InterLab®

FCC Measurement/Technical Report on

WLAN transceiver / Bluetooth 3.0 HS Mode

NG 1.1 HMI

Report Reference: MDE_BOSCH_1201_FCCa

Test Laboratory:
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Germany
7Layers AG
40880 Ratingen

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-12140-01-01

Note:
The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

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0 Summary

0.1 Technical Report Summary

Type of Authorization
Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-11 Edition) and 15 (10-1-11 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

Note:
The tests were selected and performed with reference to the FCC measurement guide line "Measurement of Digital Transmission Systems Operating under Section 15.247 March 23, 2005"
Instead of applying ANSI C63.4–1992 which is referenced in the FCC Public Note, the newer ANSI C63.4–2009 is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

0.2 Measurement Summary

FCC Part 15, Subpart C	§ 15.207		
Conducted emissions (AC power line)			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 4	Setup_01	AC Port (power line)	N/A

FCC Part 15, Subpart C	§ 15.247 (a) (1)		
Occupied bandwidth			
The measurement was performed according to FCC § 15.31			10-1-11 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_02	Temp.ant.connector	passed
op-mode 1g	Setup_02	Temp.ant.connector	passed
op-mode 1n	Setup_02	Temp.ant.connector	passed
op-mode 2b	Setup_02	Temp.ant.connector	passed
op-mode 2g	Setup_02	Temp.ant.connector	passed
op-mode 2n	Setup_02	Temp.ant.connector	passed
op-mode 3b	Setup_02	Temp.ant.connector	passed
op-mode 3g	Setup_02	Temp.ant.connector	passed
op-mode 3n	Setup_02	Temp.ant.connector	passed

FCC Part 15, Subpart C	§ 15.247 (b) (1)		
Peak power output			
The measurement was performed according to FCC § 15.31			10-1-11 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_02	Temp.ant.connector	passed
op-mode 1g	Setup_02	Temp.ant.connector	passed
op-mode 1n	Setup_02	Temp.ant.connector	passed
op-mode 2b	Setup_02	Temp.ant.connector	passed
op-mode 2g	Setup_02	Temp.ant.connector	passed
op-mode 2n	Setup_02	Temp.ant.connector	passed
op-mode 3b	Setup_02	Temp.ant.connector	passed
op-mode 3g	Setup_02	Temp.ant.connector	passed
op-mode 3n	Setup_02	Temp.ant.connector	passed

FCC Part 15, Subpart C	§ 15.247 (d)		
Spurious RF conducted emissions			
The measurement was performed according to FCC § 15.31			10-1-11 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_02	Temp.ant.connector	passed
op-mode 1g	Setup_02	Temp.ant.connector	passed
op-mode 1n	Setup_02	Temp.ant.connector	passed
op-mode 2b	Setup_02	Temp.ant.connector	passed
op-mode 2g	Setup_02	Temp.ant.connector	passed
op-mode 2n	Setup_02	Temp.ant.connector	passed
op-mode 3b	Setup_02	Temp.ant.connector	passed
op-mode 3g	Setup_02	Temp.ant.connector	passed
op-mode 3n	Setup_02	Temp.ant.connector	passed

FCC Part 15, Subpart C	§ 15.247 (d), § 15.35 (b), § 15.209		
Spurious radiated emissions			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Enclosure	passed
op-mode 2b	Setup_01	Enclosure	passed
op-mode 3b	Setup_01	Enclosure	passed
op-mode 1g	Setup_01	Enclosure	passed
op-mode 2g	Setup_01	Enclosure	passed
op-mode 3g	Setup_01	Enclosure	passed
op-mode 1n	Setup_01	Enclosure	passed
op-mode 2n	Setup_01	Enclosure	passed
op-mode 3n	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	§ 15.247 (d)		
Band edge compliance			
The measurement was performed according to FCC § 15.31 / ANSI C63.4			10-1-11 Edition / 2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_02	Temp.ant.connector	passed
op-mode 1g	Setup_02	Temp.ant.connector	passed
op-mode 1n	Setup_02	Temp.ant.connector	passed
op-mode 3b	Setup_02	Temp.ant.connector	passed
op-mode 3g	Setup_02	Temp.ant.connector	passed
op-mode 3n	Setup_02	Temp.ant.connector	passed
op-mode 3b	Setup_01	Enclosure	passed
op-mode 3g	Setup_01	Enclosure	passed
op-mode 3n	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	§ 15.247 (e)		
Power density			
The measurement was performed according to FCC § 15.31			10-1-11
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_02	Temp.ant.connector	passed
op-mode 1g	Setup_02	Temp.ant.connector	passed
op-mode 1n	Setup_02	Temp.ant.connector	passed
op-mode 2b	Setup_02	Temp.ant.connector	passed
op-mode 2g	Setup_02	Temp.ant.connector	passed
op-mode 2n	Setup_02	Temp.ant.connector	passed
op-mode 3b	Setup_02	Temp.ant.connector	passed
op-mode 3g	Setup_02	Temp.ant.connector	passed
op-mode 3n	Setup_02	Temp.ant.connector	passed

N/A not applicable (the EUT is powered by DC, vehicular use only)

Responsible for Accreditation Scope: _____ Responsible for Test Report: _____

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers AG
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716 .

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Thomas Hoell Dipl.-Ing. Andreas Petz
Report Template Version:	2012-03-14

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Carsten Steinröder
Date of Test(s):	2012-03-01 to 2012-03-08
Date of Report:	2012-03-19

1.3 Applicant Data

Company Name:	Robert Bosch Car Multimedia GmbH
Address:	Robert-Bosch-Strasse 200 31139 Hildesheim Germany
Contact Person:	Mr. Torsten Sahm

1.4 Manufacturer Data

Company Name:	please see applicant data
Address:	
Contact Person:	

2 Test object Data

2.1 General EUT Description

Equipment under Test:	WLAN transceiver / Bluetooth 3.0 HS Mode
Type Designation:	NG 1.1 HMI
Kind of Device:	Next Generation Human Machine Interface, with
(optional)	WLAN, Bluetooth and GPS
Voltage Type:	DC (Car Battery)
Voltage Level:	12 V
Tested Modulation Type:	DBPSK; OFDM:BPSK; OFDM:64-QAM

General product description:

The WLAN (Wireless Local Area Network) Transceiver is operating in the 2.4 GHz ISM band in the range 2412.0 – 2462.0 MHz and uses the Direct Sequence Spread Spectrum (DSSS) Modulation. The EUT also supports Bluetooth 3.0 HS Mode.

The OUT is connected to DC mains (Car Battery). Connection to AC mains is not possible.

Specific product description for the EUT:

It supports the modes IEE802.11b, IEE802.11g and IEE802.11n (up to 72.2 Mbps data rate / MCS7) and the Bluetooth 3.0 HS Mode. The Bluetooth 3.0 HS Mode uses the RF physical layer of WLAN by using the same radio specification and parameters.
The maximum data rate of Bluetooth 3.0 HS Mode is limited to 24 Mbps.

The EUT provides the following ports:

Ports
Temporary antenna connector
Enclosure
DC Port (power line)
Mini USB
GPS Antenna

The main components of the EUT are listed and described in Chapter 2.2

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	Date of Receipt
EUT A (Code: U7030b01)	WLAN / Bluetooth 3.0 HS transceiver	NG 1.1 HMI	-	1.01	12.0S038	–
Remark: EUT A is equipped with an integral antenna (gain = 3.0 dBi).						
EUT B (Code: U7030a01)	WLAN / Bluetooth 3.0 HS transceiver	NG 1.1 HMI	-	1.01	12.0S038	–
Remark: EUT B is equipped with a temporary antenna connector.						

NOTE: The short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	HW Status	SW Status	Serial no.	FCC ID
–	–	–	–	–	–	–

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status	FCC ID
AUX1	USB Memory Stick	32MB	-	–	-	–
AUX2	GPS antenna	-	-	–	-	–

2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup No.	Combination of EUTs	Description and Rationale
Setup_01	EUT A + AE 1 + AUX1 + AUX2	setup for radiated measurements
Setup_02	EUT B	setup for the test conducted emissions

2.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

Op. Mode	Description of Operating Modes	Remarks
op-mode 1b	TX-mode, the EUT transmits on the lowest channel (2412 MHz)	Worst case data rate 1 Mbps
op-mode 1g	TX-mode, the EUT transmits on the lowest channel (2412 MHz)	Worst case data rate 6 Mbps
op-mode 1n	TX-mode, the EUT transmits on the lowest channel (2412 MHz)	Worst case data rate 72.2 Mbps
op-mode 2b	TX-mode, the EUT transmits on the mid channel (2437 MHz)	Worst case data rate 1 Mbps
op-mode 2g	TX-mode, the EUT transmits on the mid channel (2437 MHz)	Worst case data rate 6 Mbps
op-mode 2n	TX-mode, the EUT transmits on the mid channel (2437 MHz)	Worst case data rate 72.2 Mbps
op-mode 3b	TX-mode, the EUT transmits on the highest channel (2462 MHz)	Worst case data rate 1 Mbps
op-mode 3g	TX-mode, the EUT transmits on the highest channel (2462 MHz)	Worst case data rate 6 Mbps
op-mode 3n	TX-mode, the EUT transmits on the highest channel (2462 MHz)	Worst case data rate 72.2 Mbps

2.7 Special software used for testing

The EUT is running in a mode set by the applicant's prepared scripts in a WLAN test mode. The OUT was connected via USB/LAN Converter to a Laptop/PC. Test scripts were pre-installed on the OUT and could be executed with a terminal program (Putty) on the Laptop/PC. The OUT could be set into specific transmit modes.

2.8 Product labelling

2.8.1 FCC ID label

Please refer to the documentation of the applicant.

2.8.2 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 Occupied bandwidth

Standard FCC Part 15, 10-1-11 Subpart C

The test was performed according to: FCC §15.31

3.1.1 Test Description

The Equipment Under Test (EUT) was setup to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produce the worst-case (widest) occupied bandwidth.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 30 MHz

3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (2)
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Used conversion factor: Output power (dBm) = 10 log (Output power (W) / 1mW)

3.1.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 1b	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
10.164	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
16.416	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1n	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
17.616	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2b	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
10.164	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2g	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
16.236	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2n	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
17.316	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3b	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
10.164	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
16.236	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3n	Setup_02	Temp.ant.connector

6 dB bandwidth MHz	Remarks
17.616	–

Remark: Please see annex for the measurement plot.

3.1.4 Test result: Occupied bandwidth

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1b	passed
	op-mode 1g	passed
	op-mode 1n	passed
	op-mode 2b	passed
	op-mode 2g	passed
	op-mode 2n	passed
	op-mode 3b	passed
	op-mode 3g	passed
	op-mode 3n	passed

3.2 Peak power output

Standard FCC Part 15, 10-1-11 Subpart C

The test was performed according to: FCC §15.31

3.2.1 Test Description

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT. The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

3.2.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (b) (3)
For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt.

