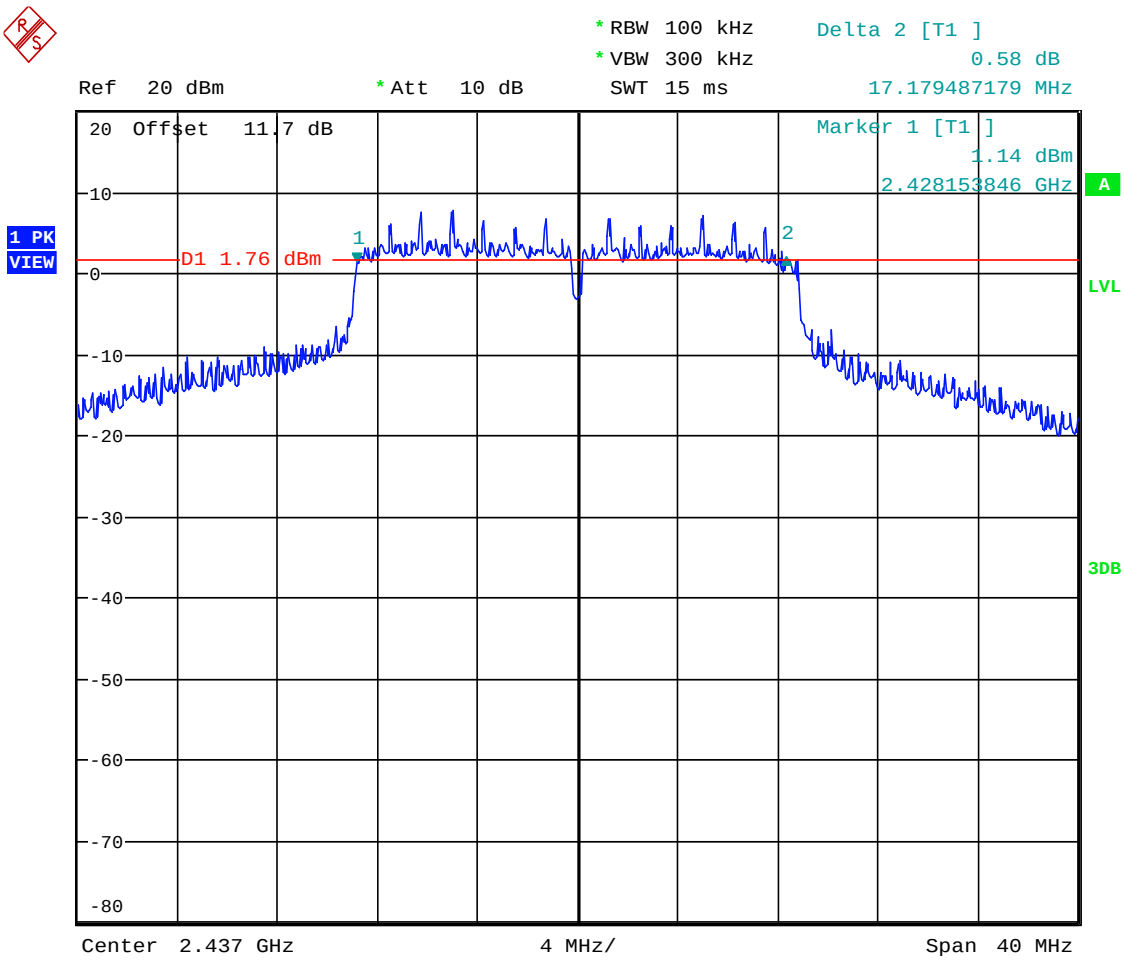
Date: 11.AUG.2014 10:33:55

Plot 5.2.4.2. 6 dB Bandwidth, BPSK Modulation, Channel #6, 2437 MHz



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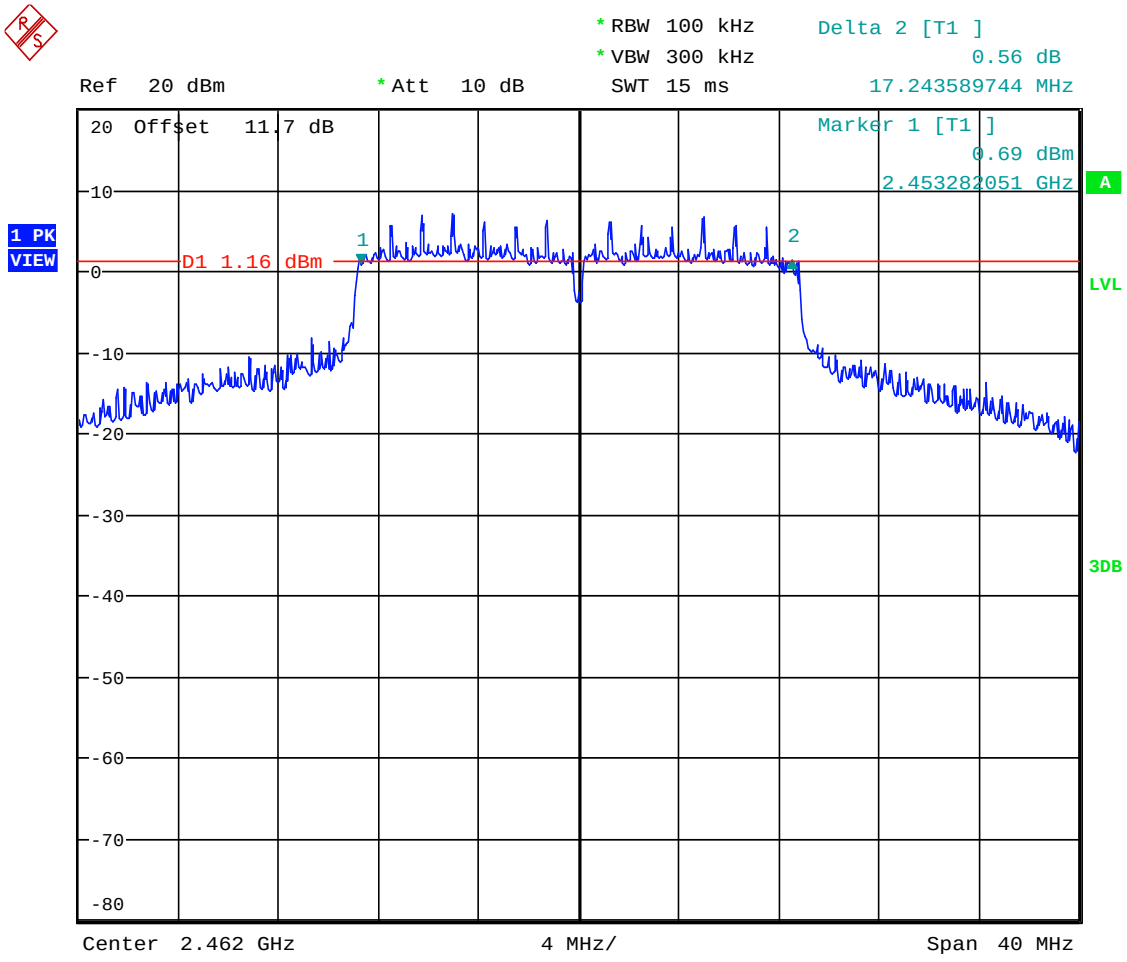
Date: 11.AUG.2014 10:38:17

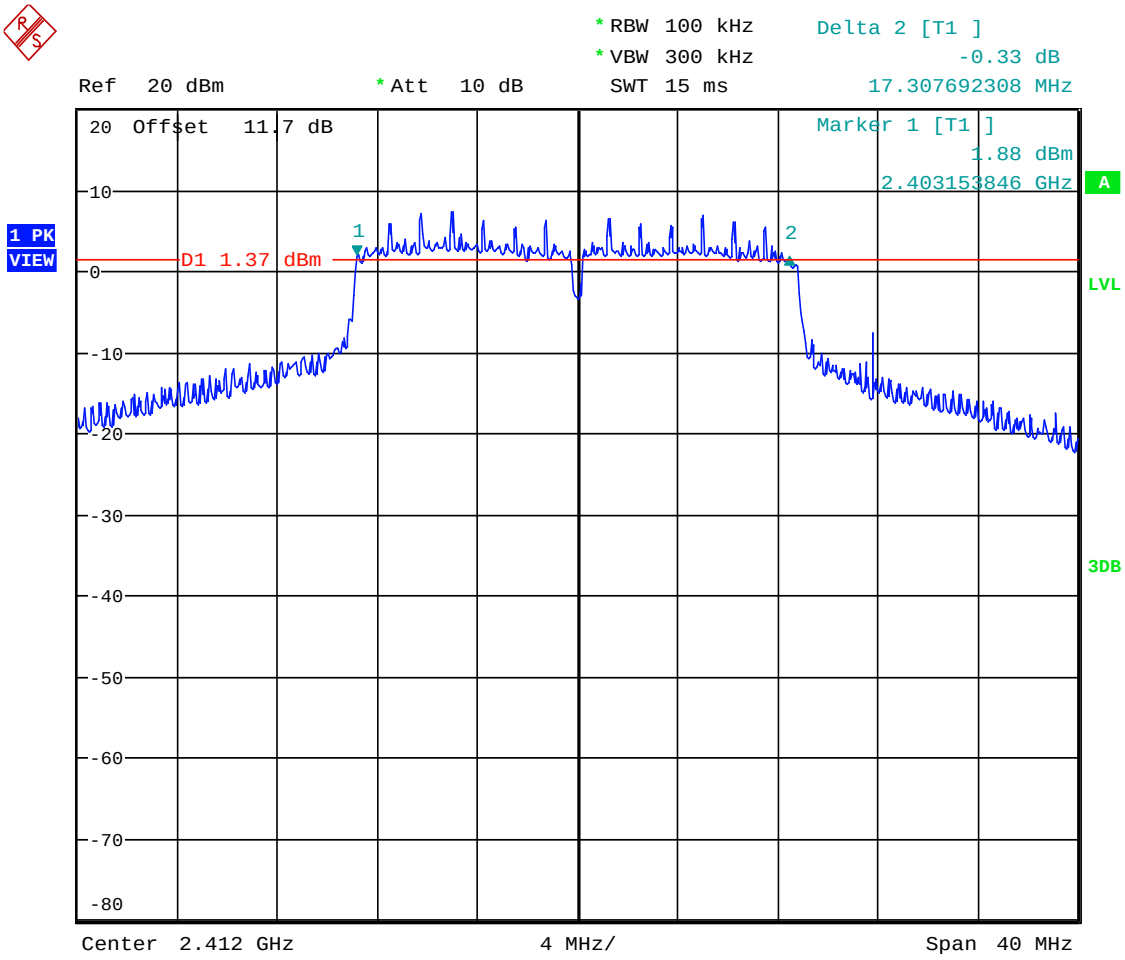
Plot 5.2.4.3. 6 dB Bandwidth, BPSK Modulation, Channel #11, 2462 MHz



Ultratech Labs

Date: 11.AUG.2014 10:41:46

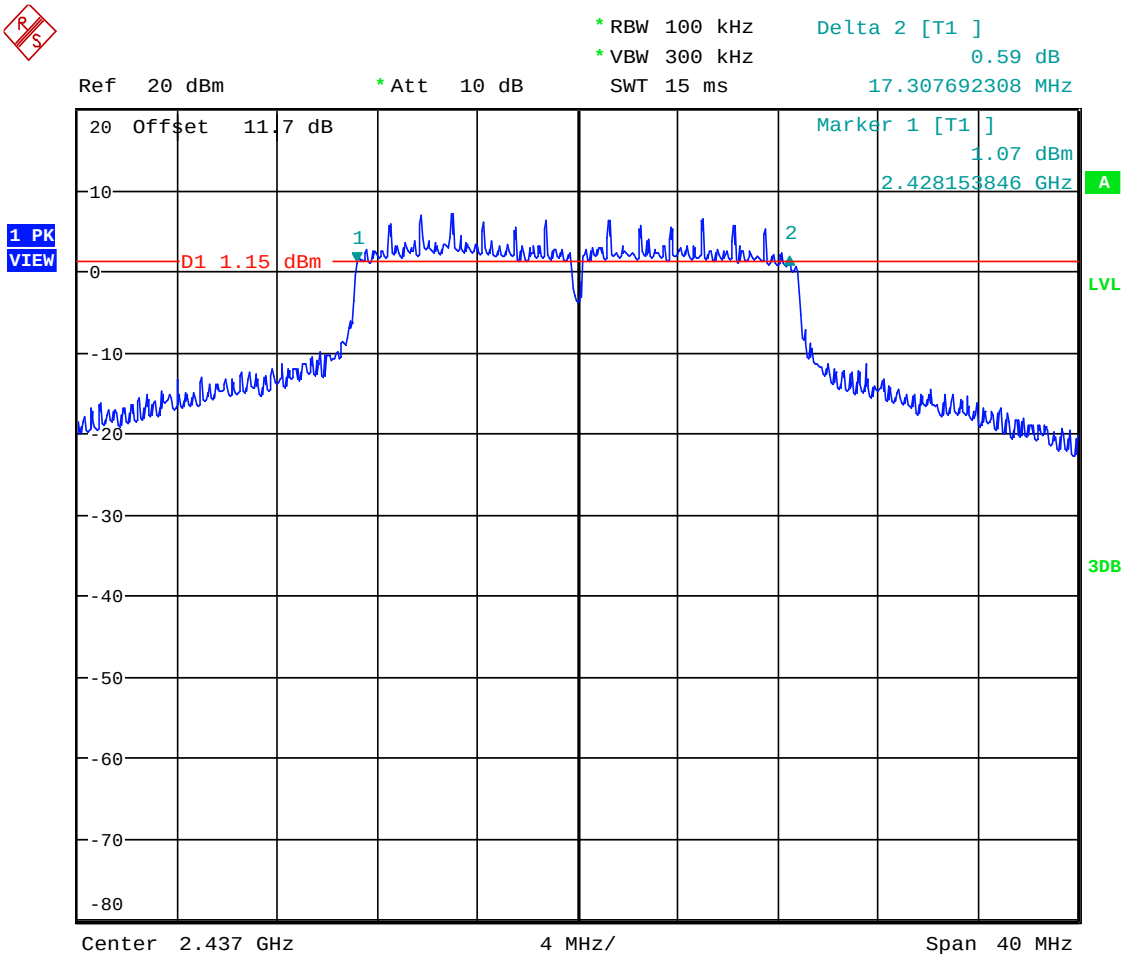
Plot 5.2.4.4. 6 dB Bandwidth, QPSK Modulation, Channel #1, 2412 MHz



Ultratech Labs

Date: 11.AUG.2014 10:47:48

Plot 5.2.4.5. 6 dB Bandwidth, QPSK Modulation, Channel #6, 2437 MHz



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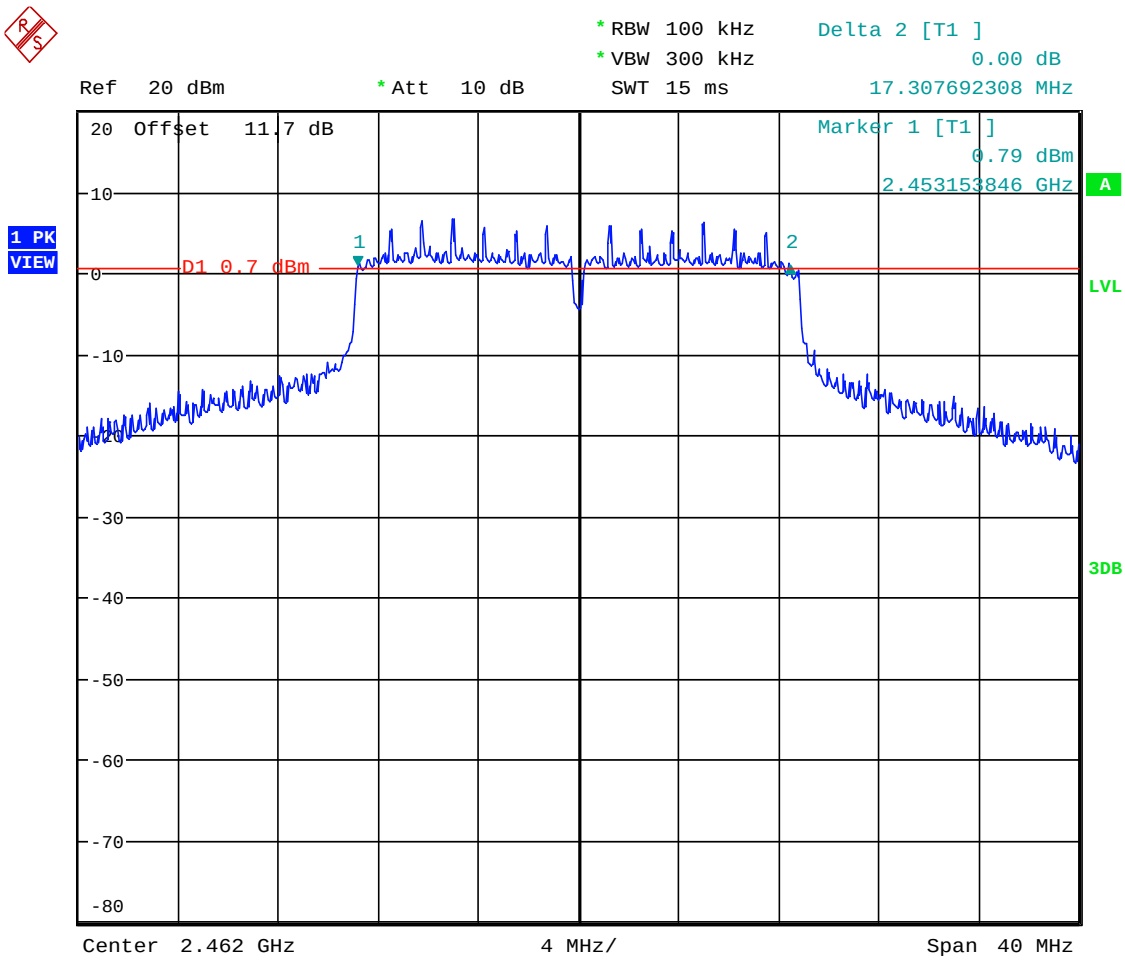
Date: 11.AUG.2014 10:51:49

Plot 5.2.4.6. 6 dB Bandwidth, QPSK Modulation, Channel #11, 2462 MHz



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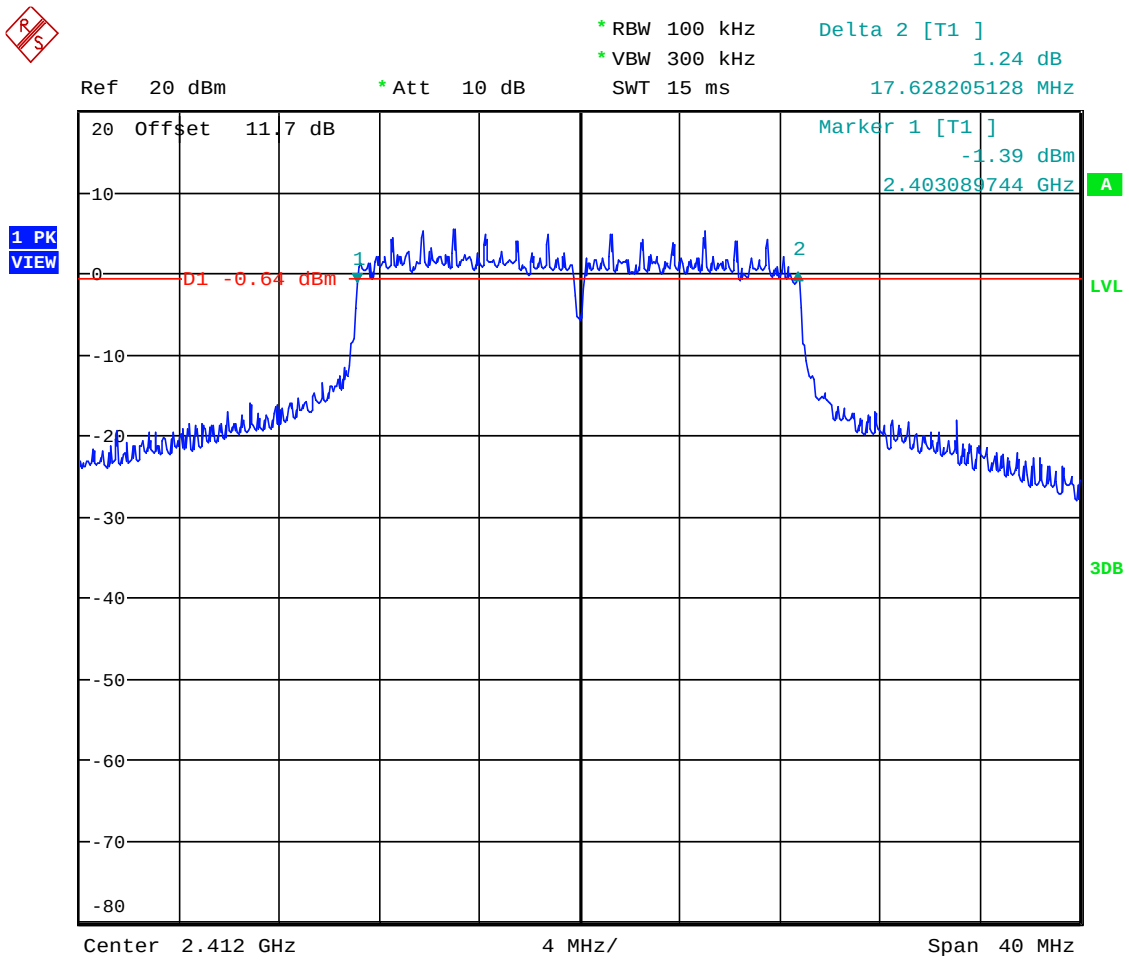
Date: 11.AUG.2014 10:59:13

Plot 5.2.4.7. 6 dB Bandwidth, 16-QAM Modulation, Channel #1, 2412 MHz



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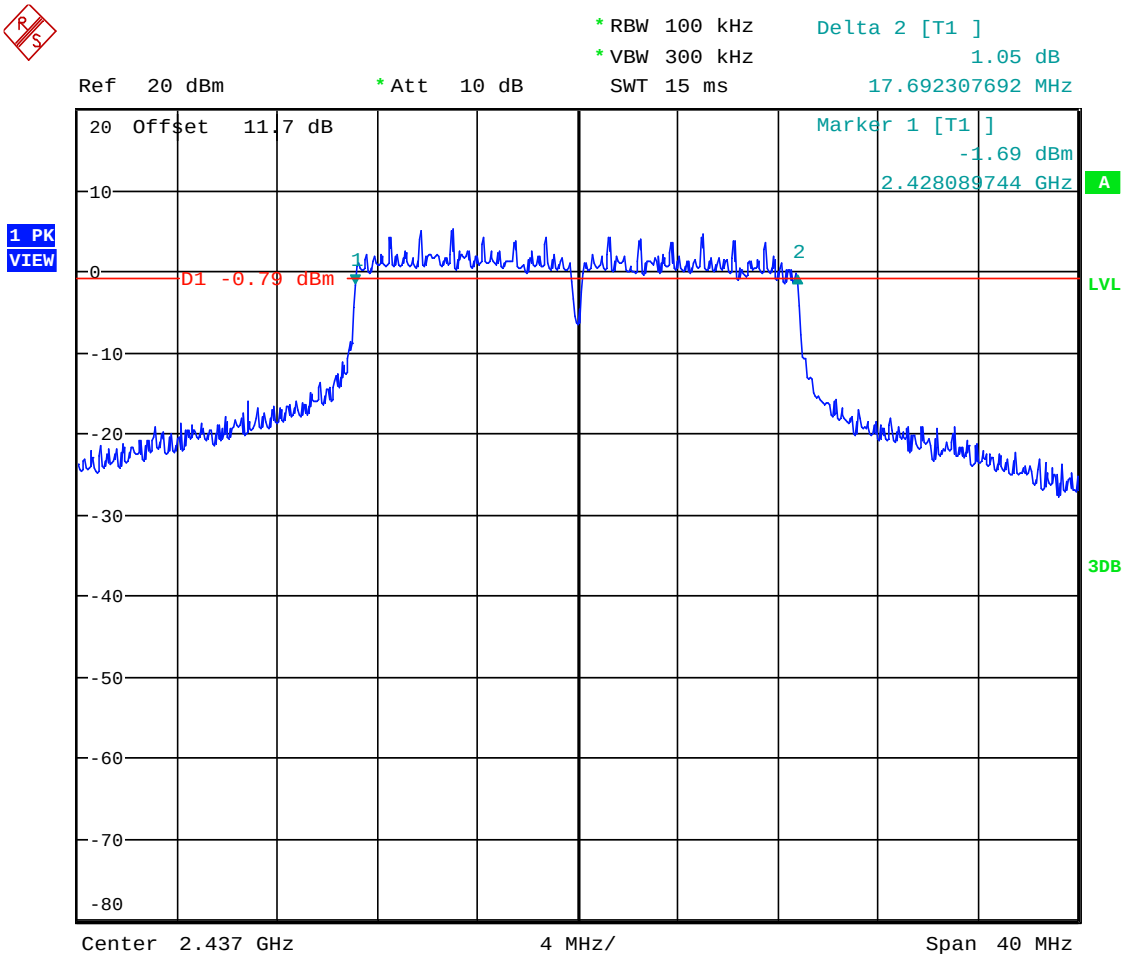
Date: 11.AUG.2014 11:04:43

Plot 5.2.4.8. 6 dB Bandwidth, 16-QAM Modulation, Channel #6, 2437 MHz



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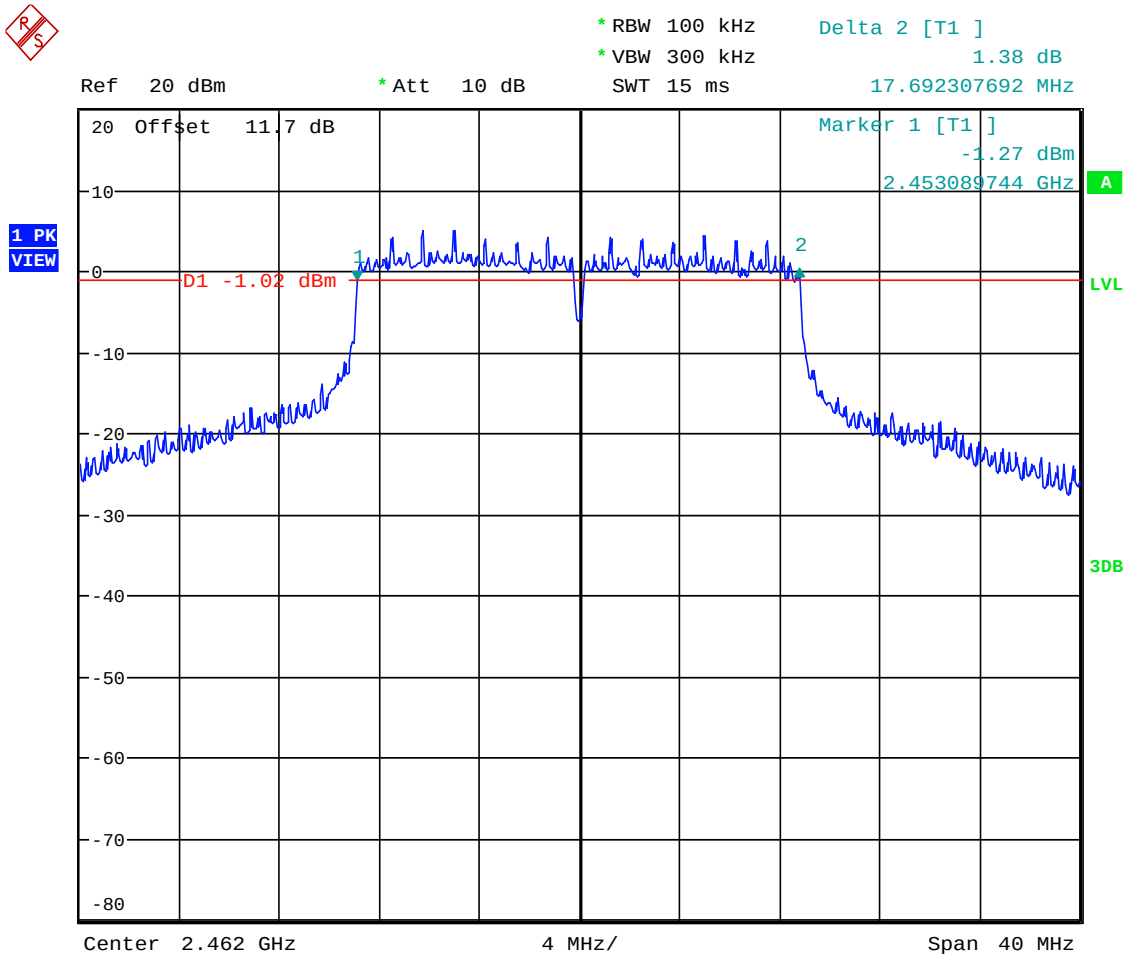
Date: 11.AUG.2014 11:09:51

Plot 5.2.4.9. 6 dB Bandwidth, 16-QAM Modulation, Channel #11, 2462 MHz



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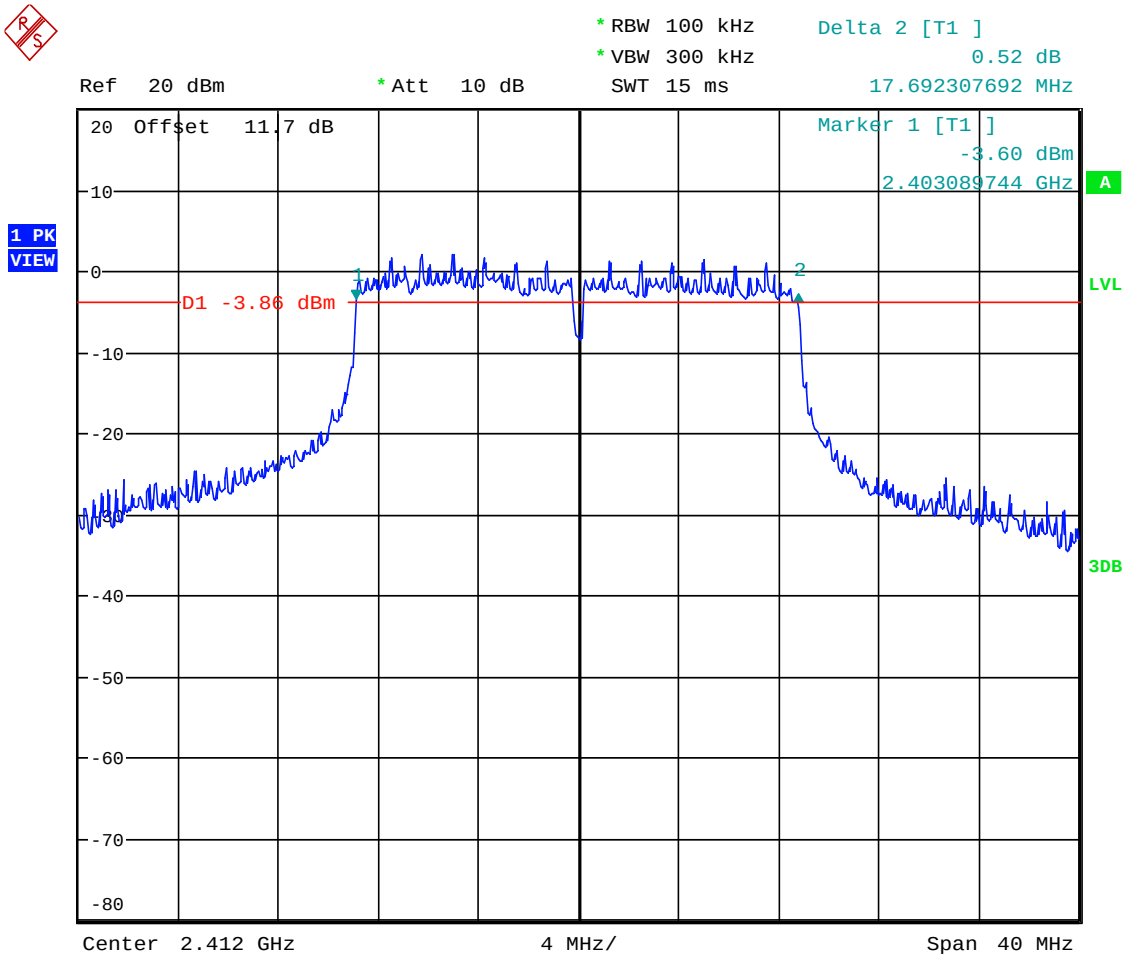
Date: 11.AUG.2014 11:16:04

Plot 5.2.4.10. 6 dB Bandwidth, 64-QAM Modulation, Channel #1, 2412 MHz



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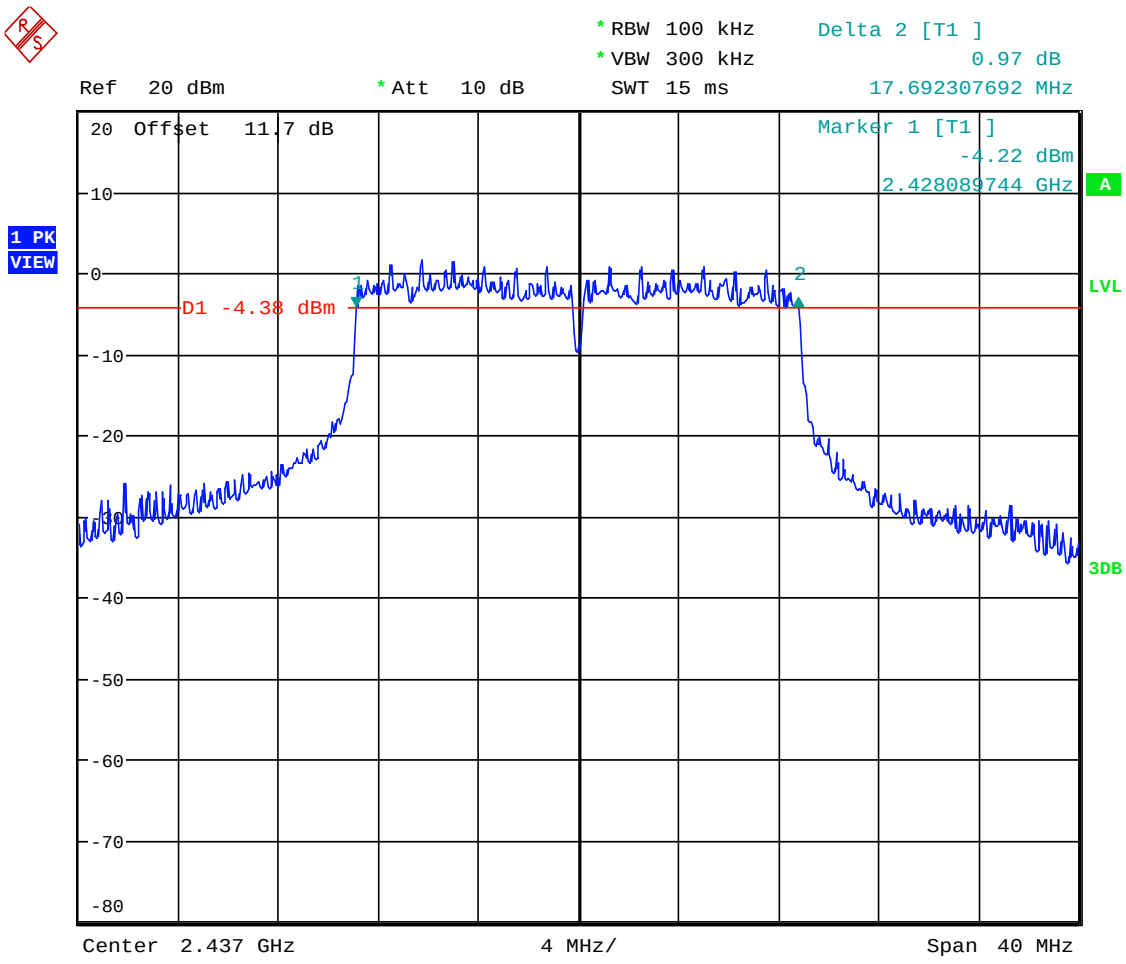
Date: 11.AUG.2014 11:23:25

Plot 5.2.4.11. 6 dB Bandwidth, 64-QAM Modulation, Channel #6, 2437 MHz



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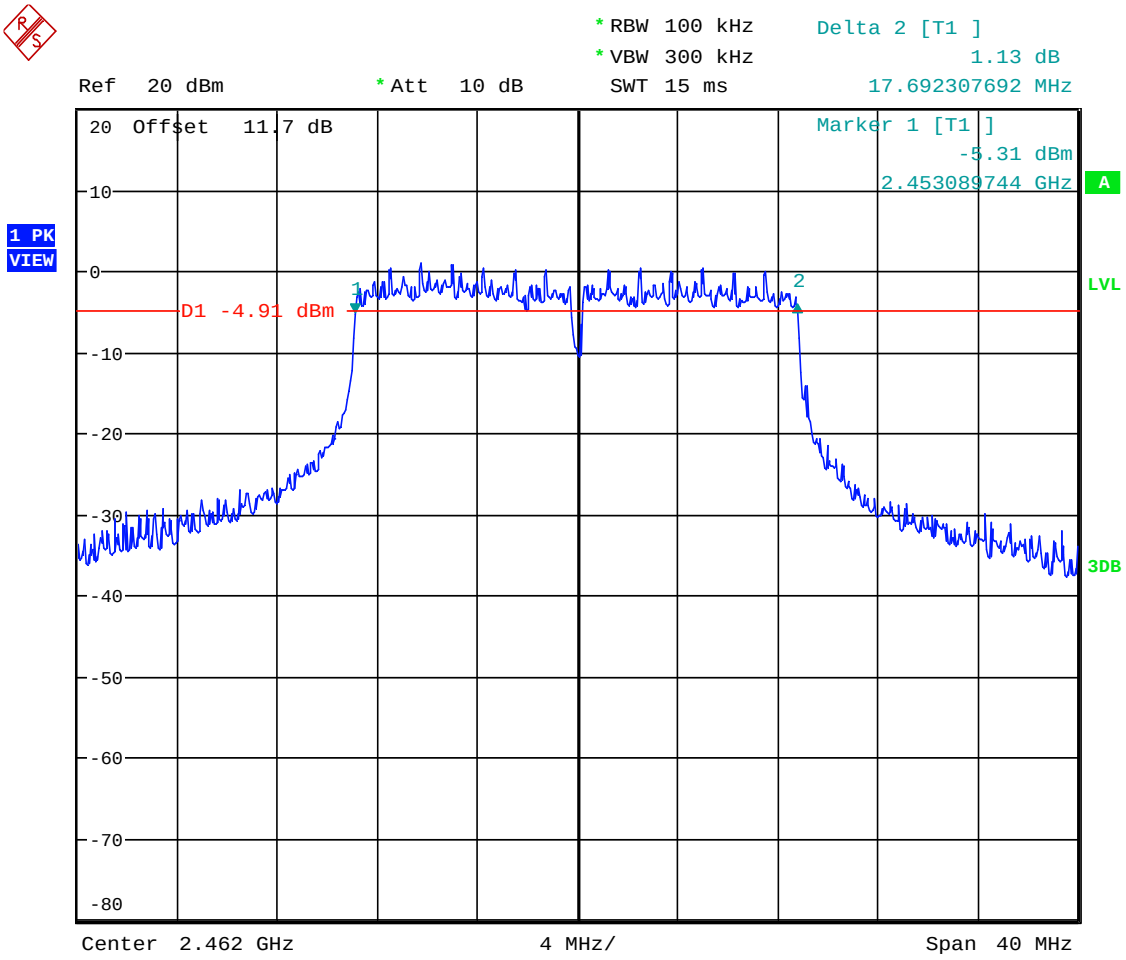
Date: 11.AUG.2014 11:26:34

Plot 5.2.4.12. 6 dB Bandwidth, 64-QAM Modulation, Channel #11, 2462 MHz



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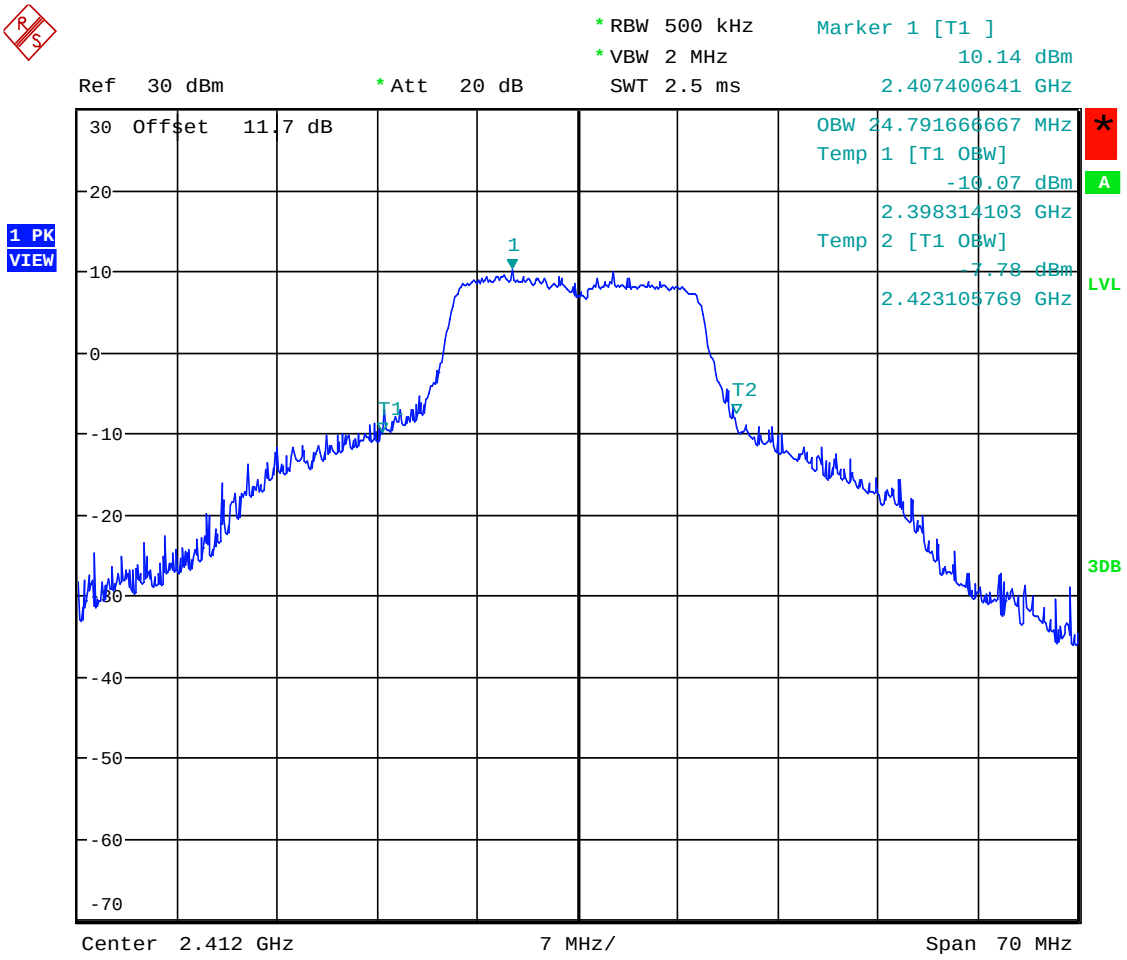
Date: 11.AUG.2014 11:29:21

Plot 5.2.4.13. 99% Bandwidth, BPSK Modulation, Channel #1, 2412 MHz



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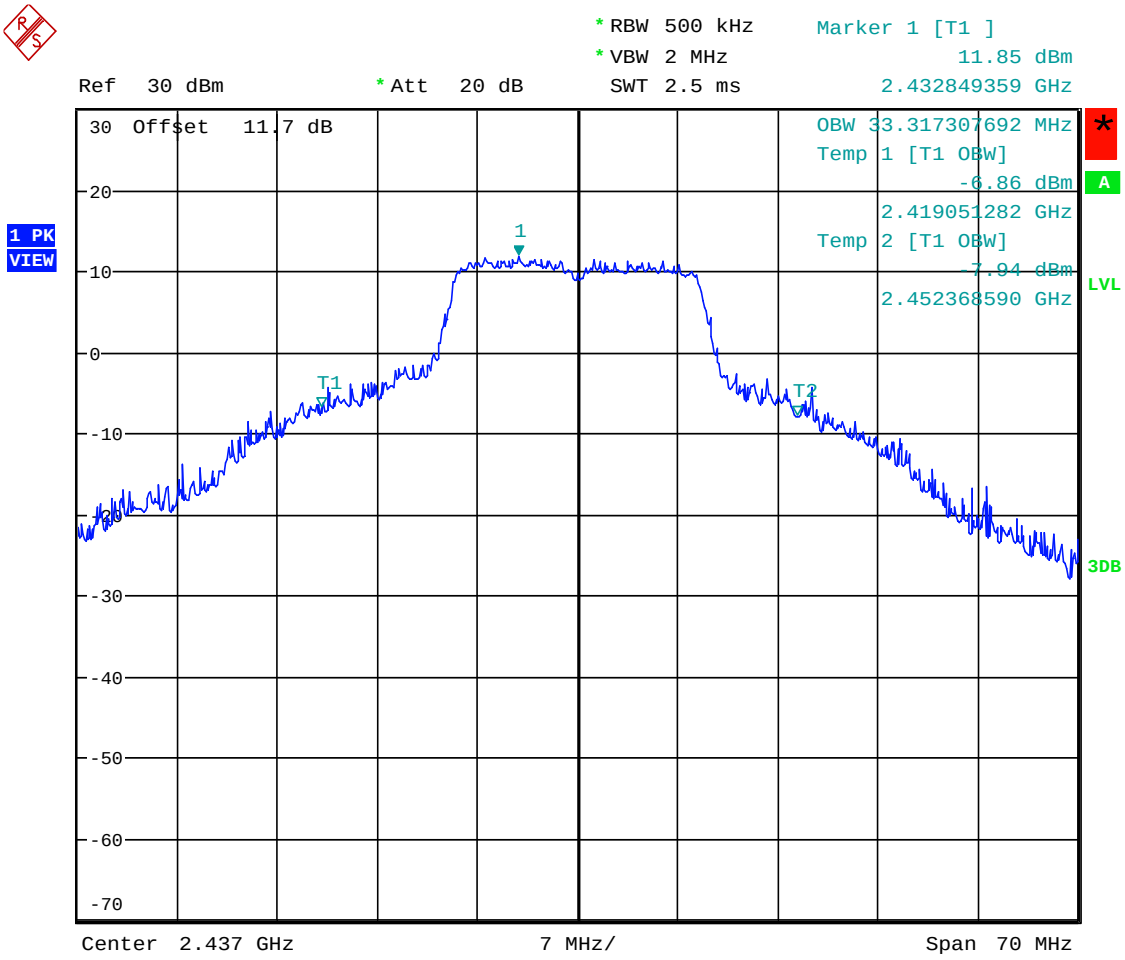
Date: 8.SEP.2014 10:22:14

