FCC Test Report

Test report no.: EMC_380FCC15.247_2003_Si-Ge
FCC Part 15.247 for DSSS systems / CANADA RSS-210

EUT: WLAN Model: BCM94306MP
FCC ID: QDS-BRCM1005

Deutscher Akkreditierungs Rat

TTI-P-G 081/94-A0

Accredited according to **ISO/IEC 17025**

Bluetooth Qualification Test Facility (BQTF)

FCC listed # 101450

IC recognized # 3925

***CETECOM* Inc.**
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Board of Directors: Dr. Harald Ansorge, Dr. Klaus Matkey, Hans Peter May

Table of Contents

1 General information

1.1 Notes

The test results of this test report relate exclusively to the test item specified in 1.5. The CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM Inc USA.

TEST REPORT PREPARED BY:
EMC Engineer: Harpreet Sidhu

1.2 Testing laboratory

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1.3 Details of applicant

Name	**:**	**Broadcom corporation**
Street	**:**	**190 Mathilda Place**
City / Zip Code	**:**	**Sunnyvale, CA 94086**
Country	**:**	**USA**
Contact	**:**	**Chris McGough**
Telephone	**:**	**408-922-5810**
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e-mail	**:**	**cmcgough@broadcom.com**

1.4 Application details

Date of receipt of application	:	2003-02-14
Date of receipt test item	:	2003-02-14
Date of test	:	2003-02-14/15/18

1.5 Test item

Manufacturer	:	Applicant
Model No. (EUT)	:	BCM94306MP
Description	:	54g wireless LAN mini PCI card
FCC ID	:	QDS-BRCM1005

Additional information

Frequency	:	2412MHz – 2462MHz
Type of modulation	:	DSSS / OFDM (orthogonal frequency division multiplexing)
Number of channels	:	11
Antenna	:	5dBi max. gain antenna
Power supply	:	3.3 VDC from Host
Output power	:	25.83dBm (382.82mW) conducted peak power **(For EIRP and Source-based time-averaged output please see page no.11)**
Extreme temp. Tolerance	:	0°C to +85°C

Host (Access Point) Information

Brand / Model / Serial No.	:	Linksys / WAP51AB / 0006250C4A8E

1.6 Test standards: FCC Part 15 §15.247 / CANADA RSS-210

NOTE: This test report represents retesting of pre-approved WLAN Model: BCM94306MP with different (Si-Ge) power amp. The original FCC filing was covered under test report no. EMC_380FCC15.247_2003

2 Technical test

2.1 Summary of test results

No deviations from the technical specification(s) were ascertained in the course of the tests Performed	
Final Verdict: (Only "passed" if all single measurements are "passed")	**Passed**

Technical responsibility for area of testing:

Date	Section	Name	Signature
2003-04-25	EMC & Radio	Lothar Schmidt (Manager)	

Responsible for test report and project leader:

Date	Section	Name	Signature
2003-04-25	EMC & Radio	Harpreet Sidhu (EMC Engineer)	

2.2 Test report

TEST REPORT

Test report no.: EMC_380FCC15.247_2003_Si-Ge

EUT: WLAN Model: BCM94306MP

FCC ID: QDS-BRCM1005

TEST REPORT REFERENCE

SPECTRUM BANDWIDTH OF DSSS SYSTEM §15.247(a) (2)
6 dB bandwidth

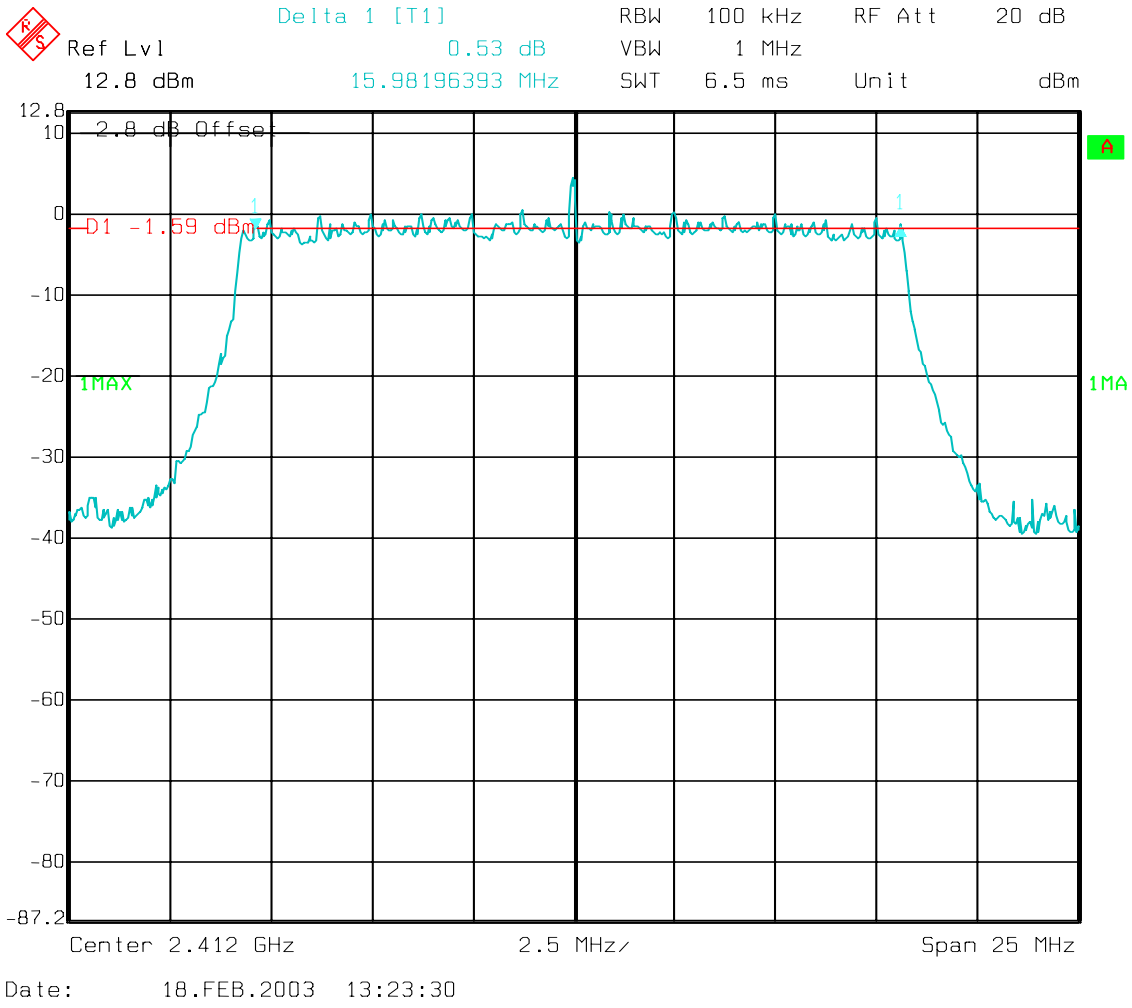
TEST CONDITIONS		6 dB BANDWIDTH (MHz)		
Frequency (MHz)		2412	2437	2462
T_{nom}(23)°C	V_{nom}(3.3) VDC	15.98	15.43	15.38

LIMIT SUBCLAUSE §15.247(a) (2)

The minimum 6dB bandwidth shall be at least 500 KHz

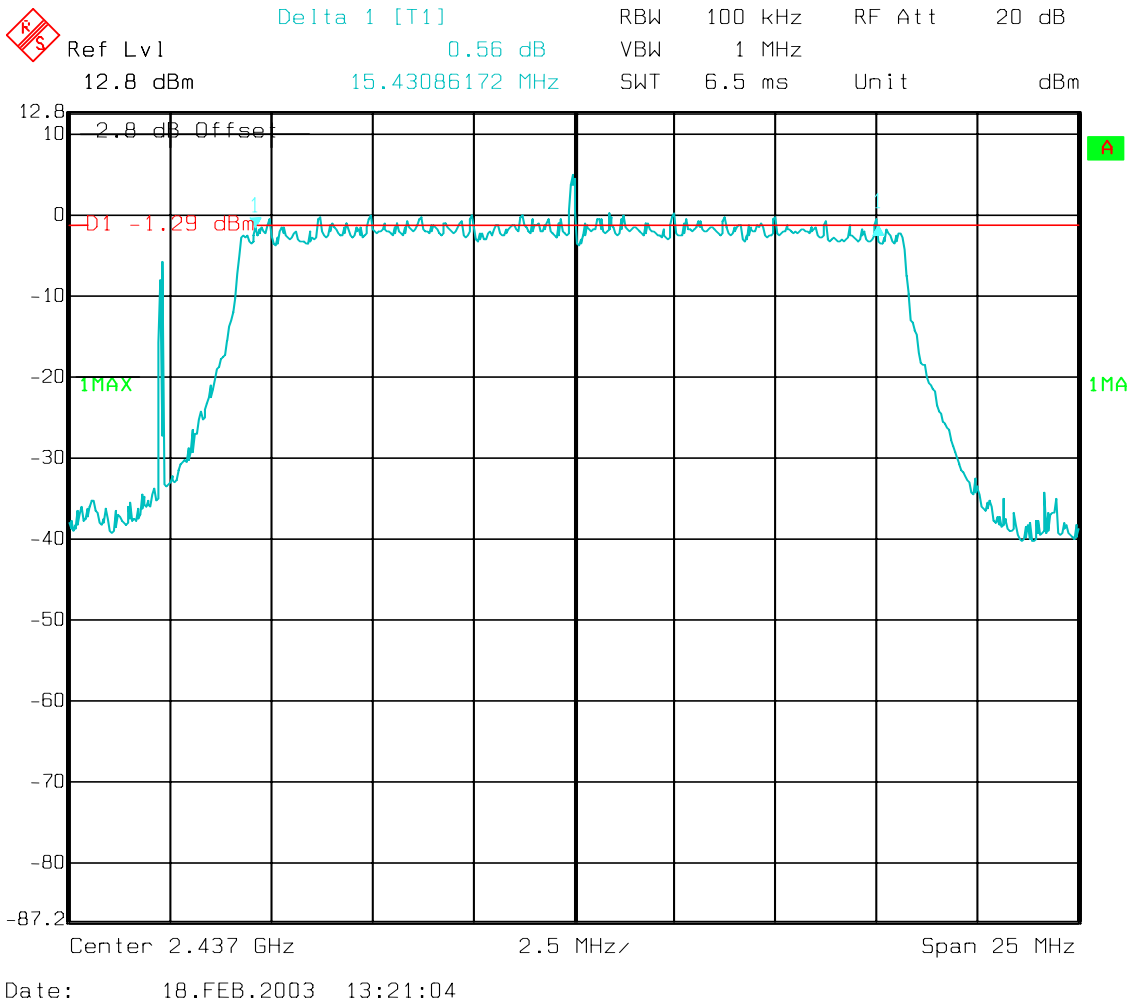
SPECTRUM BANDWIDTH OF DSSS SYSTEM **§15.247(a) (2)**
6 dB bandwidth

Lowest Channel: 2412MHz



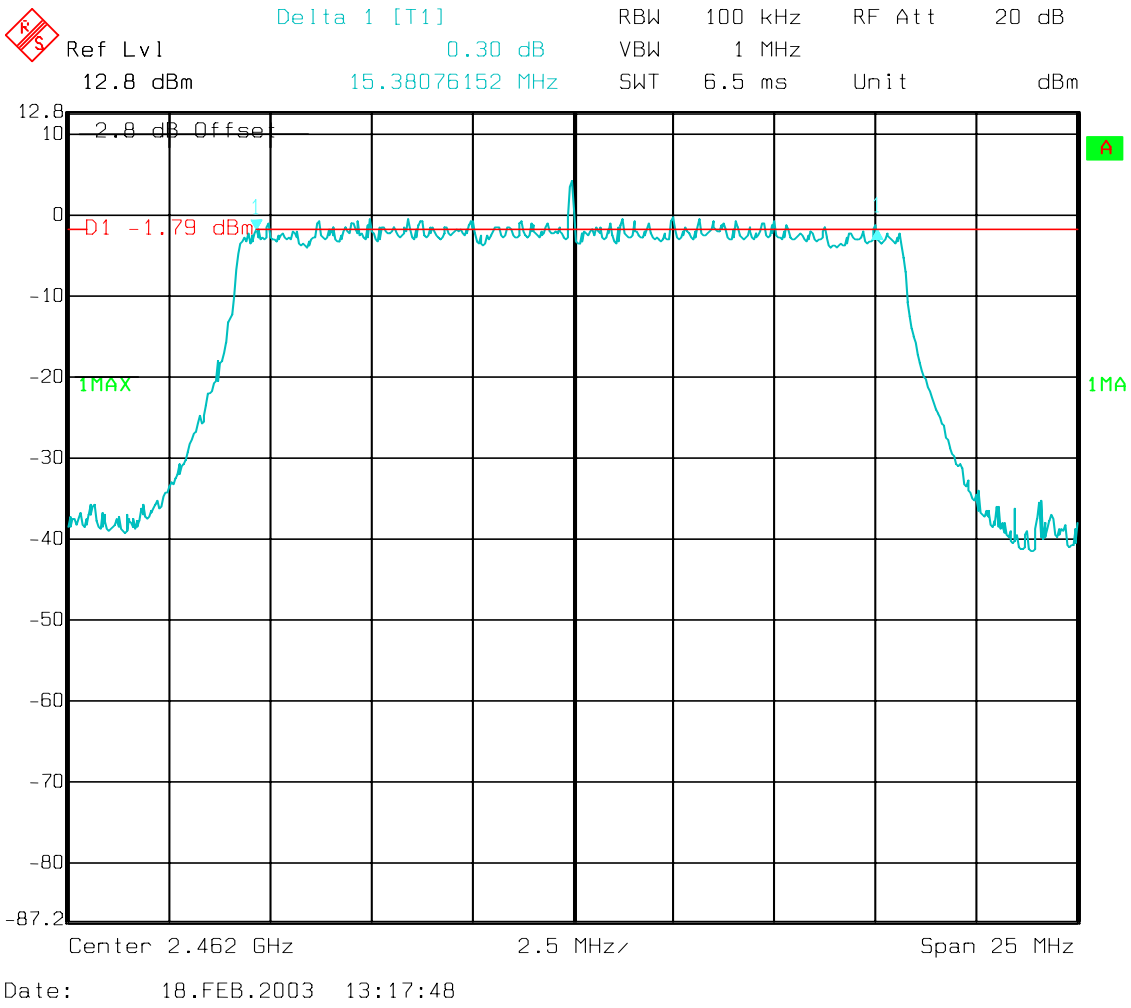
SPECTRUM BANDWIDTH OF DSSSS SYSTEM **§15.247(a) (2)**
6 dB bandwidth

Mid Channel: 2437MHz



SPECTRUM BANDWIDTH OF DSSS SYSTEM **§15.247(a) (2)**
6 dB bandwidth

Highest Channel: 2462MHz



OUTPUT POWER **§ 15.247 (b) (1)**

	Low channel	Mid channel	High channel
*Conducted Peak Power	25.62dBm	25.83dBm	25.09dBm
*Radiated Power (EIRP)	30.62dBm	30.83dBm	30.09dBm
**Source-based time averaged output	23.85dBm	24.06dBm	23.32dBm

***For details please refer to pages 12(Conducted output power results), 16(EIRP calculation) & 17(duty cycle measurements) respectively.**

****The source-based time-averaged output power is calculated using the duty cycle (measurement result see page 17-20, These values are used to determine if the TCB route can be used)**

MAXIMUM PEAK OUTPUT POWER **§ 15.247 (b) (1)**
(Conducted)

TEST CONDITIONS		MAXIMUM PEAK OUTPUT POWER (dBm)			
Frequency (MHz)			2412	2437	2462
T_{nom}(23)°C	V_{nom}(3.3) VDC	Pk	*25.62	*25.83	*25.09
Measurement uncertainty		±0.5dBm			

RBW / VBW: 10MHz

***To comply with following;**
RBW / VBW should be equal to or greater than the 6dB BW
All measured values are corrected by 10log 6dB BW / used BW

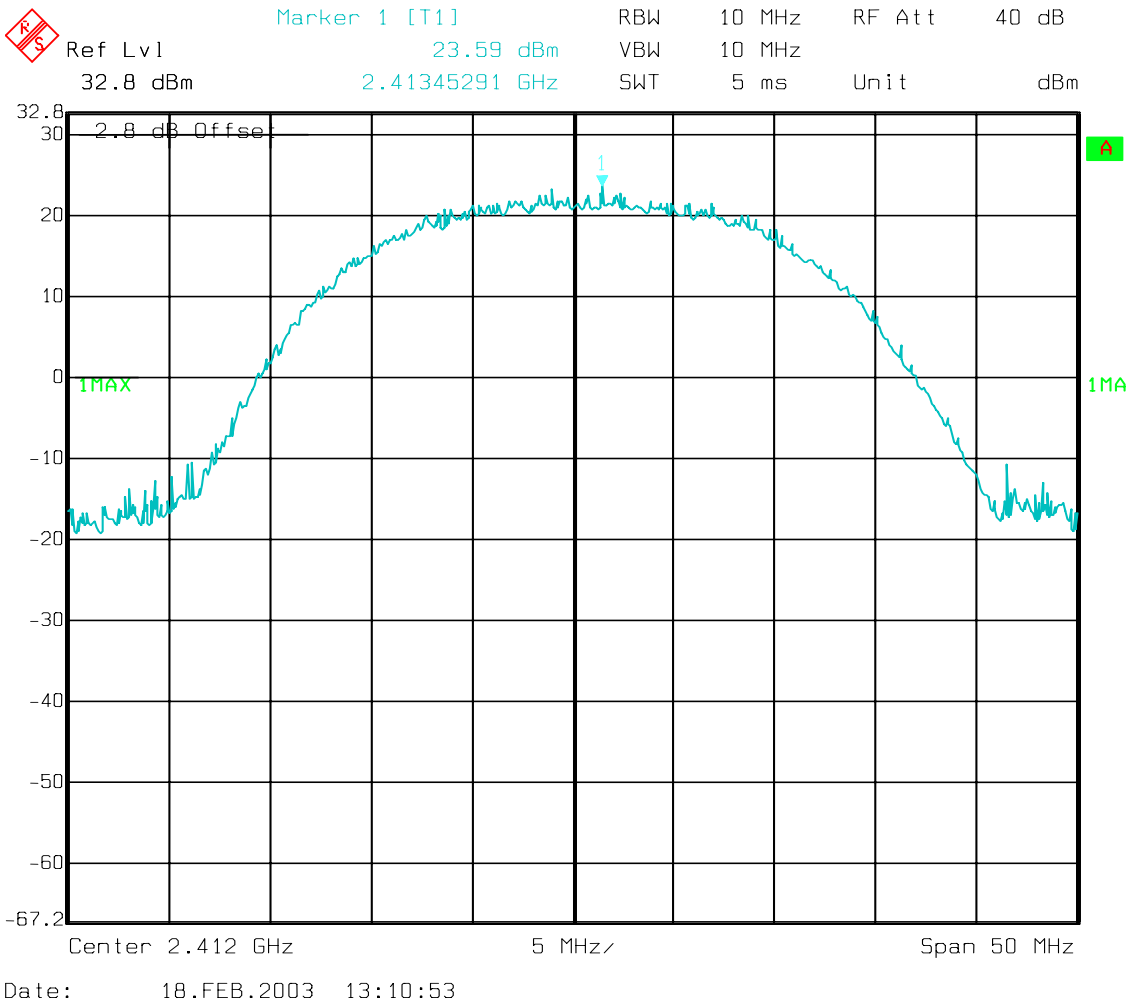
(Therefore correction factor of 2.03, 1.88 & 1.86 is added to low, mid& high channel measurements respectively)