Used conversion factor: Limit (dBm) = 10 log (Limit (W)/1mW)
==> Maximum Output Power: 30 dBm

3.2.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 1b	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.38	The EIRP including antenna gain (3.0 dBi) is 10.38 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.84	The EIRP including antenna gain (3.0 dBi) is 10.84 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1n	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.79	The EIRP including antenna gain (3.0 dBi) is 10.79 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2b	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.59	The EIRP including antenna gain (3.0 dBi) is 10.59 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2g	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.97	The EIRP including antenna gain (3.0 dBi) is 10.97 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2n	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.81	The EIRP including antenna gain (3.0 dBi) is 10.81 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3b	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.38	The EIRP including antenna gain (3.0 dBi) is 10.38 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_02	Temp.ant.connector

Output power dBm	Remarks
7.75	The EIRP including antenna gain (3.0 dBi) is 10.75 dBm

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3n	Setup_02	Temp.ant.connector

Output power dBm	Remarks
8.15	The EIRP including antenna gain (3.0 dBi) is 11.15 dBm

Remark: Please see annex for the measurement plot.

3.2.4 Test result: Peak power output

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1b	passed
	op-mode 1g	passed
	op-mode 1n	passed
	op-mode 2b	passed
	op-mode 2g	passed
	op-mode 2n	passed
	op-mode 3b	passed
	op-mode 3g	passed
	op-mode 3n	passed

3.3 Spurious RF conducted emissions

Standard FCC Part 15, 10-1-11 Subpart C

The test was performed according to: FCC §15.31

3.3.1 Test Description

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Detector: Peak-Maxhold
- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: 330 s

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance" (cf. chapter 3.5). This value is used to calculate the 20 dBc limit.

3.3.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (c)
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

3.3.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 1b	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1n	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2b	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2g	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2n	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3b	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3n	Setup_02	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Margin to limit dB

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

3.3.4 Test result: Spurious RF conducted emissions

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1b	passed
	op-mode 1g	passed
	op-mode 1n	passed
	op-mode 2b	passed
	op-mode 2g	passed
	op-mode 2n	passed
	op-mode 3b	passed
	op-mode 3g	passed
	op-mode 3n	passed

3.4 Spurious radiated emissions

Standard FCC Part 15, 10-1-11 Subpart C

The test was performed according to: ANSI C63.4–2009

3.4.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4–2009 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The test was performed at the distance of 3 m between the EUT and the receiving antenna. The measurement procedure is implemented into the EMI test software ES-K1 from R&S. The radiated emissions measurements were made in a typical installation configuration. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is performed at 2 axes. A pre-check is also performed while the EUT is powered from both AC and DC (battery) power in order to find the worst-case operating condition.

1. Measurement up to 30 MHz
The test set-up was made in accordance to the general provisions of ANSI C 63.4-2009. The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
The radiated emissions measurements were made in a typical installation configuration. The measurement procedure is implemented into the EMI test software ES-K1 from R&S. The Loop antenna HFH2-Z2 is used.
Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.
Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 200 Hz - 10 kHz
- Measuring time / Frequency step: 100 ms

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan

Preliminary test to identify the highest amplitudes relative to the limit.

Settings for step 1:

- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 µs
- Turntable angle range: –180° to 180°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: second measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –180° to 180°
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will be slowly varied by +/- 22.5° around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by +/- 25 cm around the antenna height determined. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –22.5° to + 22.5° around the determined value
- Height variation range: -0.25m to + 0.25m around the determined value

Step 4: final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:
- Detector: Quasi-Peak(< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

3. Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
The Equipment Under Test (EUT) was set up on a non-conductive support at 1.4 m height in the fully-anechoic chamber. The measurement distance was reduced to 1 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a horn antenna (18–25 GHz) are used, the steps 2-4 are omitted. Step 1 was performed with one height of the receiving antenna only.
EMI receiver settings:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.
For the data rate in mode n the test is performed as worst-case-check in order to verify that emissions have a comparable level as found at modes b and g. Typically, the measurement is performed in the frequency range 1 to 8 GHz but it depends on the emissions found during the test for the modes b and g. Please refer to the results for the used frequency range.

3.4.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (d)
... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit(dBµV/m @10m)
0.009 – 0.49	2400/F(kHz)	300	Limit (dBµV/m) + 30 dB
0.49 – 1.705	24000/F(kHz)	30	Limit (dBµV/m) + 10 dB
1.705 – 30	30	30	Limit (dBµV/m) + 10 dB

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit (dBµV/m)
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
above 960	500	3	54.0

§15.35(b)
..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

3.4.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 37 %

3.4.3.1 Measurement up to 30 MHz

Op. Mode	Setup	Port
op-mode 2b	Setup_01	Enclosure

Antenna Position	Frequency MHz	Corrected value dBµV/m		Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		PK	AV	PK	AV	PK	AV
0°	–	–	–	–	–	–	–
90°	–	–	–	–	–	–	–

Remark: No (further) spurious emissions in the range 20 dB below the limit found therefore step 2 was not performed.

3.4.3.2 Measurement above 30 MHz

Op. Mode	Setup	Port
op-mode 1b	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2386	–	54.33	39.27	–	74.0	54.0	19.67	14.73
	2484	–	55.62	39.24	–	74.0	54.0	18.38	14.76
	4824	–	47.91	45.95	–	74.0	54.0	26.09	8.05

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

Op. Mode	Setup	Port
op-mode 2b	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	4874	–	49.41	47.63	–	74.0	54.0	24.59	6.37

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

Op. Mode	Setup	Port
op-mode 3b	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV /m	Limit dBµV /m	Limit dBµV /m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2484	–	55.62	39.24	–	74.0	54.0	18.38	14.76
	4924	–	48.17	46.11	–	74.0	54.0	25.83	7.89

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

Op. Mode	Setup	Port
op-mode 1g	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV /m	Limit dBµV /m	Limit dBµV /m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2493	–	54.34	41.81	–	74.0	54.0	19.66	12.19
	4826	–	47.38	34.26	–	74.0	54.0	26.62	19.74

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 30 MHz up to 25 GHz because pre-measurements have shown that no significant spurious emissions were found outside this frequency range.

Op. Mode	Setup	Port
op-mode 2g	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV /m	Limit dBµV /m	Limit dBµV /m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2349	–	54.35	41.63	–	74.0	54.0	19.65	12.37
	4874	–	50.01	36.58	–	74.0	54.0	23.99	17.42

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 30 MHz up to 25 GHz because pre-measurements have shown that no significant spurious emissions were found outside this frequency range.

Op. Mode	Setup	Port
op-mode 3g	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV /m	Limit dBµV /m	Limit dBµV /m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2381	–	53.53	40.50	–	74.0	54.0	20.47	13.50
	2484	–	52.74	41.09	–	74.0	54.0	21.26	12.12
	4924	–	49.39	35.86	–	74.0	54.0	24.61	18.14

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 30 MHz up to 25 GHz because pre-measurements have shown that no significant spurious emissions were found outside this frequency range.

Op. Mode	Setup	Port
op-mode 1n	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV /m	Limit dBµV /m	Limit dBµV /m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2378	–	53.33	39.31	–	74.0	54.0	20.67	14.69
	2487	–	53.46	39.89	–	74.0	54.0	20.54	14.11
	4826	–	48.06	31.89	–	74.0	54.0	25.94	22.11

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 18 GHz because pre-measurements have shown that no significant spurious emissions were found outside this frequency range.

Op. Mode	Setup	Port
op-mode 2n	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV /m	Limit dBµV /m	Limit dBµV /m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2370	–	53.37	39.70	–	74.0	54.0	20.63	14.30
	2498	–	53.25	39.52	–	74.0	54.0	20.75	14.48
	4873	–	50.19	34.19	–	74.0	54.0	23.81	19.81

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 18 GHz because pre-measurements have shown that no significant spurious emissions were found outside this frequency range.

Op. Mode	Setup	Port
op-mode 3n	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV /m	Limit dBµV /m	Limit dBµV /m	Margin to limit dB	Margin to limit dB
		QP	PK	AV	QP	PK	AV	QP/PK	AV
Hor. + Vert.	2369	–	53.13	39.10	–	74.0	54.0	20.87	14.90
	2486	–	53.09	39.50	–	74.0	54.0	20.91	14.50
	4923	–	49.30	33.20	–	74.0	54.0	24.70	20.80

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 18 GHz because pre-measurements have shown that no significant spurious emissions were found outside this frequency range.

3.4.4 Test result: Spurious radiated emissions

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1b	passed
	op-mode 2b	passed
	op-mode 3b	passed
	op-mode 1g	passed
	op-mode 2g	passed
	op-mode 3g	passed
	op-mode 1n	passed
	op-mode 2n	passed
	op-mode 3n	passed

3.5 Band edge compliance

Standard FCC Part 15, 10-1-11 Subpart C

The test was performed according to: ANSI C63.4–2009, FCC §15.31

3.5.1 Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements:
1. Show compliance of the lower and higher band edge by a conducted measurement

For the conducted measurement, the Equipment Under Test (EUT) is placed in a shielded room. The EUT is set to transmit on the lowest channel (2412 MHz). The lower band edge is 2400 MHz and the EUT is set to transmit on the highest channel (2462 MHz). The higher band edge is 2483.5 MHz.
Analyzer settings for conducted measurement:
- Detector: Peak
- RBW / VBW = 100 / 300 kHz

2. Show compliance of the higher band edge falls in to restricted bands by a radiated measurement.
The radiated emissions measurements are performed in a typical installation configuration inside the fully anechoic chamber using a horn antenna at 1 m distance.
EMI receiver settings for radiated measurement:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

3.5.2 Test Requirements / Limits

FCC Part 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))."

For the conducted measurement the RF power at the band edge 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..."

For the radiated measurement of the higher band edge connected to a restricted band the limit is "specified in Section 15.209(a)".

3.5.3 Test Protocol

3.5.3.1 Lower band edge

Conducted measurement

Temperature: °C
Air Pressure: hPa
Humidity: %

Op. Mode	Setup	Port
op-mode 1b	Setup_02	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2400.00				

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_02	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2400.00				

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1n	Setup_02	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2400.00				

Remark: Please see annex for the measurement plot.

3.5.3.2 Higher band edge

Conducted measurement

Temperature: °C
Air Pressure: hPa
Humidity: %

Op. Mode	Setup	Port
op-mode 3b	Setup_02	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2483.50				

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_02	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2483.50				

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3n	Setup_02	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2483.50				

Remark: Please see annex for the measurement plot.

