ENGINEERING TEST REPORT

XBEE S2C TH
Model: S2CTH
FCC ID: MCQ-S2CTH

Applicant:

Digi International Inc.
11001 Bren Road East
Minnetonka, MN 55343

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.: DIGI-086F15C247R01

This Test report is Issued under the Authority of Tri M. Luu Vice President of Engineering UltraTech Group of Labs Date: May 22, 2014	
Report Prepared by: Dan Huynh Issued Date: May 22, 2014	Tested by: Hung Trinh Test Dates: March 17 – 24 & May 22, 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.*

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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:	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 v03r01
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, 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 v03r01	2013	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

Applicant	
Name:	Digi International Inc.
Address:	11001 Bren Road East Minnetonka, MN 55343 USA
Contact Person:	Paul Dahl Phone #: 801-765-9885 Fax #: 801-765-9895 Email Address: paul.dahl@digi.com

Manufacturer	
Name:	Digi International Inc.
Address:	10000 W 76th St. Eden Prairie, MN 55344 USA
Contact Person:	John Nyland Phone #: 952-912-4721 Fax #: n/a Email Address: john.nyland@digi.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:	Digi International Inc.
Product Name:	XBEE S2C TH
Model Name or Number:	S2CTH
Serial Number:	Test Sample
Type of Equipment:	Digital Transmission System (DTS)
Input Power Supply Type:	External DC Power Supply
Primary User Functions of EUT:	802.15.212 connectivity of embedded systems Zigbee

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:	2.1 - 3.6 VDC
RF Output Power Rating:	-26 dBm to +8 dBm
Operating Frequency Range:	2405 – 2480MHz
RF Output Impedance:	50 Ω
Channel Spacing:	5 MHz
Duty Cycle:	100%
Modulation Type:	QPSK
Oscillator Frequency(ies):	24 MHz
Antenna Connector Types:	Integral antenna, RPSMA or U.FL

2.4. ASSOCIATED ANTENNA DESCRIPTIONS

Antenna Type	Maximum Gain (dBi)
Omni-directional antenna	15
Yagi antenna	15.0
Panel antenna	19.0
Dipole antenna	2.1
Integral antenna	1.5

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	Integral antenna, RPSMA or 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:	Digi International
Model Name or Number:	N/A
Serial Number:	N/A
Connected to EUT's Port:	Module pin signals

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:	3.6 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:	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 is 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):	2405 – 2480 MHz
Frequency(ies) Tested:	2405, 2440, 2475 and 2480 MHz
RF Power Output: (measured maximum output power at antenna terminals)	7.66 dBm (5.834 mW) Peak
Normal Test Modulation:	QPSK
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:

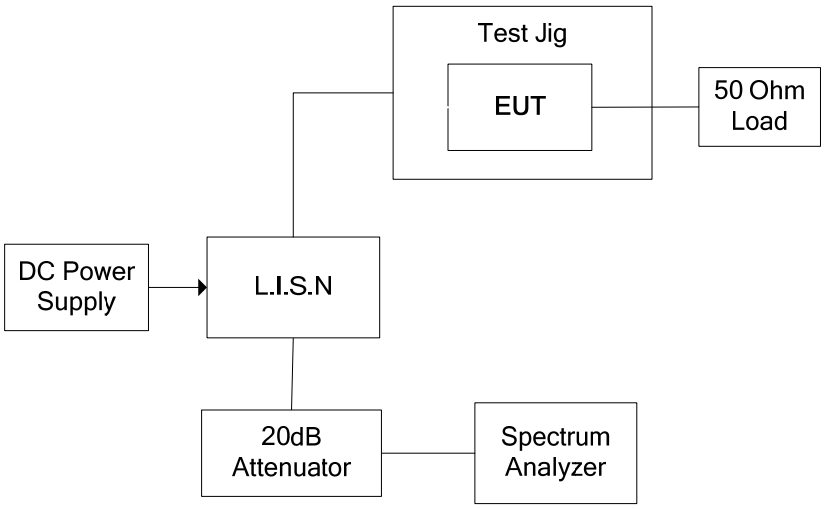
Frequency of emission (MHz)	Conducted Limits (dBμV)	
	Quasi-peak	Average
0.15–0.5 .....……..	66 to 56*	56 to 46*
0.5–5 .....……..	56	46
5-30 ……..	60 ...……..	50

*Decreases linearly with the logarithm of the frequency

5.1.2. Method of Measurements

ANSI C63.4-2009

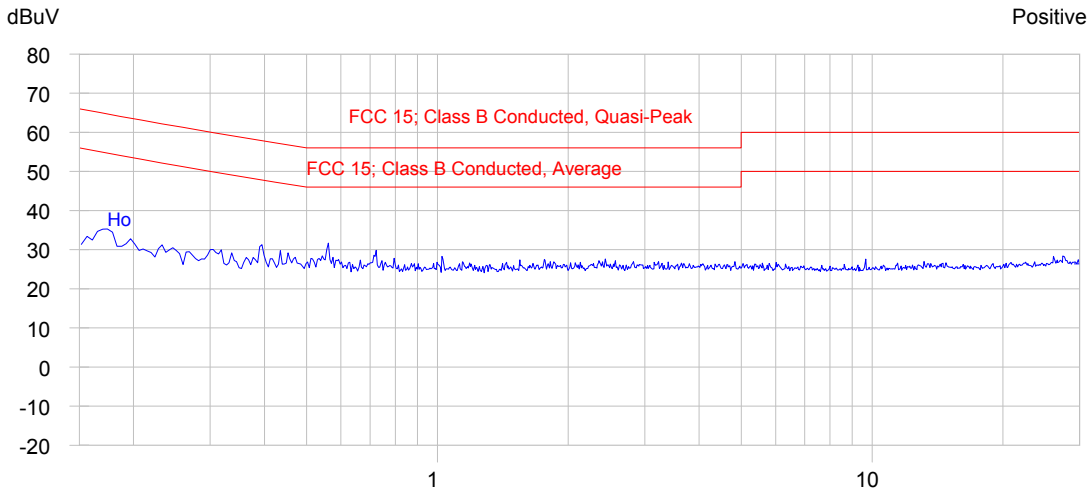
5.1.3. Test Arrangement



5.1.4. Test Data

Plot 5.1.4.1. Power Line Conducted Emissions; Line Voltage: 3.6 V DC; Line Tested: Positive

Current Graph

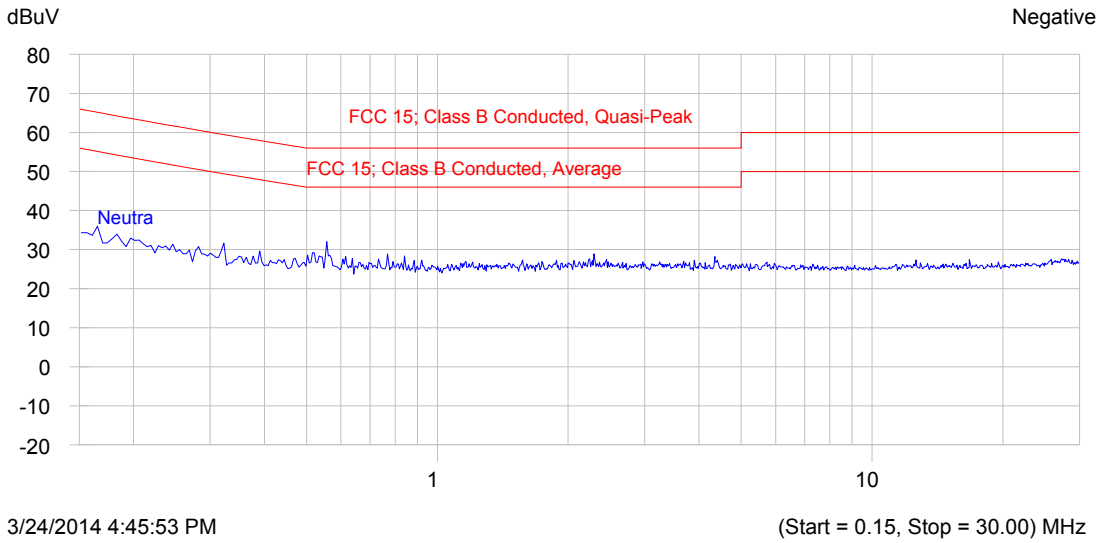


Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.166	41.7	36.4	-28.7	30.2	-24.9	Positive
0.556	41.8	37.7	-18.3	33.8	-12.2	Positive

Plot 5.1.4.2. Power Line Conducted Emissions; Line Voltage: 3.6 V DC; Line Tested: Negative

Current Graph



Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.172	40.3	36.7	-28.2	30.4	-24.5	Negative
0.558	41.1	37.8	-18.2	34.4	-11.6	Negative

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

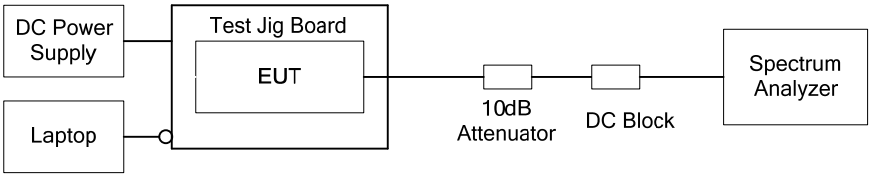
5.2.1. Limit(s)

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

5.2.2. Method of Measurements

KDB Publication No. 558074 D01 DTS Meas Guidance V03r01, Section 8.1 Option 1

5.2.3. Test Arrangement

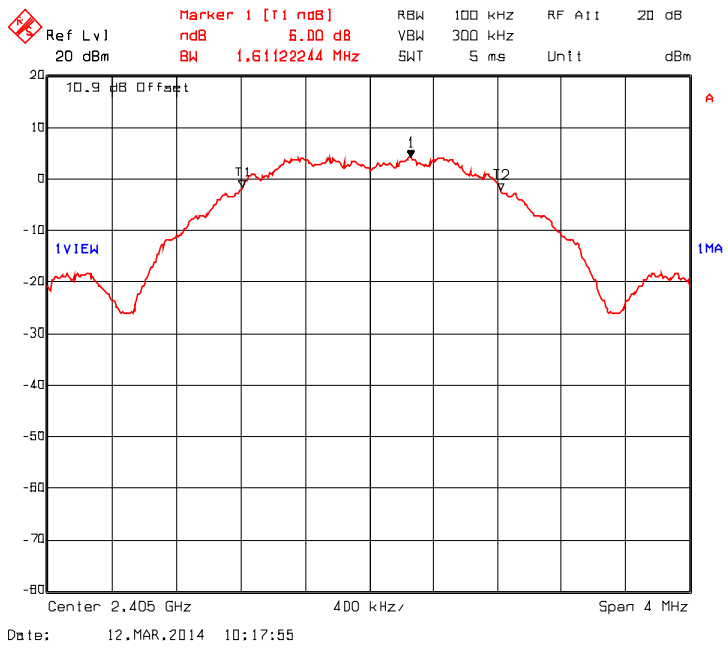


5.2.4. Test Data

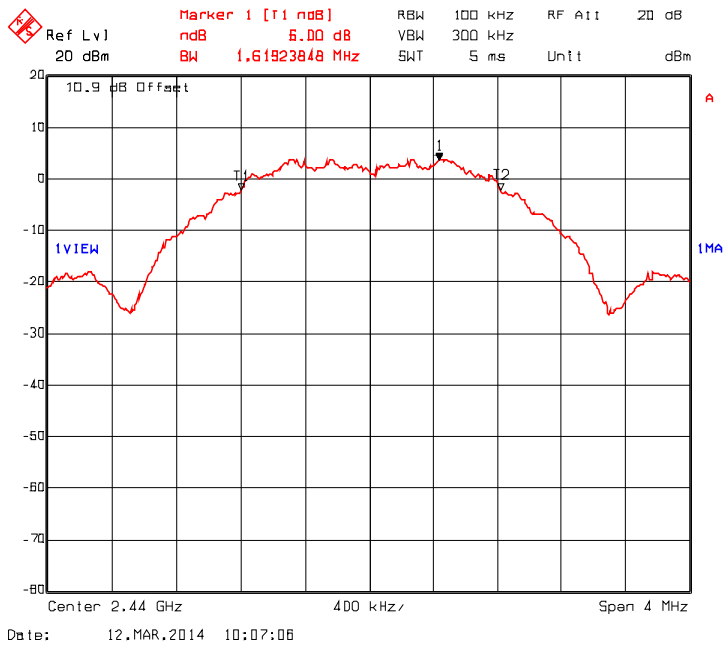
Operating Mode	Channel Number	Frequency (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
Power Setting 8 Mode 1	11	2405	1.61	2.40
	18	2440	1.62	2.44
	25	2475	1.59	2.40
	26	2480	1.60	2.38

See the following plots for detailed measurements.

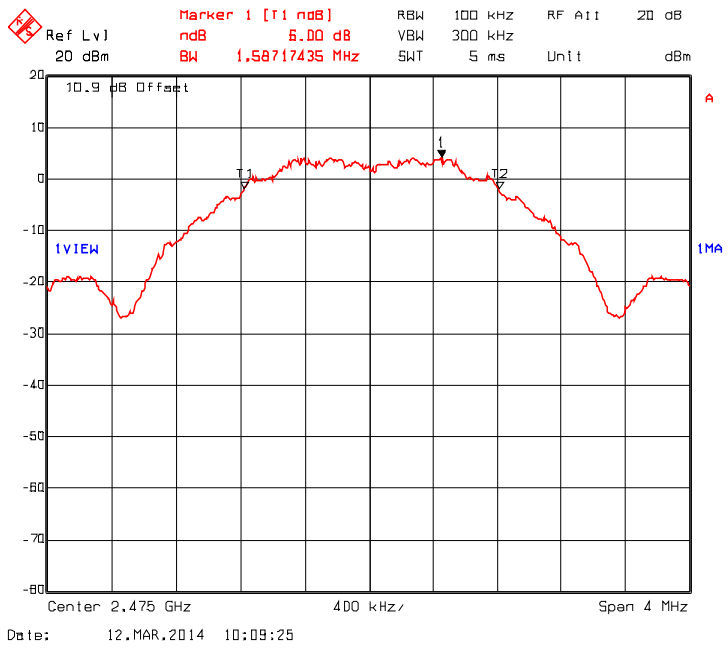
Plot 5.2.4.1. 6 dB Bandwidth, Channel 11, 2405 MHz, QPSK Modulation, Power Setting 8 Mode 1



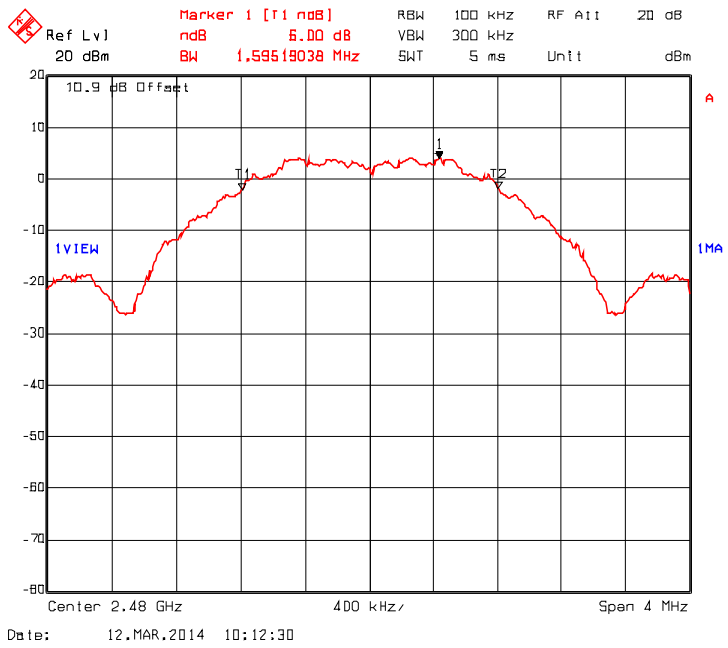
Plot 5.2.4.2. 6 dB Bandwidth, Channel 18, 2440 MHz, QPSK Modulation, Power Setting 8 Mode 1



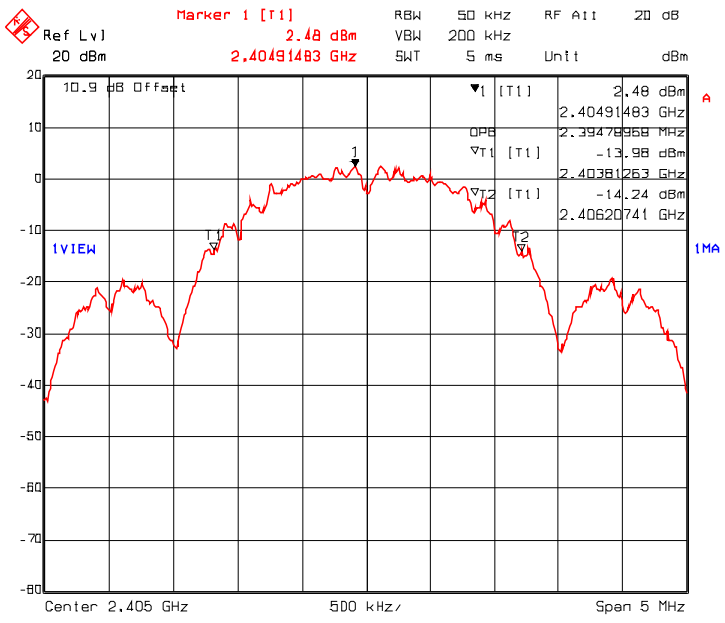
Plot 5.2.4.3. 6 dB Bandwidth, Channel 25, 2475 MHz, QPSK Modulation, Power Setting 8 Mode 1