Plot 5.2.4.14. 99% Bandwidth, BPSK Modulation, Channel #6, 2437 MHz



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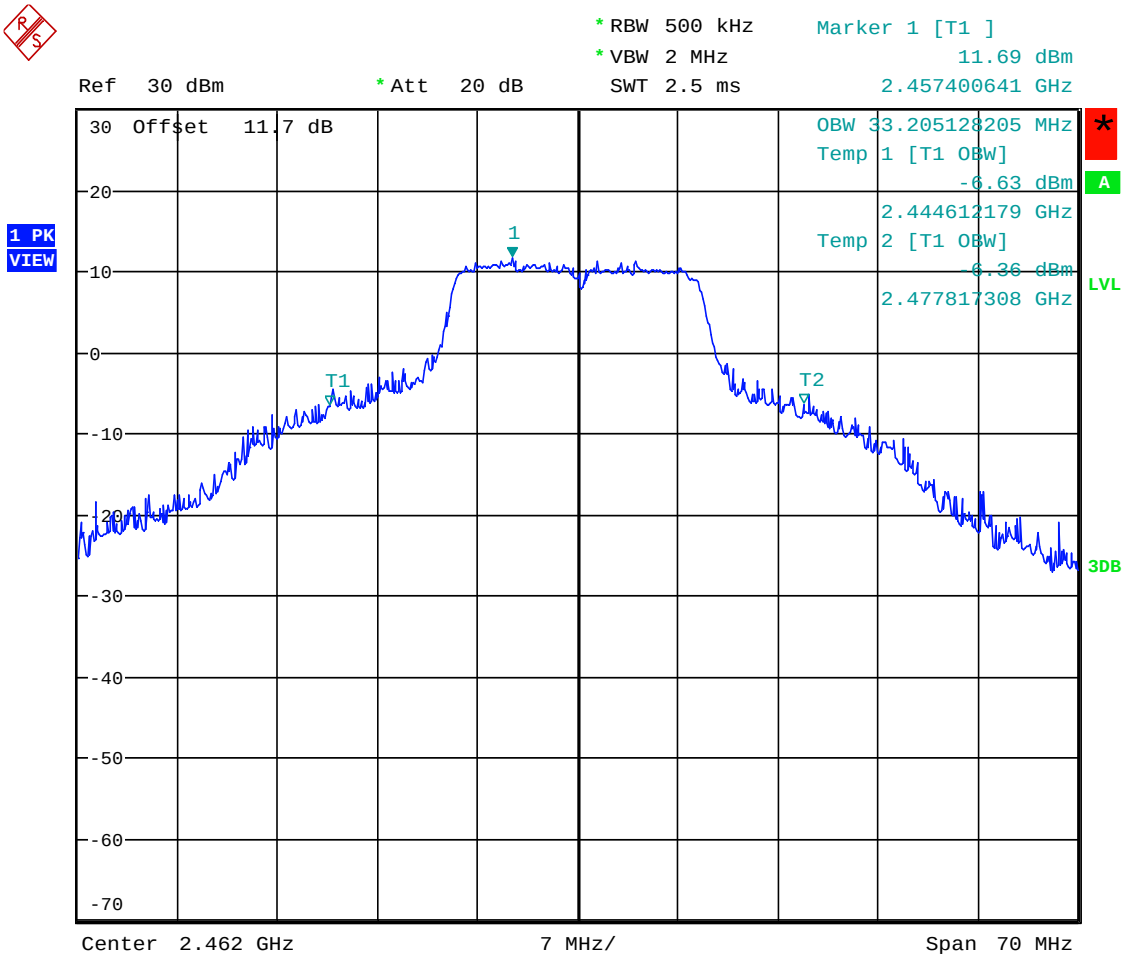
Date: 8.SEP.2014 10:24:40

Plot 5.2.4.15. 99% Bandwidth, BPSK Modulation, Channel #11, 2462 MHz



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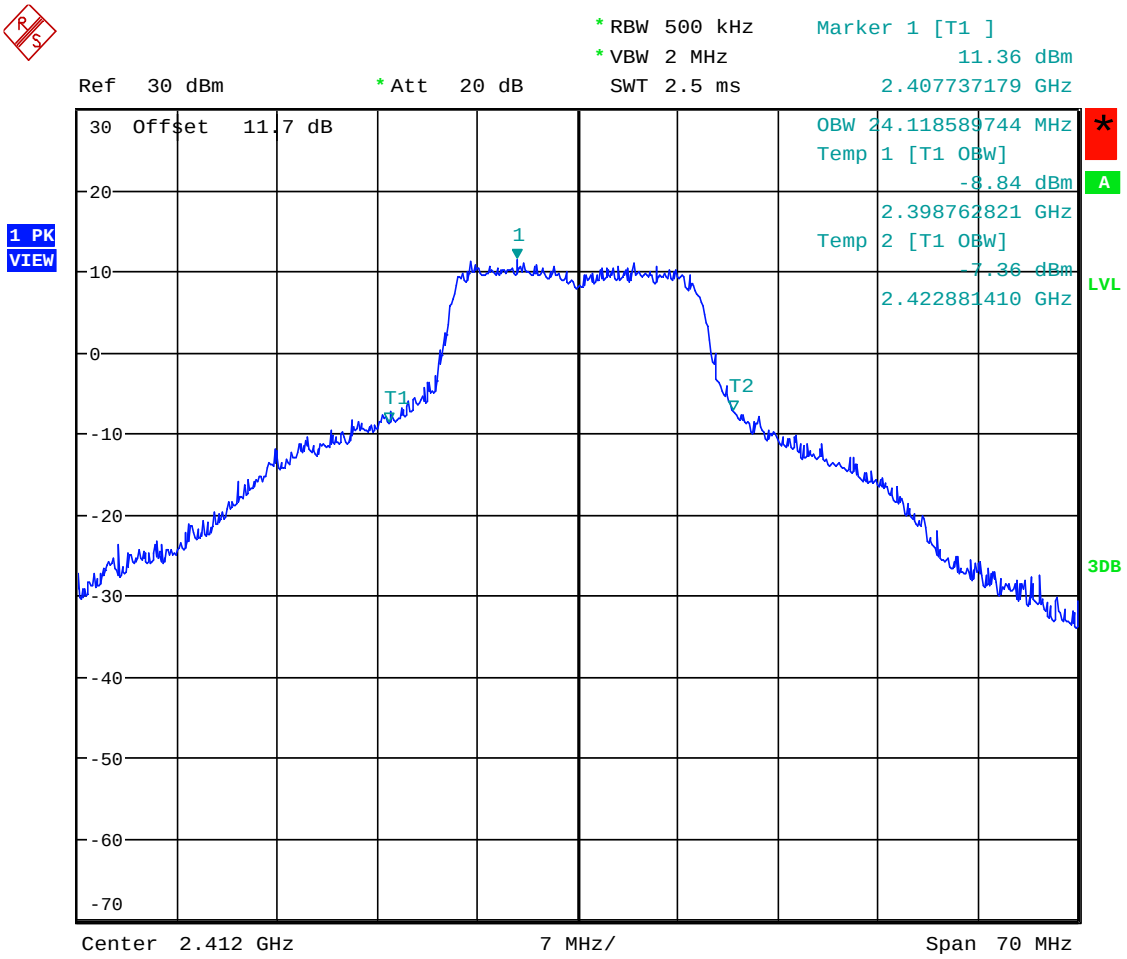
Plot 5.2.4.16. 99% Bandwidth, QPSK Modulation, Channel #1, 2412 MHz



Ultratech Labs

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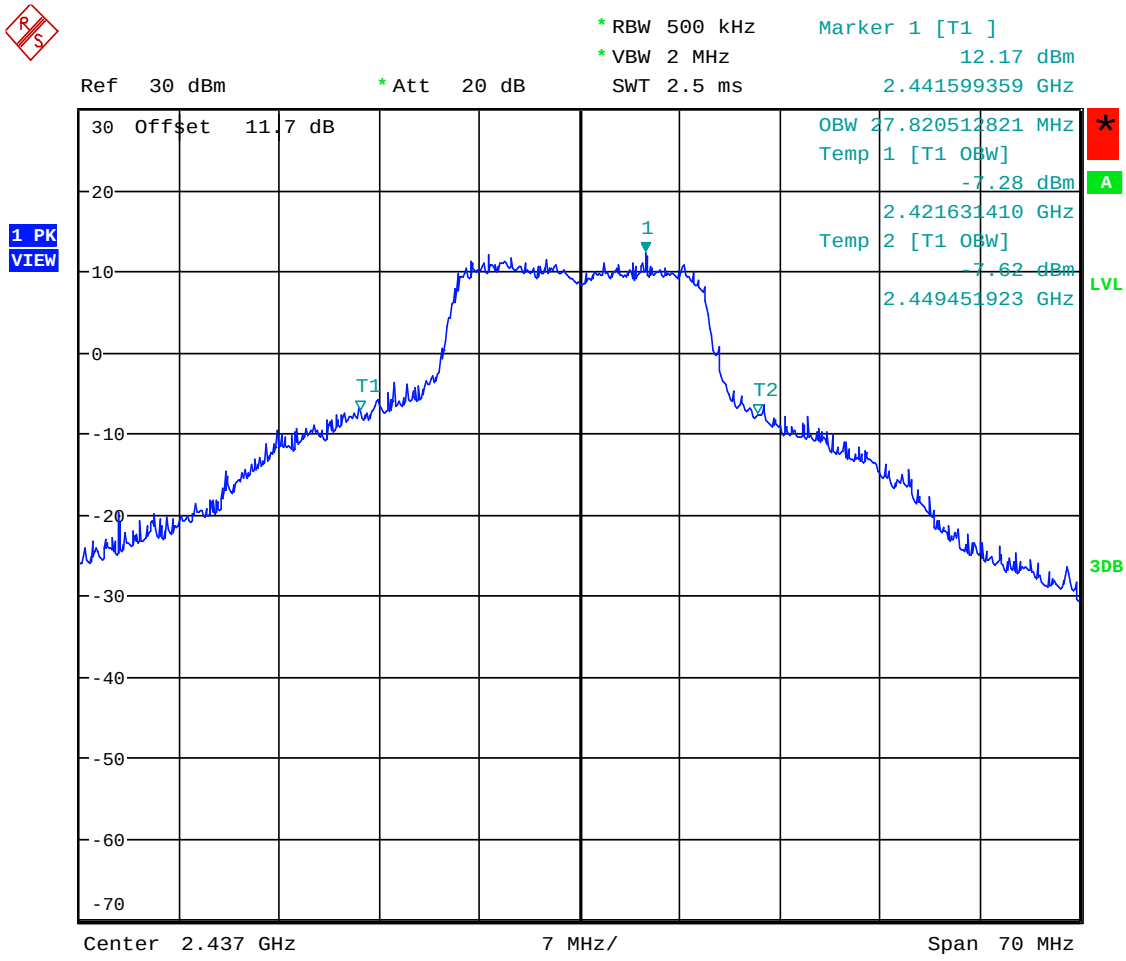
Plot 5.2.4.17. 99% Bandwidth, QPSK Modulation, Channel #6, 2437 MHz



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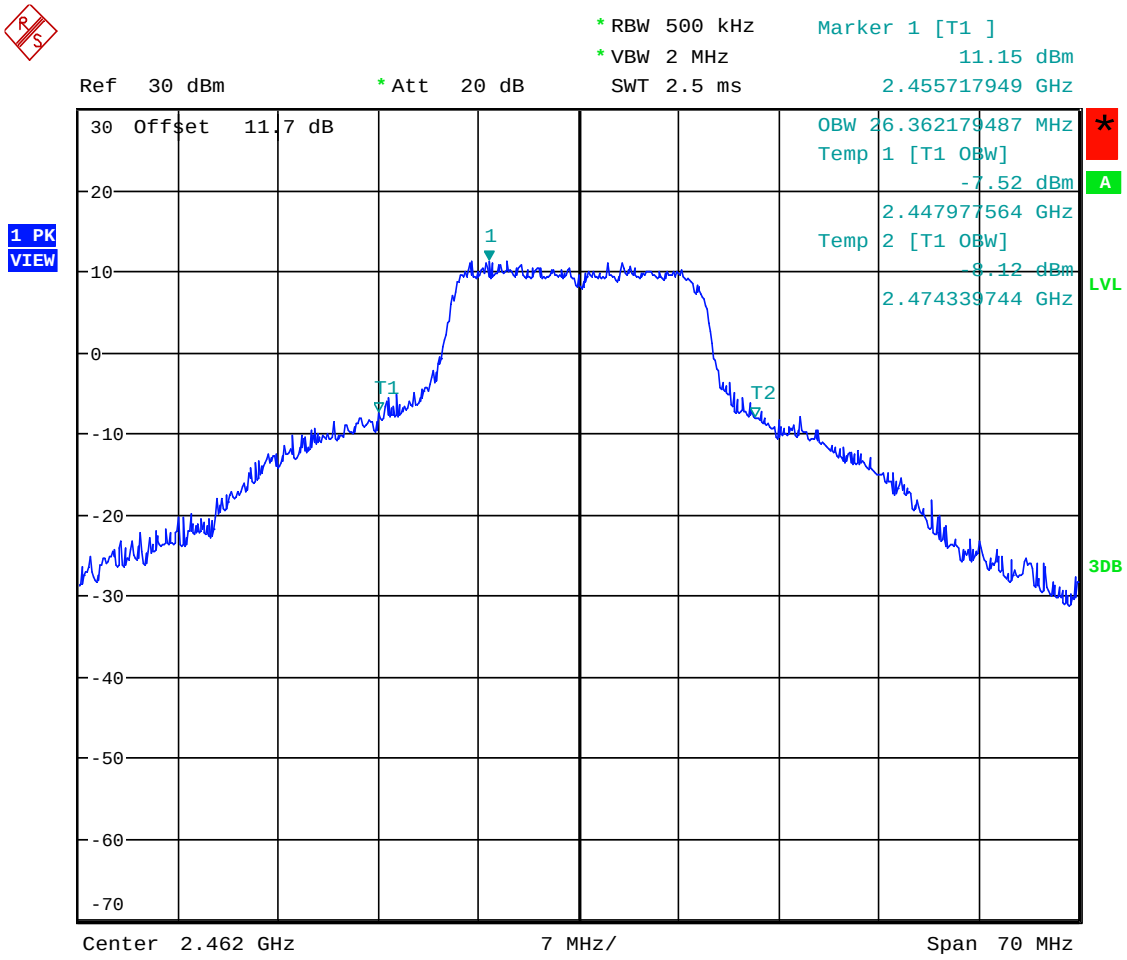
Plot 5.2.4.18. 99% Bandwidth, QPSK Modulation, Channel #11, 2462 MHz



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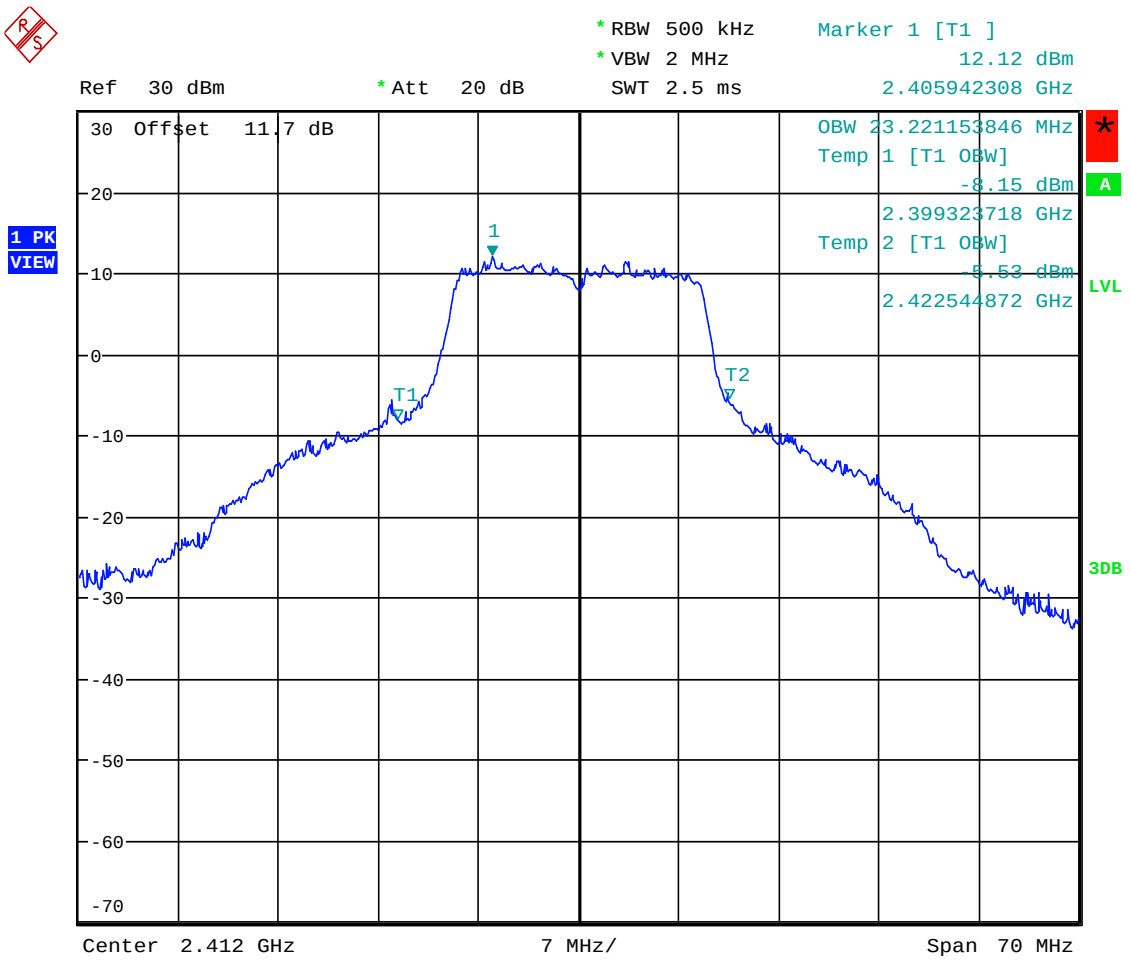
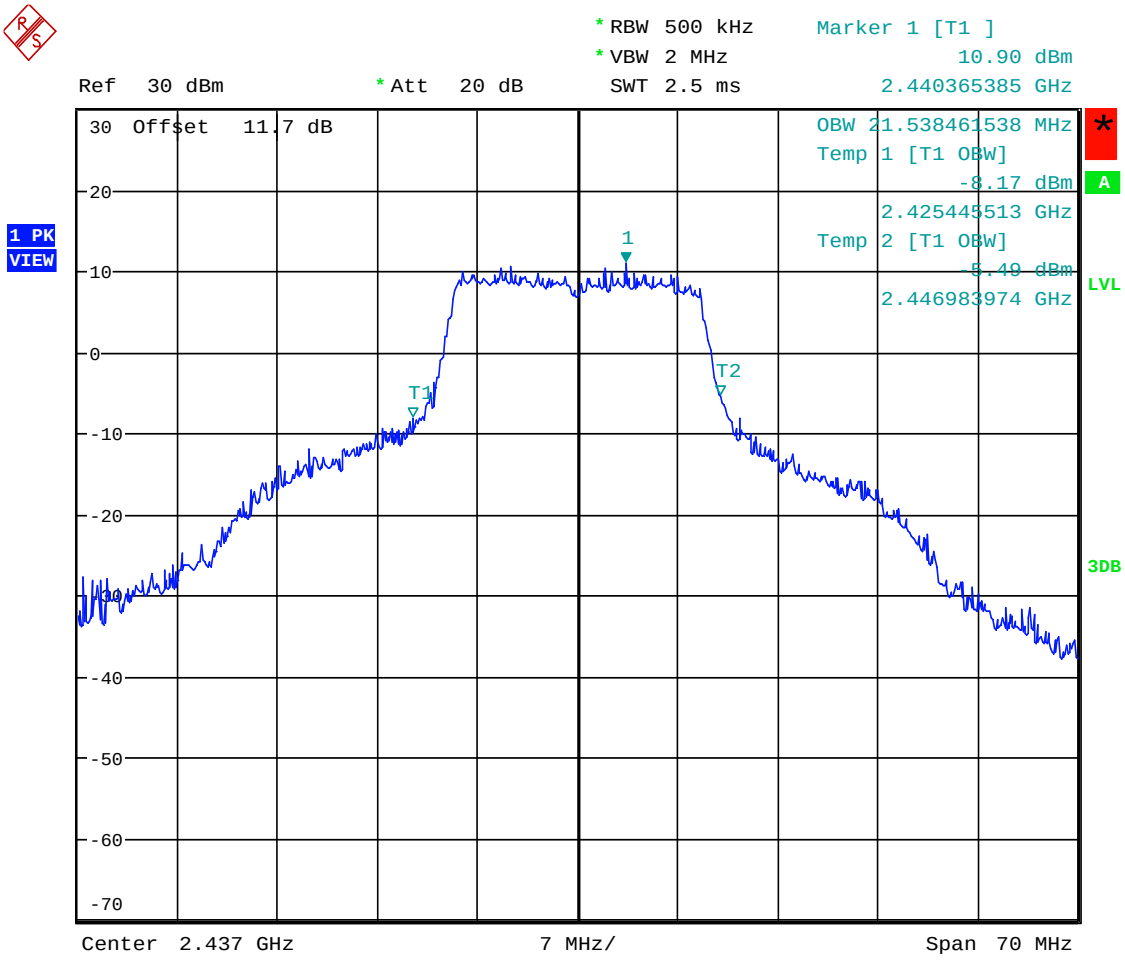
Plot 5.2.4.19. 99% Bandwidth, 16-QAM Modulation, Channel #1, 2412 MHz



Ultratech Labs

Date: 8.SEP.2014 10:42:00

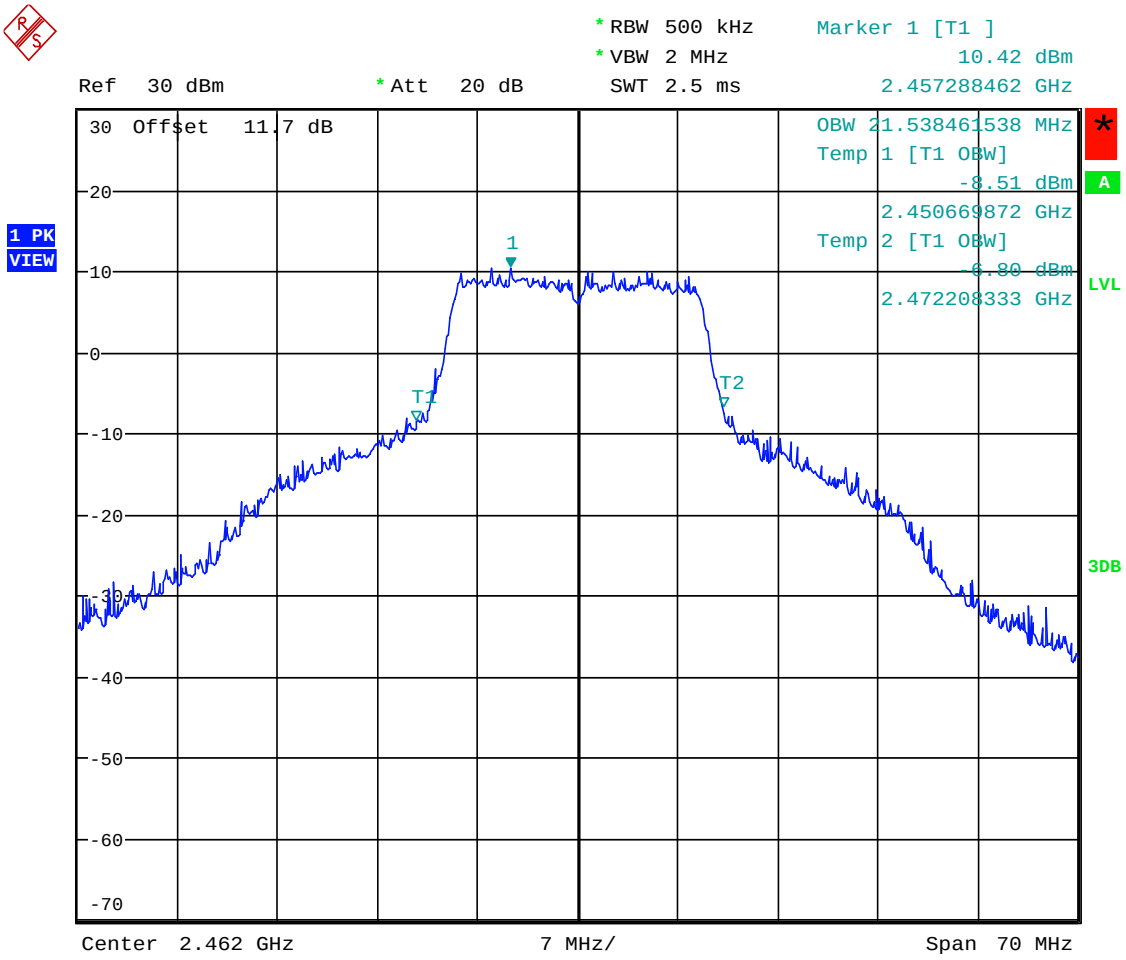
Plot 5.2.4.20. 99% Bandwidth, 16-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 8.SEP.2014 10:44:18

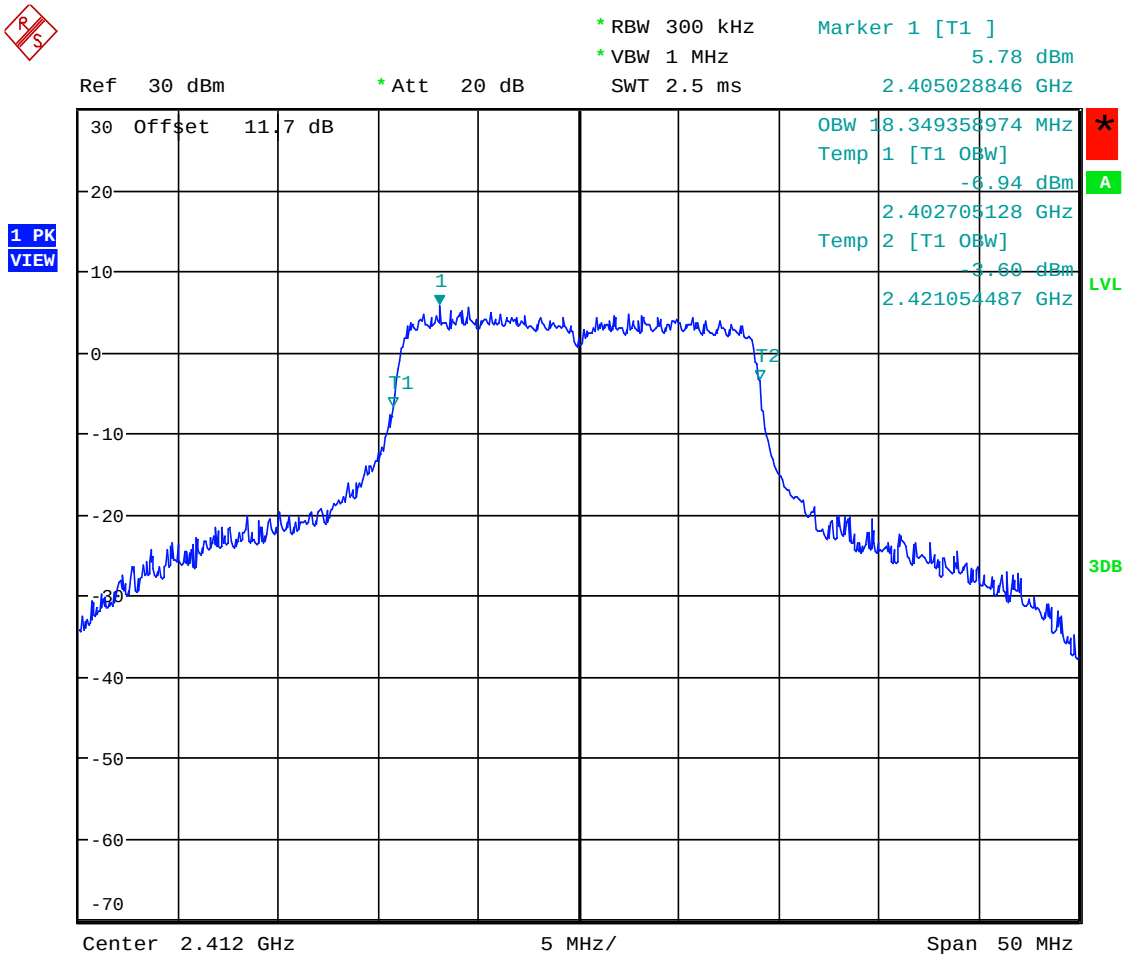
Plot 5.2.4.21. 99% Bandwidth, 16-QAM Modulation, Channel #11, 2462 MHz



Ultratech Labs

Date: 8.SEP.2014 10:46:23

Plot 5.2.4.22. 99% Bandwidth, 64-QAM Modulation, Channel #1, 2412 MHz



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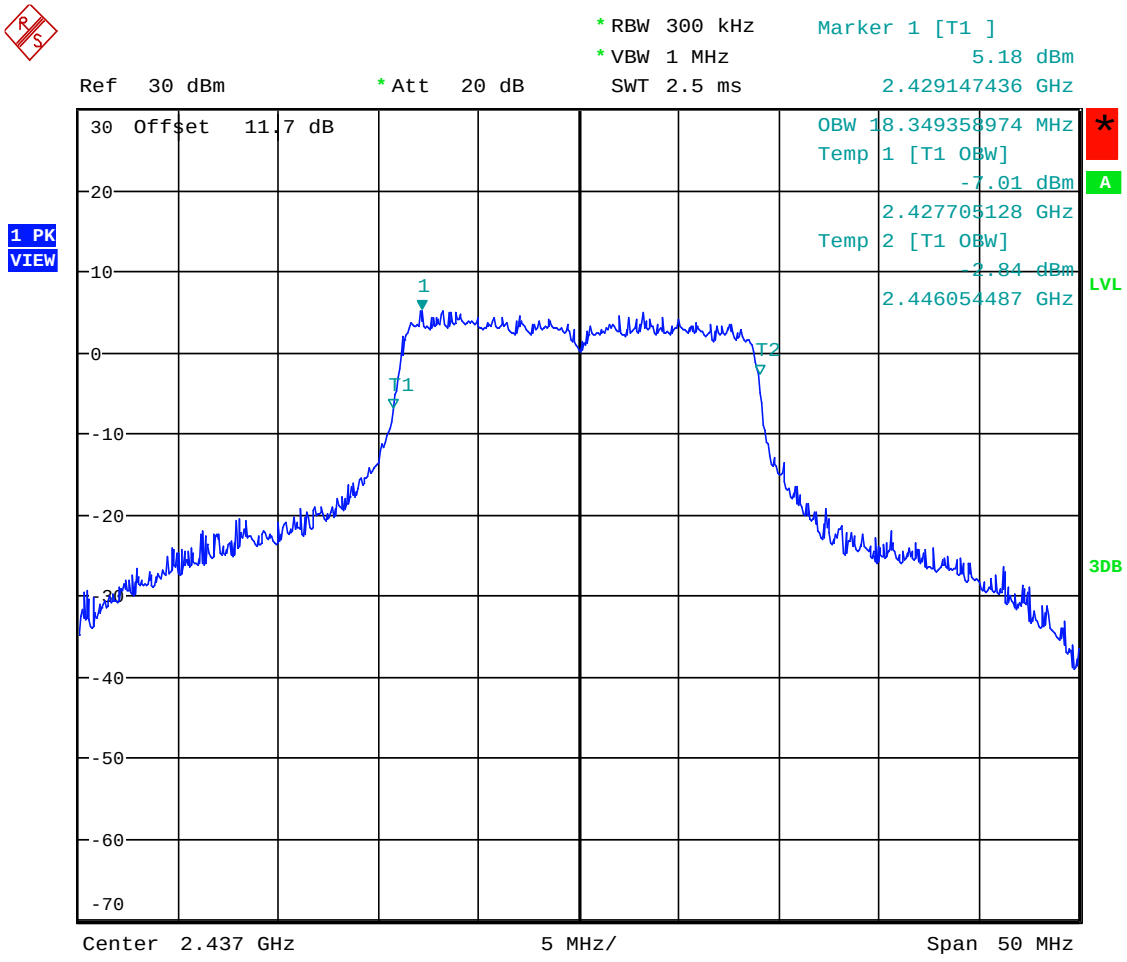
Date: 8.SEP.2014 10:50:24

Plot 5.2.4.23. 99% Bandwidth, 64-QAM Modulation, Channel #6, 2437 MHz



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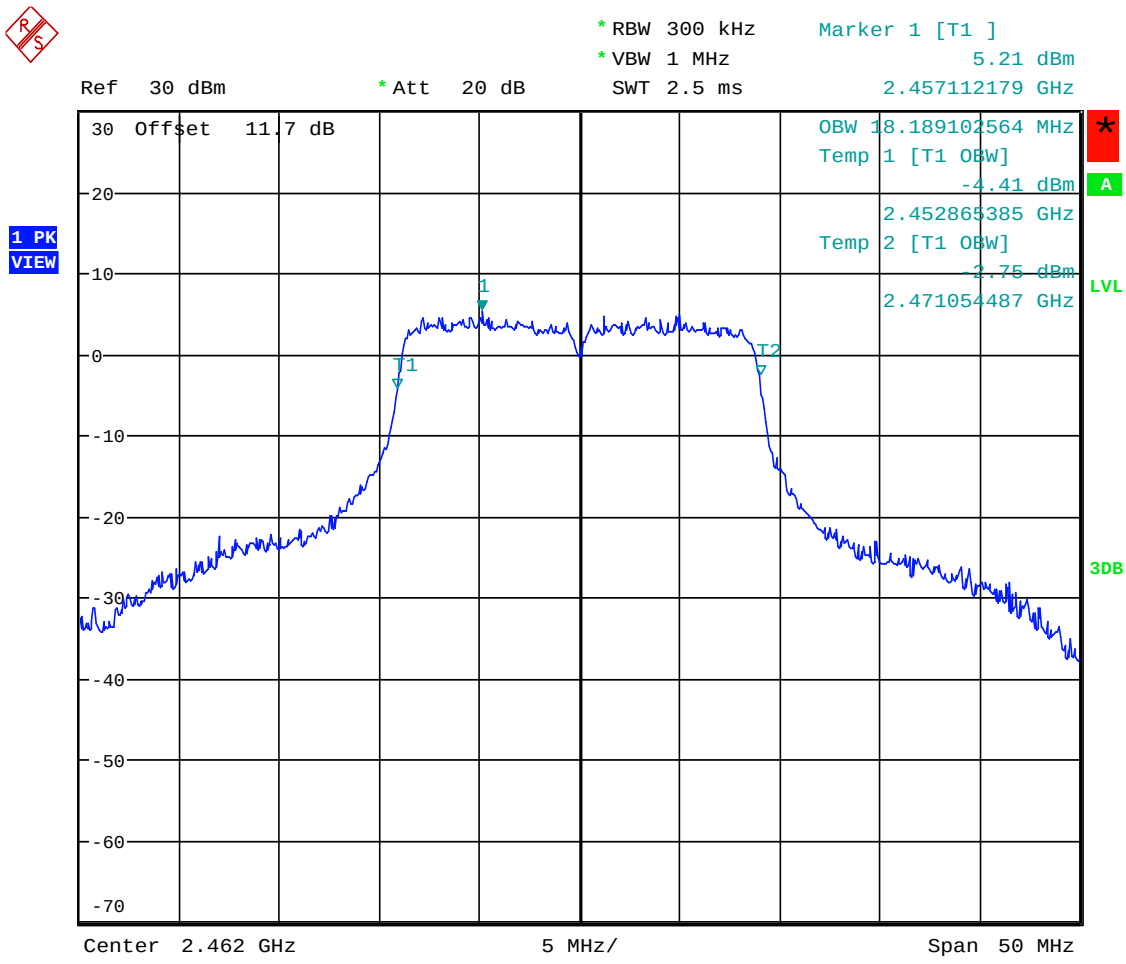
Date: 8.SEP.2014 10:53:16

Plot 5.2.4.24. 99% Bandwidth, 64-QAM Modulation, Channel #11, 2462 MHz



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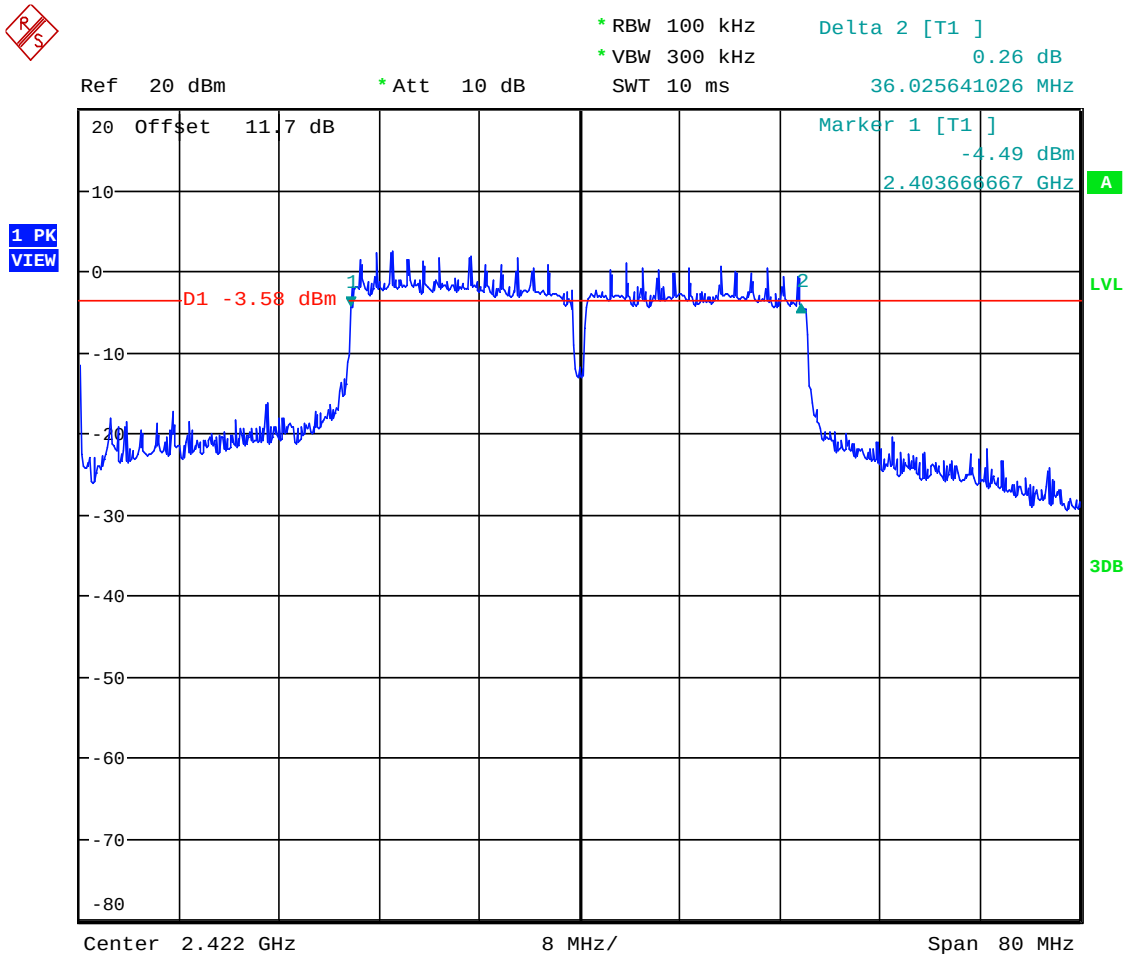
Date: 8.SEP.2014 10:55:36

(b) 40 MHz Channel Spacing Mode:

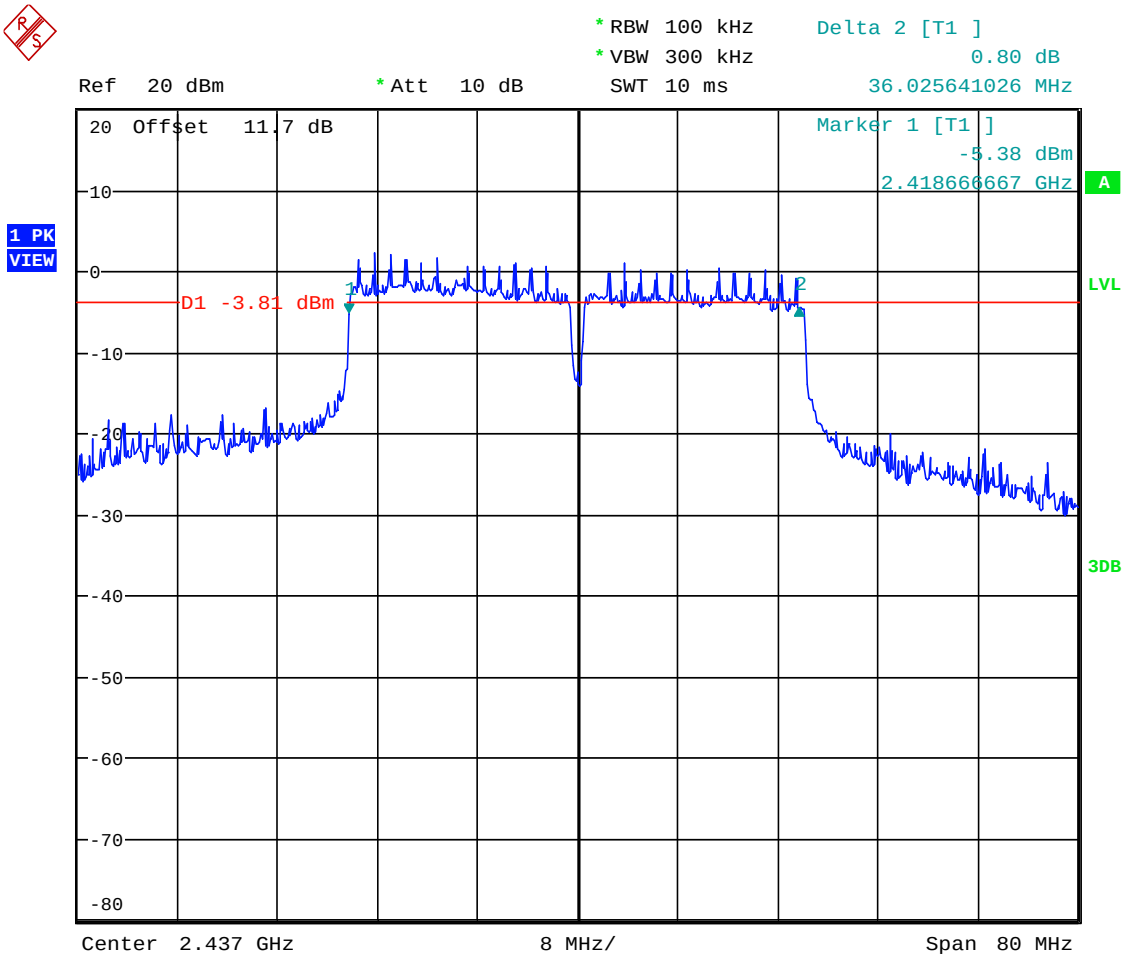
Plot 5.2.4.25. 6 dB Bandwidth, BPSK Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 11.AUG.2014 13:08:14

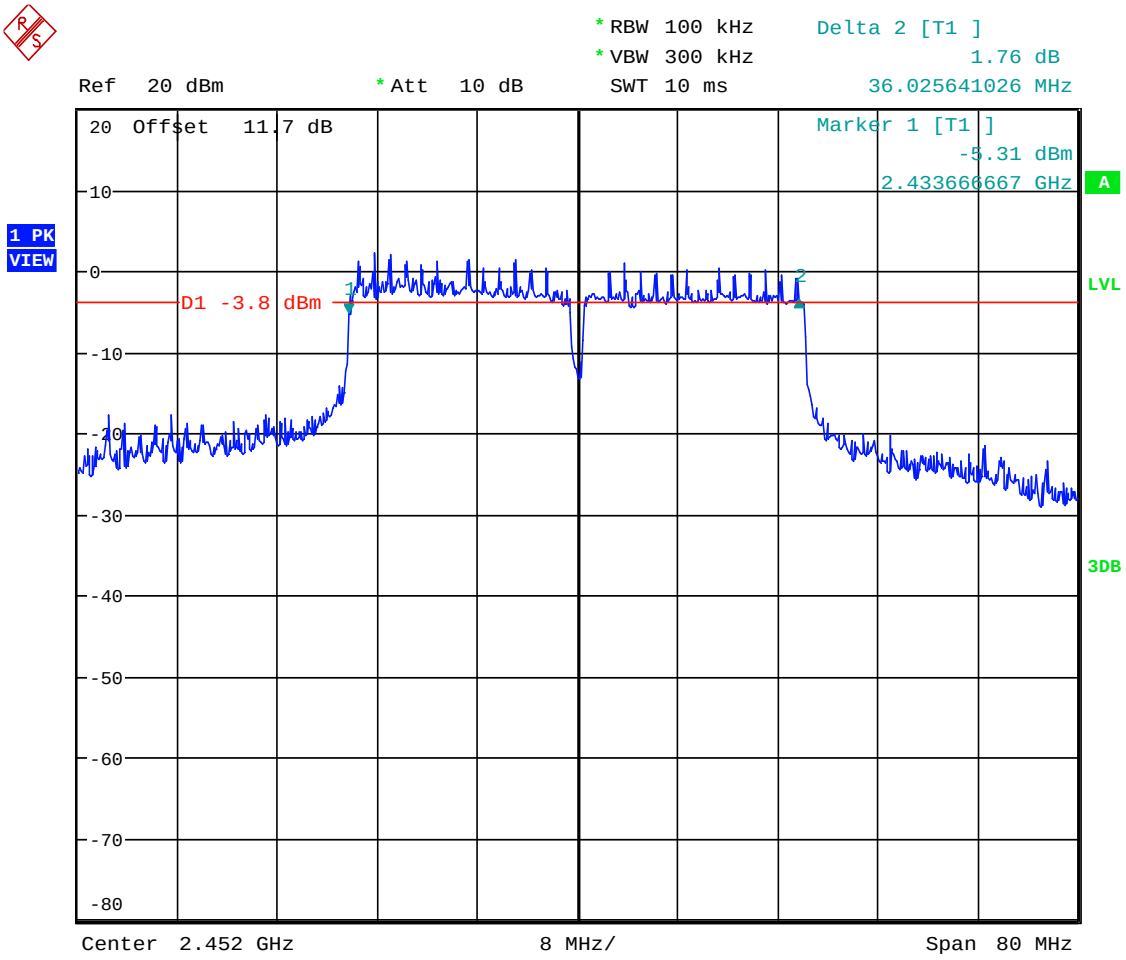
Plot 5.2.4.26. 6 dB Bandwidth, BPSK Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 11.AUG.2014 13:11:57