Radiated measurement

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 37 %

Op. Mode	Setup	Port
op-mode 3b	Setup_01	Enclosure

Frequency MHz	Polari-sation	Corrected value dBµV/m		Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		PK	AV	PK	AV	PK	AV
2483.50	Hor. + Vert.	55.62	39.24	74.0	54.0	18.38	14.76

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_01	Enclosure

Frequency MHz	Polari-sation	Corrected value dBµV/m		Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		PK	AV	PK	AV	PK	AV
2483.50	Hor. + Vert.	52.74	41.09	74.0	54.0	21.26	12.91

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3n	Setup_01	Enclosure

Frequency MHz	Polari-sation	Corrected value dBµV/m		Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		PK	AV	PK	AV	PK	AV
2483.50	Hor. + Vert.	52.35	39.41	74.0	54.0	21.65	14.59

Remark: Please see annex for the measurement plot.

3.5.4 Test result: Band edge compliance

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1b	temp_passed
	op-mode 1g	temp_passed
	op-mode 1n	temp_passed
	op-mode 3 b	temp_passed
	op-mode 3 g	temp_passed
	op-mode 3 n	temp_passed

3.6 Power density

Standard FCC Part 15, 10-1-11 Subpart C

The test was performed according to: FCC §15.31

3.6.1 Test Description

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Detector: Peak-Maxhold
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

3.6.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (e)

For digitally modulated systems, the peak 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.
…
The same method of determining the conducted output power shall be used to determine the power spectral density.

3.6.3 Test Protocol

Temperature: °C
Air Pressure: hPa
Humidity: %

Op. Mode	Setup	Port
op-mode 1b	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-6.93	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-21.07	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1n	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-21.58	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2b	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-6.67	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2g	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-20.93	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2n	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-21.05	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3b	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-8.06	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-21.22	–

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3n	Setup_02	Temp.ant.connector

Power density dBm/3 kHz	Remarks
-21.32	–

Remark: Please see annex for the measurement plot.

3.6.4 Test result: Power density

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1b	passed
	op-mode 1g	passed
	op-mode 1n	passed
	op-mode 2b	passed
	op-mode 2g	passed
	op-mode 2n	passed
	op-mode 3b	passed
	op-mode 3g	passed
	op-mode 3n	passed

4 Test Equipment

The calibration, hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	**Lab 3**
Manufacturer:	Frankonia
Description:	Anechoic Chamber for radiated testing
Type:	10.58x6.38x6.00 m³

Single Devices for Anechoic Chamber

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Air compressor	none	-	Atlas Copco	
Anechoic Chamber	10.58 x 6.38 x 6.00 m³ FCC listing 96716 3m Part15/18 IC listing 3699A-1 3m	none	Frankonia 2011/01/11 2011/02/07	 2014/01/10 2014/02/06
Controller Innco 2000	CO 2000	CO2000/328/12470 406/L	Innco innovative constructions GmbH	
Controller Maturo	MCU	961208	Maturo GmbH	
EMC camera	CE-CAM/1	-	CE-SYS	
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi	
Filter ISDN	B84312-C110-E1		Siemens&Matsushita	
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita	

Test Equipment Auxiliary Equipment for Radiated emissions

Lab ID:	**Lab 3**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Antenna mast	AS 620 P	620/37	HD GmbH	
Biconical dipole	VUBA 9117 Standard Calibration Standard Calibration	9117-108	Schwarzbeck 2008/10/27 2012/01/18	 2013/10/26 2015/01/17
Broadband Amplifier 18MHz-26GHz	JS4-18002600-32-5P	849785	Miteq	
Broadband Amplifier 1GHz-4GHz	AFS4-01000400-1Q-10P-4	-	Miteq	
Broadband Amplifier 30MHz-18GHz	JS4-00101800-35-5P	896037	Miteq	
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01-2+W38.01-2	Kabel Kusch	
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02-2+W38.02-2	Rosenberger Micro-Coax	
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2009/04/16	2012/04/15

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2009/04/28	2012/04/27
Dreheinheit	DE 325		HD GmbH	
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic	
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic	
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic	
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright	
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2009/05/27	2012/05/26
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/10/27	2014/10/26
Pyramidal Horn Antenna 26,5 GHz	3160-09	00083069	EMCO Elektronik GmbH	
Pyramidal Horn Antenna 26,5 GHz	3160-09	9910-1184	EMCO Elektronik GmbH	
Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH	
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5-10kg/024/3790709	Maturo GmbH	

Test Equipment Auxiliary Test Equipment

Lab ID:	**Lab 3**
Manufacturer:	see single devices
Description:	Single Devices for various Test Equipment
Type:	various
Serial Number:	none

Single Devices for Auxiliary Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
AC Power Source	Chroma 6404	64040001304	Chroma ATE INC.
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates
Broadband Power Divider SMA (Aux)	1515 / 93459	LN673	Weinschel Associates
Digital Multimeter 01 (Multimeter)	Voltcraft M-3860M	IJ096055	Conrad Electronics
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.
	Customized calibration		2011/10/19 2013/10/18
Digital Oscilloscope [SA2] (Aux)	TDS 784C	B021311	Tektronix GmbH
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorenwerke GmbH
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG
ThermoHygro_01 (Aux)	430202	none	Fischer Feingerätebau K. Fischer GmbH
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID: **Lab 3**
Description: Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Bluetooth Signalling Unit CBT	CBT	100589	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/11/24	2014/11/23
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/11/28	2014/11/27
Digital Radio Test Set	6103E	2359	Racal Instruments, Ltd.	
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/05/26	2013/05/25
	HW/SW Status		*Date of Start*	*Date of End*
	Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---		2007/07/16	
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/12/07	2014/12/06
	HW/SW Status		*Date of Start*	*Date of End*
	HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 ---		2007/01/02	
	SW: K62, K69		2008/11/03	
Vector Signal Generator	SMU200A	100912	Rohde & Schwarz GmbH & Co. KG	

Test Equipment Emission measurement devices

Lab ID:	**Lab 3**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Emission measurement devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Personal Computer	Dell	30304832059	Dell	
Power Sensor	NRV-Z1	836219/005	Rohde & Schwarz GmbH & Co. KG	
Powermeter	NRVS	836333/064	Rohde & Schwarz GmbH & Co. KG	
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG	
	standard calibration		2011/05/12	2014/05/11
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2011/12/05	2013/12/04
	HW/SW Status		*Date of Start*	*Date of End*
	Firmware-Update 4.34.4 from 3.45 during calibration		2009/12/03	

Test Equipment Multimeter 12

Lab ID:	**Lab 6**
Description:	Ex-Tech 520
Serial Number:	05157876

Single Devices for Multimeter 12

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Digital Multimeter 12 (Multimeter)	EX520	05157876	Extech Instruments Corp.	
	Customized calibration		2011/10/18	2013/10/17

Test Equipment Shielded Room 07

Lab ID:	**Lab 6**
Description:	Shielded Room 4m x 6m

Test Equipment T/H Logger 04

Lab ID:	**Lab 6**
Description:	Lufft Opus10
Serial Number:	7481

Single Devices for T/H Logger 04

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 04 (Environ)	Opus10 THI (8152.00)	7481	Lufft Mess- und Regeltechnik GmbH

Test Equipment Temperature Chamber 01

Lab ID:	**Lab 6**
Manufacturer:	see single devices
Description:	Temperature Chamber KWP 120/70
Type:	Weiss
Serial Number:	see single devices

Single Devices for Temperature Chamber 01

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Temperature Chamber Weiss 01	KWP 120/70	59226012190010	Weiss Umwelttechnik GmbH	
	Specific calibration		2010/03/16	2012/03/15

Test Equipment WLAN RF Test Solution

Lab ID:	**Lab 6**
Manufacturer:	7 layers AG
Description:	Regulatory WLAN RF Tests
Type:	WLAN RF
Serial Number:	001

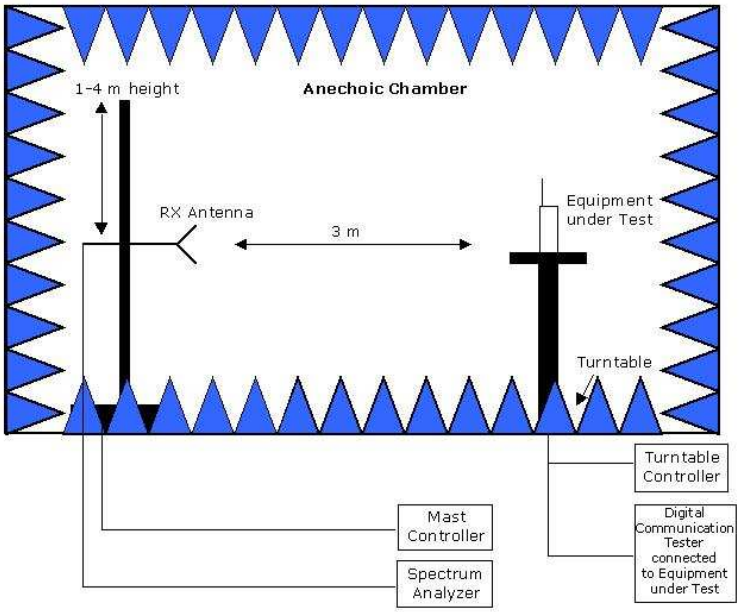
Single Devices for WLAN RF Test Solution

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Arbitrary Waveform Generator	TGA12101	284482	2013/06/20	
Power Meter NRVD	NRVD	832025/059		
	Standard Calibration		2011/06/14	2012/06/13
Power Sensor NRV Z1 A	PROBE	832279/013		
	Standard Calibration		2011/06/14	2012/06/13
Power Supply	NGSM 32/10	2725		
	Standard Calibration		2011/06/15	2013/06/14
Rubidium Frequency Normal MFS	Datum MFS	002	Datum GmbH	
	Standard Calibration		2011/08/17	2012/08/16
Signal Analyser FSIQ26	1119.6001.26	832695/007	Rohde & Schwarz GmbH & Co.KG	
Signal Generator	SMP03	833680/003	Rohde & Schwarz GmbH & Co.KG	
	Standard Calibration		2009/06/23	2012/06/22
Spectrum Analyser	FSU26	100136	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2011/05/11	2012/05/10
	FSU FW Update to v4.61 SP3, K5 v4.60 and K73 v4.61		2011/12/05	
TOCT Switching Unit	Switching Unit	030106	7 layers, Inc.	
TOCT Switching Unit (loan unit)	Switching Unit	030101	7 layers, Inc.	
Vector Signal Generator SMIQ03B	SMIQ03B	832870/017		
	Standard Calibration		2010/06/23	

5 Photo Report

Photos are included in an external report.

6 Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

Drawing 1: Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces.

7 FCC and IC Correlation of measurement requirements

The following tables show the correlation of measurement requirements for WLAN equipment and Digital Apparatus from FCC and IC standards.