LIMIT **SUBCLAUSE § 15.247 (b) (1)**

Frequency range	RF power output
2400-2483.5 MHz	1.0 Watt / 30dBm

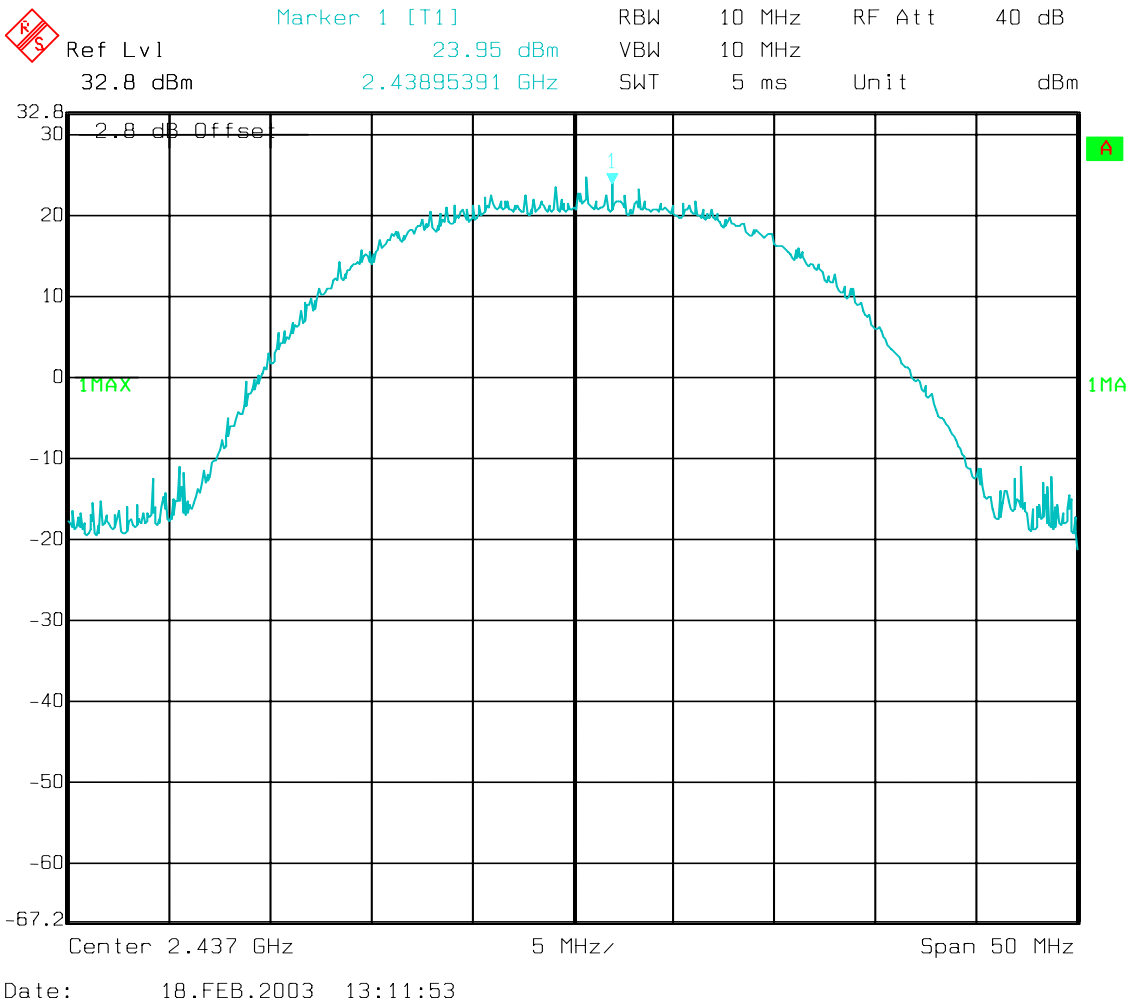
PEAK OUTPUT POWER (CONDUCTED) §15.247 (b) (1)

Lowest Channel: 2412MHz



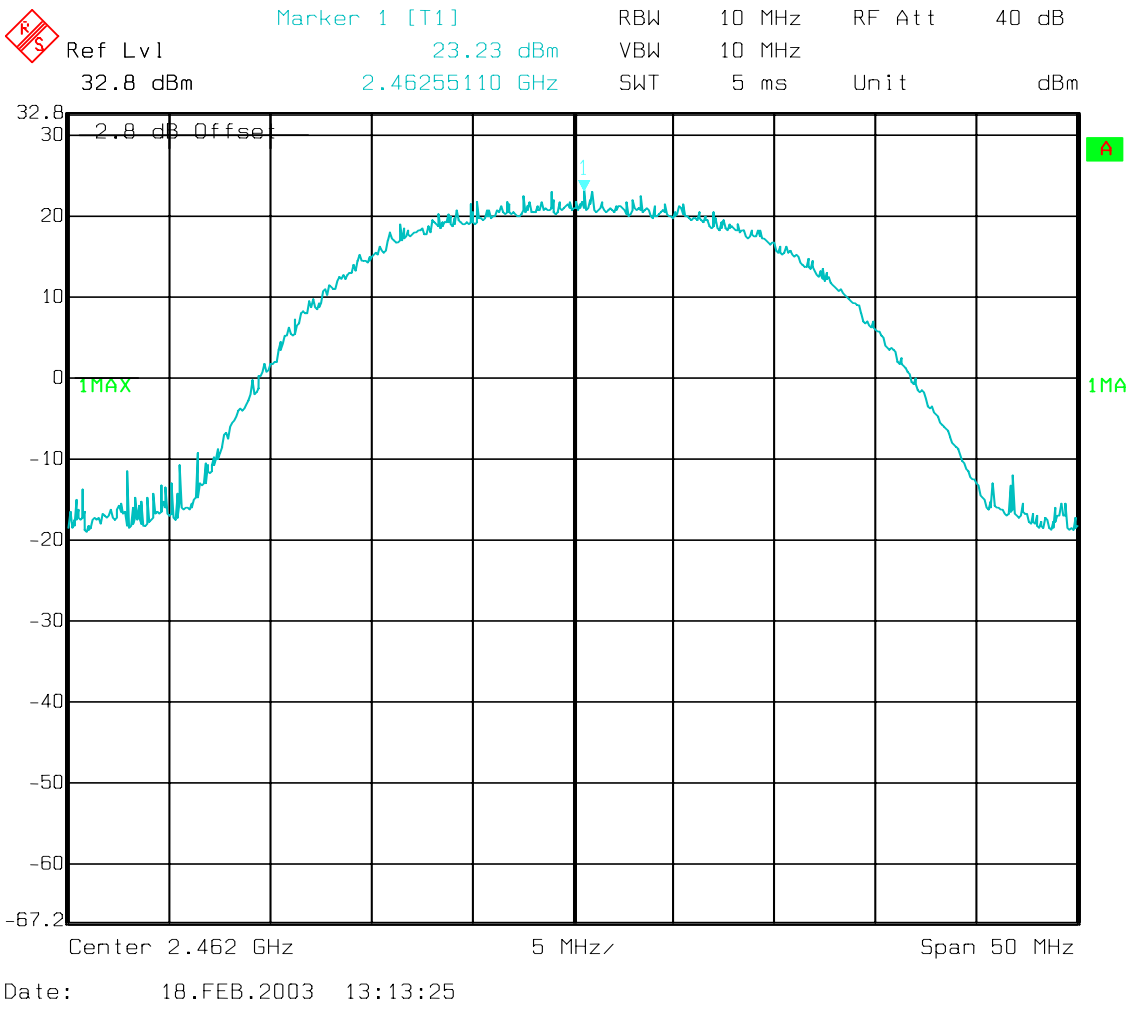
PEAK OUTPUT POWER (CONDUCTED) §15.247 (b)

Mid Channel: 2437MHz



PEAK OUTPUT POWER (CONDUCTED) §15.247 (b)

Highest Channel: 2462MHz



MAXIMUM PEAK OUTPUT POWER (RADIATED) **§ 15.247 (b) (1)**

EIRP:

TEST CONDITIONS		MAXIMUM PEAK OUTPUT POWER (dBm)		
Frequency (MHz)		2412	2437	2462
T_{nom}(23)°C	V_{nom}(3.3) VDC	*30.62	*30.83	*30.09
Measurement uncertainty		±0.5dBm		

***Note: EIRP is calculated based on 5dBi antenna and conducted peak power measurements.**

LIMIT **SUBCLAUSE § 15.247 (b) (1)**

Frequency range	RF power output
2400-2483.5 MHz	30dBm on Conducted

SOURCE-BASED TIME-AVERAGED OUTPUT

Tx_{on} = 140.2 µs

$Tx_{on}+Tx_{off}$ = 661.32 µs

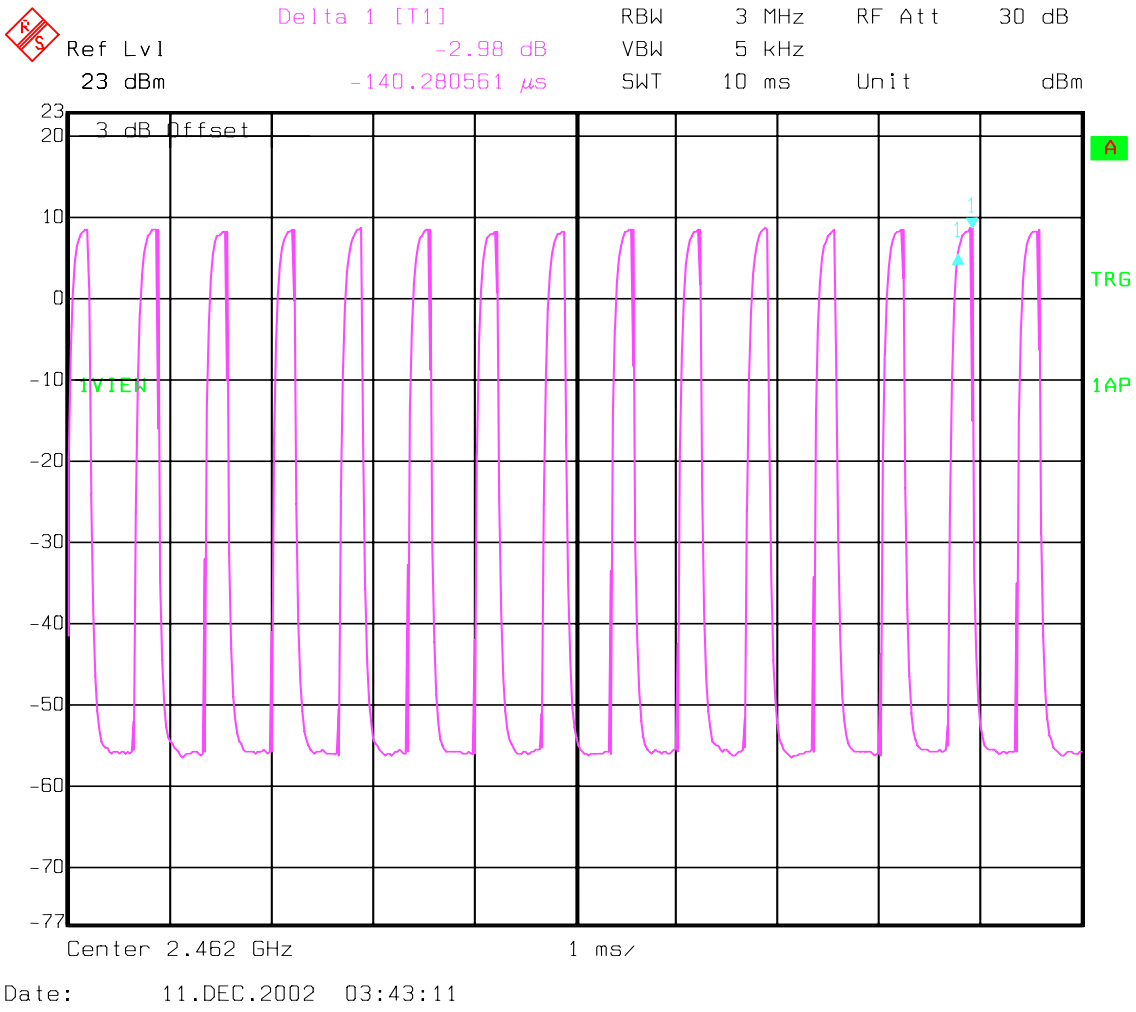
Duty factor = Tx_{on} / $Tx_{on}+Tx_{off}$ = 140.2 / 661.32 = 0.21

Therefore;
(Example for Low channel)
Source-based time averaged output = Max. EIRP + 10log(duty factor)
= 30.62 – 6.77 = **23.85dBm**

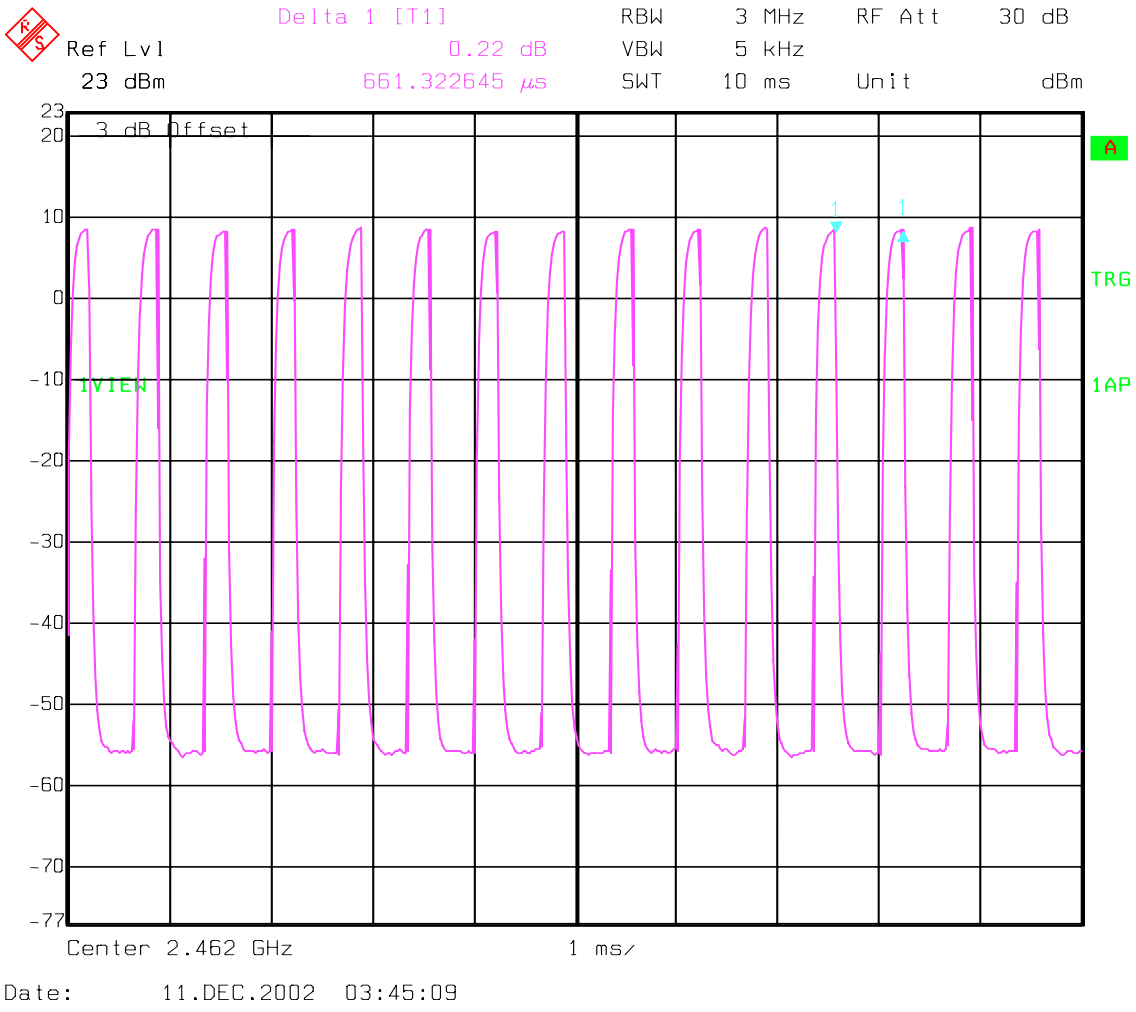
TEST CONDITIONS		**SOURCE-BASED TIME AVERAGED OUTPUT (dBm)**		
Frequency (MHz)		**2412**	**2437**	**2462**
T_{nom}(23)°C	**V_{nom}(3.3) VDC**	**23.85**	**24.06**	**23.32**