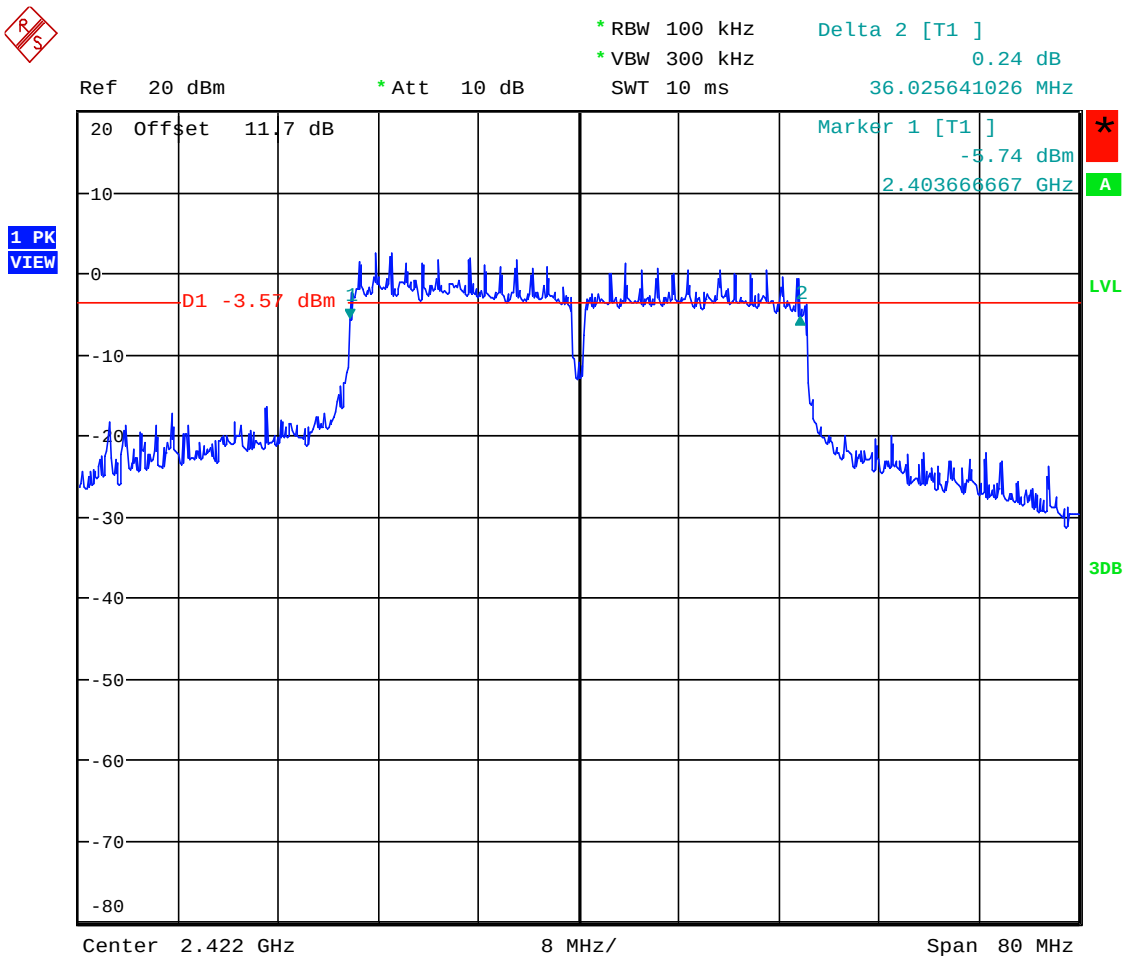
Plot 5.2.4.27. 6 dB Bandwidth, BPSK Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 11.AUG.2014 13:15:22

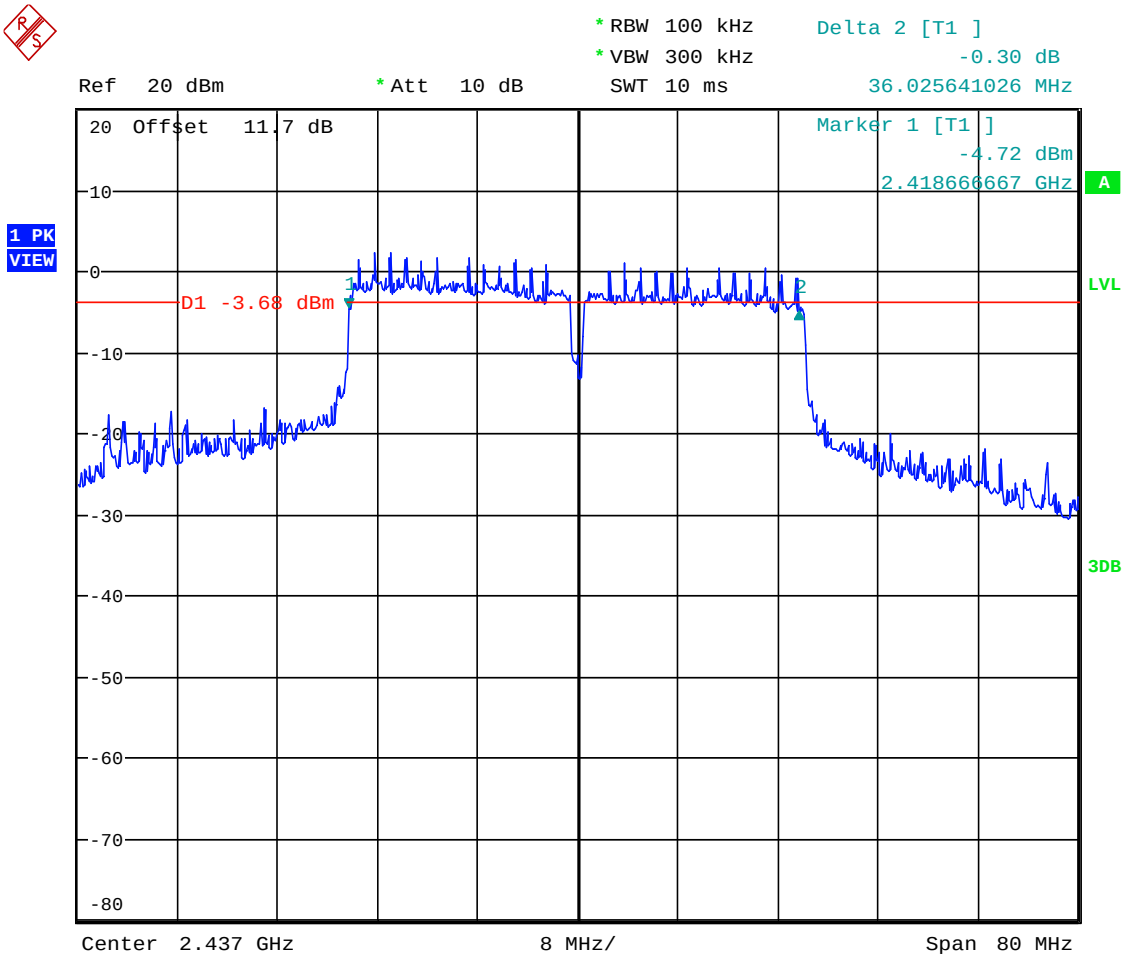
Plot 5.2.4.28. 6 dB Bandwidth, QPSK Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 11.AUG.2014 13:26:31

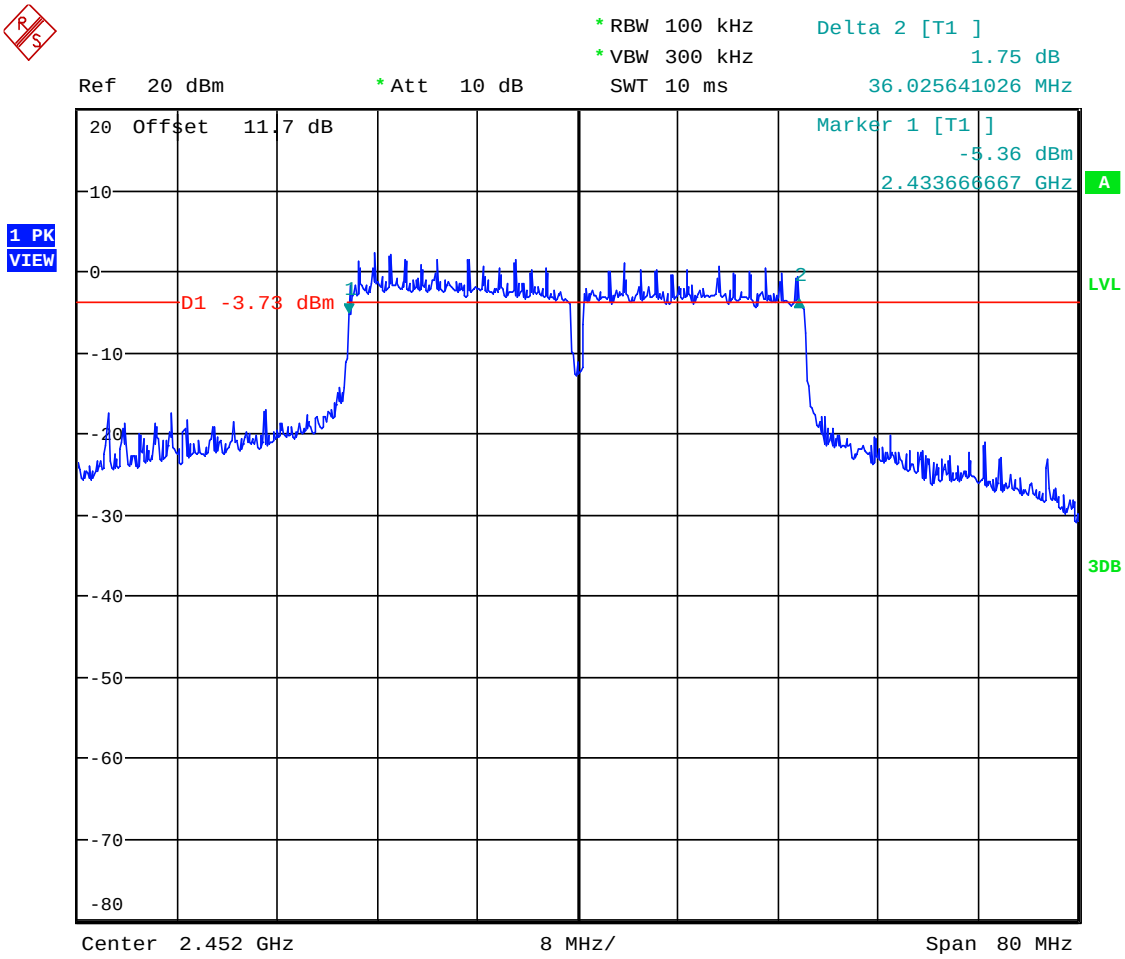
Plot 5.2.4.29. 6 dB Bandwidth, QPSK Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 11.AUG.2014 13:30:24

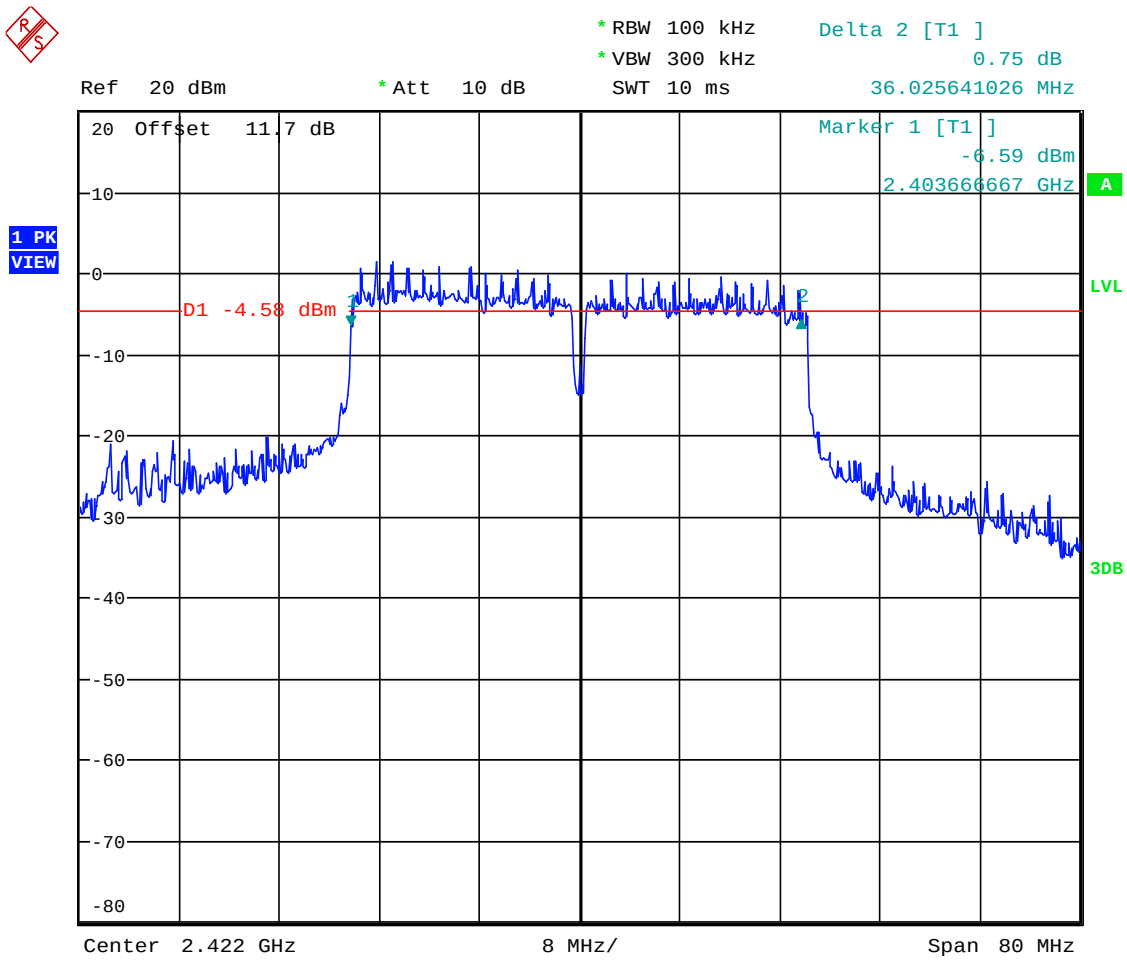
Plot 5.2.4.30. 6 dB Bandwidth, QPSK Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 11.AUG.2014 13:34:13

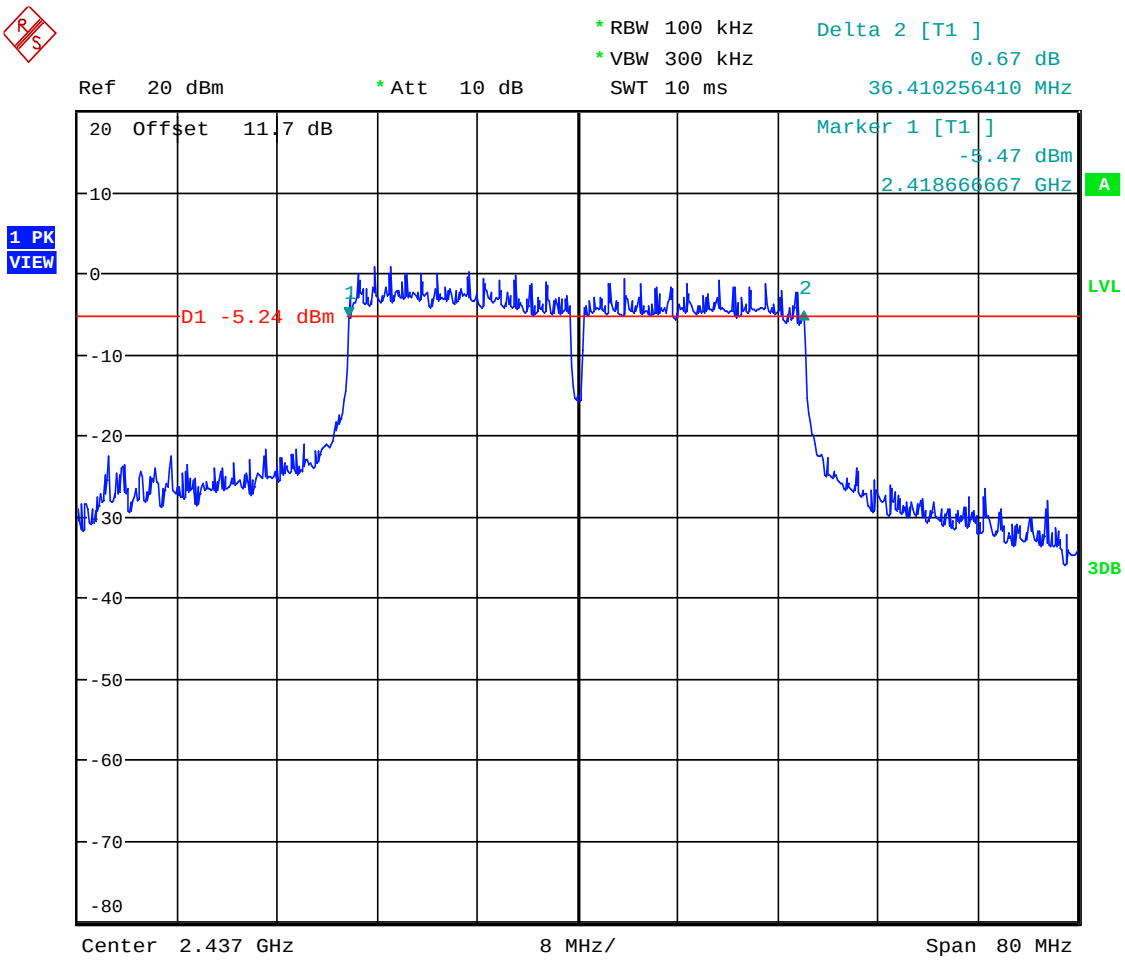
Plot 5.2.4.31. 6 dB Bandwidth, 16-QAM Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 11.AUG.2014 13:38:32

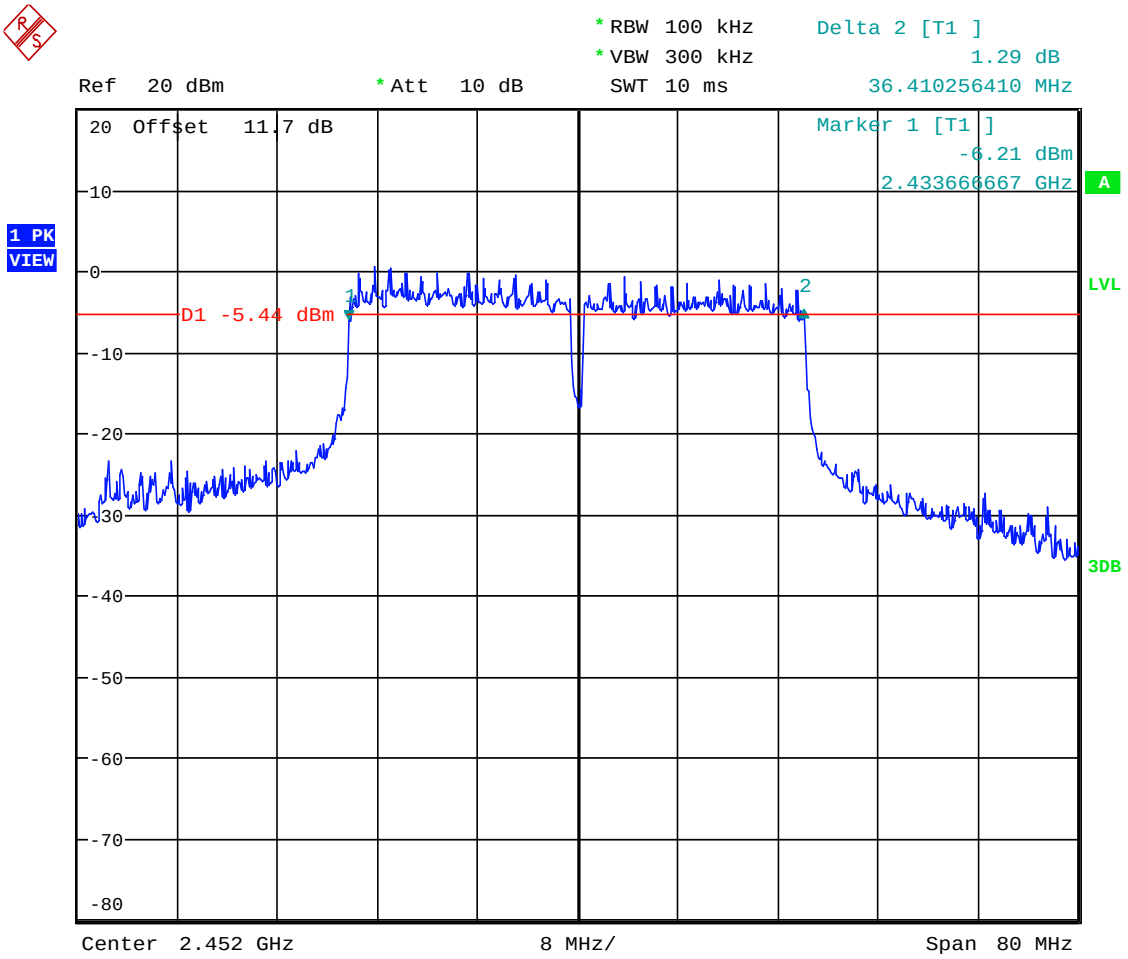
Plot 5.2.4.32. 6 dB Bandwidth, 16-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 11.AUG.2014 14:38:06

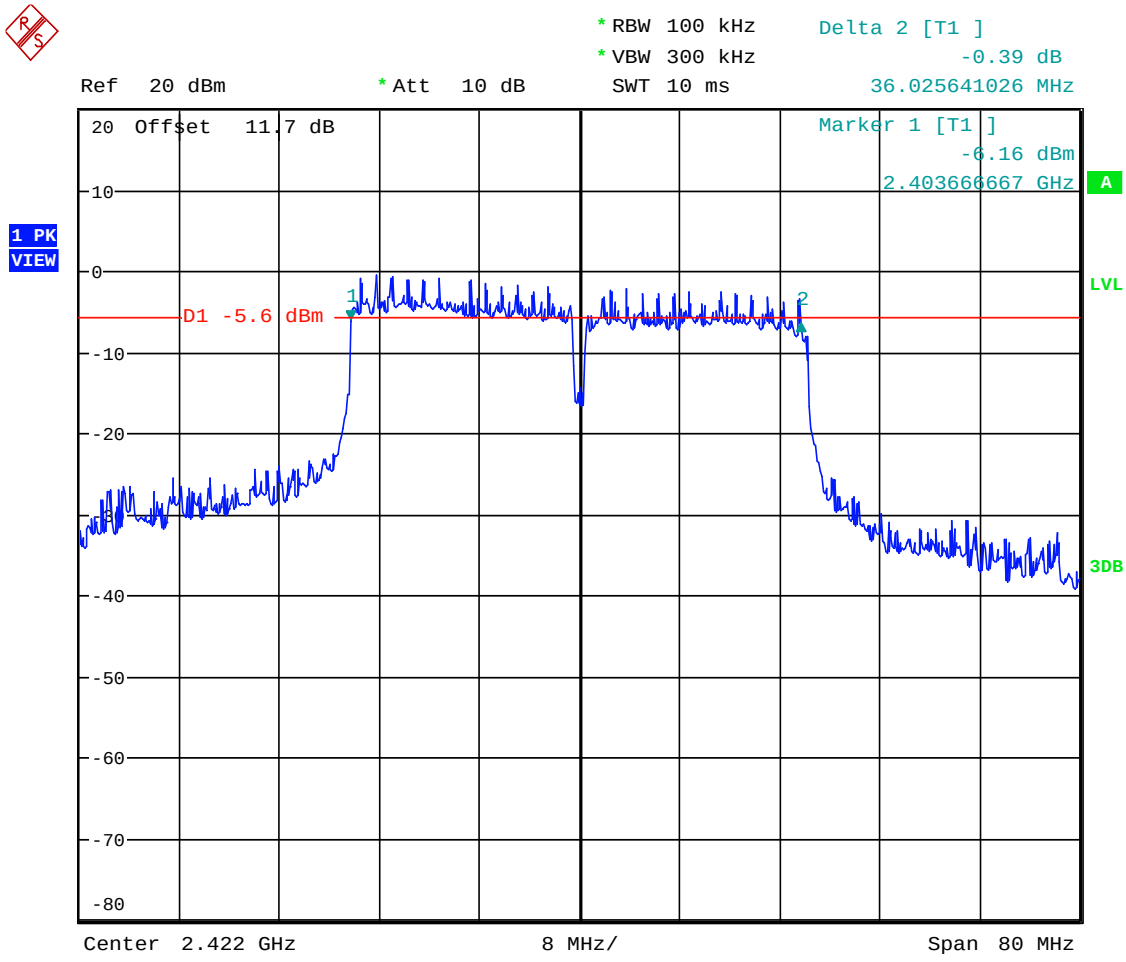
Plot 5.2.4.33. 6 dB Bandwidth, 16-QAM Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 11.AUG.2014 14:43:08

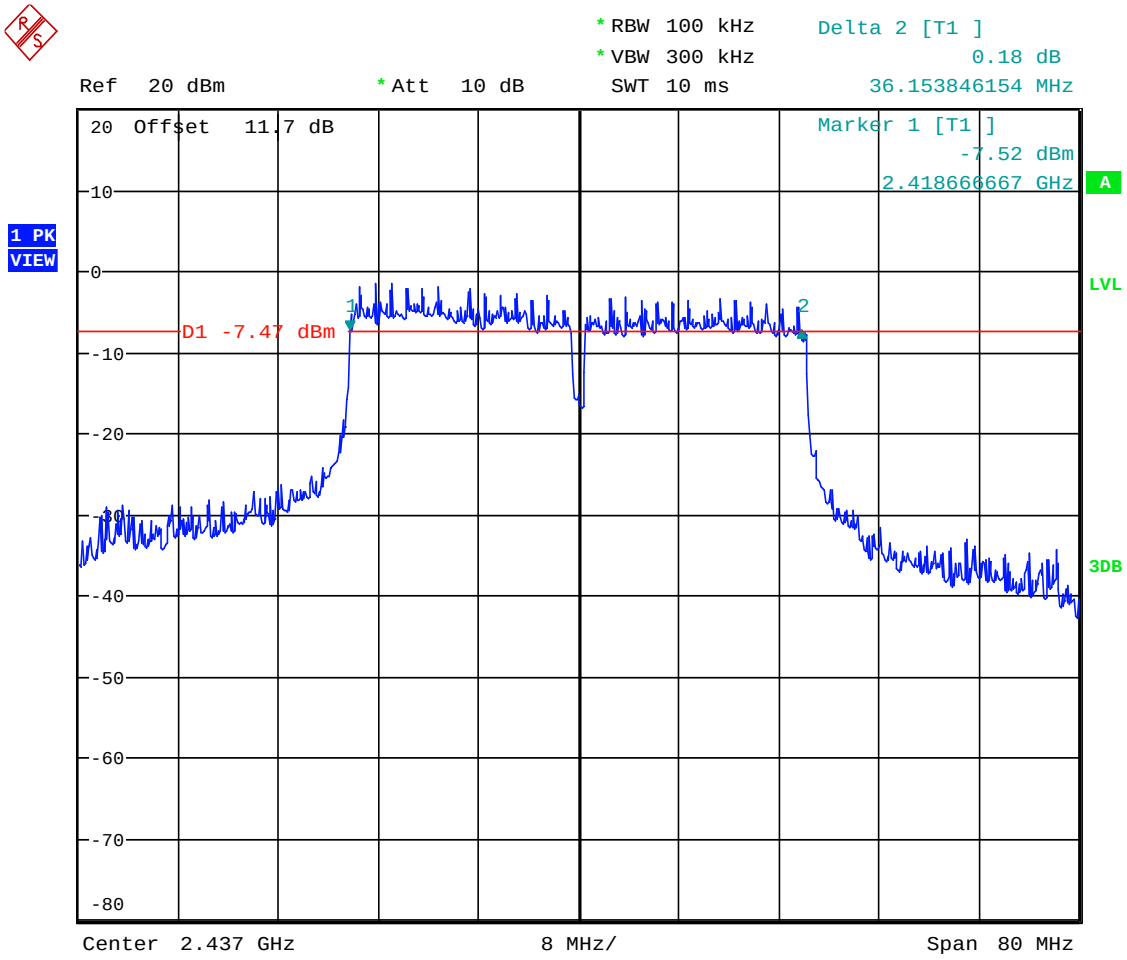
Plot 5.2.4.34. 6 dB Bandwidth, 64-QAM Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 11.AUG.2014 14:46:30

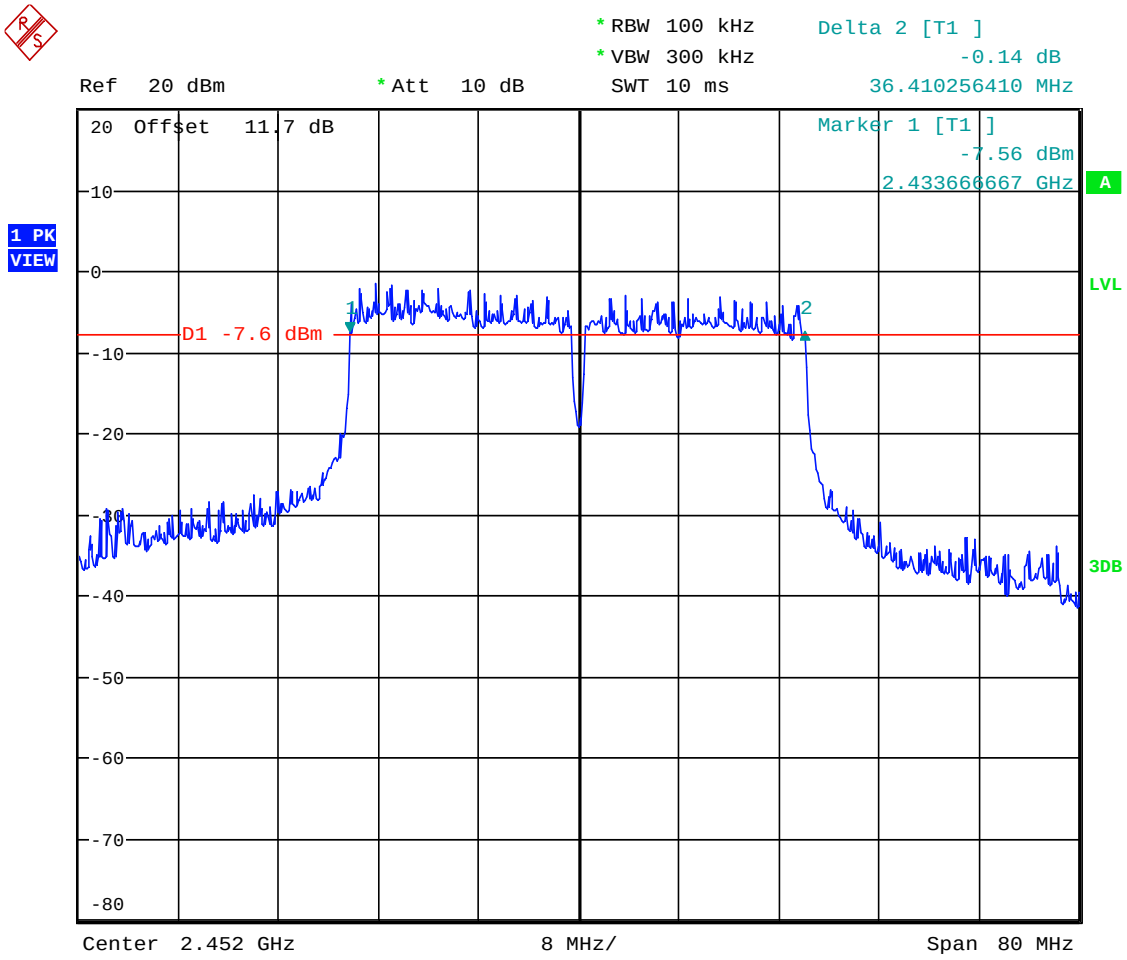
Plot 5.2.4.35. 6 dB Bandwidth, 64-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 11.AUG.2014 14:51:06

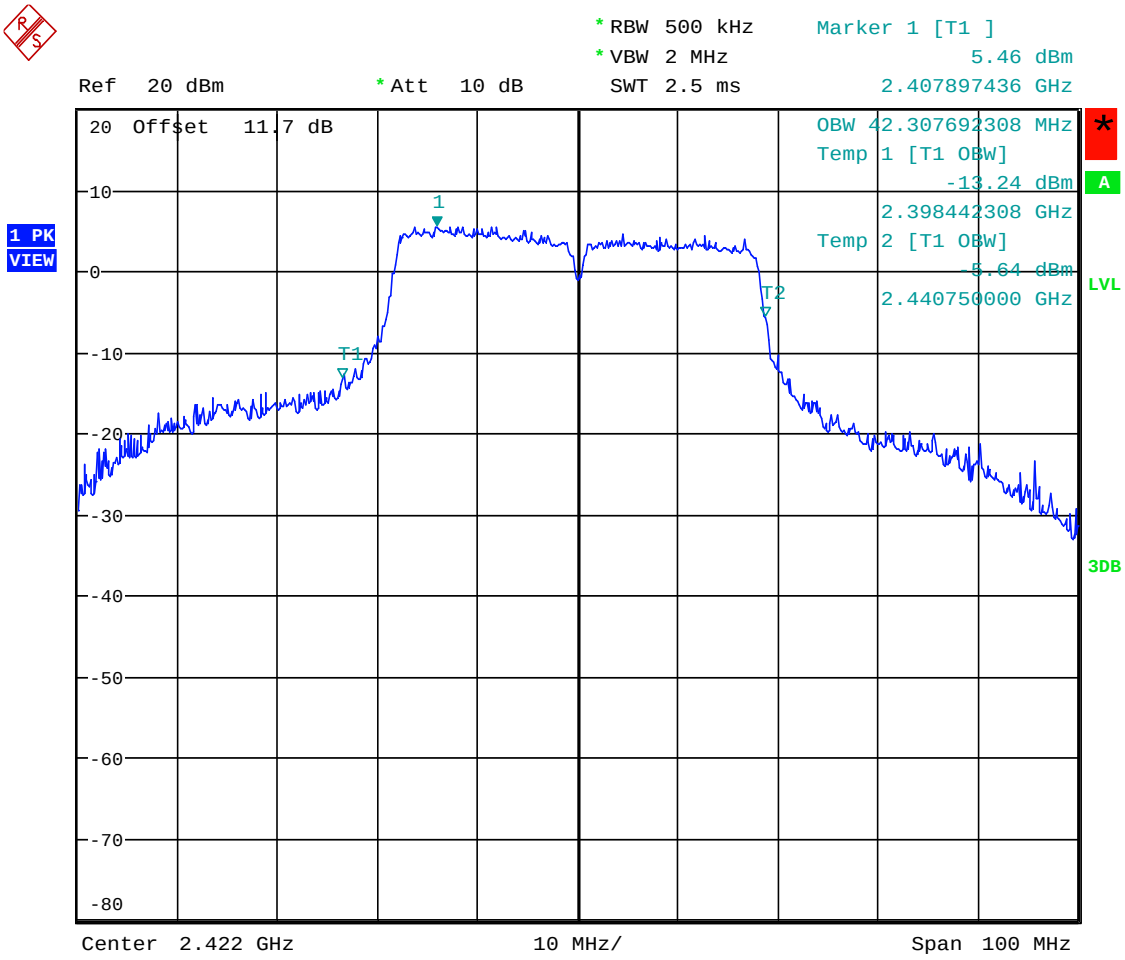
Plot 5.2.4.36. 6 dB Bandwidth, 64-QAM Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 11.AUG.2014 14:53:47

Plot 5.2.4.37. 99% Bandwidth, BPSK Modulation, Channel #3, 2422 MHz



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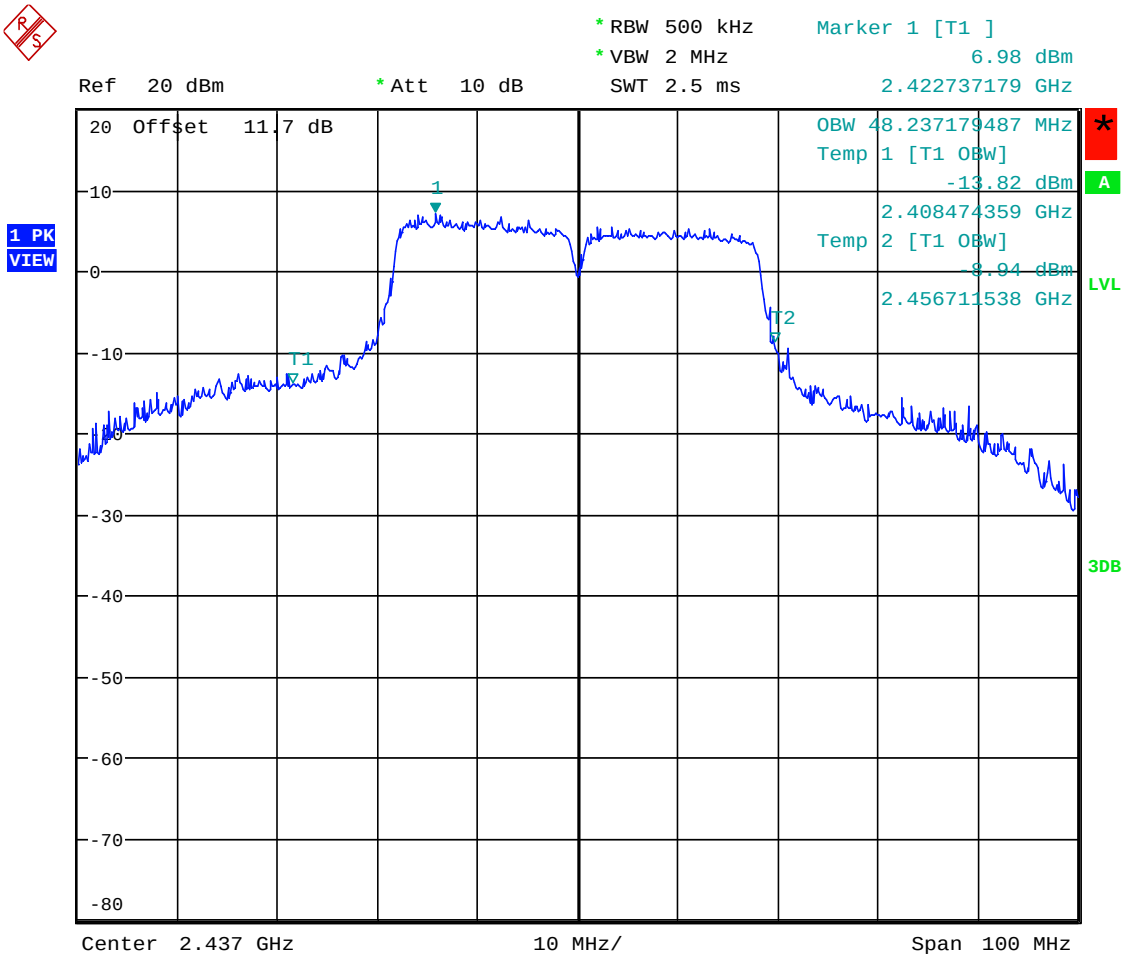
Date: 8.SEP.2014 11:31:46

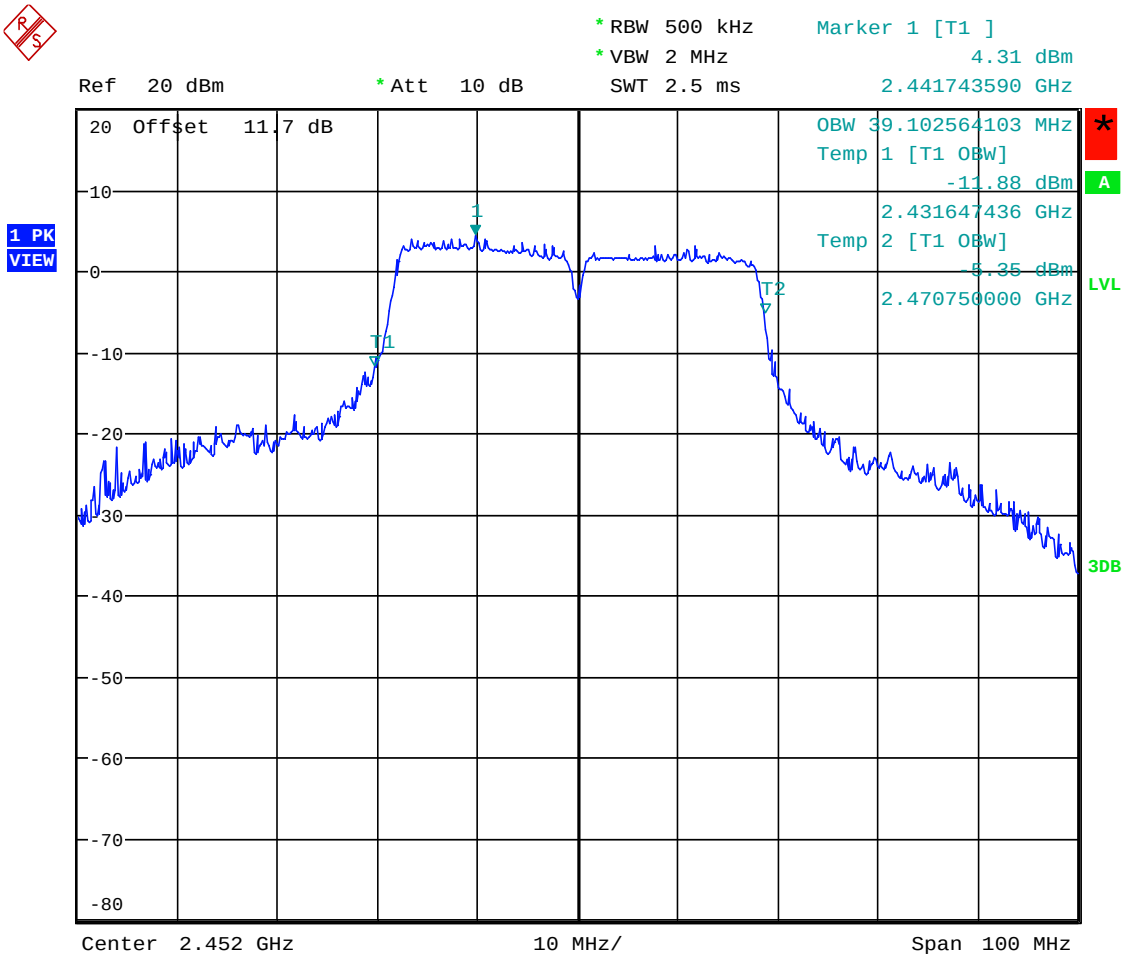
Plot 5.2.4.38. 99% Bandwidth, BPSK Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 8.SEP.2014 11:33:43

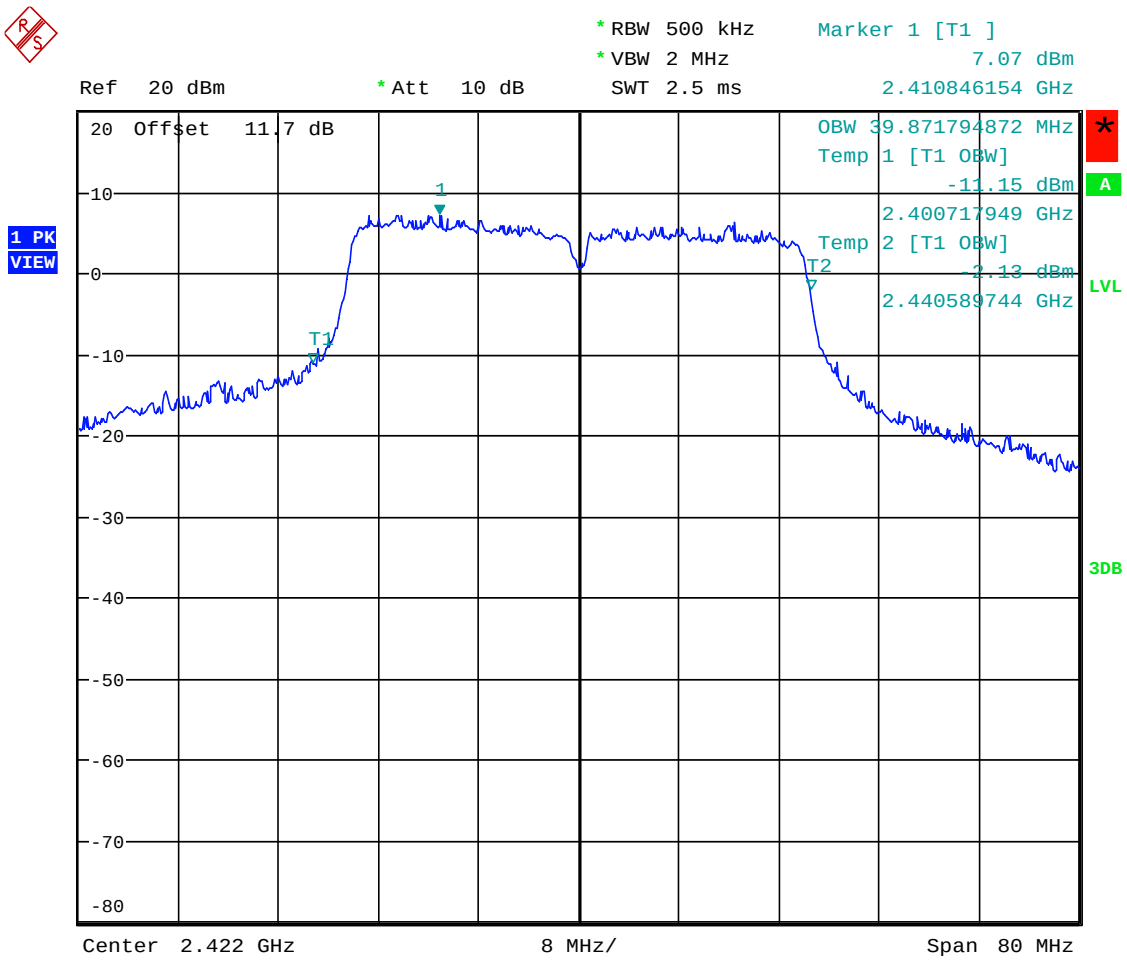
Plot 5.2.4.39. 99% Bandwidth, BPSK Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 8.SEP.2014 11:35:34