WLAN equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC mains	§ 15.207	RSS-Gen: 7.2.4
Occupied bandwidth	§ 15.247 (a) (1)	RSS-210: A8.1
Peak power output	§ 15.247 (b) (1)	RSS-210: A8.4
Spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen: 6; RSS-210: A8.5
Spurious radiated emissions	§ 15.247 (d)	RSS-Gen: 6; RSS-210: A8.5
Band edge compliance	§ 15.247 (d)	RSS-210: A8.5
Power density	§ 15.247 (e)	RSS-210: A8.2 (b)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen: 7.1.2

Digital Apparatus

Measurement	FCC reference	IC reference
Conducted Emissions (AC Power Line)	§ 15.107	ICES-003
Spurious Radiated Emissions	§ 15.109	ICES-003

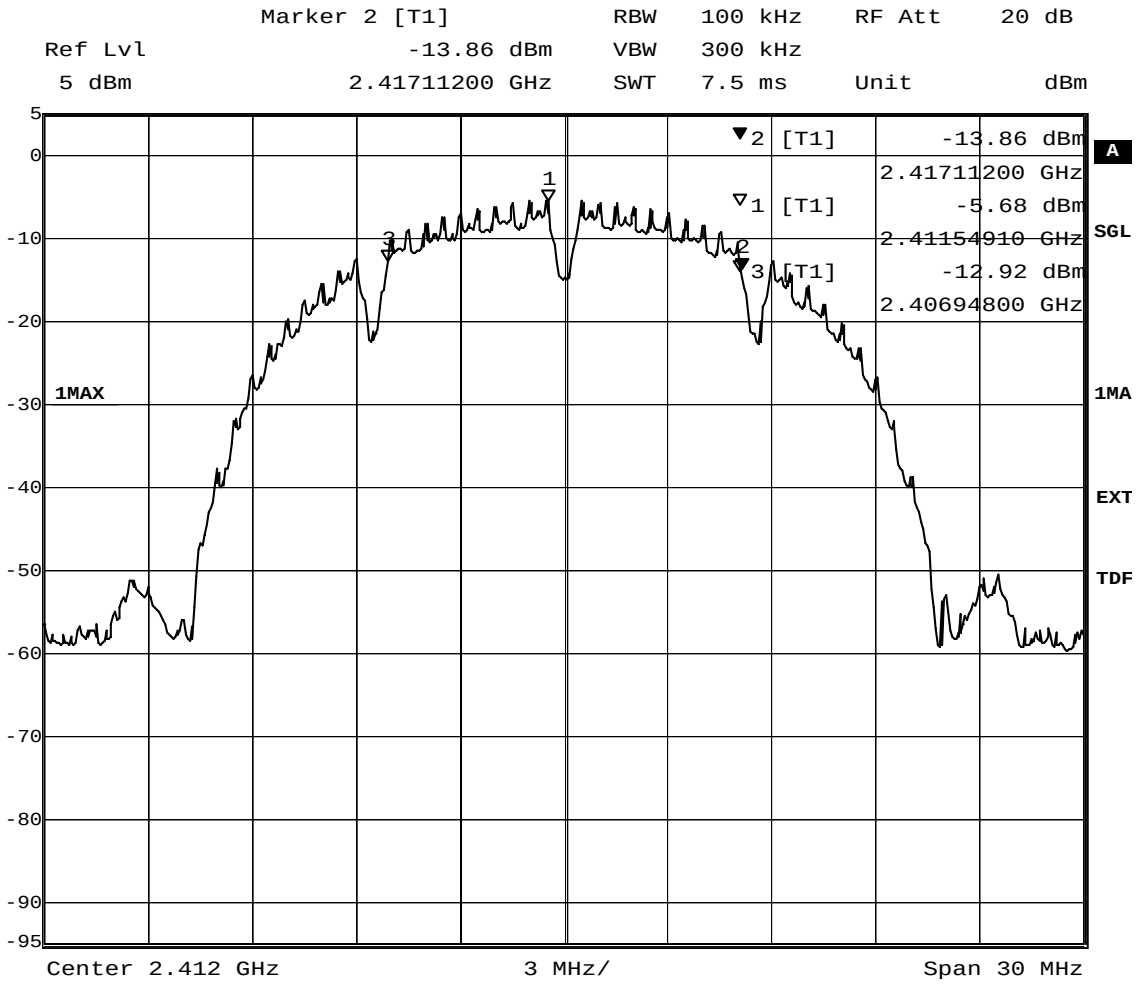
8 Annex measurement plots

8.1 Occupied bandwidth

8.1.1 Occupied bandwidth operating mode 1

Op. Mode

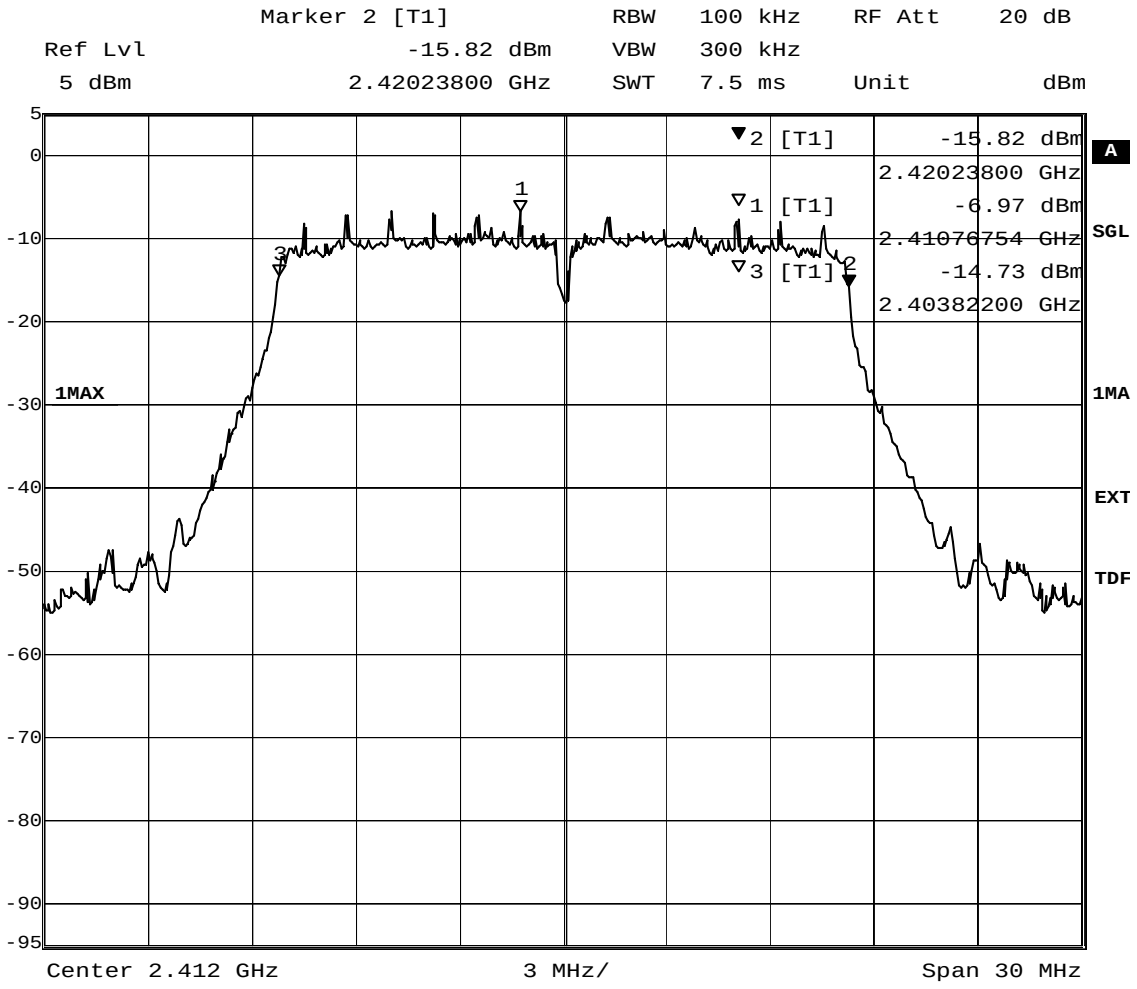
op-mode 1b



Title: 6dB Bandwidth
Comment A: CH B: 2412 MHz; 6dB bandwidth (kHz):10164
Date: 1.MAR.2012 19:50:00

Op. Mode

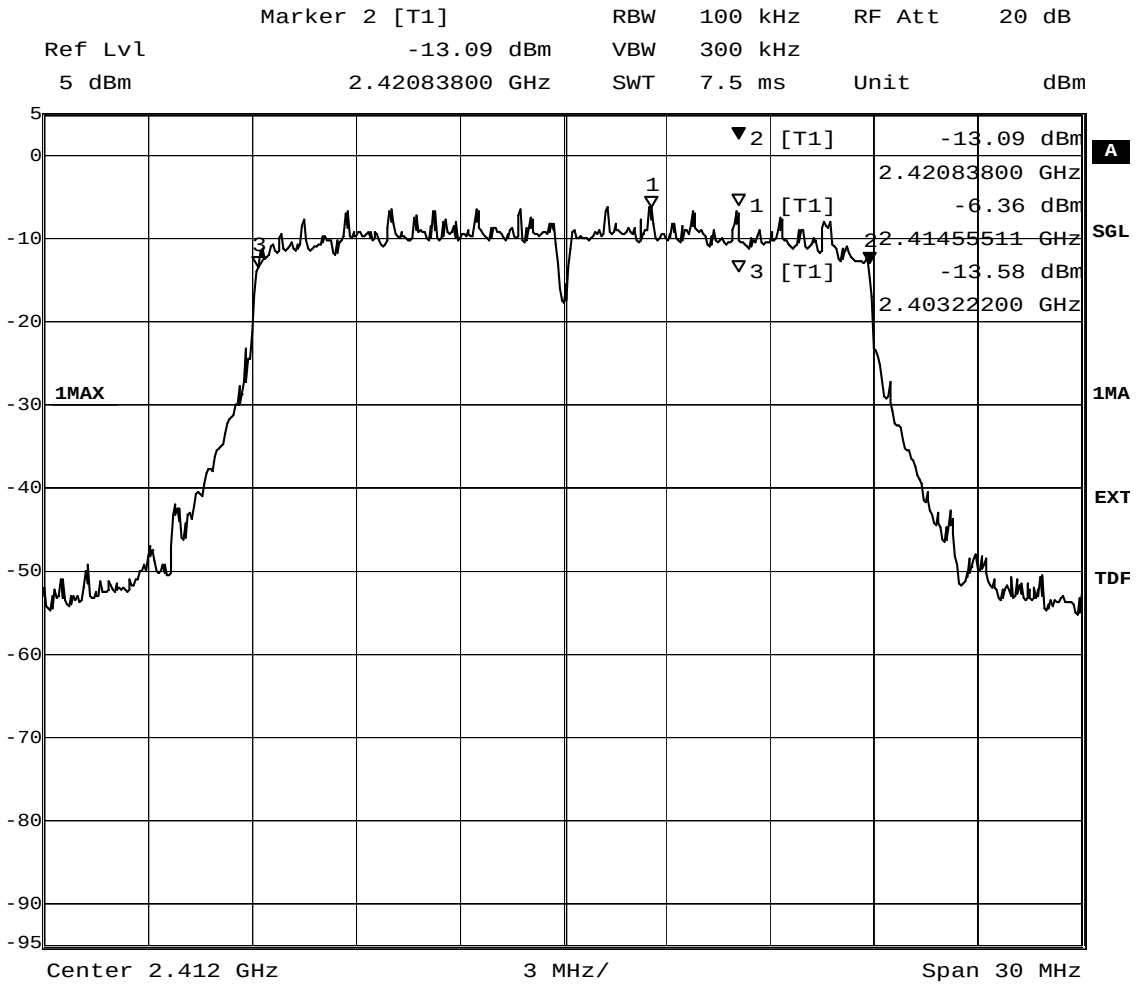
op-mode 1g



Title: 6dB Bandwidth
Comment A: CH B: 2412 MHz; 6dB bandwidth (kHz):16416
Date: 1.MAR.2012 21:33:54

