

CETECOM Inc.



CETECOM Inc.

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Issued test report consists of 56 Pages

RECOGNIZED BY INDUSTRY CANADA

IC - 3925

Test report no.: 149B FCC/2001

FCC Part 15.247

FCC ID: B94C8925A

(HP Deskjet 995C with CSR Module)

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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 generalisations 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.

1.2 Testing laboratory

CETECOM Inc.

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E-mail: lothar.schmidt@cetecomusa.com

Internet: www.cetecom.com

1.3 Details of applicant

Name : Hewlett Packard Company
Street : 18110 SE 34th St.
City : Vancouver, WA 98683
Country : USA
Telephone : +1 360 212 0471
Telefax : +1 360 212 7676
Contact : Henry Benitez
e-mail : Henry_benitez@hp.com

1.4 Application details

Date of receipt of application : 2001-04-11
Date of receipt of test item : 2001-05-01
Date of test : 2001-05-01/02

1.5 Test item

Manufacturer : applicant
Name of EUT : HP Deskjet 995C
Description : Bluetooth Wireless Printer using CSR (3Com) Module
HP part # C8925-60032
Model No. : C8925A
Serial No. : N/A
FCC ID : B94C8925A
Additional informations: :
Frequency : 2400 – 2483.5 MHz
Type of modulation : GFSK FHSS
Number of channels : 79
Antenna : Integral
Power supply : 100-240 VAC 50/60 Hz
Output power : -1.4 dBm
Extreme Temp. Limits : 0°C - +60°C

1.6 Test standards: FCC Part 15 §15.247 measured according the FCC Public notice DA00-705

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.

Technical responsibility for area of testing :

2000-05-17	EMC& Radio	Lothar Schmidt
Date	Section	Name


Signature

2.2 Testreport

TEST REPORT

Testreport no. : 149B FCC/2001

FCC ID: B94C8925A

(HP Deskjet 995C with CSR Module)

TEST REPORT REFERENCE**LIST OF MEASUREMENTS**

Paragraph	PARAMETER TO BE MEASURED	PAGE
	Transmitter parameters	
§ 15.204	Antenna gain	7
§ 15.247 (a)	Carrier frequency separation	8
§ 15.247 (a)	Number of hopping channels	9
§ 15.247 (a)	Time of occupancy (dwell time)	13
§ 15.247 (a)(1)	Spectrum Bandwidth of a FHSS System	16
§ 15.247 (b)(2)	Maximum peak output power	20
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§ 15.247 (c)(1)	Emission limitations	32
	Receiver parameters	
§ 15.209	Spurious radiations - Radiated	46
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	Photographs of the equipment	52
	ANNEX: Processing Gain (provided by manufacturer)	11 pages

NOTE: Conducted Emissions as per § 15.107/207 are carried out and documented in the HP report 1580-E.

Antenna Gain

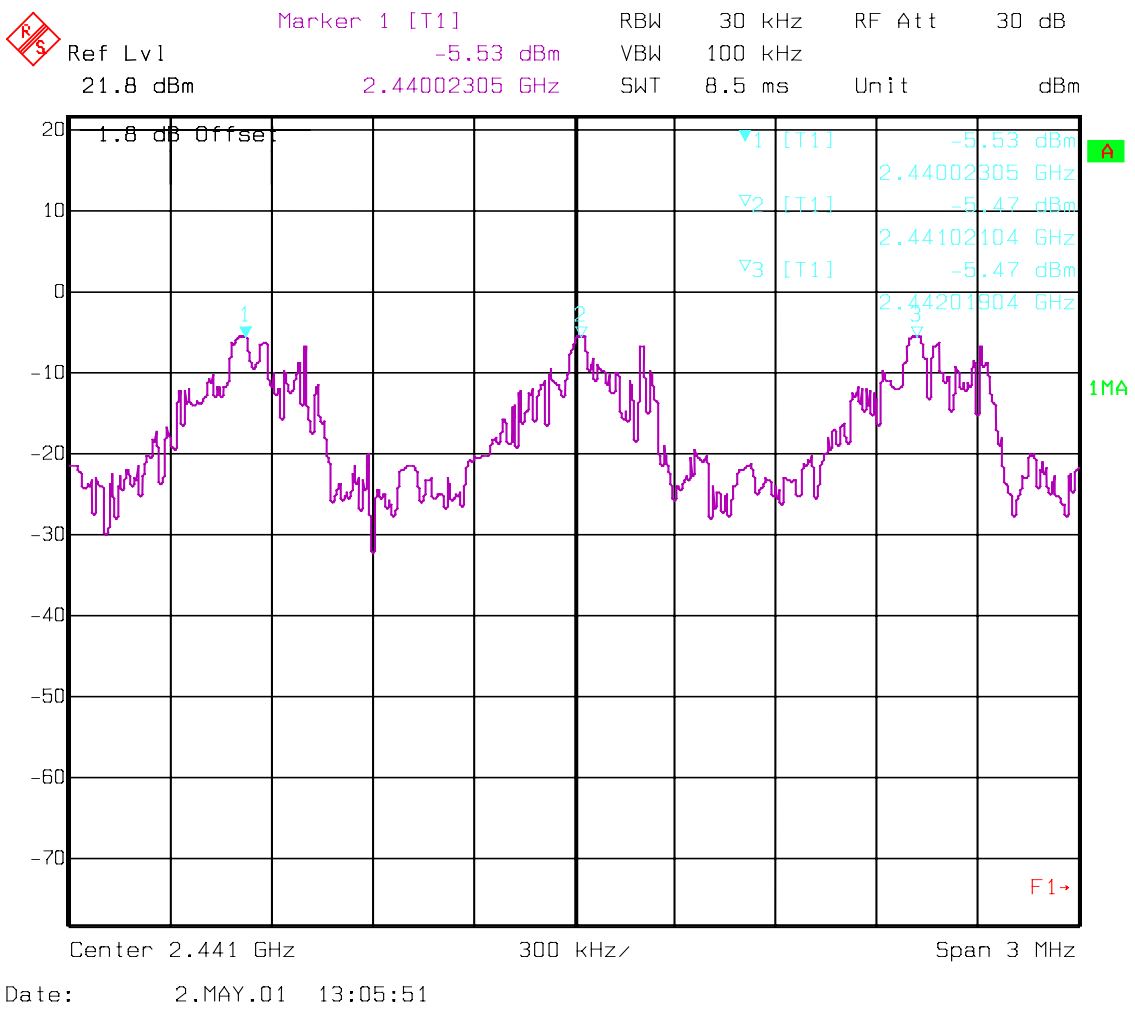
SUBCLAUSE § 15.204

The max gain is +1.74dBi

(measured effective radiated power – measured conducted power with a temporary RF-connector)

CARRIER FREQUENCY SEPERATION

§15.247(a)



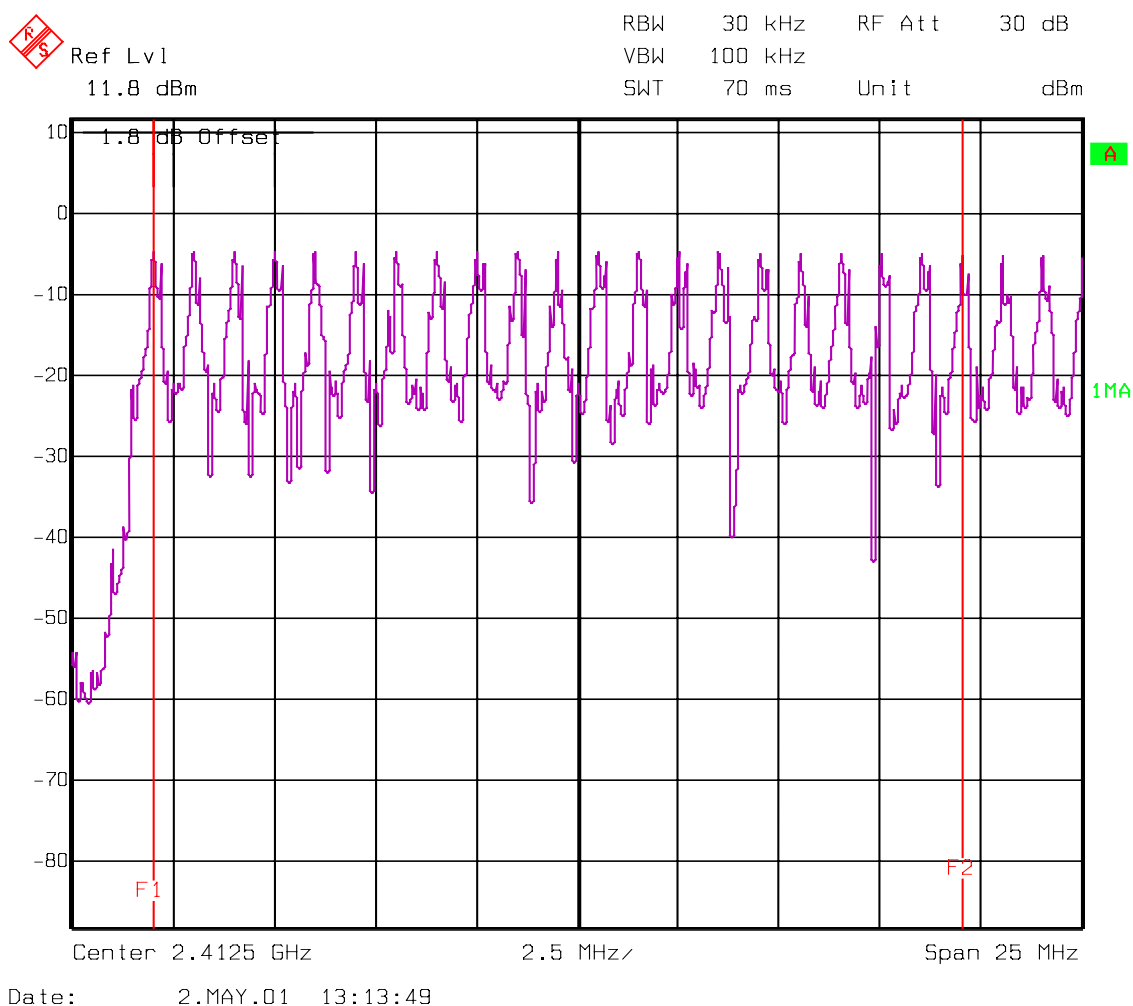
NUMBER OF HOPPING CHANNELS

§15.247(a)

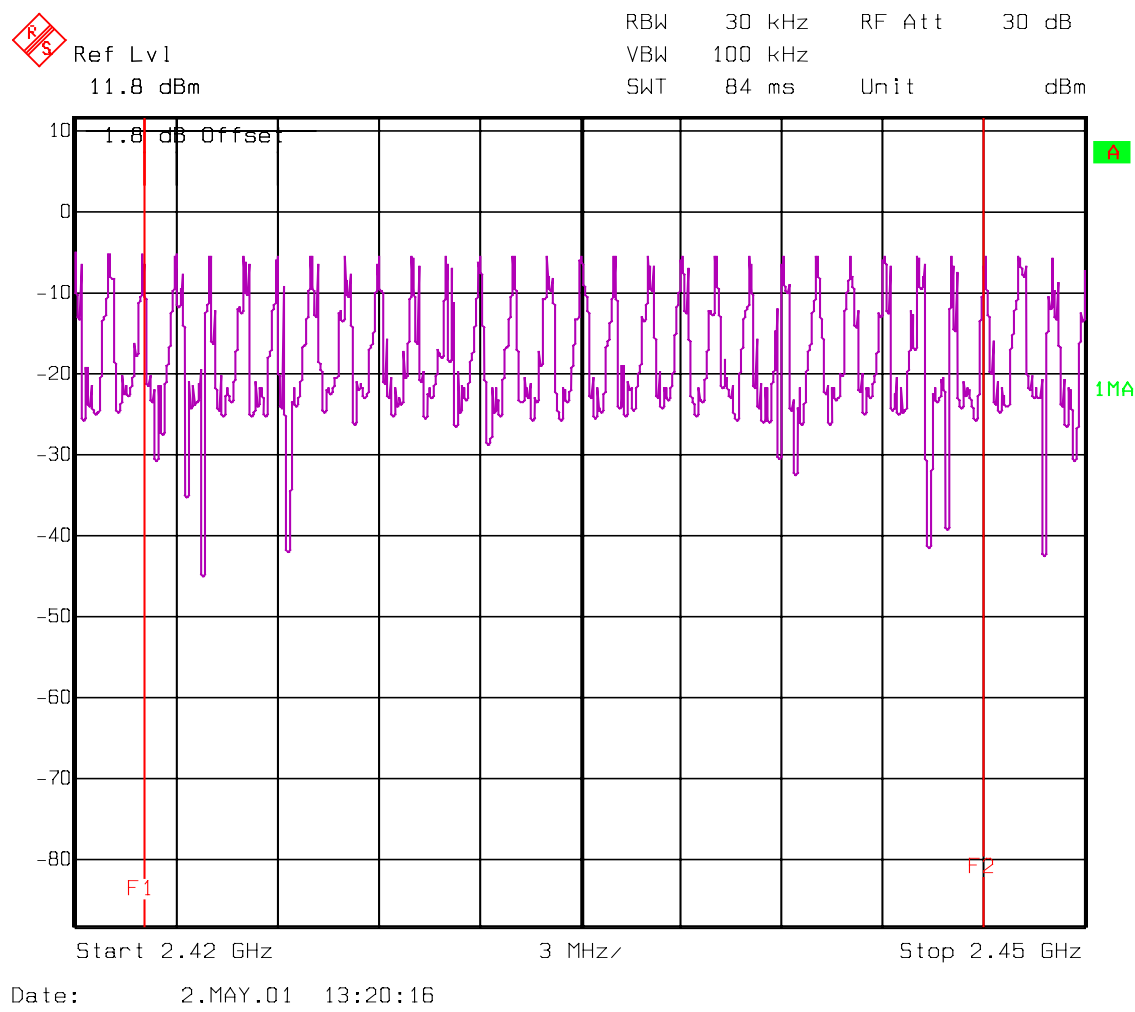
The number of hopping channels is 79 (see next 4 plots)

The right red line corresponds to the left red line from the next plot.

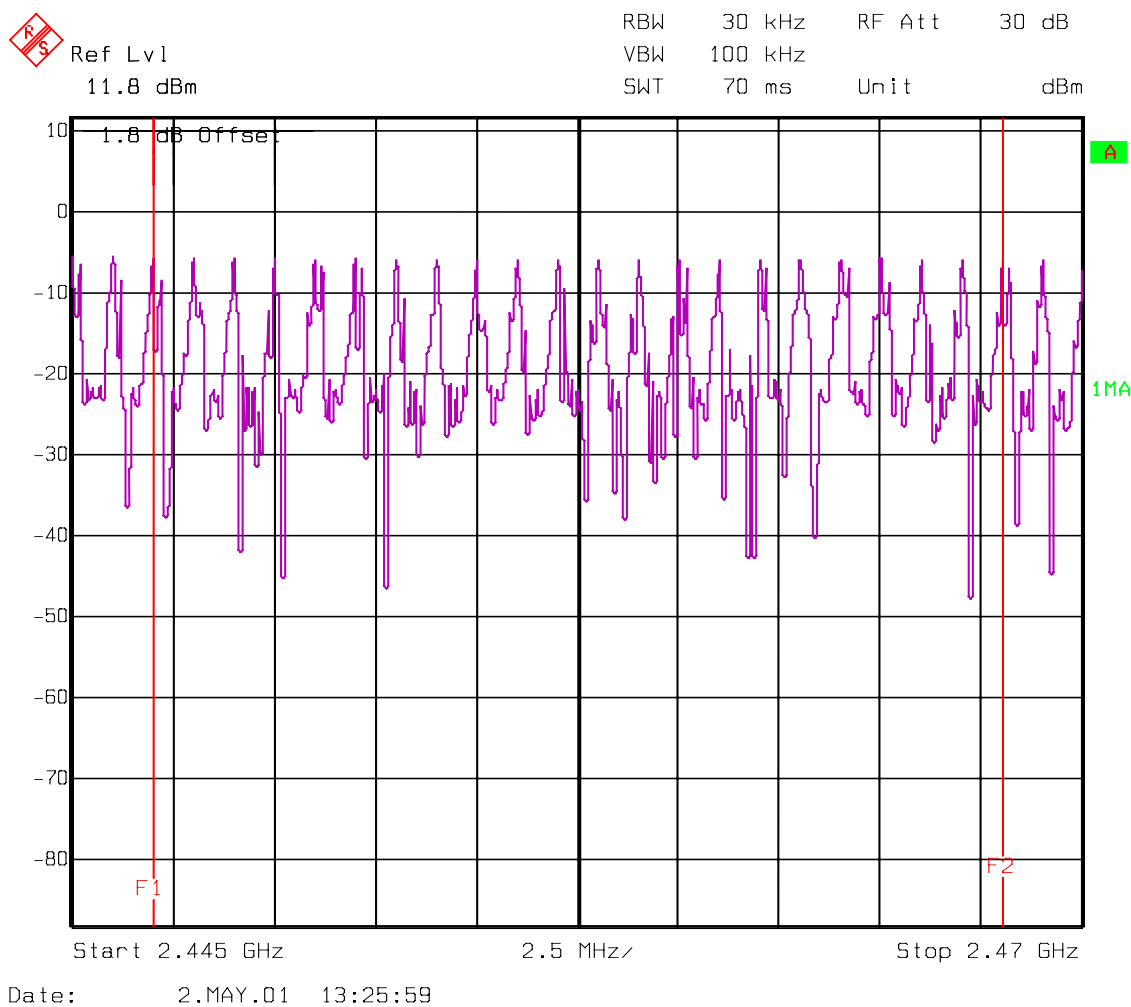
Plot 1:



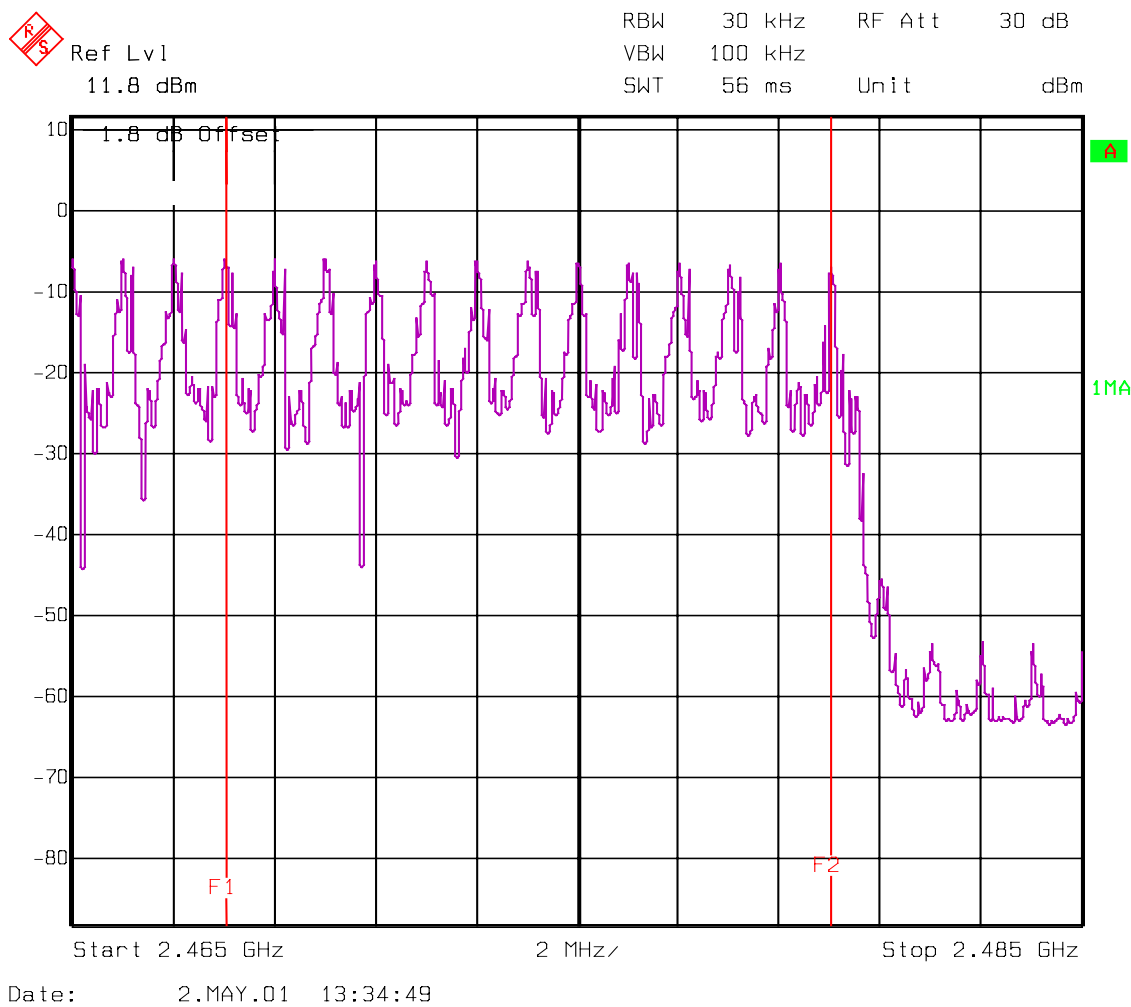
Plot 2:



Plot 3:



Plot 4:



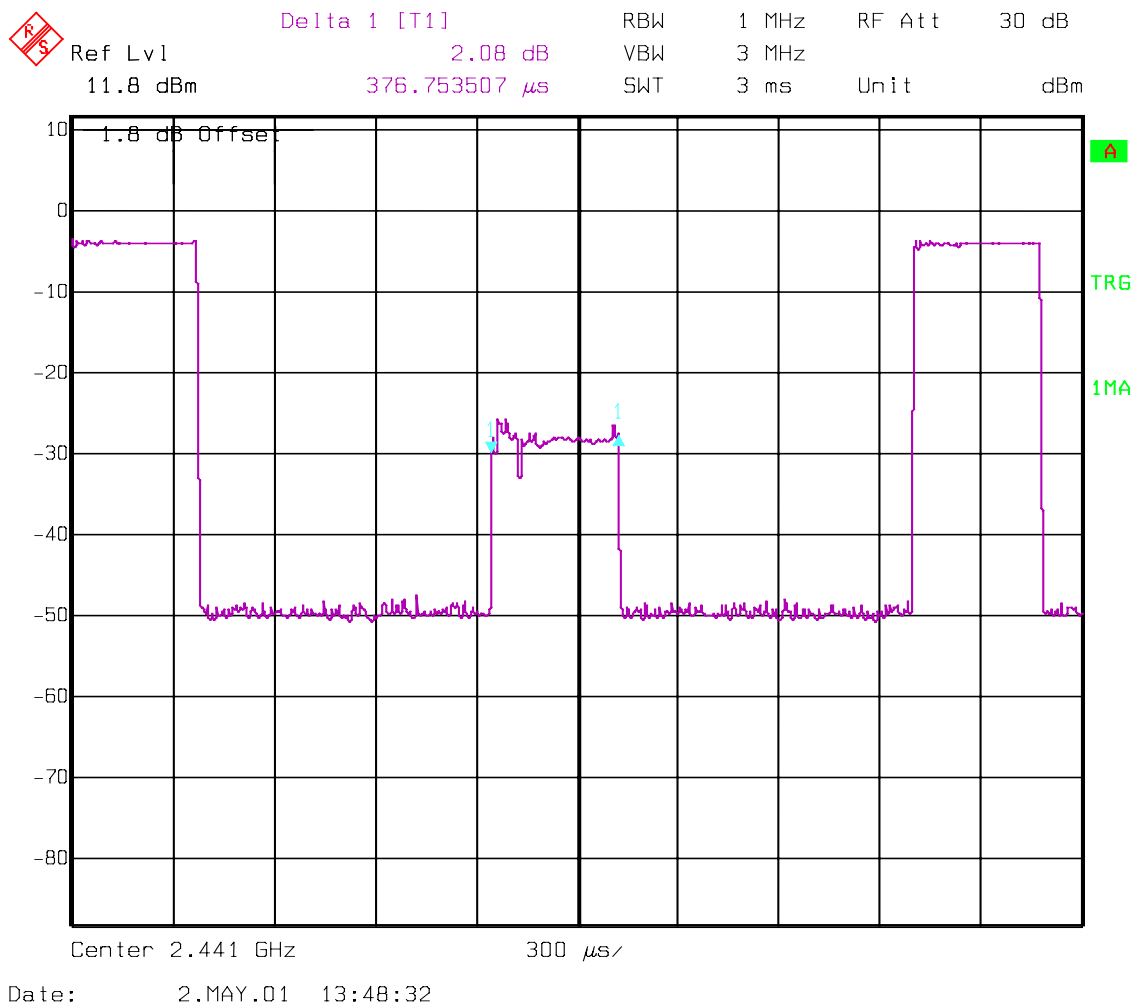
TIME OF OCCUPANCY (DWELL TIME) FOR DH1

§15.247(a)

The system makes worst case 1600 hops per second or 1 time slot has a length of 625µs with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 800 hops per second with 79 channels. So you have each channel 10.13 times per second and so for 30 seconds you have 303.9 times of appearance .