Please refer to the plots on next pages

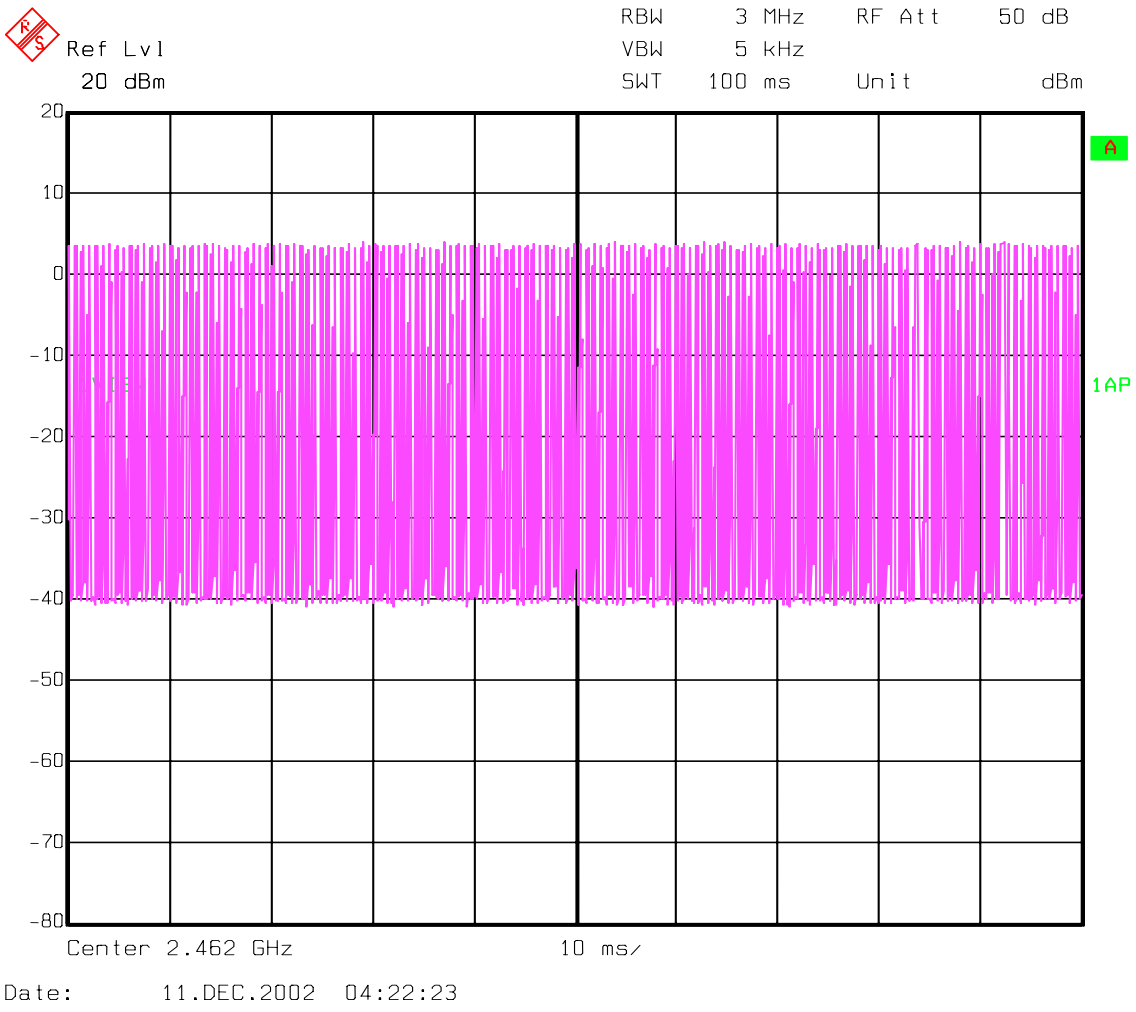
Transmitter ON time – Tx_{on}



Transmitter ON+OFF time – Tx_{on} + Tx_{off}



100ms plot – to show repetition of pattern



POWER SPECTRAL DENSITY §15.247 (d)

TEST CONDITIONS		POWER SPECTRAL DENSITY (dBm)		
Frequency (MHz)		2412	2437	2462
T_{nom}(23)°C	V_{nom}(3.3) VDC	1.13	1.64	1.28

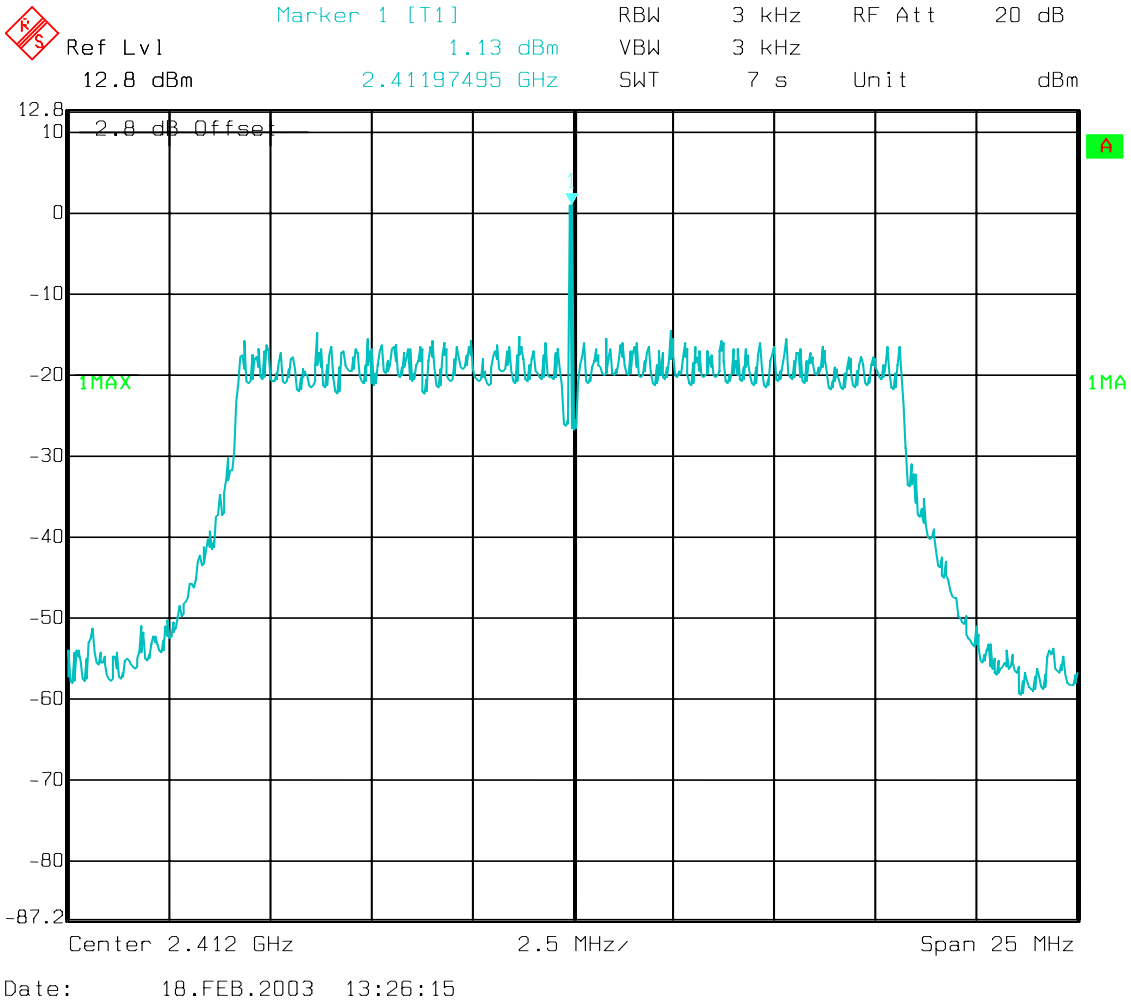
LIMIT **SUBCLAUSE §15.247(d)**

The peak power spectral density shall not be greater than 8dBm in any 3 kHz band

ANALYZER SETTINGS: RBW=3KHz, VBW=3KHz

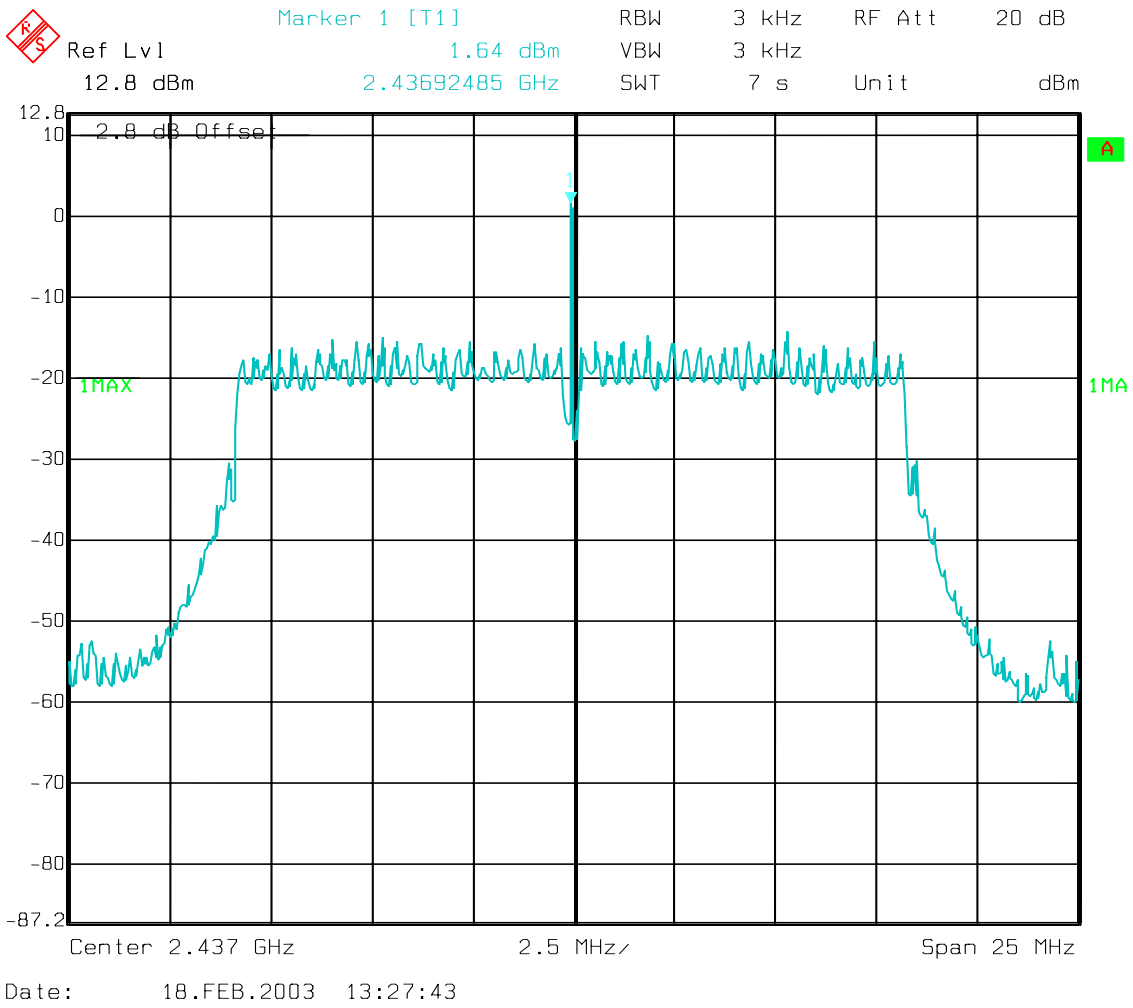
POWER SPECTRAL DENSITY §15.247(d)

Lowest Channel: 2412MHz



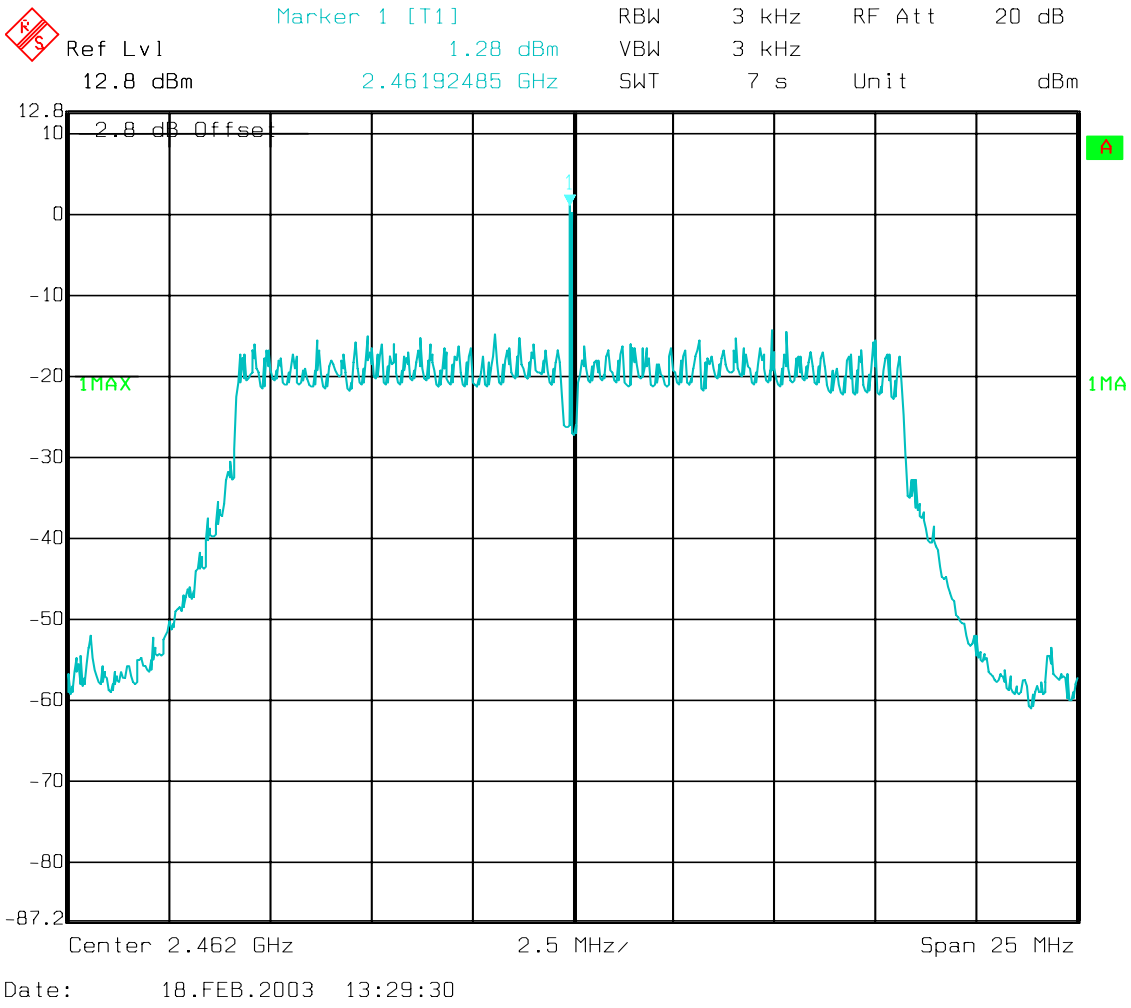
POWER SPECTRAL DENSITY §15.247(d)

Mid Channel: 2437MHz



POWER SPECTRAL DENSITY §15.247(d)

Highest Channel: 2462MHz



POWER SPECTRAL DENSITY **RSS-210**

TEST CONDITIONS		POWER SPECTRAL DENSITY (dBm/MHz)		
Frequency (MHz)		2412	2437	2462
T_{nom}(23)°C	V_{nom}(3.3) VDC	*11.37	*11.31	*11.37

***Correction factor of 60dBm is added to convert measured values from dBm/Hz to dBm/MHz**

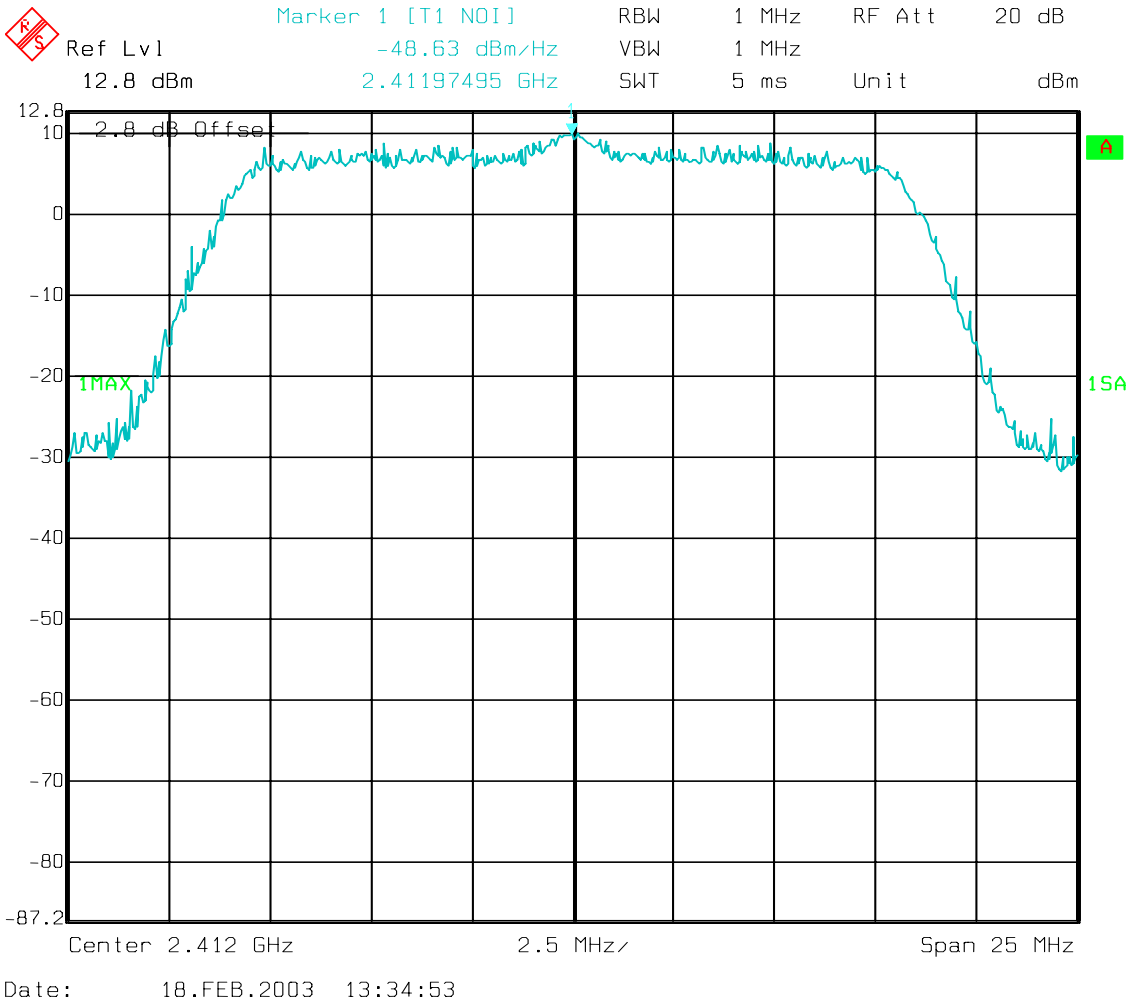
LIMIT **RSS-210**

The peak power spectral density shall be ≤ 50mW/MHz (17dBm/MHz)