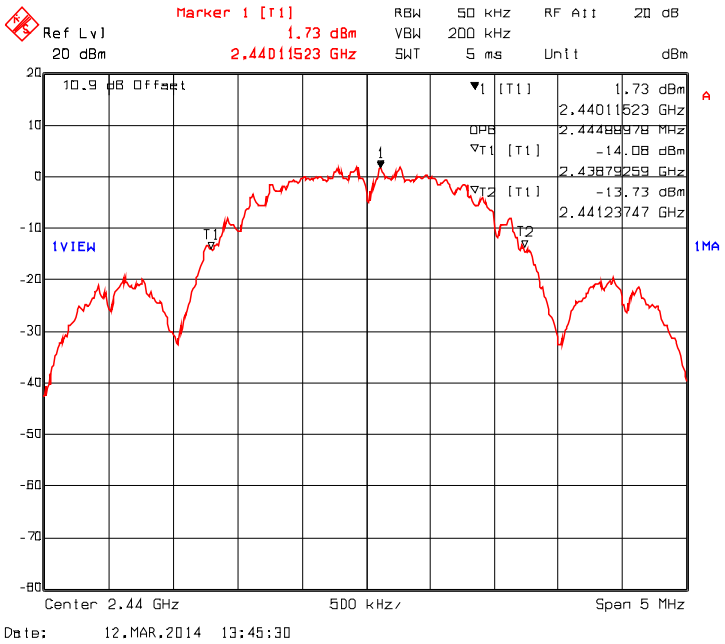
Plot 5.2.4.4. 6 dB Bandwidth, Channel 26, 2480 MHz, QPSK Modulation, Power Setting 8 Mode 1



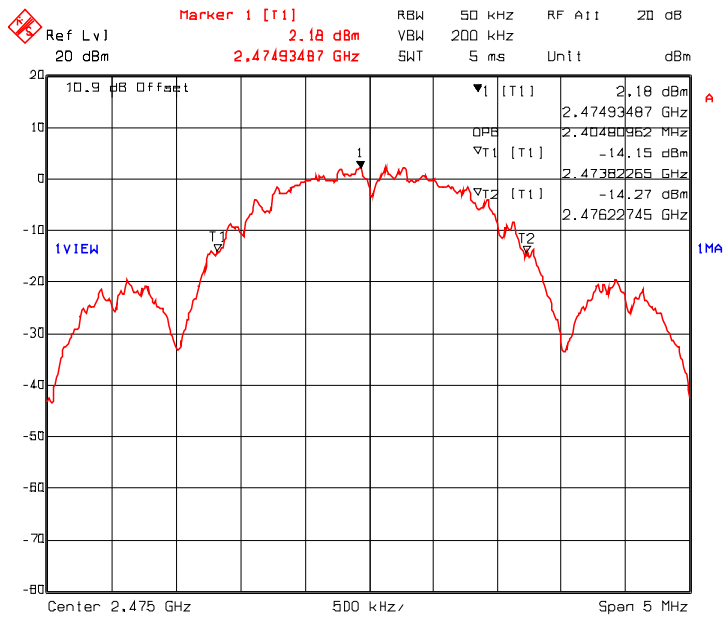
Plot 5.2.4.5. 99% Occupied Bandwidth, Channel 11, 2405 MHz, QPSK Modulation, Power Setting 8 Mode 1



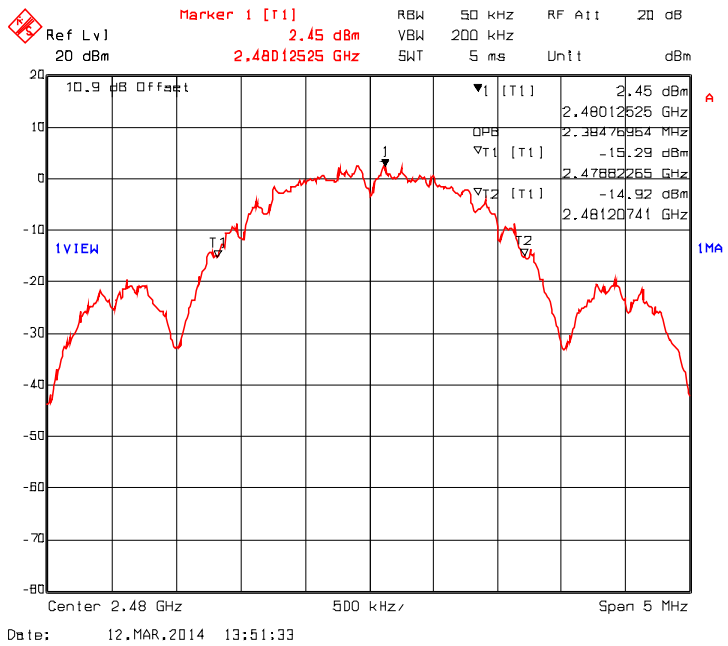
Plot 5.2.4.6. 99% Occupied Bandwidth, Channel 18, 2440 MHz, QPSK Modulation, Power Setting 8 Mode 1



Plot 5.2.4.7. 99% Occupied Bandwidth, Channel 25, 2475 MHz, QPSK Modulation, Power Setting 8 Mode 1



Plot 5.2.4.8. 99% Occupied Bandwidth, Channel 26, 2480 MHz, QPSK Modulation, Power Setting 8 Mode 1



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

5.3.1. Limit(s)

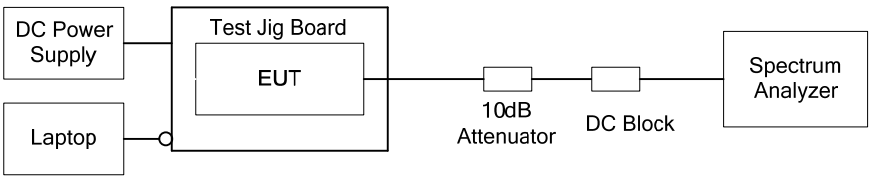
§ 15.247(b)(3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power 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 Publication No. 558074 D01 DTS Meas Guidance V03r01, Section 9.1.1 RBW ≥ DTS bandwidth

5.3.3. Test Arrangement



5.3.4. Test Data

Operating Mode	Modulation	Channel Number	Frequency (MHz)	Peak Conducted Power (dBm)	Peak Conducted Power Limit (dBm)	Margin (dBm)
Power Setting 8 Mode 1	QPSK	11	2405	7.66	30	-22.34
		18	2440	7.43	30	-22.57
		25	2475	7.52	30	-22.48
Power Setting 3 Mode 1	QPSK	26	2480	2.50	30	-27.50
Power Setting -26 Mode 0	QPSK	11	2405	-26.72	30	-56.72
		18	2440	-27.11	30	-57.11
		25	2475	-26.98	30	-56.98
		26	2480	-26.85	30	-56.85
Note: The EIRP shall not exceed 36 dBm for all proposed antennas.						

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

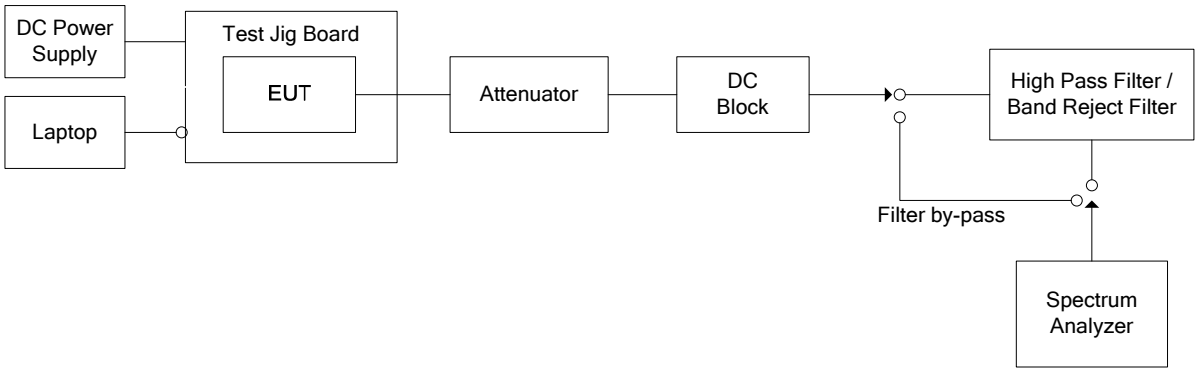
5.4.1. Limit(s)

§ 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 V03r01, Sections 11, 12 and 13.

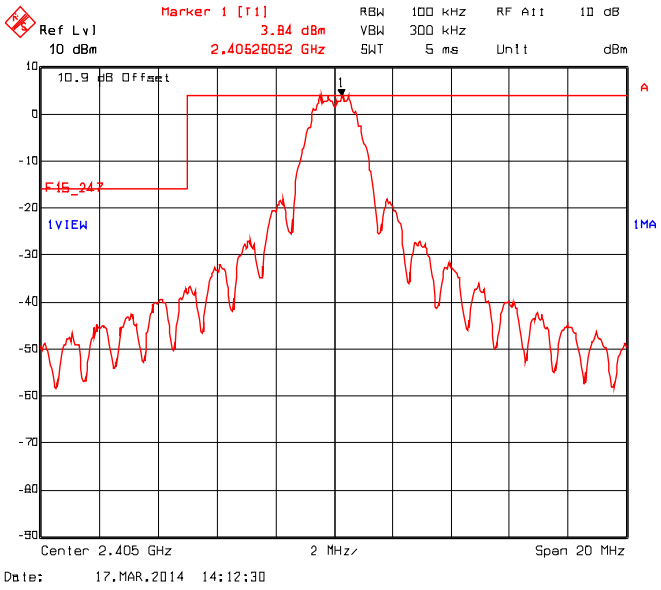
5.4.3. Test Arrangement



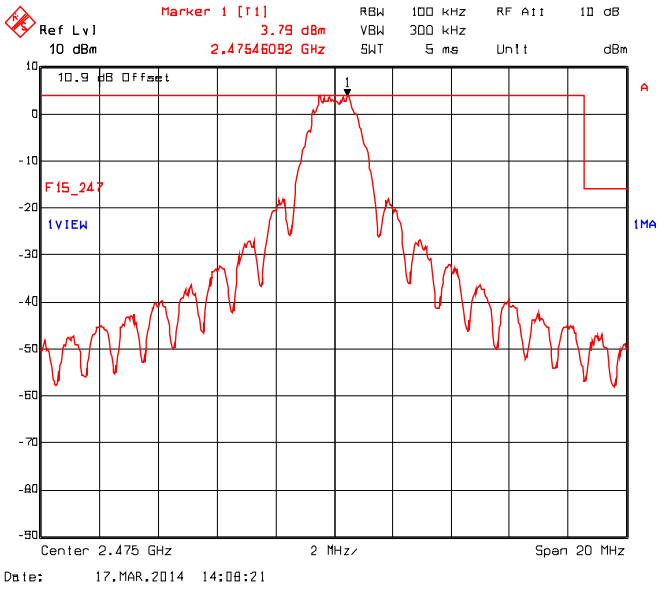
5.4.4. Test Data

5.4.4.1. Band-Edge RF Conducted Emissions

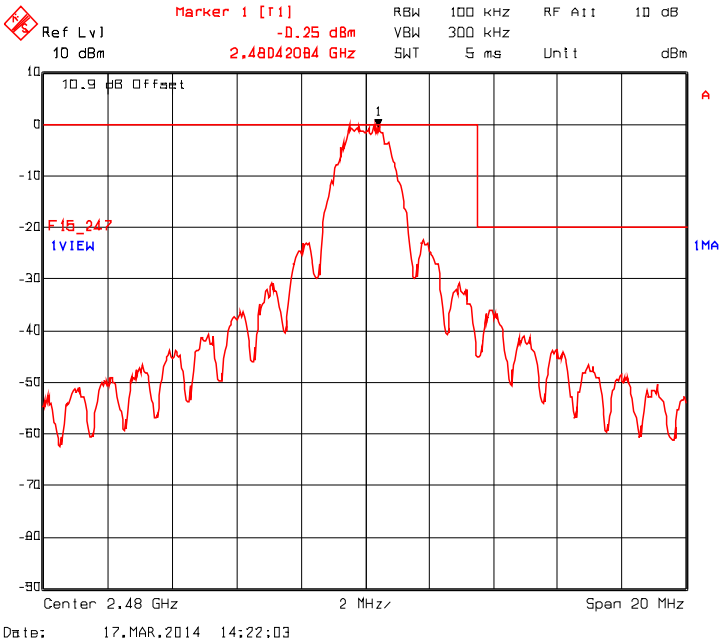
Plot 5.4.4.1.1. Band-Edge RF Conducted Emissions
Lower Band-edge, Channel 11, 2405 MHz, QPSK Modulation, Power Setting 8 Mode 1



Plot 5.4.4.1.2. Band-Edge RF Conducted Emissions
Higher Band-edge, Channel 25, 2475 MHz, QPSK Modulation, Power Setting 8 Mode 1

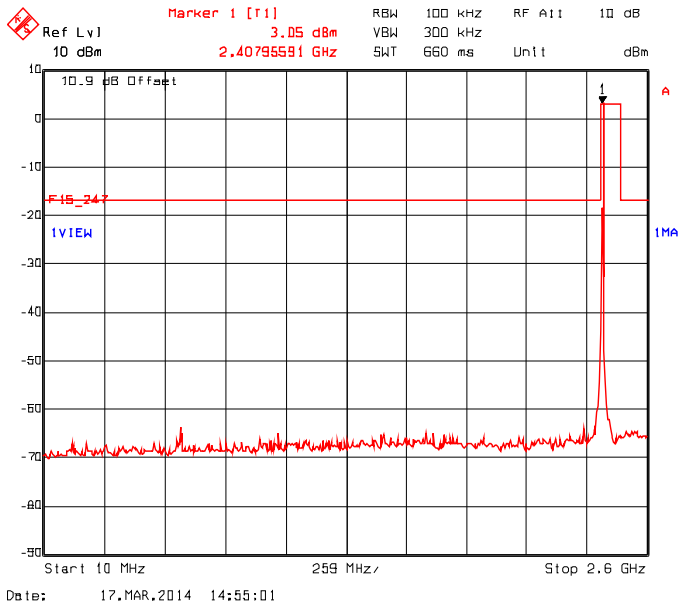


Plot 5.4.4.1.3. Band-Edge RF Conducted Emissions
Higher Band-edge, Channel 26, 2480 MHz, QPSK Modulation, Power Setting 3 Mode 1

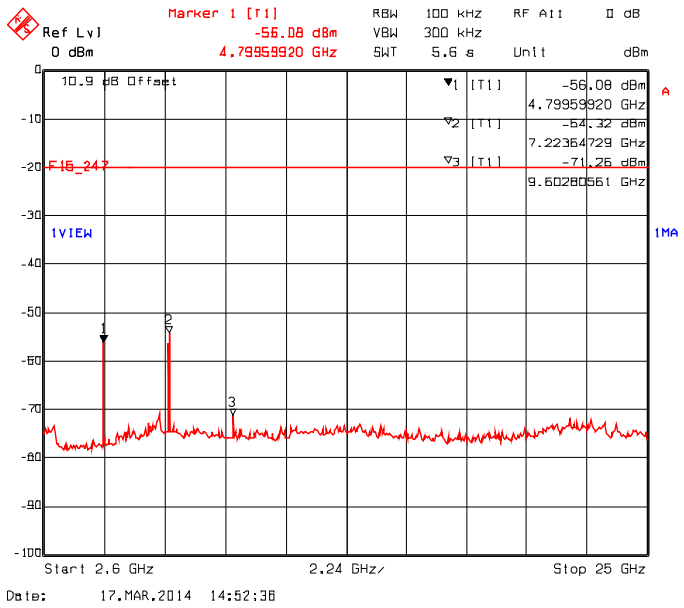


5.4.4.2. Spurious RF Conducted Emissions – Non Restricted Frequency Bands

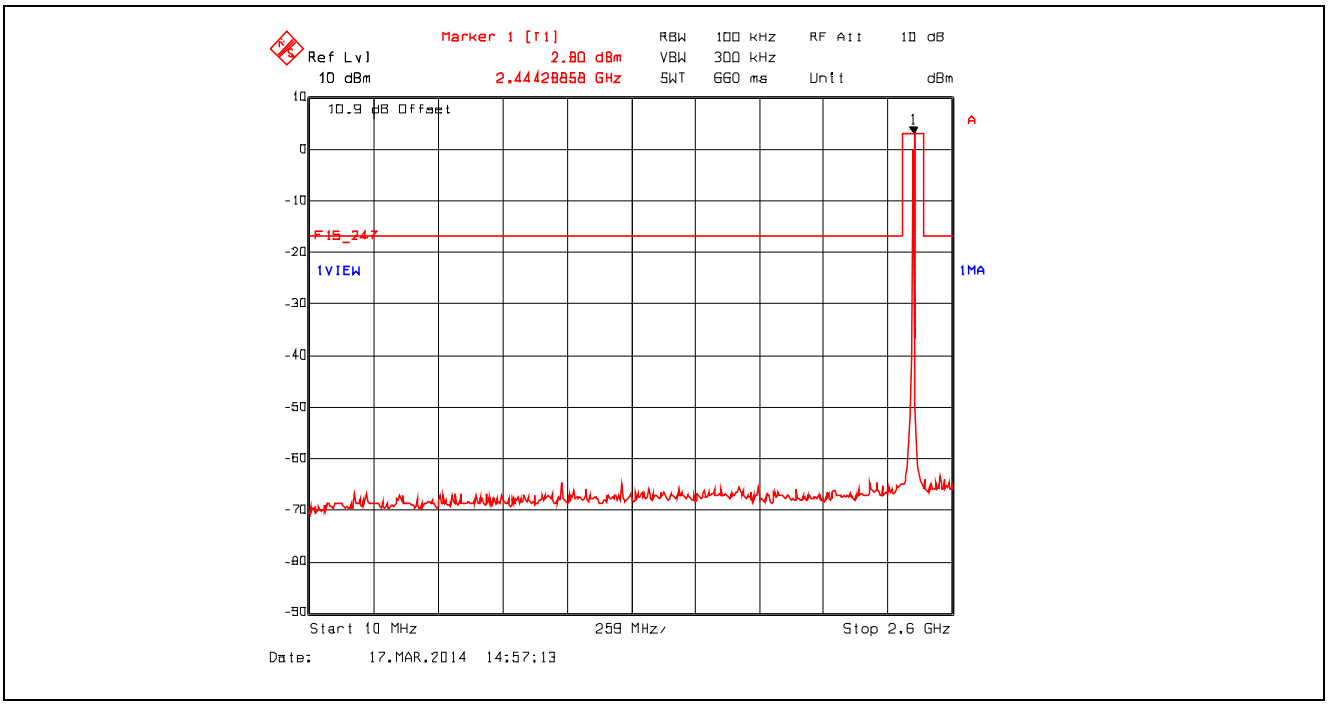
Plot 5.4.4.2.1. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 11, 2405 MHz, QPSK Modulation, Power Setting 8 Mode 1