Op. Mode

op-mode 1n

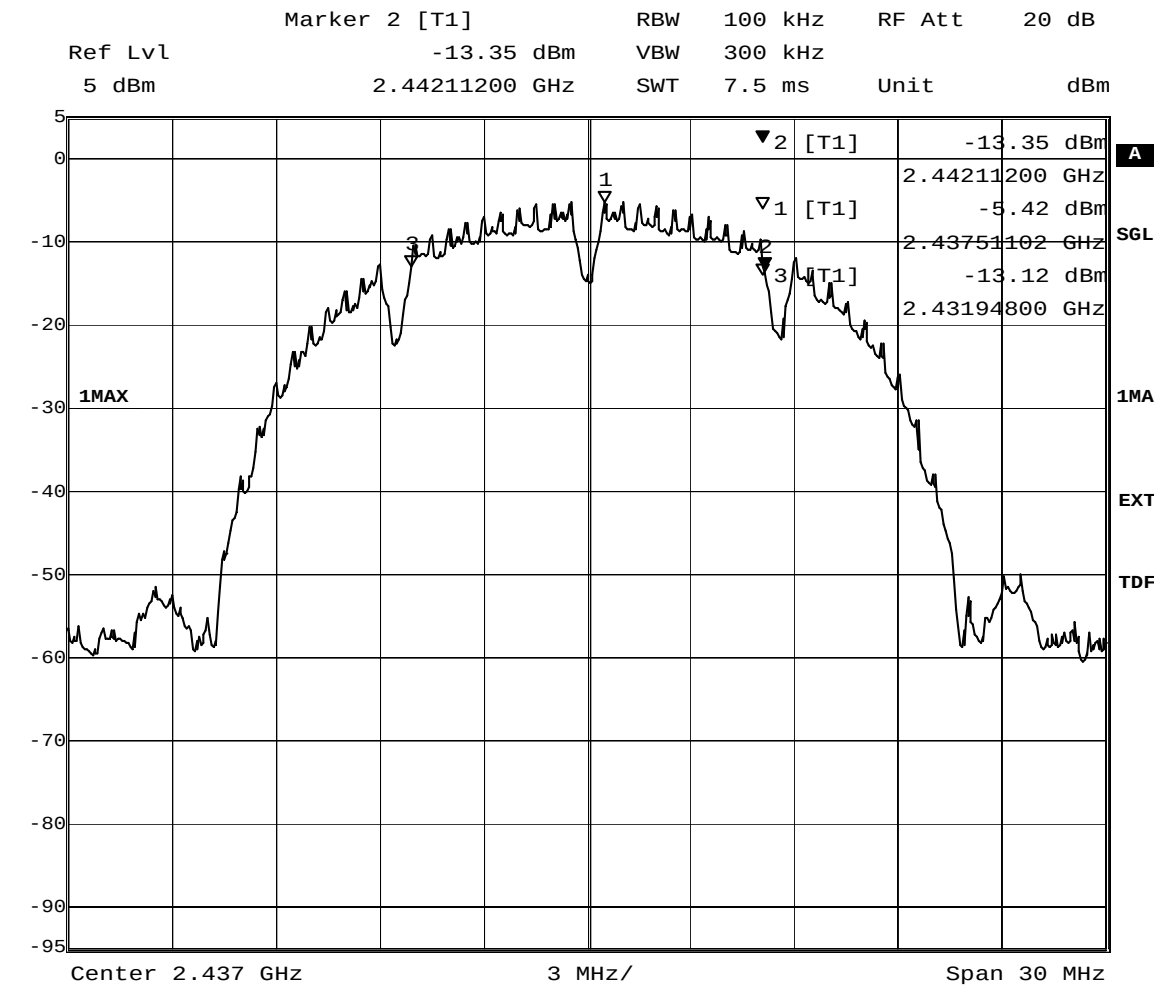


Title: 6dB Bandwidth
Comment A: CH B: 2412 MHz; 6dB bandwidth (kHz):17616
Date: 1.MAR.2012 23:19:46

8.1.2 Occupied bandwidth operating mode 2

Op. Mode

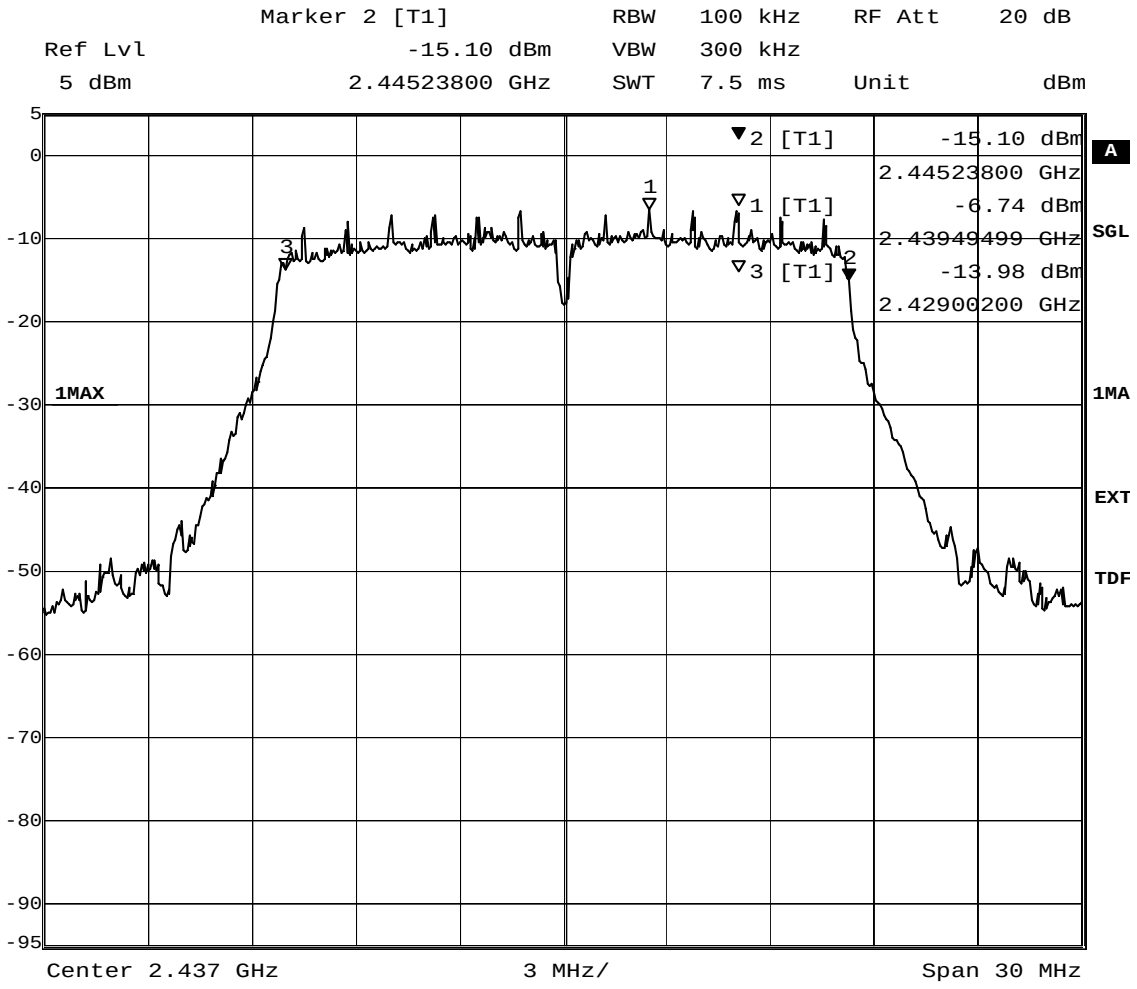
op-mode 2b



Title: 6dB Bandwidth
Comment A: CH M: 2437 MHz; 6dB bandwidth (kHz):10164
Date: 1.MAR.2012 20:26:23