ANALYZER SETTINGS: RBW=1MHz, VBW=1MHz

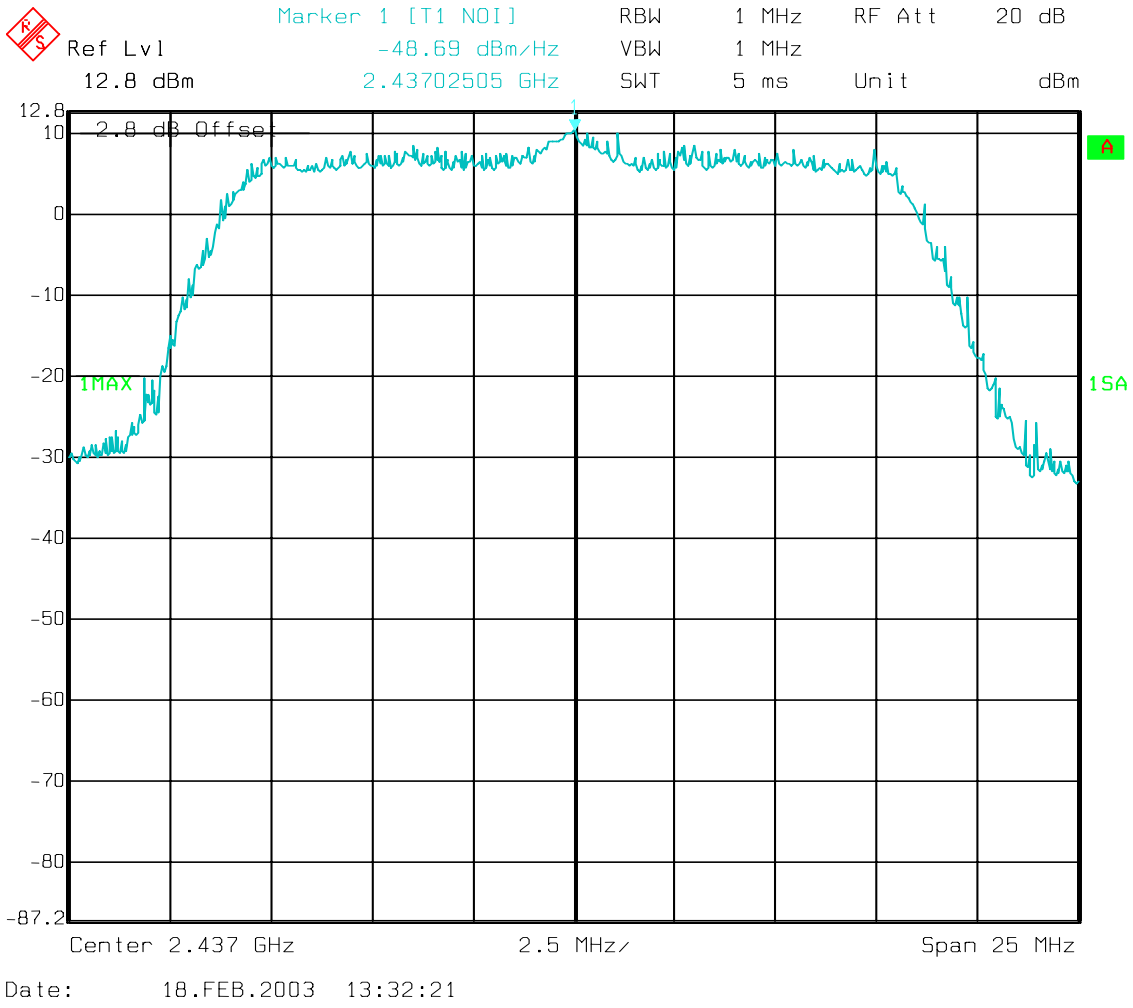
POWER SPECTRAL DENSITY RSS-210

Lowest Channel: 2412MHz



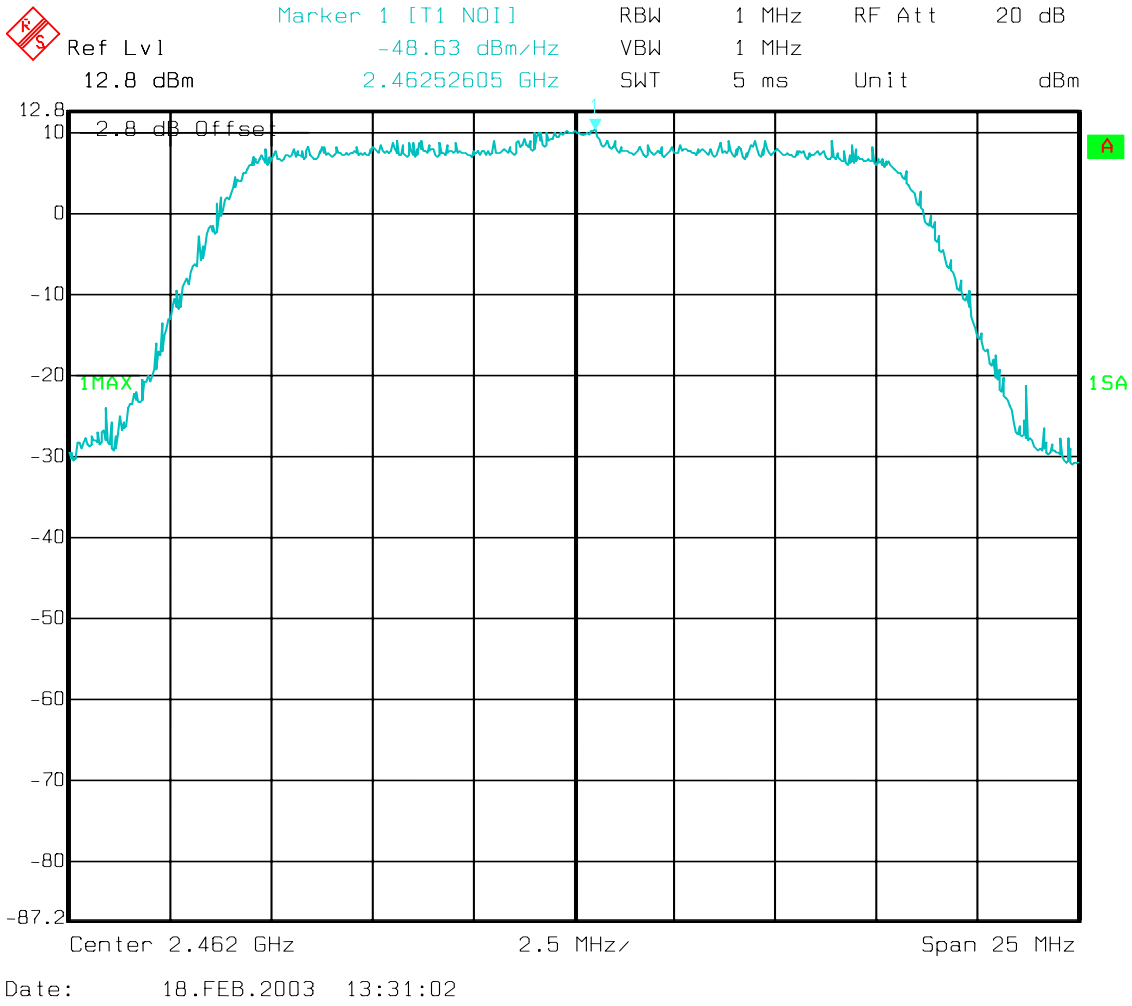
POWER SPECTRAL DENSITY RSS-210

Mid Channel: 2437MHz



POWER SPECTRAL DENSITY **RSS-210**

Highest Channel: 2462MHz

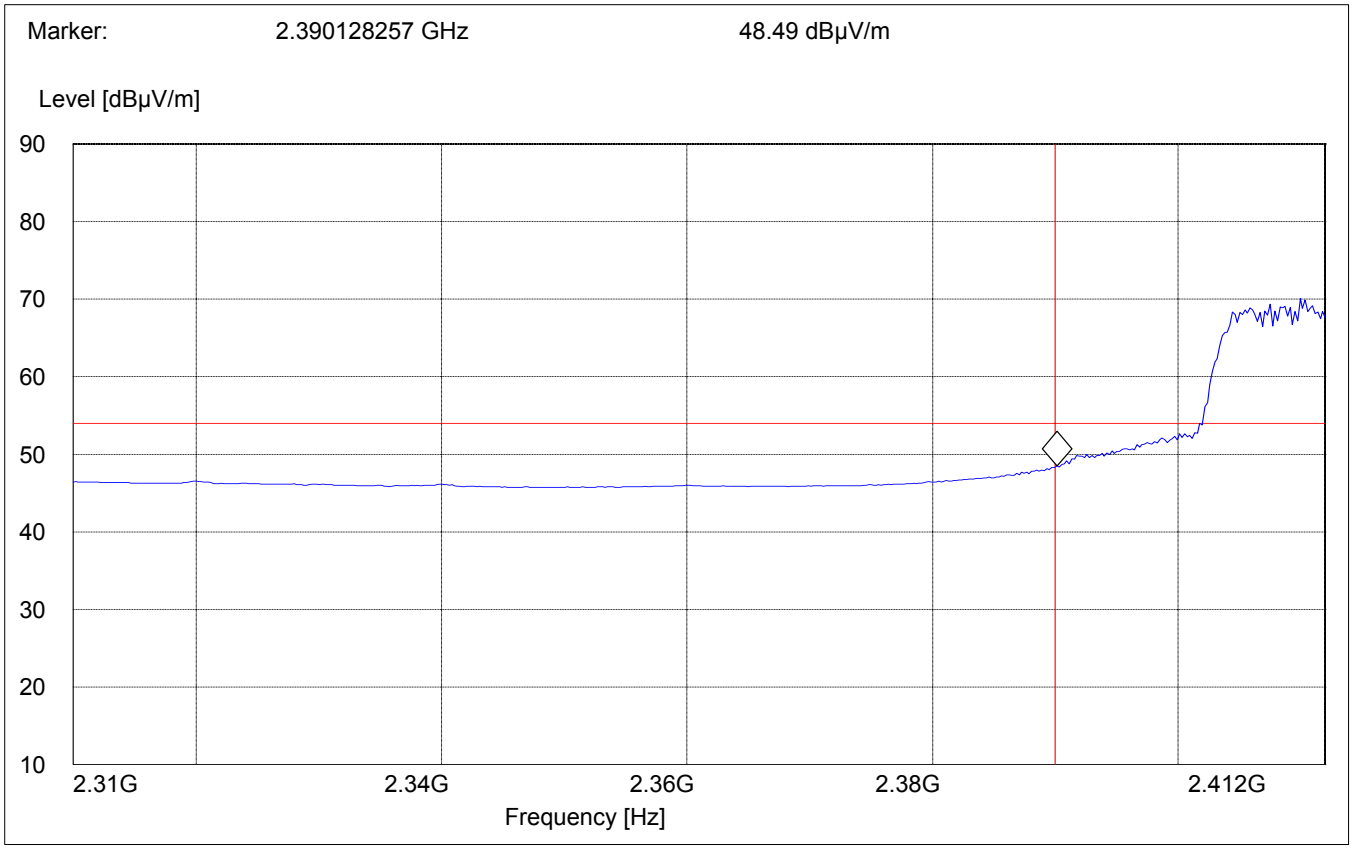


BAND EDGE COMPLIANCE §15.247 (c)

Low frequency section (spurious in the restricted band 2310 – 2390 MHz) (Average measurement)

Operating condition : Tx at 2412MHz
SWEEP TABLE : "FCC15.247 LBE_AVG"
Limit Line : 54dBµV

Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
2.31 GHz	2.412 GHz	MaxPeak	Coupled	1 MHz	10Hz	#326 horn (dBi)

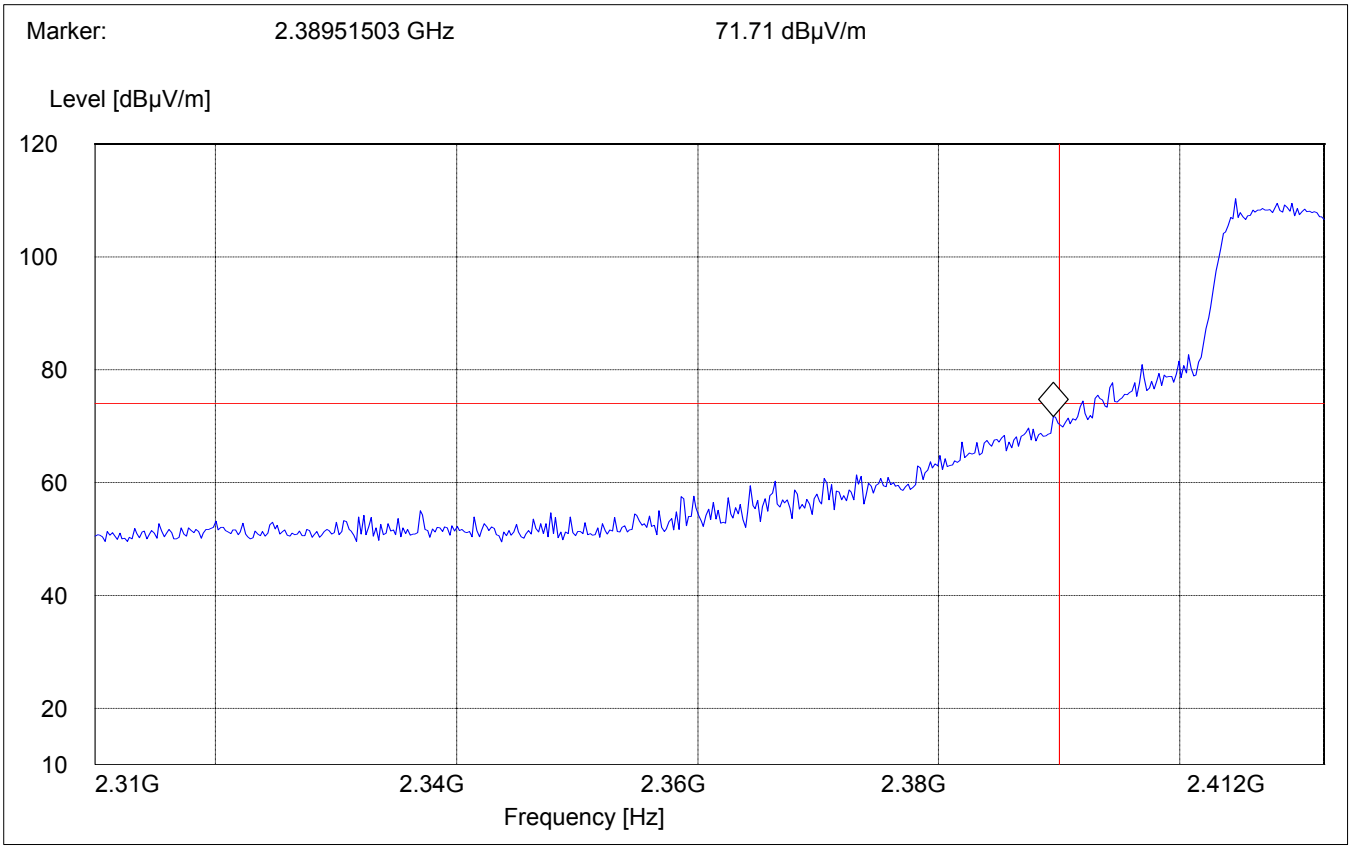


BAND EDGE COMPLIANCE §15.247 (c)

Low frequency section (spurious in the restricted band 2310 – 2390 MHz) (Peak measurement)

Operating condition : Tx at 2412MHz
SWEEP TABLE : "FCC15.247 LBE_Pk"
Limit Line : 74dBµV

Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
2.31 GHz	2.412 GHz	MaxPeak	Coupled	1 MHz	1MHz	#326 horn (dBi)

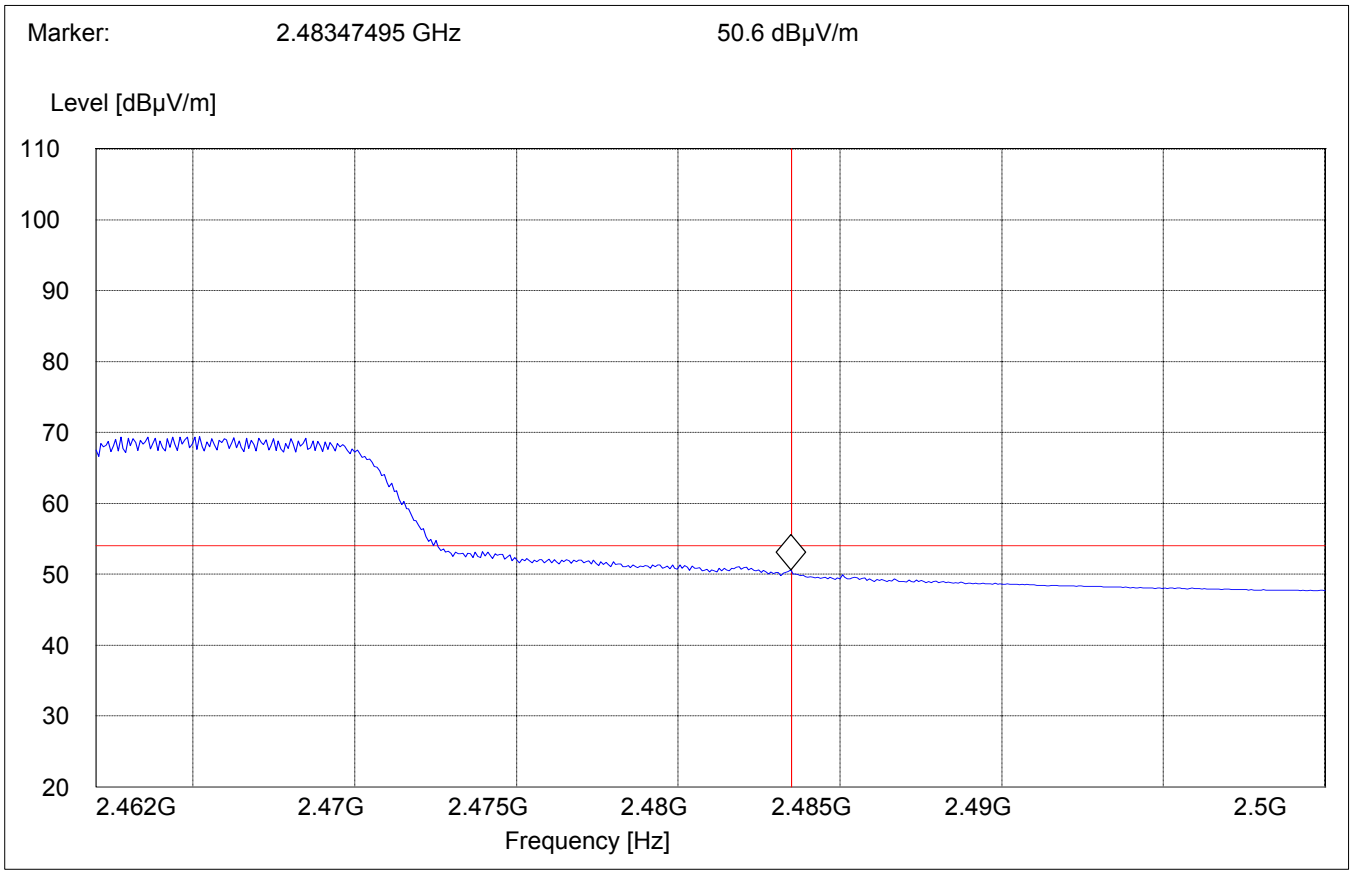


BAND EDGE COMPLIANCE §15.247 (c)