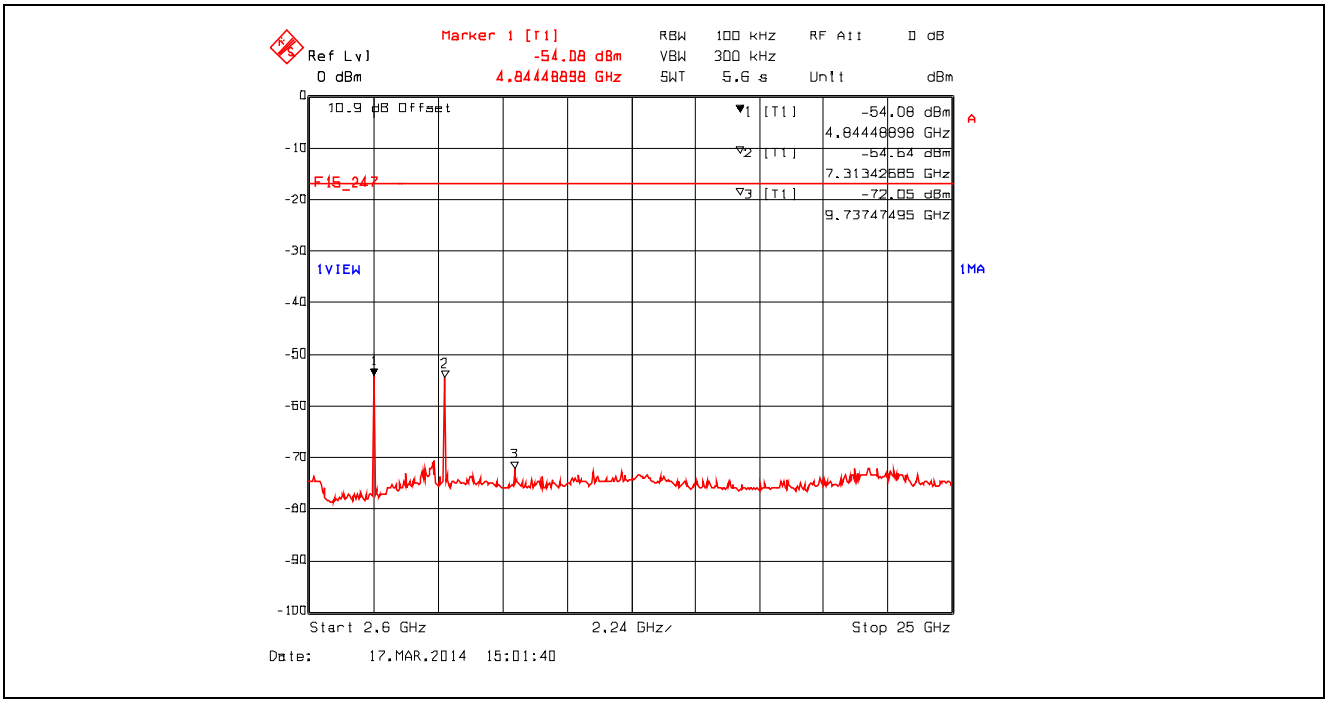
Plot 5.4.4.2.2. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 11, 2405 MHz, QPSK Modulation, Power Setting 8 Mode 1



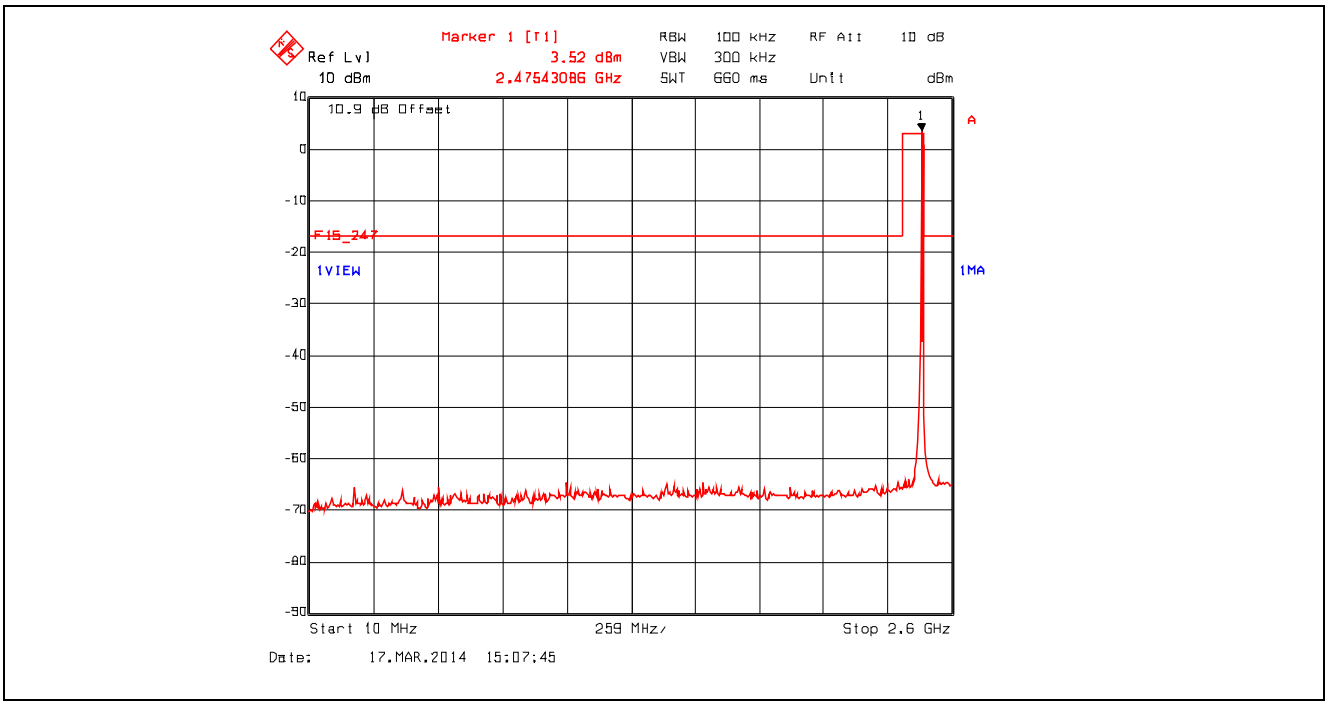
Plot 5.4.4.2.3. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 18, 2440 MHz, QPSK Modulation, Power Setting 8 Mode 1



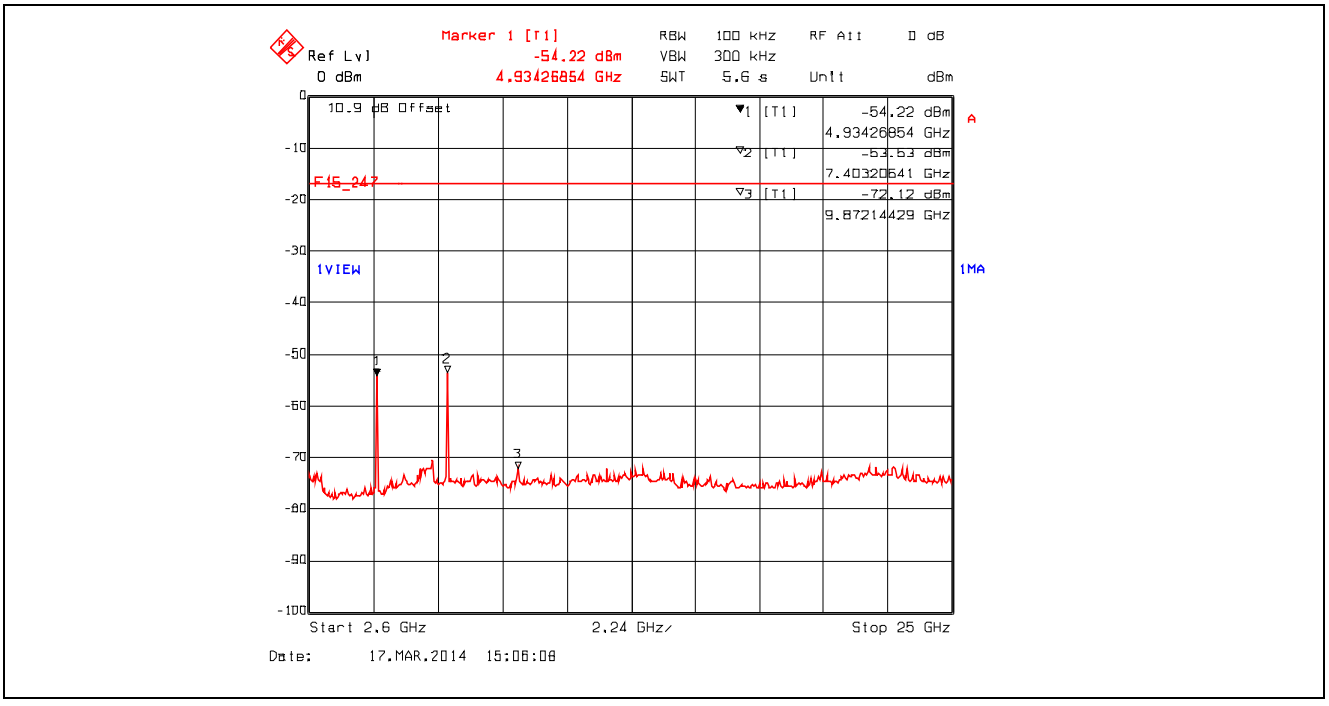
Plot 5.4.4.2.4. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 18, 2440 MHz, QPSK Modulation, Power Setting 8 Mode 1



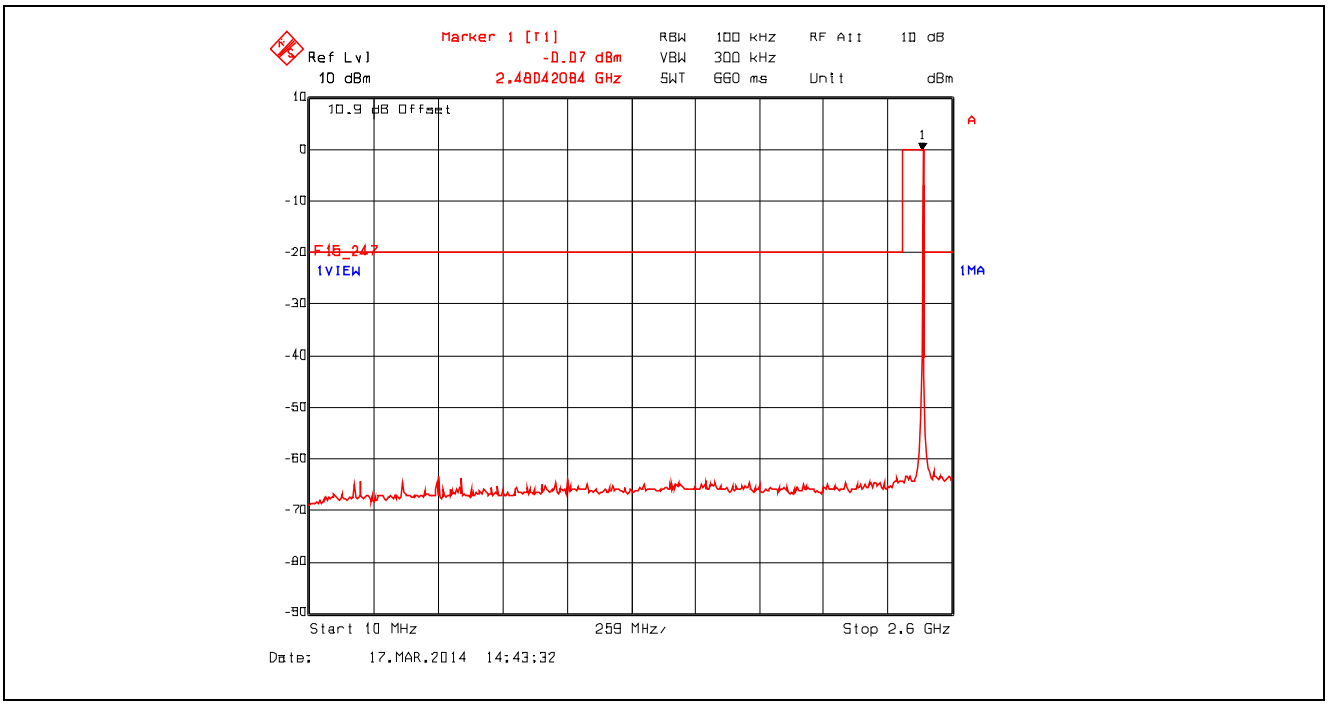
Plot 5.4.4.2.5. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 25, 2475 MHz, QPSK Modulation, Power Setting 8 Mode 1



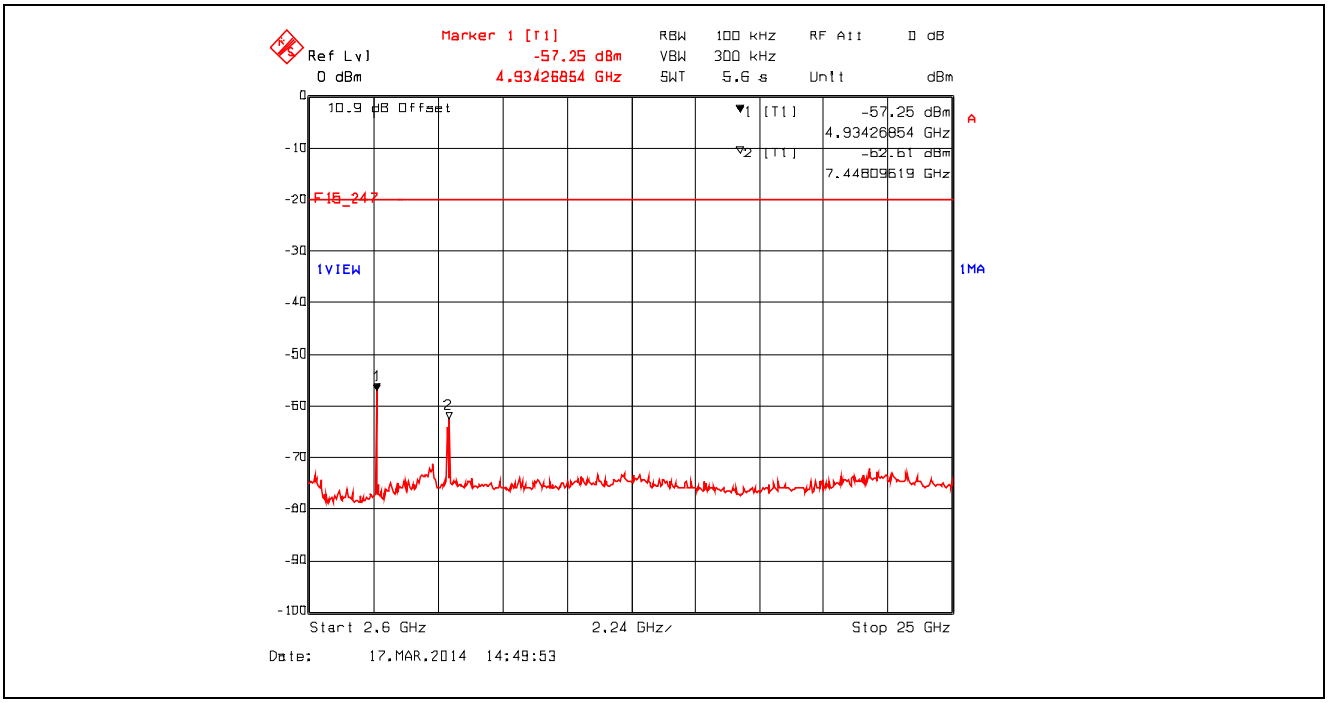
Plot 5.4.4.2.6. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 25, 2475 MHz, QPSK Modulation, Power Setting 8 Mode 1