Plot 5.2.4.40. 99% Bandwidth, QPSK Modulation, Channel #3, 2422 MHz



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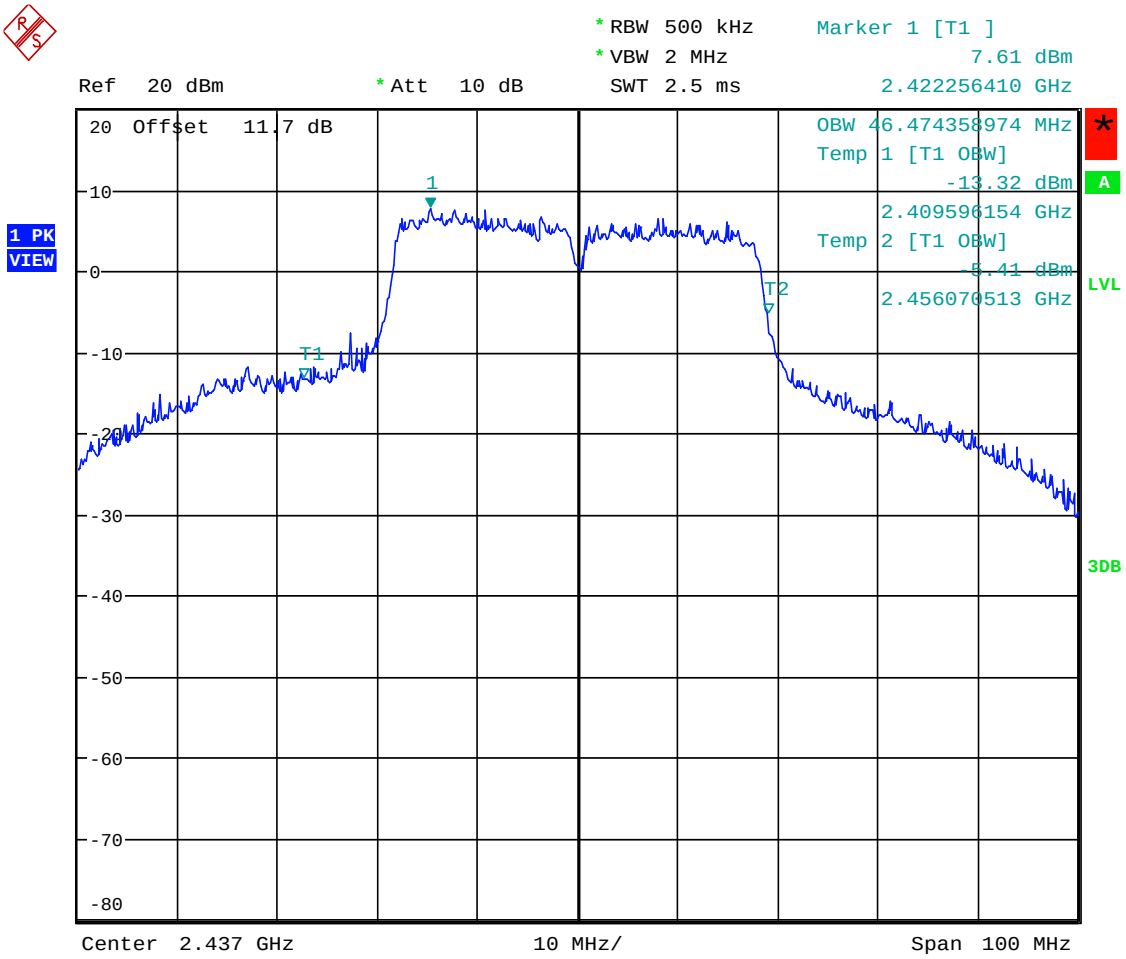
Date: 8.SEP.2014 11:24:50

Plot 5.2.4.41. 99% Bandwidth, QPSK Modulation, Channel #6, 2437 MHz



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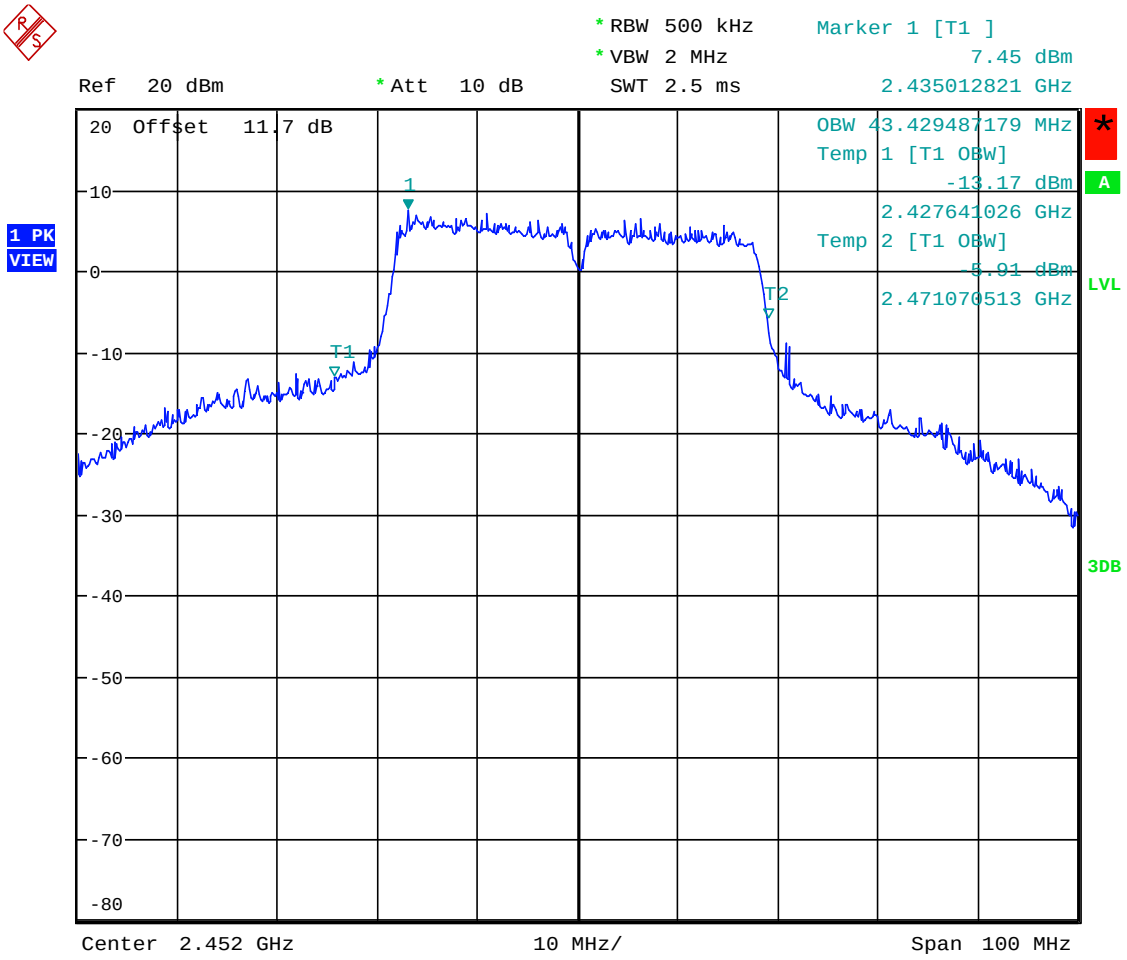
Date: 8.SEP.2014 11:28:11

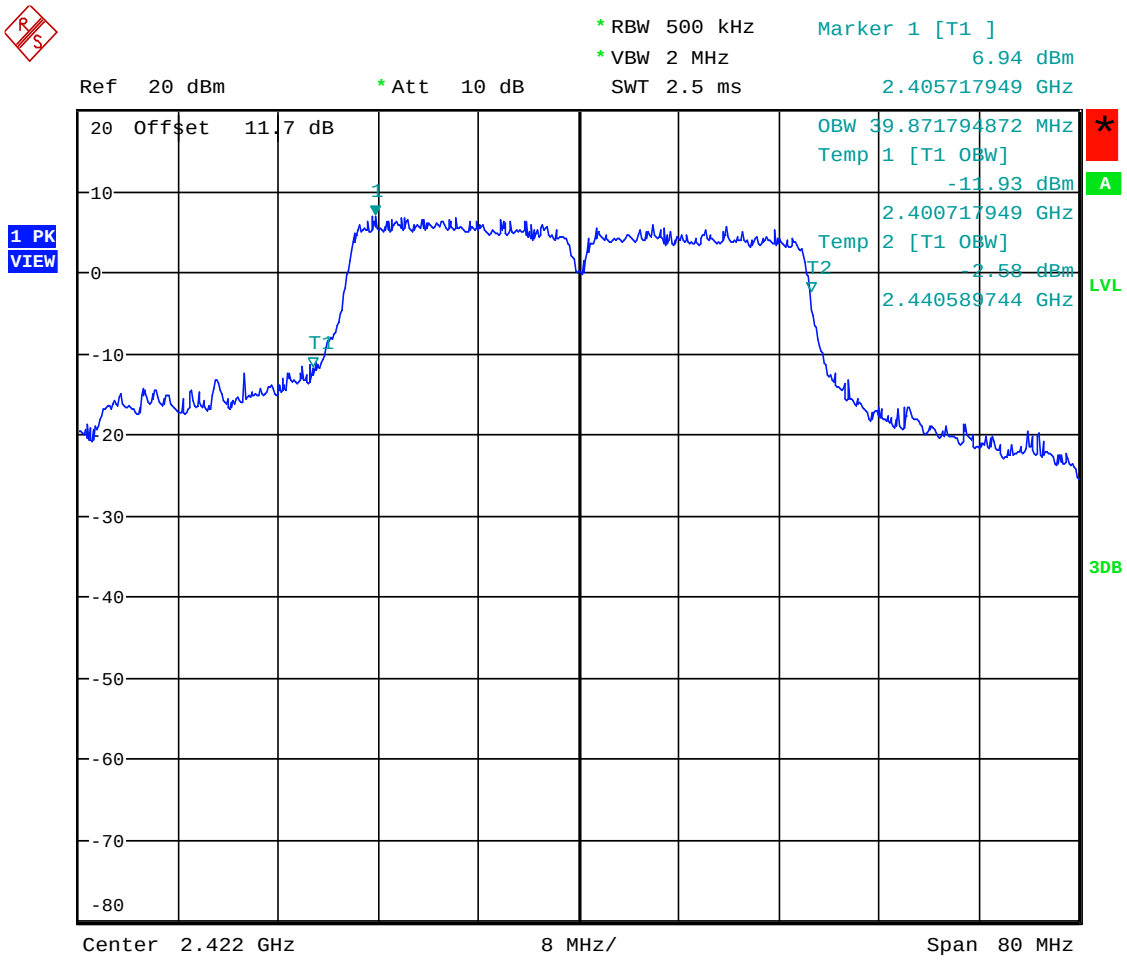
Plot 5.2.4.42. 99% Bandwidth, QPSK Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 8.SEP.2014 11:30:05

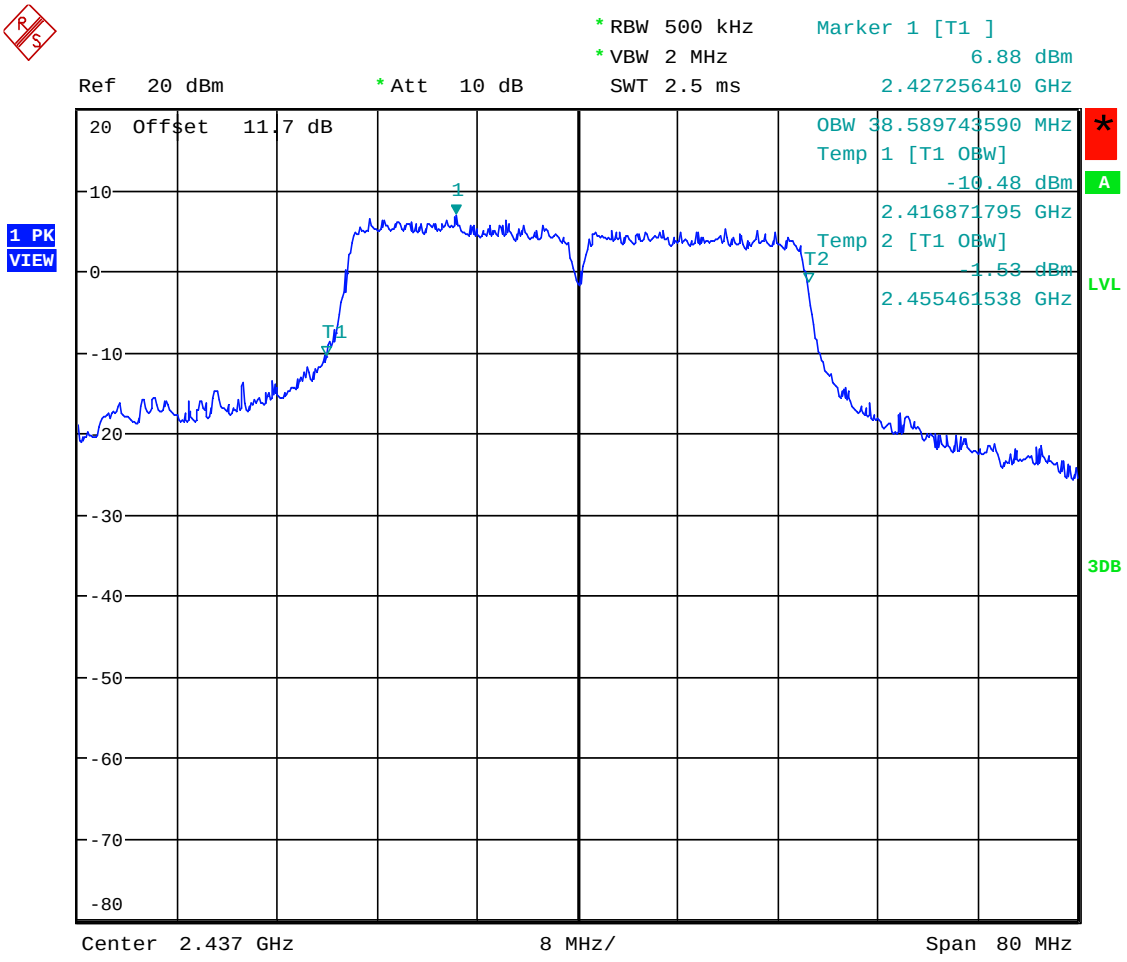
Plot 5.2.4.43. 99% Bandwidth, 16-QAM Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 8.SEP.2014 11:14:49

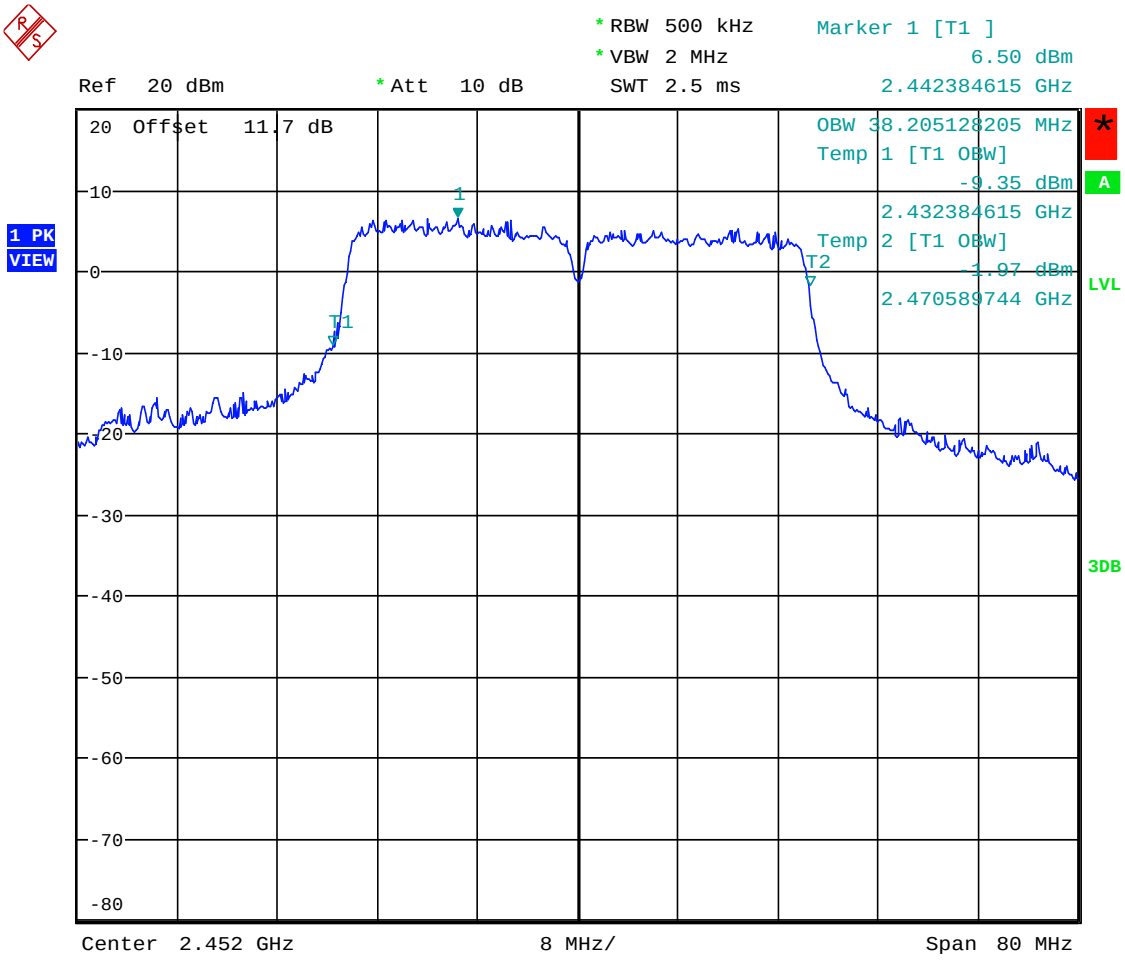
Plot 5.2.4.44. 99% Bandwidth, 16-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 8.SEP.2014 11:19:02

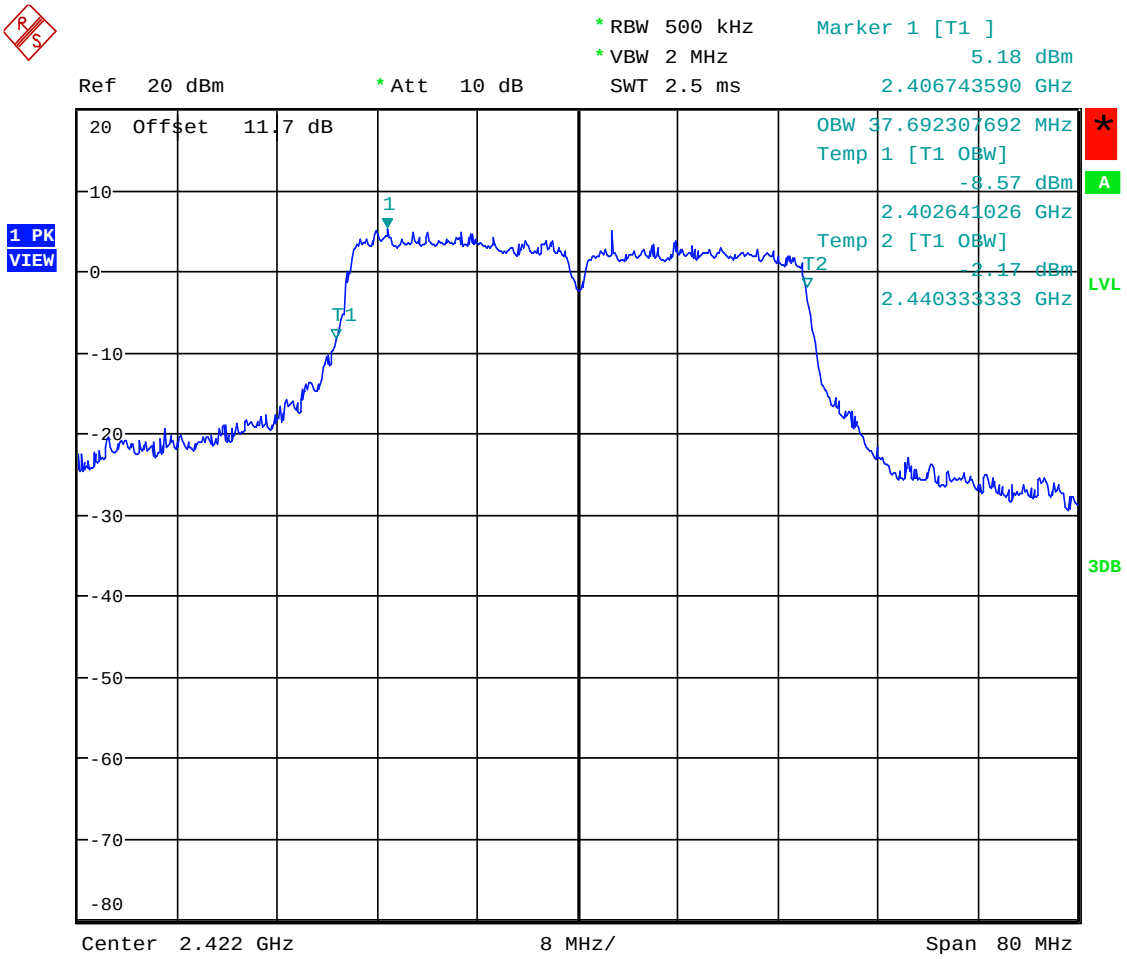
Plot 5.2.4.45. 99% Bandwidth, 16-QAM Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 8.SEP.2014 11:21:25

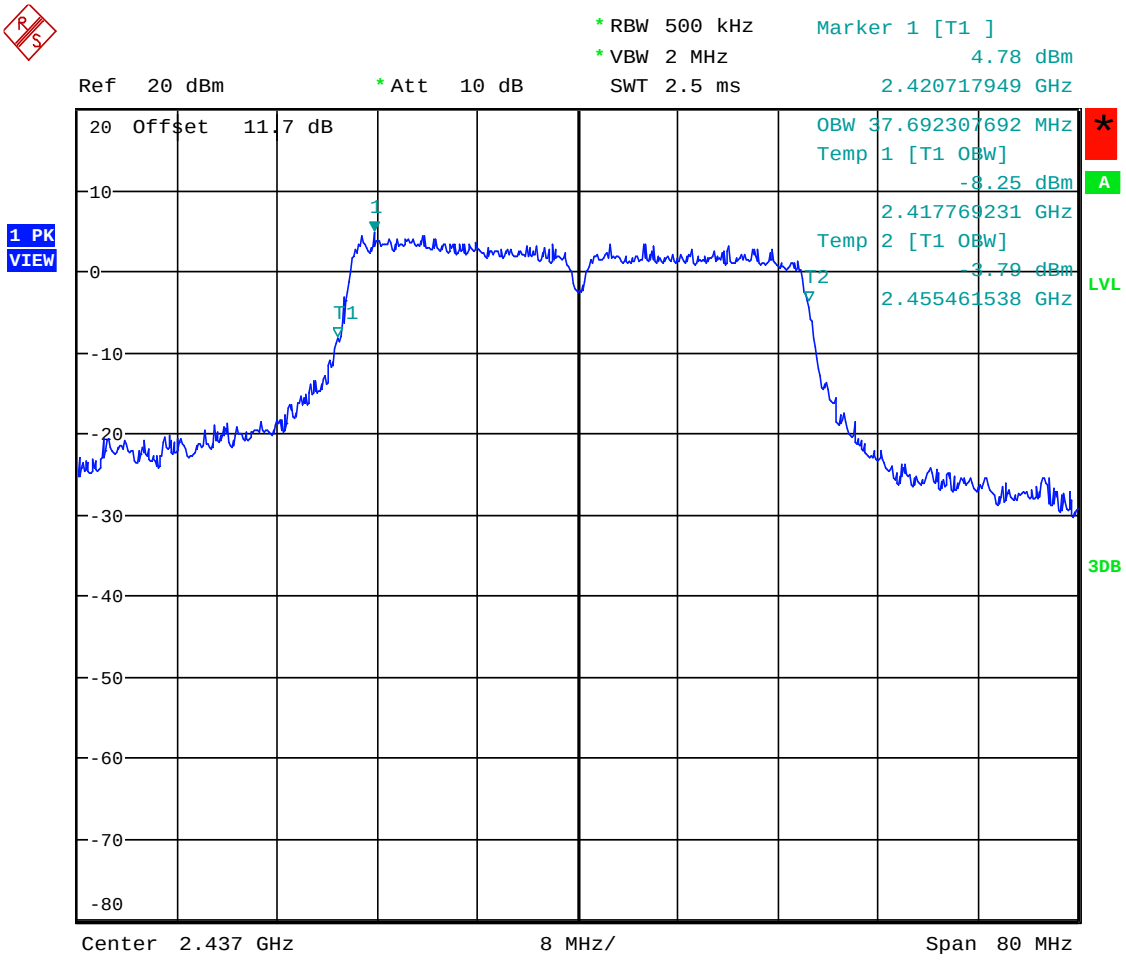
Plot 5.2.4.46. 99% Bandwidth, 64-QAM Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 8.SEP.2014 11:00:55

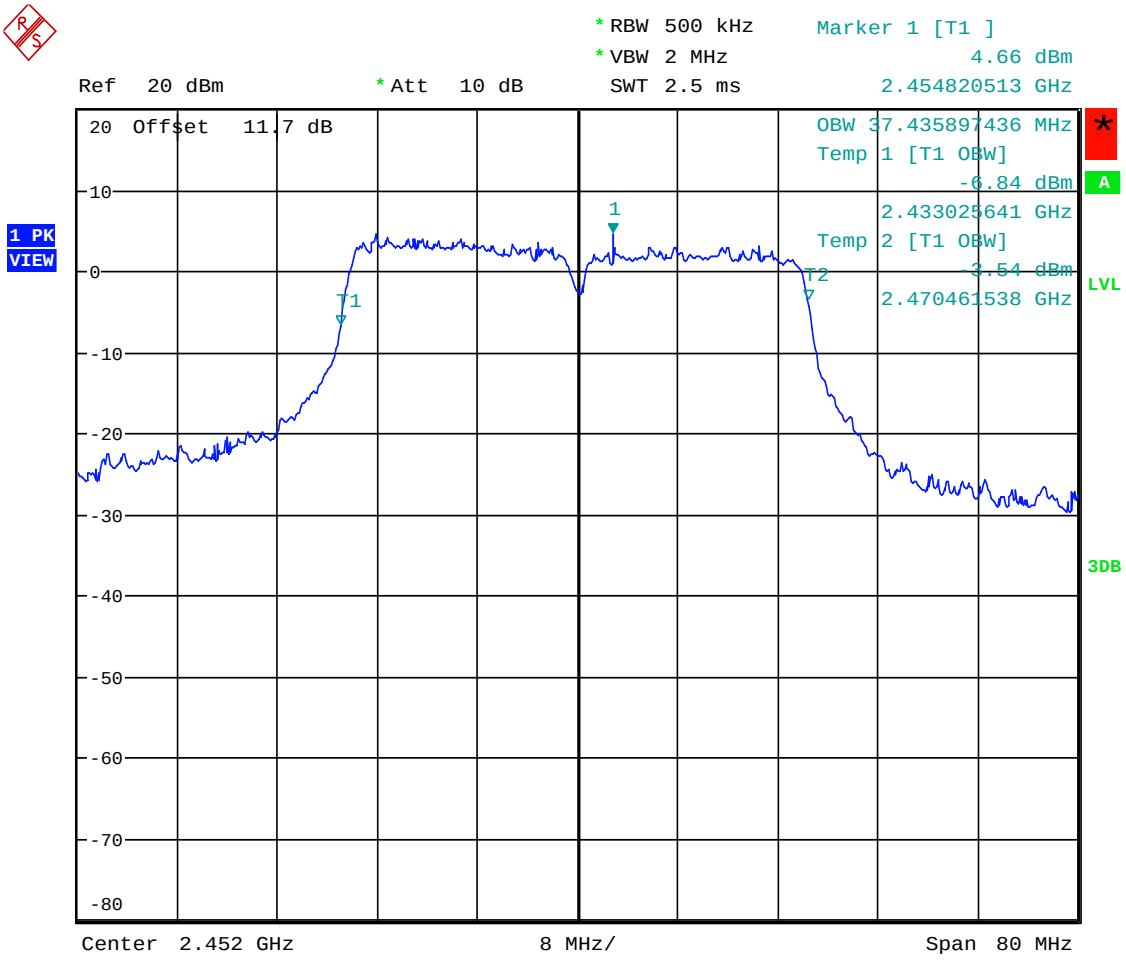
Plot 5.2.4.47. 99% Bandwidth, 64-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 8.SEP.2014 11:02:45

Plot 5.2.4.48. 99% Bandwidth, 64-QAM Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 8.SEP.2014 11:12:05

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

5.3.1. Limit(s)

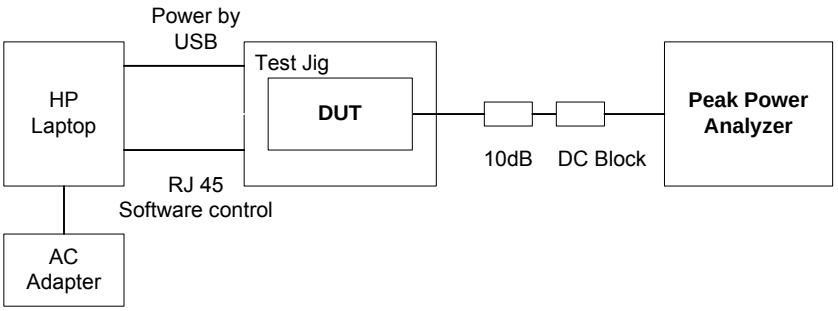
§ 15.247(b)(3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power 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(c)(1)(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

5.3.2. Method of Measurements & Test Arrangement

KDB Publication No. 558074 D01 DTS Meas Guidance V03r02, Section 9.1.1 RBW ≥ DTS bandwidth

5.3.3. Test Arrangement



5.3.4. Test Data

(a) 20 MHz Channel Spacing Mode:

MCS Index	Modulation	Data Rate (Mbps)	Channel Number	Frequency (MHz)	Power Setting	Peak Cond. Power (dBm)	Power Limit (dBm)	EIRP* Power (dBm)
MCS0	BPSK ½	6.5	1	2412	**15.0**	21.08	30.0	21.86
MCS0	BPSK ½	6.5	6	2437	**14.0**	20.36	30.0	21.14
MCS0	BPSK ½	6.5	11	2462	**14.0**	20.36	30.0	21.14
MCS2	QPSK ¾	19.5	1	2412	**15.0**	20.99	30.0	21.77
MCS2	QPSK ¾	19.5	6	2437	**14.0**	20.21	30.0	20.99
MCS2	QPSK ¾	19.5	11	2462	**14.0**	20.10	30.0	20.88
MCS4	16-QAM ¾	39	1	2412	**15.0**	20.85	30.0	21.63
MCS4	16-QAM ¾	39	6	2437	**14.0**	20.36	30.0	21.14
MCS4	16-QAM ¾	39	11	2462	**14.0**	20.31	30.0	21.09
MCS7	64-QAM 5/6	65	1	2412	**11.0**	20.41	30.0	21.19
MCS7	64-QAM 5/6	65	6	2437	**11.0**	20.31	30.0	21.09
MCS7	64-QAM 5/6	65	11	2462	**11.0**	19.84	30.0	20.62

(b) 40 MHz Channel Spacing Mode:

MCS Index	Modulation	Data Rate (Mbps)	Channel Number	Frequency (MHz)	Power Setting	Peak Cond. Power (dBm)	Power Limit (dBm)	EIRP* Power (dBm)
MCS0	BPSK ½	13.5	3	2422	**14.0**	20.94	30.0	21.72
MCS0	BPSK ½	13.5	6	2437	**15.5**	21.31	30.0	22.09
MCS0	BPSK ½	13.5	9	2452	**13.0**	20.41	30.0	21.19
MCS2	QPSK ¾	40.5	3	2422	**14.0**	20.89	30.0	21.67
MCS2	QPSK ¾	40.5	6	2437	**15.5**	21.03	30.0	21.81
MCS2	QPSK ¾	40.5	9	2452	**13.0**	20.34	30.0	21.12
MCS4	16-QAM ¾	81	3	2422	**14.0**	20.56	30.0	21.34
MCS4	16-QAM ¾	81	6	2437	**15.5**	20.36	30.0	21.14
MCS4	16-QAM ¾	81	9	2452	**13.0**	19.78	30.0	20.56
MCS7	64-QAM 5/6	135	3	2422	**11.0**	20.21	30.0	20.99
MCS7	64-QAM 5/6	135	6	2437	**11.0**	20.15	30.0	20.93
MCS7	64-QAM 5/6	135	9	2452	**11.0**	19.22	30.0	20.00

*EIRP Calculation: Antenna gain = 1.6dBi, 5" UFL-SMA antenna cable assembly loss = 0.82dB.
Net antenna assembly gain is (1.6 – 0.82) dBi = 0.78 dBi

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

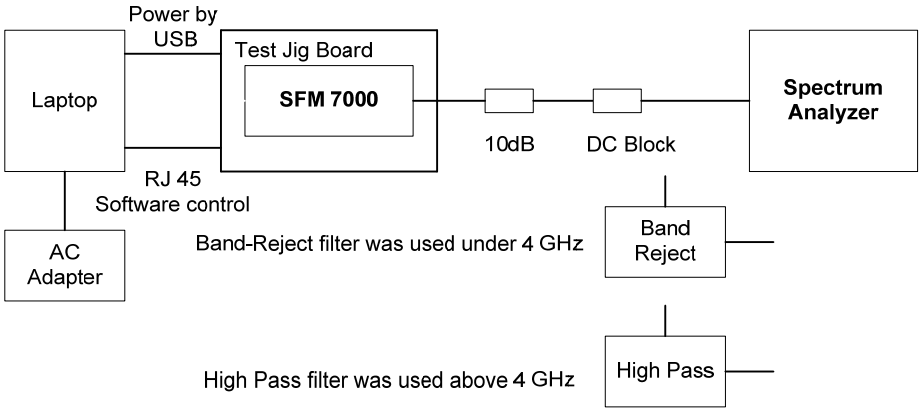
5.4.1. Limit(s)

§ 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.

5.4.2. Method of Measurements

KDB Publication No. 558074 D01 DTS Meas Guidance V03r02, Sections 11,12 & 13 and ANSI C63.10.

5.4.3. Test Arrangement

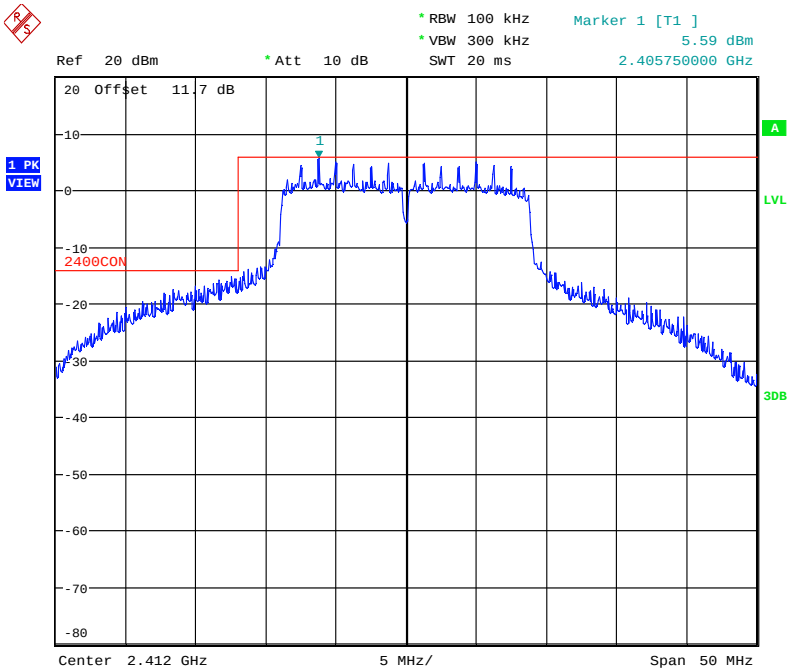


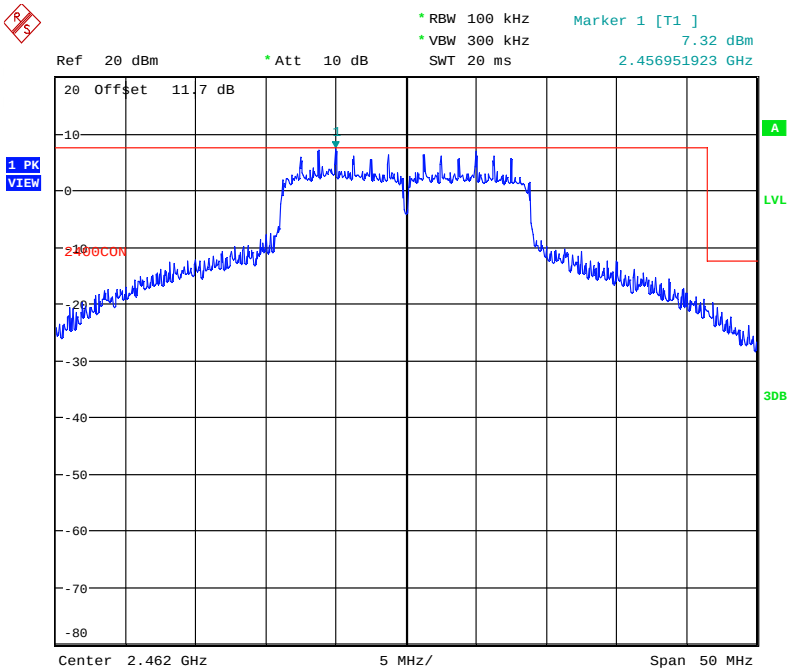
5.4.4. Test Data

5.4.4.1. Band-Edge RF Conducted Emissions

(a) 20 MHz Channel Spacing Mode:

Plot 5.4.4.1.1. Band-Edge RF Conducted Emissions, BPSK Modulation, 2412 & 2462 MHz





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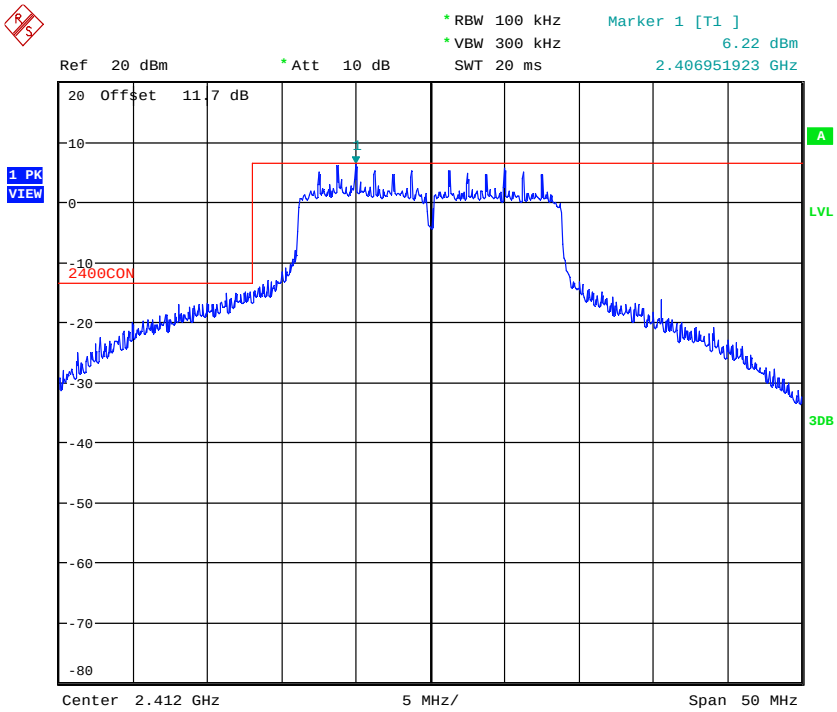
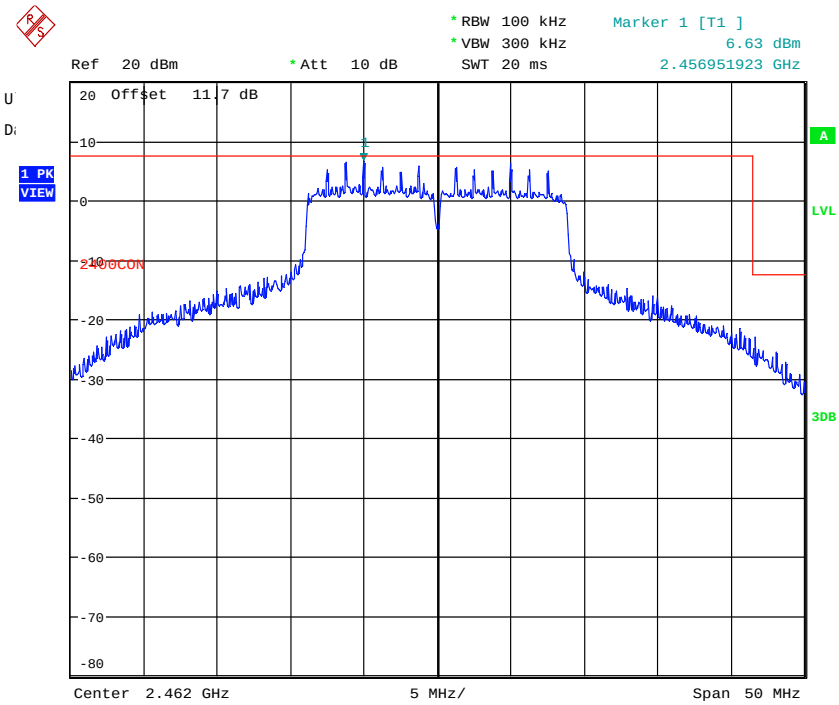
Date: 5.SEP.2014 11:37:23

Plot 5.4.4.1.2. Band-Edge RF Conducted Emissions, QPSK Modulation, 2412 & 2462 MHz





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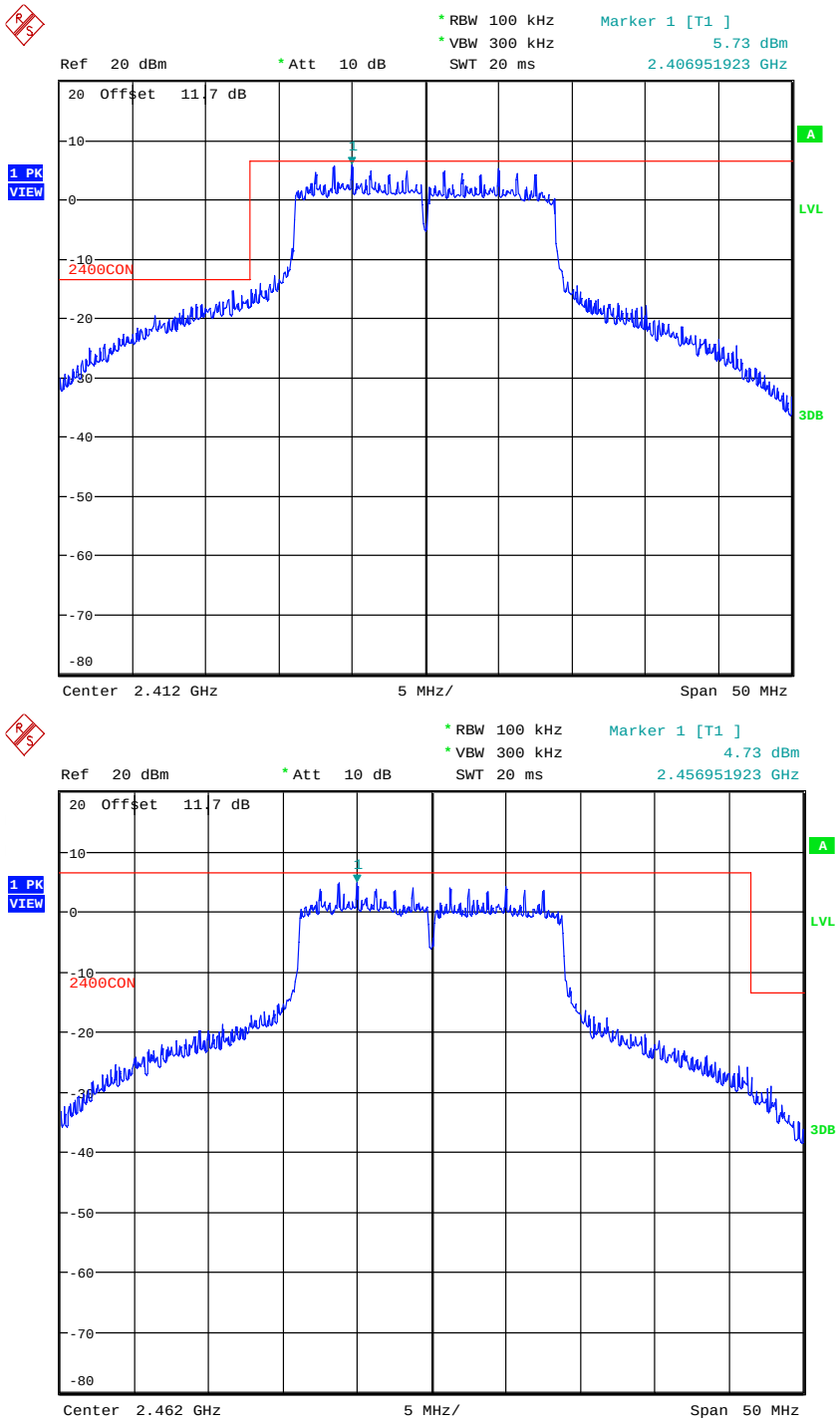
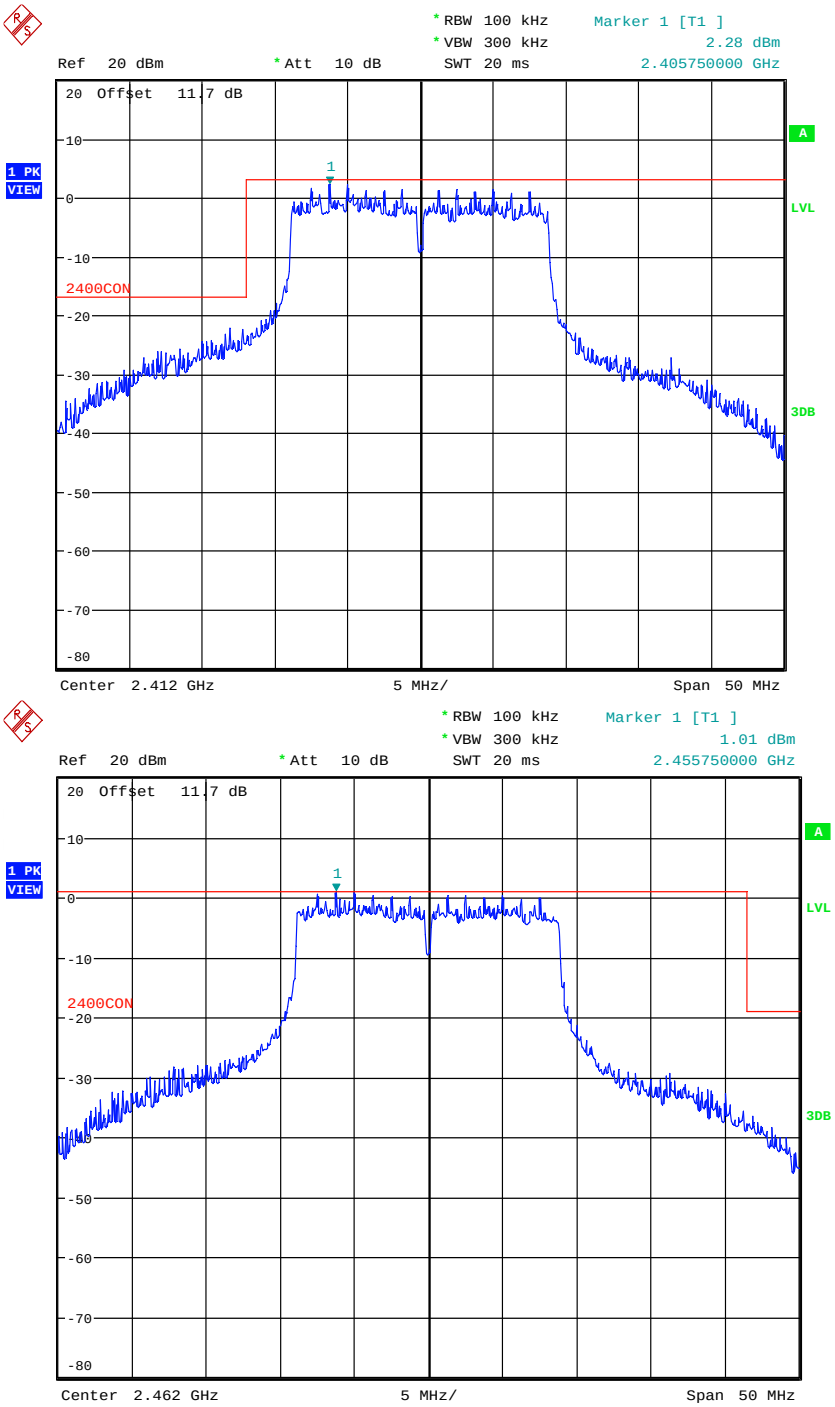
Date: 5.SEP.2014 12:49:24