High frequency section (spurious in the restricted band 2483.5 – 2500 MHz) (Average measurement)

Operating condition : Tx at 2472MHz
SWEEP TABLE : "FCC15.247 HBE_AVG"
Limit Line : 54dBµV

Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
2.462 GHz	2.5 GHz	MaxPeak	Coupled	1 MHz	10Hz	#326 horn (dBi)

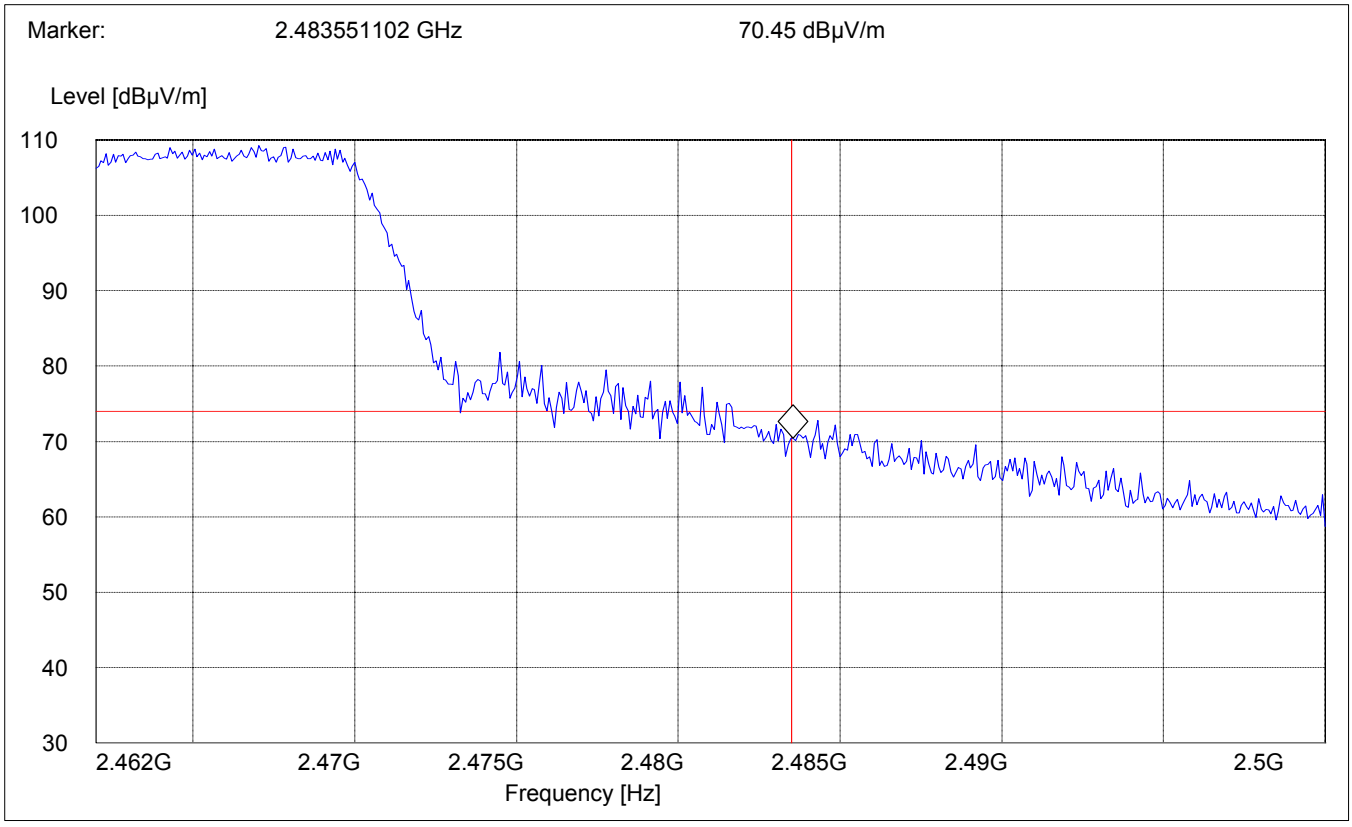


BAND EDGE COMPLIANCE §15.247 (c)

High frequency section (spurious in the restricted band 2483.5 – 2500 MHz) (Peak measurement)

Operating condition : Tx at 2472MHz
SWEEP TABLE : "FCC15.247 HBE_PK"
Limit Line : 74dBµV

Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
2.462 GHz	2.5 GHz	MaxPeak	Coupled	1 MHz	1MHz	#326 horn (dBi)



EMISSION LIMITATIONS **§ 15.247 (c) (1)**
Transmitter (Conducted)
LIMITS

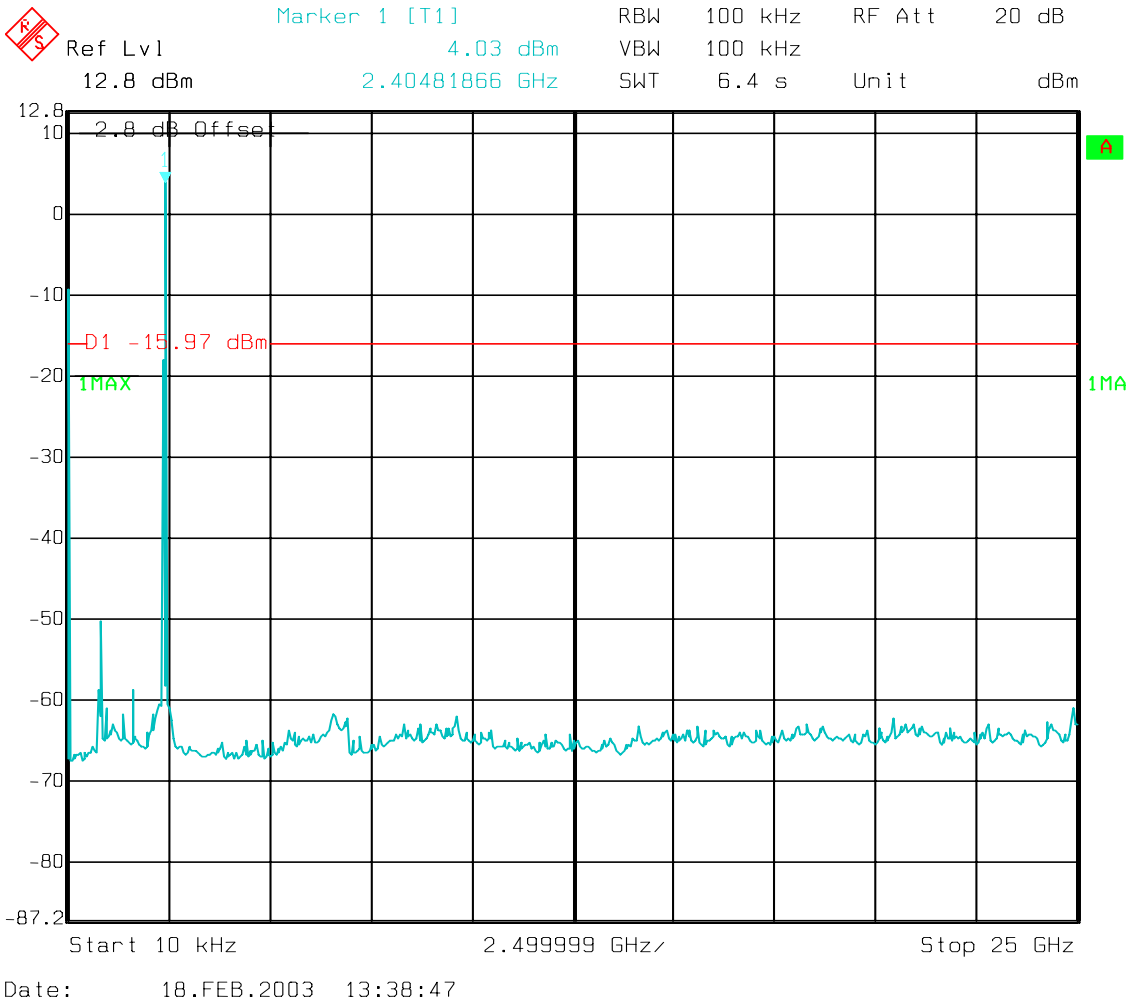
In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions, which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

NOTE: Frequency resolution is not fine enough to show the exact frequency of the carrier.

EMISSION LIMITATIONS - Conducted (Transmitter) § 15.247 (c) (1)

Lowest Channel (2412MHz): 10kHz - 25GHz

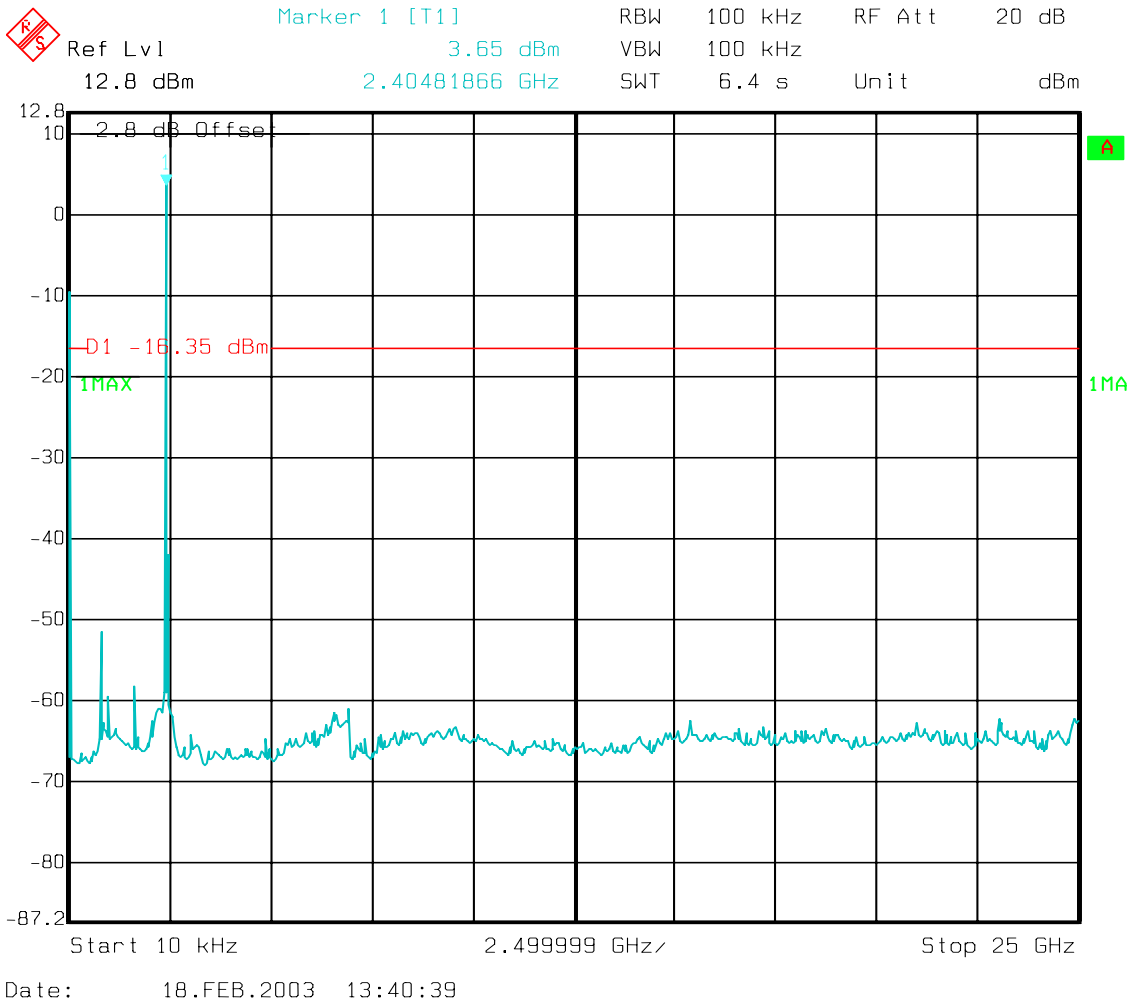
NOTE: The peak above the limit line is the carrier frequency.



EMISSION LIMITATIONS - Conducted (Transmitter) § 15.247 (c) (1)

Mid Channel (2437MHz): 10kHz - 25GHz

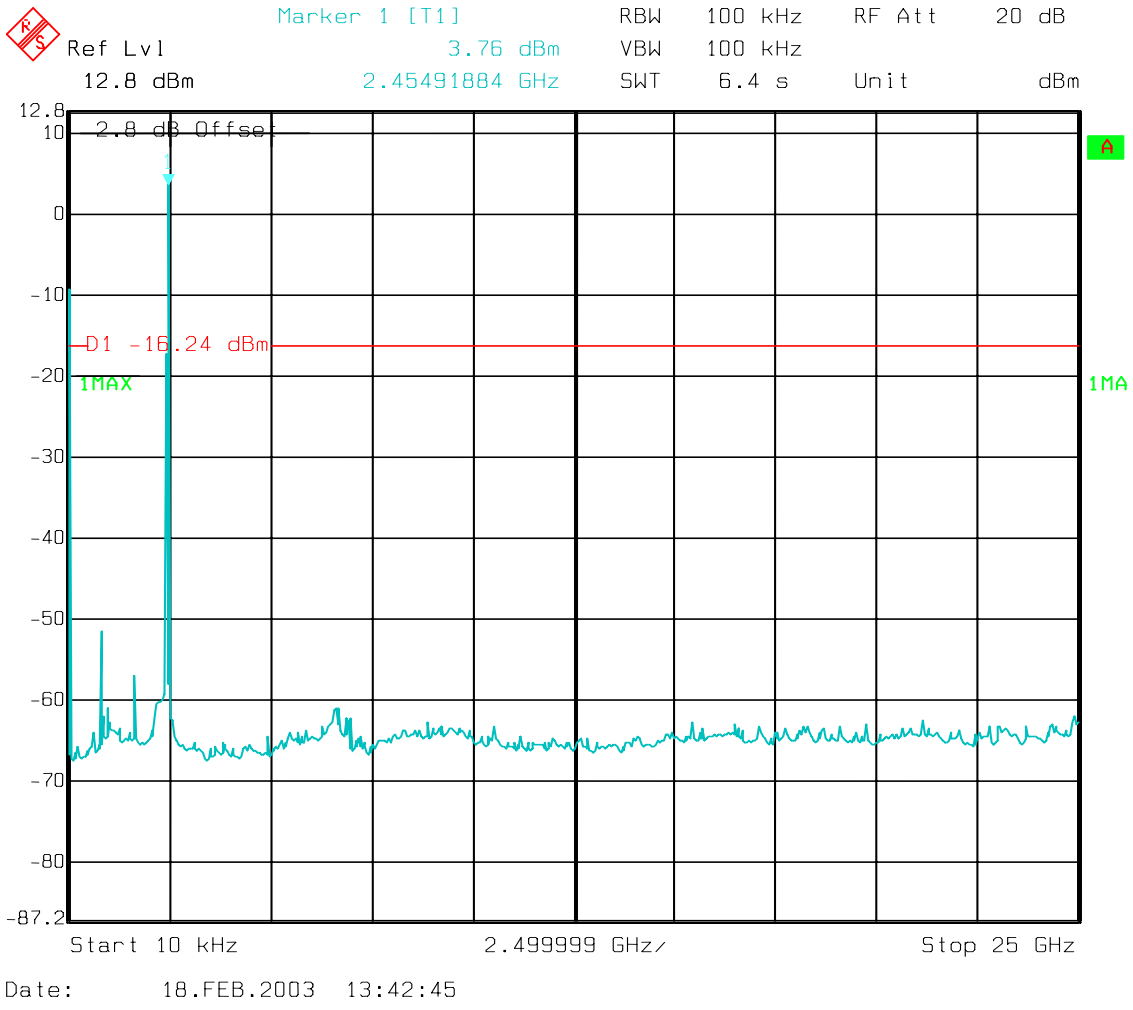
NOTE: The peak above the limit line is the carrier frequency.



EMISSION LIMITATIONS - Conducted (Transmitter) § 15.247 (c) (1)

Highest Channel (2462MHz): 10MHz - 25GHz

NOTE: The peak above the limit line is the carrier frequency.



EMISSION LIMITATIONS **§ 15.247 (c) (1)**
Transmitter (Radiated)

LIMITS

In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions, which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

NOTE:
1. The radiated emissions were done with different settings, using the relevant pre-amplifiers for the relevant frequency ranges. This is the reason that the graphs show different noise levels. In the range between 3 and 25 GHz very short cable connections to the antenna was used to minimize the noise level.

2. All measurements are done in peak mode unless specified with the plots.

Results for the radiated measurements below 30MHz according § 15.33

Frequency	Measured values	Remarks
9KHz – 30MHz	No emissions found, caused by the EUT	This is valid for all the tested channels

EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)

Note: All radiated measurements were made in all three orthogonal planes. The values reported are the maximum values.