Each Tx-time per appearance is 376.75 µs.

So we have $303.9 * 376.75 \mu s = 144.49 \text{ ms}$ per 30 seconds.



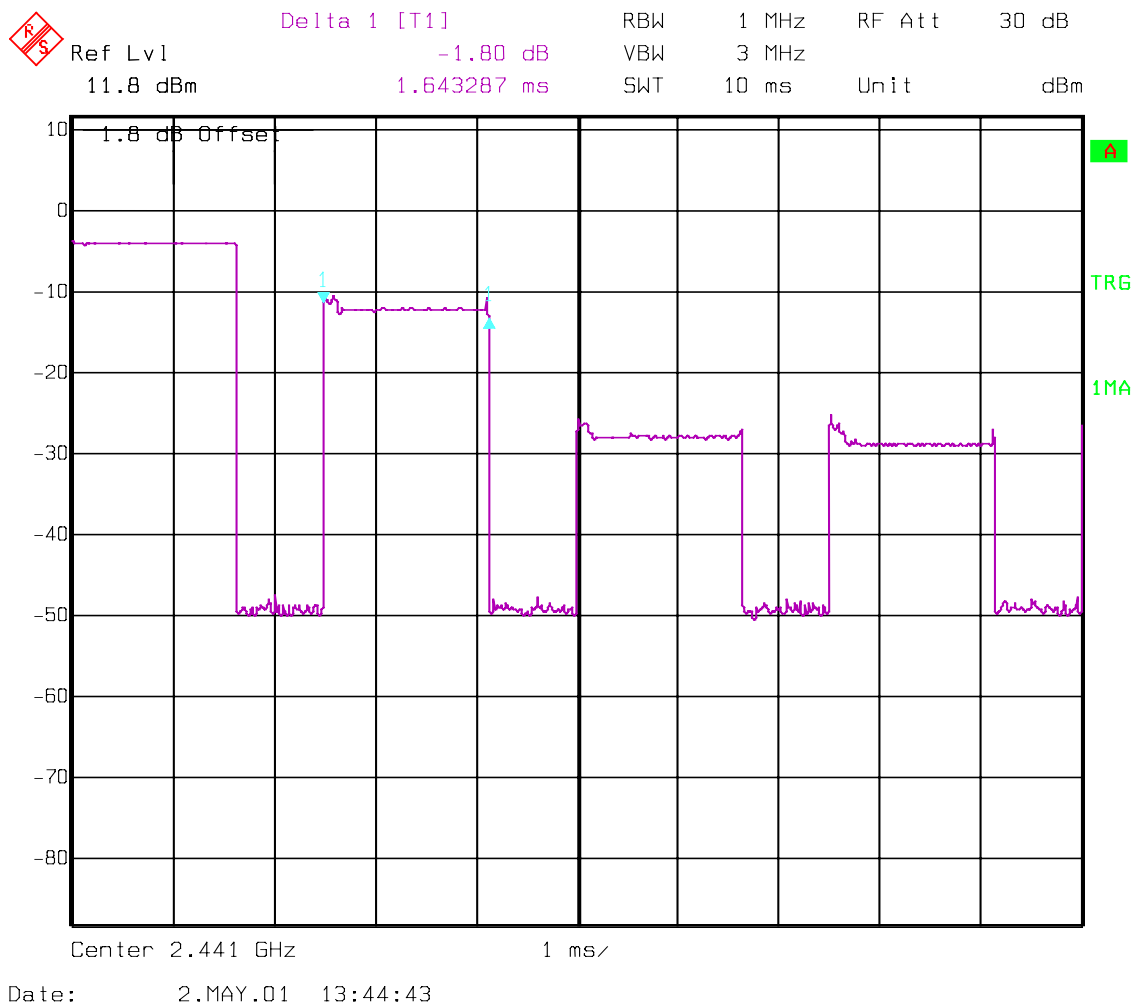
TIME OF OCCUPANCY (DWEELL TIME) FOR DH3

§15.247(a)

A DH3 Packets need 3 time slots for transmit and 1 for receicing, then the system makes worst case 400 hops per second with 79 channels. So you have each channel 5.1 times per second and so for 30 seconds you have 153 times of appearance .

Each Tx-time per appearance is 1.64 ms.

So we have $153 * 1.64 \text{ ms} = 250.92 \text{ ms}$ per 30 seconds.



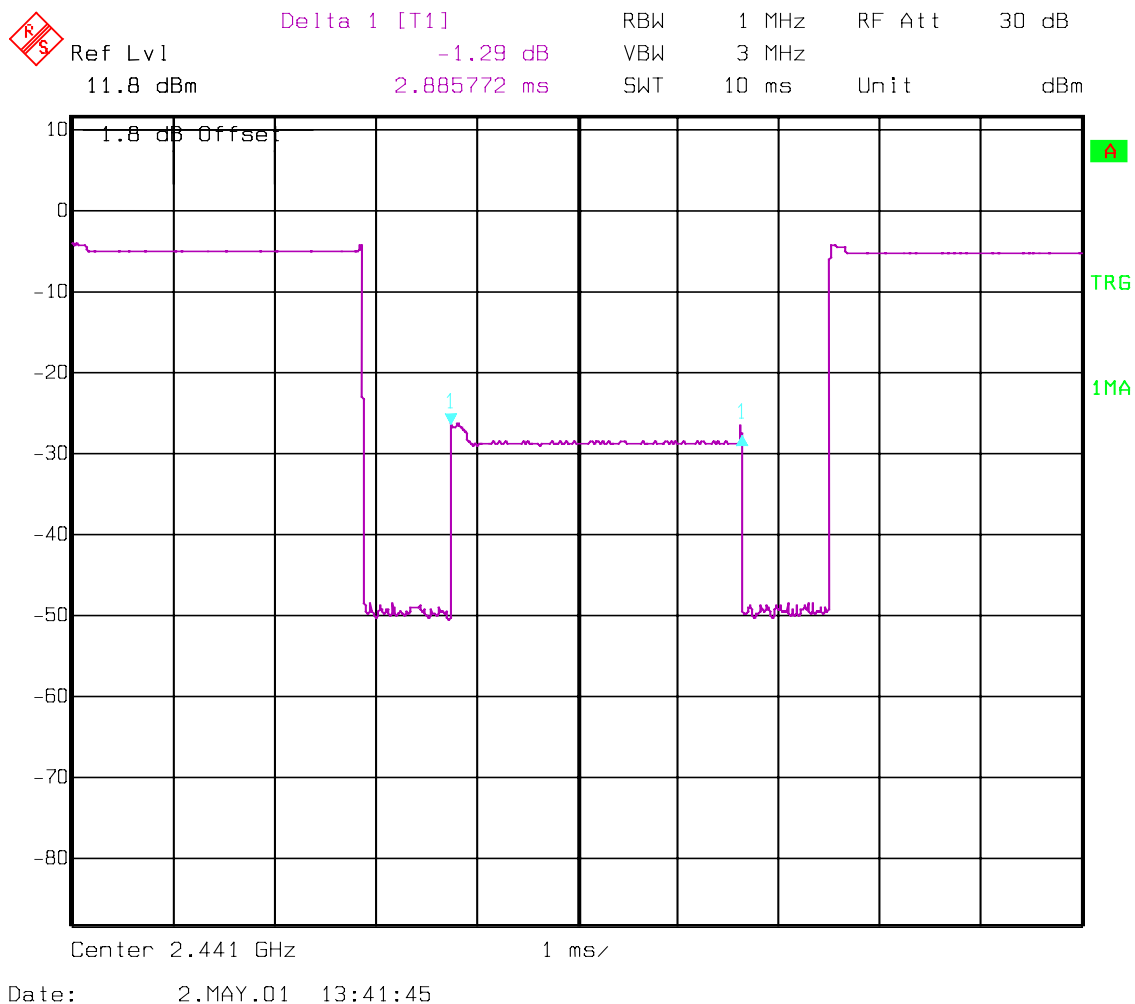
TIME OF OCCUPANCY (DWELL TIME) FOR DH5

§15.247(a)

At DH5 Packets you need 5 time slots for transmit and 1 for receiving, then the system makes worst case 266,7 hops per second with 79 channels. So you have each channel 3.36 times per second and so for 30 seconds you have 100,8 times of appearance .

Each tx-time per appearance is 2.88 ms.

So we have $100.8 * 2.88\text{ms} = 290.30\text{ ms}$ per 30 seconds.

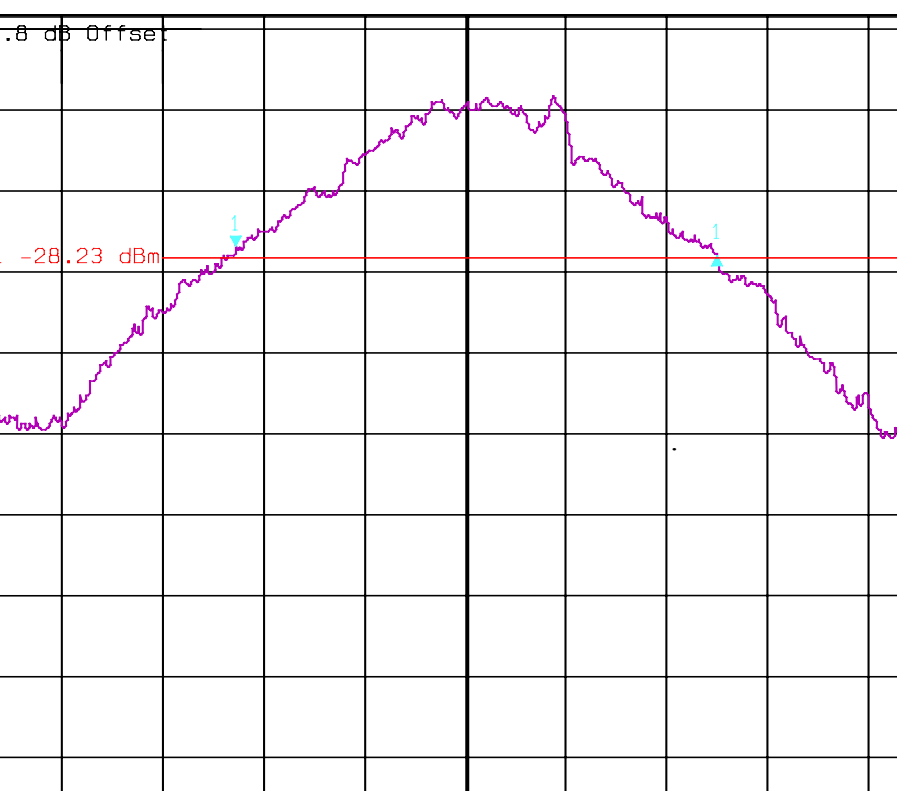


**SPECTRUM BANDWIDTH OF FHSS SYSTEM
20 dB bandwidth****§15.247(a)**

TEST CONDITIONS		20 dB BANDWIDTH (kHz)		
Frequency (MHz)		2402	2441	2481
T _{nom} (23)°C	V _{nom} 0V	953.90	993.98	945.89
Measurement uncertainty		±3dB		

RBW / VBW as provided in the "Measurement Guidelines" (DA 00-705, March 30, 2000)**LIMIT****SUBCLAUSE §15.247(a) (1)****The maximum 20dB bandwidth shall be at maximum 1000 KHz**

§15.247(a)

A spectrum analyzer display showing a signal spectrum. The vertical axis (Y-axis) represents power in dBm, ranging from -90 to 0. The horizontal axis (X-axis) represents frequency, with a center frequency of 2.402 GHz and a span of 2 MHz. The resolution bandwidth (RBW) is 10 kHz, and the video bandwidth (VBW) is 10 kHz. The sweep time (SWT) is 50 ms. The reference level (Ref Lvl) is 1.8 dBm. The signal is a noisy, broad peak centered around 2.402 GHz, with a maximum power of approximately -10 dBm. A red horizontal line is drawn at -28.23 dBm, labeled 'D1 -28.23 dBm'. Two blue arrows point to the signal at this level, with a label 'Delta 1 [T1]' and a value of -0.90 dB. The text '1.8 dB Offset' is visible in the top left corner. The text '1MA' is visible in the bottom right corner. The date and time 'Date: 3.MAY.01 12:40:24' are displayed at the bottom.

Ref Lvl 1.8 dBm

Delta 1 [T1] -0.90 dB

RBW 10 kHz

VBW 10 kHz

SWT 50 ms

Unit dBm

1.8 dB Offset

D1 -28.23 dBm

Delta 1 [T1] -0.90 dB

Center 2.402 GHz

200 kHz

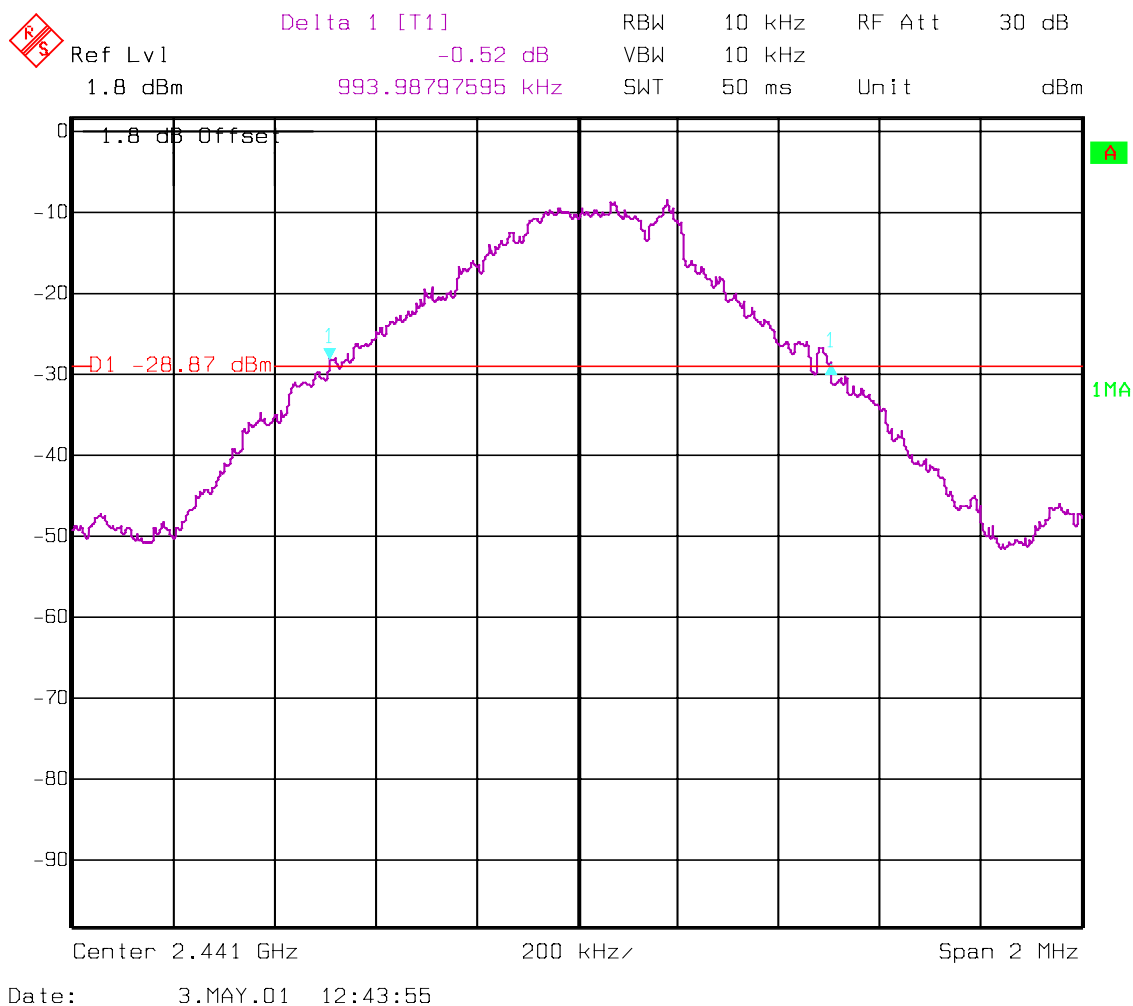
Span 2 MHz

Date: 3.MAY.01 12:40:24

SPECTRUM BANDWIDTH OF FHSS SYSTEM 20 dB bandwidth

§15.247(a)

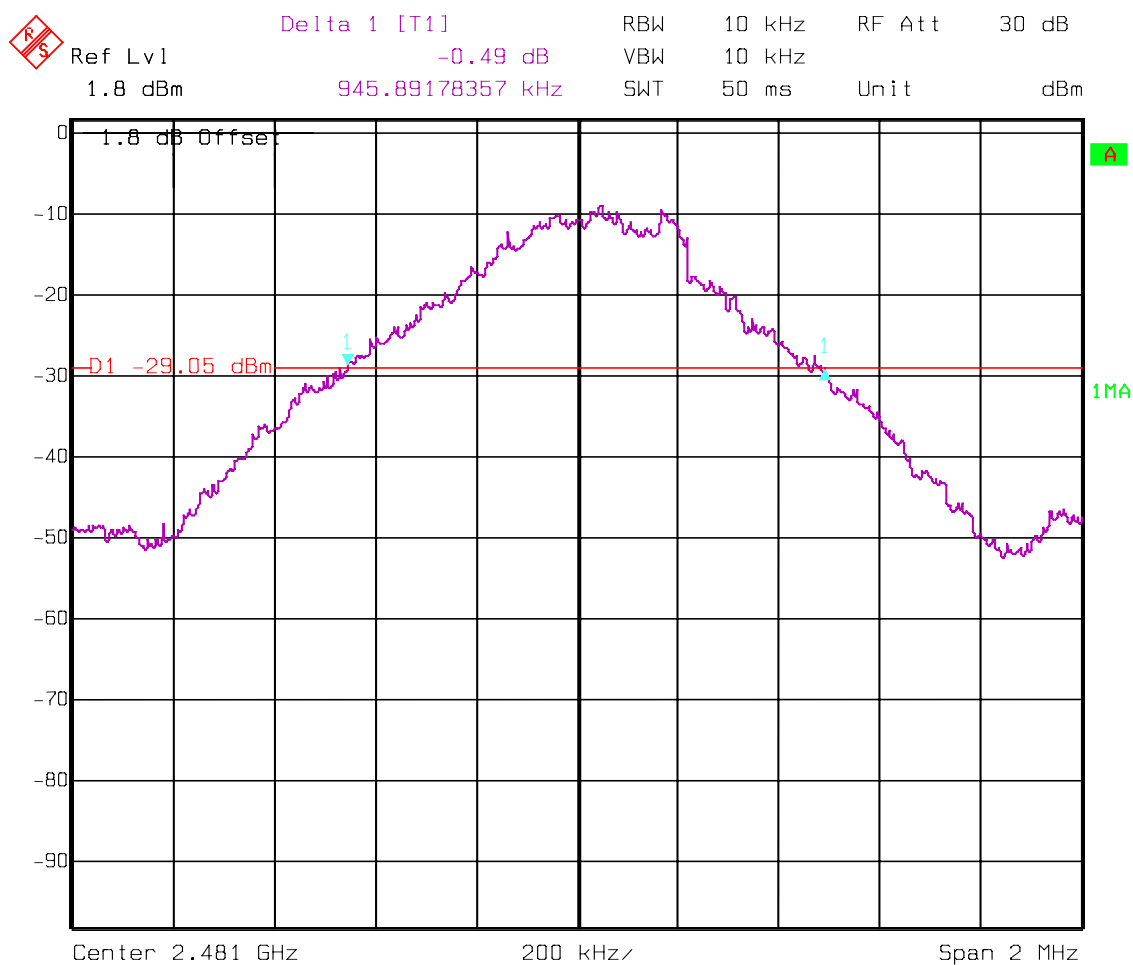
Mid Channel: 2441MHz



SPECTRUM BANDWIDTH OF FHSS SYSTEM 20 dB bandwidth

§15.247(a)

Highest Channel: 2481MHz



Date: 3.MAY.01 12:48:01

**MAXIMUM PEAK OUTPUT POWER
(conducted)****SUBCLAUSE § 15.247 (b) (1)**

TEST CONDITIONS		MAXIMUM PEAK OUTPUT POWER (dBm)			
Frequency (MHz)		2402		2441	2481
T _{nom} (23)°C	V _{nom} 0V	PK	-2.26	-2.96	-3.65
		AV	-2.71	-3.35	-4.09
Maximum deviation from output power under extreme test conditions (dBc)		-5.24 / -4.96 Pk/Av		-5.37 / -5.15 Pk/Av	-6.85 / -6.58 Pk/Av
Measurement uncertainty		±3dB			

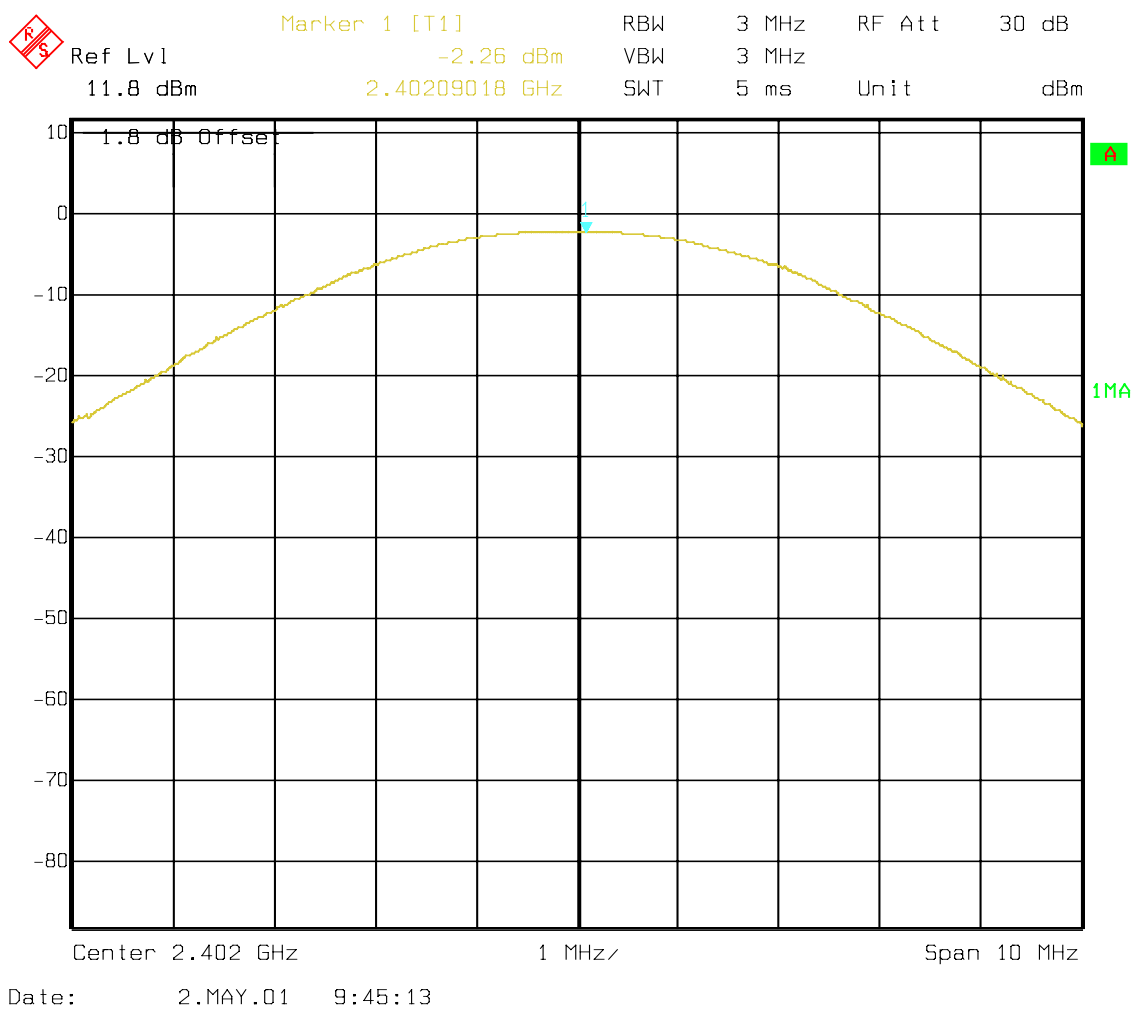
RBW / VBW : 3 MHz**LIMIT****SUBCLAUSE § 15.247 (b) (1)**