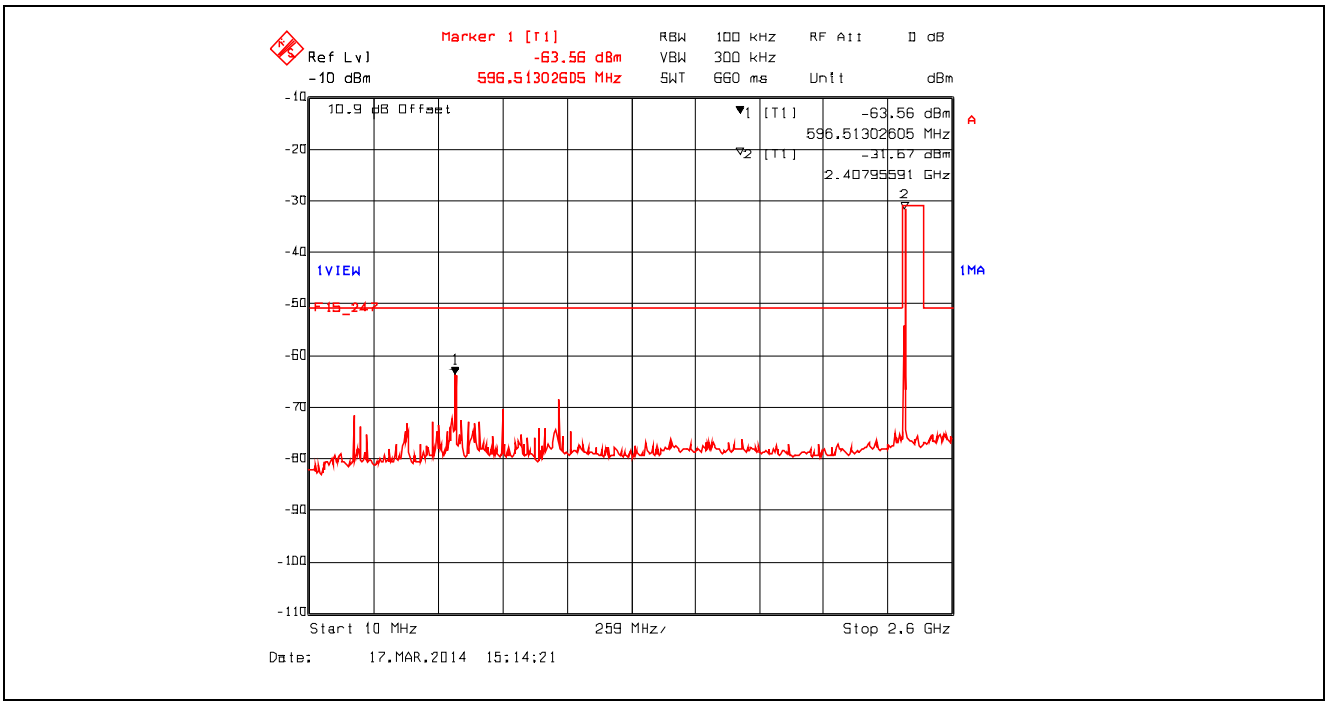
Plot 5.4.4.2.7. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 26, 2480 MHz, QPSK Modulation, Power Setting 3 Mode 1



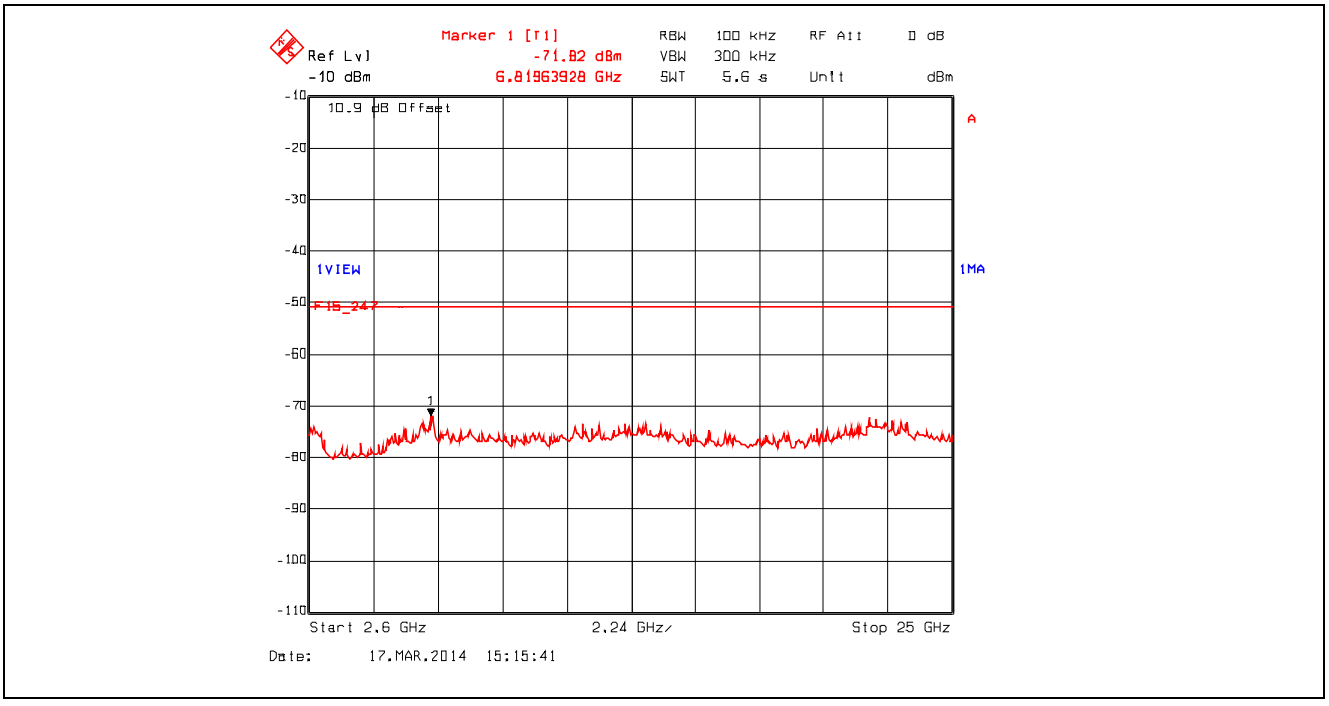
Plot 5.4.4.2.8. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 26, 2480 MHz, QPSK Modulation, Power Setting 3 Mode 1



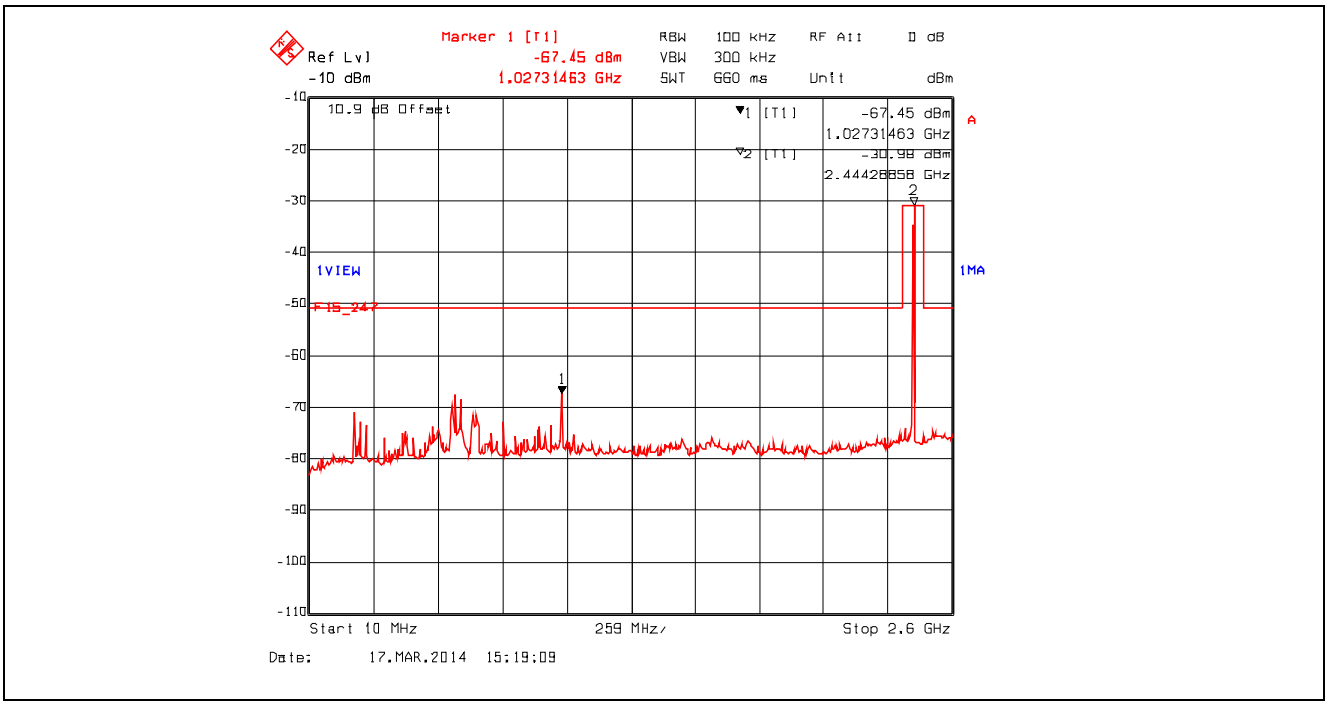
Plot 5.4.4.2.9. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 11, 2405 MHz, QPSK Modulation, Power Setting -26 Mode 0



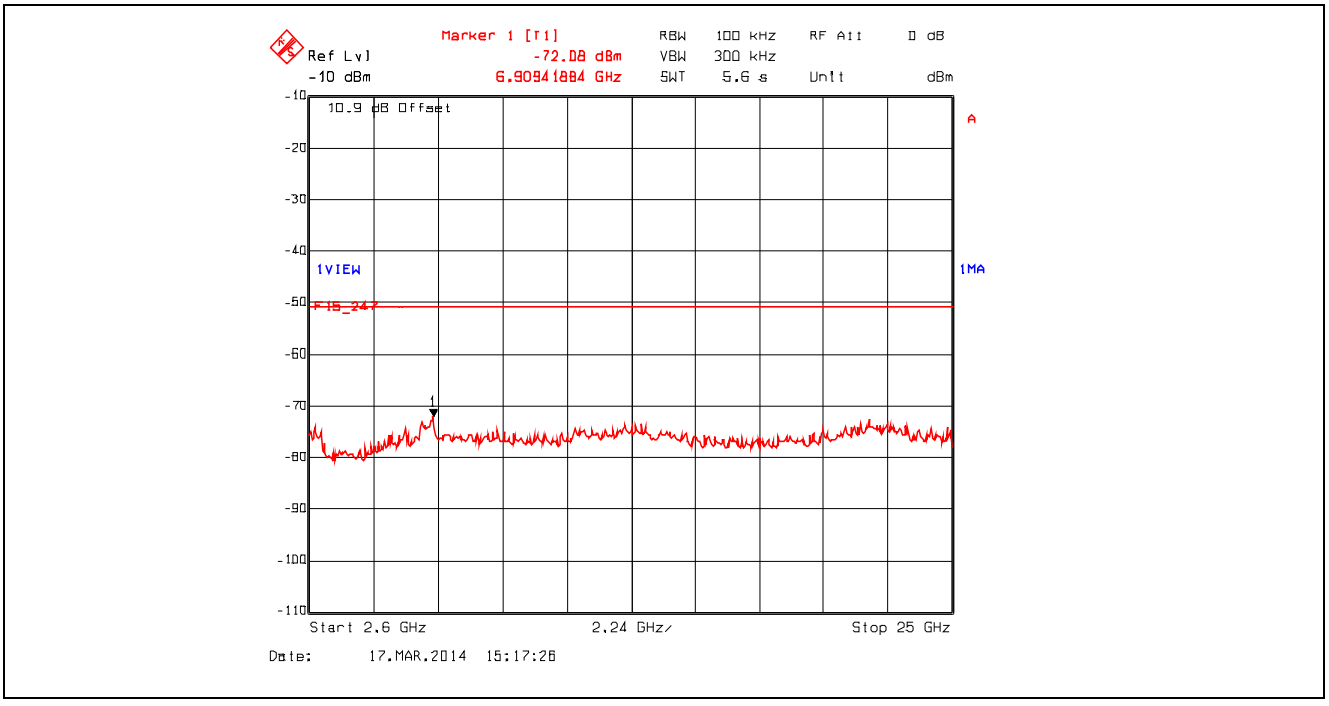
Plot 5.4.4.2.10. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 11, 2405 MHz, QPSK Modulation, Power Setting -26 Mode 0



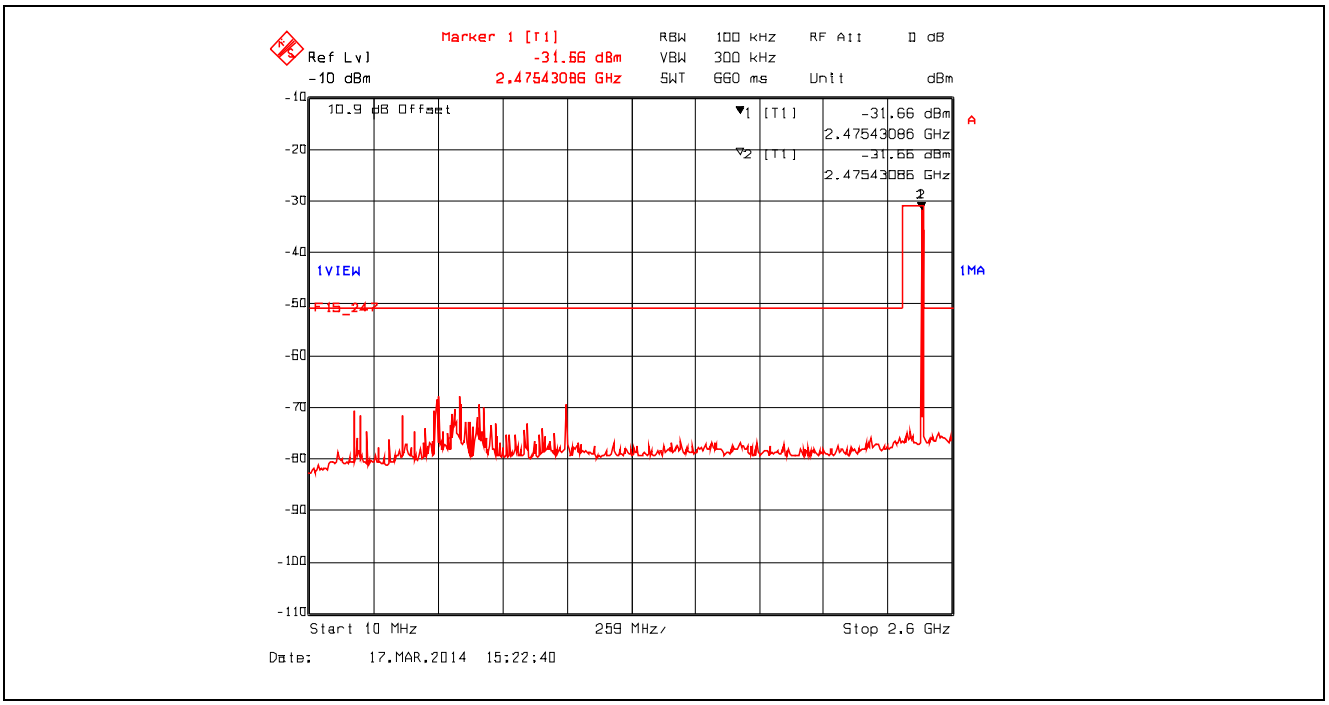
Plot 5.4.4.2.11. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 18, 2440 MHz, QPSK Modulation, Power Setting -26 Mode 0