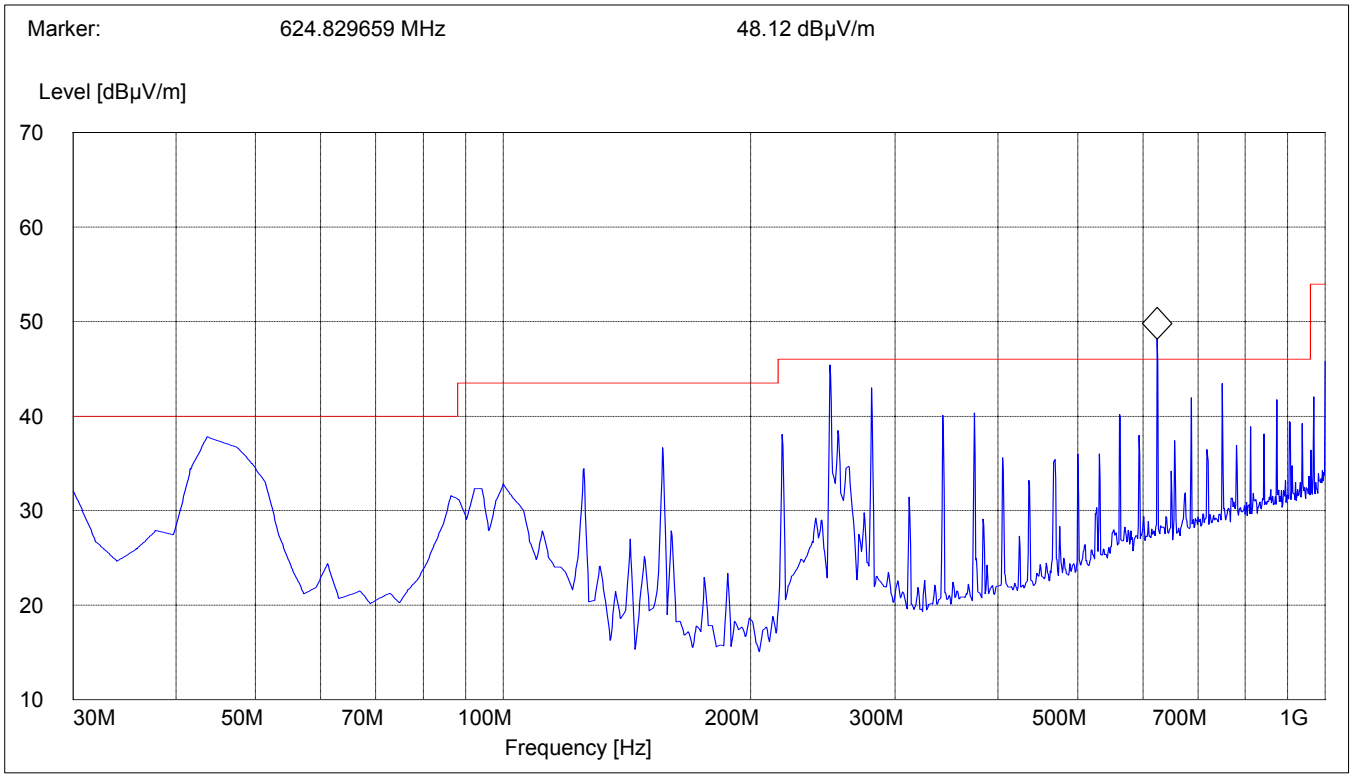
Transmit at Lowest channel Frequency 2412MHz			
Frequency (MHz)	Level (dBµV/m)		
	Peak	Quasi-Peak	Average
249.66	45.42	43.42	
624.83	48.12	43.34	
9643.2	52.33		
Transmit at Middle channel Frequency 2437MHz			
Frequency (MHz)	Level (dBµV/m)		
	Peak	Quasi-Peak	Average
9763.5	50.04		
Transmit at Highest channel Frequency 2462MHz			
Frequency (MHz)	Level (dBµV/m)		
	Peak	Quasi-Peak	Average
9853.7	44.18		

EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)

Lowest Channel (2412MHz): 30MHz – 1GHz

Note: This plot is valid for all three (low, mid, high) channels. This plot shows peak measurements only; all peaks close to or above the limit line were attenuated significantly when subjected to Quasi-peak (for details see page 38)

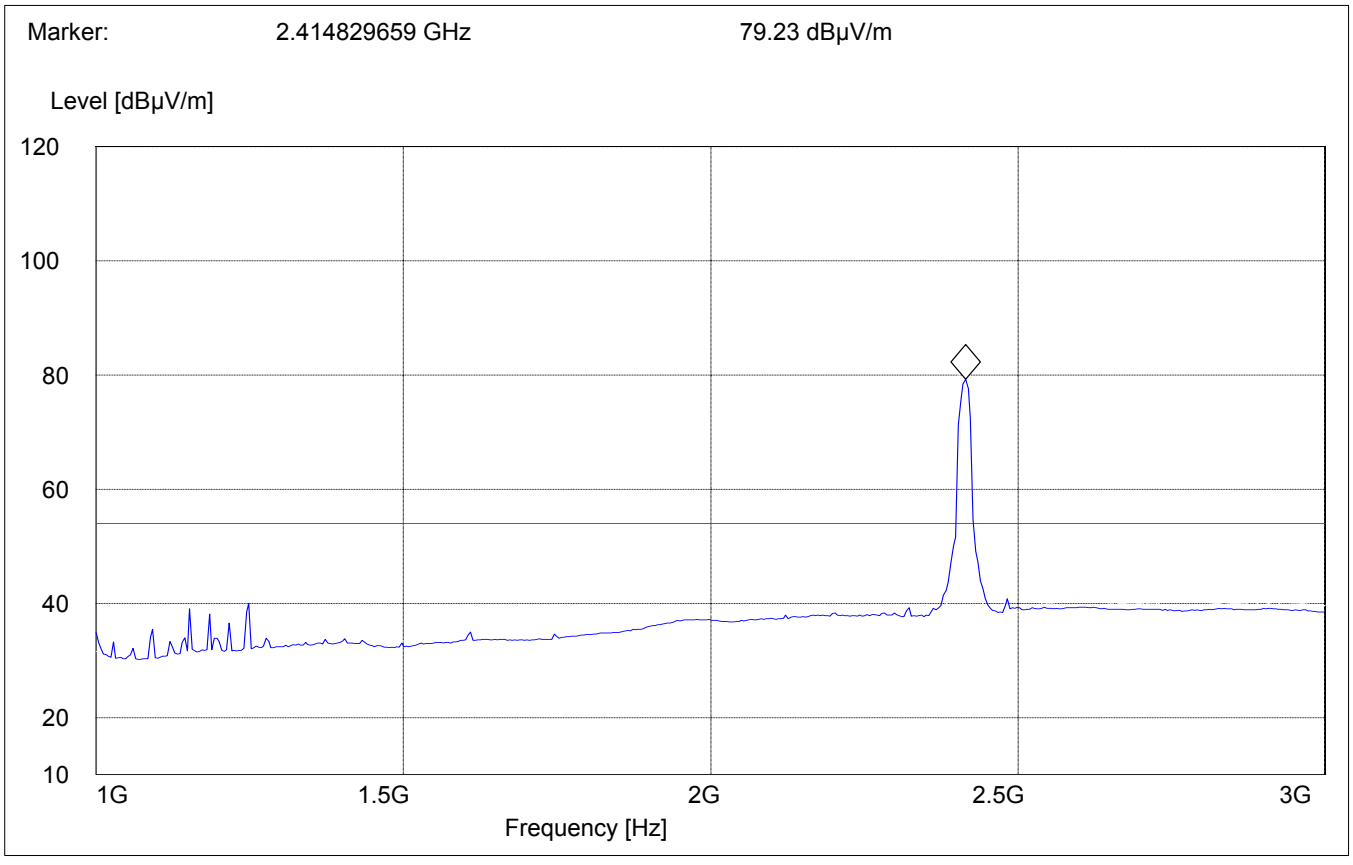
SWEEP TABLE:		"BT Spuri hi 30-1G"			
Short Description:		Bluetooth 30MHz-1GHz			
Start Frequency	Stop Frequency	Detector	Meas. Time	RBW VBW	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	3141-#1186



EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)
Lowest Channel (2412MHz): 1GHz – 3GHz
Average Measurement with VBW=10Hz

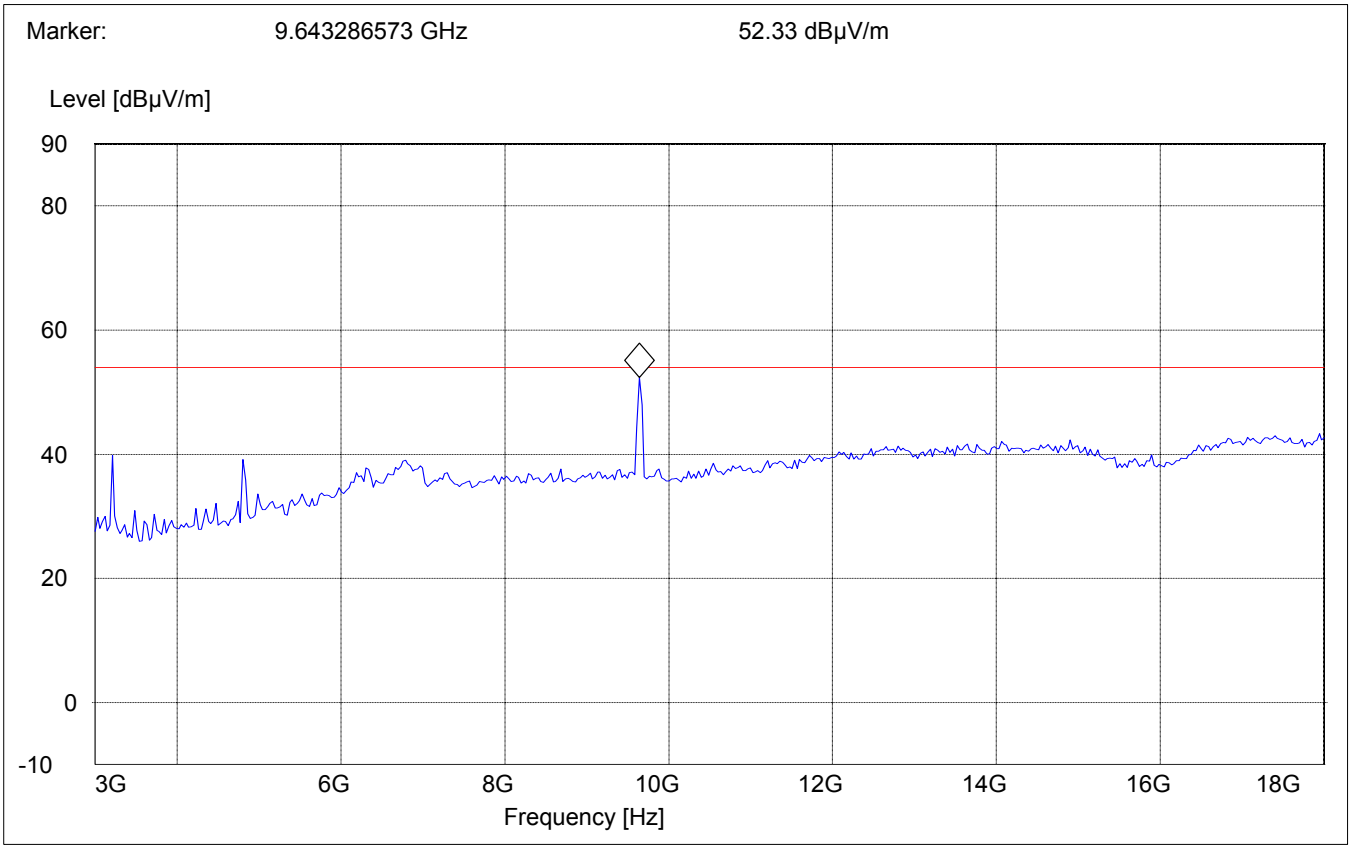
Note: The peak above the limit line is the carrier freq.

SWEEP TABLE:		"BT Spuri hi 1-3G"				
Short Description:		Bluetooth Spurious 1-3GHz				
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
1.0 GHz	3.0 GHz	MaxPeak	Coupled	1 MHz	10Hz	#326 horn (dBi)



EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)
Lowest Channel (2412MHz): 3GHz – 18GHz

SWEEP TABLE:		"BT Spuri hi 3-18G"				
Short Description:		Bluetooth Spurious 3-18GHz				
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
3.0 GHz	18.0 GHz	MaxPeak	Coupled	1 MHz	1 MHz	#326 horn (dBi)

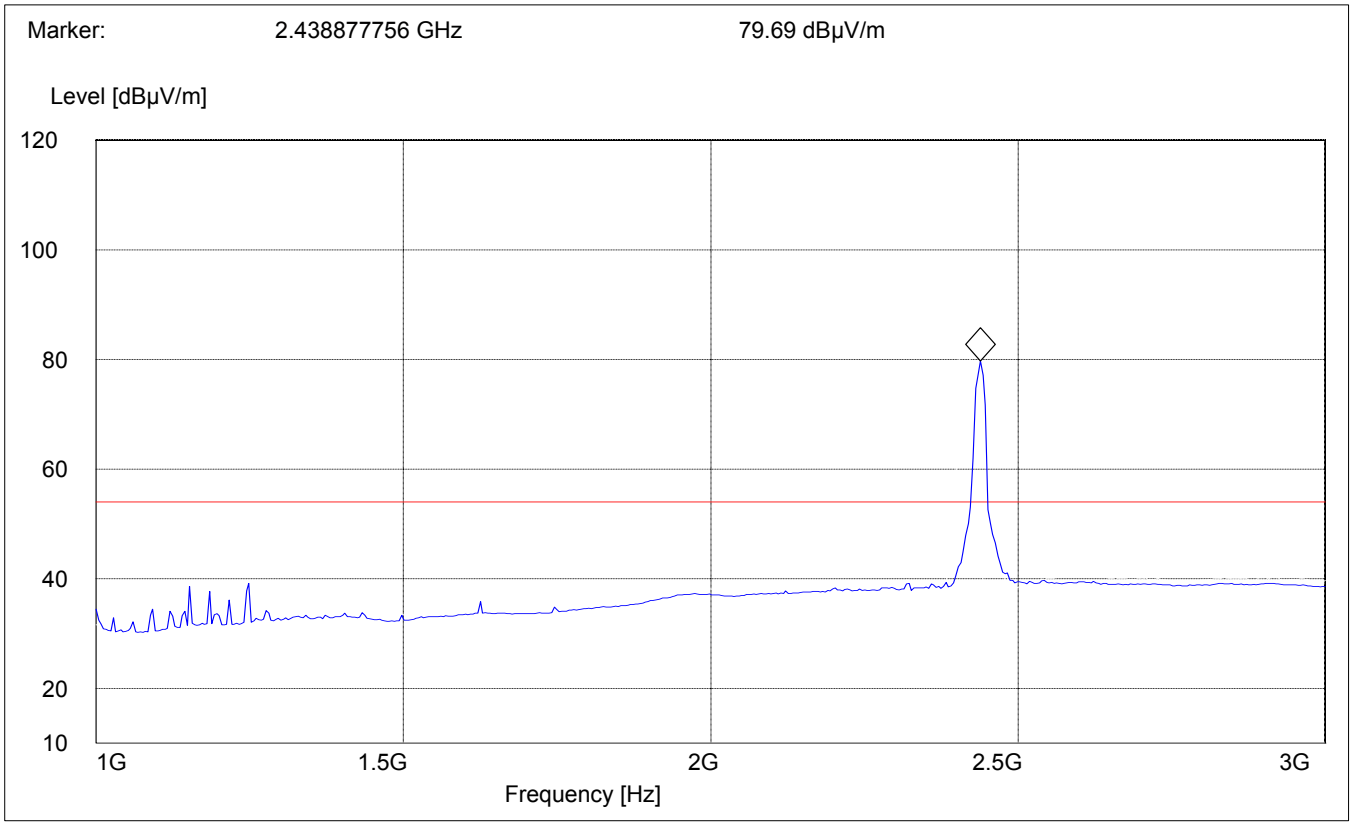


EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)
Mid Channel (2437MHz): 1GHz – 3GHz

Average Measurement with VBW=10Hz

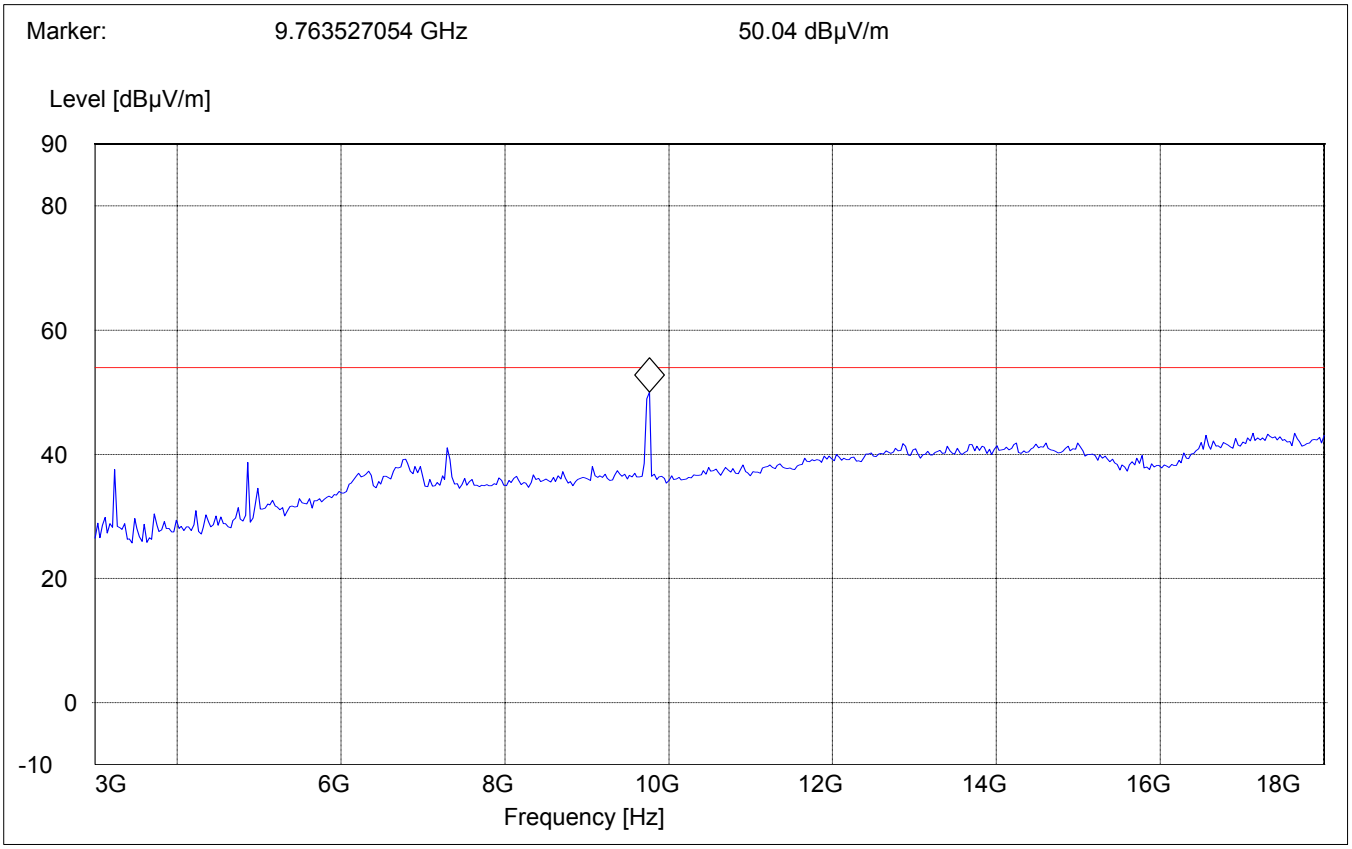
Note: The peak above the limit line is the carrier freq.