Frequency range	RF power output
2400-2483.5 MHz	1.0 Watt

Peak output power (conducted)

§15.247 (b)

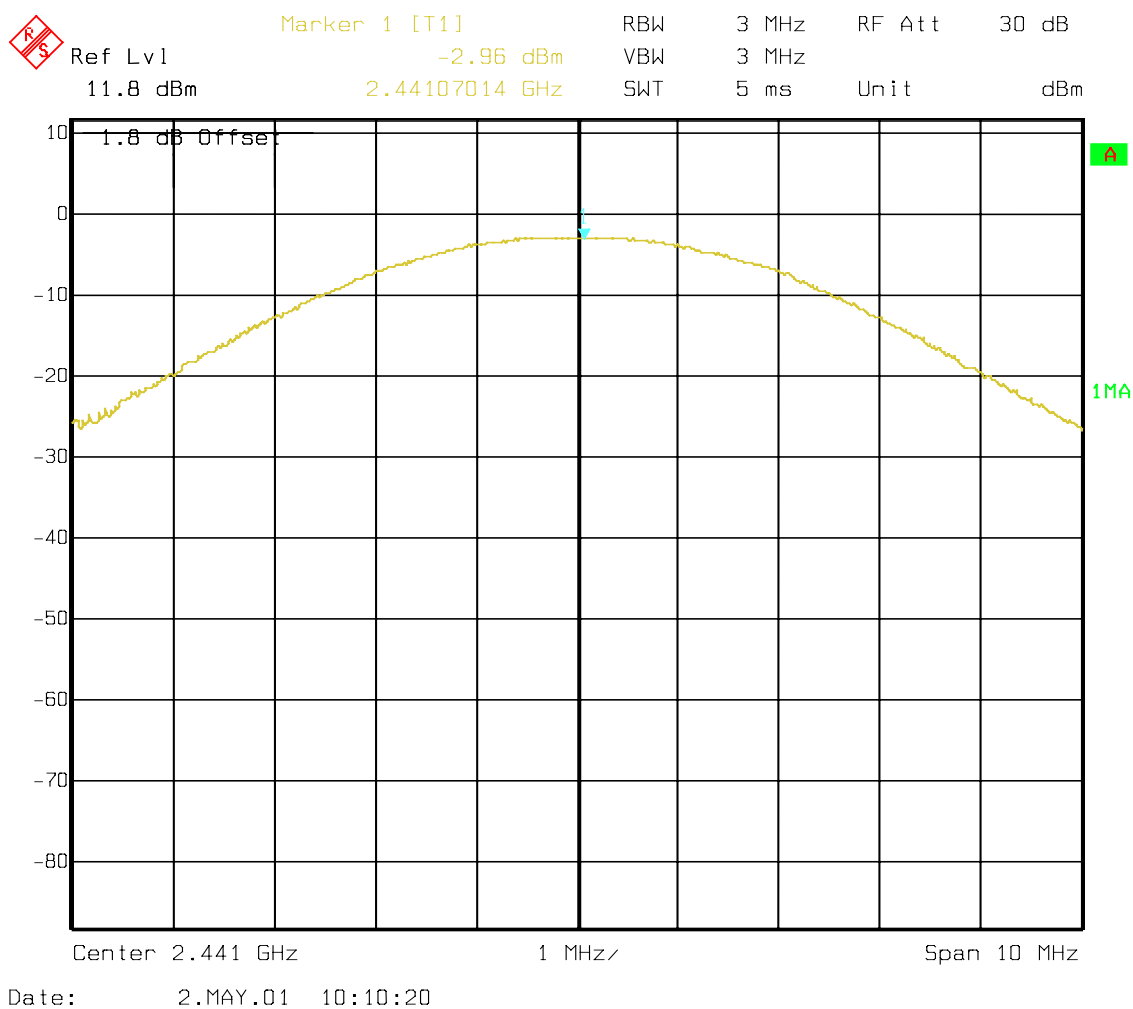
Lowest Channel: 2402MHz



Peak output power (conducted)

§15.247 (b)

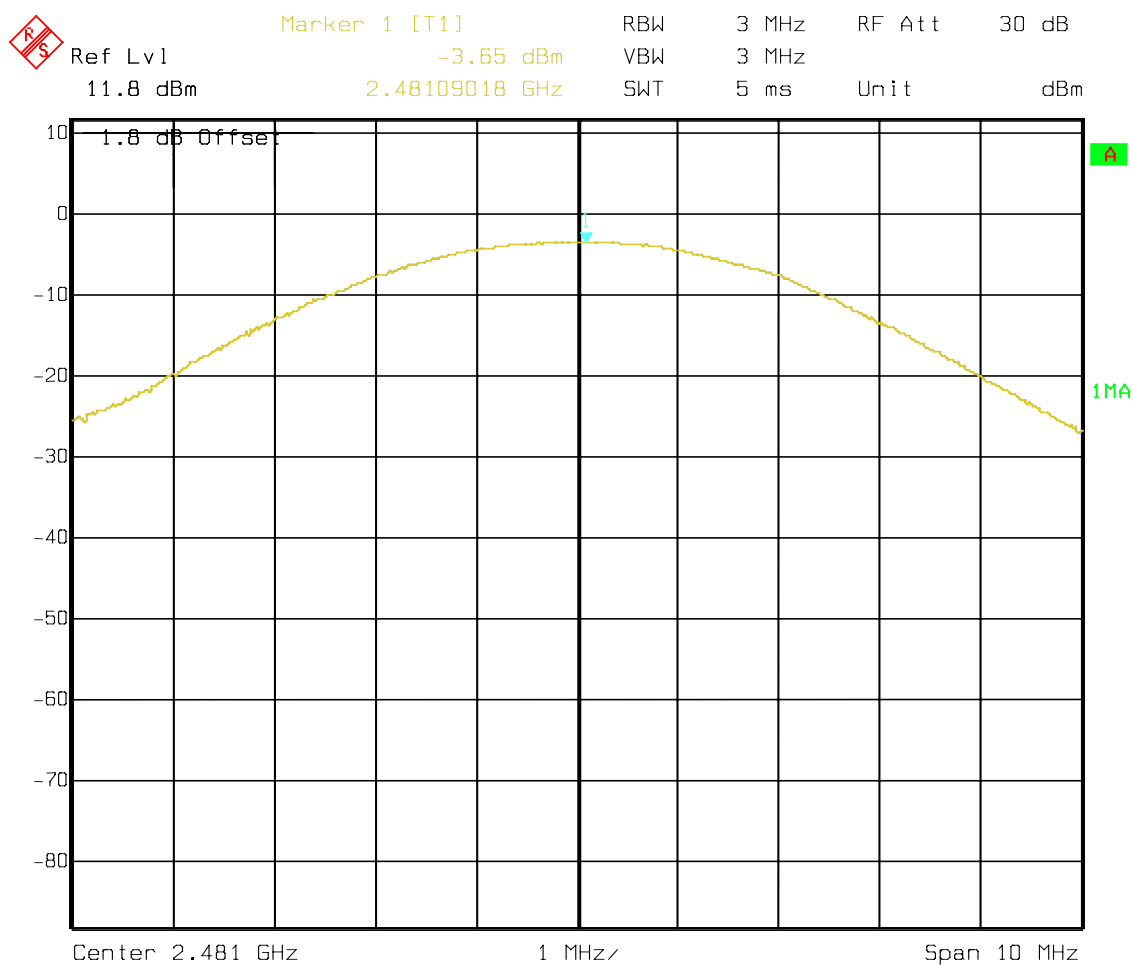
Mid Channel: 2441MHz



Peak output power (conducted)

§15.247 (b)

Highest Channel: 2481MHz



Date: 2.MAY.01 10:14:12

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

TEST CONDITIONS		MAXIMUM PEAK OUTPUT POWER (dBm)		
Frequency (MHz)		2402	2441	2481
T _{nom} (23)°C	V _{nom} (3.6)V	4.14	3.26	5.02
Measurement uncertainty		±3dB		

RBW/VBW : 3 MHz**Measured at a distance of 3m****LIMIT****SUBCLAUSE § 15.247 (b) (1)**

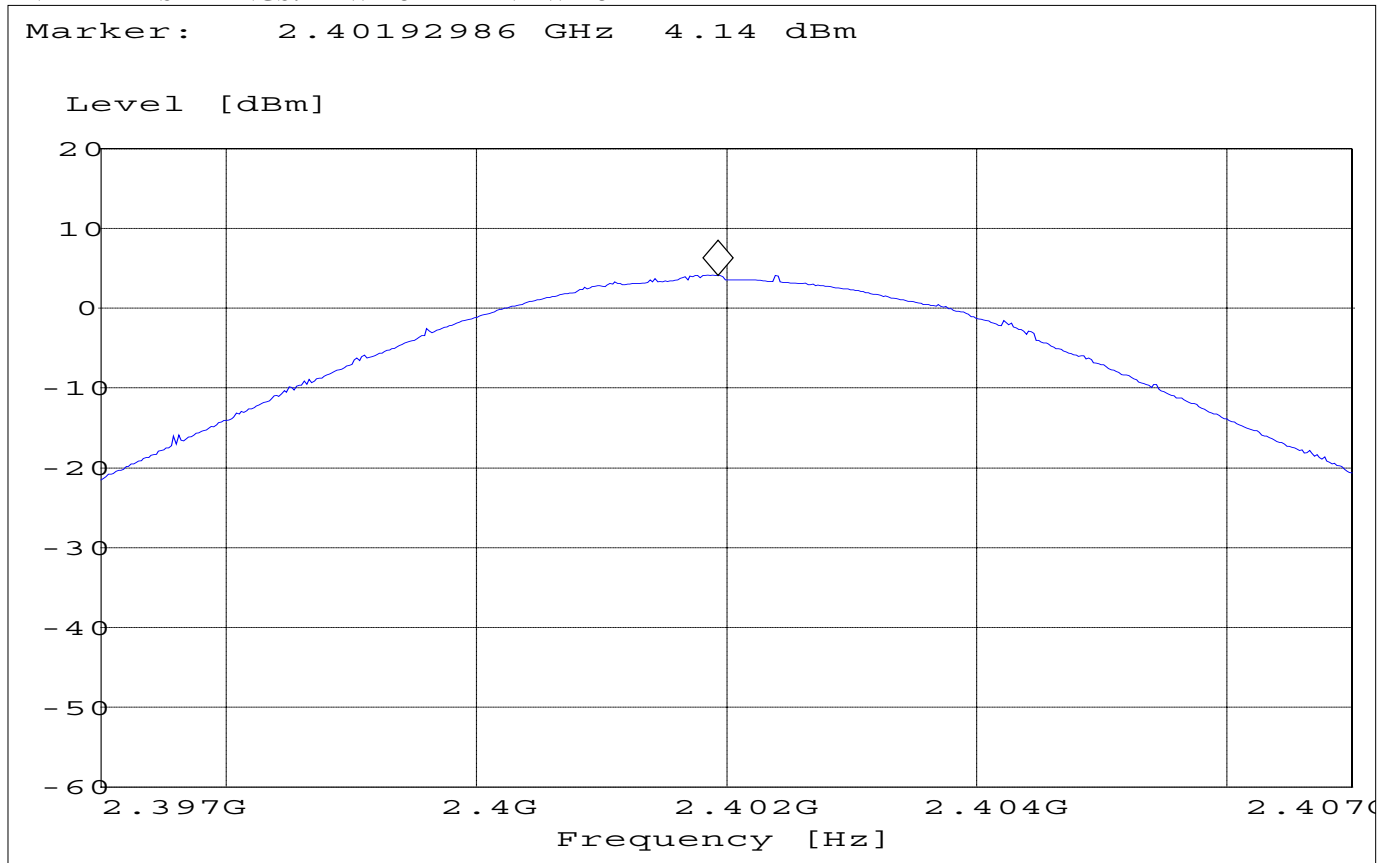
Frequency range	RF power output
2400-2483.5 MHz	1.0 Watt

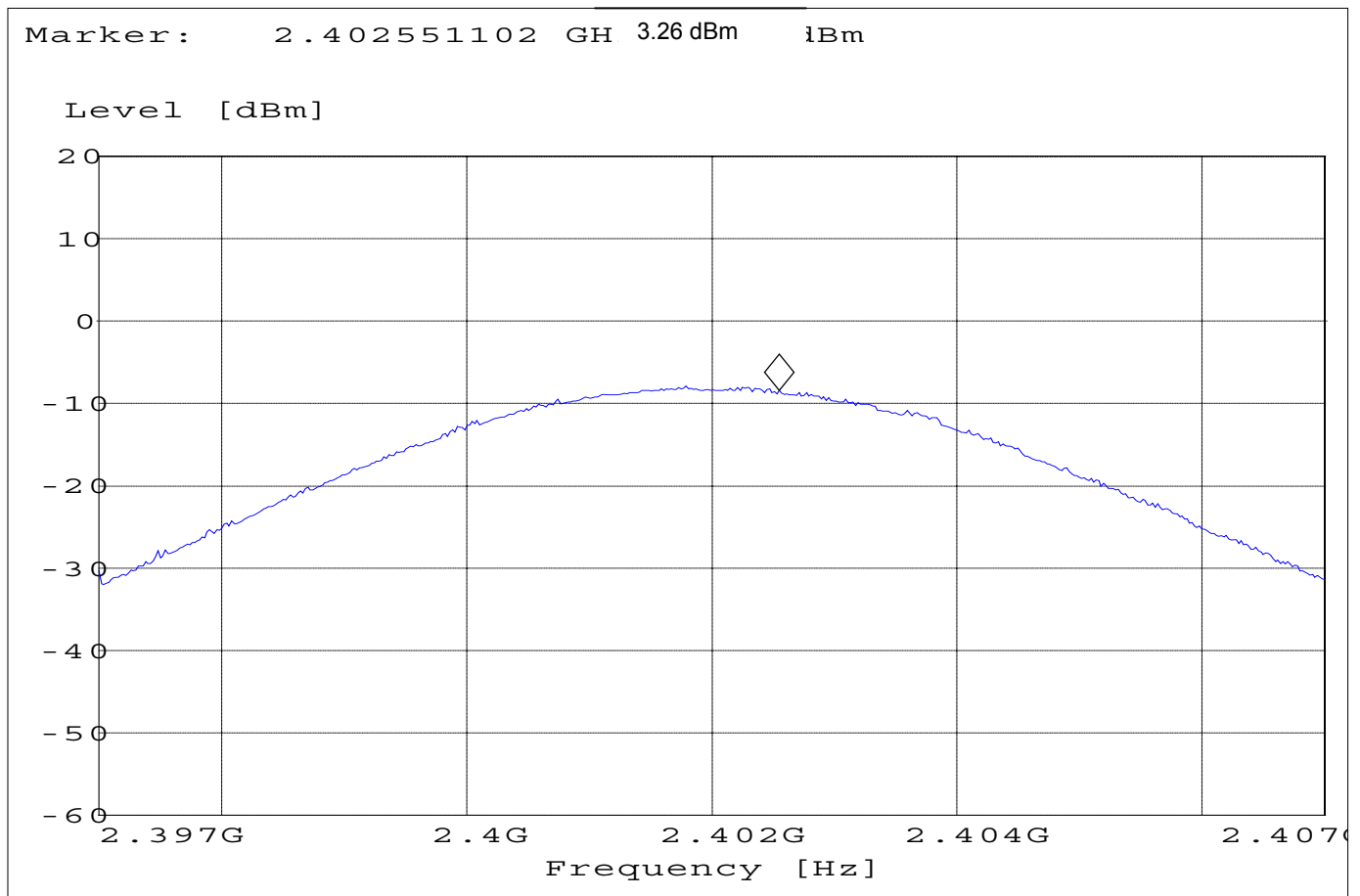
Peak output power (Radiated)

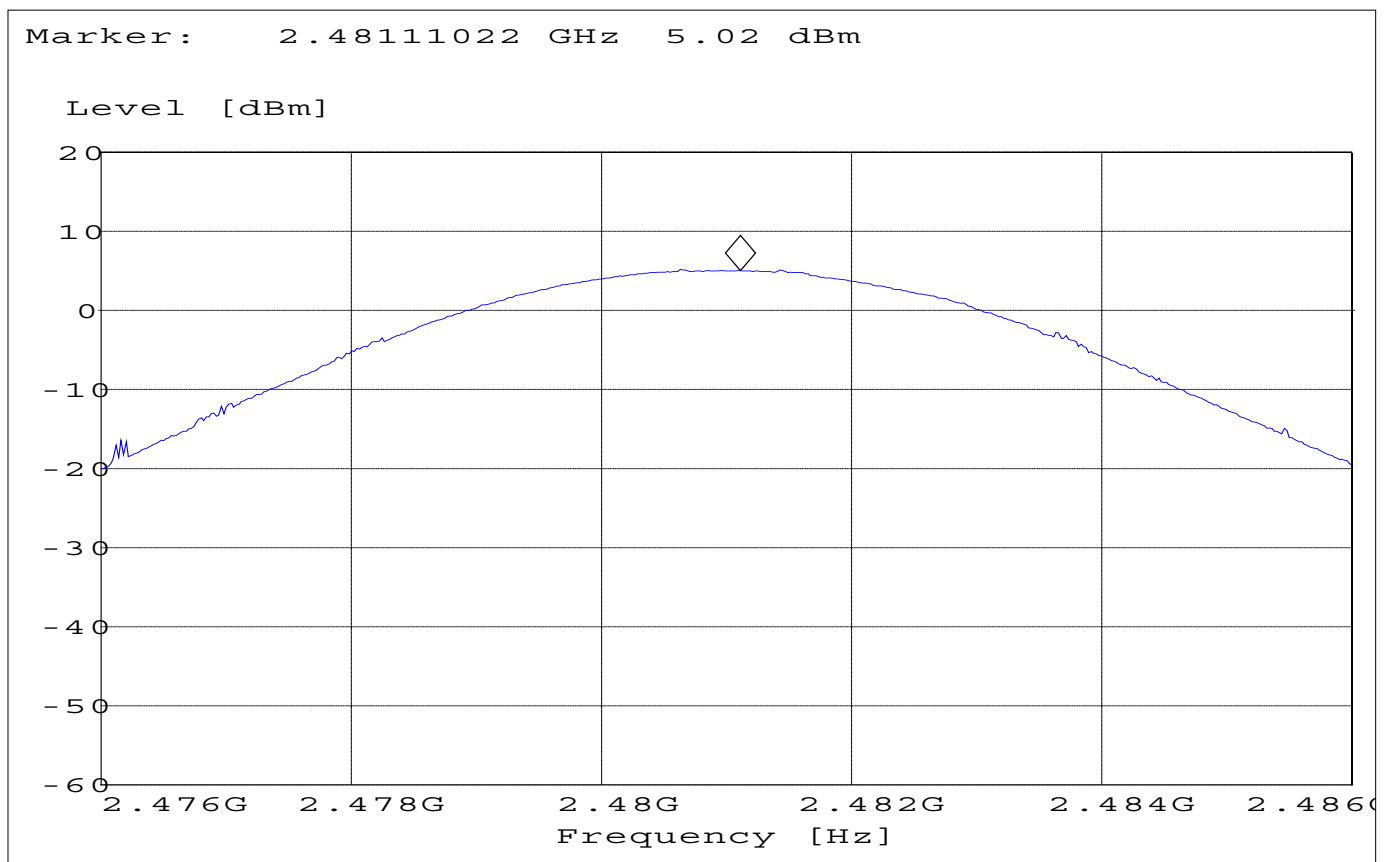
§15.247 (b) (1)

Lowest Channel: 2402MHz

ANALYZER SETTINGS: RBW = 3MHz VBW = 3MHz



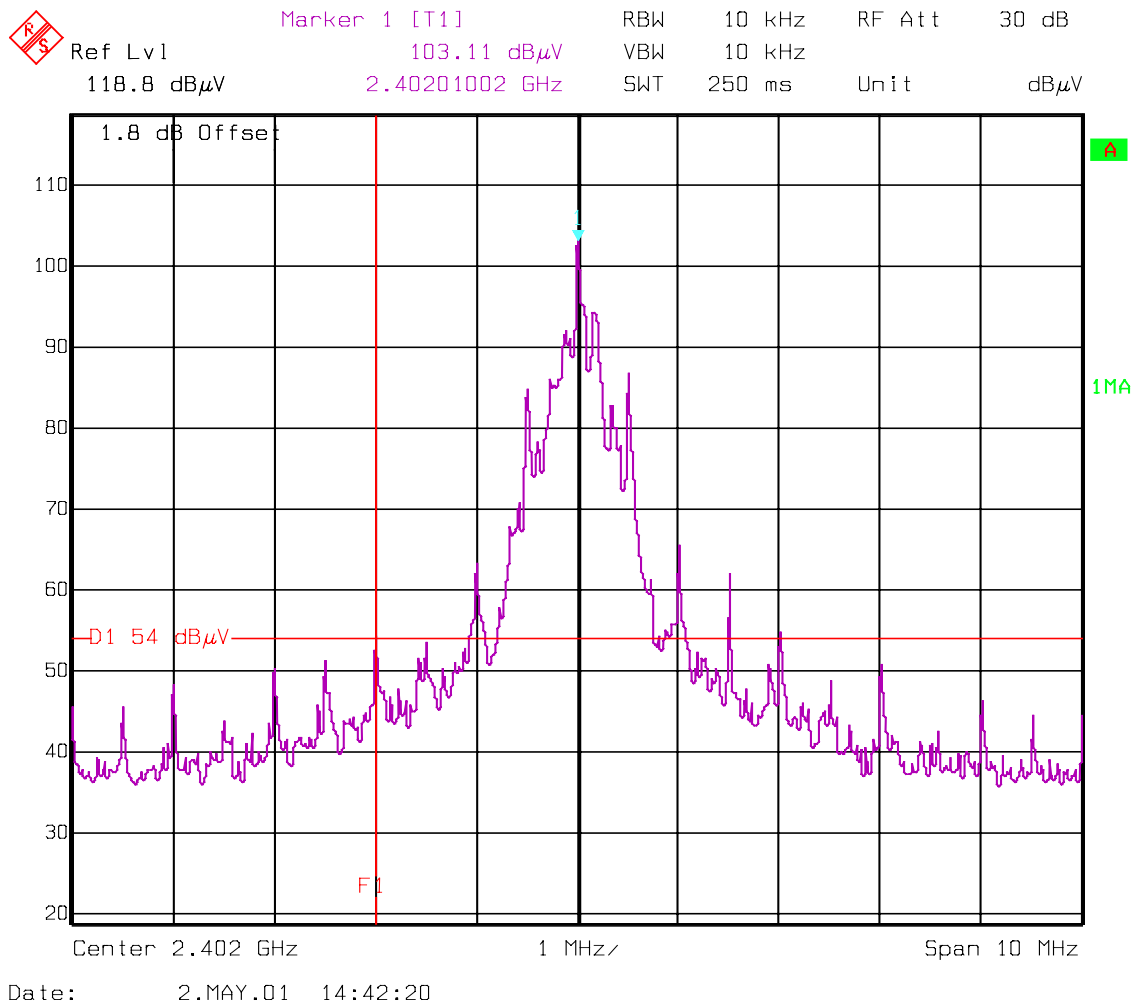
Peak output power (Radiated)**§15.247 (b) (1)****Mid Channel: 2441MHz****ANALYZER SETTINGS: RBW = 3MHz VBW = 3MHz**