Plot 5.4.4.1.3. Band-Edge RF Conducted Emissions, 16-QAM Modulation, 2412 & 2462 MHz



Ultratech Labs
Date: 5.SEP.2014 13:08:17

Plot 5.4.4.1.4. Band-Edge RF Conducted Emissions, 64-QAM Modulation, 2412 & 2462 MHz



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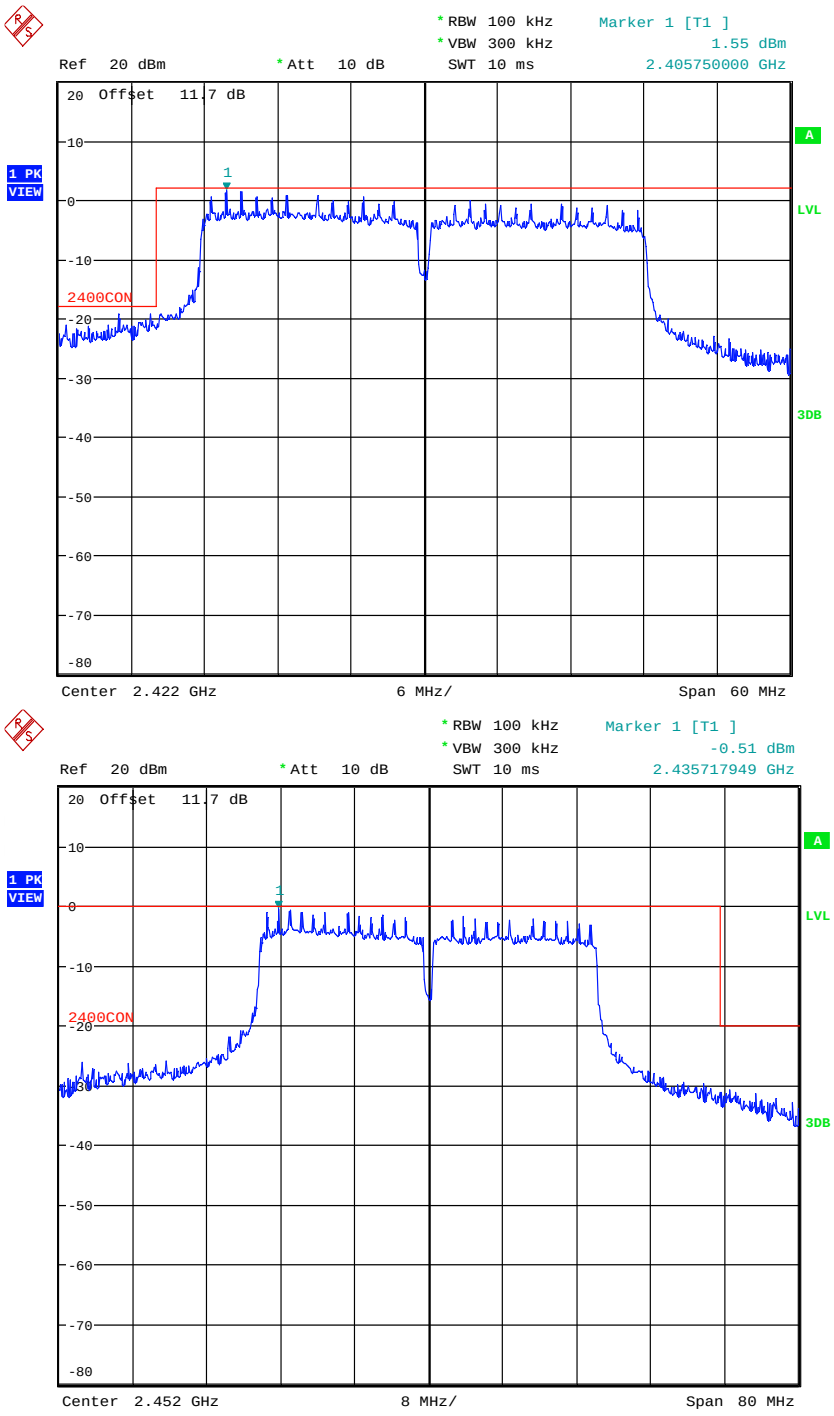
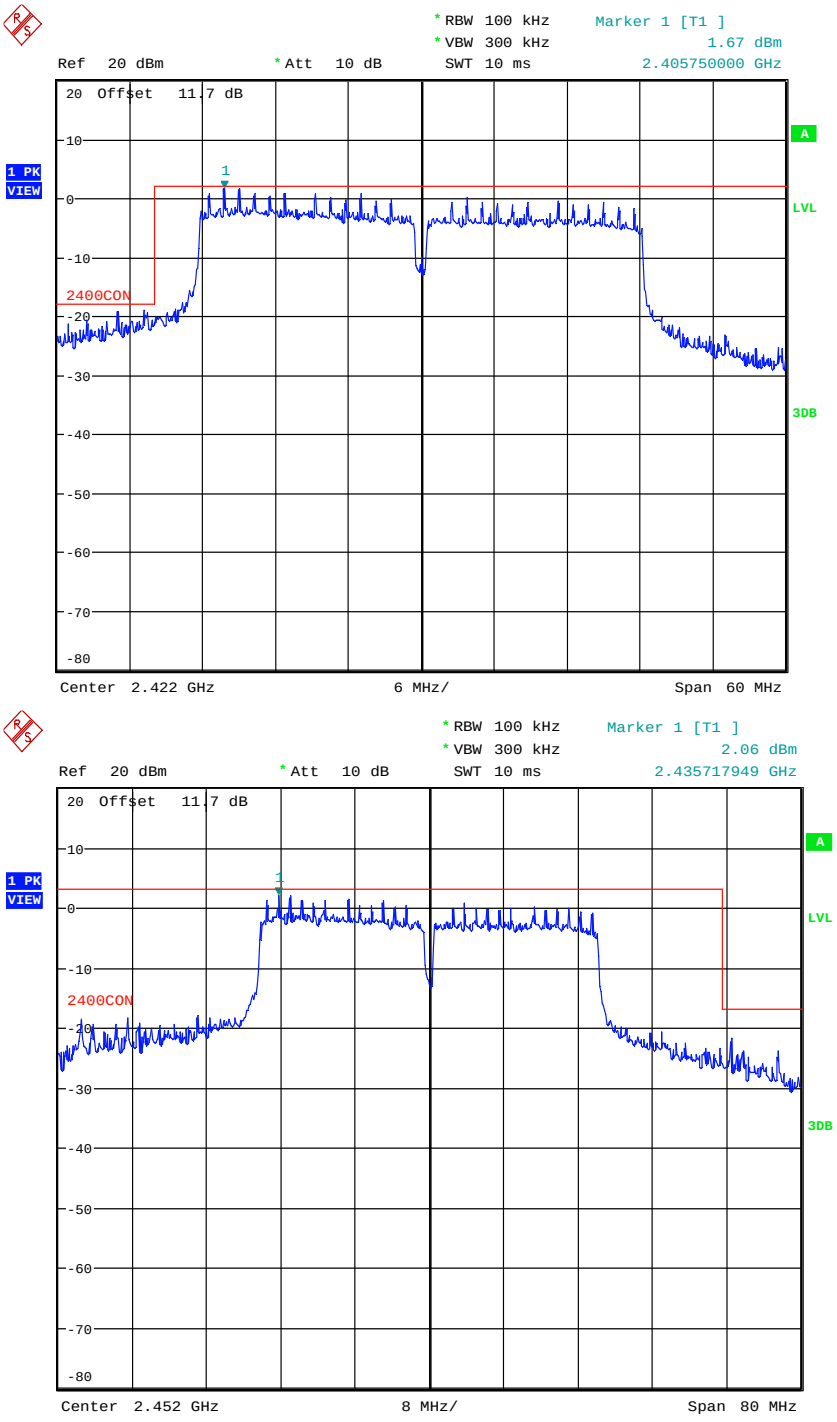
Date: 5.SEP.2014 13:10:39

(b) 40 MHz Channel Spacing Mode:

Plot 5.4.4.1.5. Band-Edge RF Conducted Emissions, BPSK Modulation, 2422 & 2452 MHz



Plot 5.4.4.1.6. Band-Edge RF Conducted Emissions, QPSK Modulation, 2422 & 2452 MHz



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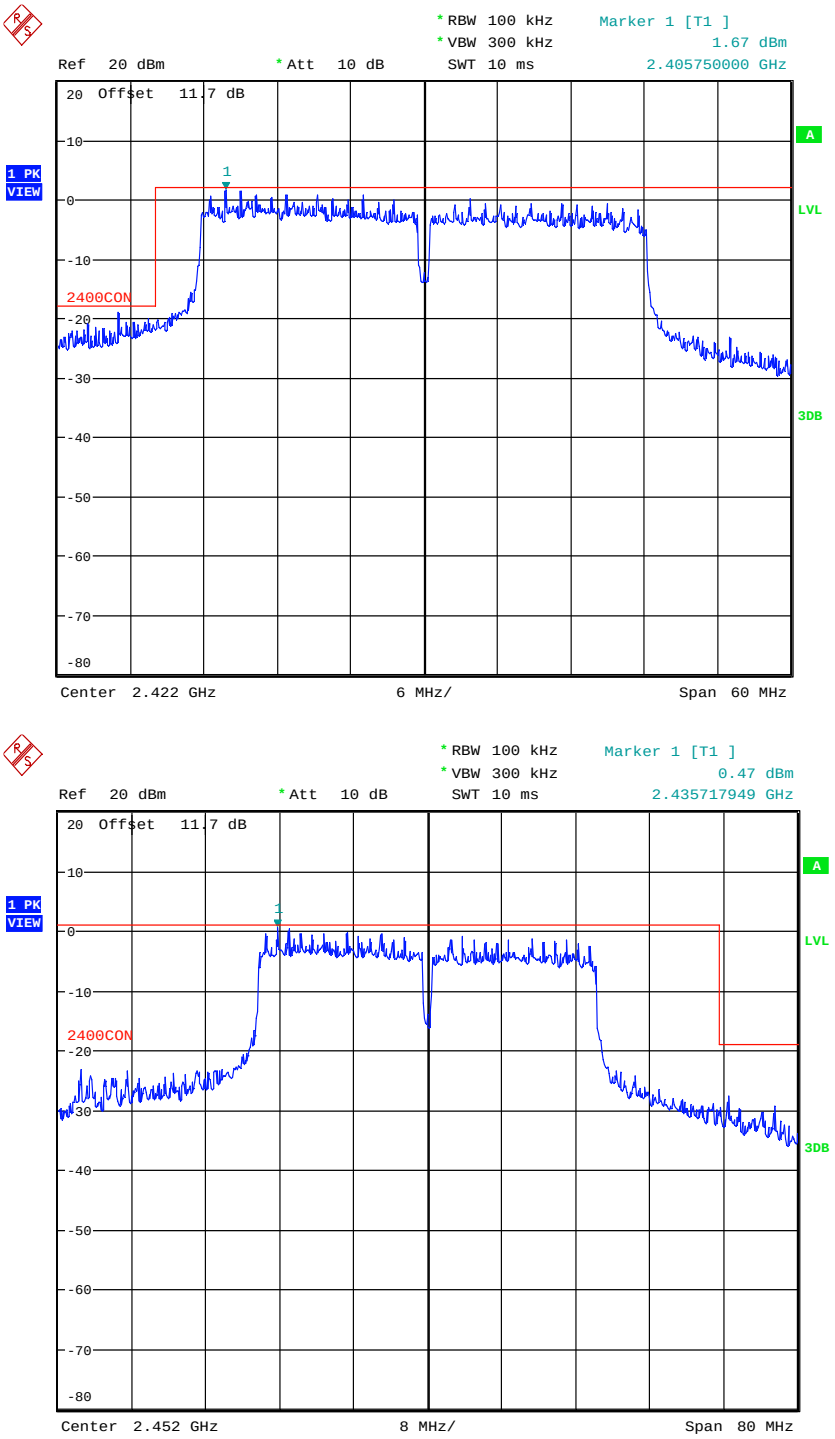
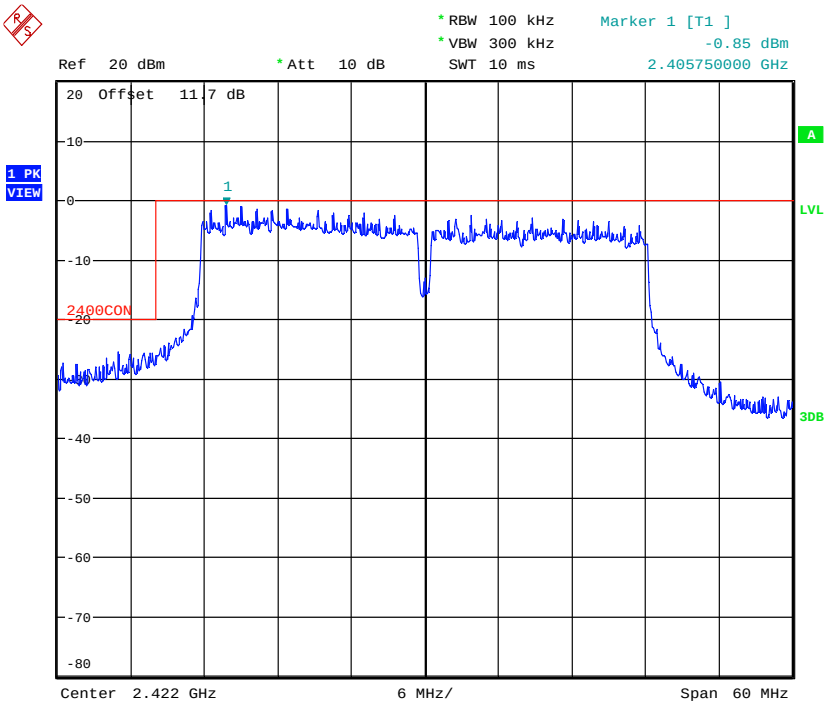
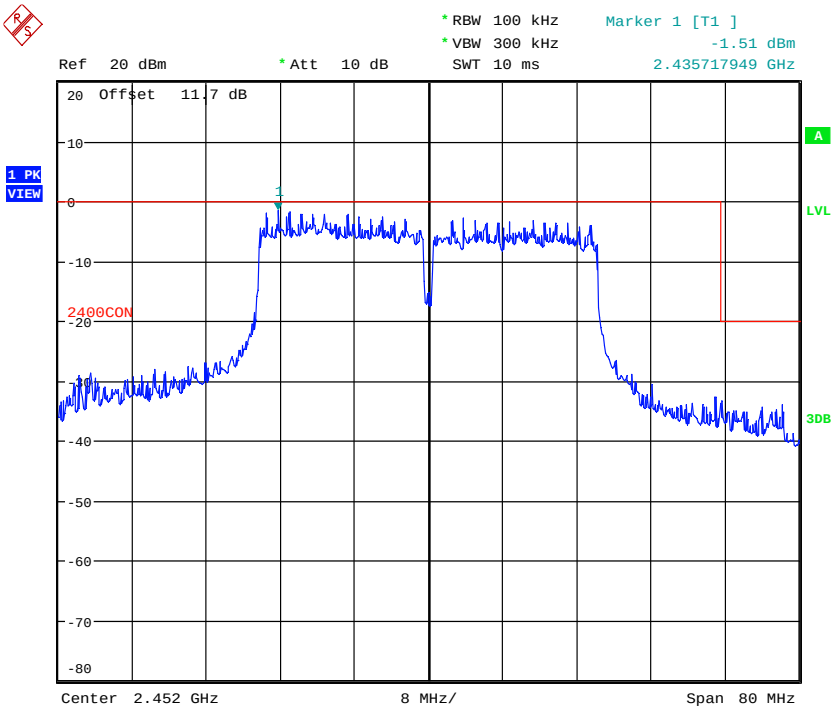
Date: 5.SEP.2014 13:40:33

Plot 5.4.4.1.7. Band-Edge RF Conducted Emissions, 16-QAM Modulation, 2422 & 2452 MHz



Plot 5.4.4.1.8. Band-Edge RF Conducted Emissions, 64-QAM Modulation, 2422 & 2452 MHz





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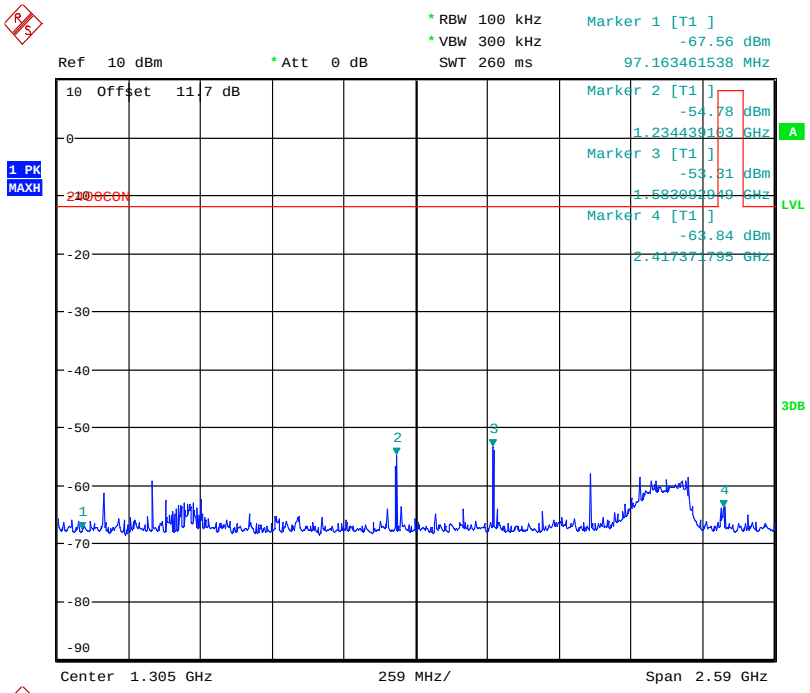
Date: 5.SEP.2014 13:18:59

5.4.4.2. Spurious RF Conducted Emissions in Non-Restricted Frequency Bands

Note: Highest cond. power measured in BPSK modulation, hence it represent the worst case of testing emission.

Plot 5.4.4.2.1. Conducted Spurious Emissions, 20MHz Ch Spacing, 2412 MHz, BPSK Modulation, 10 MHz – 25 GHz



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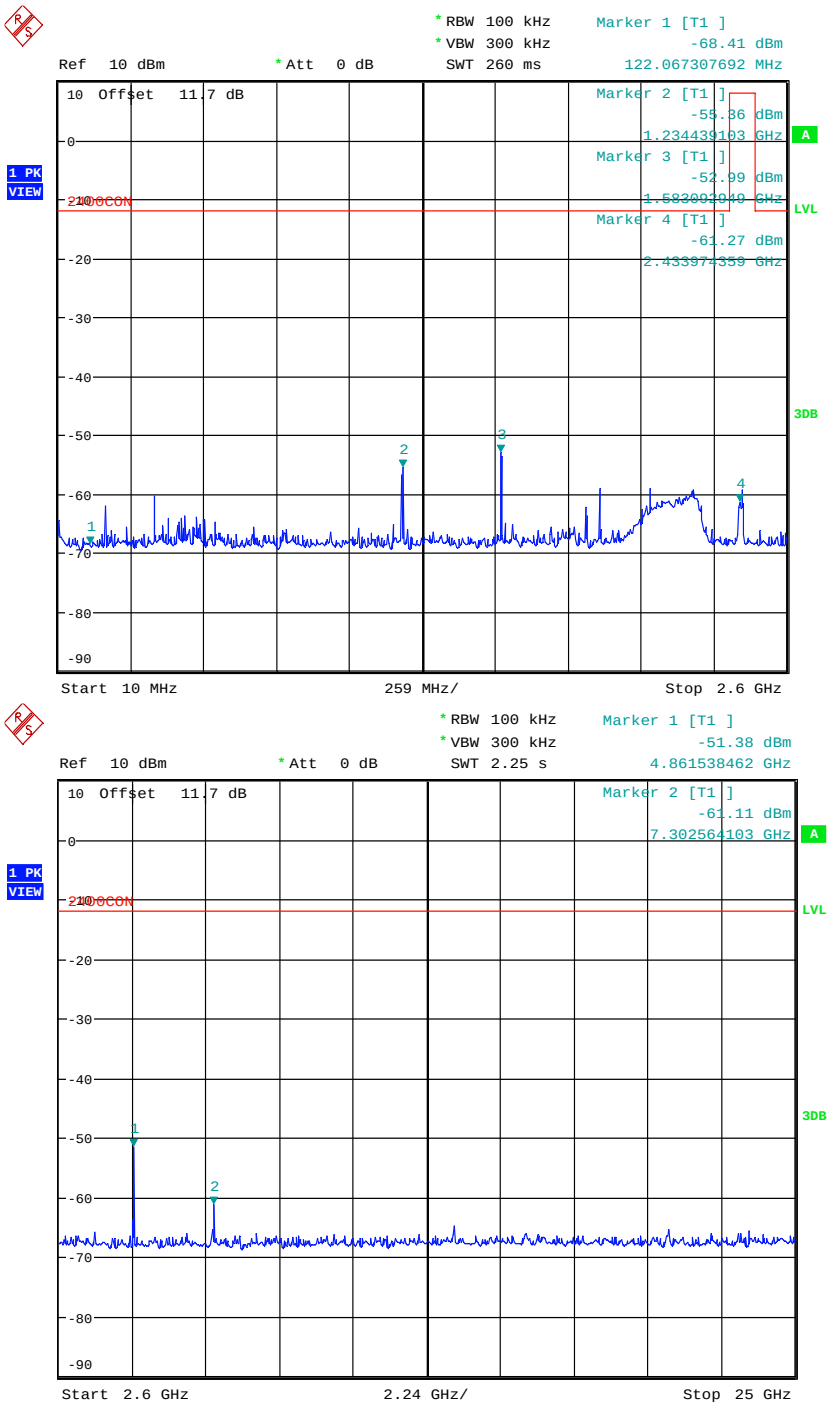
Date: 5.SEP.2014 10:15:20

Plot 5.4.4.2.2. Conducted Spurious Emissions, 20MHz Ch Spacing, 2437 MHz, BPSK Modulation, 10 MHz – 25 GHz



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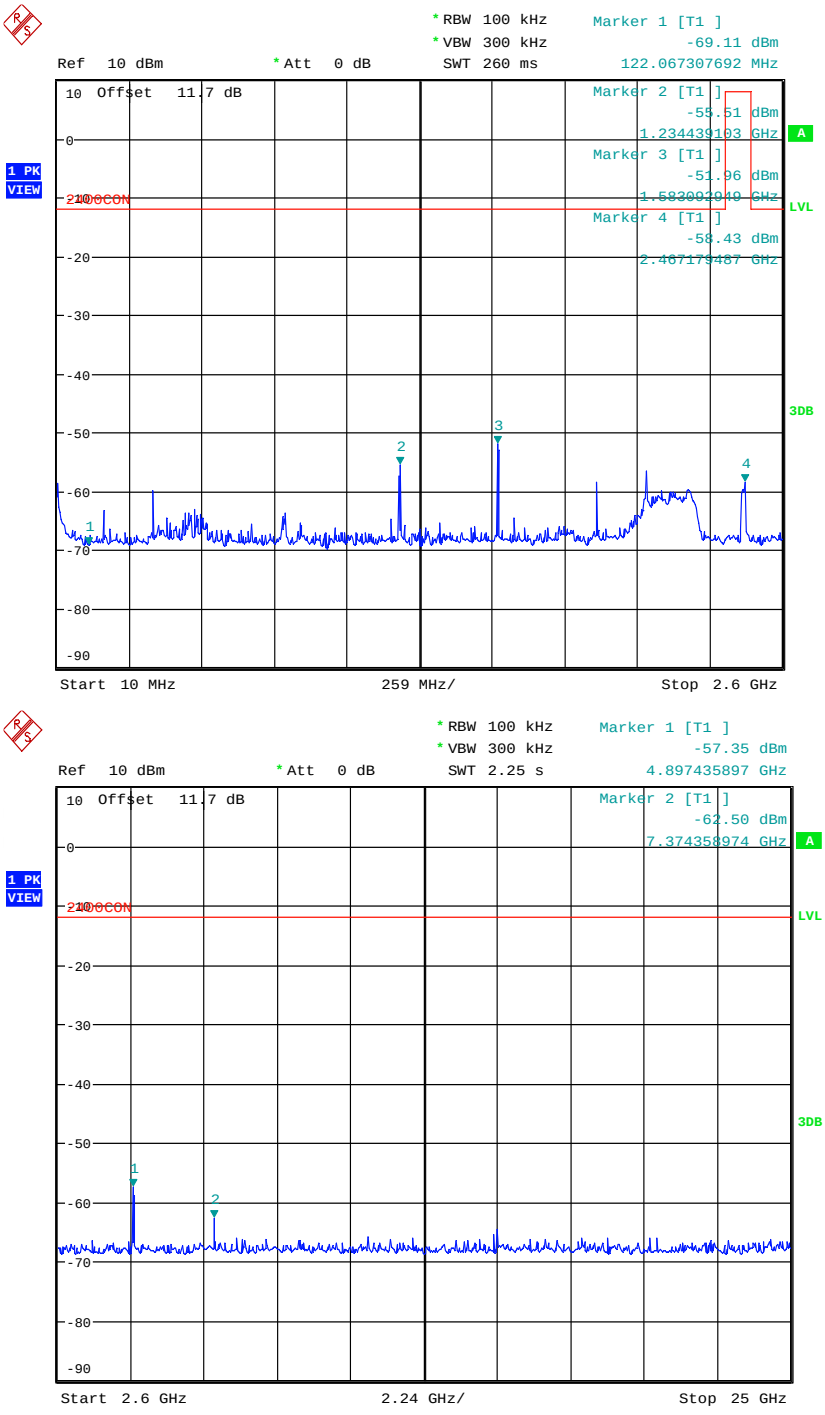
Date: 5.SEP.2014 10:17:37

Plot 5.4.4.2.3. Conducted Spurious Emissions, 20MHz Ch Spacing, 2462 MHz, BPSK Modulation, 10 MHz – 25 GHz



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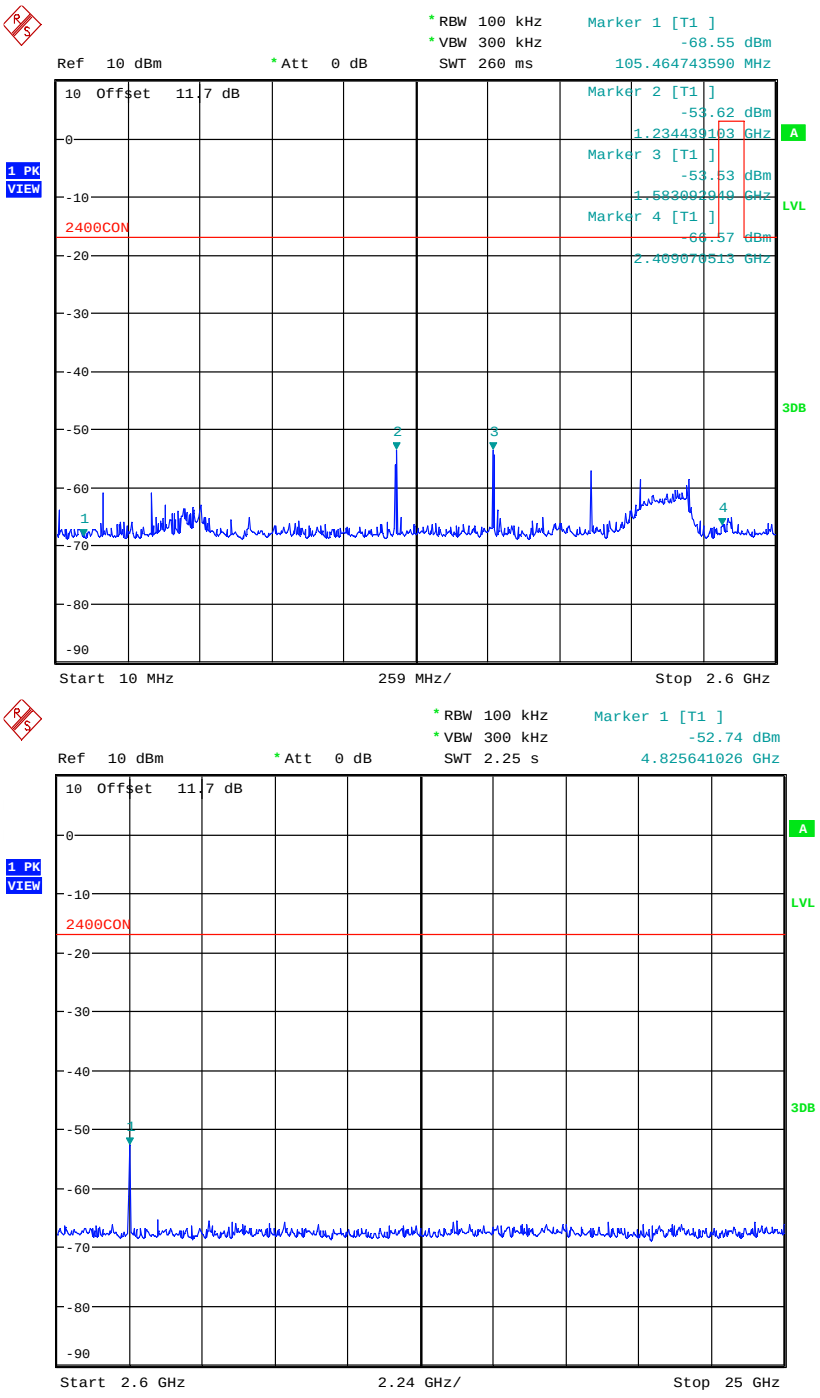
Date: 5.SEP.2014 10:19:34

Plot 5.4.4.2.4. Conducted Spurious Emissions, 40MHz Ch Spacing, 2422 MHz, BPSK Modulation, 10 MHz – 25 GHz



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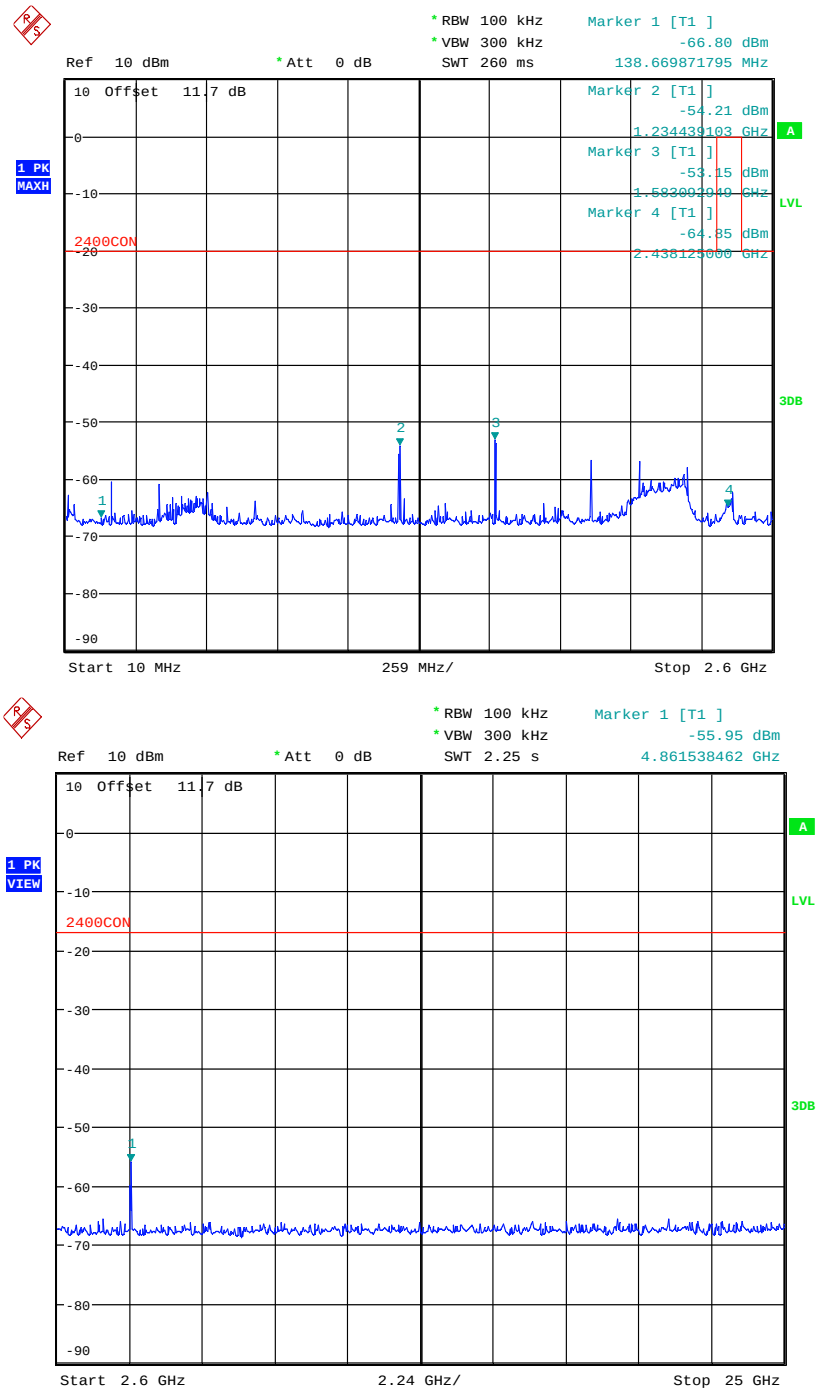
Date: 5.SEP.2014 10:03:35

Plot 5.4.4.2.5. Conducted Spurious Emissions, 40MHz Ch Spacing, 2437 MHz, BPSK Modulation, 10 MHz – 25 GHz



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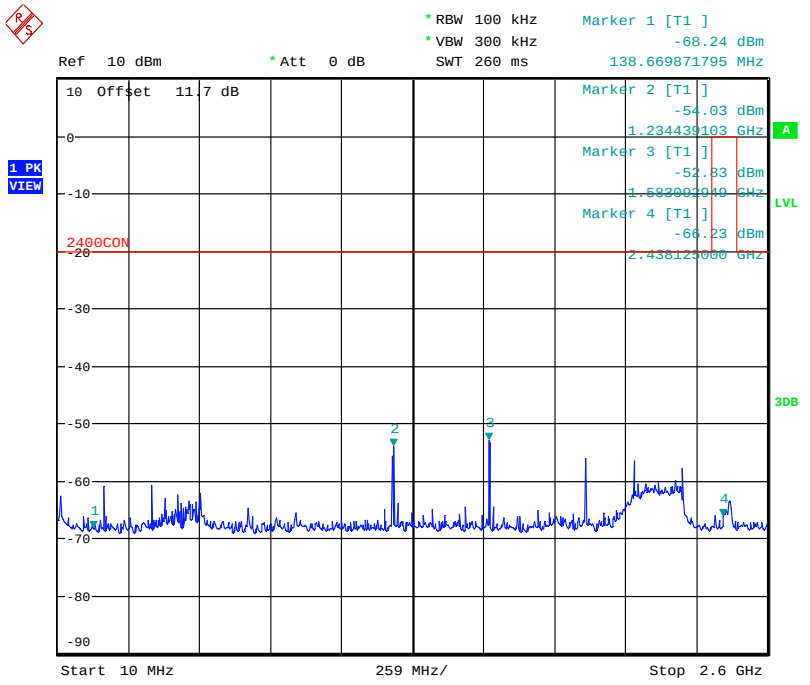
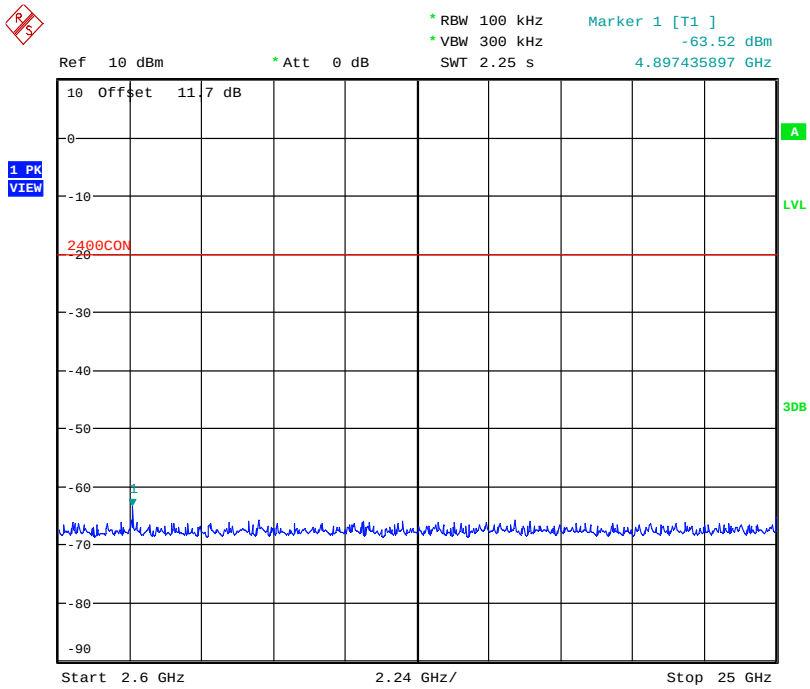
Date: 5.SEP.2014 10:06:02

Plot 5.4.4.2.6. Conducted Spurious Emissions, 40MHz Ch Spacing, 2452 MHz, BPSK Modulation, 10 MHz – 25 GHz





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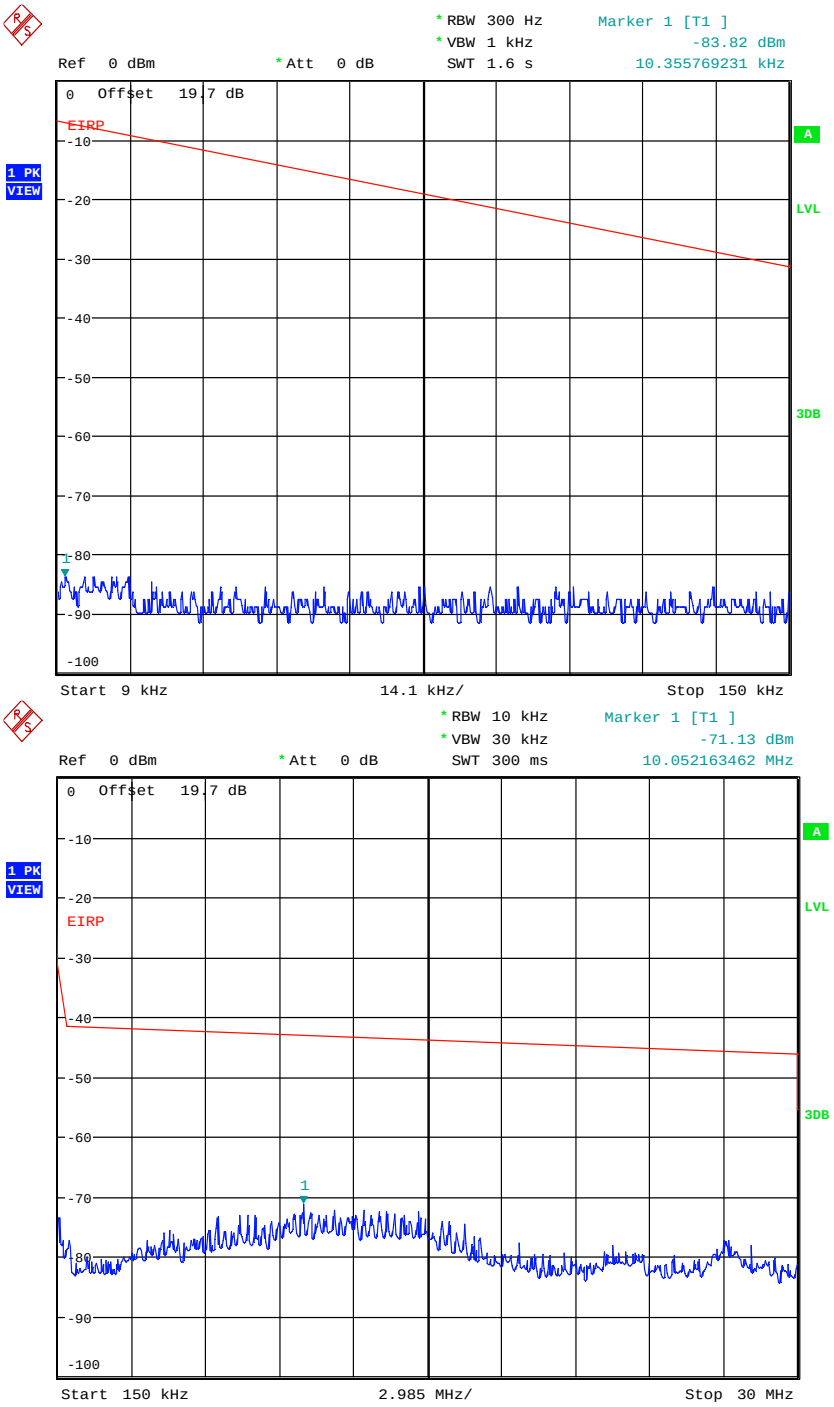
Date: 5.SEP.2014 10:09:24

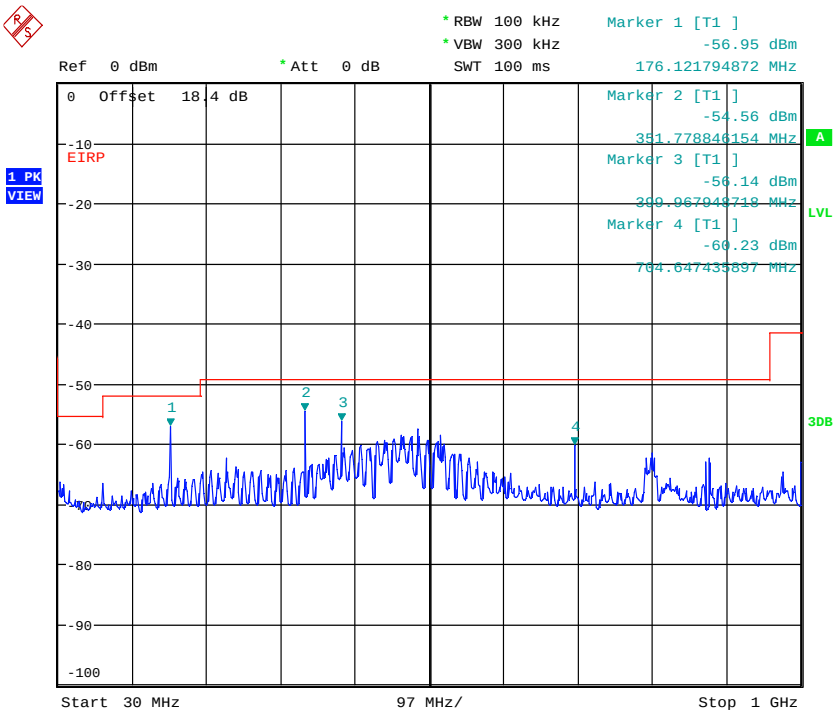
5.4.4.3. Spurious RF Conducted Emissions in Restricted Frequency Bands

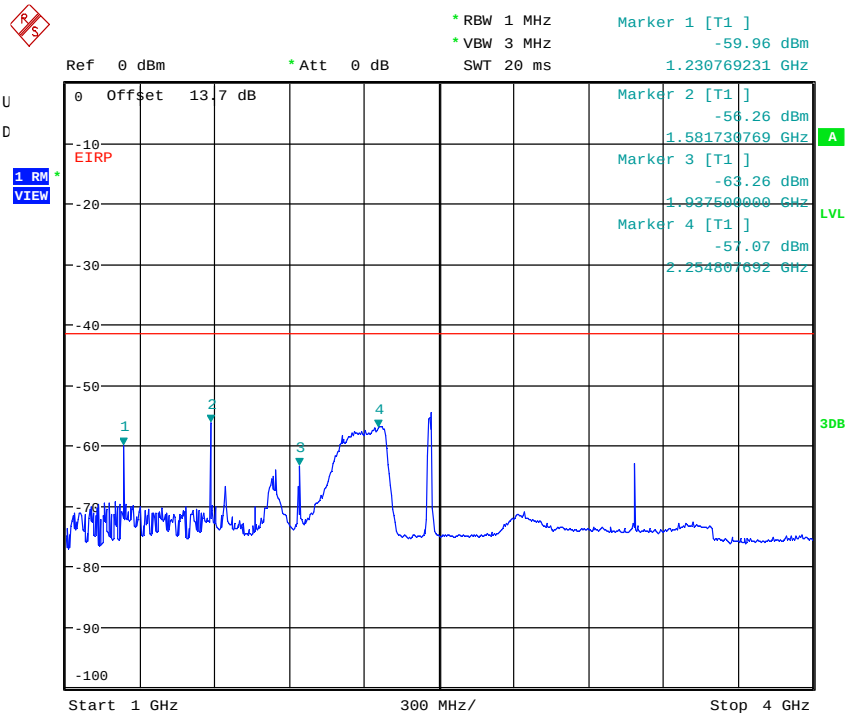
Note: Highest cond. power measured in BPSK modulation, hence it represent the worst case of testing emission.