SWEEP TABLE:		"BT Spuri hi 1-3G"				
Short Description:		Bluetooth Spurious 1-3GHz				
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
1.0 GHz	3.0 GHz	MaxPeak	Coupled	1 MHz	10Hz	#326 horn (dBi)



EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)
Mid Channel (2437MHz): 3GHz – 18GHz

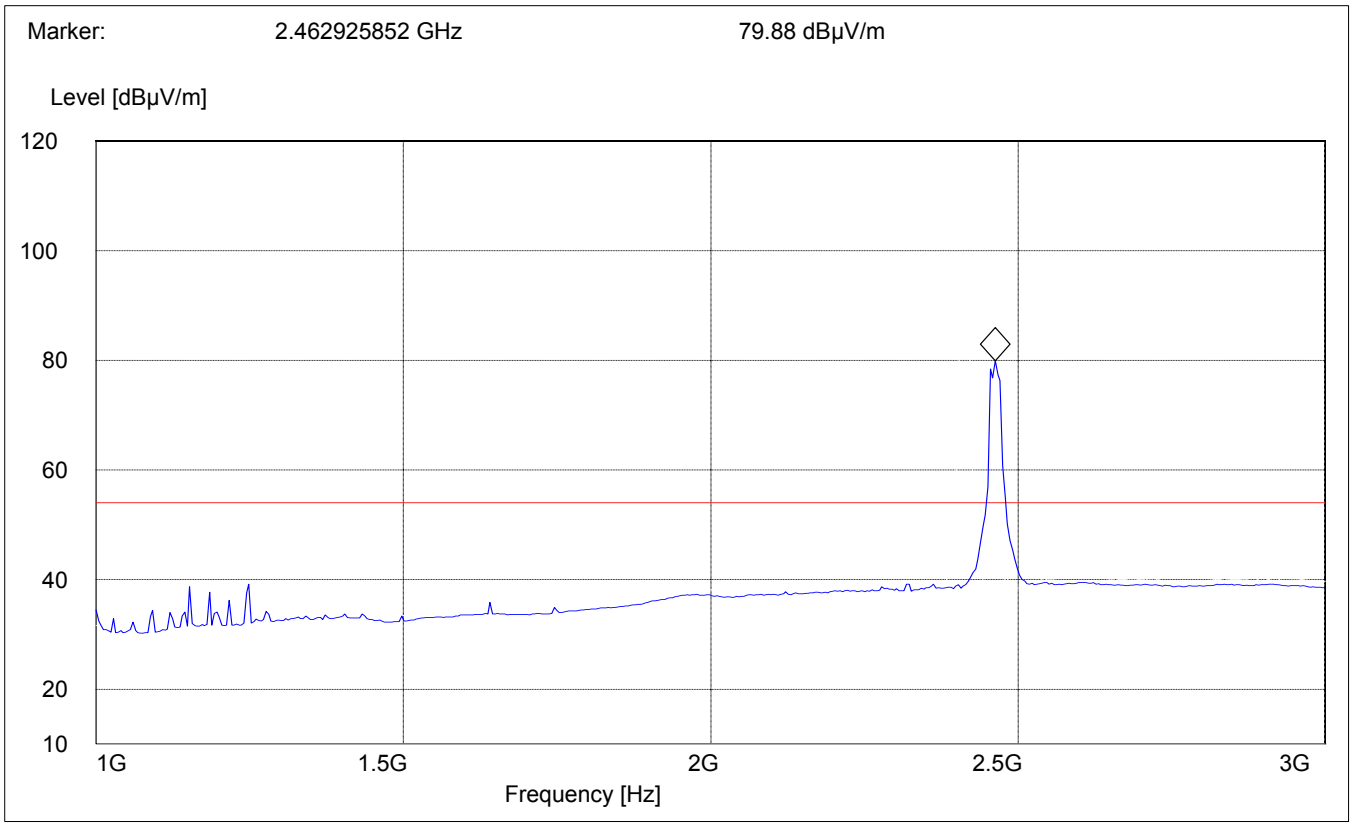
SWEEP TABLE:		"BT Spuri hi 3-18G"				
Short Description:		Bluetooth Spurious 3-18GHz				
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
3.0 GHz	18.0 GHz	MaxPeak	Coupled	1 MHz	1 MHz	#326 horn (dBi)



EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)
Highest Channel (2462MHz): 1GHz – 3GHz
Average Measurement with VBW=10Hz

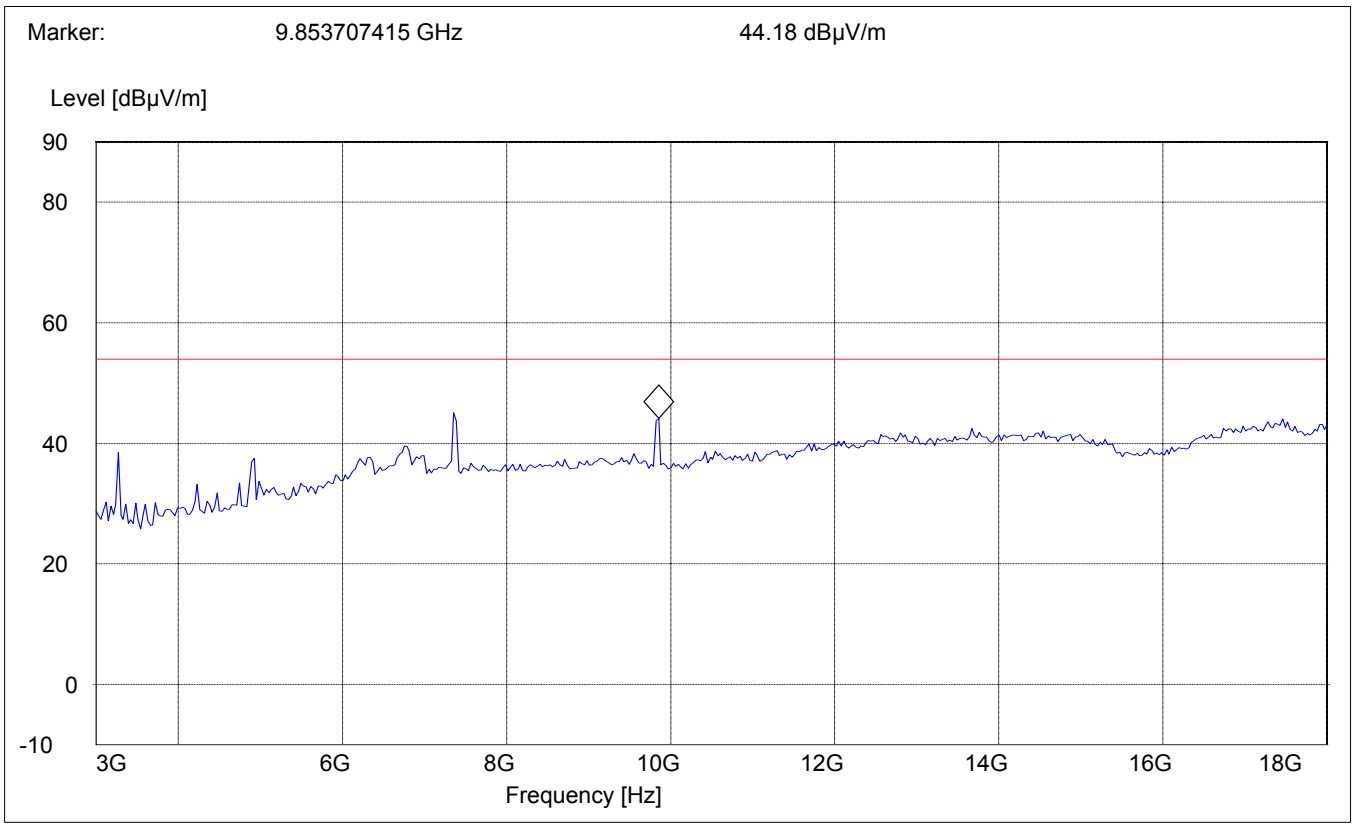
Note: The peak above the limit line is the carrier freq.

SWEEP TABLE:		"BT Spuri hi 1-3G"				
Short Description:		Bluetooth Spurious 1-3GHz				
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
1.0 GHz	3.0 GHz	MaxPeak	Coupled	1 MHz	10Hz	#326 horn (dBi)



EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)
Highest Channel (2462MHz): 3GHz – 18GHz

SWEEP TABLE:		"BT Spuri hi 3-18G"				
Short Description:		Bluetooth Spurious 3-18GHz				
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
3.0 GHz	18.0 GHz	MaxPeak	Coupled	1 MHz	1 MHz	#326 horn (dBi)



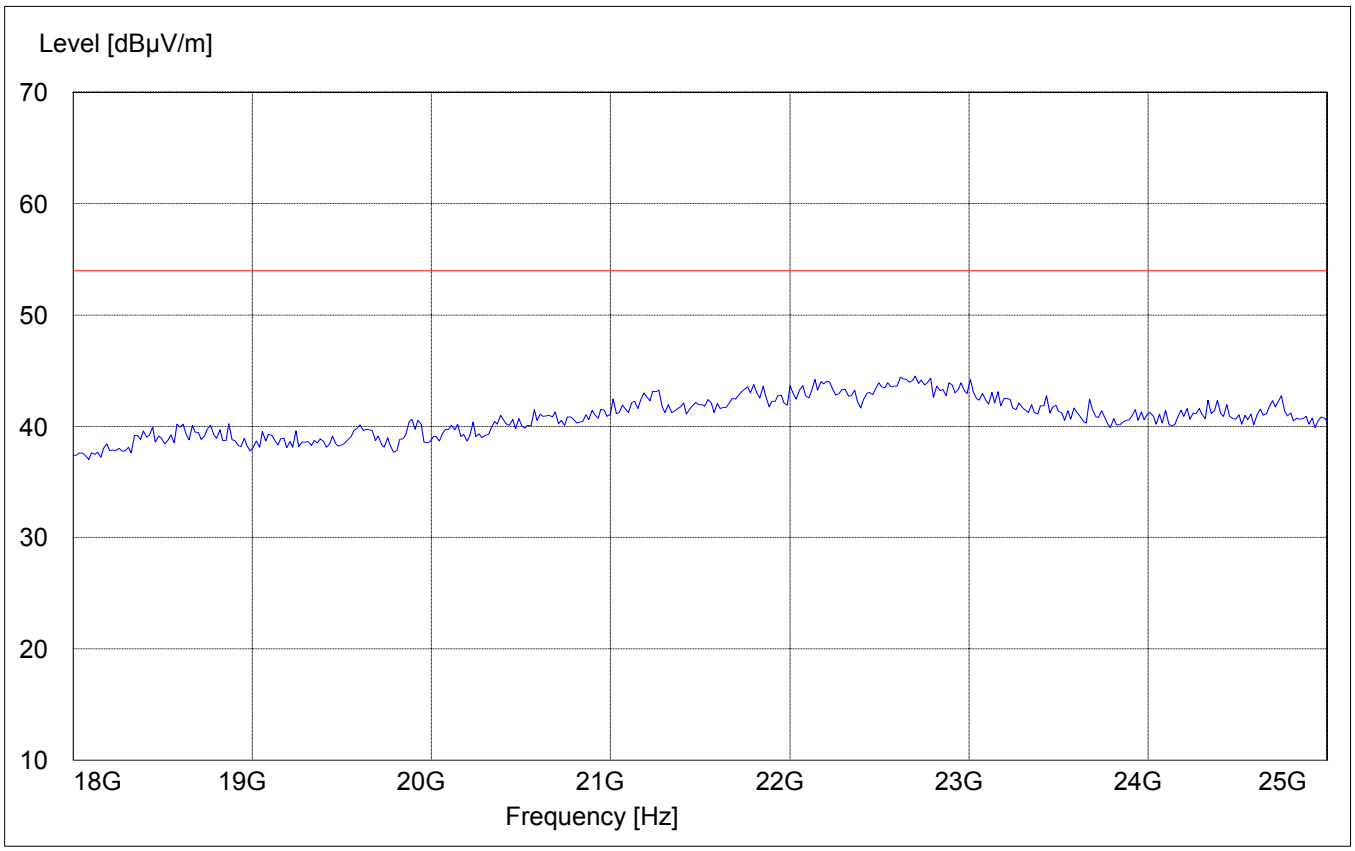
EMISSION LIMITATIONS - Radiated (Transmitter) § 15.247 (c) (1)

18GHz – 25GHz

Note: This plot is valid for all three (low, mid, high) channels.

SWEEP TABLE: "BT Spuri hi 18-25G"
Short Description: Bluetooth Spurious 18-25GHz

Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW VBW	Transducer
18 GHz	25 GHz	MaxPeak	Coupled	1 MHz	#326 horn (dBi)



CONDUCTED EMISSIONS § 15.107/207

Measured with AC/DC power adapter

SWEEP TABLE: "55022 cond"

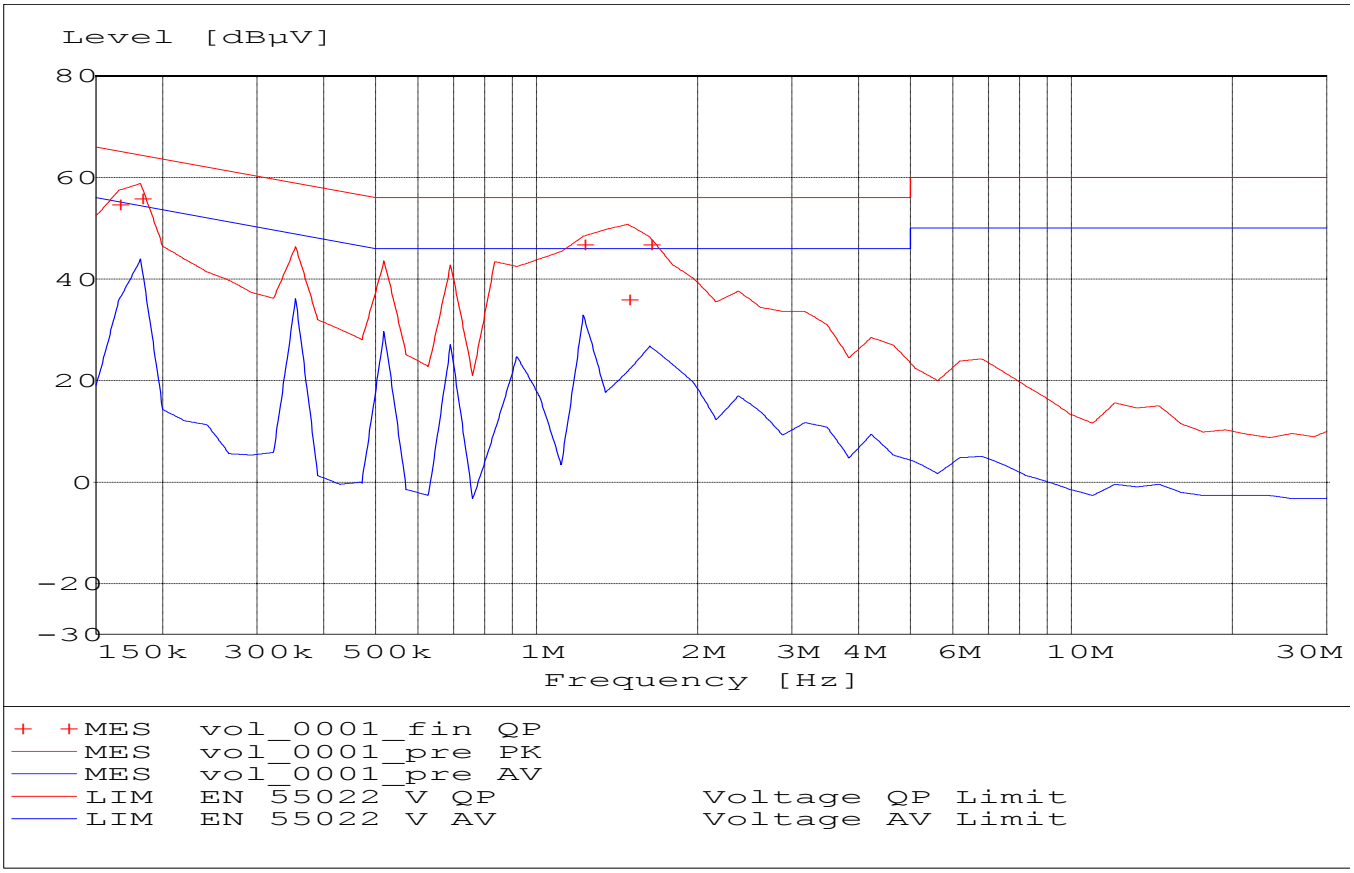
Short Description:		EN 55022 for 150KHz-30MHz			
Start Frequency	Stop Frequency	Detector	Meas Time	IF Bandw.	Transducer
150.0 kHz	30.0 MHz	MaxPeak	Coupled	10 kHz	None

Technical specification: 15.107 / 15.207 (Revised as of August 20, 2002)

Limit

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50
* Decreases with logarithm of the frequency		

ANALYZER SETTINGS: RBW = 10KHz VBW = 10KHz



MEASUREMENT RESULT: "vol_0001_fin QP"

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.165000	54.70	0.0	65	10.5	2	---
0.181500	55.90	0.0	64	8.5	1	---
1.221041	46.80	0.0	56	9.2	2	---
1.477460	35.90	0.0	56	20.1	1	---
1.625206	46.90	0.0	56	9.1	1	---

RECEIVER SPURIOUS RADIATION § 15.209

Limits

Frequency (MHz)	Field strength (µV/m)	Measurement distance (m)
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/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

NOTE:
The radiated emissions were done with different settings, using the relevant pre-amplifiers for the relevant frequency ranges. This is the reason that the graphs show different noise levels. In the range between 3 and 25 GHz very short cable connections to the antenna was used to minimize the noise level.