Peak output power (Radiated)**§15.247 (b) (1)****Highest Channel: 2481MHz****ANALYZER SETTINGS: RBW = 3MHz VBW = 3MHz**

BAND EDGE COMPLIANCE OF CONDUCTED EMISSIONS

§15.247 (c)

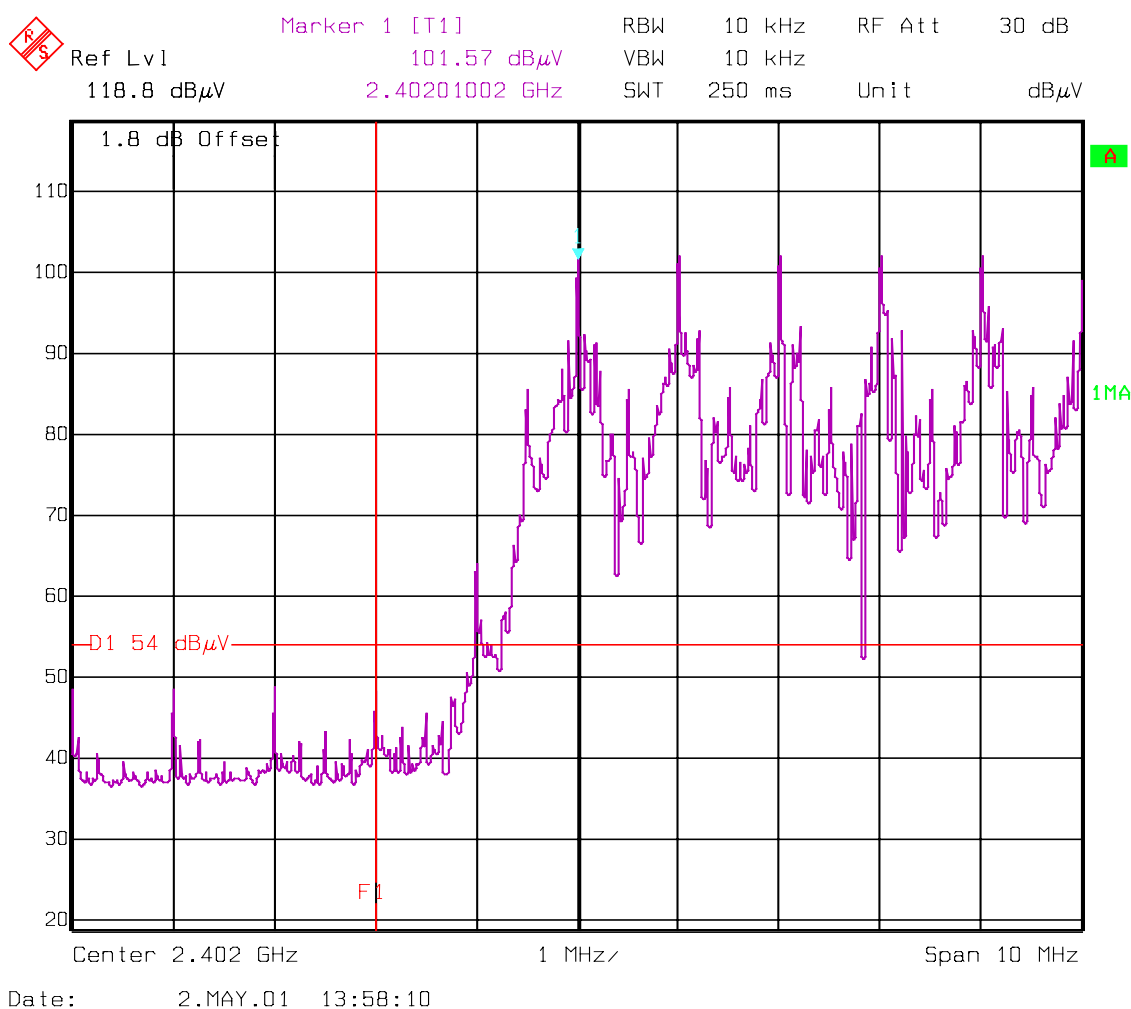
Low frequency section (hopping off)



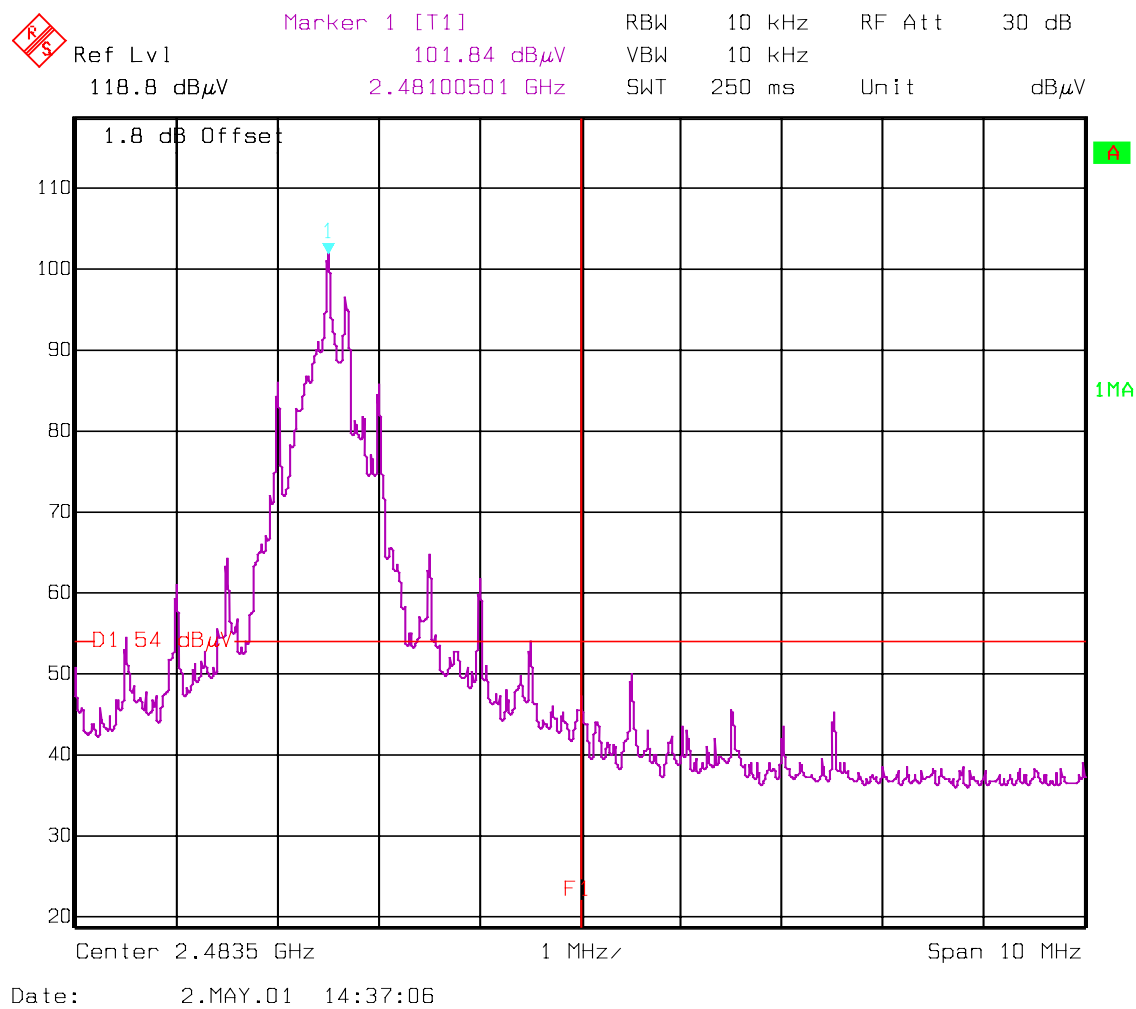
Band-edge compliance of conducted emissions

§15.247 (c)

Low frequency section (hopping on)



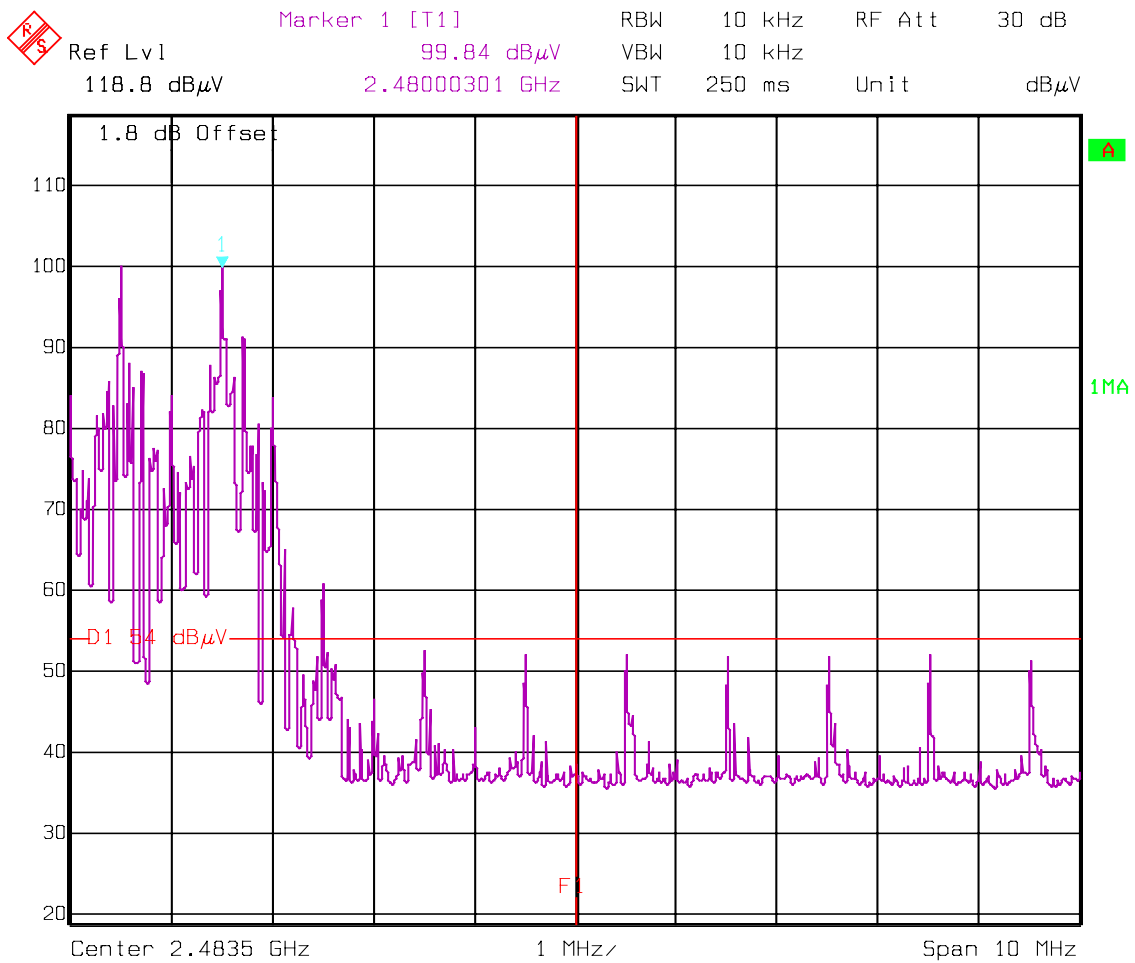
Band-edge compliance of conducted emissions §15.247 (c)
high frequency section (hopping off)



Band-edge compliance of conducted emissions

§15.247 (c)

high frequency section (hopping on)



Date: 2.MAY.01 14:01:10

EMISSION LIMITATIONS- Conducted (Transmitter)

§ 15.247 (c) (1)

EMISSION LIMITATIONS					
f (MHz)			limit max. allowed emmission power	actual attenuation below frequency of operation (dB)	results
2402			30 dBm	-	Operating frequency
all peaks <<limit				see plot	complies
2441			30 dBm	-	Operating frequency
all peaks <<limit				see plot	complies
2481			30 dBm		Operating frequency
all peaks <<limit				see plot	complies
Measurement uncertainty		± 3dB			

LIMITS

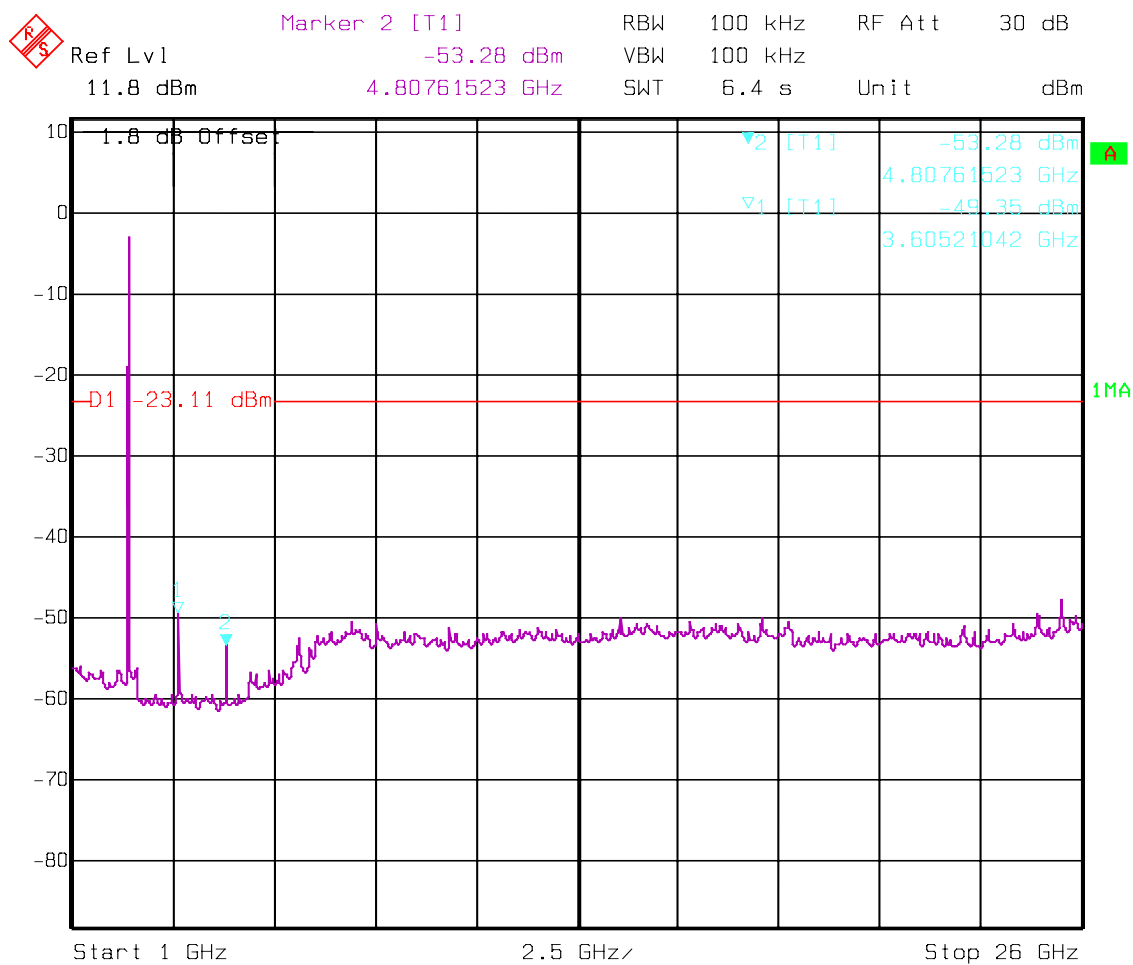
SUBCLAUSE § 15.247 (c)

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)).

EMISSION LIMITATIONS - Conducted (Transmitter)

§ 15.247 (c) (1)

Lowest Channel: 1GHz - 26 GHz

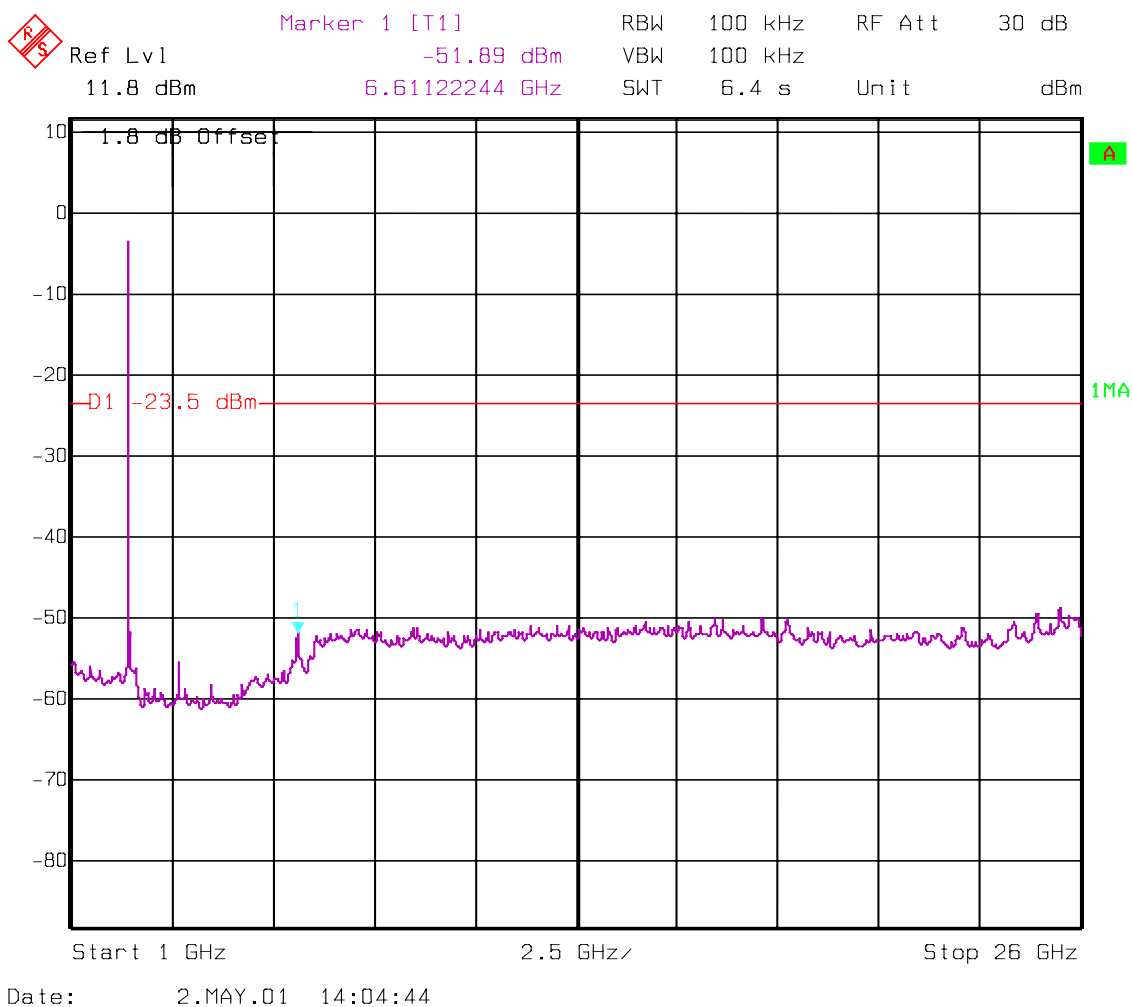


Date: 2.MAY.01 14:25:36

EMISSION LIMITATIONS - Conducted (Transmitter)

§ 15.247 (c) (1)

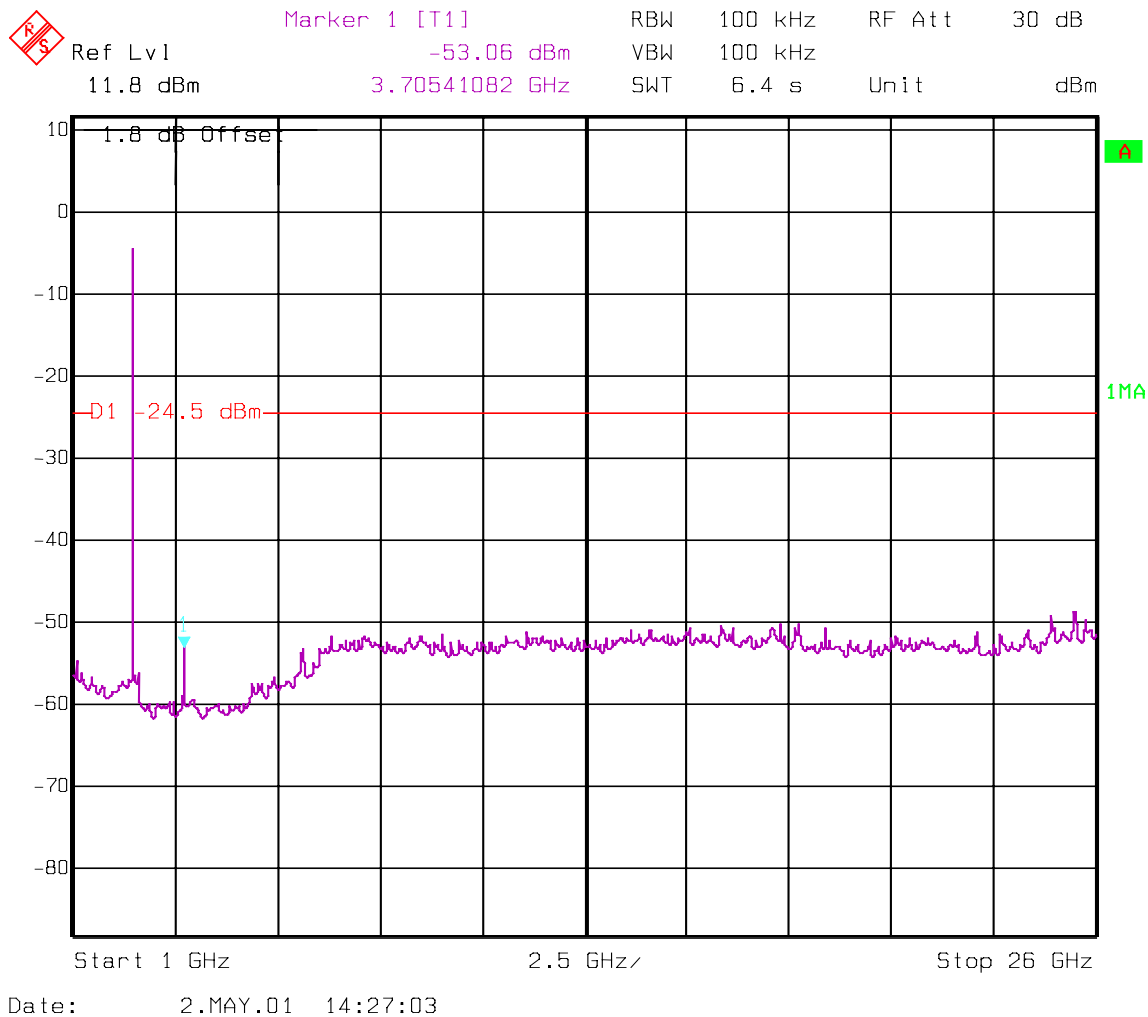
Mid Channel: 1GHz - 26 GHz



EMISSION LIMITATIONS - Conducted (Transmitter)