Plot 5.4.4.3.1. Conducted Spurious Emissions, 20MHz Ch Spacing, 2412 MHz, BPSK Modulation, 9 kHz – 25 GHz



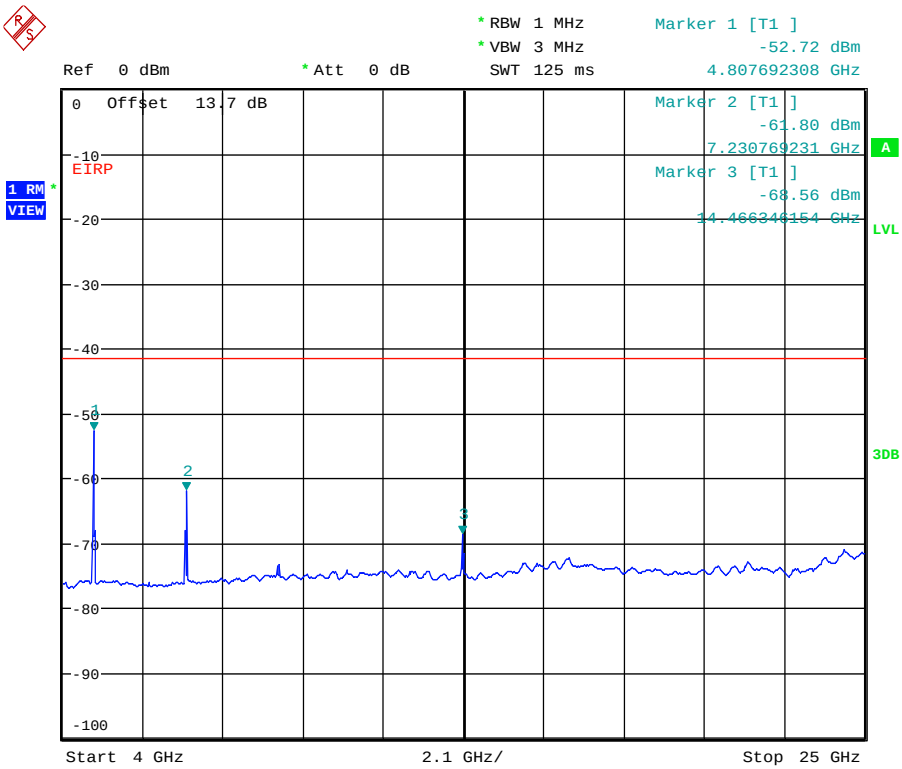
Ultratech Labs
Date: 4.SEP.2014 14:17:56





Ultratech Labs

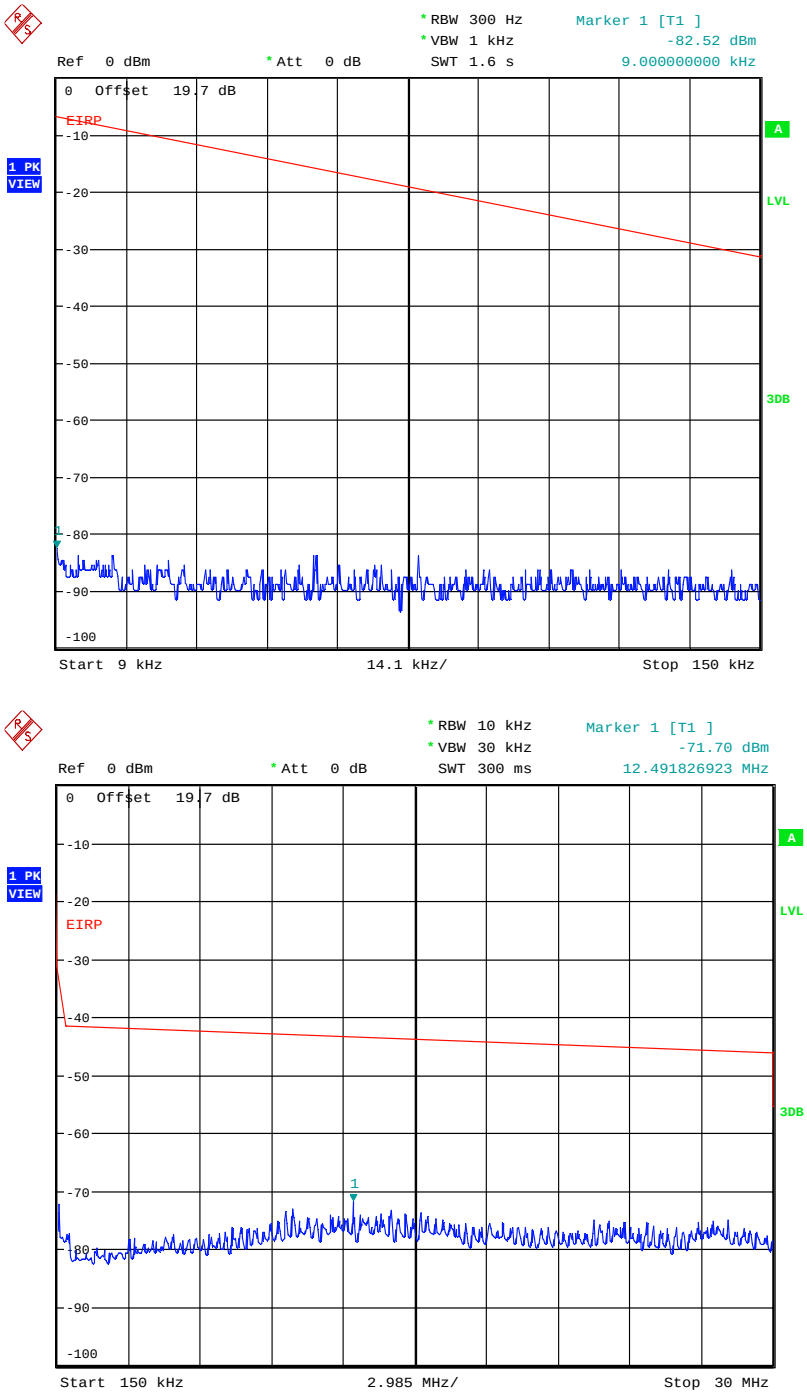
Date: 4.SEP.2014 14:49:50



Ultratech Labs

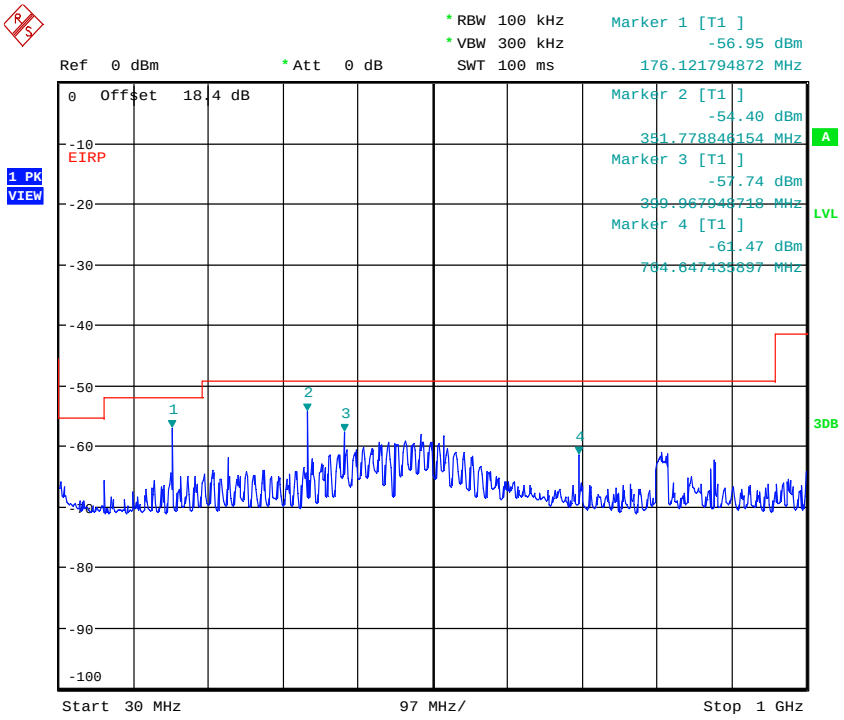
Date: 4.SEP.2014 14:56:58

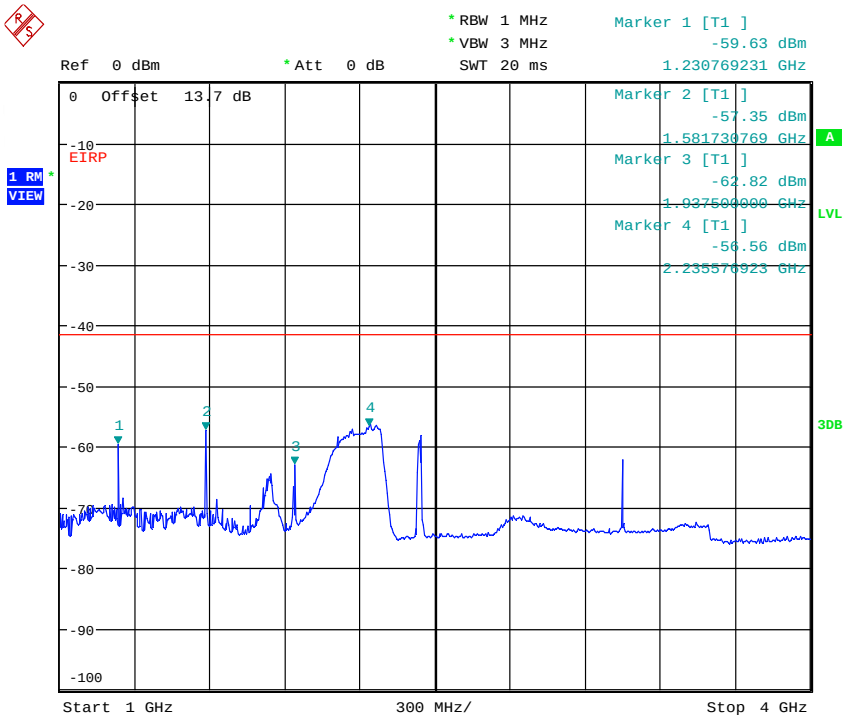
Plot 5.4.4.3.2. Conducted Spurious Emissions, 20MHz Ch Spacing, 2437 MHz, BPSK Modulation, 9 kHz – 25 GHz



Ultratech Labs

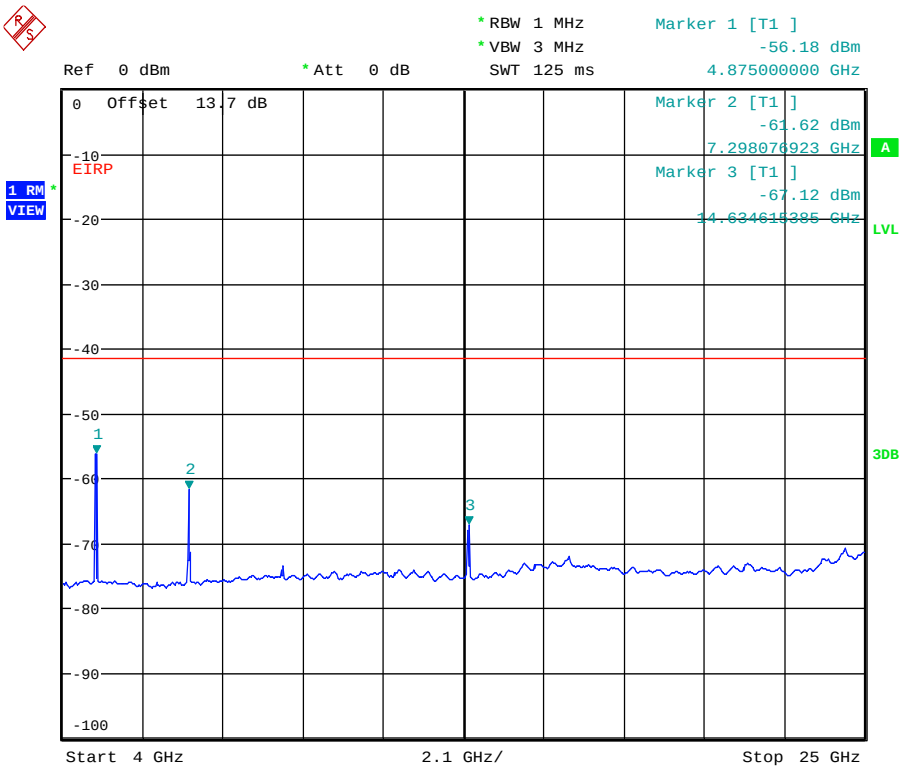
Date: 4.SEP.2014 14:35:23





Ultratech Labs

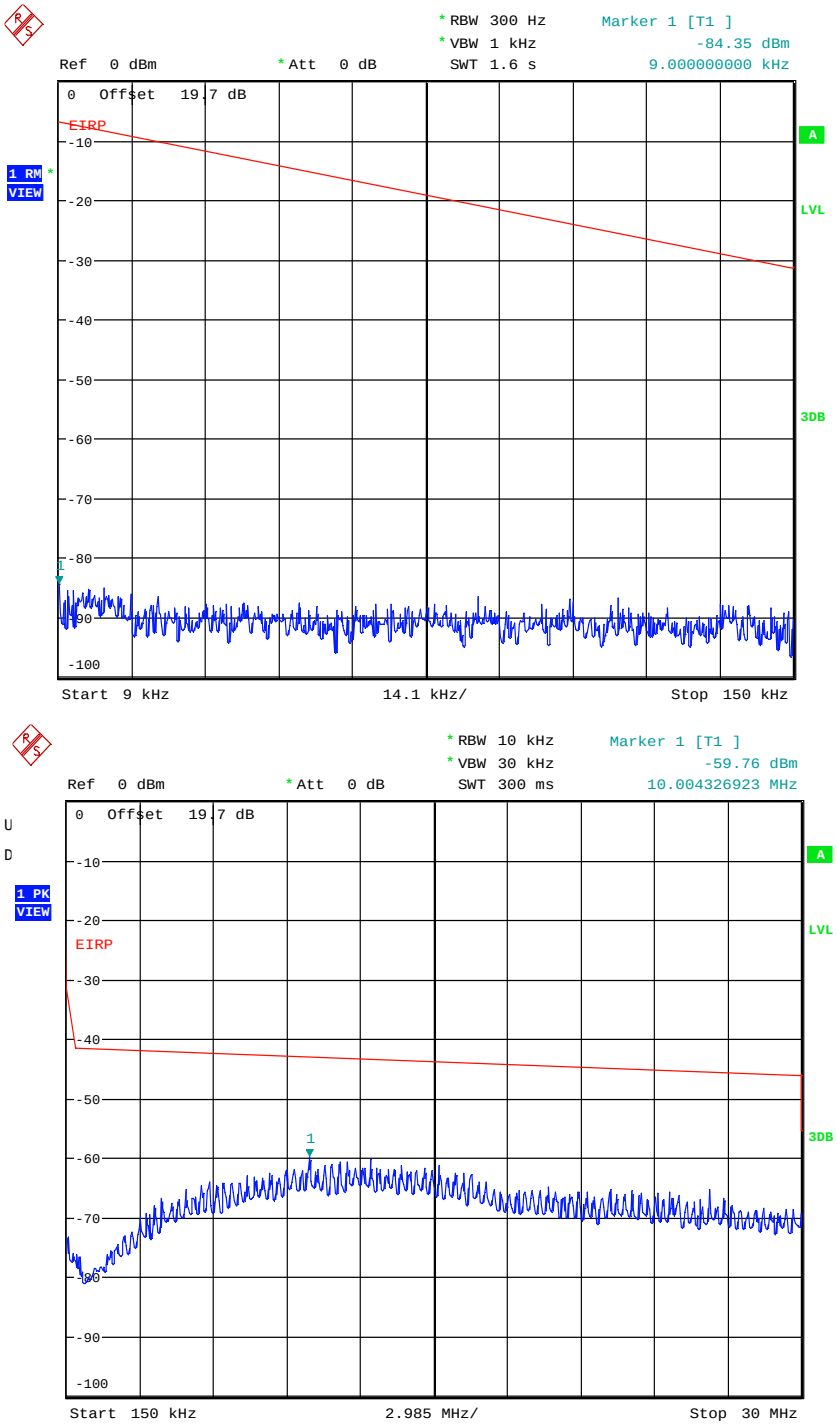
Date: 4.SEP.2014 14:43:00



Ultratech Labs

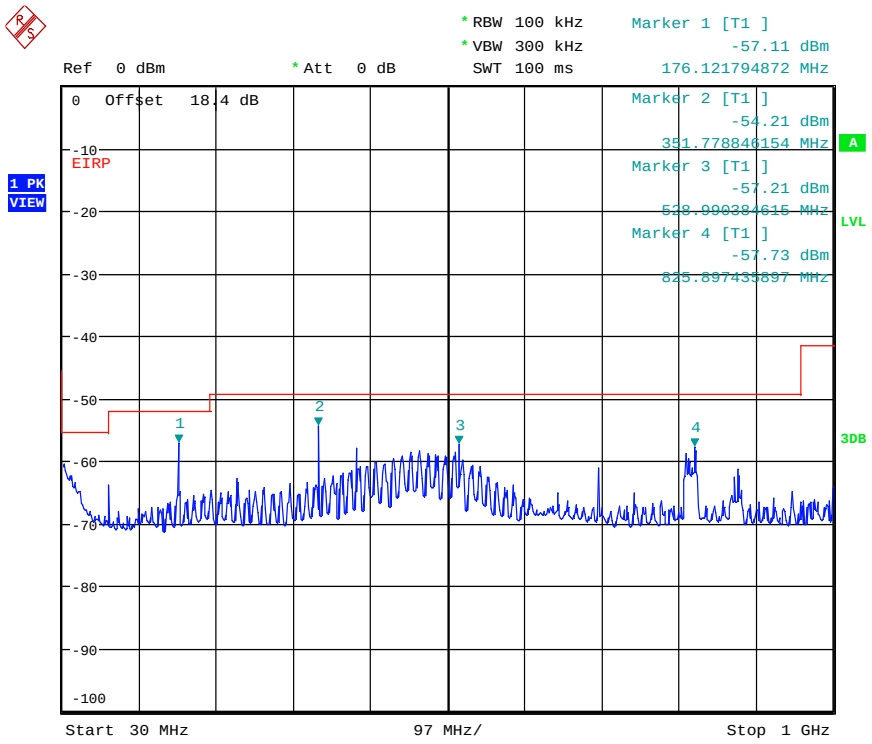
Date: 4.SEP.2014 14:55:08

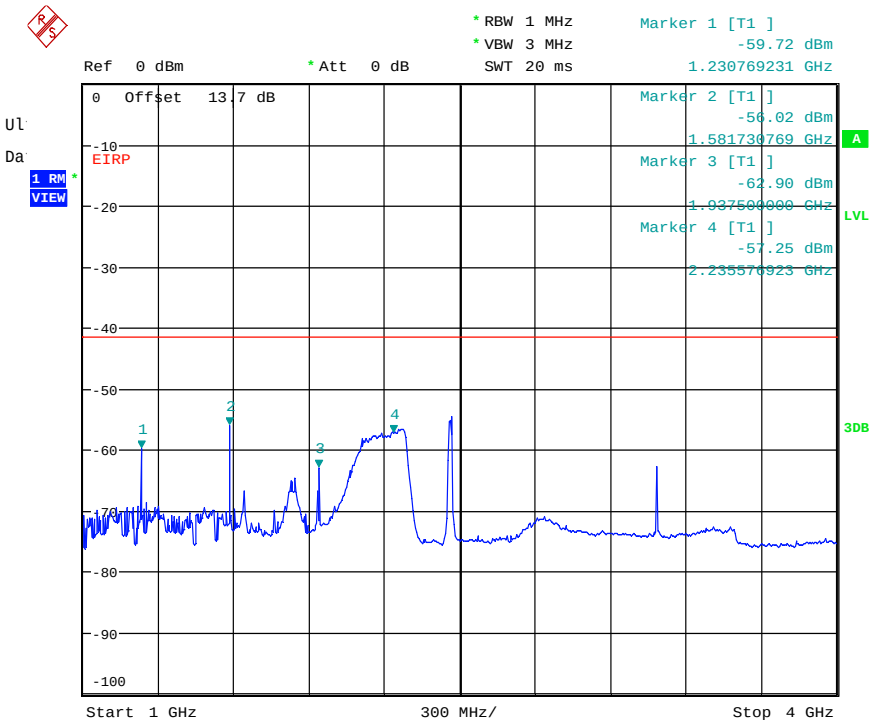
Plot 5.4.4.3.3. Conducted Spurious Emissions, 20MHz Ch Spacing, 2462 MHz, BPSK Modulation, 9 kHz – 25 GHz



Ultratech Labs

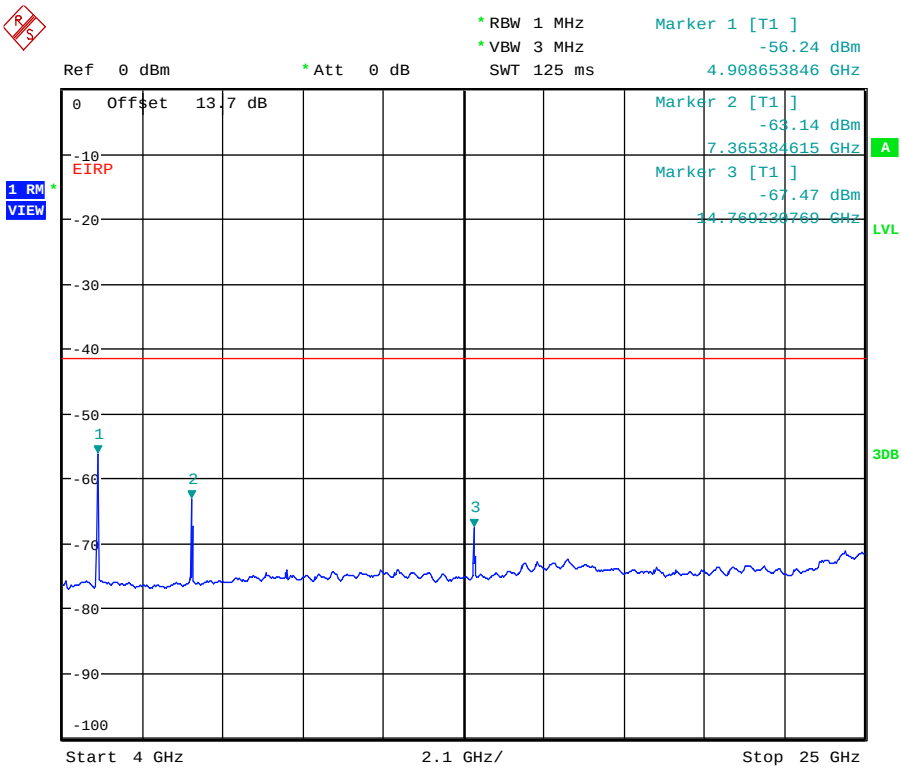
Date: 3.SEP.2014 11:36:37





Ultratech Labs

Date: 4.SEP.2014 14:46:02



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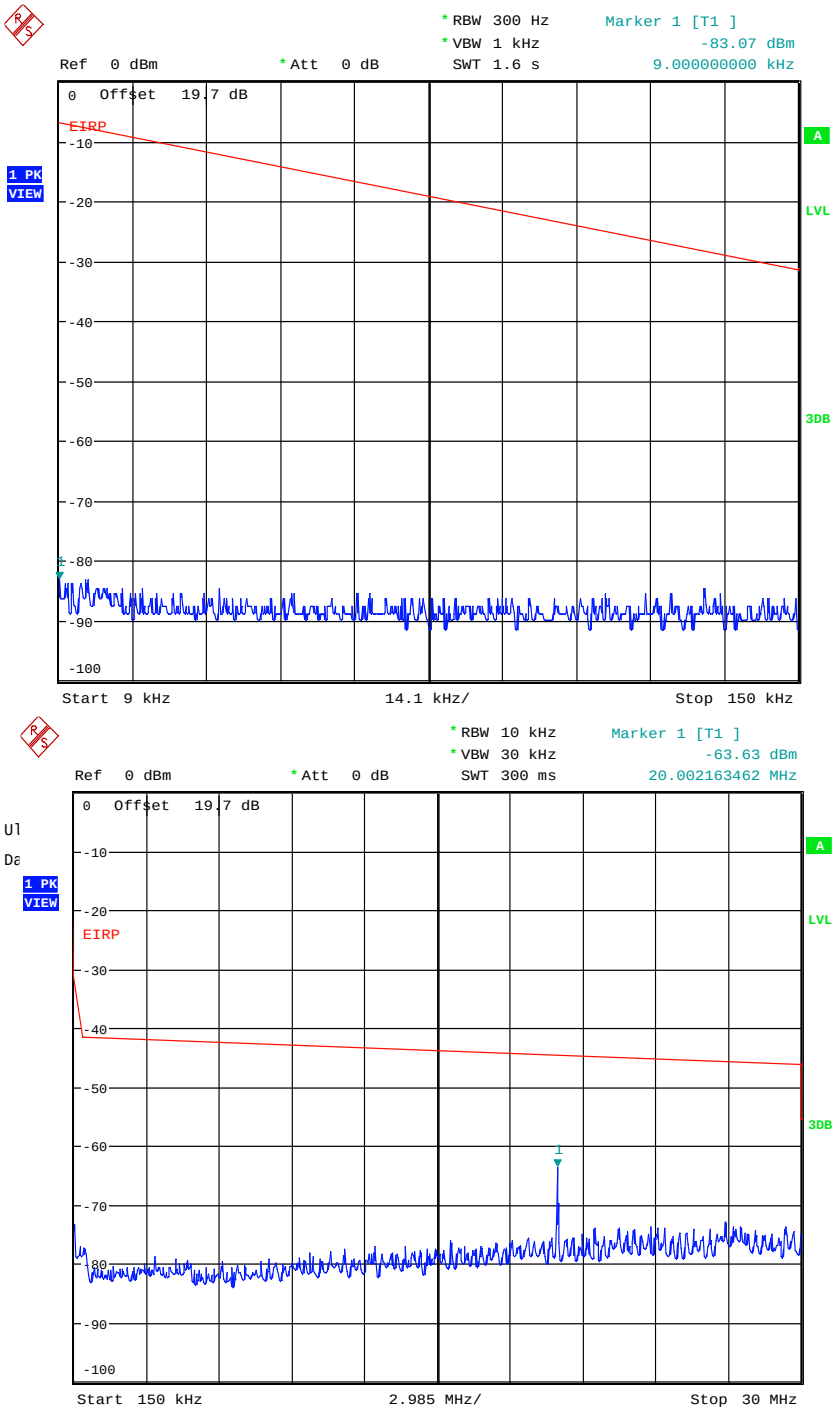
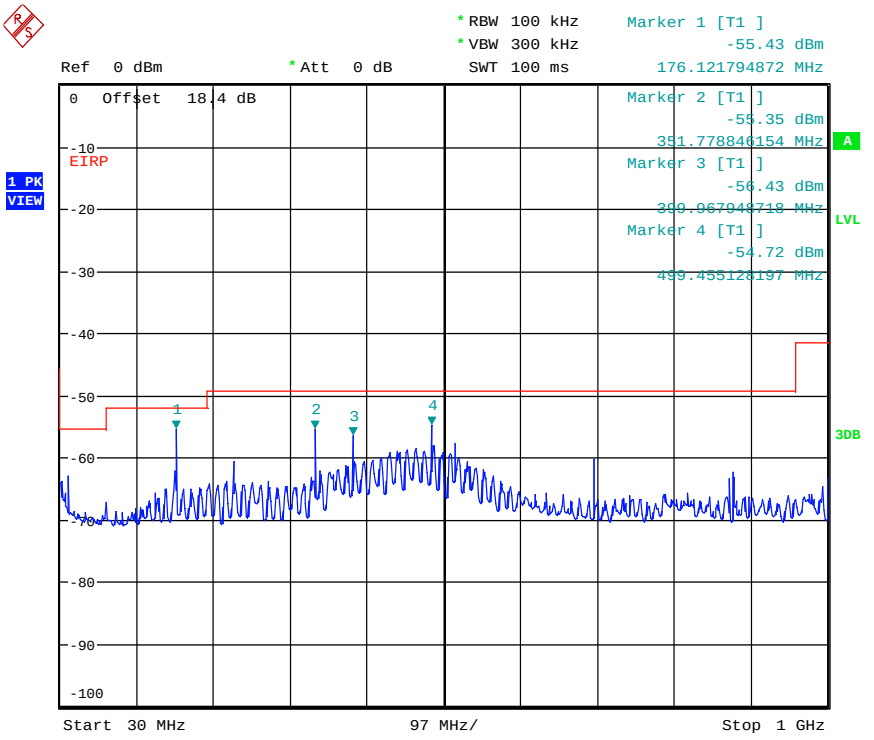
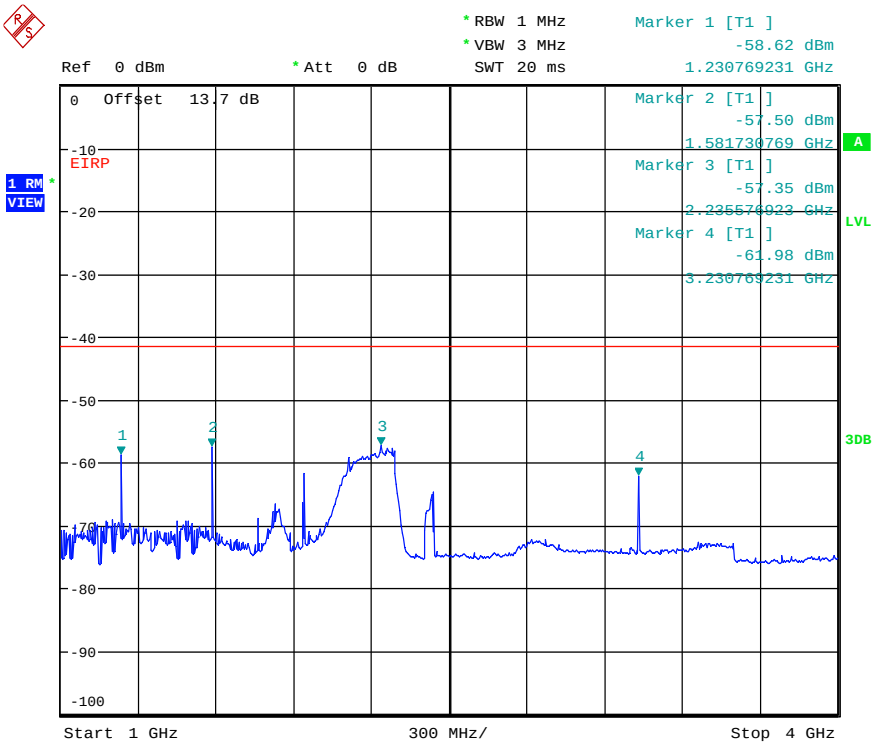
Date: 4.SEP.2014 14:53:05

Plot 5.4.4.3.4. Conducted Spurious Emissions, 40MHz Ch Spacing, 2422 MHz, BPSK Modulation, 9 kHz – 25 GHz

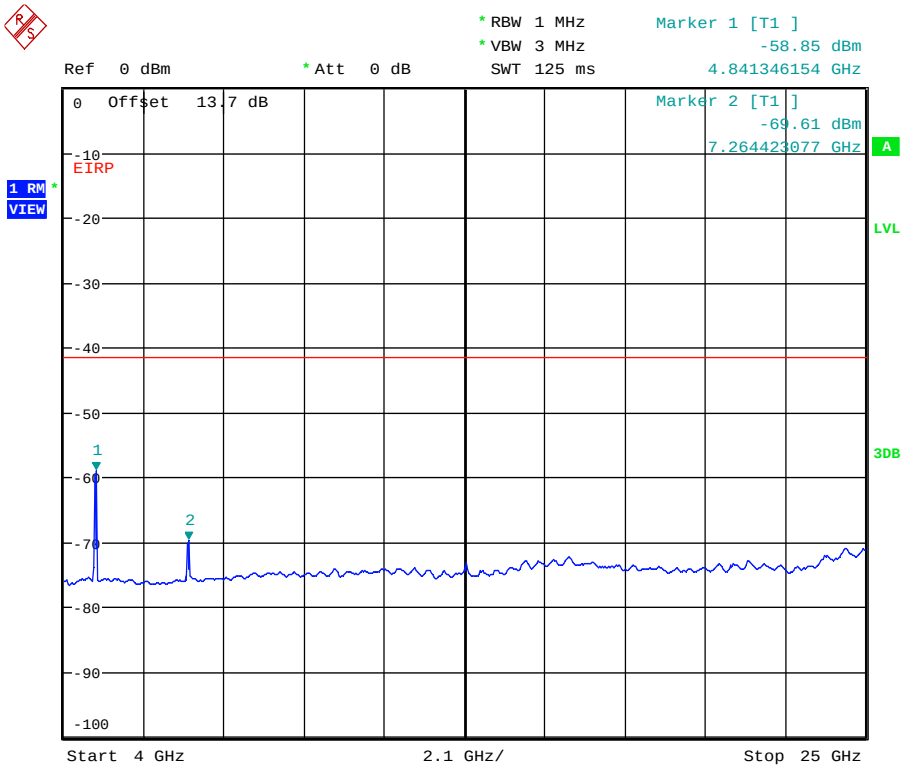






Ultratech Labs

Date: 4.SEP.2014 15:53:43



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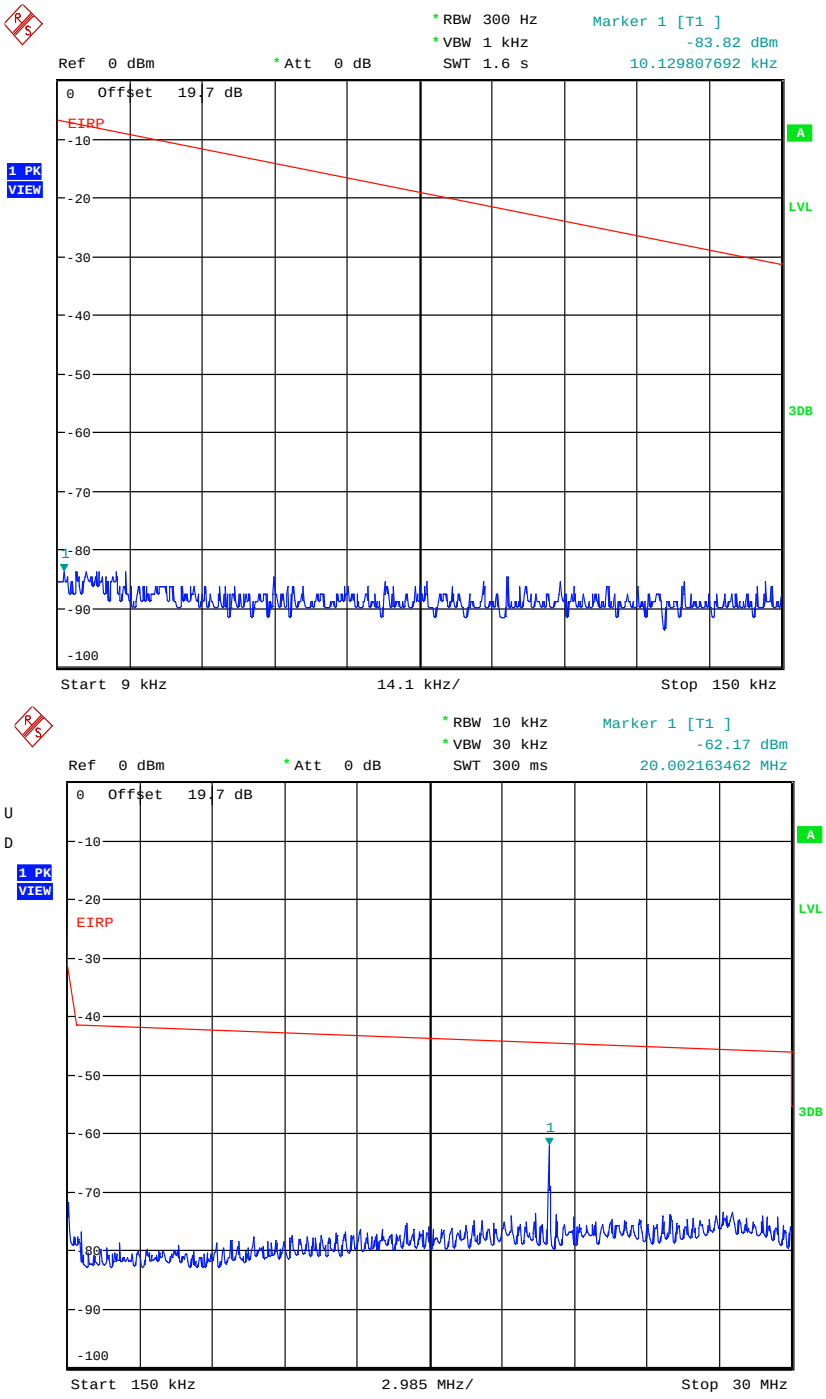
Date: 4.SEP.2014 16:15:39

Plot 5.4.4.3.5. Conducted Spurious Emissions, 40MHz Ch Spacing, 2437 MHz, BPSK Modulation, 9 kHz – 25 GHz



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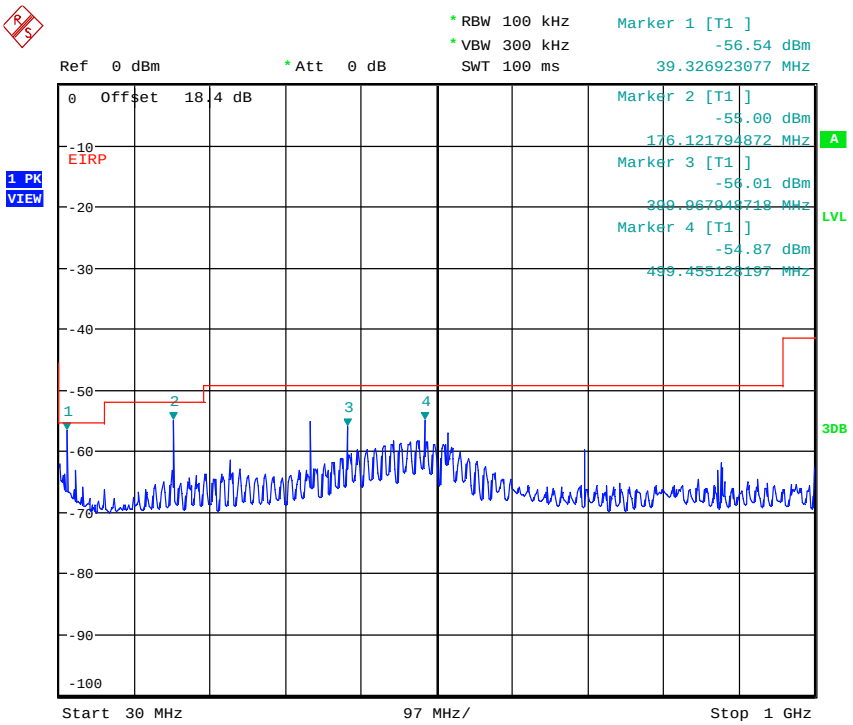
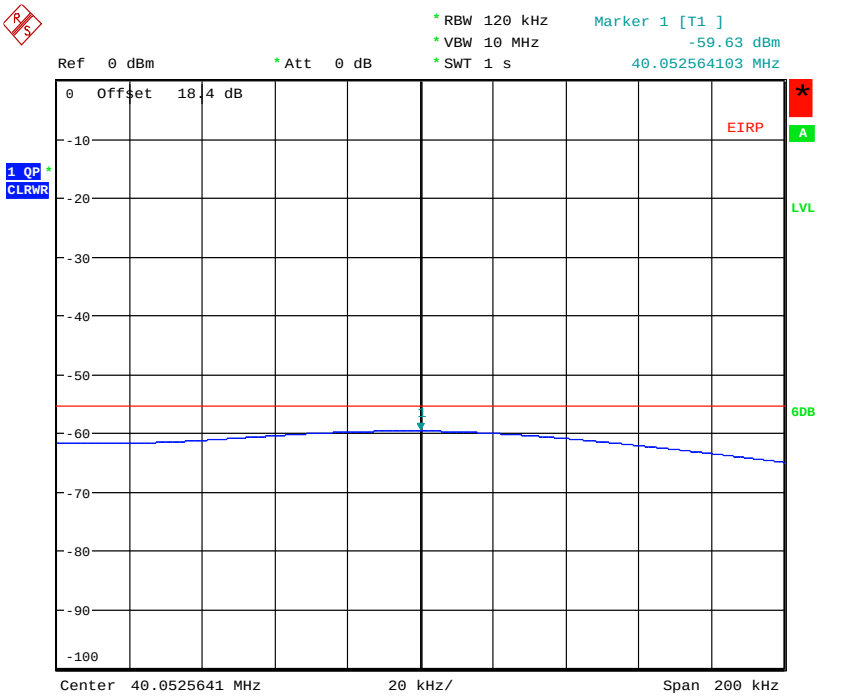
Date: 4.SEP.2014 13:39:50





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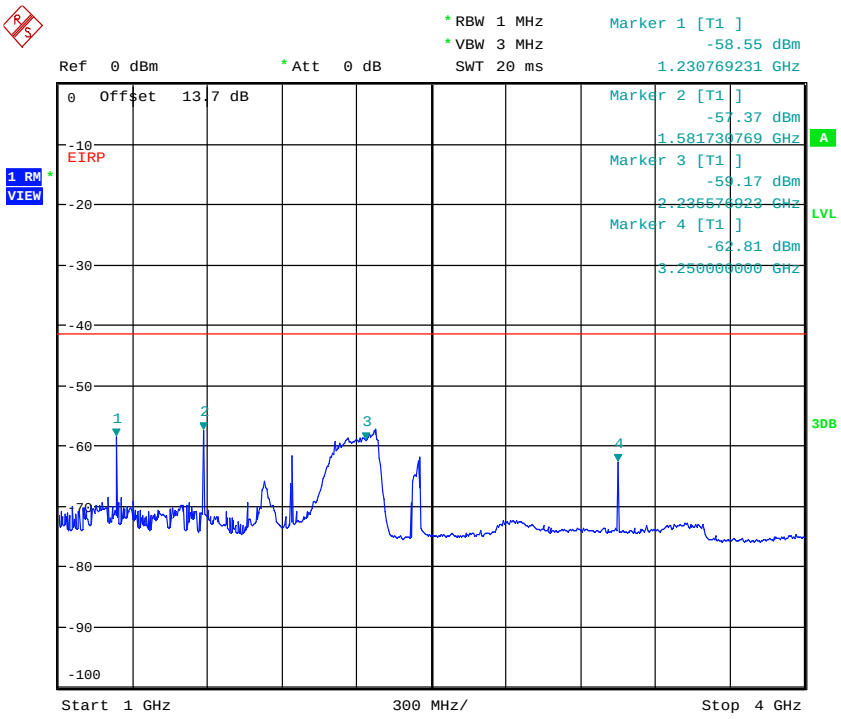
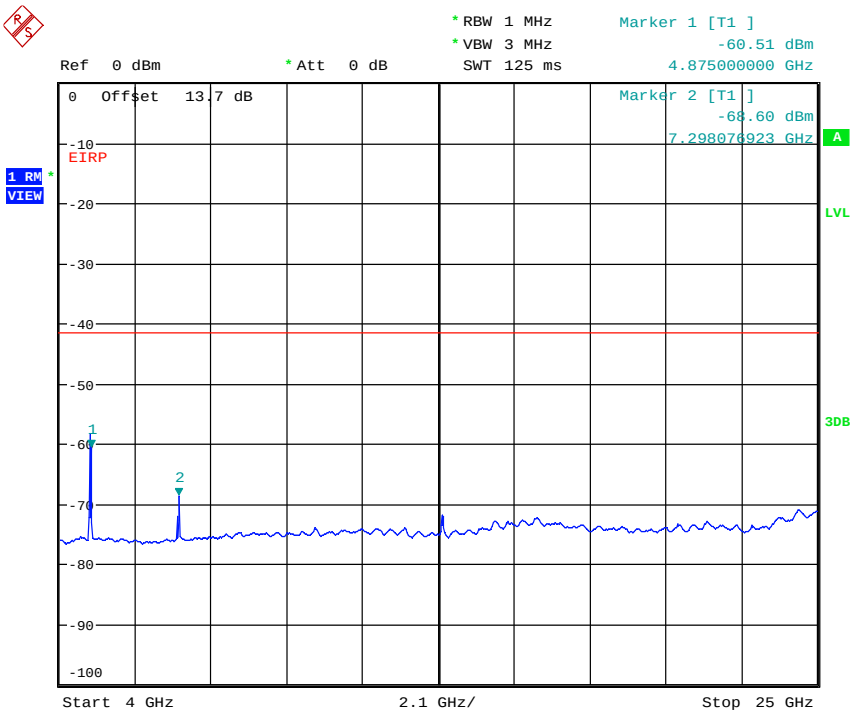
Date: 4.SEP.2014 10:50:26