Op. Mode

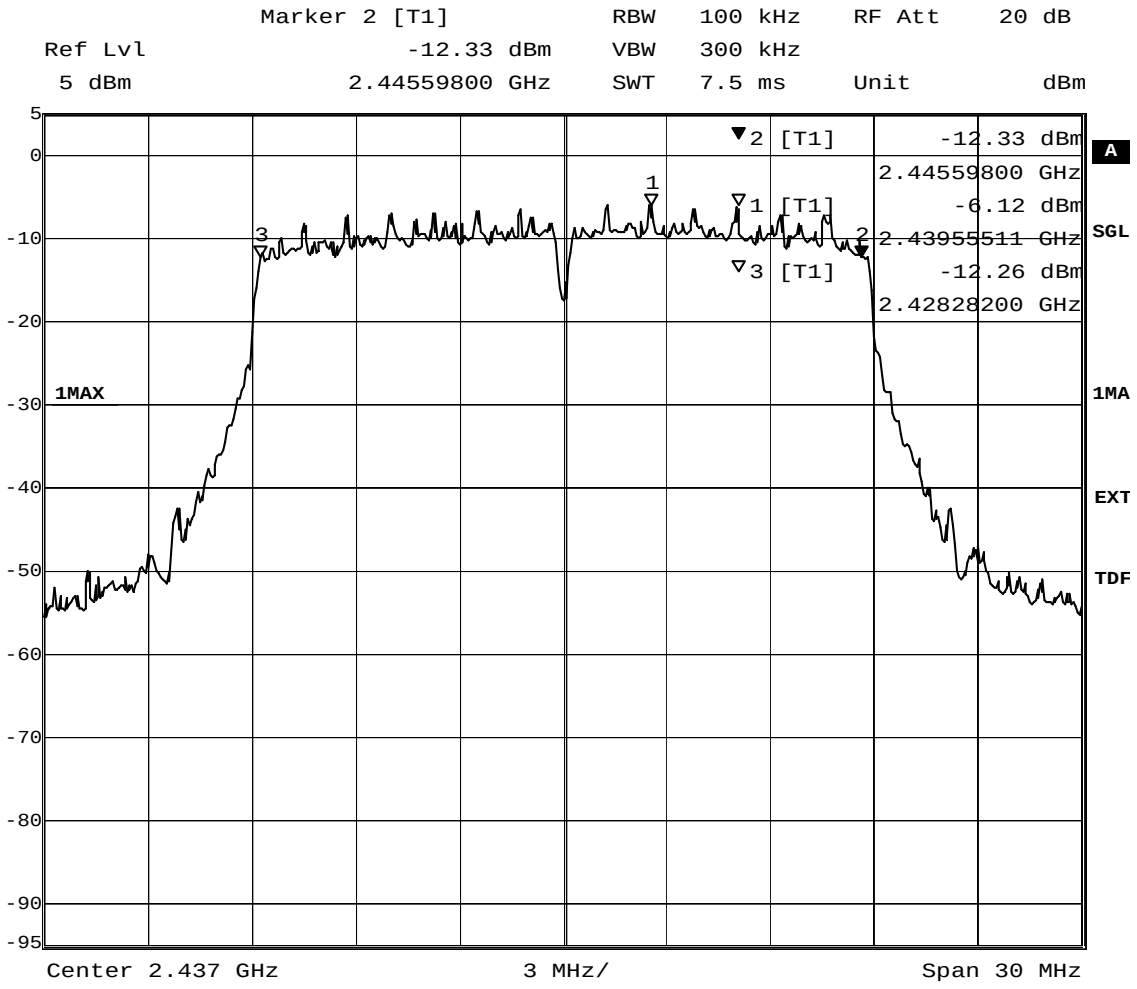
op-mode 2g



Title: 6dB Bandwidth
Comment A: CH M: 2437 MHz; 6dB bandwidth (kHz):16236
Date: 1.MAR.2012 22:08:19

Op. Mode

op-mode 2n

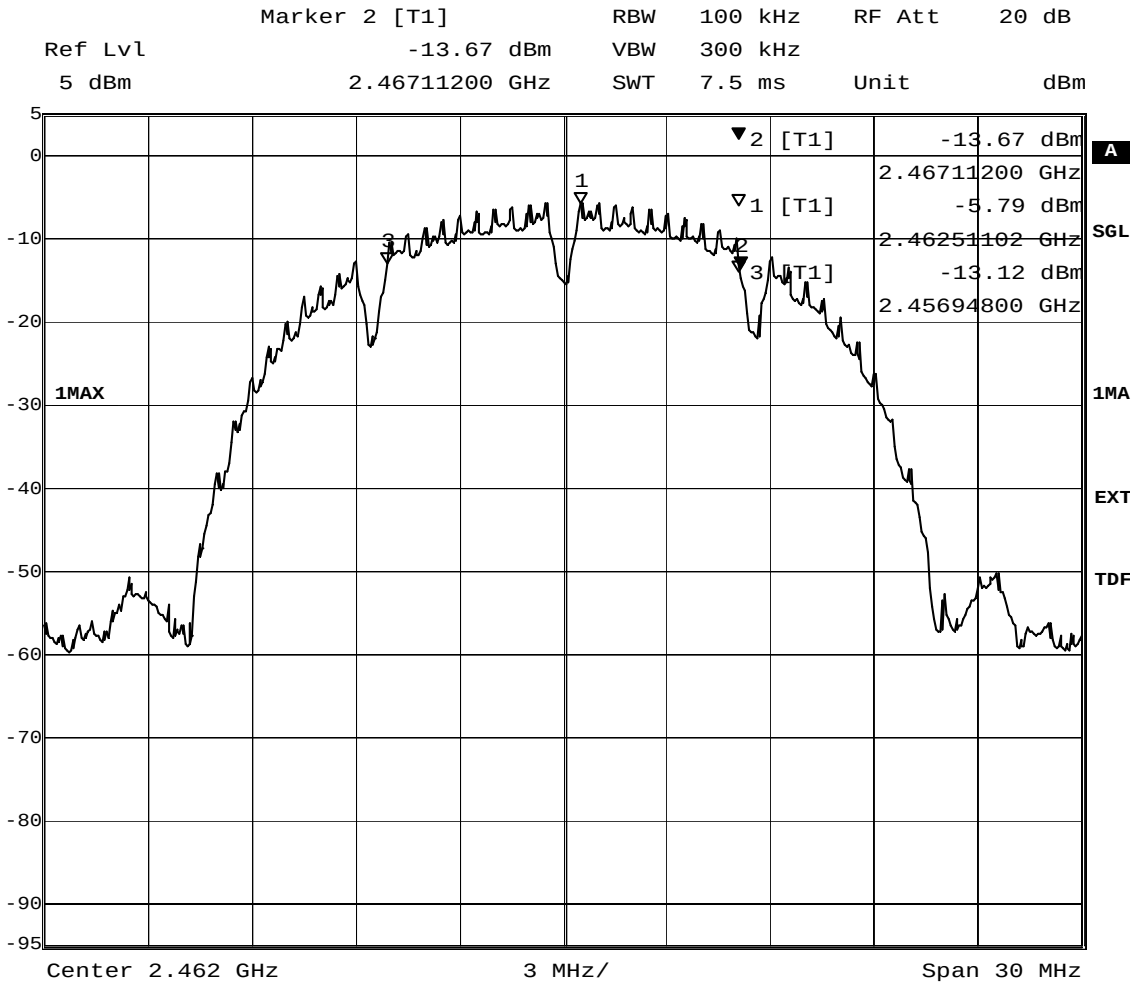


Title: 6dB Bandwidth
Comment A: CH M: 2437 MHz; 6dB bandwidth (kHz):17316
Date: 1.MAR.2012 23:52:19

8.1.3 Occupied bandwidth operating mode 3

Op. Mode

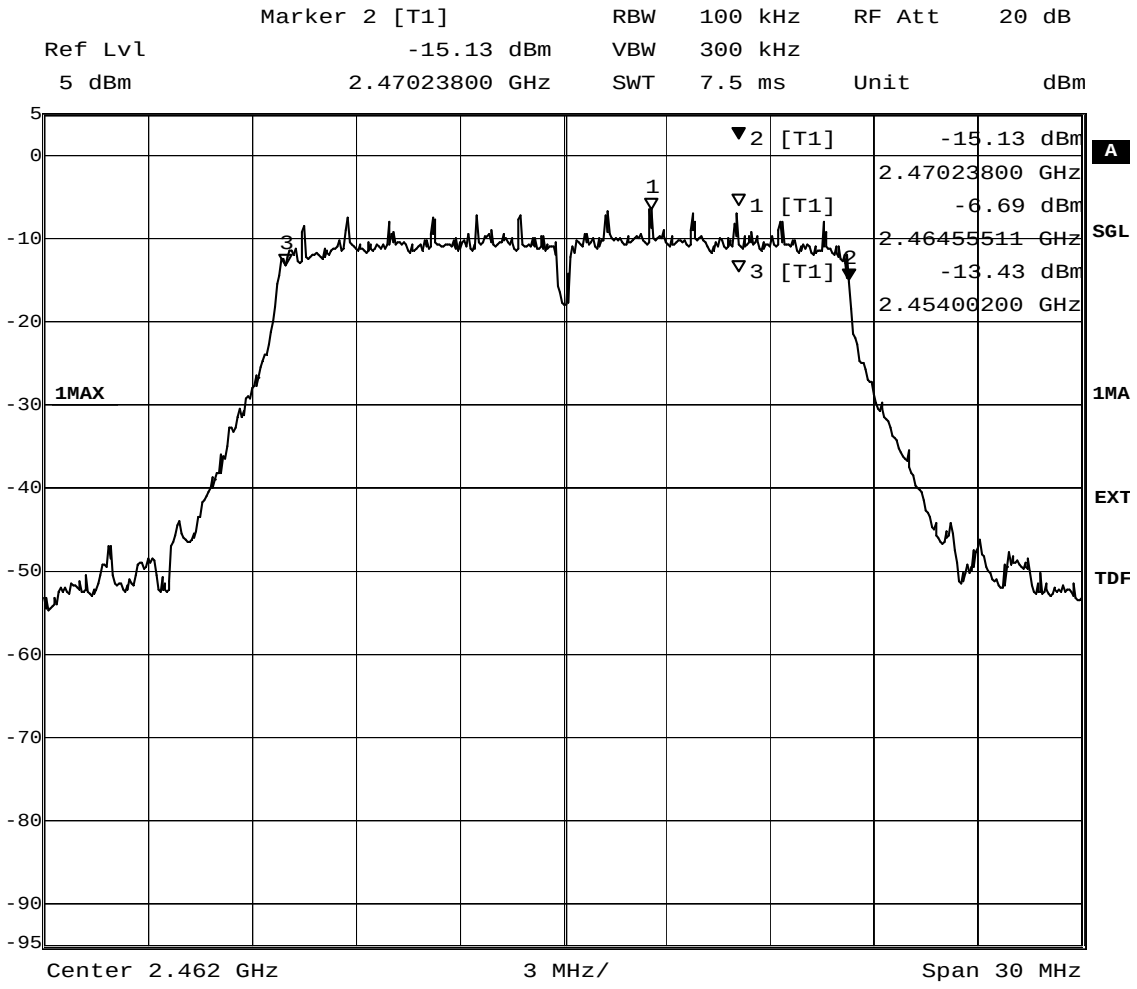
op-mode 3b



Title: 6dB Bandwidth
Comment A: CH T: 2462 MHz; 6dB bandwidth (kHz):10164
Date: 1.MAR.2012 21:00:33