§ 15.247 (c) (1)

Highest Channel: 1GHz - 26 GHz



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

NOTE: The spurious 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 18 and 26 GHz very short cable connections to the antenna was used to minimize the noise level. Channel 1: 2402 MHz; Channel 2: 2441 MHz; Channel 3: 2481 MHz

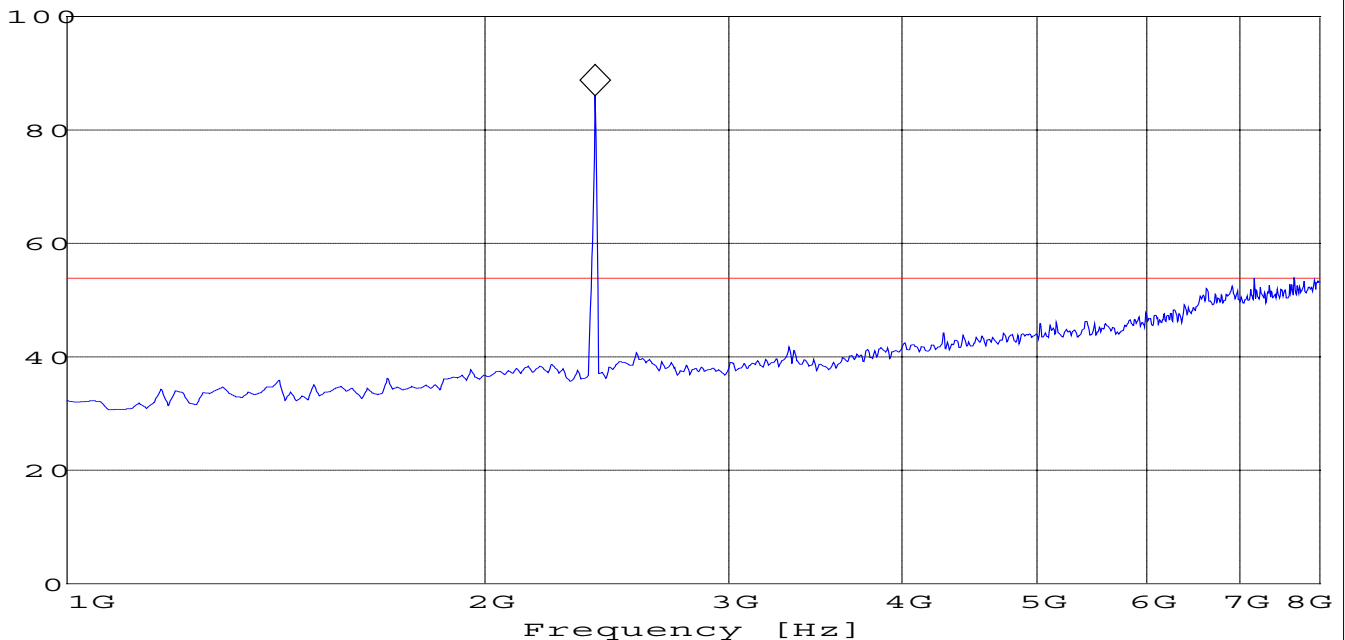
All measurements were against the limits for the restricted bands. Only in case of exceeding the limits it will be analyzed if it is outside a restricted band or not.

If it is outside the restricted bands the lower limits will apply and the relevant frequencies will be checked against these limits.

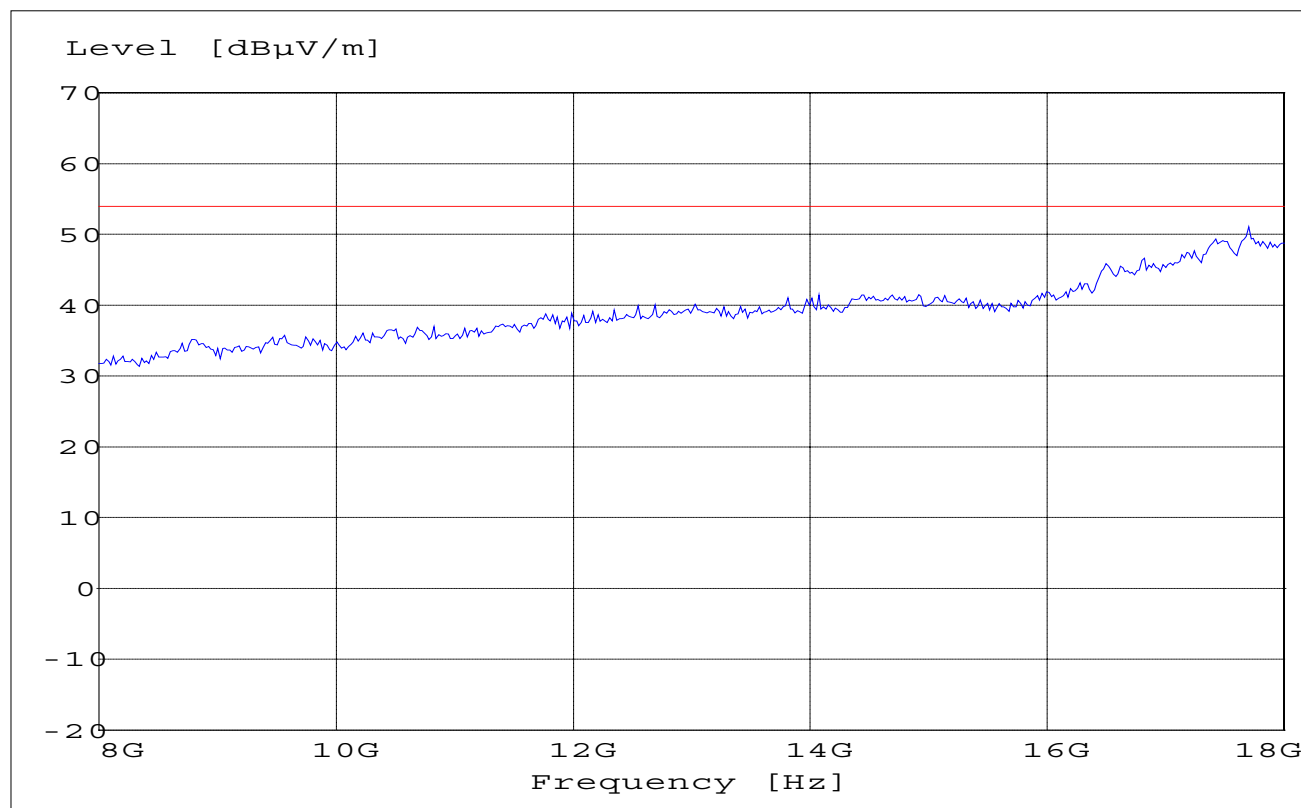
EMISSION LIMITATIONS - Radiated (Transmitter)**SUBCLAUSE § 15.247 (c) (1)****Lowest Channel: 1GHz – 8GHz****ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz**

Marker: 2.402805611 GHz 85.98 dBμV/m

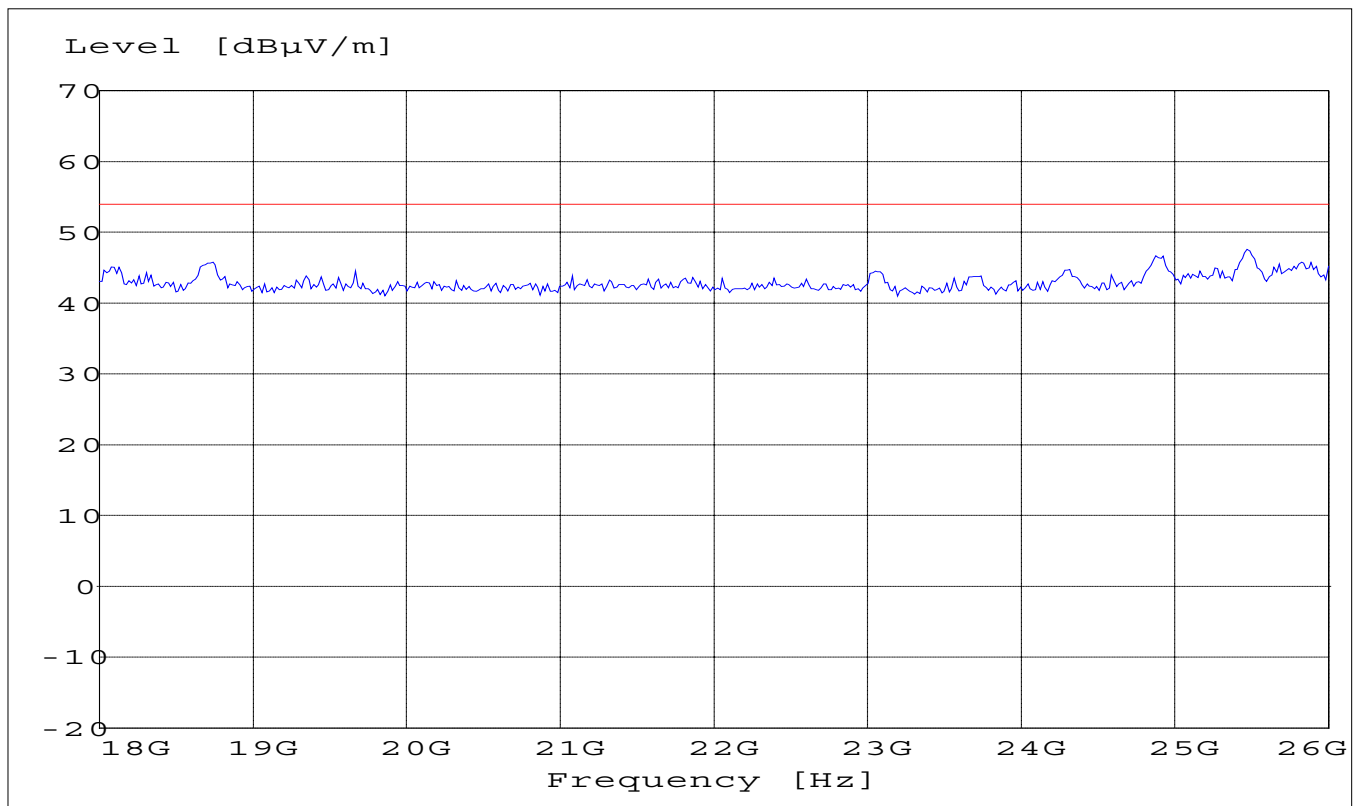
Level [dBμV/m]

**LIMITS****SUBCLAUSE § 15.247 (c)**

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)).

EMISSION LIMITATIONS - Radiated (Transmitter)**SUBCLAUSE § 15.247 (c) (1)****Lowest Channel: 8GHz – 18GHz****ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz****LIMITS****SUBCLAUSE § 15.247 (c)**

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)).

EMISSION LIMITATIONS - Radiated (Transmitter)**SUBCLAUSE § 15.247 (c) (1)****Lowest Channel: 18GHz – 26GHz****ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz****LIMITS****SUBCLAUSE § 15.247 (c)**

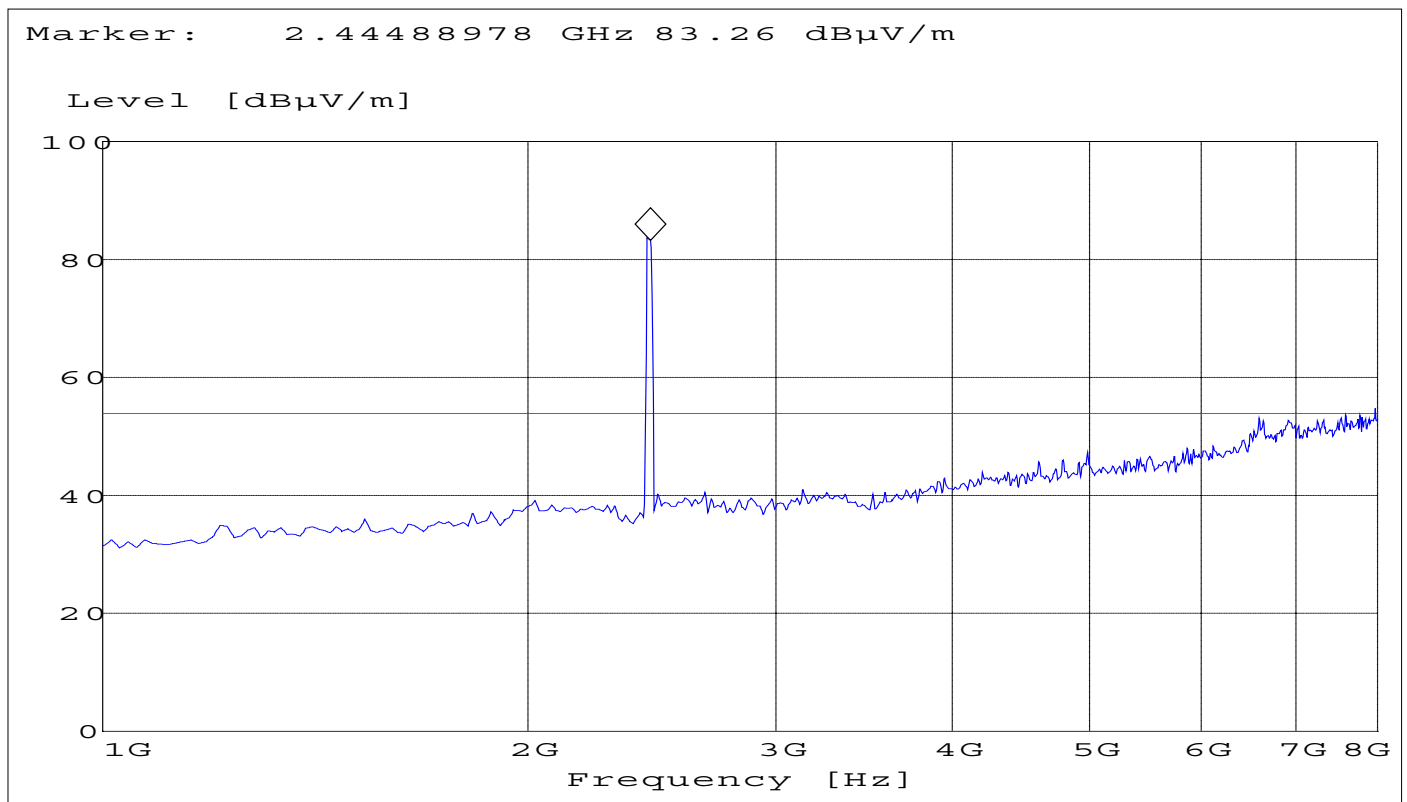
In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

EMISSION LIMITATIONS - Radiated (Transmitter)

SUBCLAUSE § 15.247 (c) (1)

Mid Channel: 1GHz – 8GHz

NOTE: Frequency resolution is not fine enough to show the exact frequency of the carrier, refer to plots following page no. 24

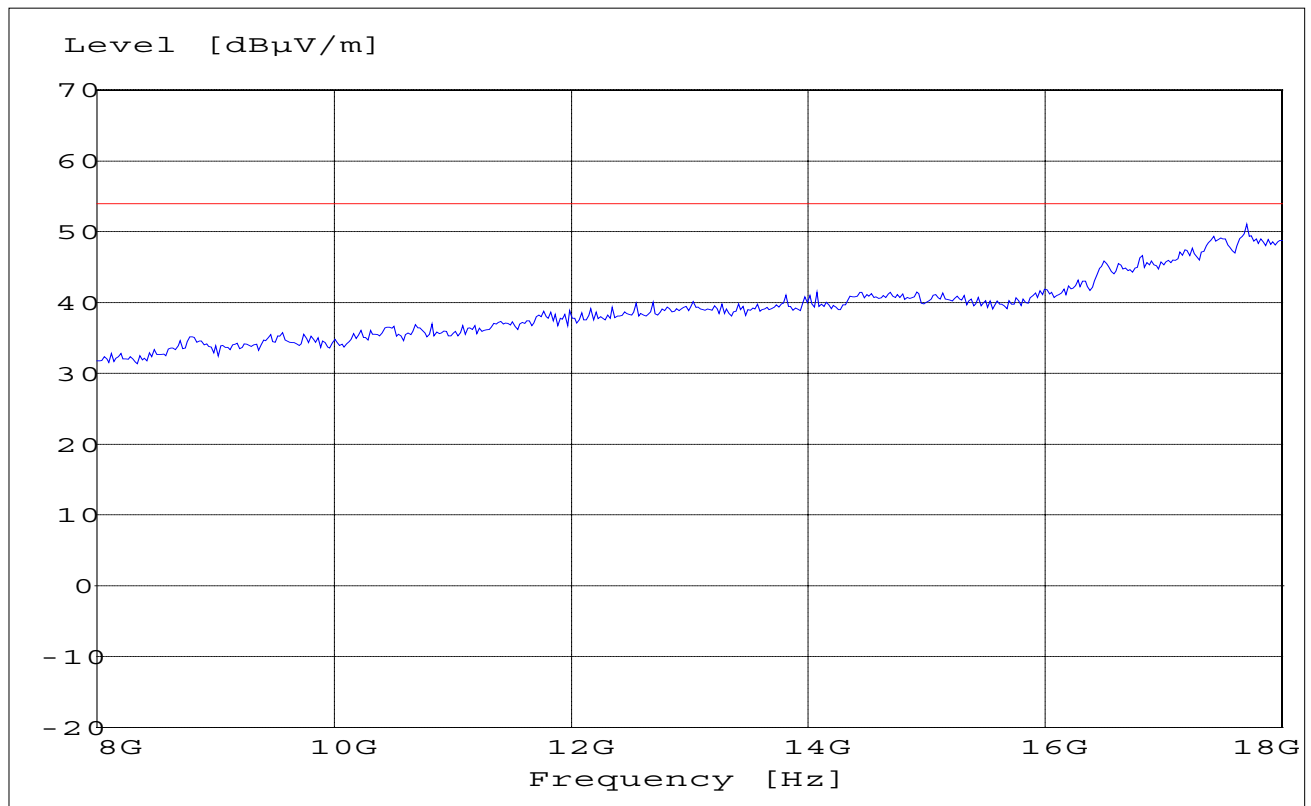


ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz

LIMITS

SUBCLAUSE § 15.247 (c)

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)).

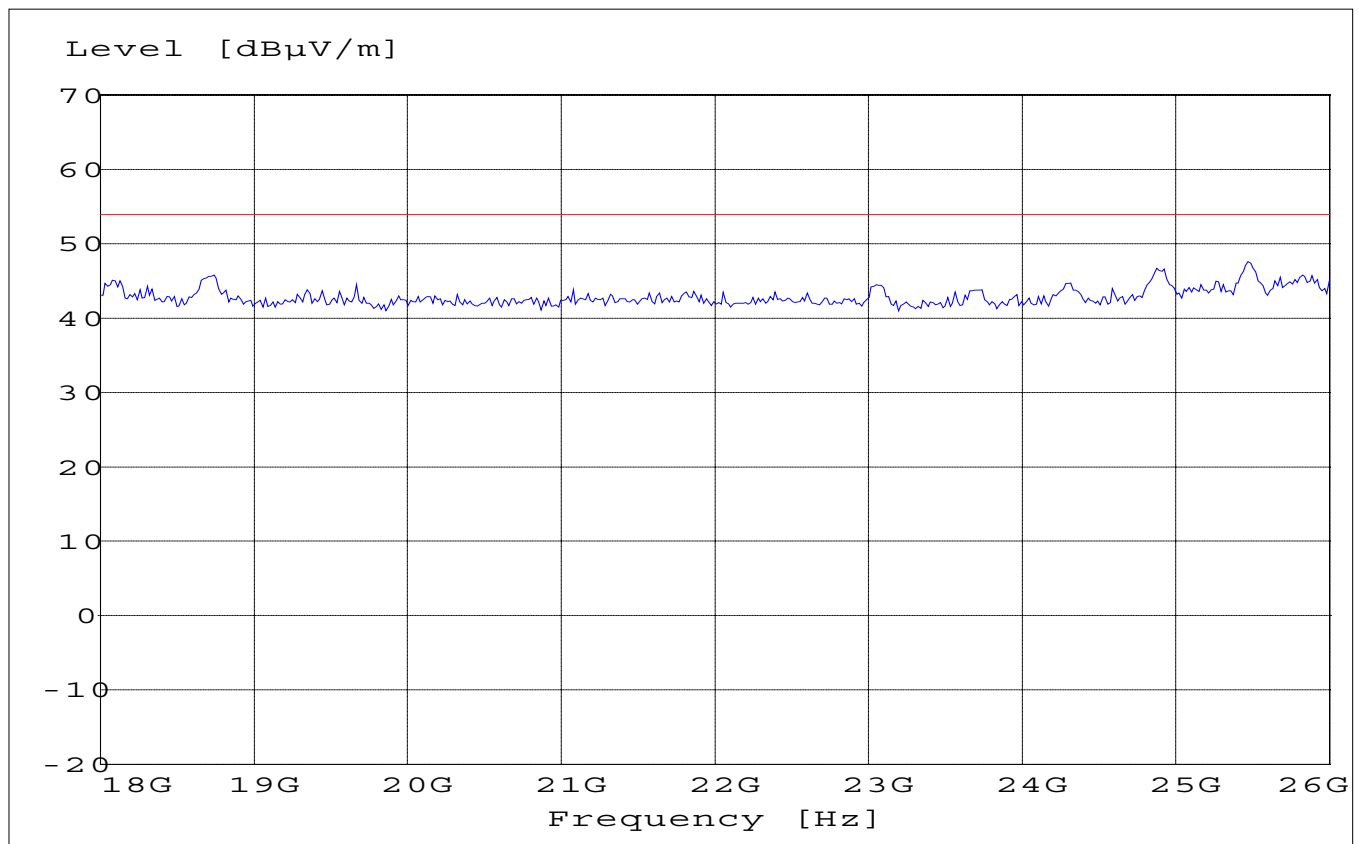
EMISSION LIMITATIONS - Radiated (Transmitter)**SUBCLAUSE § 15.247 (c) (1)****Mid Channel: 8GHz – 18GHz****ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz****LIMITS****SUBCLAUSE § 15.247 (c)**

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)).