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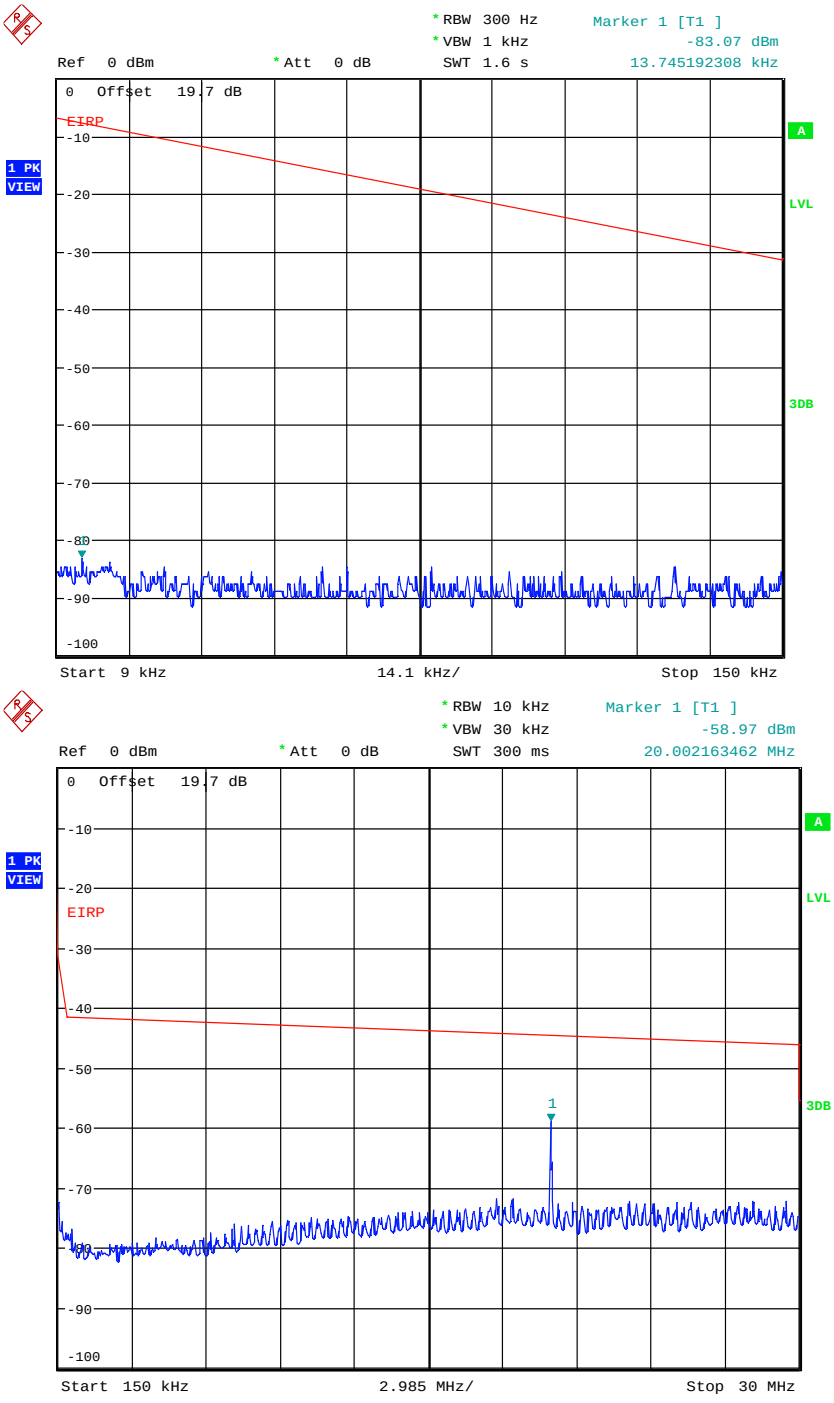
Date: 4.SEP.2014 16:12:00

Plot 5.4.4.3.6. Conducted Spurious Emissions, 40MHz Ch Spacing, 2452 MHz, BPSK Modulation, 9 kHz – 25 GHz



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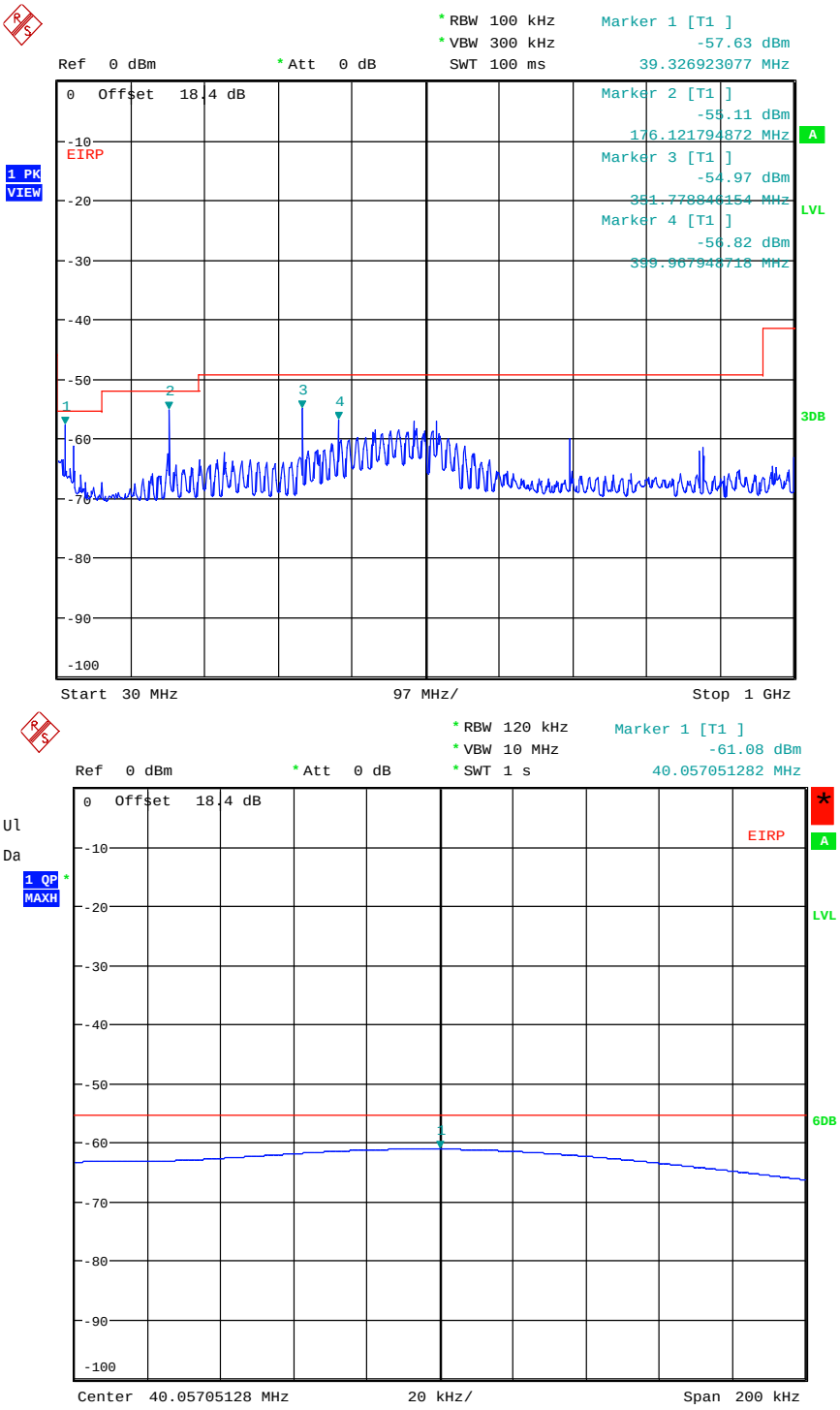
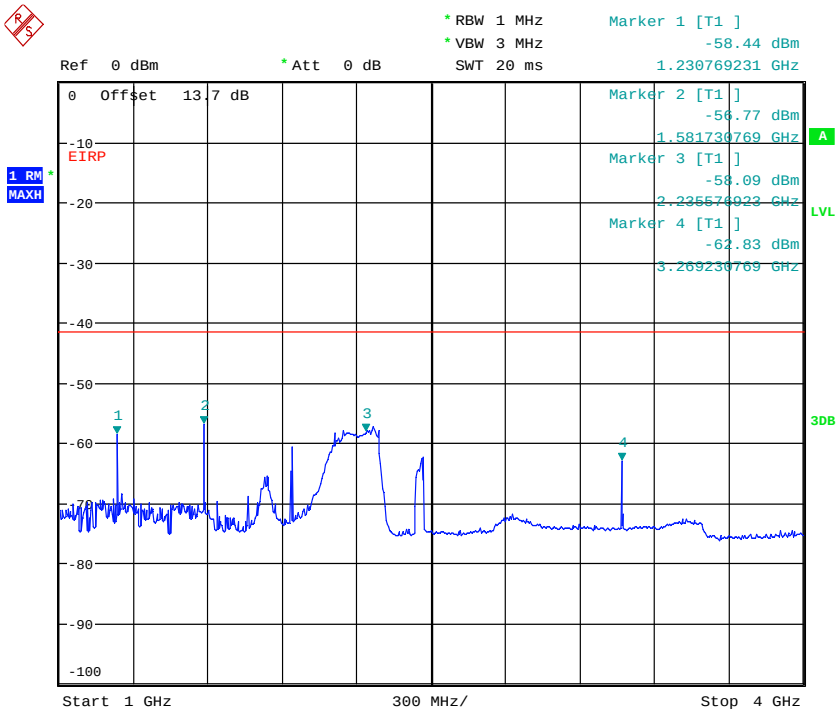
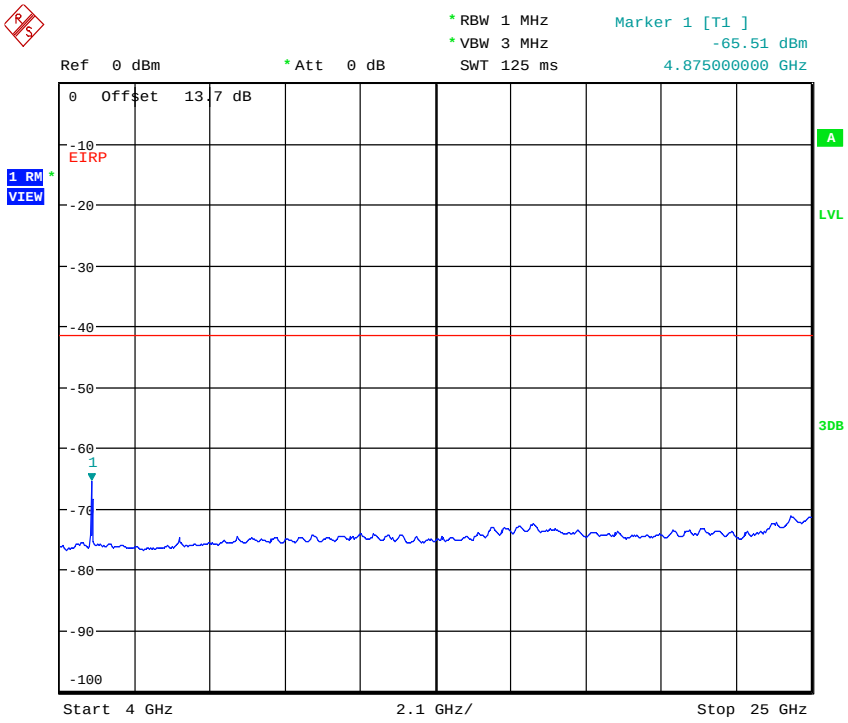
Date: 4.SEP.2014 13:37:10



Ultratech Labs

Date: 4.SEP.2014 13:25:06





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Date: 4.SEP.2014 16:09:17

5.5. RADIATED SPURIOUS EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

5.5.1. Limit(s)

§ 15.247 (d): 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 15.205(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

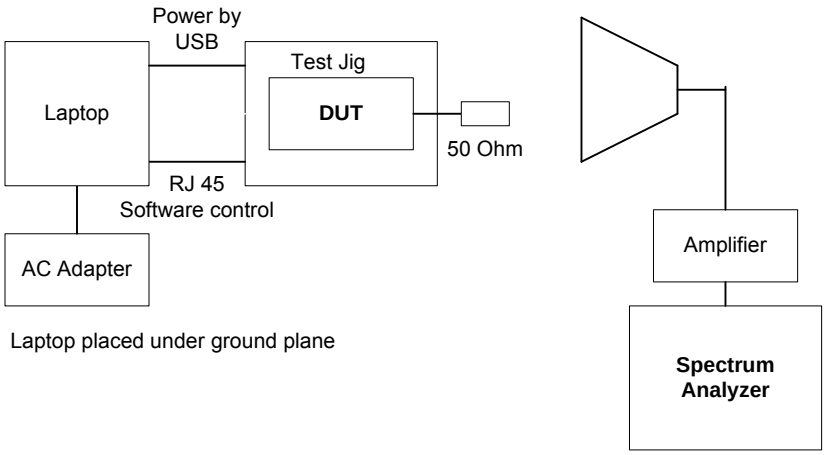
Section 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

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

5.5.2. Method of Measurements

KDB Publication No. 558074 D01 DTS Meas Guidance V03r02, Sections 12.2.1 & 12.2.7, ANSI C63.10 and ANSI 63.4 procedures.

5.5.3. Test Arrangement



5.5.4. Test Data

Remark(s):

- All spurious emissions that were in excess of 20 dB below the specified limit recorded.
- DUT terminated with 50 Ohm load to measure unwanted spurious emissions.
- Since the highest conducted output power measured with BPSK modulation, it chosen as the worst case of emission for testing.

5.5.4.1. Spurious Radiated Emissions for 20 MHz Channel Spacing

Fundamental Frequency:	2412 MHz
Operating Mode:	BPSK modulation
Frequency Test Range:	960 MHz - 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Margin (dB)	Pass/ Fail
4824	68.59	50.61	V	54.0	-3.4	Pass
4824	65.79	47.51	H	54.0	-6.5	Pass
7236	64.58	47.86	V	54.0	-6.1	Pass
7236	62.33	44.71	H	54.0	-9.3	Pass

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

Fundamental Frequency:	2437 MHz
Operating Mode:	BPSK modulation
Frequency Test Range:	960 MHz - 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Margin (dB)	Pass/ Fail
4874	68.74	50.82	V	54.0	-3.2	Pass
4874	68.32	51.43	H	54.0	-2.6	Pass
7311	66.65	50.63	V	54.0	-3.4	Pass
7311	63.36	47.48	H	54.0	-6.5	Pass

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

Fundamental Frequency:	2462 MHz					
Operating Mode:	BPSK modulation					
Frequency Test Range:	960 MHz - 25 GHz					
Frequency (MHz)	**RF Peak Level (dBµV/m)**	**RF Avg Level (dBµV/m)**	**Antenna Plane (H/V)**	**Limit 15.209 (dBµV/m)**	**Margin (dB)**	**Pass/ Fail**
4924	68.90	51.01	V	54.0	-3.0	Pass
4924	68.61	51.08	H	54.0	-2.9	Pass
7386	65.47	49.97	V	54.0	-4.0	Pass
7386	64.81	48.29	H	54.0	-5.7	Pass
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.						

5.5.4.2. Spurious Radiated Emissions for 40 MHz Channel Spacing

Fundamental Frequency:	2422 MHz					
Operating Mode:	BPSK modulation					
Frequency Test Range:	960 MHz - 25 GHz					
Frequency (MHz)	**RF Peak Level (dBµV/m)**	**RF Avg Level (dBµV/m)**	**Antenna Plane (H/V)**	**Limit 15.209 (dBµV/m)**	**Margin (dB)**	**Pass/ Fail**
4844	65.09	46.04	V	54.0	-8.0	Pass
4844	62.88	45.49	H	54.0	-8.5	Pass
7266	59.47	44.07	V	54.0	-9.9	Pass
7266	57.46	43.27	H	54.0	-10.7	Pass
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.						

Fundamental Frequency:	2437 MHz					
Operating Mode:	BPSK modulation					
Frequency Test Range:	960 MHz - 25 GHz					
Frequency (MHz)	**RF Peak Level (dBµV/m)**	**RF Avg Level (dBµV/m)**	**Antenna Plane (H/V)**	**Limit 15.209 (dBµV/m)**	**Margin (dB)**	**Pass/ Fail**
4874	68.25	50.58	V	54.0	-3.4	Pass
4874	65.60	48.71	H	54.0	-5.3	Pass
7311	63.37	47.03	V	54.0	-7.0	Pass
7311	58.92	44.41	H	54.0	-9.6	Pass
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.						

Fundamental Frequency:	2452 MHz
Operating Mode:	BPSK modulation
Frequency Test Range:	960 MHz - 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Margin (dB)	Pass/ Fail
4904	62.94	45.35	V	54.0	-8.6	Pass
4904	60.61	43.92	H	54.0	-10.1	Pass
7356	59.50	44.24	V	54.0	-9.8	Pass
7356	57.19	42.22	H	54.0	-11.8	Pass

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

Unintentional Emissions in 30 MHz - 1 GHz Range:

Remarks:

- DUT terminated with 50 Ohm load to measure unwanted spurious emissions
- All spurious emissions that are in excess of 20 dB below the specified limit recorded as per below.

Frequency (MHz)	RF Level (dBµV/m)	Detector Used (Peak/QP/Avg)	Antenna Plane (H/V)	Limit at 3 m (dBµV/m)	Margin (dB)
146.60	25.82	Peak	V	43.5	-18.7
146.60	30.45	Peak	H	43.5	-13.0
284.13	37.90	Peak	V	46.0	-8.1
284.13	29.51	Peak	H	46.0	-16.5
362.42	26.45	Peak	H	46.0	-19.5
800.08	38.94	Peak	V	46.0	-7.1
800.08	33.39	Peak	H	46.0	-12.6
959.93	35.93	Peak	V	46.0	-10.1
959.93	34.29	Peak	H	46.0	-11.7

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

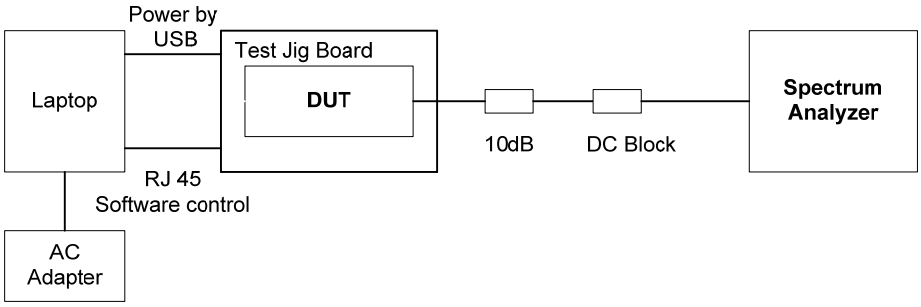
5.6.1. Limit(s)

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

Publication No. KDB Publication No. 558074 D01 DTS Meas Guidance V03r02, Section 10.2 Method PKPSD

5.6.3. Test Arrangement



5.6.4. Test Data

(a) 20 MHz Channel Spacing Mode:

MCS Index	Modulation	Data Rate (Mbps)	Channel Number	Frequency (MHz)	Power Spectral Density (dBm)	PSD Limit (dBm)
MCS0	BPSK ½	6.5	1	2412	-8.84	+8.0
MCS0	BPSK ½	6.5	6	2437	-6.77	+8.0
MCS0	BPSK ½	6.5	11	2462	-7.17	+8.0
MCS2	QPSK ¾	19.5	1	2412	-9.22	+8.0
MCS2	QPSK ¾	19.5	6	2437	-8.18	+8.0
MCS2	QPSK ¾	19.5	11	2462	-7.76	+8.0
MCS4	16-QAM ¾	39	1	2412	-9.24	+8.0
MCS4	16-QAM ¾	39	6	2437	-10.43	+8.0
MCS4	16-QAM ¾	39	11	2462	-9.31	+8.0
MCS7	64-QAM 5/6	65	1	2412	-12.72	+8.0
MCS7	64-QAM 5/6	65	6	2437	-13.14	+8.0
MCS7	64-QAM 5/6	65	11	2462	-13.44	+8.0

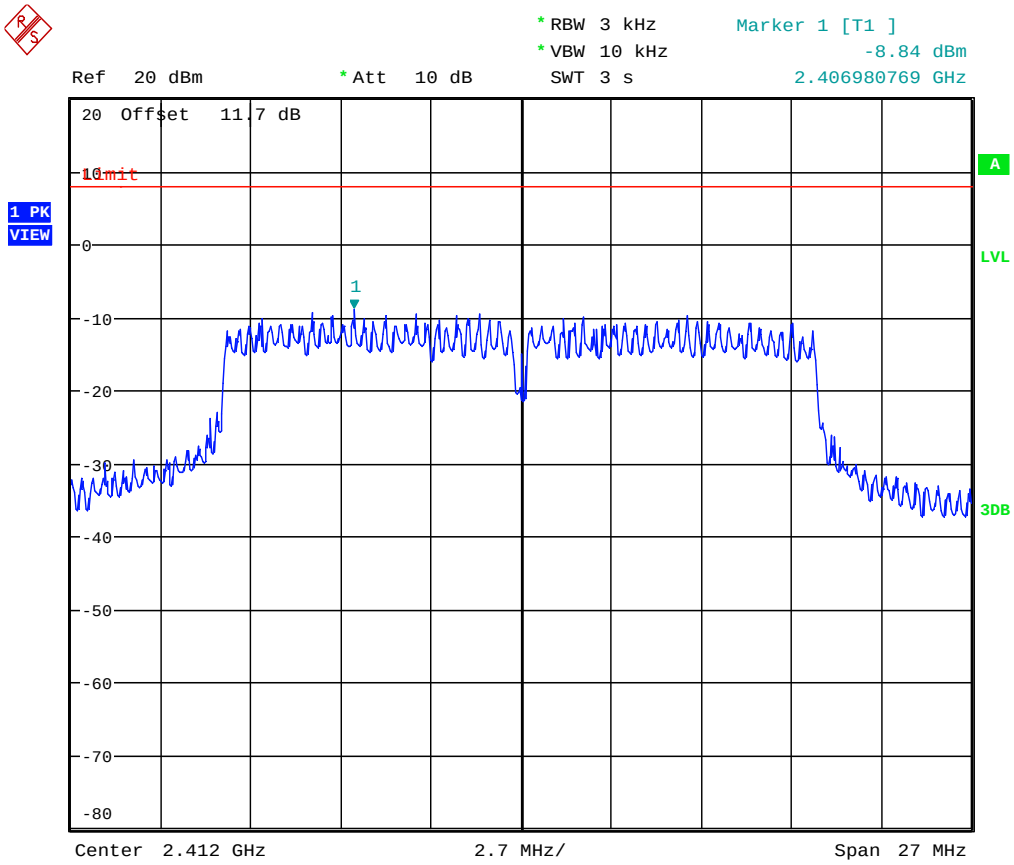
(b) 40 MHz Channel Spacing Mode:

MCS Index	Modulation	Data Rate (Mbps)	Channel Number	Frequency (MHz)	Power Spectral Density (dBm)	PSD Limit (dBm)
MCS0	BPSK ½	13.5	3	2422	-13.46	+8.0
MCS0	BPSK ½	13.5	6	2437	-12.72	+8.0
MCS0	BPSK ½	13.5	9	2452	-15.54	+8.0
MCS2	QPSK ¾	40.5	3	2422	-12.43	+8.0
MCS2	QPSK ¾	40.5	6	2437	-12.51	+8.0
MCS2	QPSK ¾	40.5	9	2452	-11.99	+8.0
MCS4	16-QAM ¾	81	3	2422	-13.43	+8.0
MCS4	16-QAM ¾	81	6	2437	-13.39	+8.0
MCS4	16-QAM ¾	81	9	2452	-14.07	+8.0
MCS7	64-QAM 5/6	135	3	2422	-15.10	+8.0
MCS7	64-QAM 5/6	135	6	2437	-15.41	+8.0
MCS7	64-QAM 5/6	135	9	2452	-15.46	+8.0

*See the following plots for measurement details.

(a) 20 MHz Channel Spacing Mode:

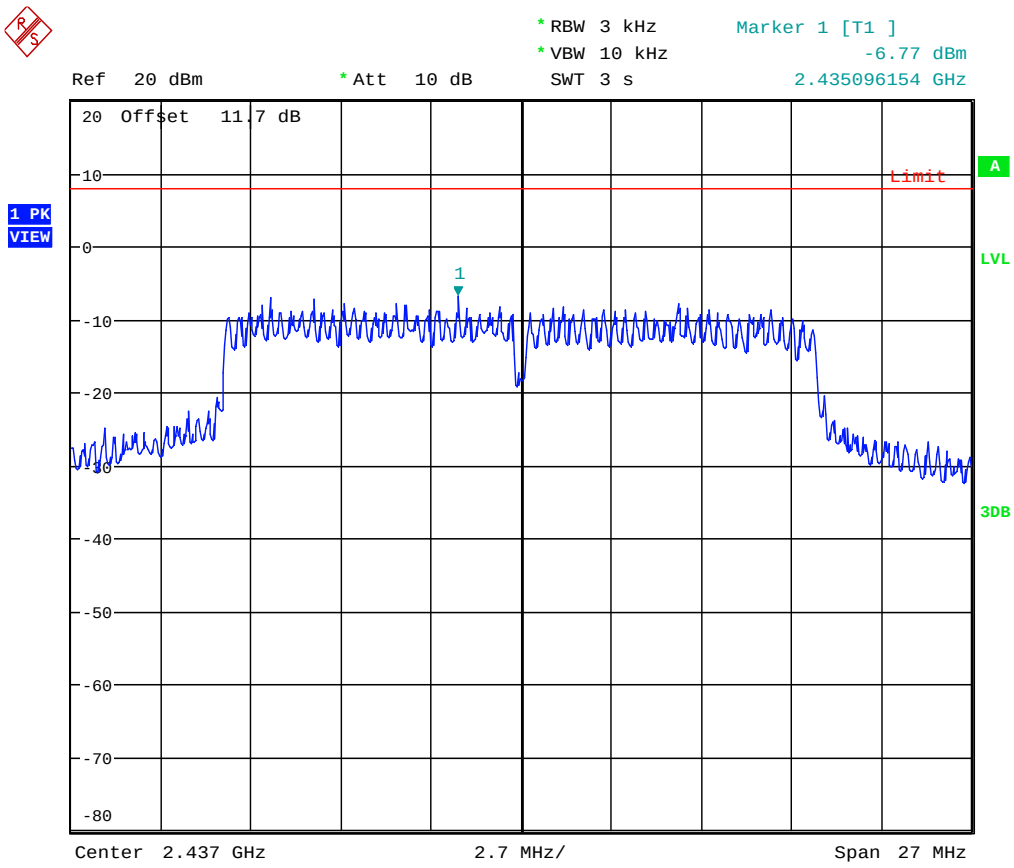
Plot 5.6.4.1. Power Spectral Density, BPSK Modulation, Channel #1, 2412 MHz



Ultratech Labs

Date: 5.SEP.2014 14:13:15

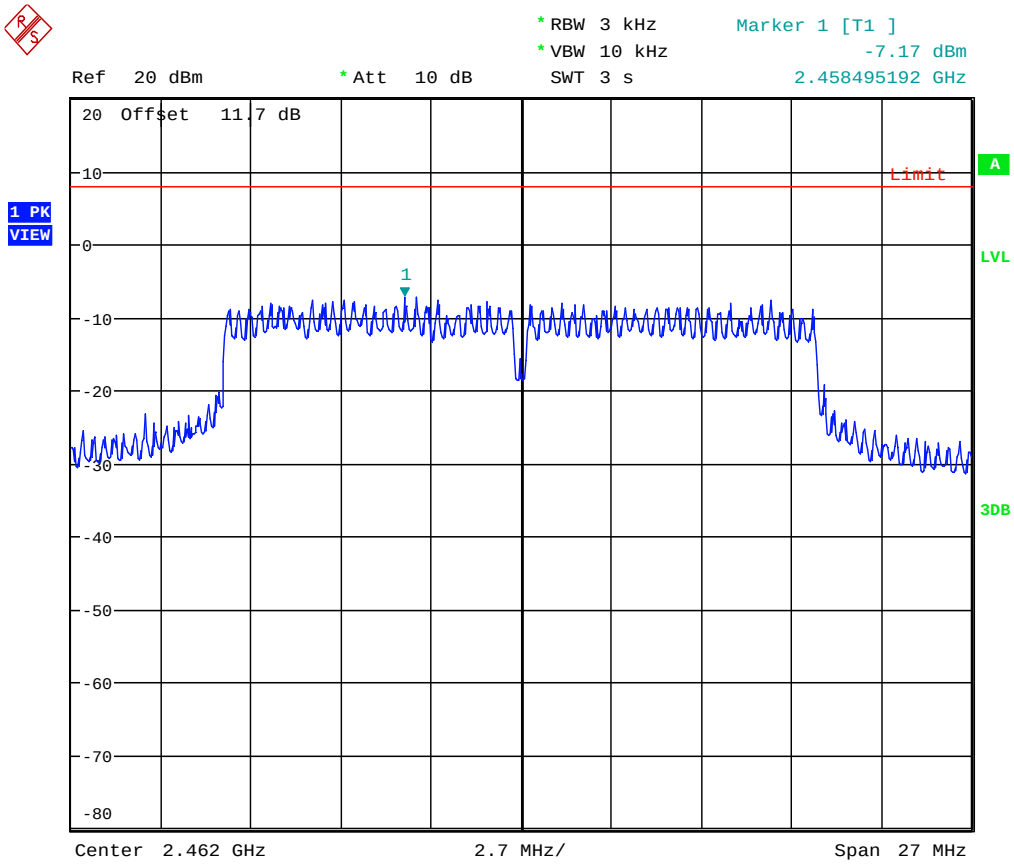
Plot 5.6.4.2. Power Spectral Density, BPSK Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 14:17:31

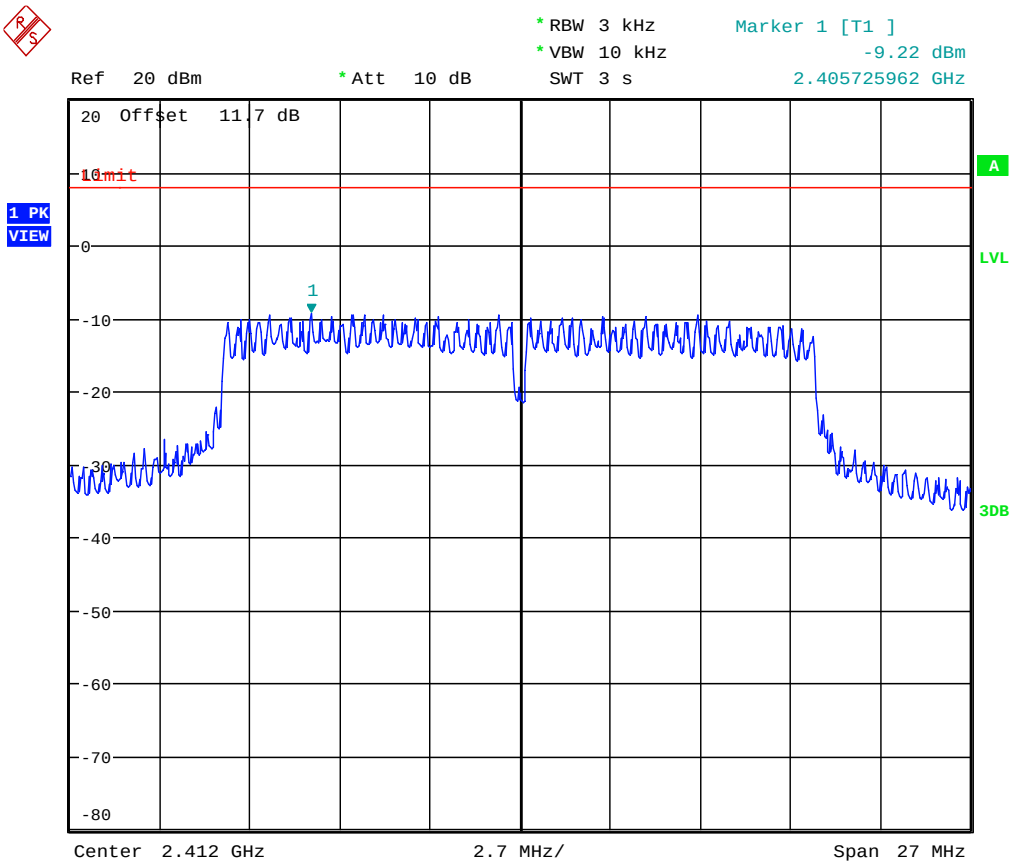
Plot 5.6.4.3. Power Spectral Density, BPSK Modulation, Channel #11, 2462 MHz



Ultratech Labs

Date: 5.SEP.2014 14:29:29

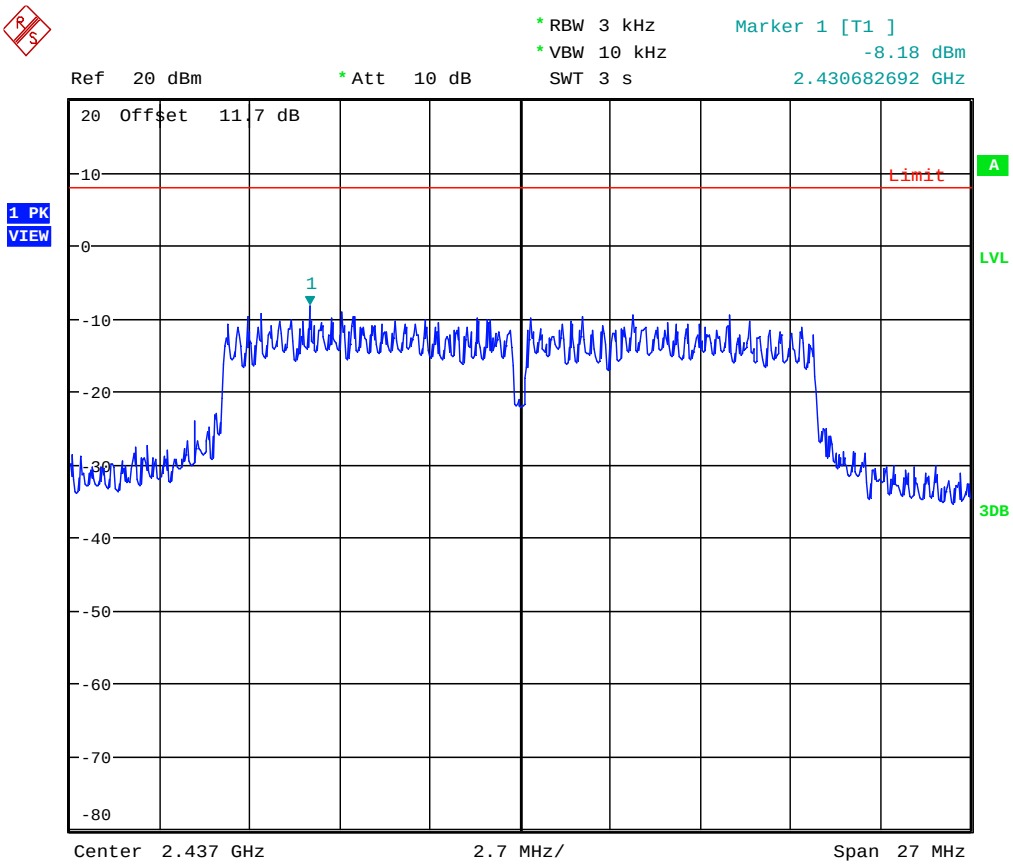
Plot 5.6.4.4. Power Spectral Density, QPSK Modulation, Channel #1, 2412 MHz



Ultratech Labs

Date: 5.SEP.2014 14:41:25

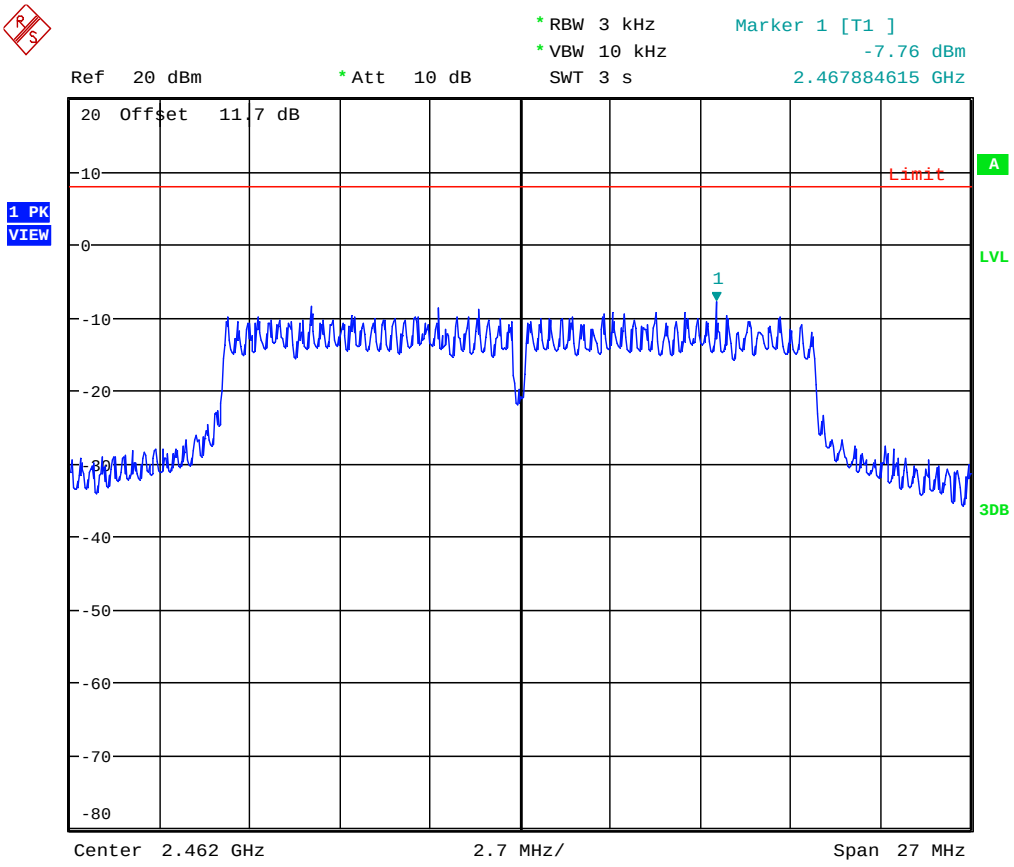
Plot 5.6.4.5. Power Spectral Density, QPSK Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 14:37:17

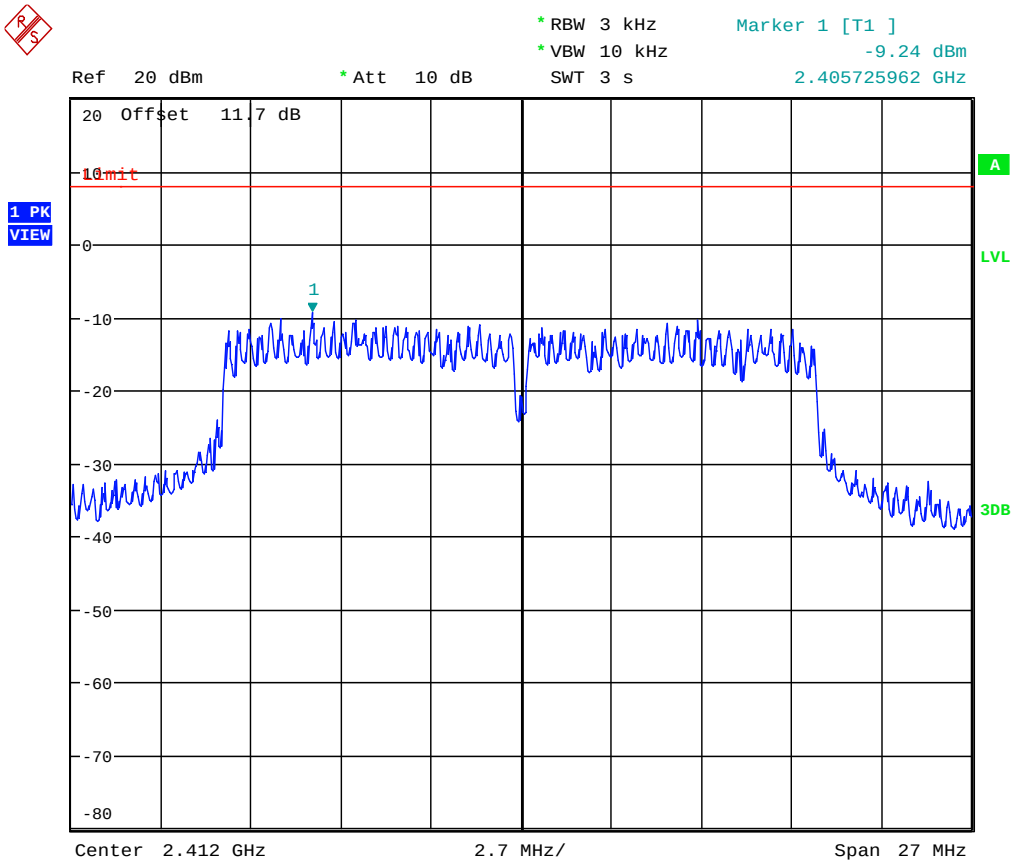
Plot 5.6.4.6. Power Spectral Density, QPSK Modulation, Channel #11, 2462 MHz



Ultratech Labs

Date: 5.SEP.2014 14:34:34

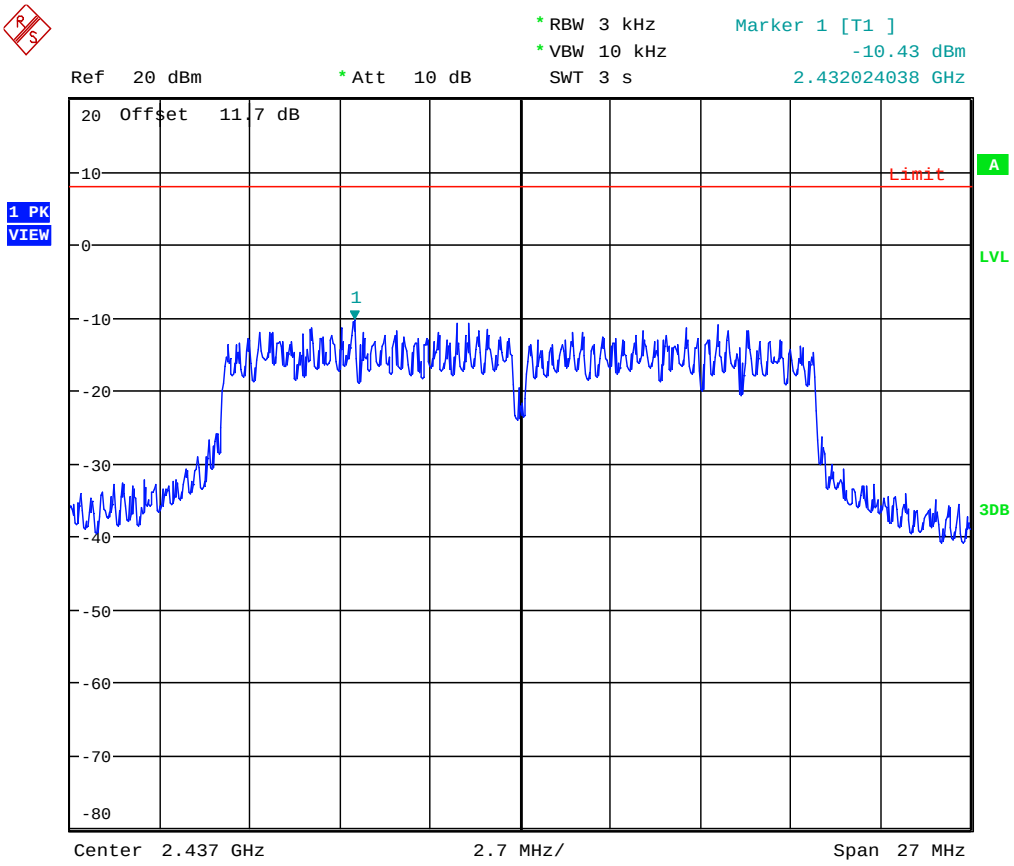
Plot 5.6.4.7. Power Spectral Density, 16-QAM Modulation, Channel #1, 2412 MHz



Ultratech Labs

Date: 5.SEP.2014 14:46:03

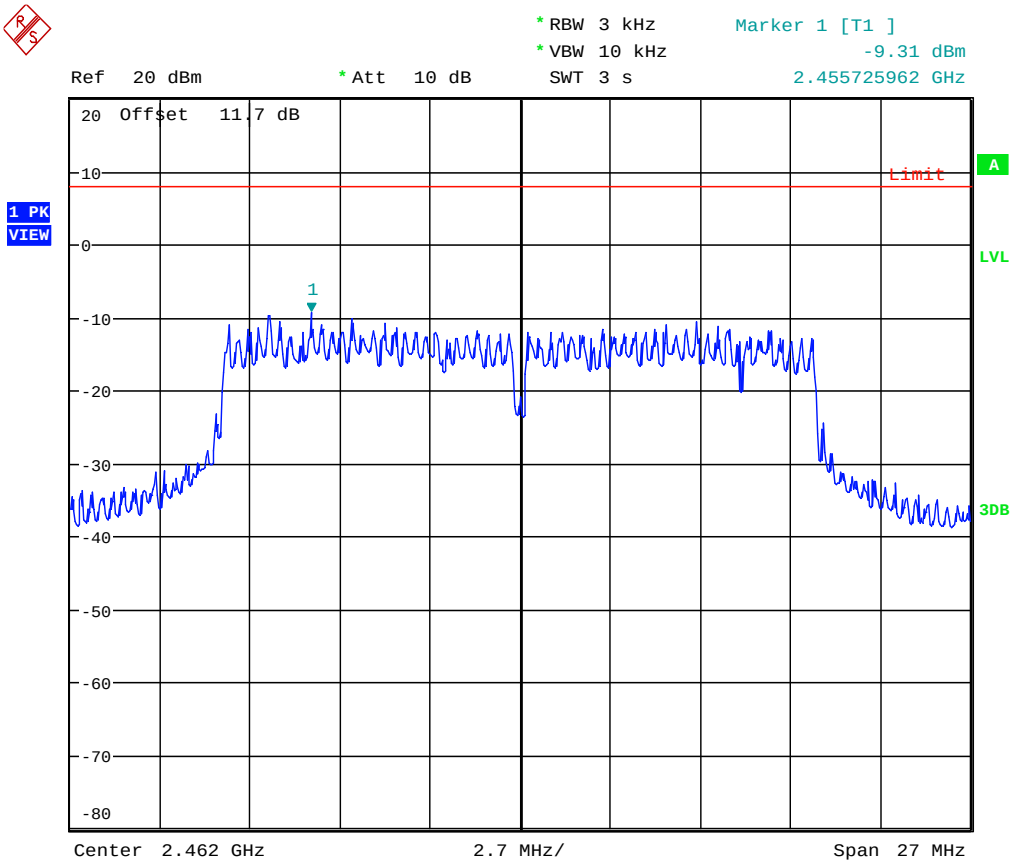
Plot 5.6.4.8. Power Spectral Density, 16-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 14:47:53