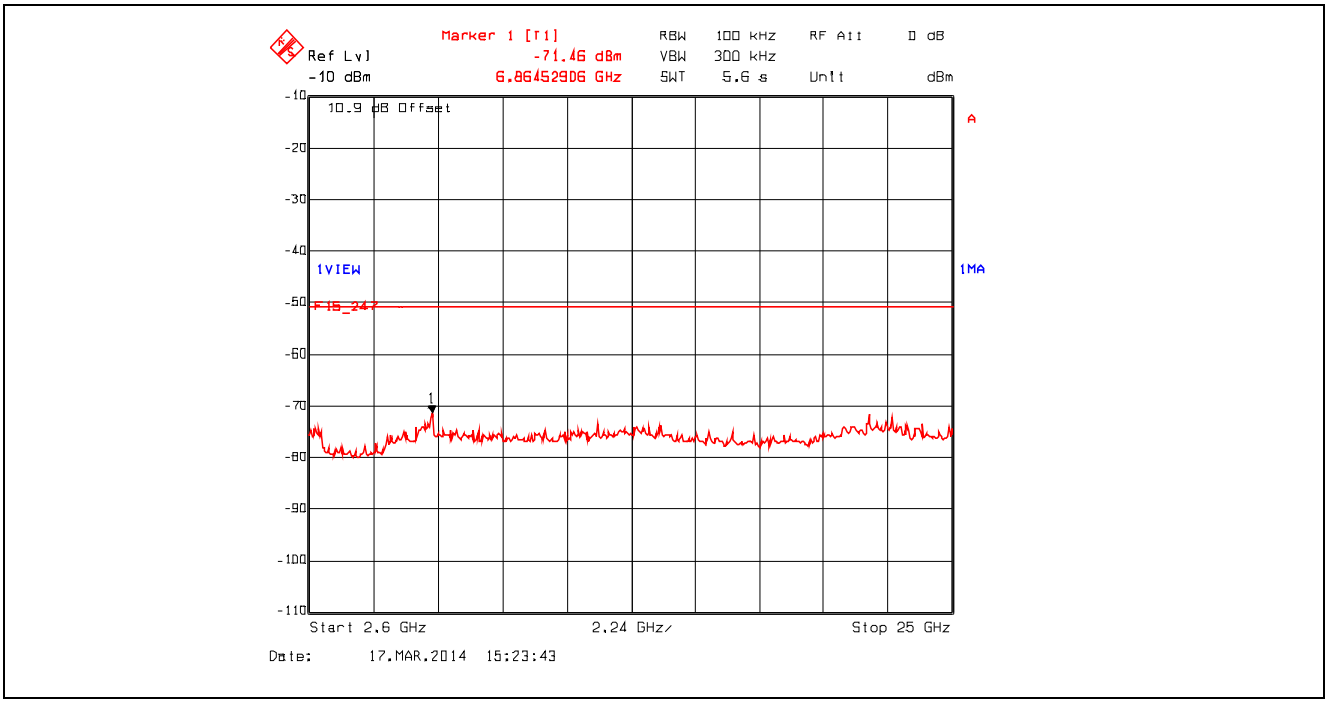
Plot 5.4.4.2.12. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 18, 2440 MHz, QPSK Modulation, Power Setting -26 Mode 0



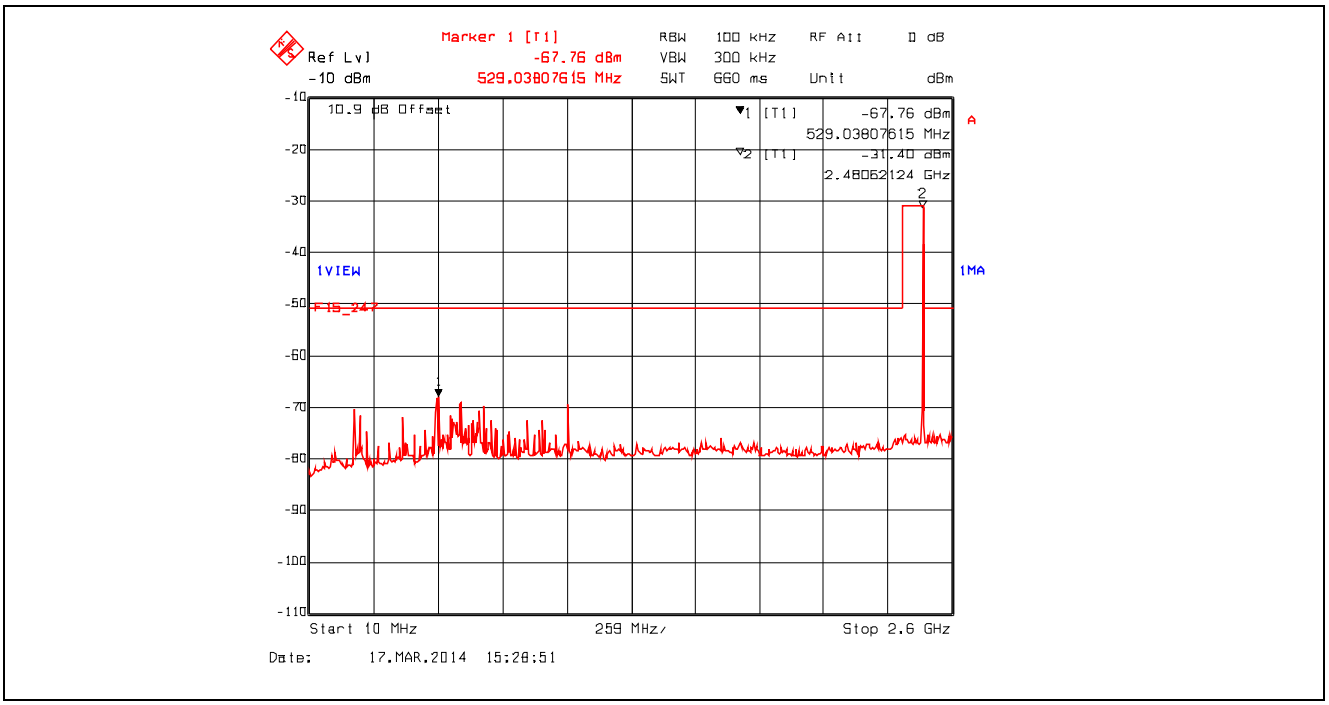
Plot 5.4.4.2.13. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 25, 2475 MHz, QPSK Modulation, Power Setting -26 Mode 0



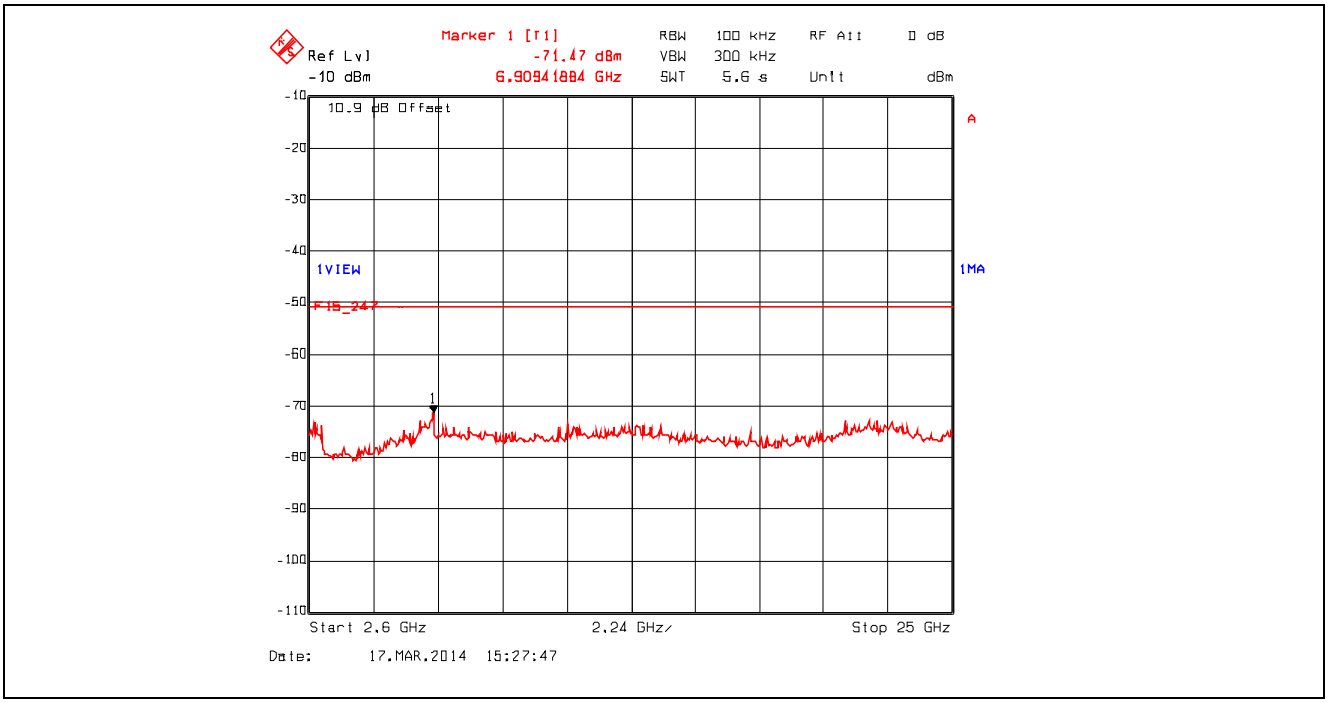
Plot 5.4.4.2.14. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 25, 2475 MHz, QPSK Modulation, Power Setting -26 Mode 0



Plot 5.4.4.2.15. Conducted Spurious Emissions - Non Restricted Frequency Bands, 10 MHz – 2.6 GHz
Channel 26, 2480 MHz, QPSK Modulation, Power Setting -26 Mode 0



Plot 5.4.4.2.16. Conducted Spurious Emissions - Non Restricted Frequency Bands, 2.6 GHz – 25 GHz
Channel 26, 2480 MHz, QPSK Modulation, Power Setting -26 Mode 0

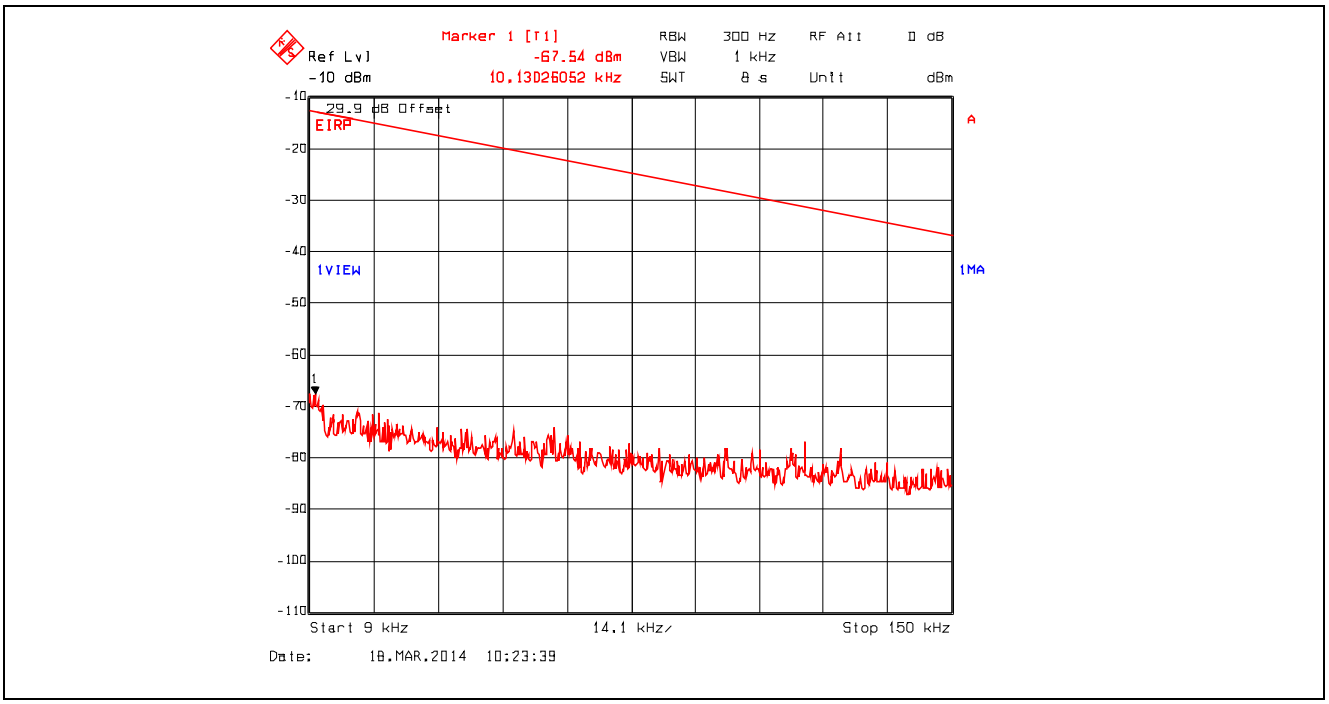


5.4.4.3. Conducted Spurious Emissions – Restricted Bands, Highest Power Setting with Highest Gain Antenna (19 dBi)

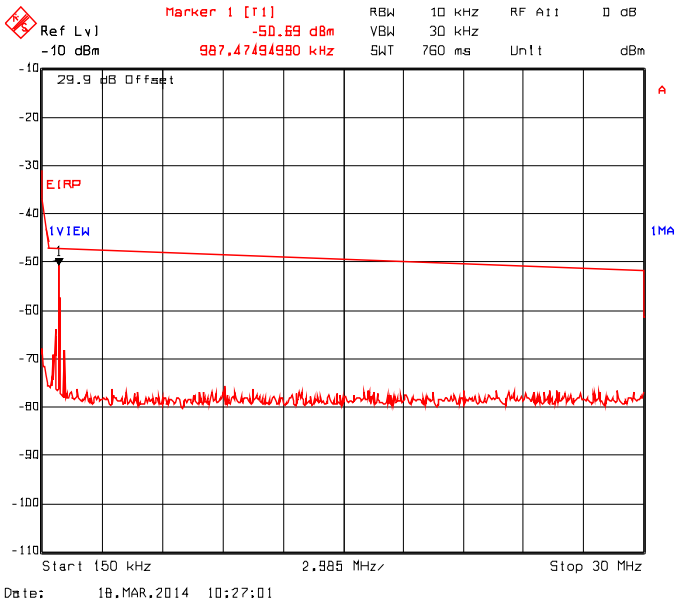
Remark(s):

- Offset: Insertion Loss (10.87 dB) + Highest Antenna Gain (19 dBi) = 29.87 dB

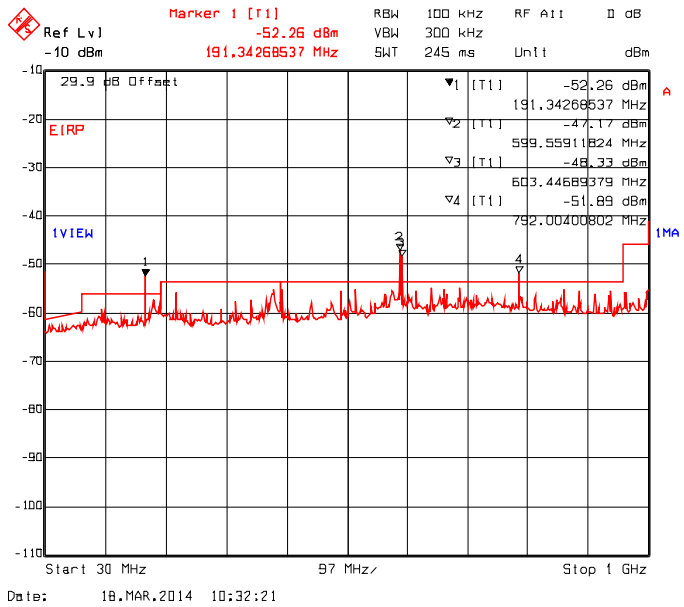
Plot 5.4.4.3.1. Conducted Spurious Emissions – Restricted Bands
2405 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 9 kHz - 150 kHz



Plot 5.4.4.3.2. Conducted Spurious Emissions – Restricted Bands
2405 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 150 kHz – 30 MHz

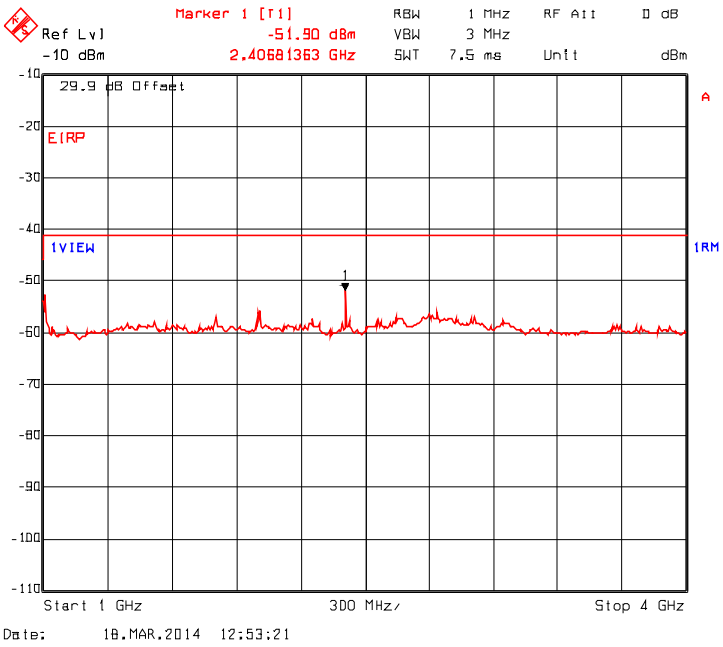


Plot 5.4.4.3.3. Conducted Spurious Emissions – Restricted Bands
2405 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 30 MHz – 1 GHz