EMISSION LIMITATIONS - Radiated (Transmitter)

SUBCLAUSE § 15.247 (c) (1)

Mid Channel: 18GHz – 26GHz



ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz

LIMITS

SUBCLAUSE § 15.247 (c)

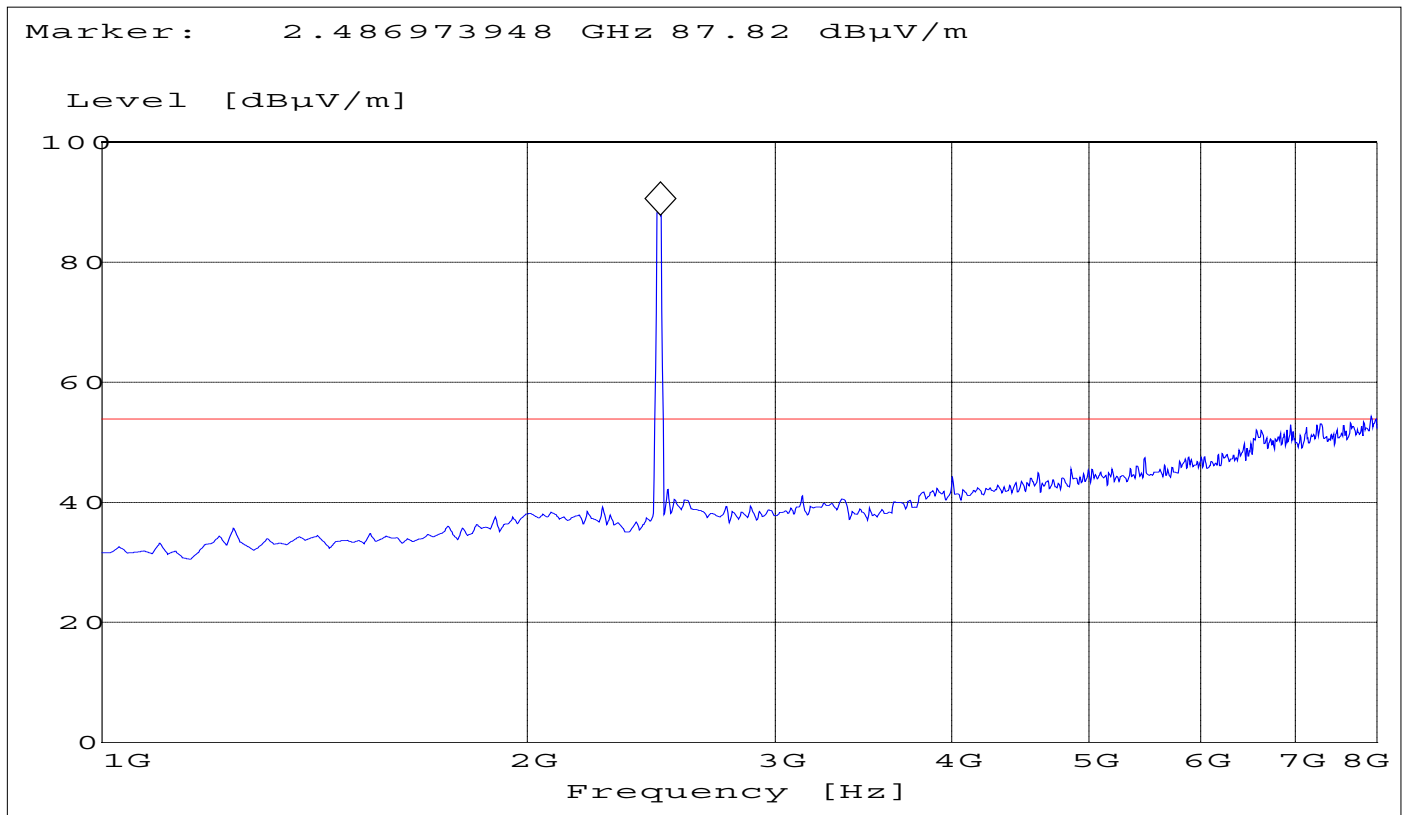
In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

EMISSION LIMITATIONS - Radiated (Transmitter)

SUBCLAUSE § 15.247 (c) (1)

Highest Channel: 1GHz – 8GHz

NOTE: Frequency resolution is not fine enough to show the exact frequency of the carrier, refer to plots following page no. 24



ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz

LIMITS

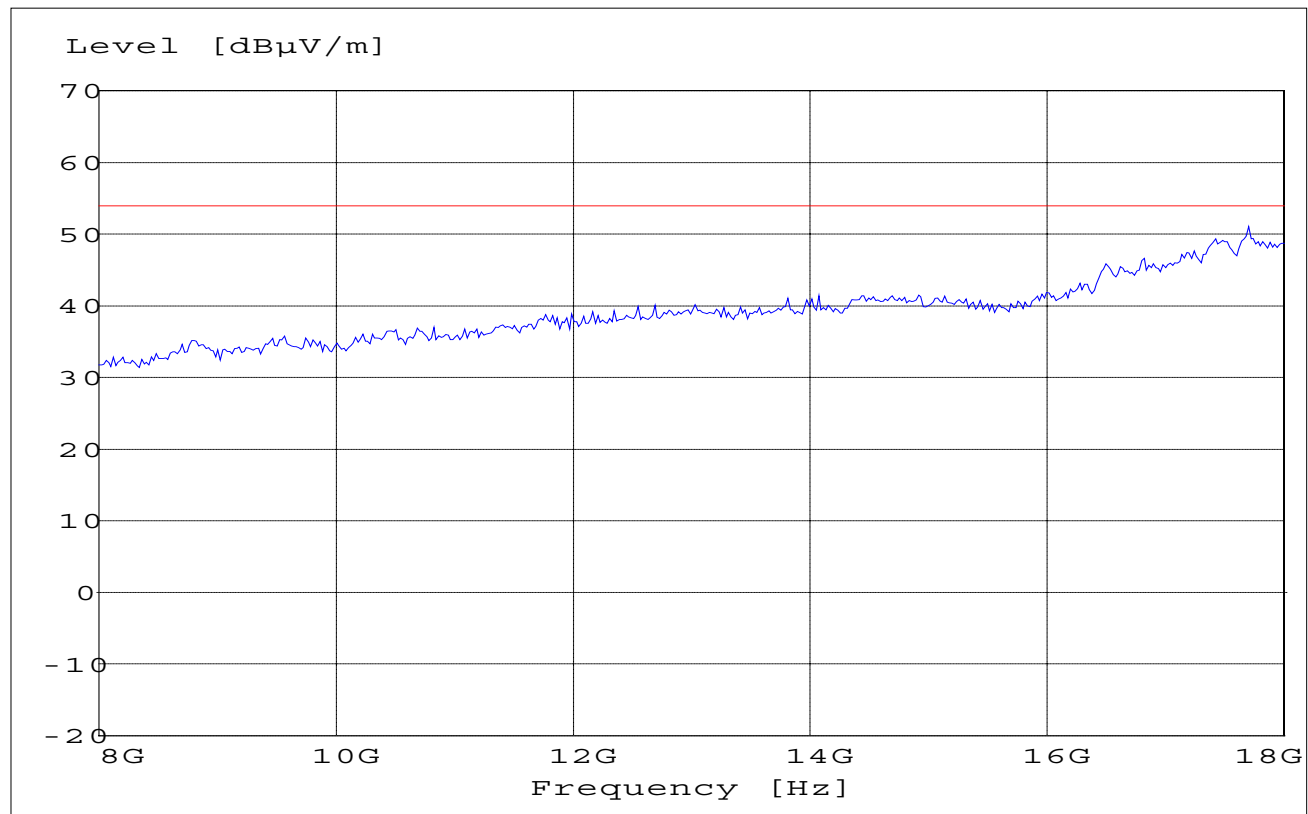
SUBCLAUSE § 15.247 (c)

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)).

EMISSION LIMITATIONS - Radiated (Transmitter)

SUBCLAUSE § 15.247 (c) (1)

Highest Channel: 8GHz – 18GHz

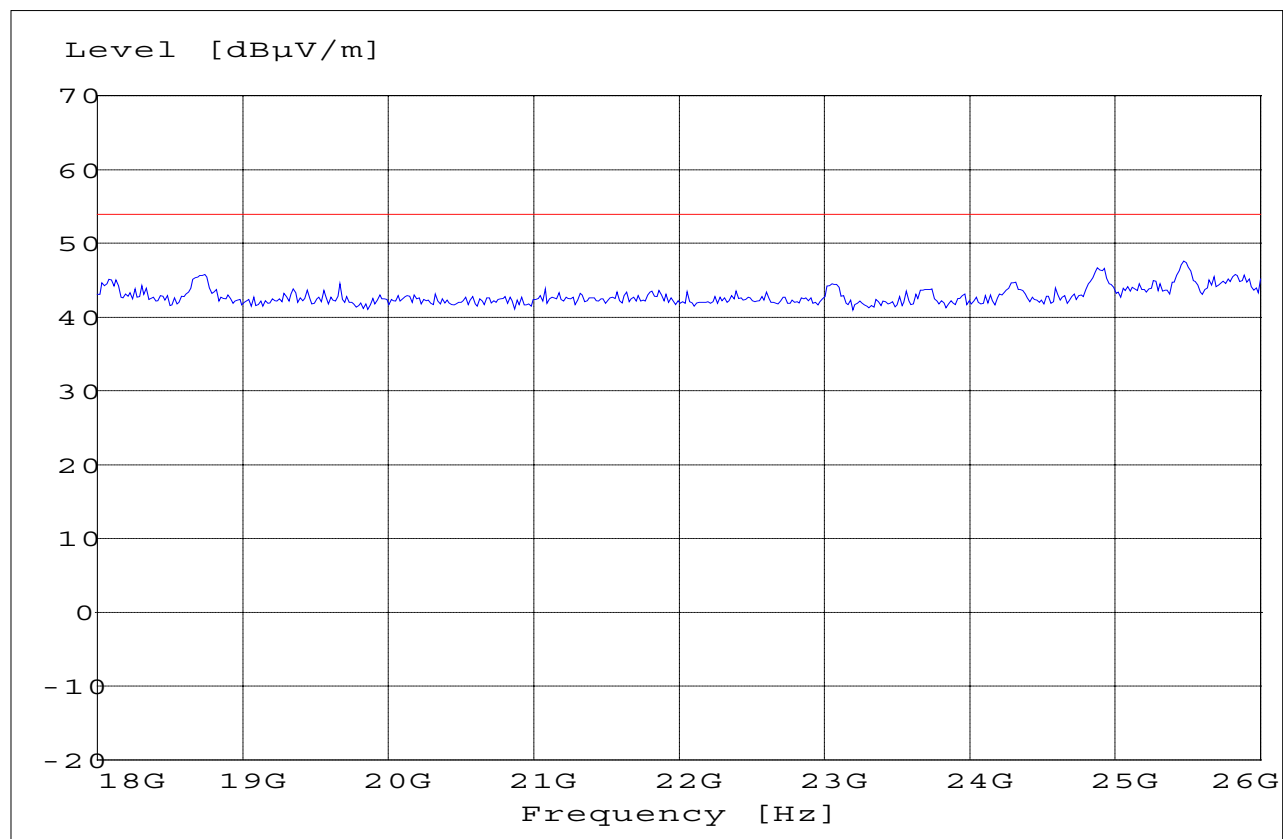


ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz

LIMITS

SUBCLAUSE § 15.247 (c)

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)).

EMISSION LIMITATIONS - Radiated (Transmitter)**SUBCLAUSE § 15.247 (c) (1)****Highest Channel: 18GHz – 26GHz****ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz****LIMITS****SUBCLAUSE § 15.247 (c)**

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)).

§ 15.209

Radiated

SPURIOUS EMISSIONS LEVEL (μV/m)								
2402 MHz			2442 MHz			2481 MHz		
f (MHz)	Detector	Level (μV/m)	f (MHz)	Detector	Level (μV/m)	f (MHz)	Detector	Level (μV/m)
all peaks <<limit								
Measurement uncertainty			±3 dB					

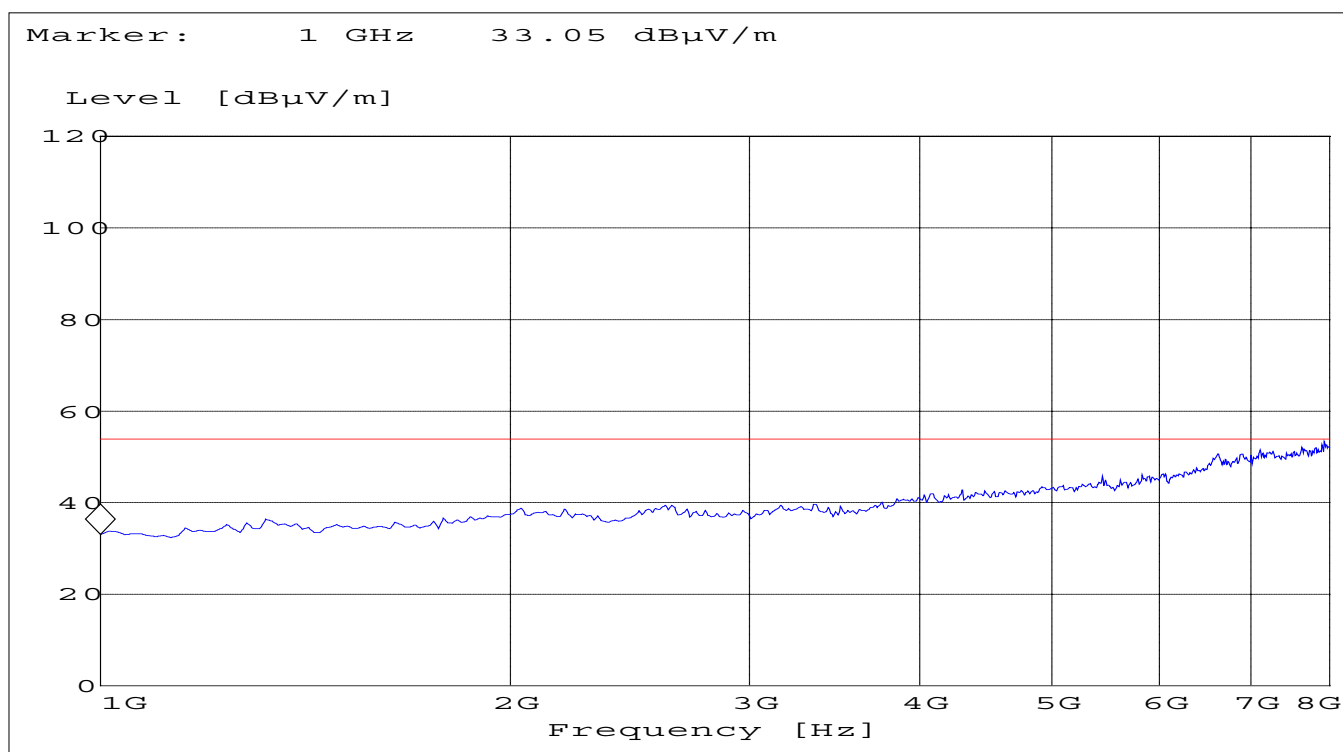
SUBCLAUSE § 15.209

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

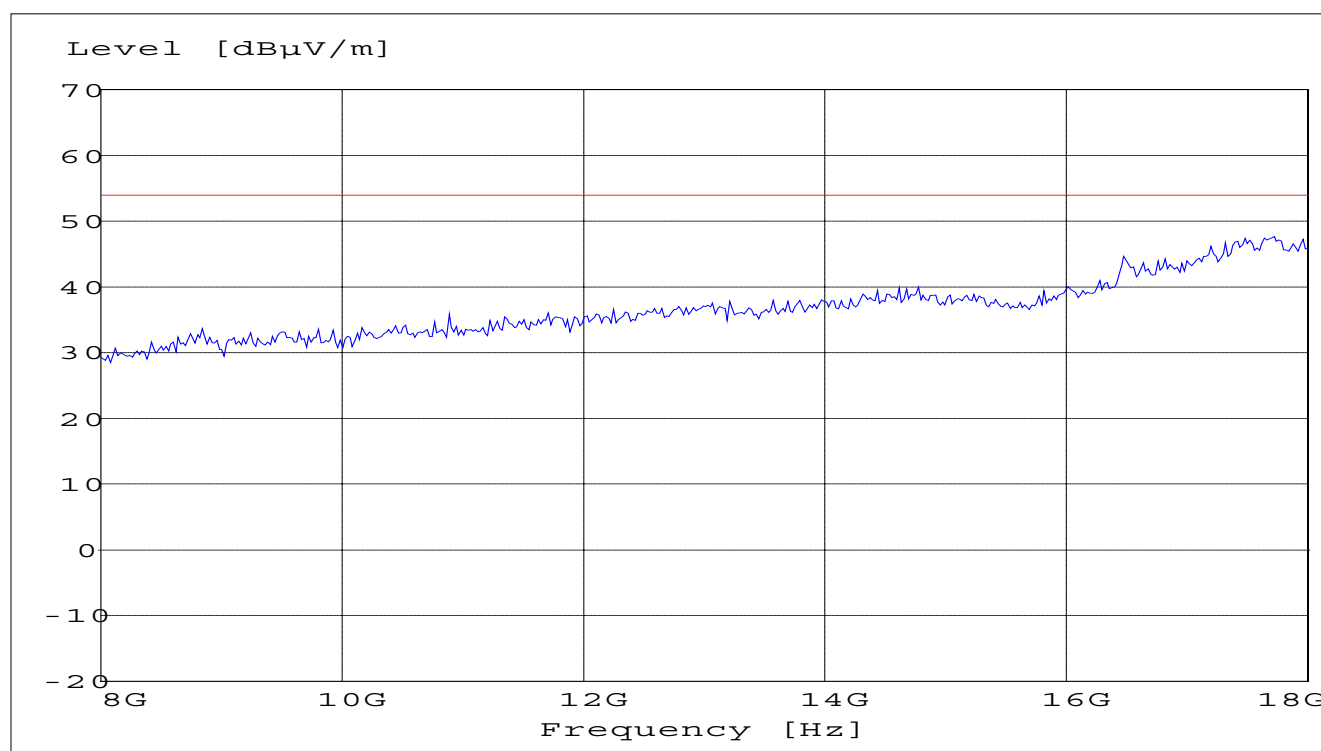
RECEIVER SPURIOUS RADIATION

§ 15.209

1GHz – 8GHz (This plot is valid for all three channels)



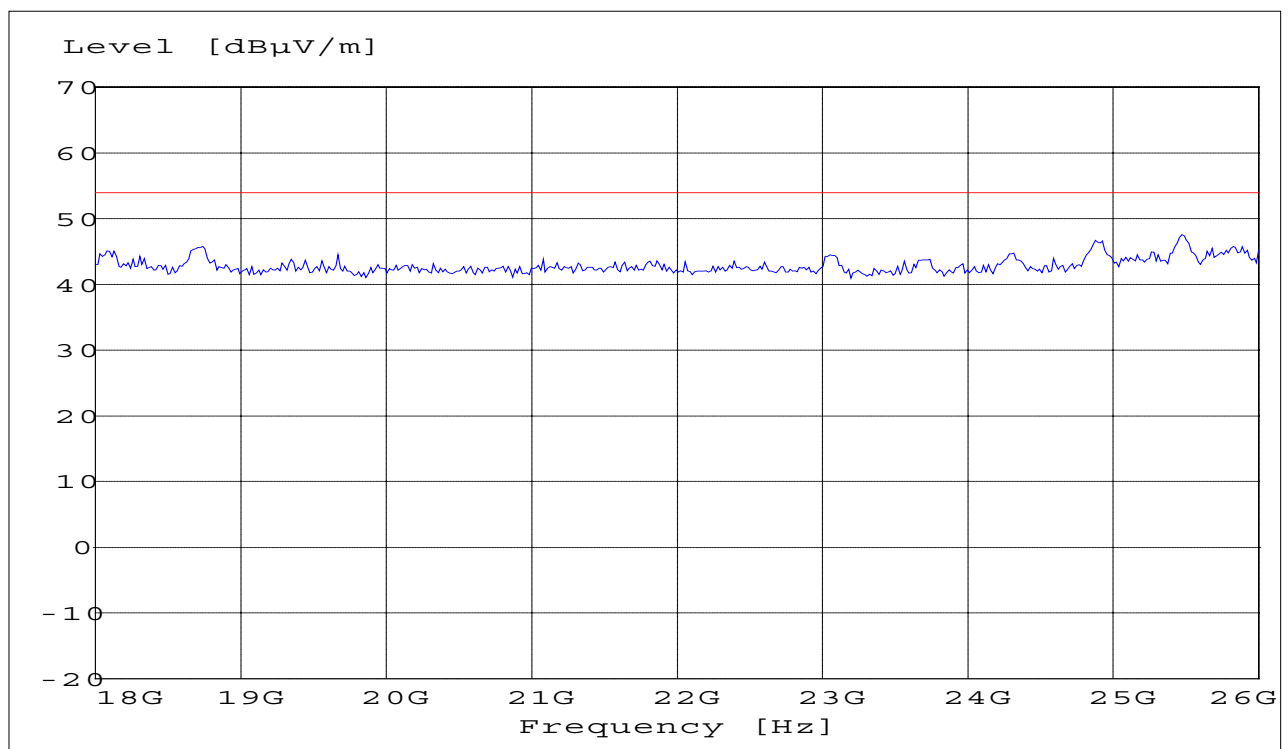
ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz

RECEIVER SPURIOUS RADIATION**§ 15.209****8GHz – 18GHz (This plot is valid for all three channels)****ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz**

RECEIVER SPURIOUS RADIATION

§ 15.209

18GHz – 26GHz (This plot is valid for all three channels)

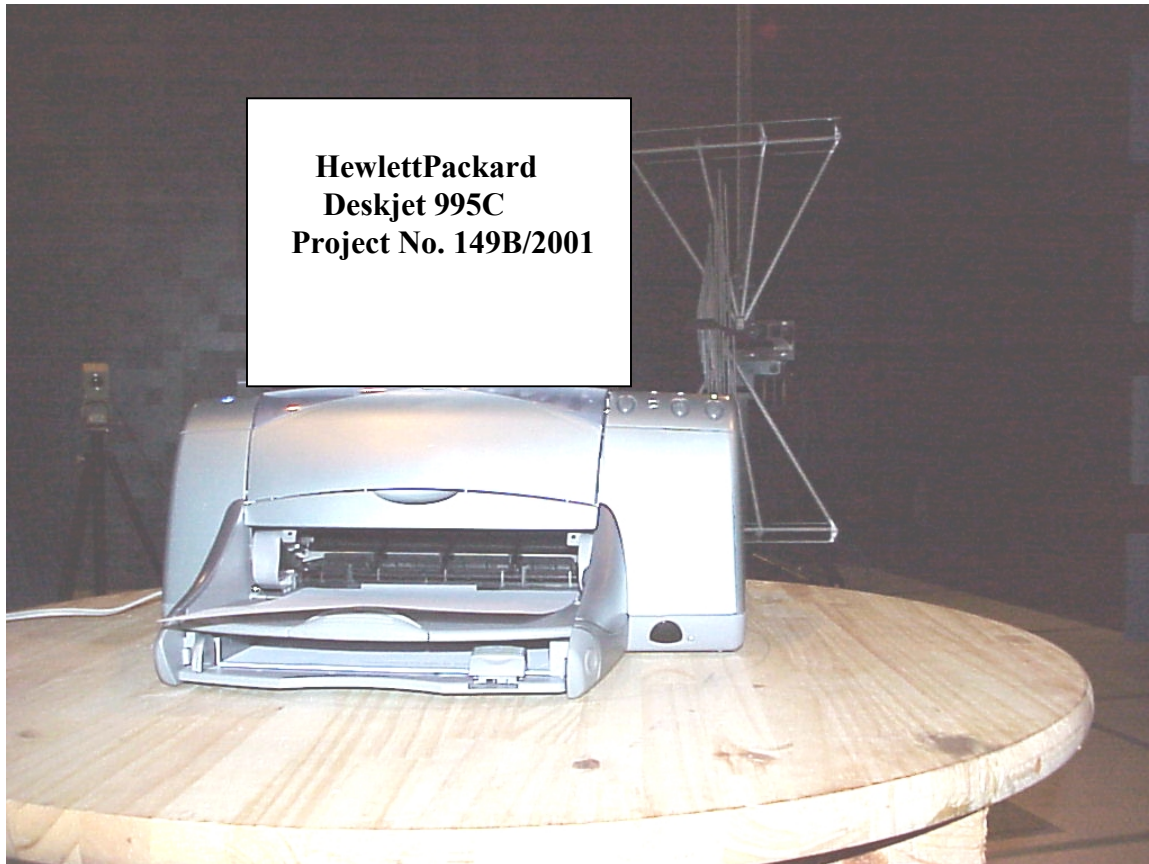


ANALYZER SETTINGS: RBW = 1MHz VBW = 1MHz

[illegible]