Op. Mode

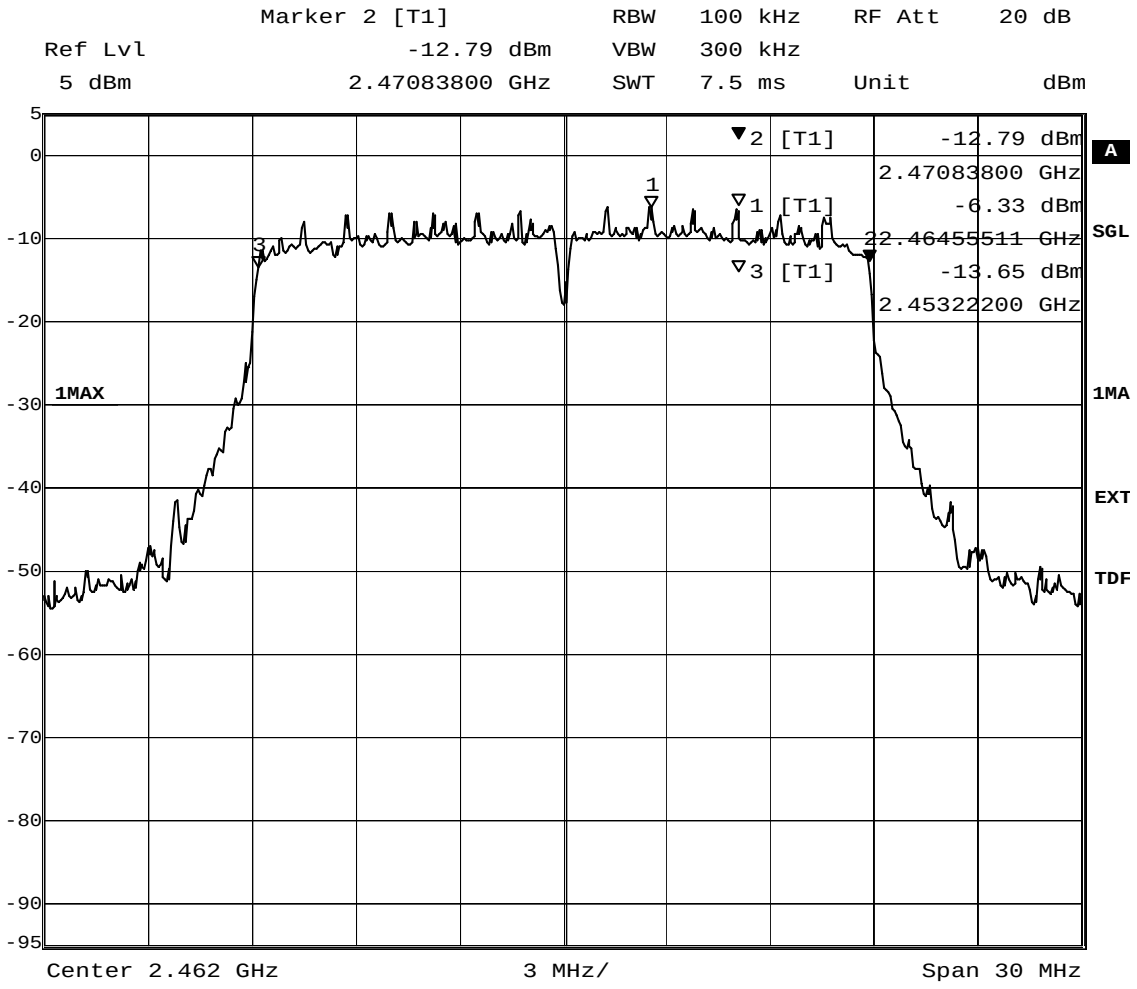
op-mode 3g



Title: 6dB Bandwidth
Comment A: CH T: 2462 MHz; 6dB bandwidth (kHz):16236
Date: 1.MAR.2012 22:43:48

Op. Mode

op-mode 3n



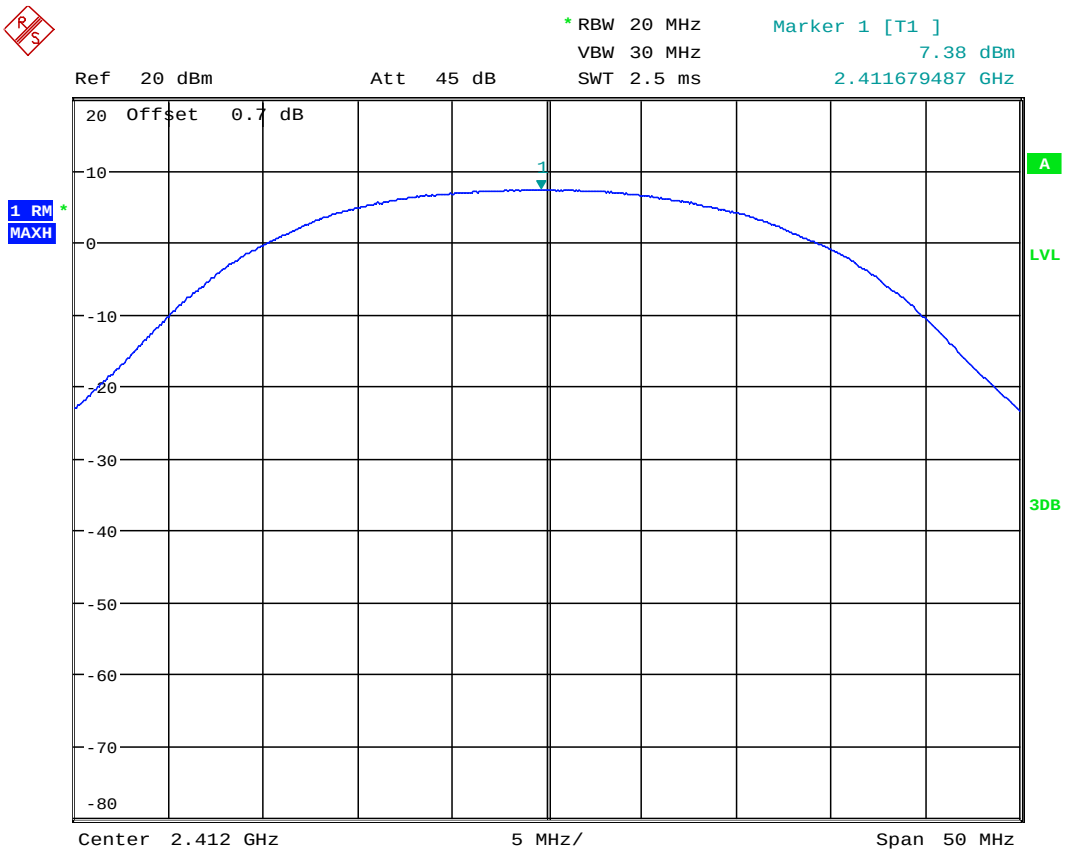
Title: 6dB Bandwidth
Comment A: CH T: 2462 MHz; 6dB bandwidth (kHz):17616
Date: 2.MAR.2012 00:24:54