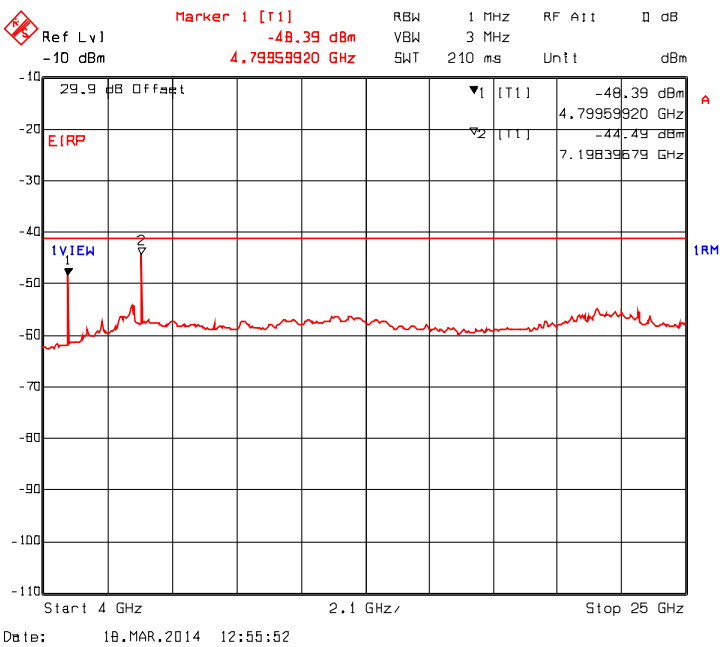


Marker 1, 2, 3 and 4 are outside of the restricted bands

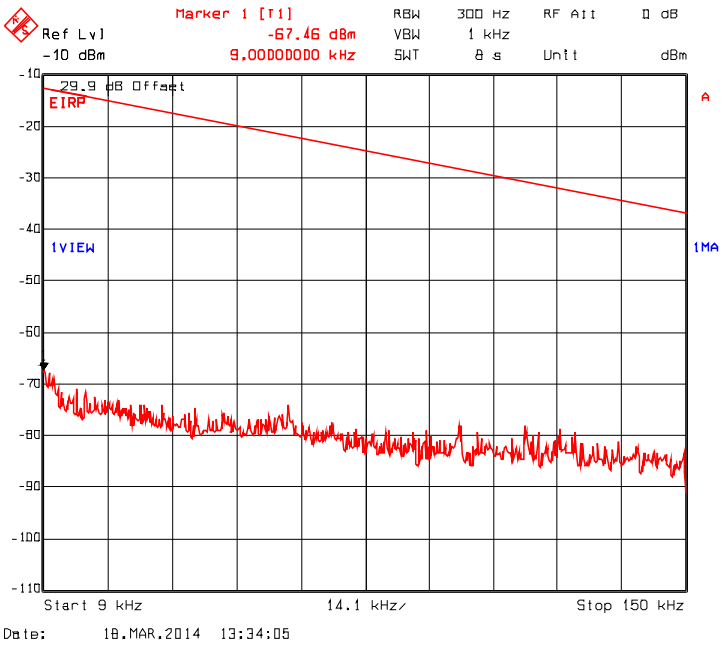
Plot 5.4.4.3.4. Conducted Spurious Emissions – Restricted Bands
2405 MHz, QPSK Modulation, Power Setting 8 Mode 1, RMS Detector with Band Reject Filter, 1 GHz – 4 GHz



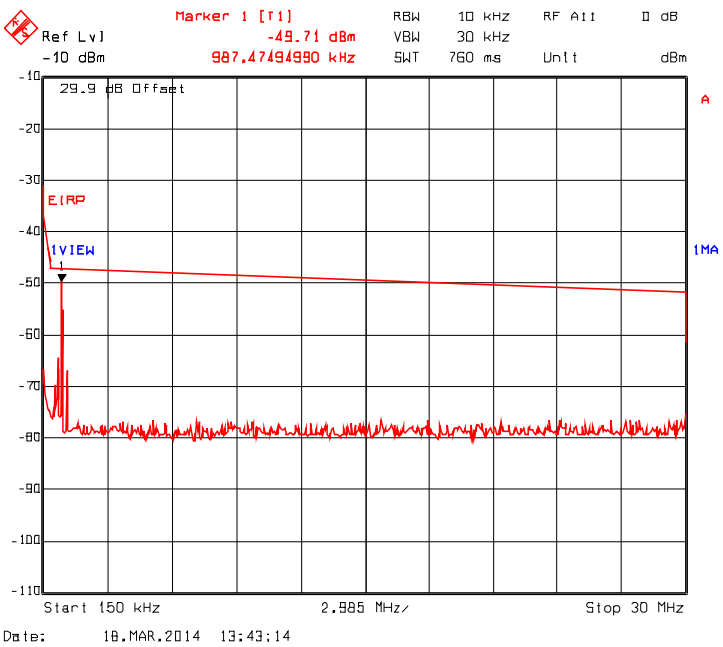
Plot 5.4.4.3.5. Conducted Spurious Emissions – Restricted Bands
2405 MHz, QPSK Modulation, Power Setting 8 Mode 1, RMS Detector with High Pass Filter, 4 GHz – 25 GHz



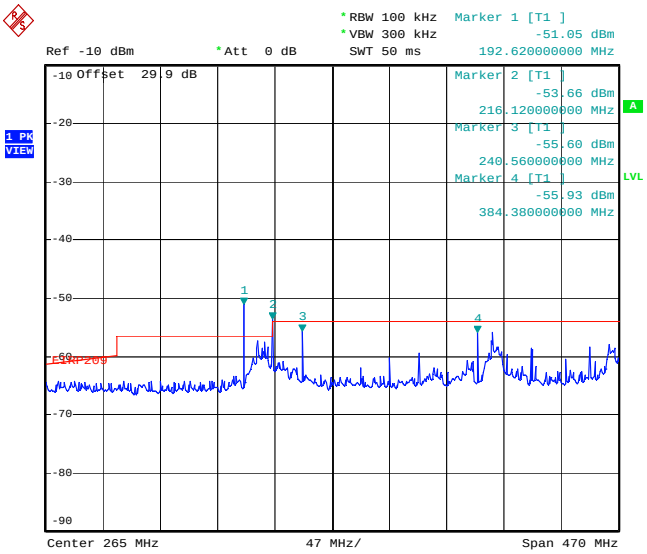
Plot 5.4.4.3.6. Conducted Spurious Emissions – Restricted Bands
2440 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 9 kHz - 150 kHz



Plot 5.4.4.3.7. Conducted Spurious Emissions – Restricted Bands
2440 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 150 kHz – 30 MHz

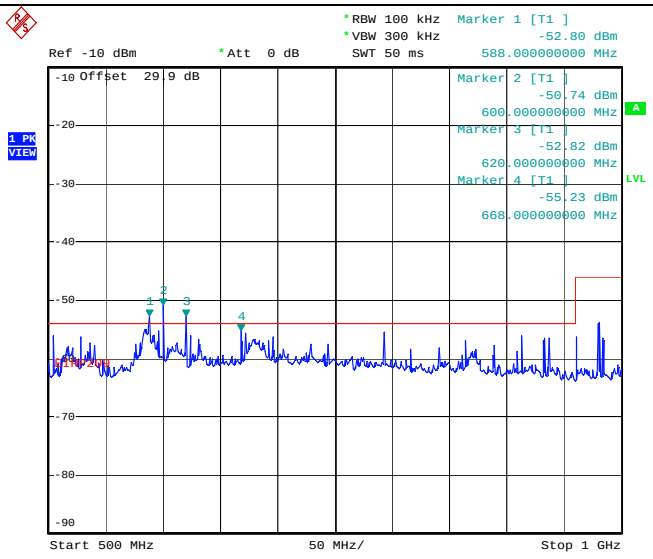


Plot 5.4.4.3.8. Conducted Spurious Emissions – Restricted Bands
2440 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 30 MHz – 500 MHz



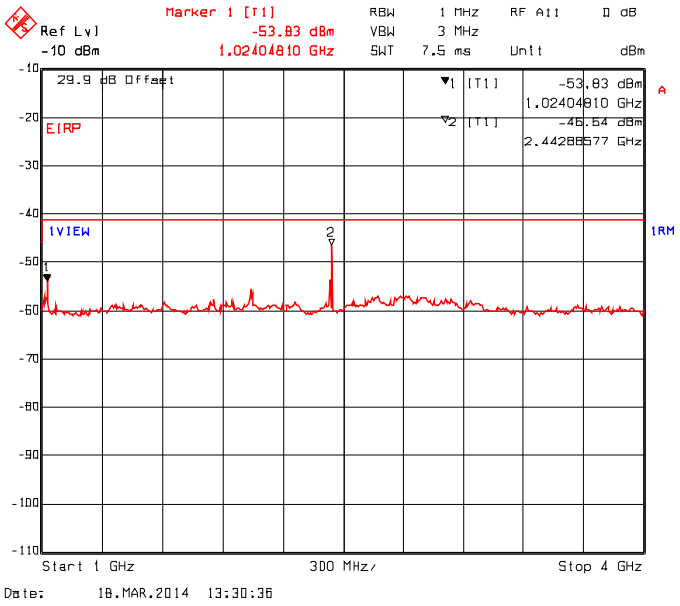
Marker 1, 2 and 4 are outside of the restricted bands

Plot 5.4.4.3.9. Conducted Spurious Emissions – Restricted Bands
2440 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 500 MHz – 1 GHz

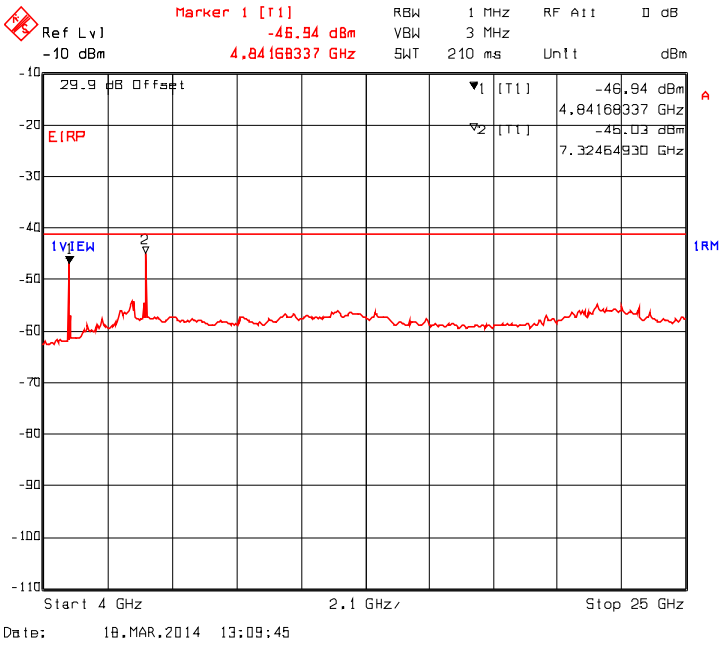


Marker 1, 2, 3 and 4 are outside of the restricted bands

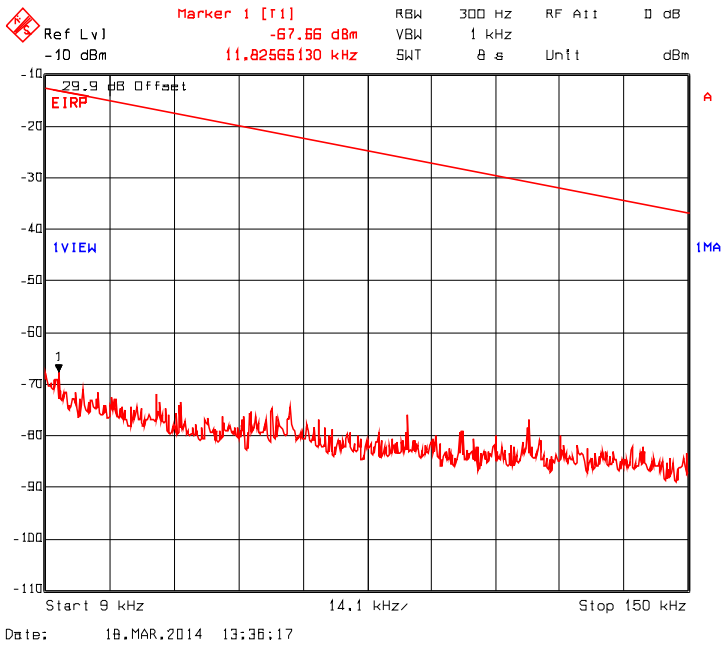
Plot 5.4.4.3.10. Conducted Spurious Emissions – Restricted Bands
2440 MHz, QPSK Modulation, Power Setting 8 Mode 1, RMS Detector with Band Reject Filter, 1 GHz – 4 GHz



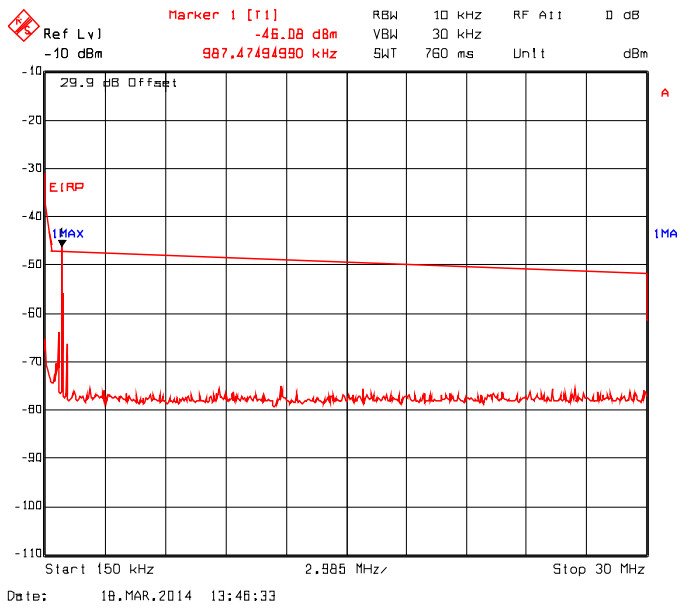
Plot 5.4.4.3.11. Conducted Spurious Emissions – Restricted Bands
2440 MHz, QPSK Modulation, Power Setting 8 Mode 1, RMS Detector with High Pass Filter, 4 GHz – 25 GHz



Plot 5.4.4.3.12. Conducted Spurious Emissions – Restricted Bands
2475 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 9 kHz - 150 kHz

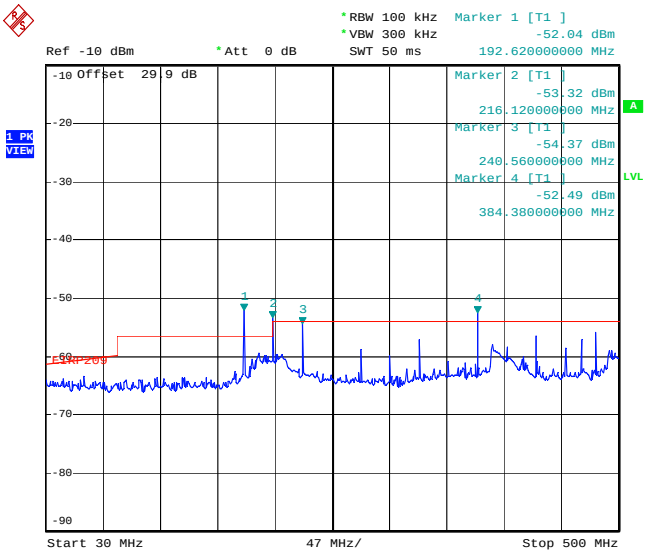


Plot 5.4.4.3.13. Conducted Spurious Emissions – Restricted Bands
2475 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 150 kHz – 30 MHz



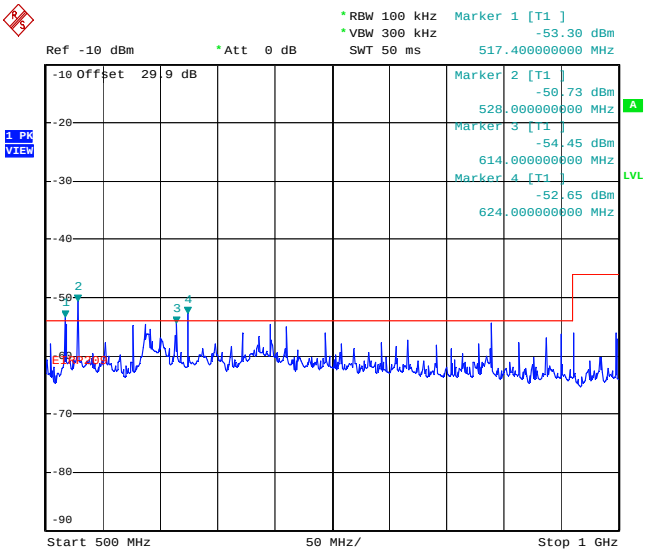
Marker 1 is outside of the restricted bands

Plot 5.4.4.3.14. Conducted Spurious Emissions – Restricted Bands
2475 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 30 MHz – 500 MHz