Test site

RADIATED EMISSIONS



Photographs of the equipment

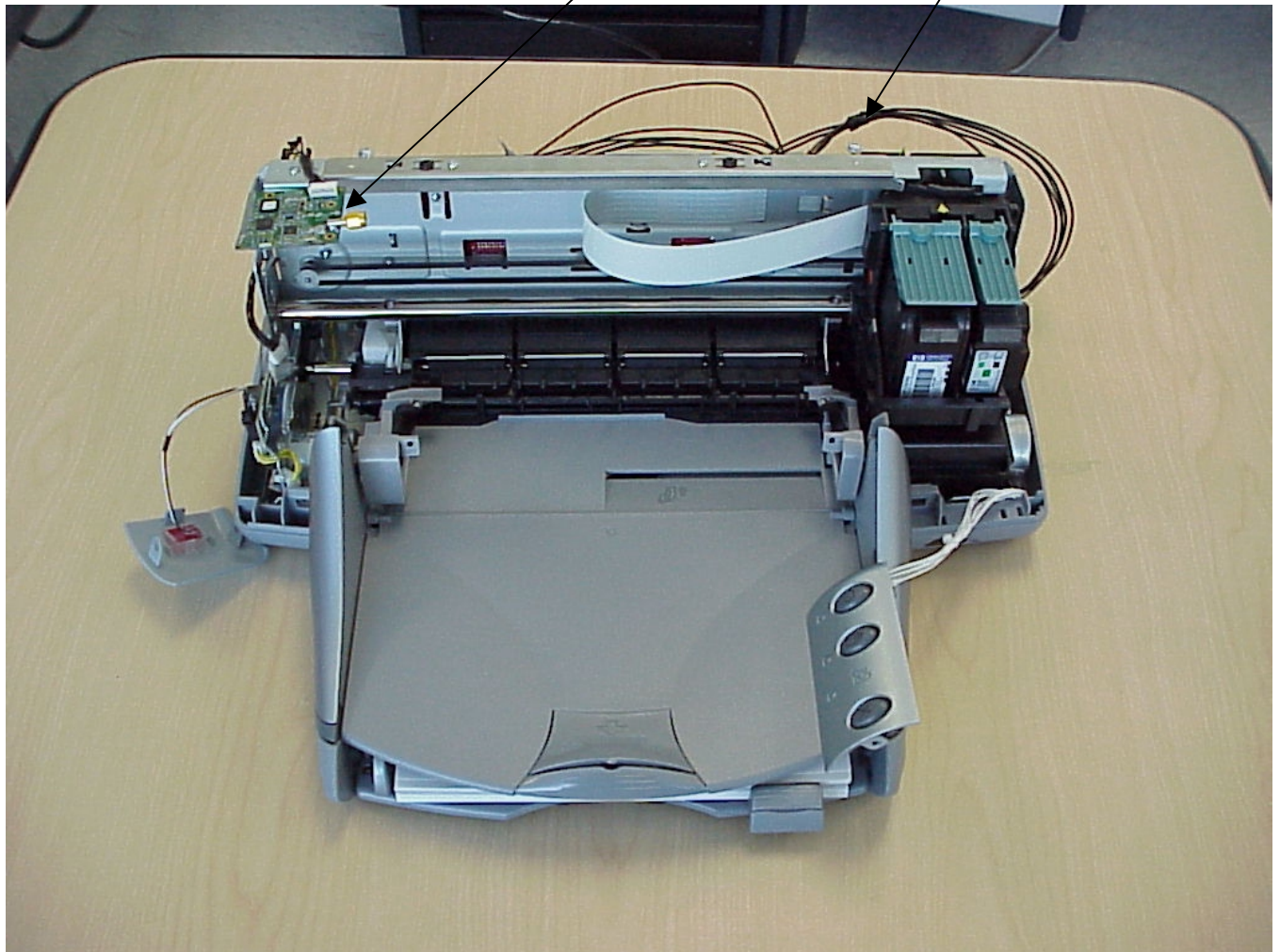
Photograph no.: 1



Photographs of the equipment

Photograph no.: 2

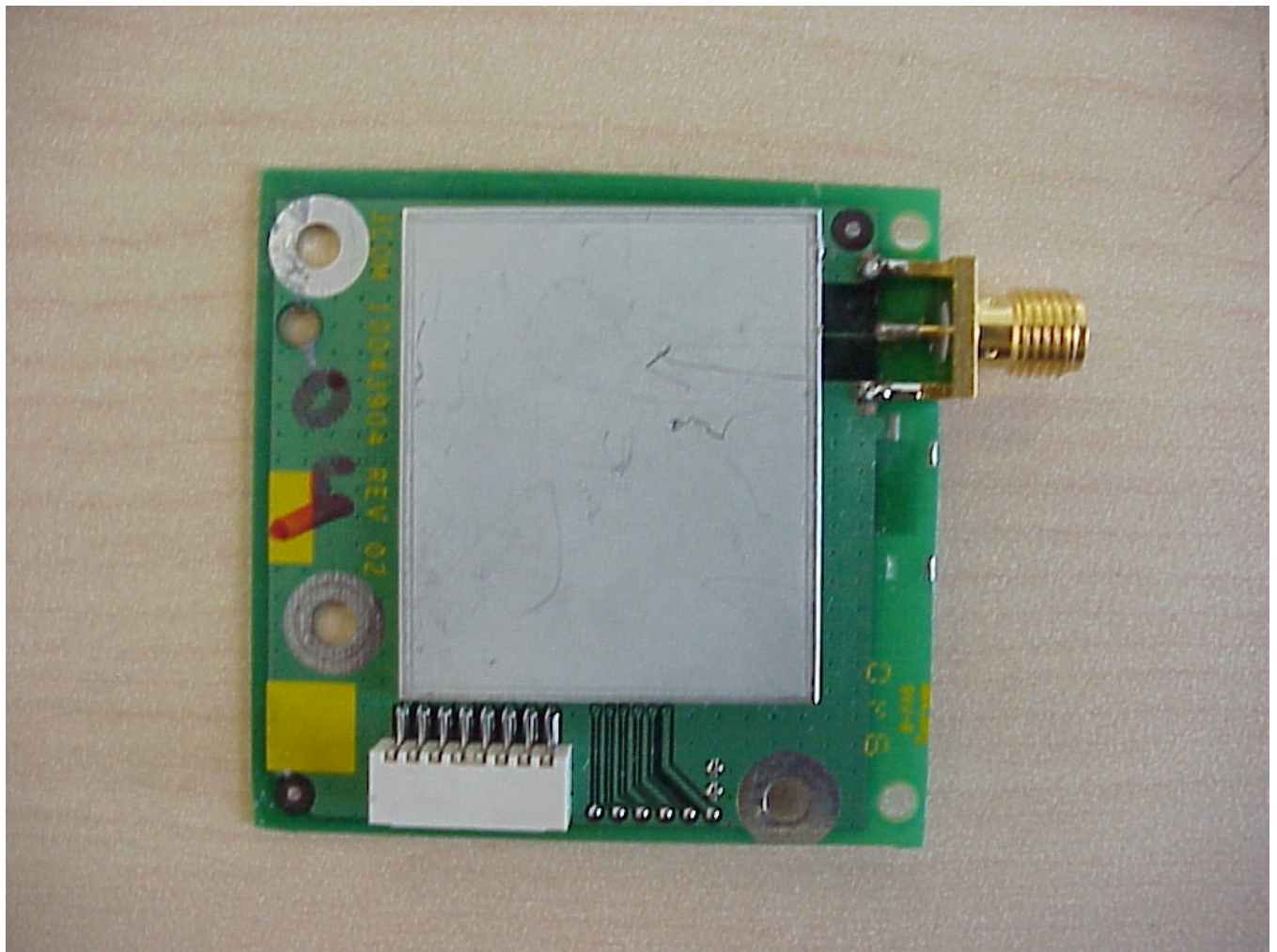
Extended cable length between module printer PCB for temperature measurements. Only used for conducted measurements (module with SMA connector)



Photographs of the equipment

Photograph no.: 3

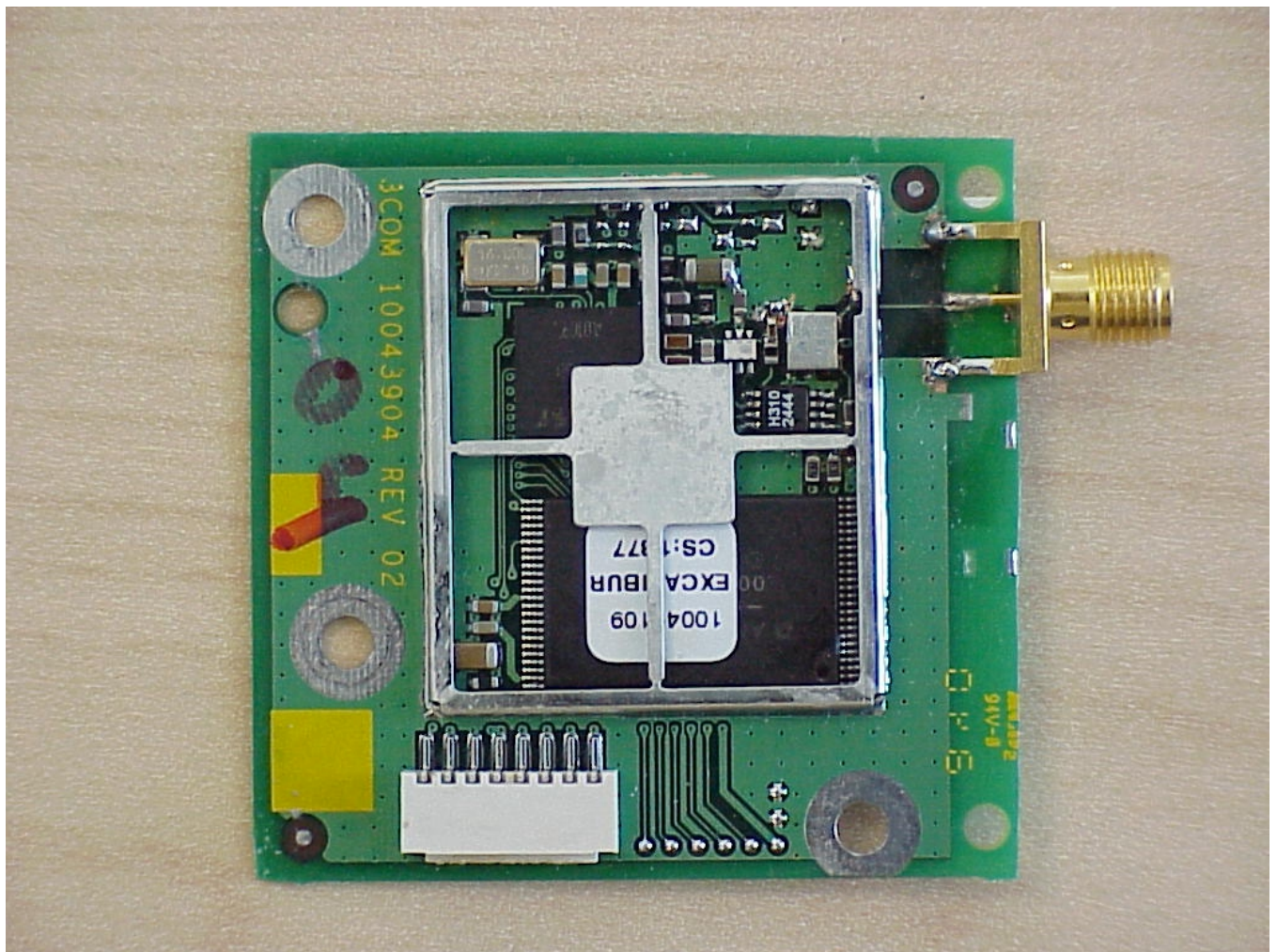
Module used for conductd measurements (top view with sheilding) The antenna is integrated on the board.



Photographs of the equipment

Photograph no.: 4

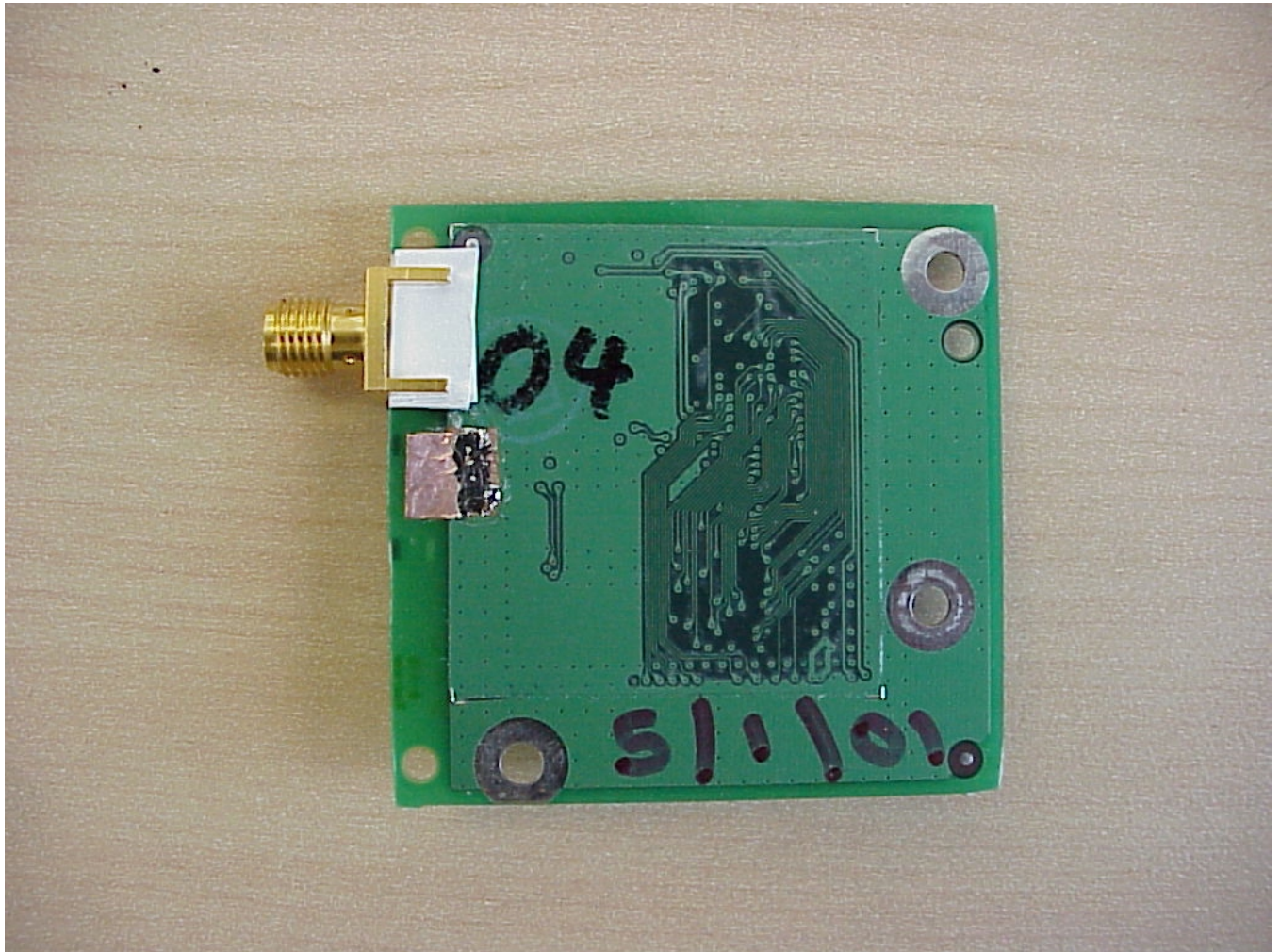
Module used for conductd measurements (top view without sheilding)



Photographs of the equipment

Photograph no.: 5

Module used for conductd measurements (bottom view)



MEMORANDUM

Distribution: Peter Flittner, Robert Young, James Collier

cc:

Prepared By: Alex Busteed

Subject: Results of Processing Gain Tests for FCC Qualification

1 INTRODUCTION

This memo presents the results of the Processing Gain (PG) tests carried out for FCC qualification of the Cambridge Silicon Radio BC01B Bluetooth chip. The FCC states that the PG from a hybrid Bluetooth receiver must be greater than 17 dB when measured in accordance with the Continuous Wave (CW) jamming margin method. Testing of the BC01b has found the PG due to the DS section to be approximately 5 dB and the PG due to the FH part to be approximately 15 dB. It is therefore concluded that the BC01B complies with the FCC PG requirements for radio communication systems.

The rest of this paper outlines the PG measurement technique and discusses the test results. Appendix A contains a list of test equipment and Appendix B contains a printout of the measurement results.

2 METHOD**2.1 PG Definition**

The Processing Gain from a frequency hopping communication system is derived from two parts, the FH section and the DS section. The PG due to FH is given by a simple equation and is constant. However measurement of the PG due to DS is a little more complex. One technique is to use the CW jamming margin method. This method measures PG due to DS using the following algorithm:

A CW signal generator is stepped in 50kHz increments across the passband of the system, recording at each point the generator level required to produce the 0.1% Packet Error Rate (PER). This is the jammer level. This level is then referenced to the output power of the intended Bluetooth signal and the Jammer to Signal Ratio JSR is thus calculated. The worst 4

JSR measurements are discarded and the worst remaining JSR is used to calculate the PG due to DS as follows:

$$G_p = SNR + JSR_{\min} + L_{\text{sys}}$$

where G_p = the processing gain of the system, SNR = the signal to noise ratio required for 0.1% BER, $JSR_{\min}$ = minimum J/S ratio and L_{sys} = system losses.

2.2 PG Measurement Technique

Figure 1 provides an overview of the PG measurement technique. The measurement is performed in two parts, measurement of the system SNR and measurement of $JSR_{\min}$.

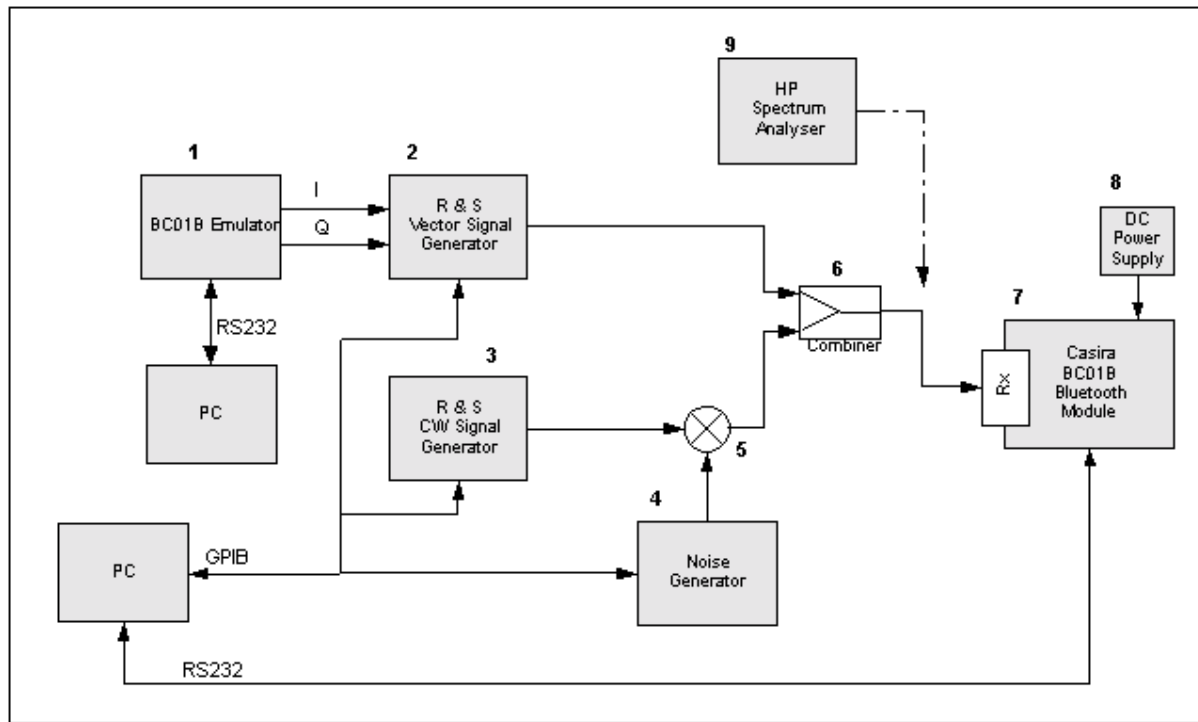


Figure 1: PG Measurement Technique

The system SNR is calculated using the following algorithm. Generate Bluetooth PRBS-9 packets using a BC01B emulator (1) and a Vector Signal Generator (2). Combine this signal with white noise of a constant level, which is generated using a noise source (4) and a CW Signal Generator (3). Then vary the level of the Bluetooth signal until the BER measured by the BC01B (7) is 0.1%. The resulting SNR is the signal level divided by the Noise level.

The JSR for a given jamming frequency is calculated using the following algorithm. Generate Bluetooth PRBS-9 packets using the BC01B emulator (1) and the Vector Signal Generator (2). Combine this signal with a constant CW tone at the jamming frequency using a CW Signal Generator (5) and a combiner (6). Then vary the level of the Bluetooth signal until the PER measured by the Casira Bluetooth Module (7) is 0.1%. The resulting JSR is the signal level divided by the jamming level.

3 RESULTS

3.1 Overview

The measurements found that the PG due to DS caused by the access code in page and inquiry mode is found to be approximately 5dB when the access code is a relatively random mixture of 1's and 0's. A random access code causes the most Inter Symbol Interference (ISI) and hence the worst PG for a hybrid system. Therefore only the results for this access code are used in the PG calculation.

The PG due to FH is given as

$$PG_{FH} = 10 \log_{10} (\text{number of frequency hops})$$

The number of hops in a Bluetooth system is 32, therefore the PG due to FH is approximately 15 dB. When this is added to the PG due to DS, the total PG for the BC01B is approximately 20 dB, above the minimum PG requirement for FCC qualification.