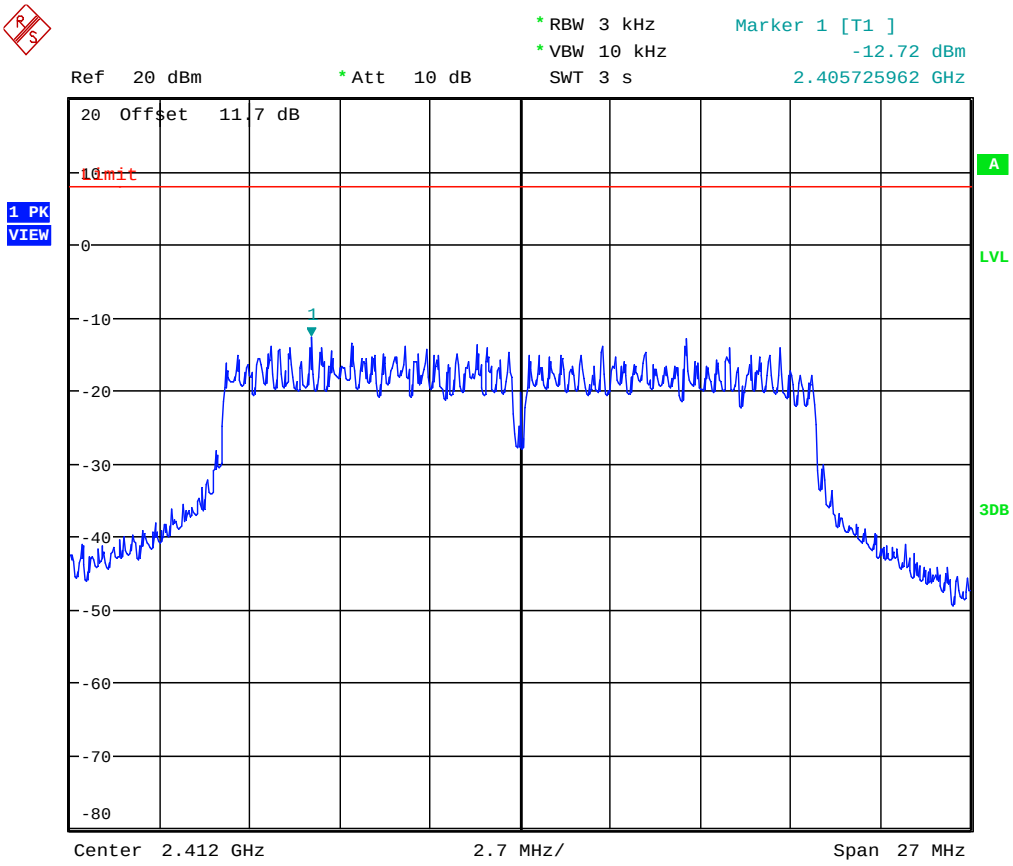
Plot 5.6.4.9. Power Spectral Density, 16-QAM Modulation, Channel #11, 2462 MHz



Ultratech Labs

Date: 5.SEP.2014 14:52:07

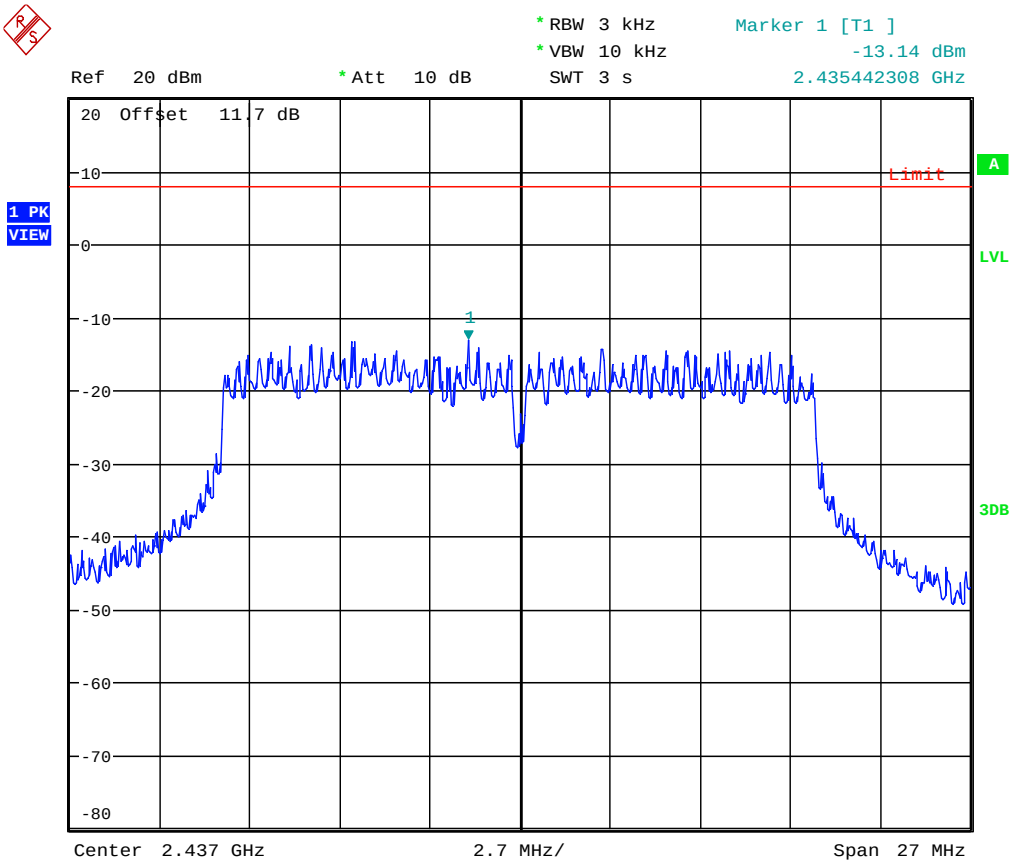
Plot 5.6.4.10. Power Spectral Density, 64-QAM Modulation, Channel #1, 2412 MHz



Ultratech Labs

Date: 5.SEP.2014 15:03:12

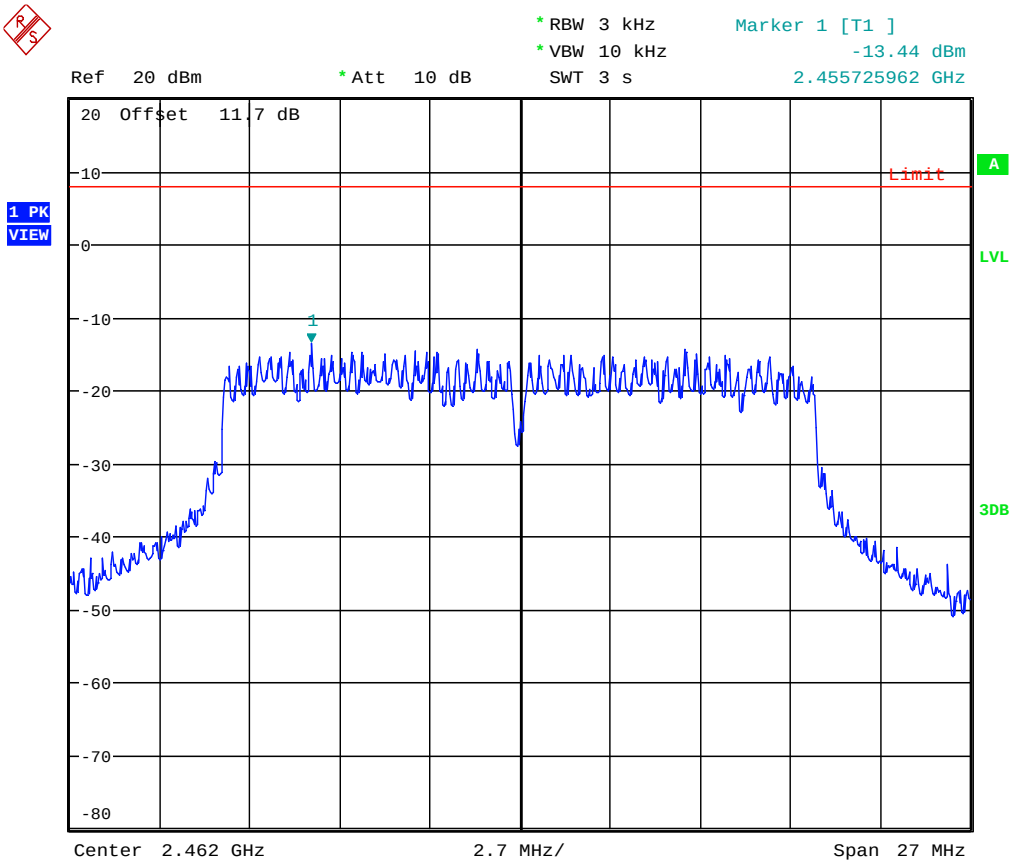
Plot 5.6.4.11. Power Spectral Density, 64-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 14:58:06

Plot 5.6.4.12. Power Spectral Density, 64-QAM Modulation, Channel #11, 2462 MHz

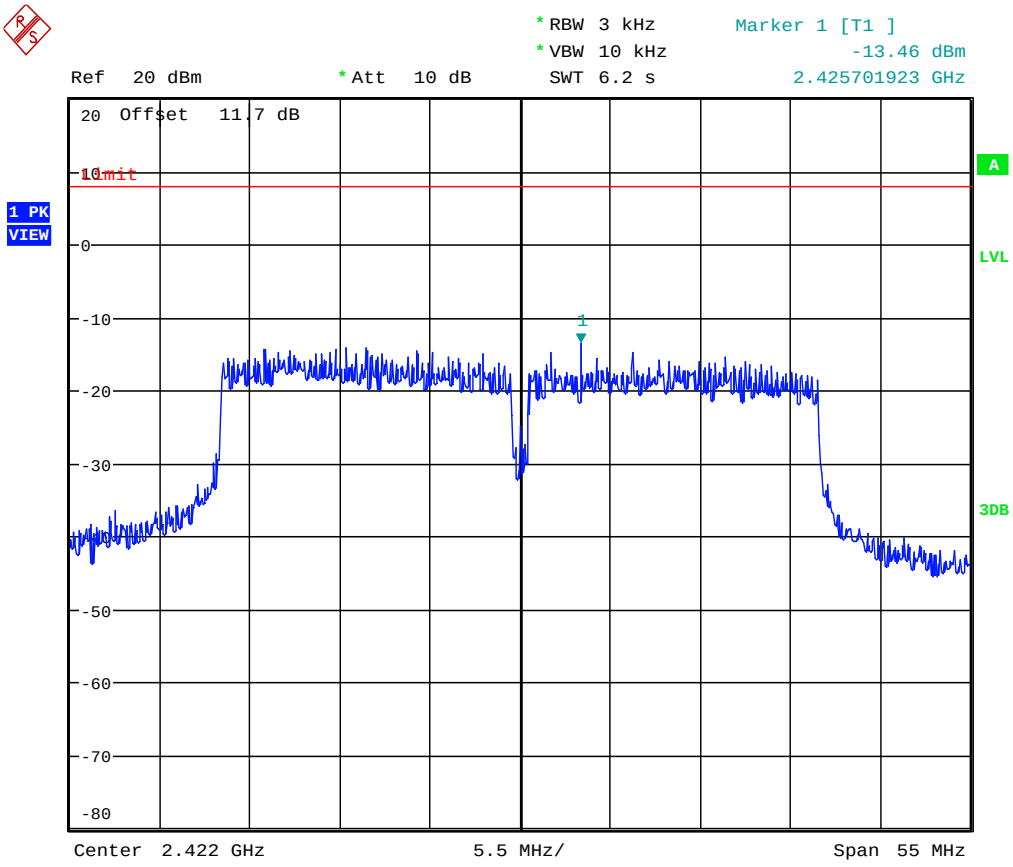


Ultratech Labs

Date: 5.SEP.2014 14:55:24

(b) 40 MHz Channel Spacing Mode:

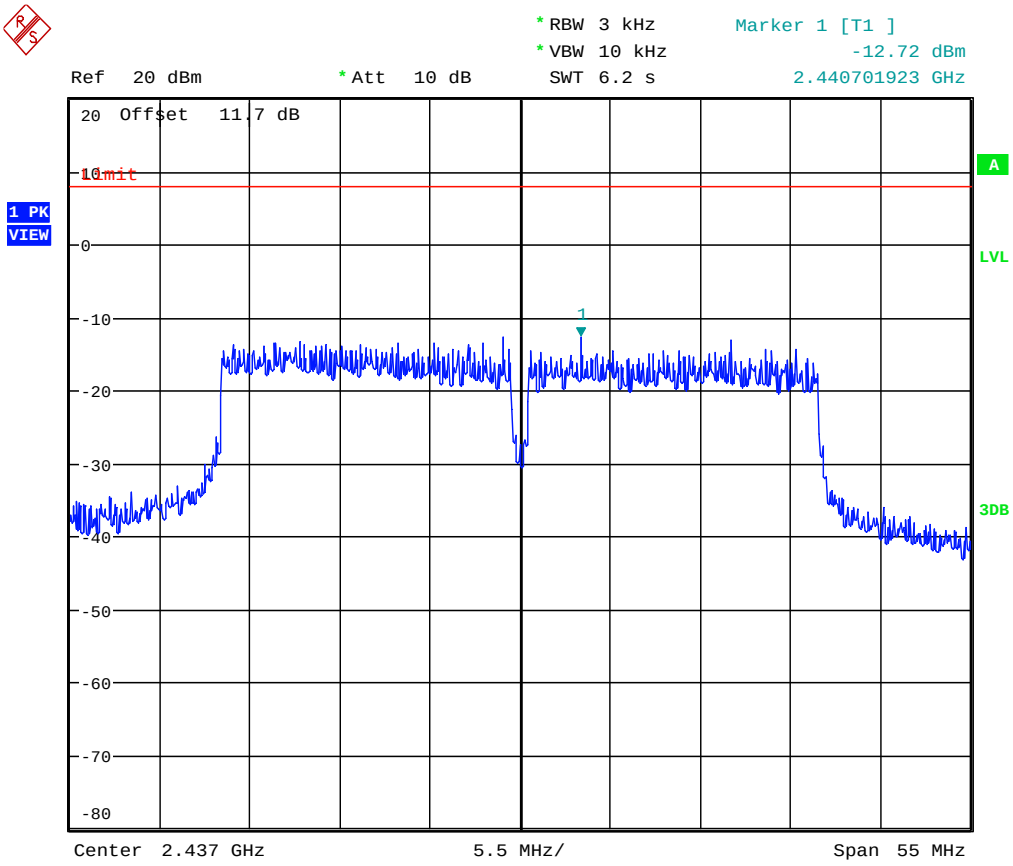
Plot 5.6.4.13. Power Spectral Density, BPSK Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 5.SEP.2014 15:08:01

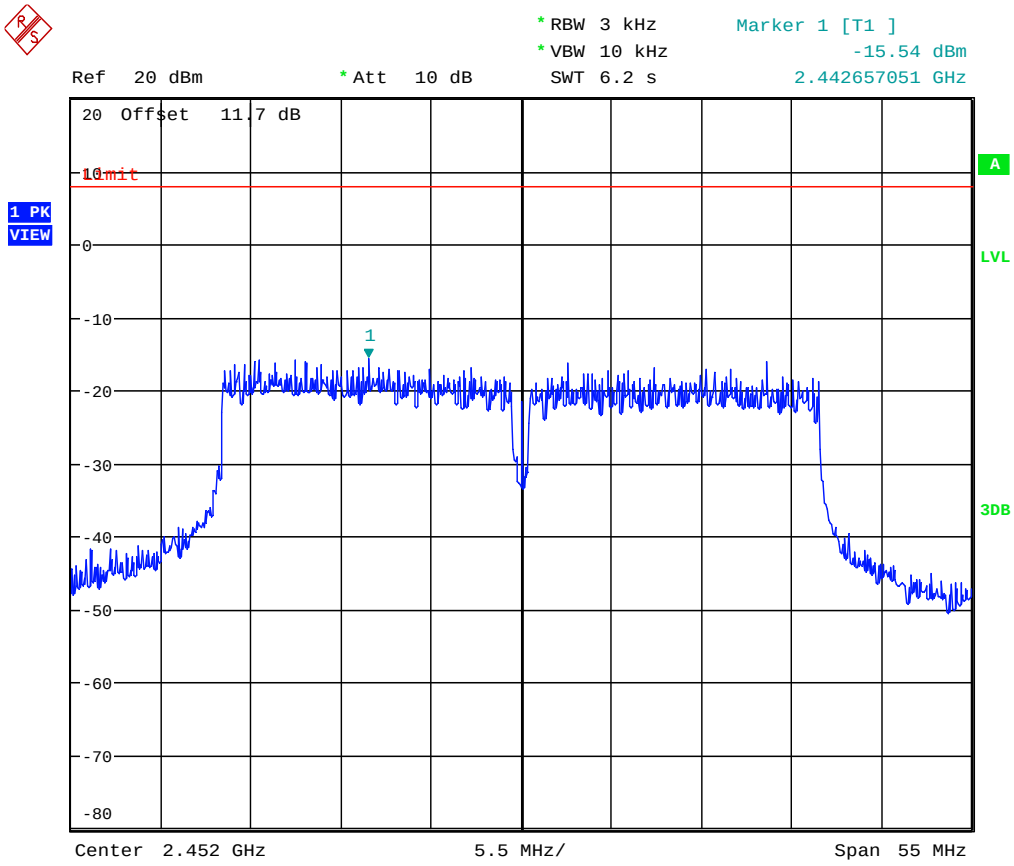
Plot 5.6.4.14. Power Spectral Density, BPSK Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 15:12:12

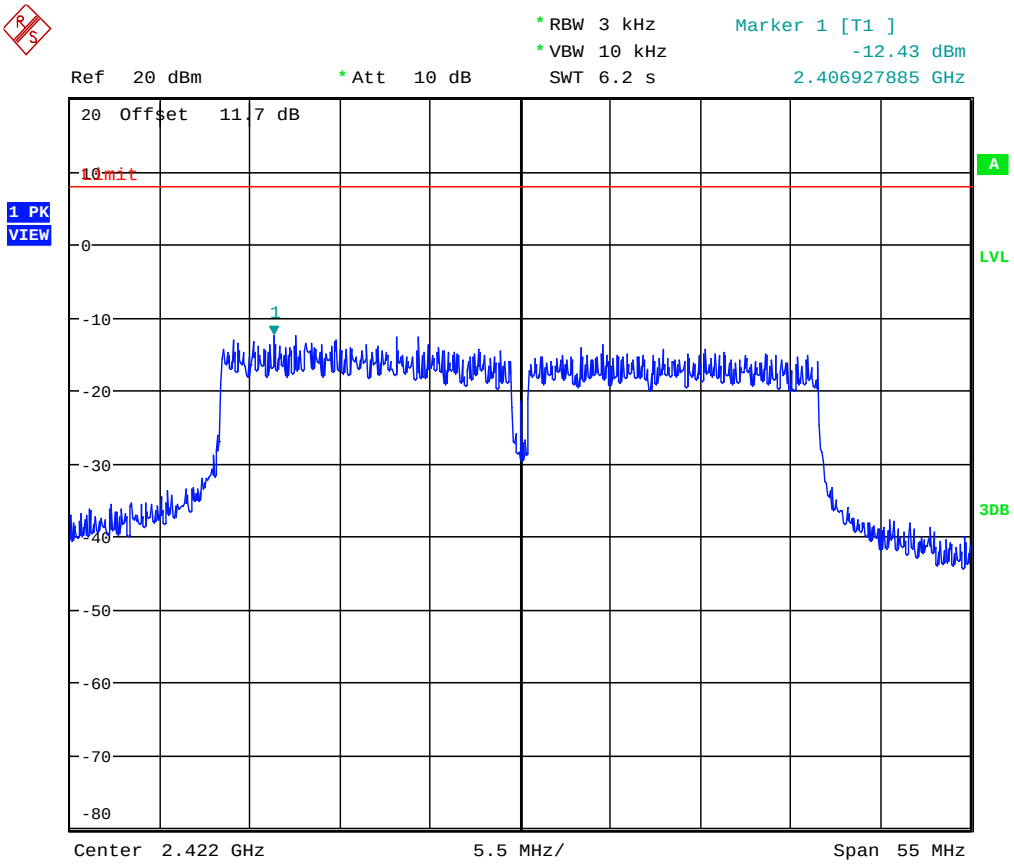
Plot 5.6.4.15. Power Spectral Density, BPSK Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 5.SEP.2014 15:29:57

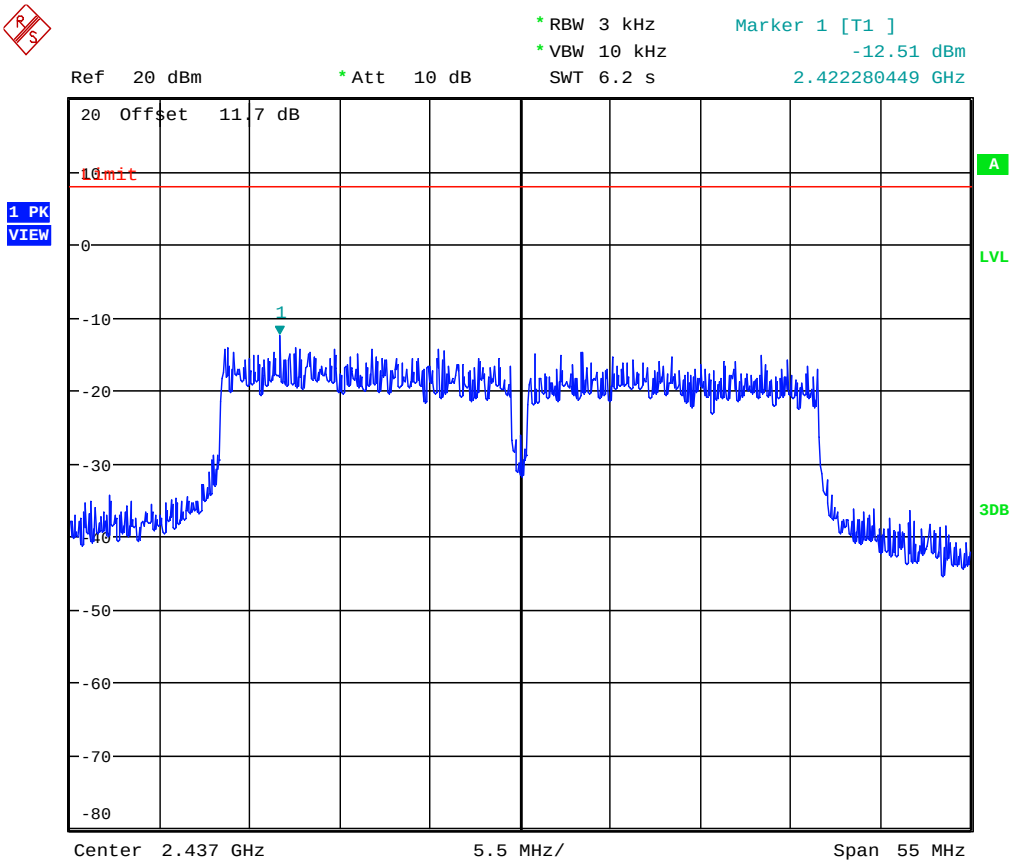
Plot 5.6.4.16. Power Spectral Density, QPSK Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 5.SEP.2014 16:15:23

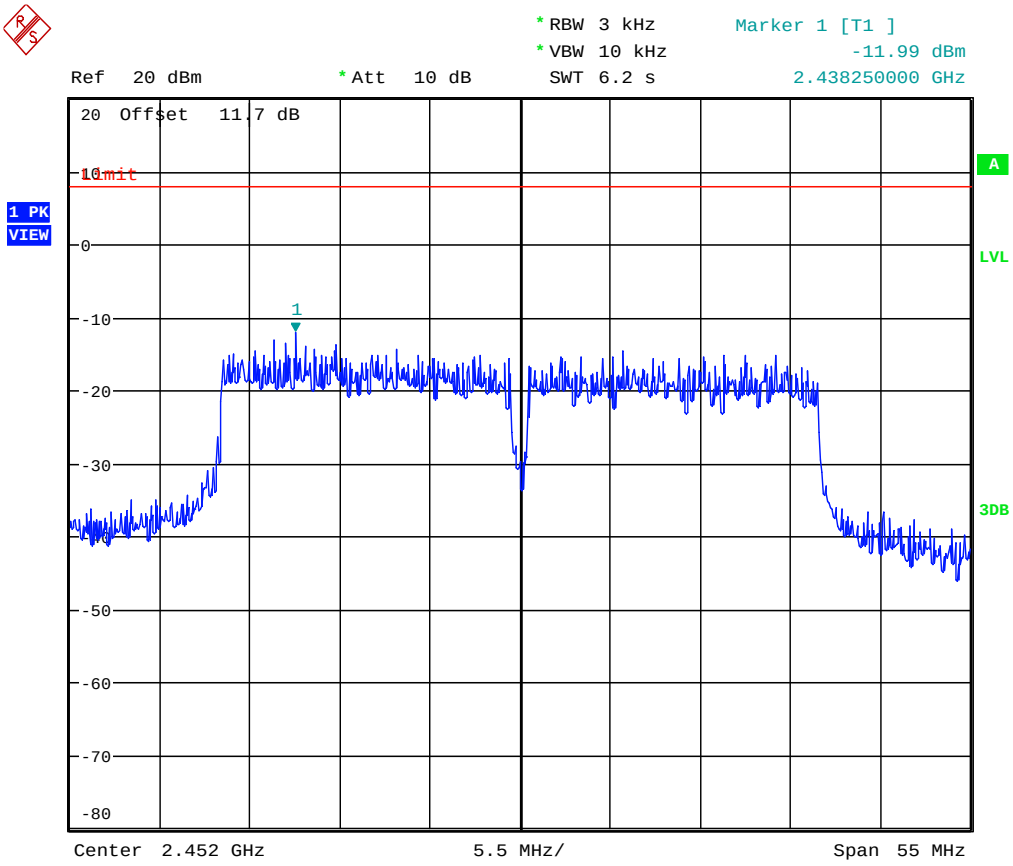
Plot 5.6.4.17. Power Spectral Density, QPSK Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 15:34:44

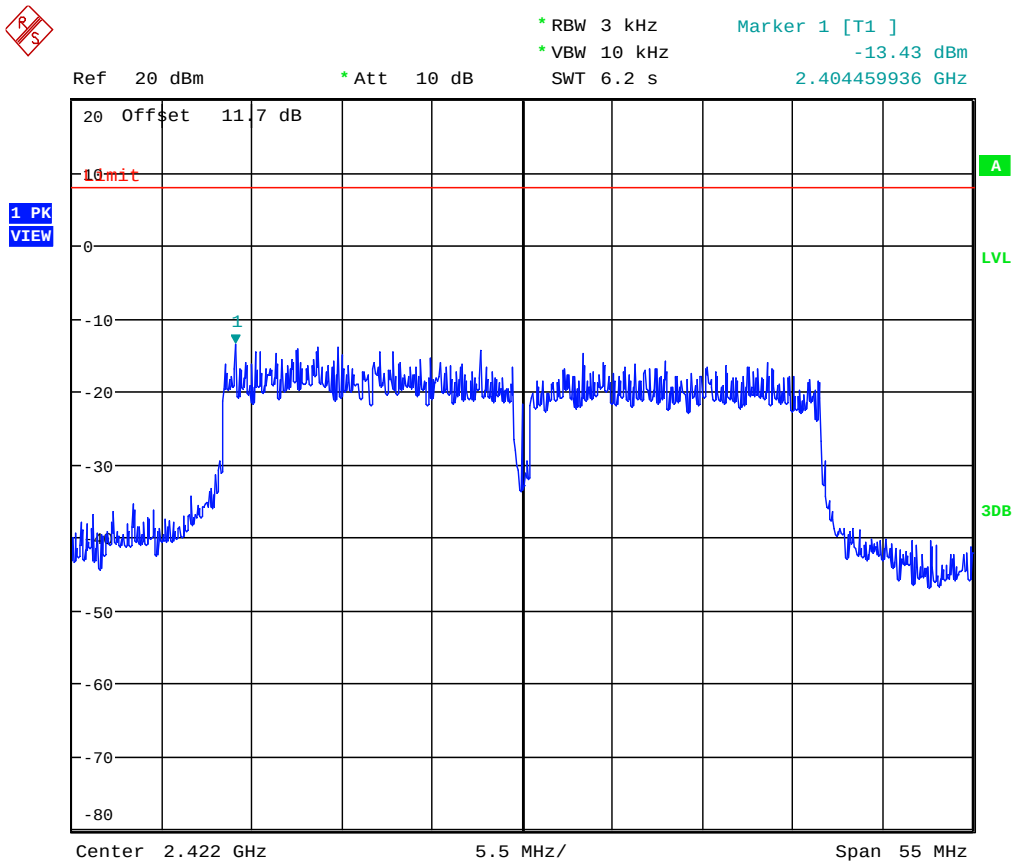
Plot 5.6.4.18. Power Spectral Density, QPSK Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 5.SEP.2014 15:32:40

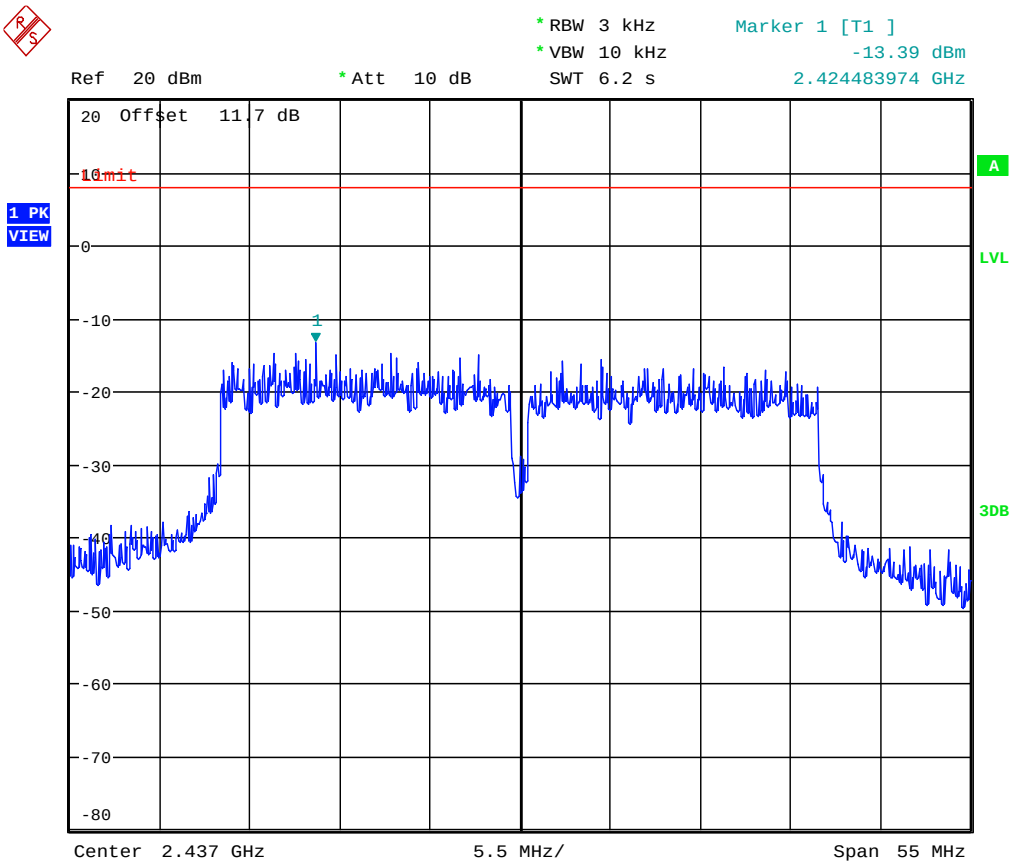
Plot 5.6.4.19. Power Spectral Density, 16-QAM Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 5.SEP.2014 16:18:16

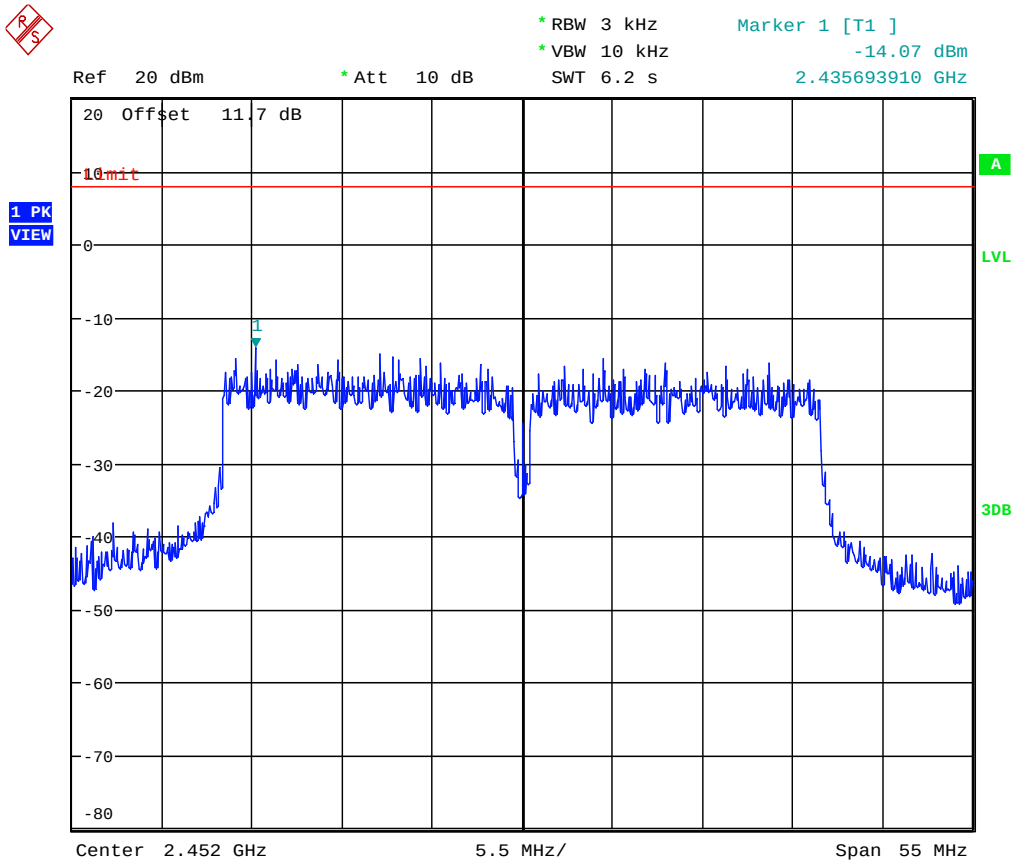
Plot 5.6.4.20. Power Spectral Density, 16-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 16:20:57

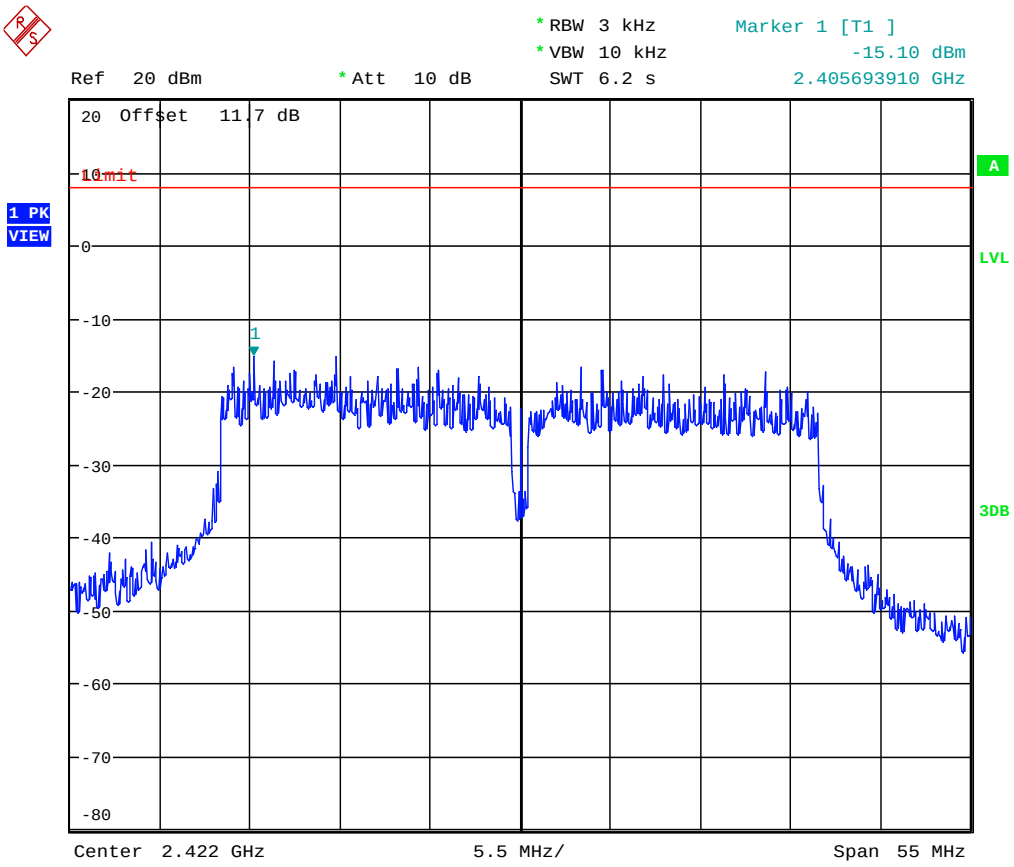
Plot 5.6.4.21. Power Spectral Density, 16-QAM Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 5.SEP.2014 16:23:13

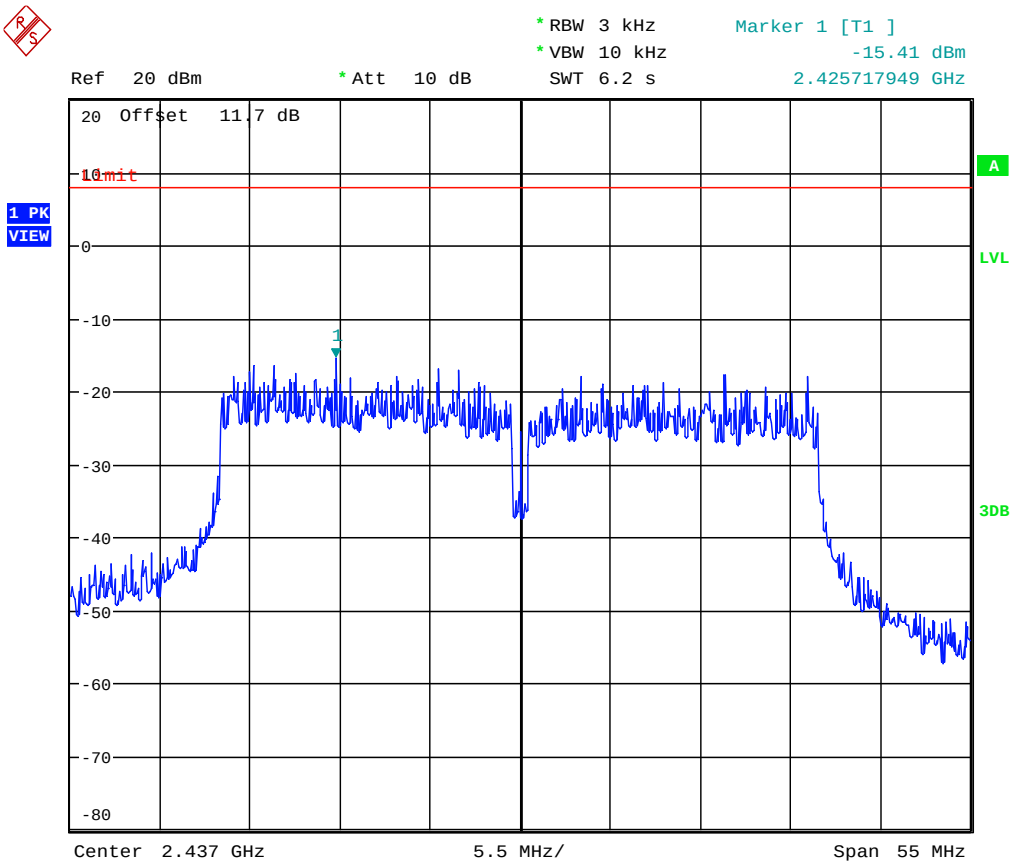
Plot 5.6.4.22. Power Spectral Density, 64-QAM Modulation, Channel #3, 2422 MHz



Ultratech Labs

Date: 5.SEP.2014 16:34:26

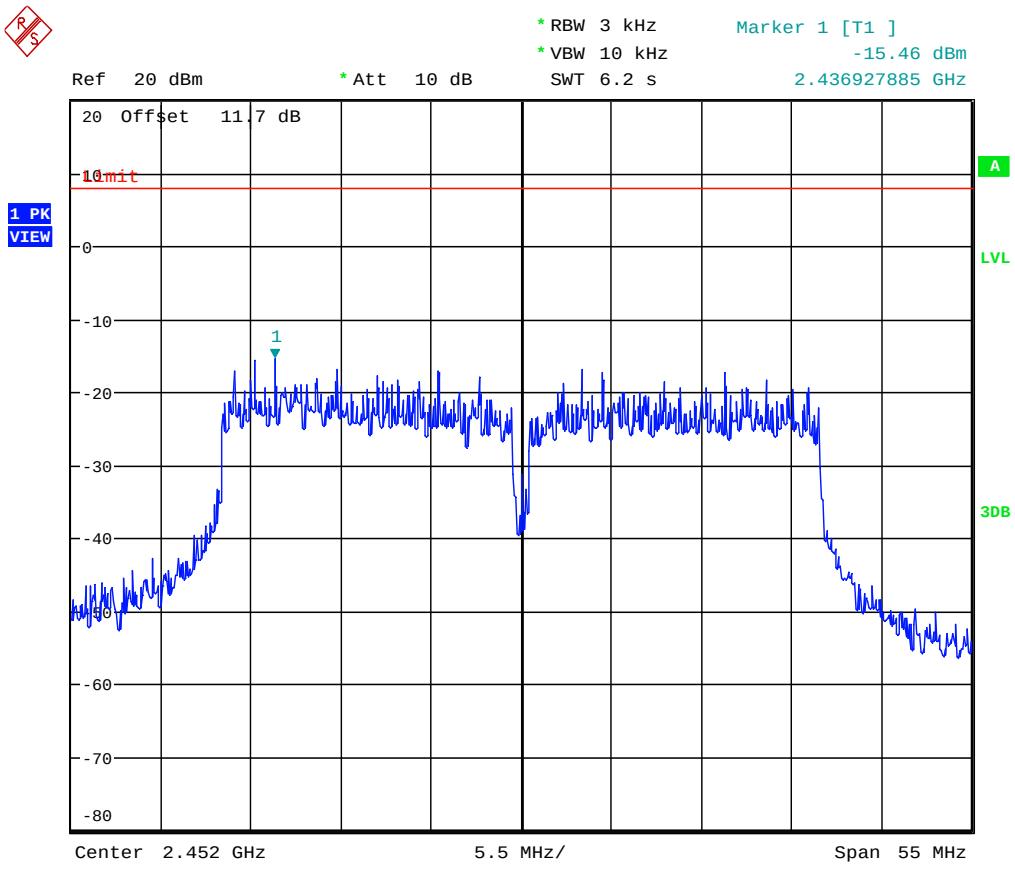
Plot 5.6.4.23. Power Spectral Density, 64-QAM Modulation, Channel #6, 2437 MHz



Ultratech Labs

Date: 5.SEP.2014 16:32:14

Plot 5.6.4.24. Power Spectral Density, 64-QAM Modulation, Channel #9, 2452 MHz



Ultratech Labs

Date: 5.SEP.2014 16:30:20

5.7. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091]

The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation.

FCC 47 CFR § 1.1310:

TABLE 1—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 TO TABLE 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 TO TABLE 1: 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.

5.7.1. Method of Measurements

Refer to Sections 1.1310, 2.1091

In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

(1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
(2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
(3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
(4) Any other RF exposure related issues that may affect MPE compliance

Calculation Method of RF Safety Distance:

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

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

5.7.2. RF Evaluation

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
Minimum calculated separation distance between antenna and persons required: **3.6 cm**	Manufacturer' instruction for separation distance between antenna and persons required: **20 cm**
Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement	Antenna installation and device operating instructions shall be provided to installers to maintain and ensure compliance with RF exposure requirements.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Refer to user's manual for RF exposure Information.
Any other RF exposure related issues that may affect MPE compliance	None

*The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

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

S = 1.0 mW/cm^2
EIRP = 22.1 dBm = $10^{(22.1/10)}$ mW = 162.2 mW (Worst Case)

(Minimum Safe Distance, r) = $\sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}} = \sqrt{\frac{162.2}{4 \cdot \pi \cdot (1.0)}} \approx 3.6cm$

EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Agilent	E7401A	US40240432	9 kHz–1.5 GHz	14 Mar 2015
Attenuator	Pasternack	PE7010-20	-	DC–2 GHz	02 Jan 2015
L.I.S.N	EMCO	3825/2R	1165	0.01 -30 MHz	05 Nov 2014
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	14 Jul 2015
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	19 Jun 2015
Attenuator	Pasternack	7024-20	6	DC–26.5 GHz	Cal on use
DC Block	Hewlett Packard	11742A	12460	0.045–26.5 GHz	Cal on use
DC Power Supply	Tenma	72-7295	490300270	1 – 40 Vdc	Cal on use
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2400 MHz	Cal on use
Band Reject Filter	Micro-Tronics	BRM50701	105	Cut off 2.4-2.483 GHz	Cal on use
Spectrum Analyzer	Rohde & Schwarz	ESU40	100037	20Hz–40 GHz	05 Apr 2015
RF Amplifier	AH System	PAM-0118	225	0.02 – 18 GHz	07 Apr 2015
Biconi-Log Antenna	EMCO	3142C	26873	0.026 – 3 GHz	14 Apr 2015
Horn Antenna	Emco	3155	5955	1 -18 GHz	26 Mar 2015
Horn Antenna	ETS Lindgren	3160-09	118385	18 -26.5 GHz	04 Aug 2016
Attenuator	Pasternack	7024-10	4	DC–26.5 GHz	Cal on use
Signal Generator	Hewlett Packard	8648C	3443U00391	0.1 – 3.2 GHz	11 Feb 2015

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:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 1.44**	**± 1.8**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 2.89**	**± 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:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 2.39**	**± 2.6**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 4.79**	**± 5.2**

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

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