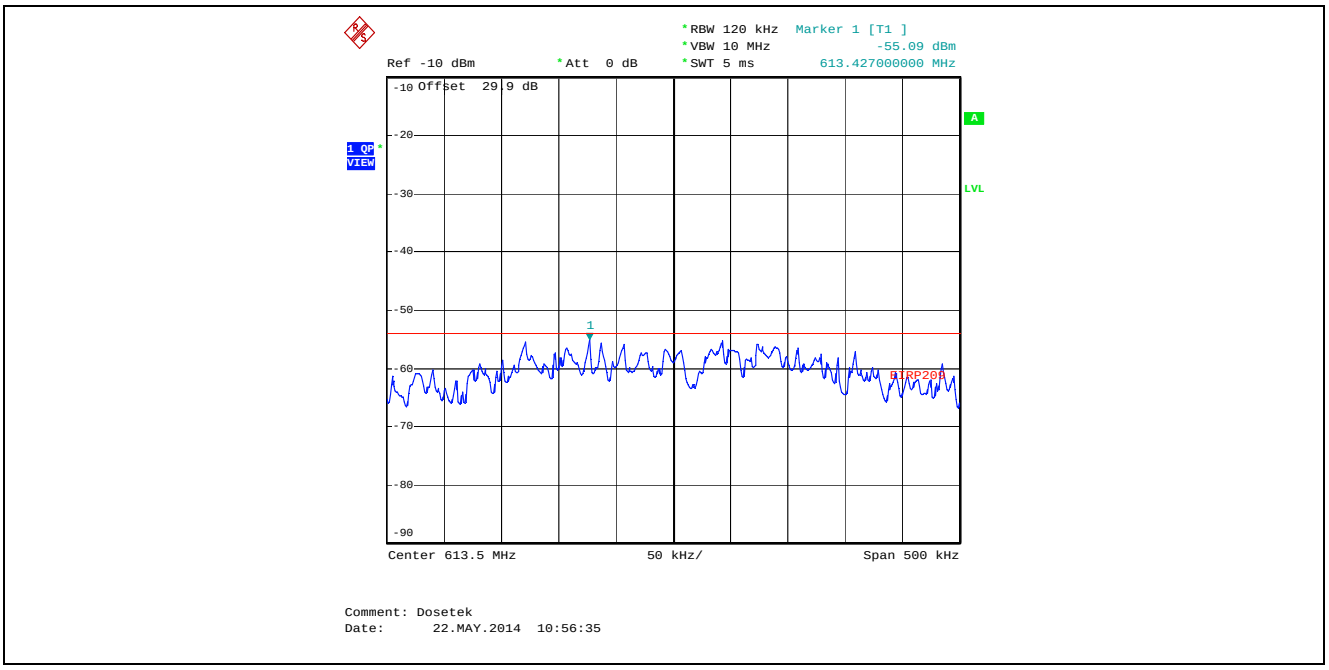
Marker 1, 2 and 4 are outside of the restricted bands

Plot 5.4.4.3.15. Conducted Spurious Emissions – Restricted Bands
2475 MHz, QPSK Modulation, Power Setting 8 Mode 1, Peak Detector with Band Reject Filter, 500 MHz – 1 GHz

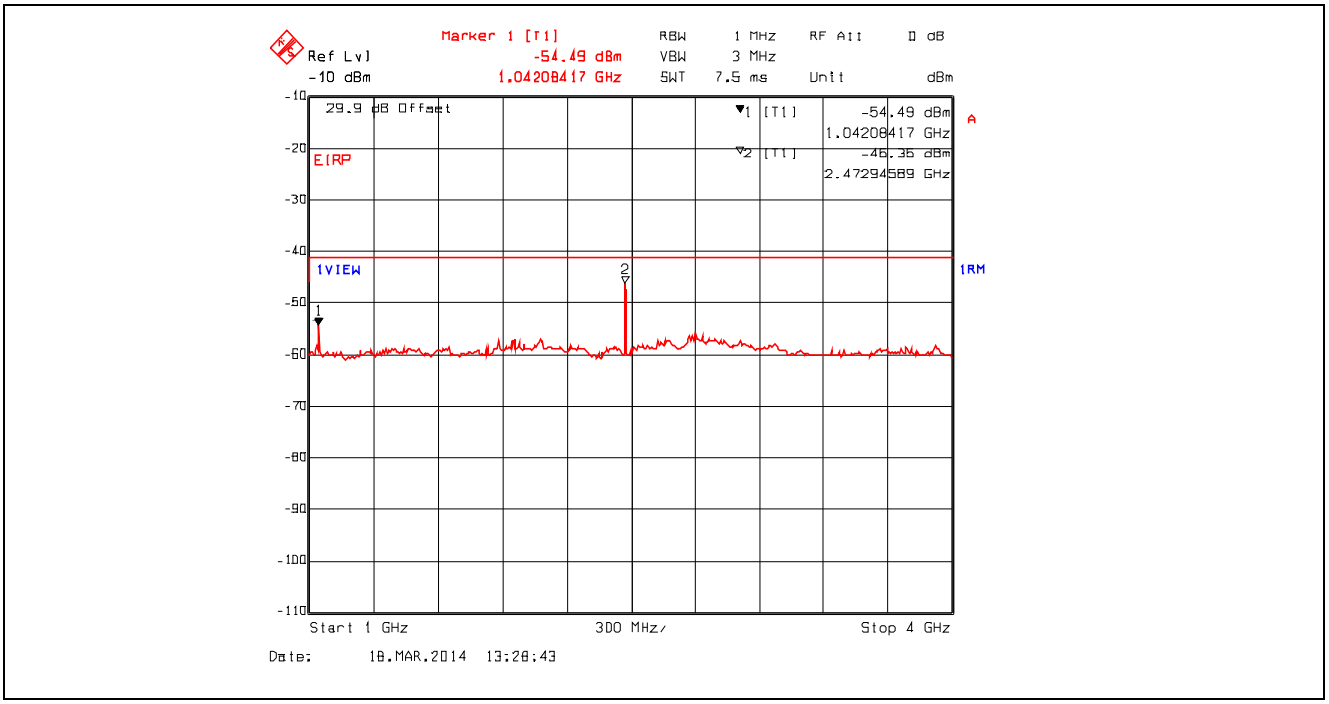


Marker 1, 2 and 4 are outside of the restricted bands

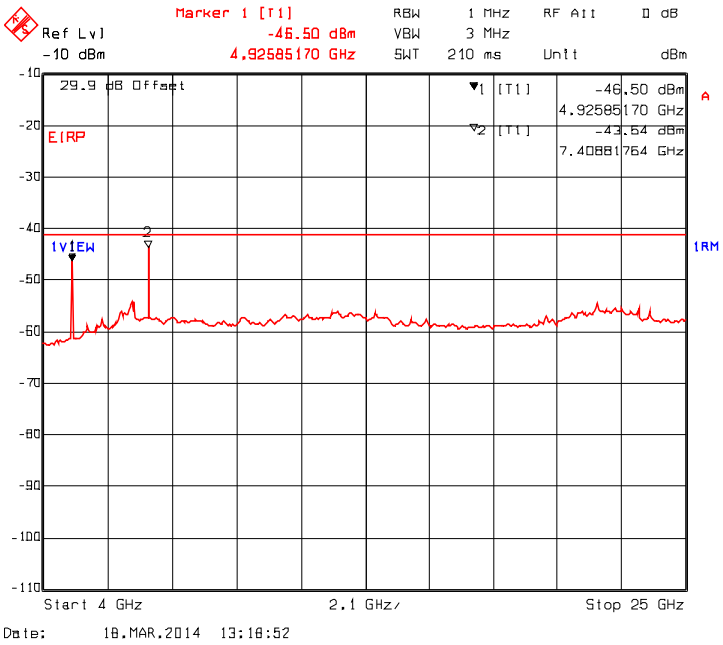
Plot 5.4.4.3.16. Conducted Spurious Emissions – Restricted Bands
2475 MHz, QPSK Modulation, Power Setting 8 Mode 1, Quasi Peak Detector with Band Reject Filter, 613.5 MHz



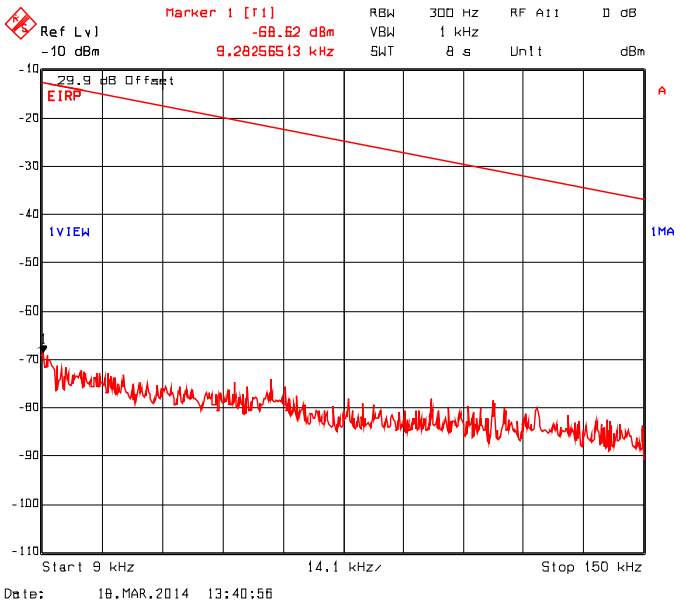
Plot 5.4.4.3.17. Conducted Spurious Emissions – Restricted Bands
2475 MHz, QPSK Modulation, Power Setting 8 Mode 1, RMS Detector with Band Reject Filter, 1 GHz – 4 GHz



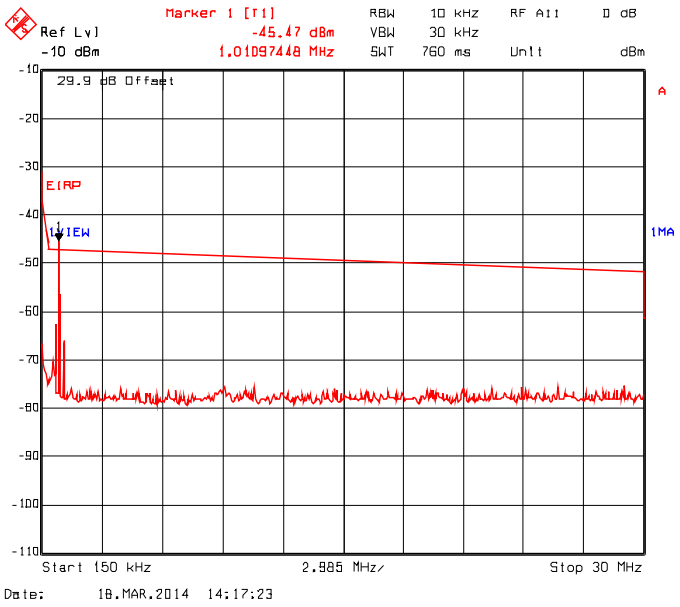
Plot 5.4.4.3.18. Conducted Spurious Emissions – Restricted Bands
2475 MHz, QPSK Modulation, Power Setting 8 Mode 1, RMS Detector with High Pass Filter, 4 GHz – 25 GHz



Plot 5.4.4.3.19. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, Peak Detector with Band Reject Filter, 9 kHz - 150 kHz

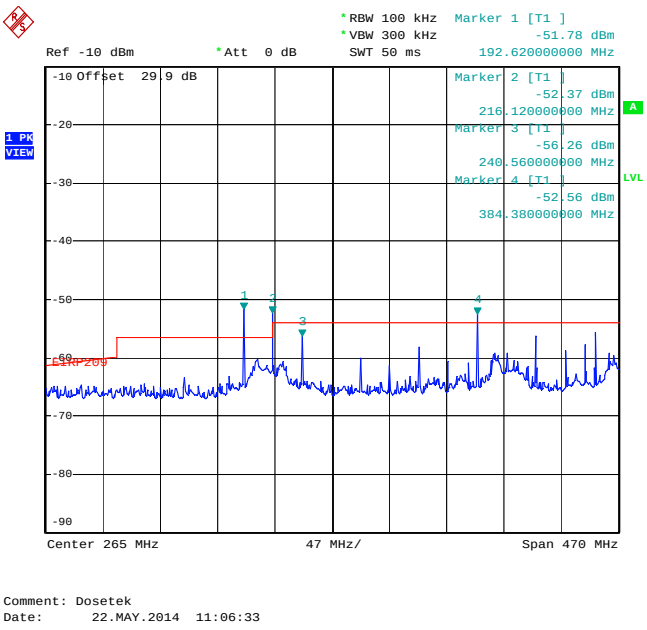


Plot 5.4.4.3.20. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, Peak Detector with Band Reject Filter, 150 kHz – 30 MHz



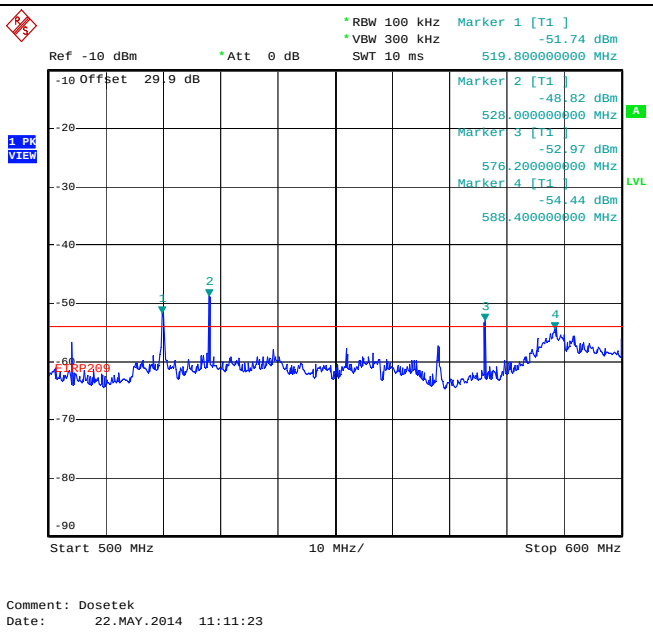
Marker 1 is outside of the restricted bands

Plot 5.4.4.3.21. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, Peak Detector with Band Reject Filter, 30 MHz – 500 MHz



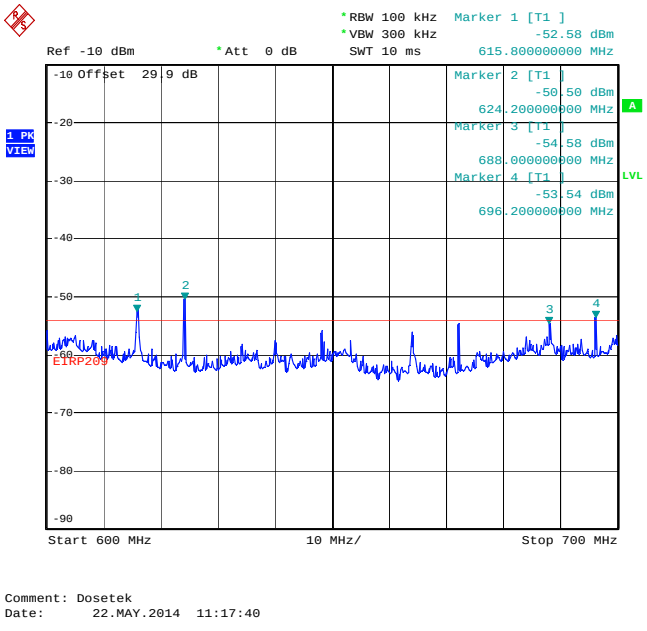
Marker 1, 2 and 4 are outside of the restricted bands

Plot 5.4.4.3.22. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, Peak Detector with Band Reject Filter, 500 MHz – 600 MHz



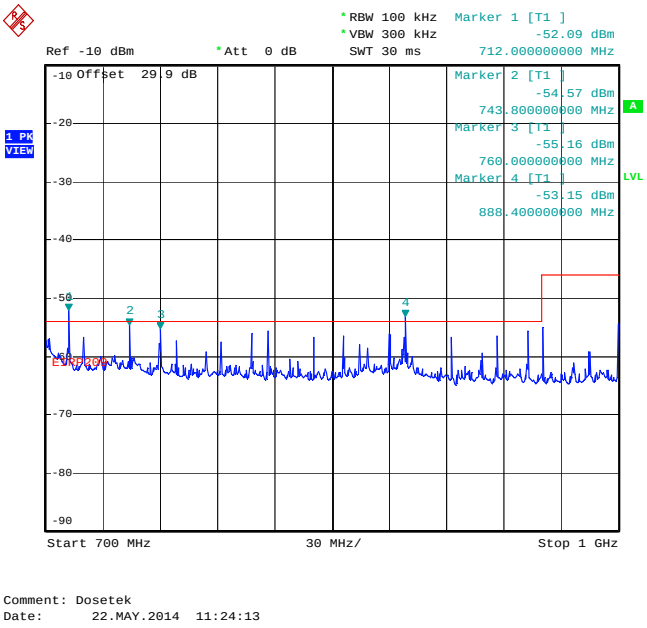
Marker 1, 2, 3 and 4 are outside of the restricted bands

Plot 5.4.4.3.23. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, Peak Detector with Band Reject Filter, 600 MHz – 700 MHz



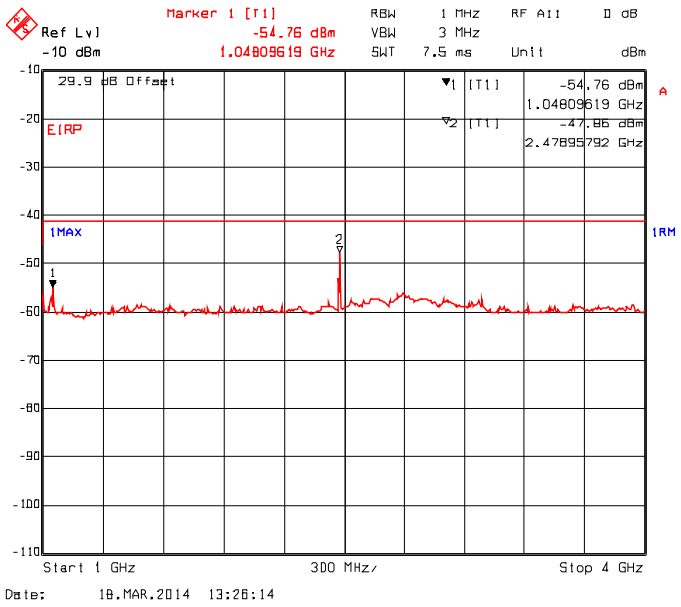
Marker 1, 2, 3 and 4 are outside of the restricted bands

Plot 5.4.4.3.24. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, Peak Detector with Band Reject Filter, 700 MHz – 1 GHz