3.2 Detailed Results

Test Date:	17/11/00
Sample Time:	30 seconds
Access Code:	c6967e
Signal Frequency:	2.432GHz
Receiver Sensitivity:	-88.7 dBm
Jammer Signal Level:	-85.7 dBm
Measured SNR:	18.8dB
System Losses:	2dB

To calculate processing gain, ignore the worst 20% of data points and then apply the following formula:

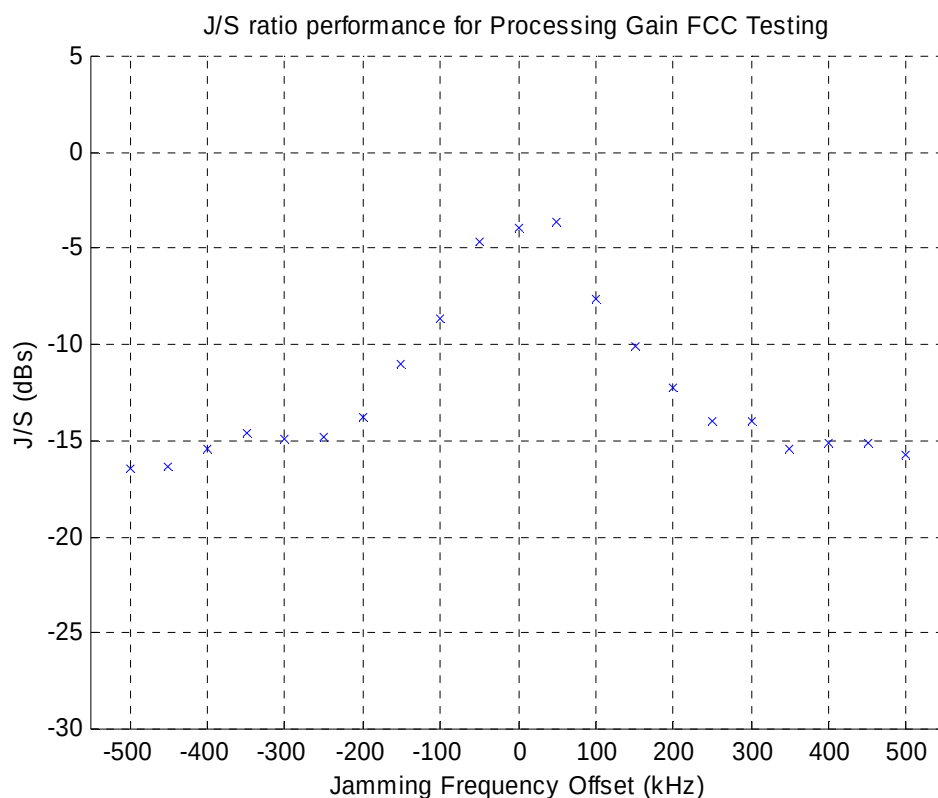
$$G_p = SNR + JSR_{\min} + L_{\text{sys}}$$

Where G_p = Processing Gain of the module
 SNR = signal to noise ratio of the module
 $JS_{\min}$ = minimum J/S ratio after the worst 20% of J/S samples have been discarded
 L_{sys} = System losses

A total of 20 samples were taken by stepping the jamming signal frequency offsets in 50kHz increments over the bandwidth of the receiver. The worst 4 samples were found at -500kHz, -450kHz, -400kHz and 500kHz and were discarded. The remaining minimum J/S ratio was found to be -15.4dB at an offset of +350kHz

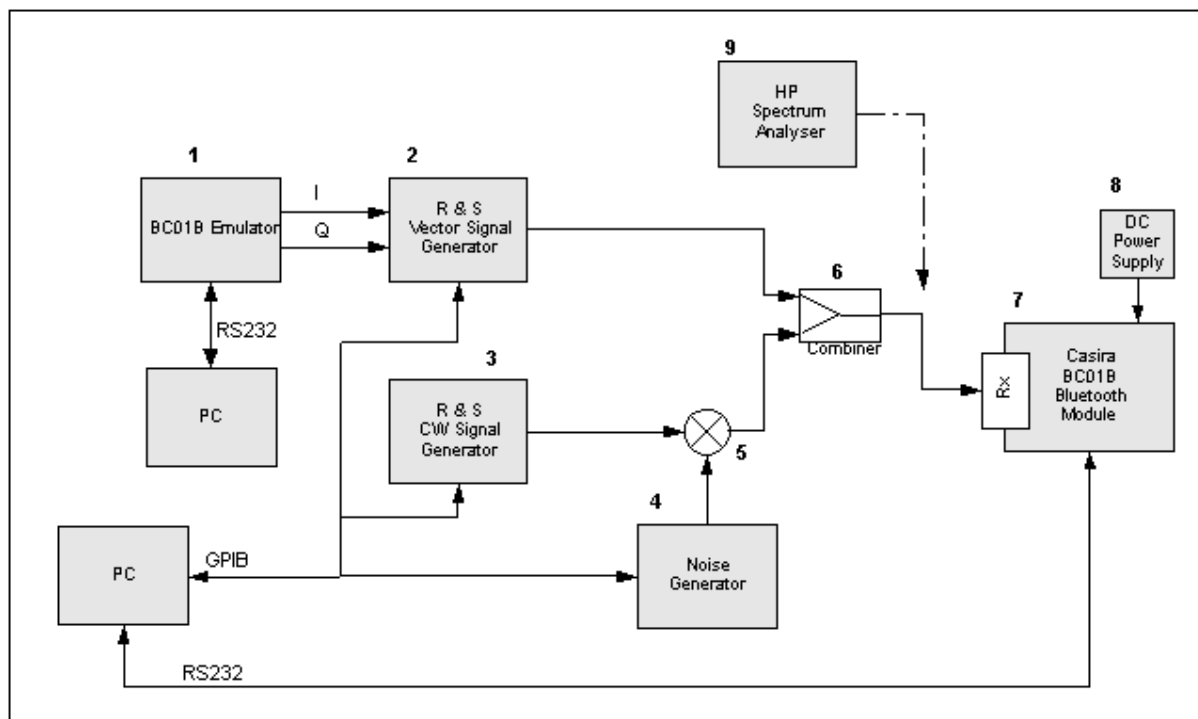
Thus, the processing gain due to direct sequence spreading in page and inquiry mode is

$$G_p = 18.8 - 15.4 + 2 = 5.4\text{dB}$$



APPENDIX A - TEST EQUIPMENT LIST

Reference:	Instrument Type	Name
1	BlueCore Emulator Board	N/A
2	Vector Signal Generator	IFR2052
3	CW Signal Generator	IFR2025
4	White Noise Generator	HP33120A
5	RF Mixer	M8HC-7
6	RF Combiner	6 dB loss combiner
7	Bluetooth Motherboard and BC01B Module	Casira Development Kit
8	5V, 4A DC Power Supply	N/A
9	Spectrum Analyser	HP E4405B



APPENDIX B - TEST RESULTS

Timestamp: 14:42.43, 16/11/2000

Signal Freq = 2.432 GHz

Jammer Level = -85.7 dBm

Jammer Offset = -500 kHz

Level = -68.7 dBm	BER = 0.03%	PER = 0.01%	SER1 = 0.01%	SER2 = 0.01%
Level = -70.7 dBm	BER = 0.32%	PER = 0.79%	SER1 = 0.79%	SER2 = 0.79%
Level = -69.7 dBm	BER = 0.11%	PER = 0.18%	SER1 = 0.18%	SER2 = 0.18%
Level = -68.7 dBm	BER = 0.04%	PER = 0.03%	SER1 = 0.02%	SER2 = 0.02%
Level = -69.2 dBm	BER = 0.06%	PER = 0.05%	SER1 = 0.05%	SER2 = 0.05%
Level = -69.7 dBm	BER = 0.11%	PER = 0.16%	SER1 = 0.16%	SER2 = 0.16%
Level = -69.5 dBm	BER = 0.09%	PER = 0.11%	SER1 = 0.11%	SER2 = 0.11%
Level = -69.3 dBm	BER = 0.07%	PER = 0.05%	SER1 = 0.05%	SER2 = 0.05%

J/S = -16.50 dB (SER = 0.05%)

Signal Freq = 2.432 GHz

Jammer Level = -85.7 dBm

Jammer Offset = -450 kHz

Level = -69.2 dBm	BER = 0.06%	PER = 0.05%	SER1 = 0.05%	SER2 = 0.05%
Level = -71.2 dBm	BER = 0.84%	PER = 1.72%	SER1 = 1.69%	SER2 = 1.69%
Level = -70.2 dBm	BER = 0.26%	PER = 0.40%	SER1 = 0.40%	SER2 = 0.40%
Level = -69.2 dBm	BER = 0.07%	PER = 0.06%	SER1 = 0.06%	SER2 = 0.06%
Level = -69.7 dBm	BER = 0.12%	PER = 0.18%	SER1 = 0.18%	SER2 = 0.18%
Level = -69.5 dBm	BER = 0.09%	PER = 0.14%	SER1 = 0.14%	SER2 = 0.14%
Level = -69.3 dBm	BER = 0.07%	PER = 0.08%	SER1 = 0.08%	SER2 = 0.08%

J/S = -16.40 dB (SER = 0.08%)

Signal Freq = 2.432 GHz

Jammer Level = -85.7 dBm

Jammer Offset = -400 kHz

Level = -69.3 dBm	BER = 0.04%	PER = 0.02%	SER1 = 0.02%	SER2 = 0.02%
Level = -71.3 dBm	BER = 0.44%	PER = 0.72%	SER1 = 0.71%	SER2 = 0.71%
Level = -70.3 dBm	BER = 0.13%	PER = 0.11%	SER1 = 0.11%	SER2 = 0.11%
Level = -69.3 dBm	BER = 0.04%	PER = 0.01%	SER1 = 0.01%	SER2 = 0.01%
Level = -69.8 dBm	BER = 0.08%	PER = 0.03%	SER1 = 0.02%	SER2 = 0.02%
Level = -70.3 dBm	BER = 0.13%	PER = 0.10%	SER1 = 0.10%	SER2 = 0.10%

J/S = -15.40 dB (SER = 0.10%)

Signal Freq = 2.432 GHz

Jammer Level = -85.7 dBm

Jammer Offset = -350 kHz

Level = -70.3 dBm	BER = 0.05%	PER = 0.01%	SER1 = 0.01%	SER2 = 0.01%
Level = -72.3 dBm	BER = 0.88%	PER = 1.67%	SER1 = 1.64%	SER2 = 1.64%
Level = -71.3 dBm	BER = 0.19%	PER = 0.10%	SER1 = 0.10%	SER2 = 0.10%
Level = -70.3 dBm	BER = 0.06%	PER = 0.01%	SER1 = 0.01%	SER2 = 0.01%
Level = -70.8 dBm	BER = 0.09%	PER = 0.04%	SER1 = 0.04%	SER2 = 0.04%
Level = -71.3 dBm	BER = 0.17%	PER = 0.12%	SER1 = 0.12%	SER2 = 0.12%

Level = -71.1 dBm BER = 0.13% PER = 0.05% SER1 = 0.05% SER2 = 0.05%

J/S = -14.60 dB (SER = 0.05%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = -300 kHz

Level = -71.1 dBm BER = 0.03% PER = 0.15% SER1 = 0.15% SER2 = 0.15%
Level = -69.1 dBm BER = 0.00% PER = 0.00% SER1 = 0.00% SER2 = 0.00%
Level = -70.1 dBm BER = 0.01% PER = 0.00% SER1 = 0.00% SER2 = 0.00%
Level = -71.1 dBm BER = 0.03% PER = 0.19% SER1 = 0.19% SER2 = 0.19%
Level = -70.6 dBm BER = 0.02% PER = 0.04% SER1 = 0.04% SER2 = 0.04%
Level = -70.8 dBm BER = 0.02% PER = 0.09% SER1 = 0.09% SER2 = 0.09%

J/S = -14.90 dB (SER = 0.09%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = -250 kHz

Level = -70.8 dBm BER = 0.00% PER = 0.03% SER1 = 0.02% SER2 = 0.02%
Level = -72.8 dBm BER = 0.05% PER = 2.34% SER1 = 2.29% SER2 = 2.29%
Level = -71.8 dBm BER = 0.01% PER = 0.33% SER1 = 0.33% SER2 = 0.33%
Level = -70.8 dBm BER = 0.00% PER = 0.03% SER1 = 0.03% SER2 = 0.03%
Level = -71.3 dBm BER = 0.01% PER = 0.11% SER1 = 0.11% SER2 = 0.11%
Level = -71.1 dBm BER = 0.00% PER = 0.11% SER1 = 0.11% SER2 = 0.11%
Level = -70.9 dBm BER = 0.00% PER = 0.03% SER1 = 0.03% SER2 = 0.03%

J/S = -14.80 dB (SER = 0.03%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = -200 kHz

Level = -70.9 dBm BER = 0.00% PER = 0.00% SER1 = 0.00% SER2 = 0.00%
Level = -72.9 dBm BER = 0.00% PER = 0.34% SER1 = 0.34% SER2 = 0.34%
Level = -71.9 dBm BER = 0.00% PER = 0.07% SER1 = 0.07% SER2 = 0.07%
Level = -72.4 dBm BER = 0.00% PER = 0.15% SER1 = 0.15% SER2 = 0.15%
Level = -72.2 dBm BER = 0.00% PER = 0.12% SER1 = 0.12% SER2 = 0.12%
Level = -72.0 dBm BER = 0.00% PER = 0.05% SER1 = 0.05% SER2 = 0.05%

J/S = -13.80 dB (SER = 0.07%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = -150 kHz

Level = -71.9 dBm BER = 0.00% PER = 0.00% SER1 = 0.00% SER2 = 0.00%
Level = -73.9 dBm BER = 0.00% PER = 0.03% SER1 = 0.02% SER2 = 0.02%
Level = -75.9 dBm BER = 0.01% PER = 0.83% SER1 = 0.82% SER2 = 0.82%
Level = -74.9 dBm BER = 0.00% PER = 0.16% SER1 = 0.16% SER2 = 0.16%
Level = -73.9 dBm BER = 0.00% PER = 0.03% SER1 = 0.02% SER2 = 0.02%
Level = -74.4 dBm BER = 0.00% PER = 0.08% SER1 = 0.07% SER2 = 0.07%
Level = -74.9 dBm BER = 0.00% PER = 0.18% SER1 = 0.18% SER2 = 0.18%

Level = -74.7 dBm BER = 0.00% PER = 0.10% SER1 = 0.10% SER2 = 0.10%

J/S = -11.00 dB (SER = 0.10%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = -100 kHz

Level = -74.7 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -76.7 dBm	BER = 0.00%	PER = 0.05%	SER1 = 0.05%	SER2 = 0.05%
Level = -78.7 dBm	BER = 0.01%	PER = 2.05%	SER1 = 2.01%	SER2 = 2.01%
Level = -77.7 dBm	BER = 0.00%	PER = 0.30%	SER1 = 0.30%	SER2 = 0.30%
Level = -76.7 dBm	BER = 0.00%	PER = 0.06%	SER1 = 0.06%	SER2 = 0.06%
Level = -77.2 dBm	BER = 0.00%	PER = 0.13%	SER1 = 0.12%	SER2 = 0.12%
Level = -77.0 dBm	BER = 0.00%	PER = 0.08%	SER1 = 0.07%	SER2 = 0.07%

J/S = -8.70 dB (SER = 0.07%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = -50 kHz

Level = -77.0 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -79.0 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -81.0 dBm	BER = 0.01%	PER = 0.05%	SER1 = 0.05%	SER2 = 0.05%
Level = -83.0 dBm	BER = 0.16%	PER = 0.73%	SER1 = 0.72%	SER2 = 0.72%
Level = -82.0 dBm	BER = 0.03%	PER = 0.26%	SER1 = 0.26%	SER2 = 0.26%
Level = -81.0 dBm	BER = 0.01%	PER = 0.06%	SER1 = 0.06%	SER2 = 0.06%
Level = -81.5 dBm	BER = 0.02%	PER = 0.13%	SER1 = 0.13%	SER2 = 0.13%
Level = -81.3 dBm	BER = 0.02%	PER = 0.11%	SER1 = 0.11%	SER2 = 0.11%
Level = -81.1 dBm	BER = 0.04%	PER = 0.06%	SER1 = 0.06%	SER2 = 0.06%

J/S = -4.60 dB (SER = 0.06%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = +0 kHz

Level = -68.7 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -70.7 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -72.7 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -74.7 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -76.7 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -78.7 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -80.7 dBm	BER = 0.01%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -82.7 dBm	BER = 0.04%	PER = 0.04%	SER1 = 0.03%	SER2 = 0.03%
Level = -84.7 dBm	BER = 7.51%	PER = 48.26%	SER1 = 27.11%	SER2 = 28.05%
Level = -83.7 dBm	BER = 0.31%	PER = 1.01%	SER1 = 0.86%	SER2 = 0.86%
Level = -82.7 dBm	BER = 0.05%	PER = 0.24%	SER1 = 0.18%	SER2 = 0.18%
Level = -81.7 dBm	BER = 0.01%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -82.2 dBm	BER = 0.02%	PER = 0.13%	SER1 = 0.10%	SER2 = 0.10%
Level = -82.0 dBm	BER = 0.02%	PER = 2.31%	SER1 = 2.24%	SER2 = 2.24%
Level = -81.8 dBm	BER = 0.02%	PER = 0.06%	SER1 = 0.05%	SER2 = 0.05%

J/S = -3.90 dB (SER = 0.05%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = +50 kHz

Level = -81.8 dBm	BER = 0.11%	PER = 0.02%	SER1 = 0.02%	SER2 = 0.02%
Level = -83.8 dBm	BER = 0.68%	PER = 2.16%	SER1 = 1.82%	SER2 = 1.82%
Level = -82.8 dBm	BER = 0.28%	PER = 0.35%	SER1 = 0.29%	SER2 = 0.29%
Level = -81.8 dBm	BER = 0.09%	PER = 0.02%	SER1 = 0.02%	SER2 = 0.02%
Level = -82.3 dBm	BER = 0.15%	PER = 0.25%	SER1 = 0.22%	SER2 = 0.22%
Level = -82.1 dBm	BER = 0.12%	PER = 0.09%	SER1 = 0.07%	SER2 = 0.07%

J/S = -3.60 dB (SER = 0.07%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = +100 kHz

Level = -82.1 dBm	BER = 1.55%	PER = 15.88%	SER1 = 13.44%	SER2 = 13.51%
Level = -80.1 dBm	BER = 0.28%	PER = 5.78%	SER1 = 5.47%	SER2 = 5.47%
Level = -78.1 dBm	BER = 0.03%	PER = 0.09%	SER1 = 0.09%	SER2 = 0.09%

J/S = -7.60 dB (SER = 0.09%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = +150 kHz

Level = -78.1 dBm	BER = 0.41%	PER = 13.58%	SER1 = 11.96%	SER2 = 12.16%
Level = -76.1 dBm	BER = 0.09%	PER = 0.42%	SER1 = 0.42%	SER2 = 0.42%
Level = -74.1 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -75.1 dBm	BER = 0.01%	PER = 0.02%	SER1 = 0.02%	SER2 = 0.02%
Level = -76.1 dBm	BER = 0.04%	PER = 0.41%	SER1 = 0.41%	SER2 = 0.41%
Level = -75.6 dBm	BER = 0.03%	PER = 0.10%	SER1 = 0.10%	SER2 = 0.10%

J/S = -10.10 dB (SER = 0.10%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = +200 kHz

Level = -75.6 dBm	BER = 0.26%	PER = 7.53%	SER1 = 7.00%	SER2 = 7.00%
Level = -73.6 dBm	BER = 0.02%	PER = 0.17%	SER1 = 0.17%	SER2 = 0.17%
Level = -71.6 dBm	BER = 0.00%	PER = 0.00%	SER1 = 0.00%	SER2 = 0.00%
Level = -72.6 dBm	BER = 0.00%	PER = 0.03%	SER1 = 0.03%	SER2 = 0.03%
Level = -73.6 dBm	BER = 0.02%	PER = 0.14%	SER1 = 0.14%	SER2 = 0.14%
Level = -73.1 dBm	BER = 0.01%	PER = 0.04%	SER1 = 0.04%	SER2 = 0.04%
Level = -73.3 dBm	BER = 0.01%	PER = 0.05%	SER1 = 0.05%	SER2 = 0.05%
Level = -73.5 dBm	BER = 0.03%	PER = 0.09%	SER1 = 0.09%	SER2 = 0.09%

J/S = -12.20 dB (SER = 0.09%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = +250 kHz

Level = -73.5 dBm BER = 0.25% PER = 3.58% SER1 = 3.46% SER2 = 3.46%
 Level = -71.5 dBm BER = 0.01% PER = 0.03% SER1 = 0.03% SER2 = 0.03%
 Level = -72.5 dBm BER = 0.06% PER = 0.57% SER1 = 0.57% SER2 = 0.57%
 Level = -72.0 dBm BER = 0.02% PER = 0.12% SER1 = 0.12% SER2 = 0.12%
 Level = -71.5 dBm BER = 0.01% PER = 0.04% SER1 = 0.04% SER2 = 0.04%
 Level = -71.7 dBm BER = 0.01% PER = 0.05% SER1 = 0.05% SER2 = 0.05%
 Level = -71.9 dBm BER = 0.02% PER = 0.10% SER1 = 0.10% SER2 = 0.10%

J/S = -14.00 dB (SER = 0.05%)

Signal Freq = 2.432 GHz
 Jammer Level = -85.7 dBm
 Jammer Offset = +300 kHz

Level = -71.7 dBm BER = 0.08% PER = 0.10% SER1 = 0.10% SER2 = 0.10%

J/S = -14.00 dB (SER = 0.10%)

Signal Freq = 2.432 GHz
 Jammer Level = -85.7 dBm
 Jammer Offset = +350 kHz

Level = -71.7 dBm BER = 0.25% PER = 1.43% SER1 = 1.41% SER2 = 1.41%
 Level = -69.7 dBm BER = 0.02% PER = 0.03% SER1 = 0.02% SER2 = 0.02%
 Level = -70.7 dBm BER = 0.08% PER = 0.14% SER1 = 0.14% SER2 = 0.14%
 Level = -70.2 dBm BER = 0.03% PER = 0.74% SER1 = 0.74% SER2 = 0.74%
 Level = -69.7 dBm BER = 0.02% PER = 0.02% SER1 = 0.02% SER2 = 0.02%
 Level = -69.9 dBm BER = 0.02% PER = 0.03% SER1 = 0.02% SER2 = 0.02%
 Level = -70.1 dBm BER = 0.03% PER = 0.03% SER1 = 0.03% SER2 = 0.03%
 Level = -70.3 dBm BER = 0.03% PER = 0.06% SER1 = 0.06% SER2 = 0.06%
 Level = -70.5 dBm BER = 0.06% PER = 0.13% SER1 = 0.13% SER2 = 0.13%

J/S = -15.40 dB (SER = 0.06%)

Signal Freq = 2.432 GHz
 Jammer Level = -85.7 dBm
 Jammer Offset = +400 kHz

Level = -70.3 dBm BER = 0.07% PER = 0.05% SER1 = 0.05% SER2 = 0.05%
 Level = -72.3 dBm BER = 1.28% PER = 4.62% SER1 = 4.42% SER2 = 4.42%
 Level = -71.3 dBm BER = 0.24% PER = 0.48% SER1 = 0.47% SER2 = 0.47%
 Level = -70.3 dBm BER = 0.06% PER = 0.06% SER1 = 0.06% SER2 = 0.06%
 Level = -70.8 dBm BER = 0.12% PER = 0.15% SER1 = 0.15% SER2 = 0.15%
 Level = -70.6 dBm BER = 0.11% PER = 0.08% SER1 = 0.08% SER2 = 0.08%

J/S = -15.10 dB (SER = 0.08%)

Signal Freq = 2.432 GHz
 Jammer Level = -85.7 dBm
 Jammer Offset = +450 kHz

Level = -70.6 dBm BER = 0.17% PER = 0.11% SER1 = 0.11% SER2 = 0.11%
 Level = -68.6 dBm BER = 0.01% PER = 0.00% SER1 = 0.00% SER2 = 0.00%
 Level = -69.6 dBm BER = 0.04% PER = 0.00% SER1 = 0.00% SER2 = 0.00%

Level = -70.6 dBm BER = 0.17% PER = 0.08% SER1 = 0.07% SER2 = 0.07%
Level = -71.6 dBm BER = 0.60% PER = 0.70% SER1 = 0.69% SER2 = 0.69%
Level = -71.1 dBm BER = 0.31% PER = 0.30% SER1 = 0.29% SER2 = 0.29%
Level = -70.6 dBm BER = 0.19% PER = 0.11% SER1 = 0.11% SER2 = 0.11%
Level = -70.1 dBm BER = 0.09% PER = 0.03% SER1 = 0.02% SER2 = 0.02%
Level = -70.3 dBm BER = 0.10% PER = 0.05% SER1 = 0.05% SER2 = 0.05%
Level = -70.5 dBm BER = 0.16% PER = 0.06% SER1 = 0.06% SER2 = 0.06%
Level = -70.7 dBm BER = 0.20% PER = 0.05% SER1 = 0.05% SER2 = 0.05%
Level = -70.9 dBm BER = 0.26% PER = 0.15% SER1 = 0.15% SER2 = 0.15%

J/S = -15.10 dB (SER = 0.07%)

Signal Freq = 2.432 GHz
Jammer Level = -85.7 dBm
Jammer Offset = +500 kHz

Level = -68.7 dBm BER = 0.01% PER = 0.00% SER1 = 0.00% SER2 = 0.00%
Level = -70.7 dBm BER = 0.12% PER = 0.19% SER1 = 0.19% SER2 = 0.19%
Level = -69.7 dBm BER = 0.03% PER = 0.01% SER1 = 0.01% SER2 = 0.01%
Level = -70.2 dBm BER = 0.07% PER = 0.12% SER1 = 0.12% SER2 = 0.12%
Level = -70.0 dBm BER = 0.04% PER = 0.06% SER1 = 0.06% SER2 = 0.06%

J/S = -15.70 dB (SER = 0.06%)