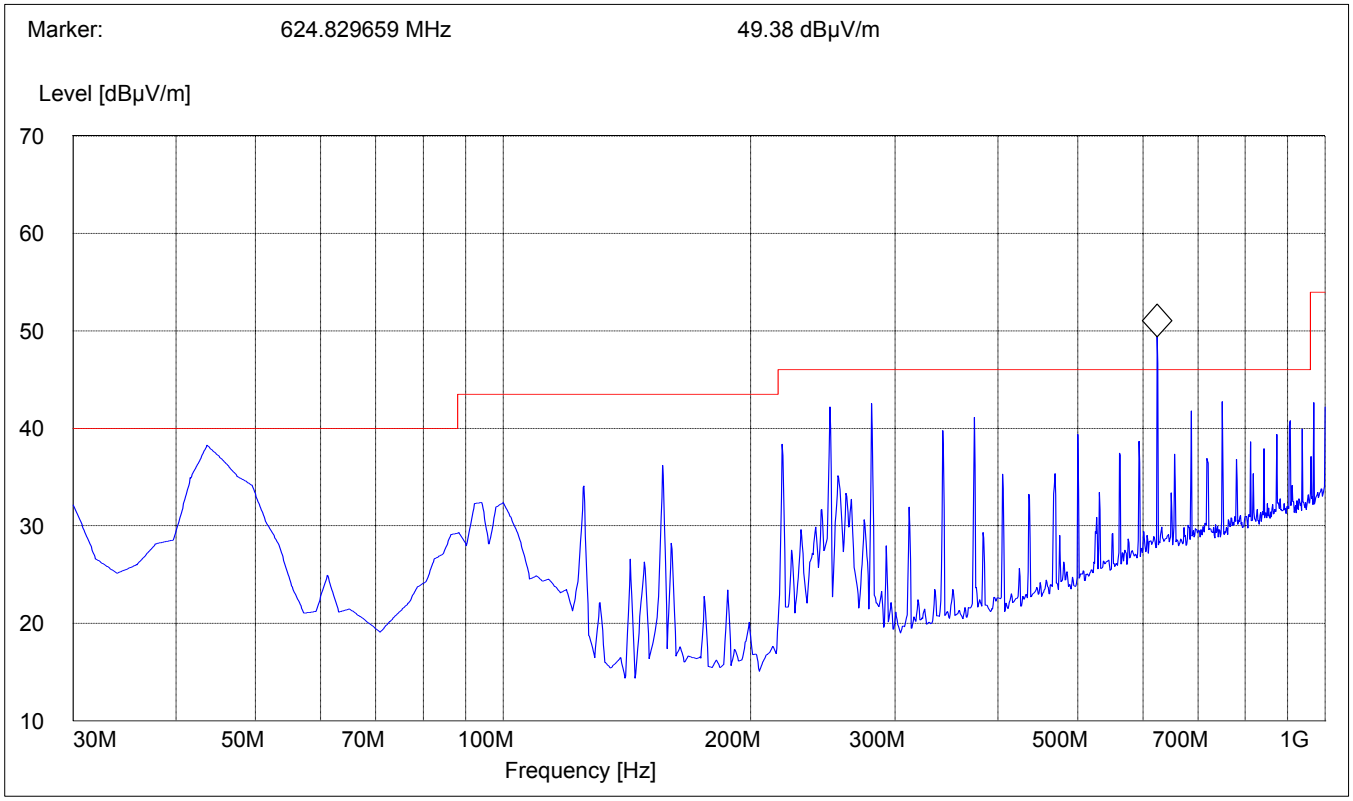
RECEIVER SPURIOUS RADIATION § 15.209

30MHz – 1GHz

Note: This plot shows peak measurements only; the peak above the limit line was attenuated significantly when subjected to Quasi-peak.

SWEEP TABLE:		"BT Spuri hi 30-1G"			
Short Description:		Bluetooth 30MHz-1GHz			
Start Frequency	Stop Frequency	Detector	Meas. Time	RBW VBW	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	3141-#1186

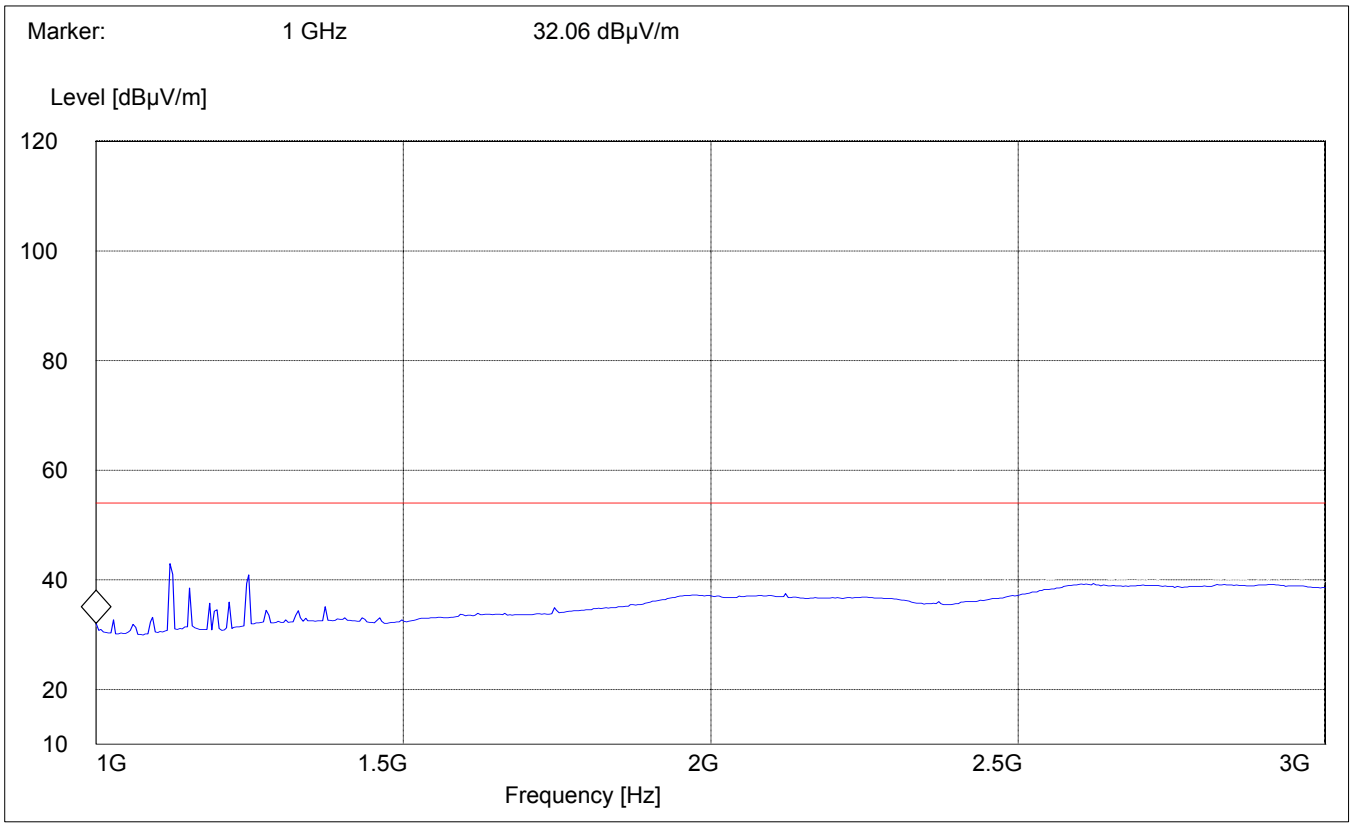
Freq.(MHz)	Pk (dBµv)	QPk (dBµv)
624.83	49.38	44.59



RECEIVER SPURIOUS RADIATION § 15.209
1GHz – 3GHz
Average Measurement with VBW=10Hz

SWEEP TABLE: "BT Spuri hi 1-3G"
Short Description: Bluetooth Spurious 1-3GHz

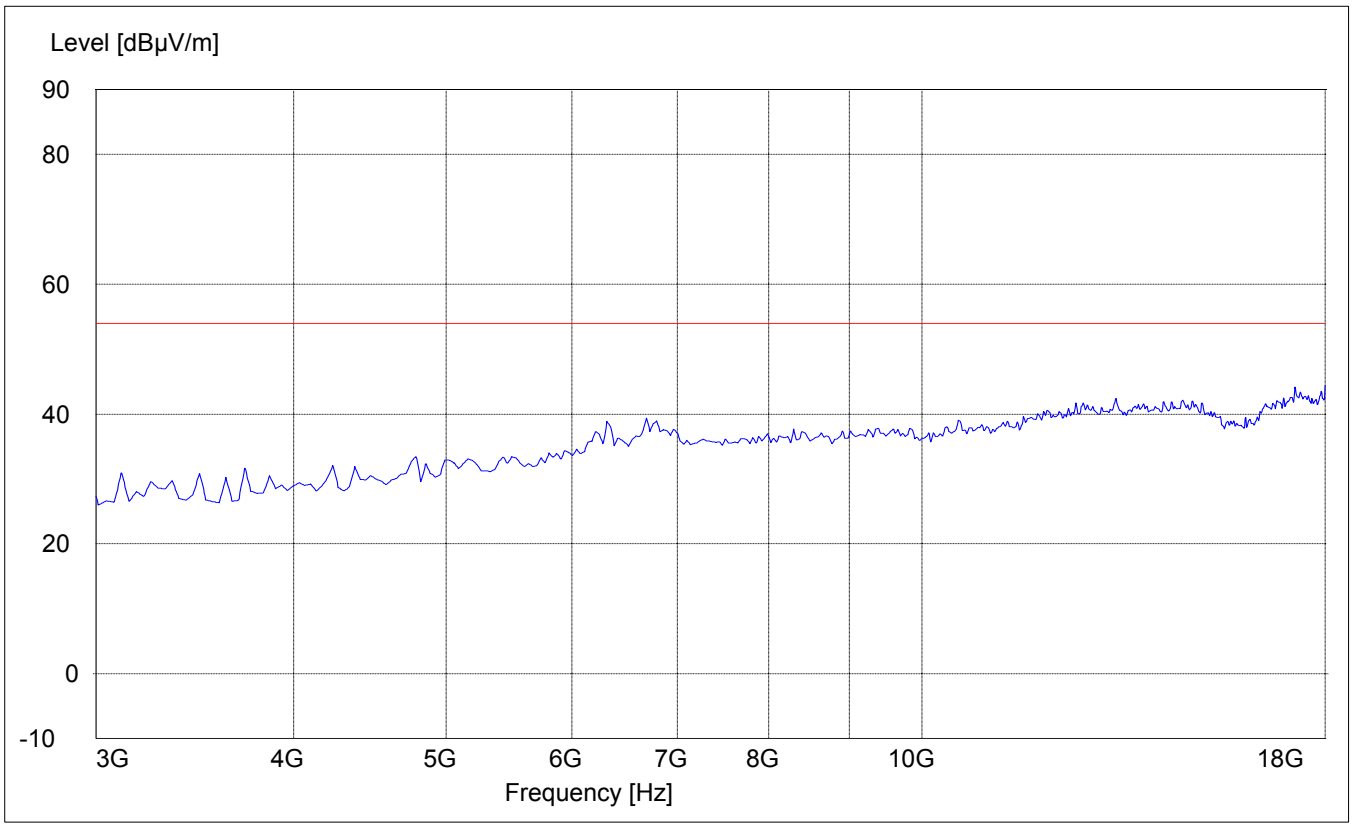
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW	VBW	Transducer
1.0 GHz	3.0 GHz	MaxPeak	Coupled	1 MHz	10Hz	#326 horn (dBi)



RECEIVER SPURIOUS RADIATION § 15.209
3GHz – 18GHz

SWEEP TABLE: "BT Spuri hi 3-18G"
Short Description: Bluetooth Spurious 3-18GHz

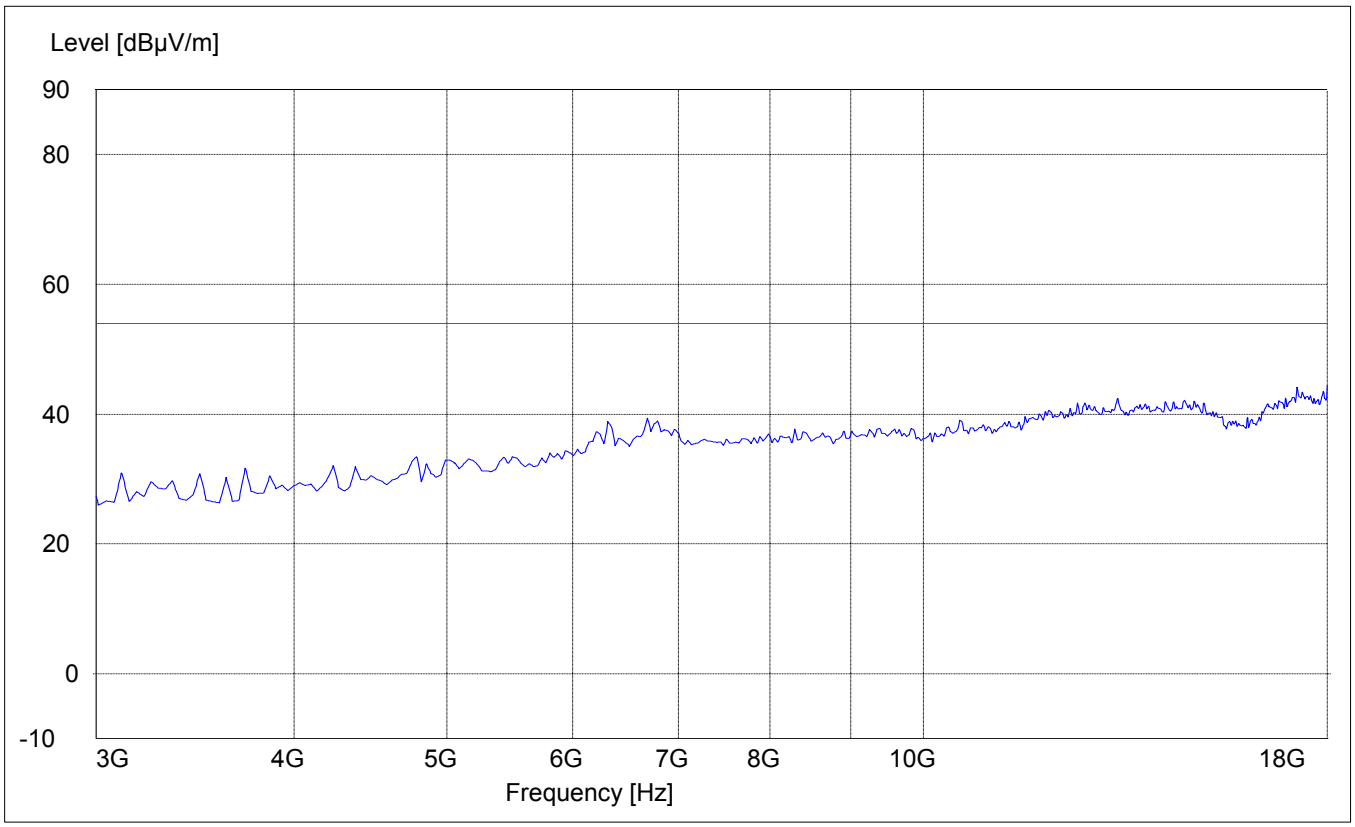
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW VBW	Transducer
3.0 GHz	18 GHz	MaxPeak	Coupled	1 MHz	#326 horn (dBi)



RECEIVER SPURIOUS RADIATION § 15.209
18GHz – 25GHz

SWEEP TABLE: "BT Spuri hi 18-25G"
Short Description: Bluetooth Spurious 18-25GHz

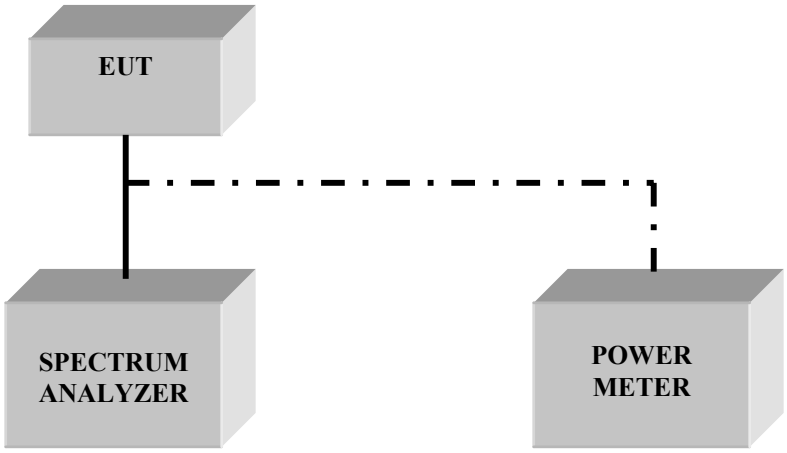
Start Frequency	Stop Frequency	Detector Time	Meas. Bandw.	RBW VBW	Transducer
18 GHz	25 GHz	MaxPeak	Coupled	1 MHz	#141 horn (dBi)



TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No	Instrument/Ancillary	Type	Manufacturer	Serial No.
01	Spectrum Analyzer	ESIB 40	Rohde & Schwarz	100107
02	Spectrum Analyzer	FSEM 30	Rohde & Schwarz	826880/010
03	Signal Generator	SMY02	Rohde & Schwarz	836878/011
04	Power-Meter	EPM-442A	Hewlett Packard	GB37170232
05	Power Amplifier	250W1000	Amplifier Research	300031
06	Biconilog Antenna	3141	EMCO	0005-1186
07	Horn Antenna	SAS-200/571	AH Systems	325
08	Power Splitter	11667B	Hewlett Packard	645348
09	Climatic Chamber	VT4004	Votch	G1115
10	Pre-Amplifier	JS4-00102600	Miteq	00616
11	2-3GHz band reject filter	BRM50701	Microtronics	NA
12	Power Sensor	URV5-Z2	Rohde & Schwarz	DE30807

BLOCK DIAGRAMS
Conducted Testing



Radiated Testing