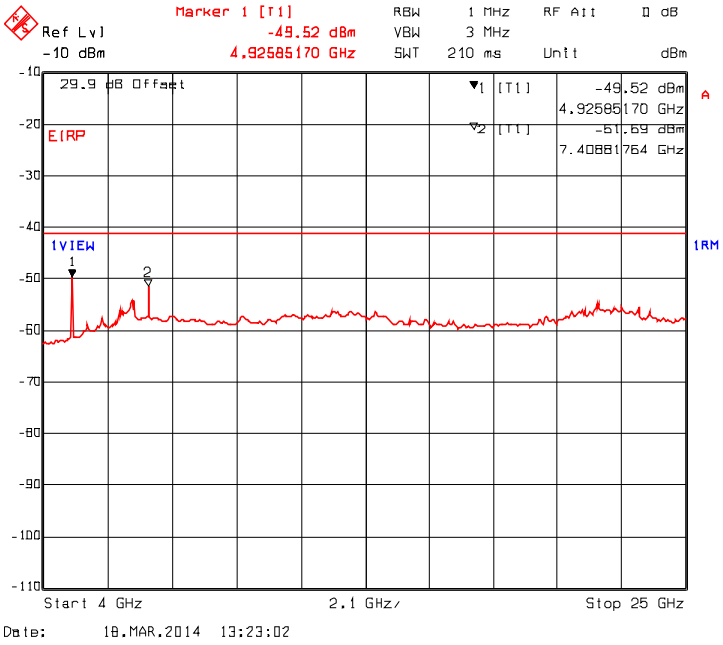


Marker 1, 2, 3 and 4 are outside of the restricted bands

Plot 5.4.4.3.25. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, RMS Detector with High Pass Filter, 1 GHz – 4 GHz



Plot 5.4.4.3.26. Conducted Spurious Emissions – Restricted Bands
2480 MHz, QPSK Modulation, Power Setting 3 Mode 1, RMS Detector with High Pass Filter, 4 GHz – 25 GHz



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

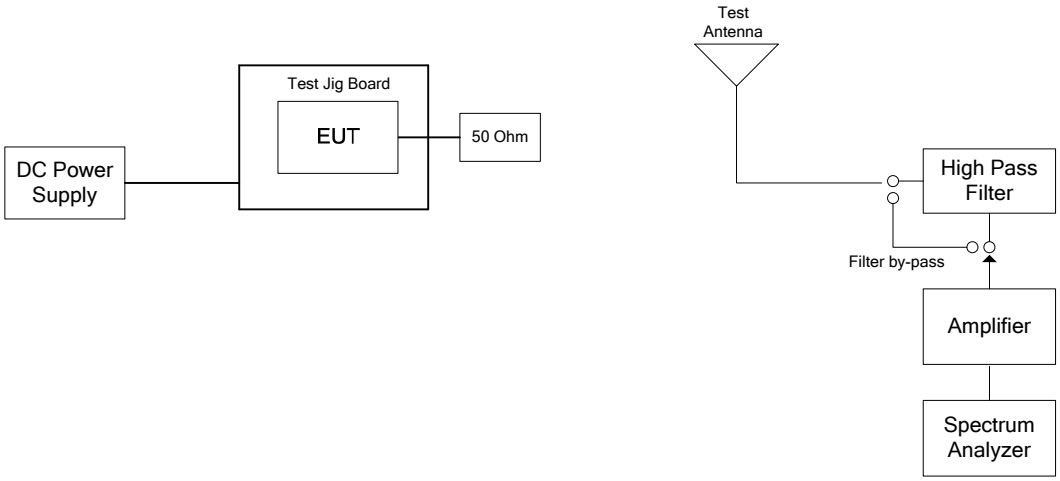
Section 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

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

5.5.2. Method of Measurements

KDB Publication No. D01 DTS Meas Guidance v03r01, Section **12.2.7** and ANSI C63.10.

5.5.3. Test Arrangement



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 = (EIRP – 20log(3) + 104.8) - 20

Fundamental Frequency:	2405 MHz
Output Power:	26.66 dBm EIRP
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
4810	55.10	44.50	V	54.0	101.9	-9.5	Pass*
4810	53.02	42.48	H	54.0	101.9	-11.5	Pass*

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

Fundamental Frequency:	2440 MHz
Output Power:	26.43 dBm EIRP
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
4880	55.54	45.87	V	54.0	101.7	-8.1	Pass*
4880	56.12	45.67	H	54.0	101.7	-8.3	Pass*
7320	52.58	40.08	V	54.0	101.7	-13.9	Pass*
7320	51.30	38.99	H	54.0	101.7	-15.0	Pass*

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

Fundamental Frequency:	2475 MHz
Output Power:	26.52 dBm EIRP
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
4950	54.48	43.98	V	54.0	101.8	-10.0	Pass*
4950	56.15	45.83	H	54.0	101.8	-8.2	Pass*
7425	53.78	41.65	V	54.0	101.8	-12.4	Pass*
7425	53.68	41.29	H	54.0	101.8	-12.7	Pass*

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

Fundamental Frequency:	2480 MHz
Output Power:	21.50 dBm EIRP
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
7440	50.36	38.28	V	54.0	96.8	-15.7	Pass*
9920	54.84	41.62	V	54.0	96.8	-12.4	Pass*
7440	50.21	38.16	H	54.0	96.8	-15.8	Pass*
9920	54.05	41.19	H	54.0	96.8	-12.8	Pass*

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

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

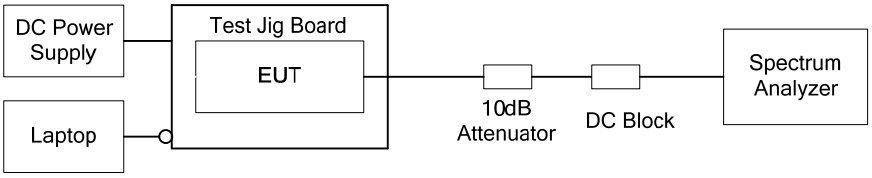
5.6.1. Limit(s)

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 V03r01, Section 10.2 Method PKPSD

5.6.3. Test Arrangement

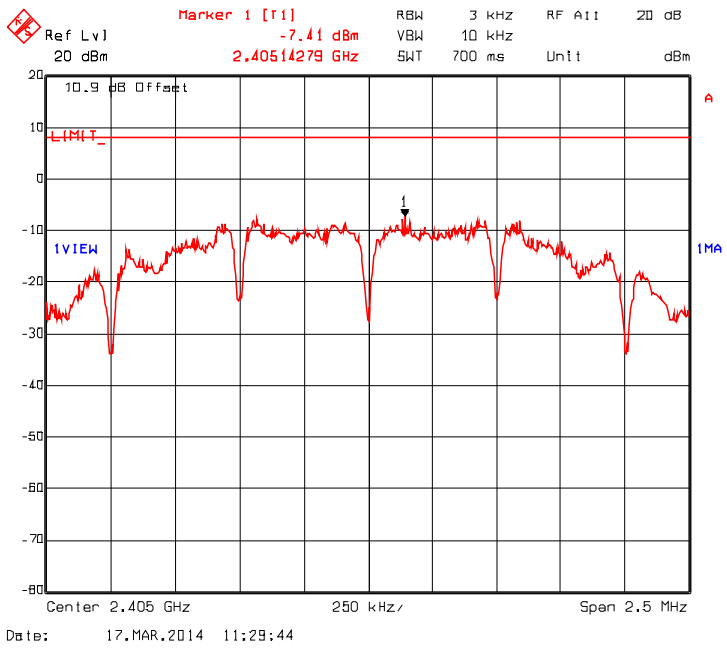


5.6.4. Test Data

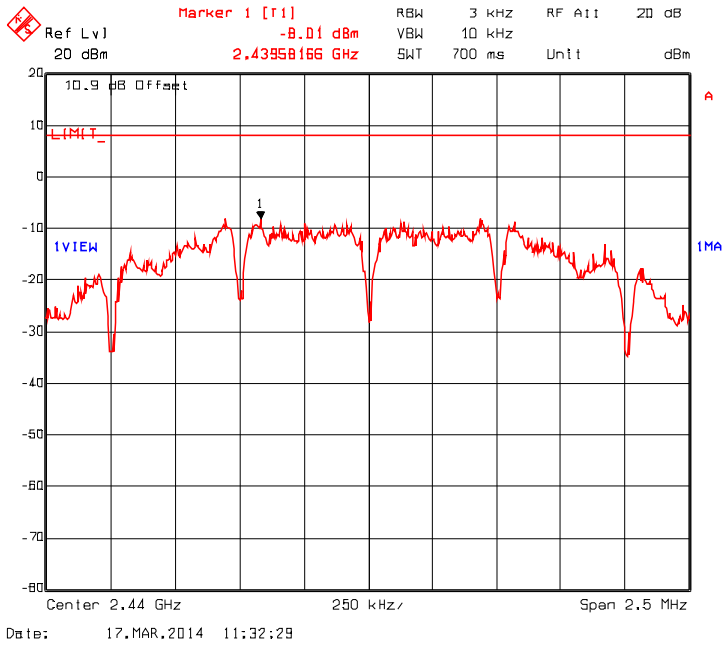
Operating Mode	Channel Number	Frequency (MHz)	*PSD in 3 kHz BW (dBm)	Limit (dBm)	Margin (dB)
Power Setting 8 Mode 1	11	2405	-7.41	8	-15.41
	18	2440	-8.01	8	-16.01
	25	2475	-8.06	8	-16.06
	26	2480	-12.17	8	-20.17

*See the following plots for measurement details.

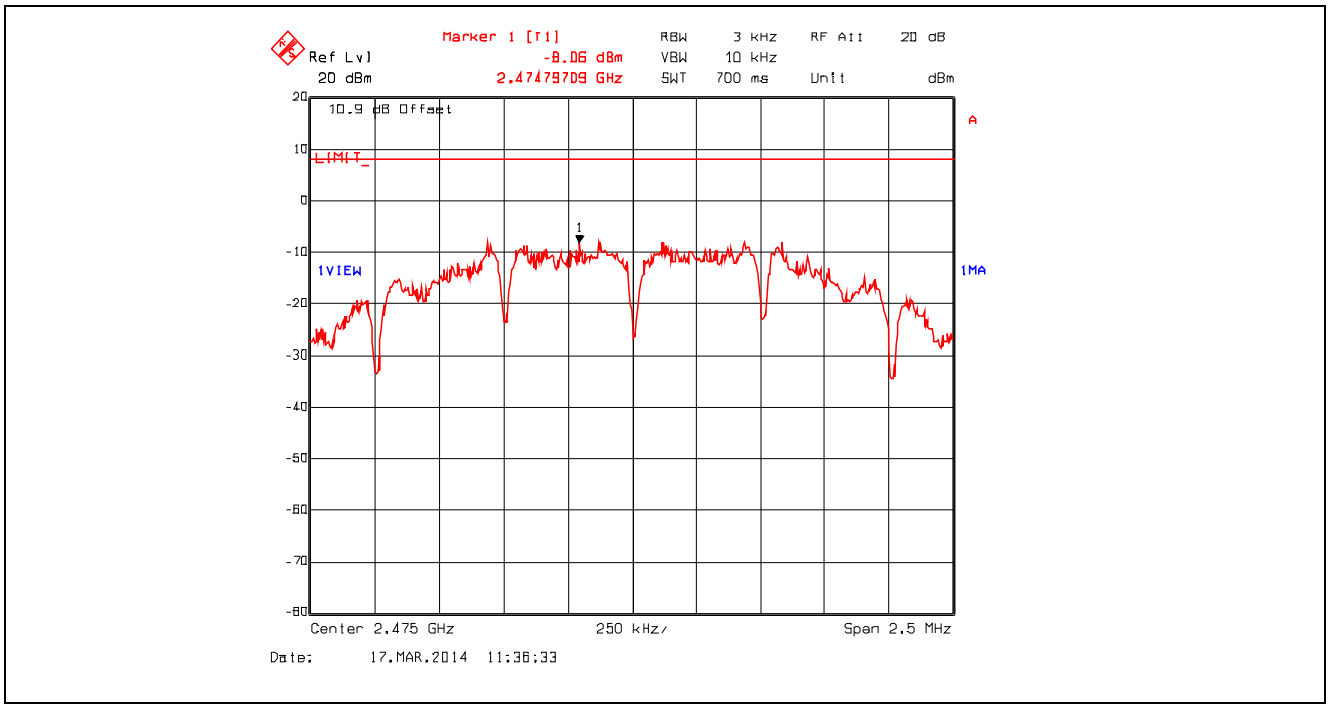
Plot 5.6.4.1. Power Spectral Density, Channel 11, 2405 MHz, QPSK Modulation, Power Setting 8 Mode 1



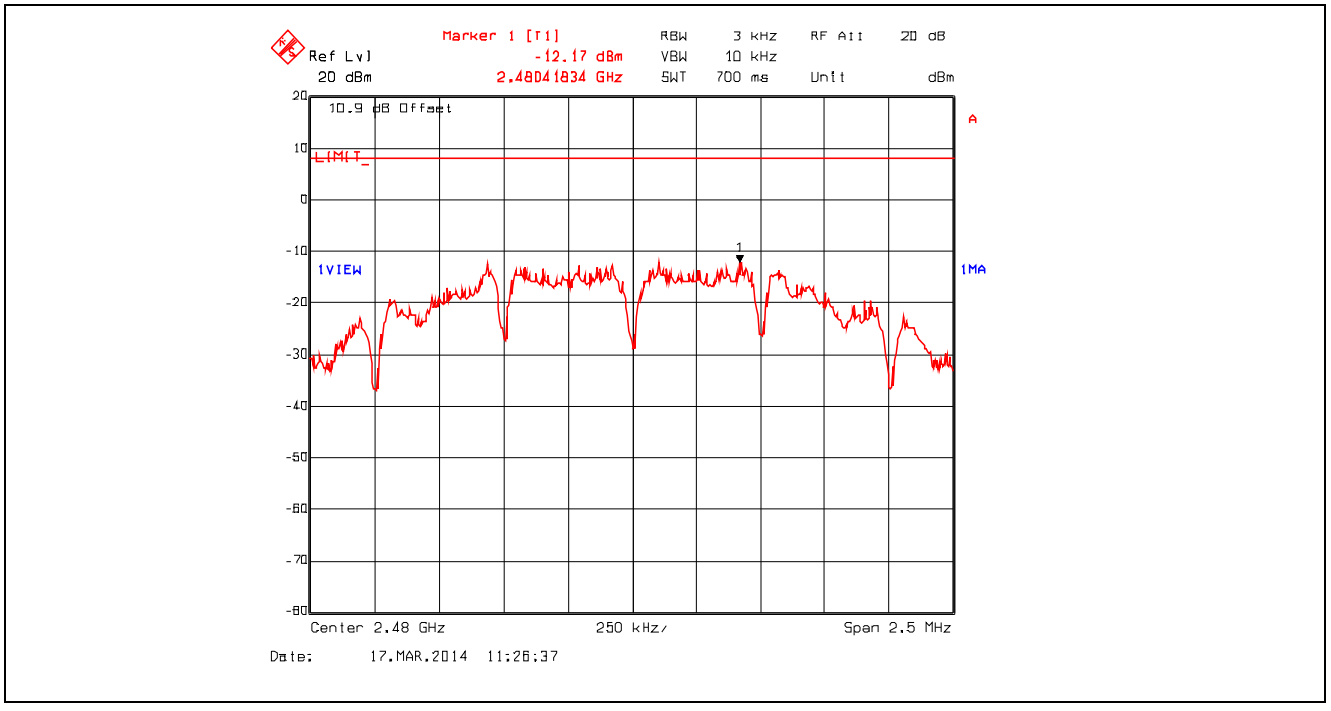
Plot 5.6.4.2. Power Spectral Density, Channel 18, 2440 MHz, QPSK Modulation, Power Setting 8 Mode 1



Plot 5.6.4.3. Power Spectral Density, Channel 25, 2475 MHz, QPSK Modulation, Power Setting 8 Mode 1



Plot 5.6.4.4. Power Spectral Density, Channel 26, 2480 MHz, QPSK Modulation, Power Setting 3 Mode 1



5.7. RF EXPOSURE REQUIRMENTS [§§ 15.247(e)(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: ***18 cm**	Manufacturer' instruction for separation distance between antenna and persons required: **20 cm minimum**
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 = 36 dBm = $10^{(36/10)}$ mW = 3981 mW (Worst Case)

(Minimum Safe Distance, r) = $\sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}} = \sqrt{\frac{3981}{4 \cdot \pi \cdot (1.0)}} \approx 18cm$

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	3825/2	8907-1531	10 kHz -100 MHz	14 May 2014
DC Power Supply	Tenma	72-7295	490300270	1 – 40 Vdc	Cal on use
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20Hz–40 GHz	08 Nov 2014
Attenuator	Pasternack	7024-10	4	DC–26.5 GHz	Cal on use
DC Block	Hewlett Packard	11742A	12460	0.045–26.5 GHz	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	FSP	100646	9 kHz – 7 GHz	25 Sep 2014
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	25 Jun 2014
RF Amplifier	Hewlett Packard	8447F	2805A03287	0.1 – 1300 MHz	15 Mar 2015
Biconi-Log Antenna	EMCO	3142C	34792	26 – 3000 MHz	26 Jun 2014
Horn Antenna	EMCO	3155	6570	1 – 18 GHz	07 Jun 2014
Horn Antenna	EMCO	3160-09	118385	18 – 26.5 GHz	30 July 2014

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**