8.2 Peak power output

8.2.1 Peak power output operating mode 1

Op. Mode

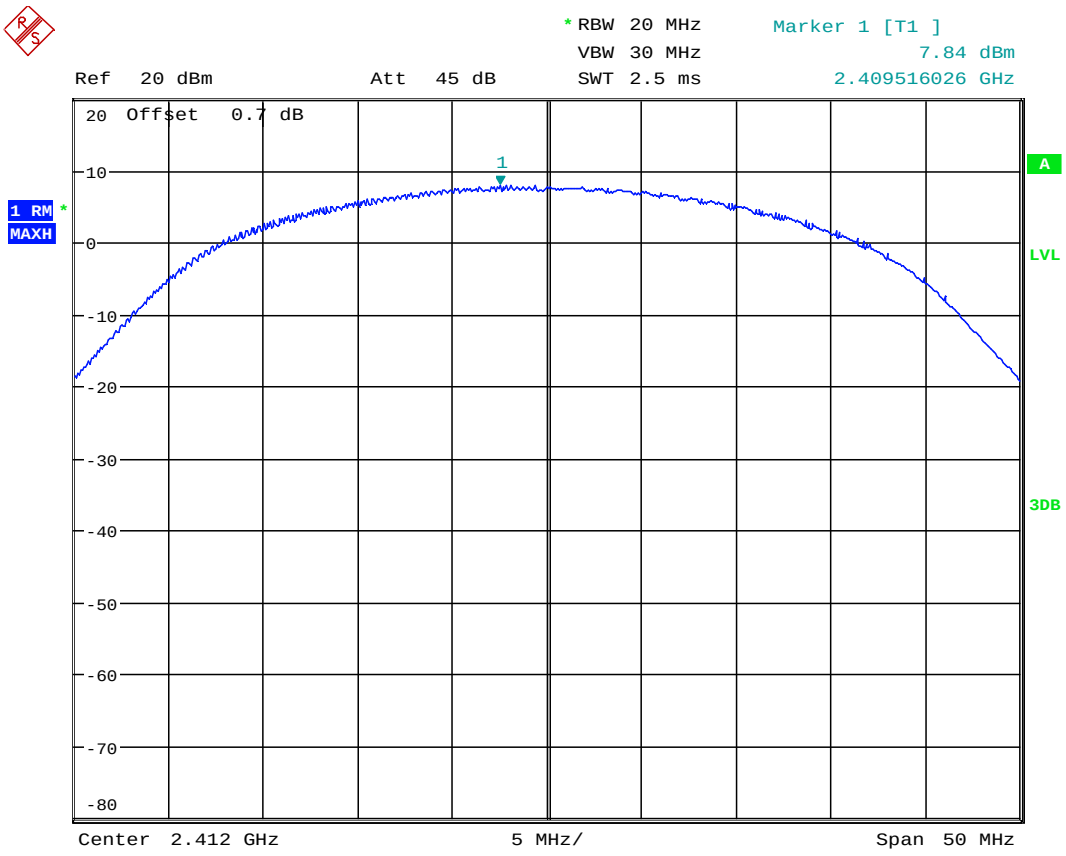
op-mode 1b



Date: 7.MAR.2012 15:00:23

Op. Mode

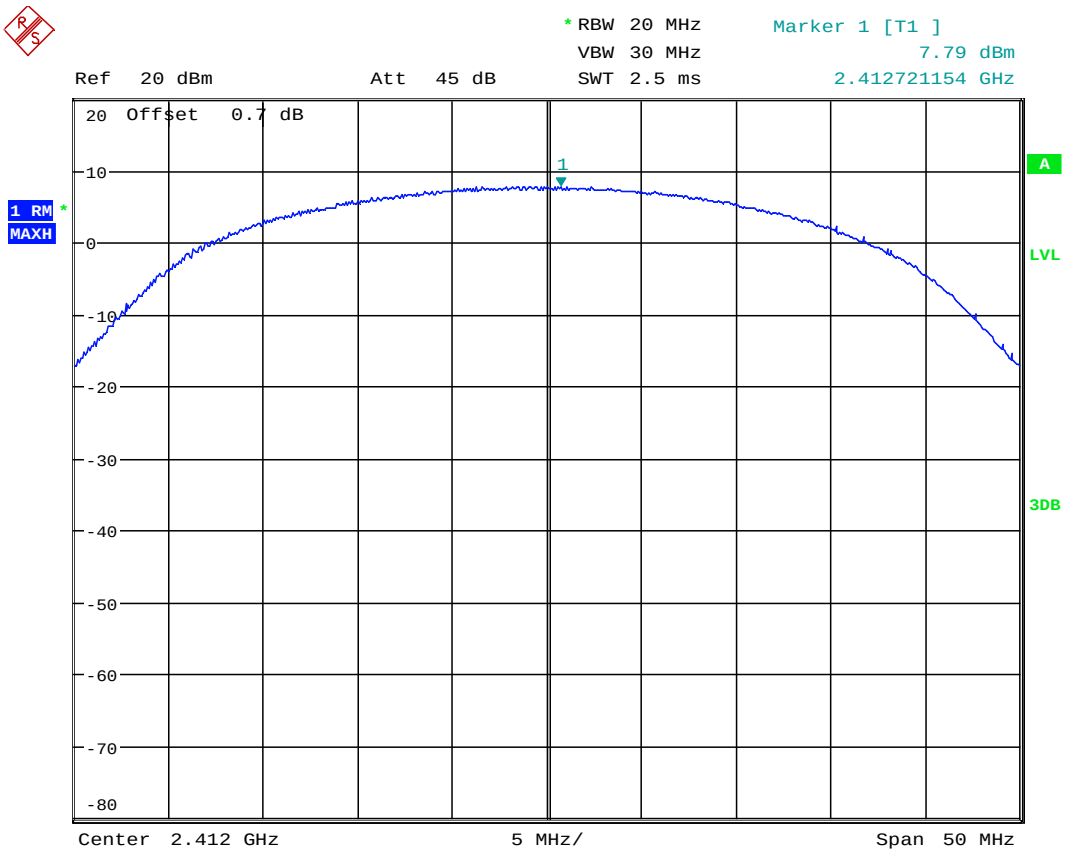
op-mode 1g



Date: 7.MAR.2012 15:04:54

Op. Mode

op-mode 1n

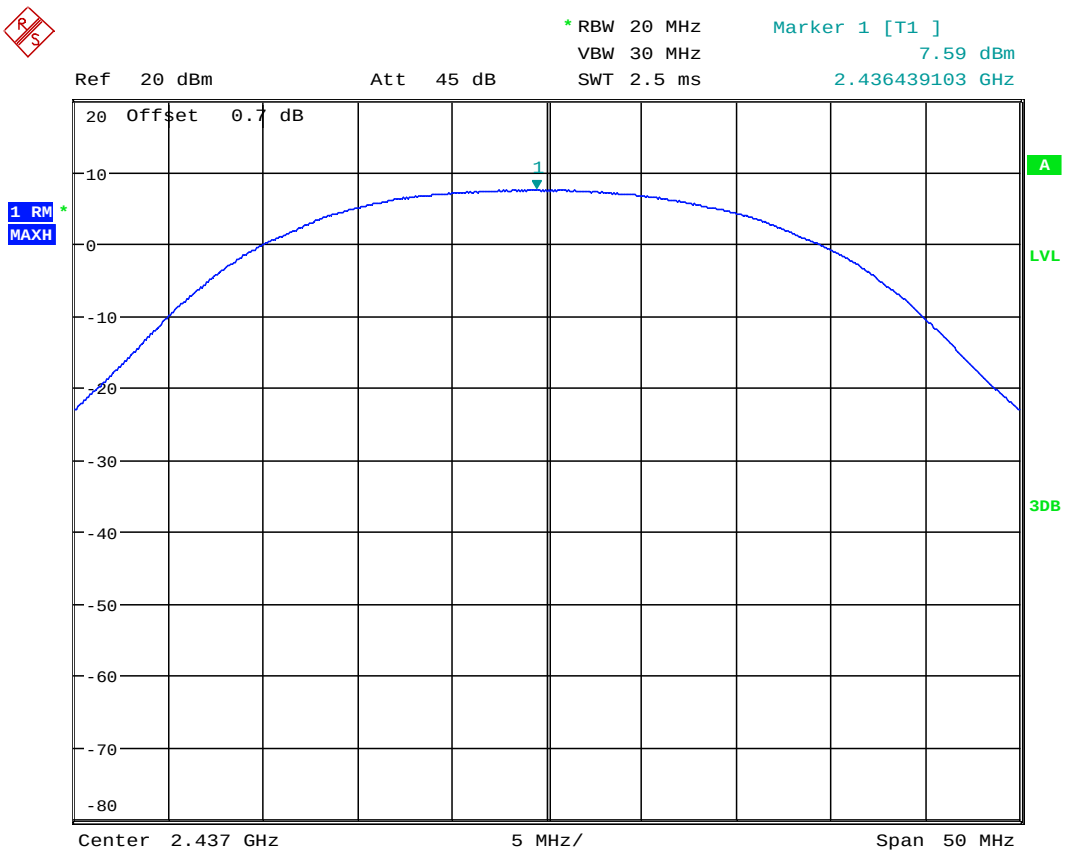


Date: 7.MAR.2012 15:06:18

8.2.2 Peak power output operating mode 2

Op. Mode

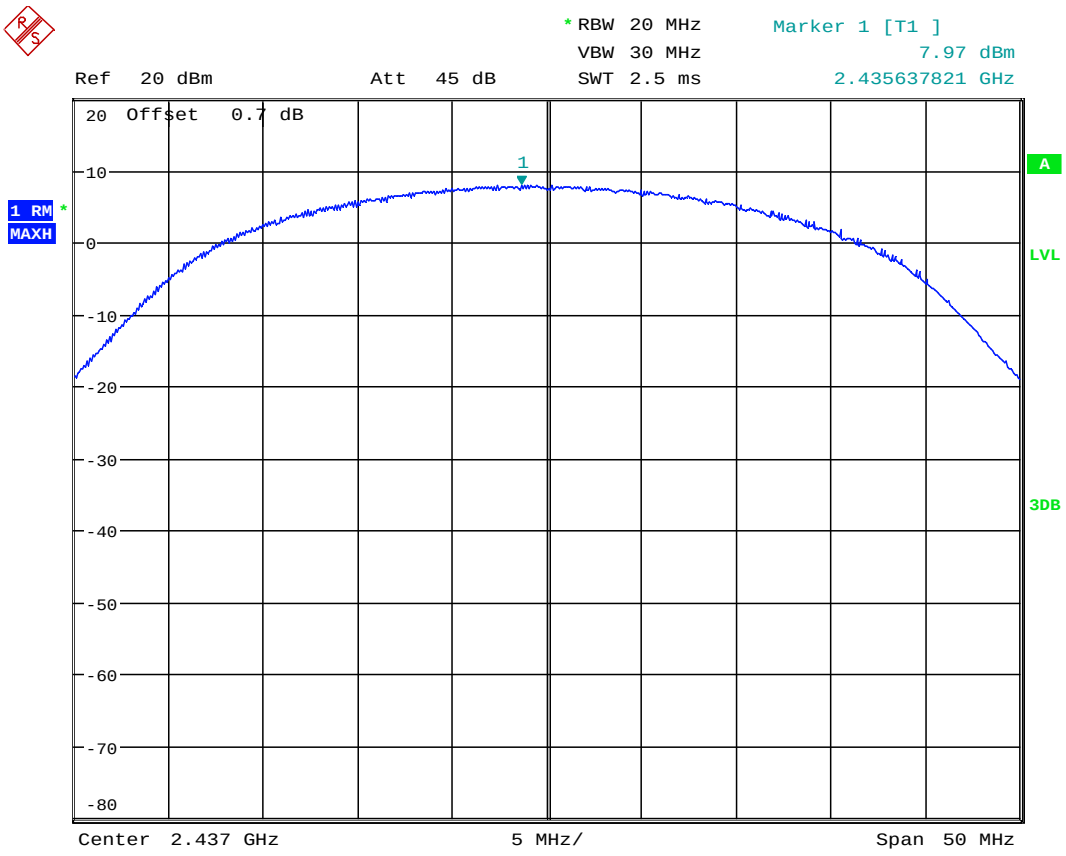
op-mode 2b



Date: 7.MAR.2012 15:10:14

Op. Mode

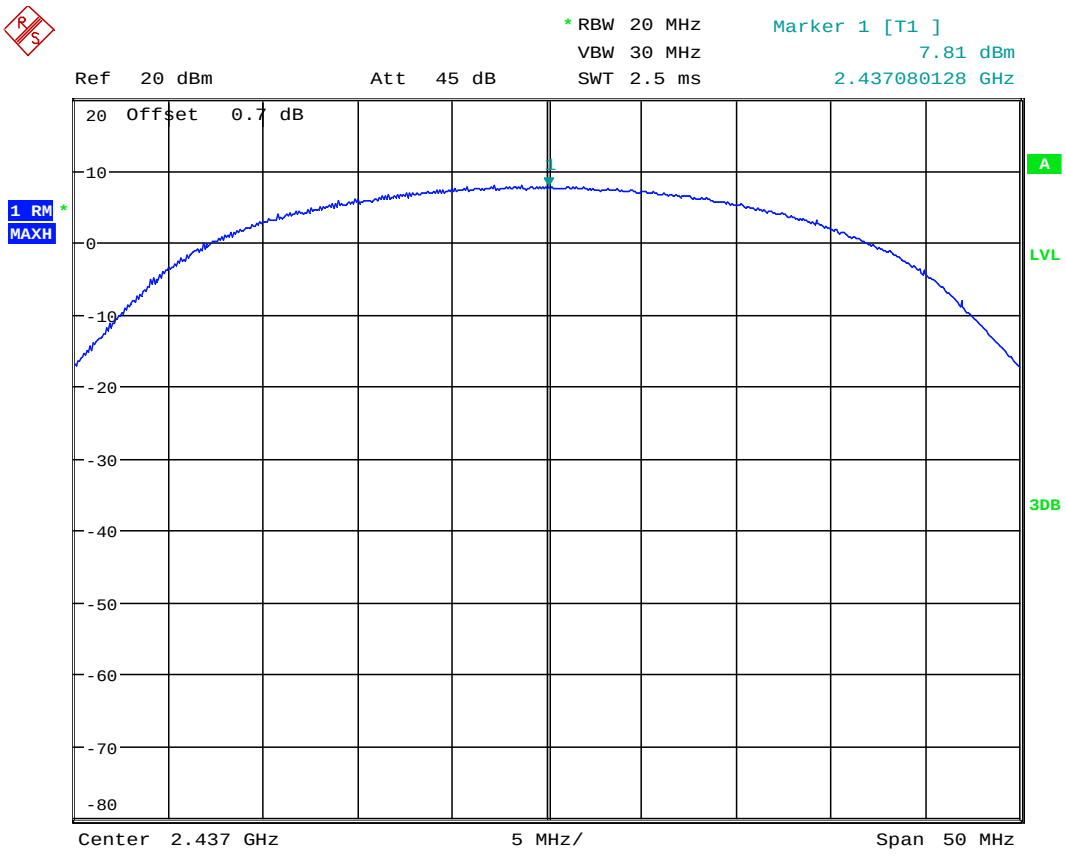
op-mode 2g



Date: 7.MAR.2012 15:11:05

Op. Mode

op-mode 2n

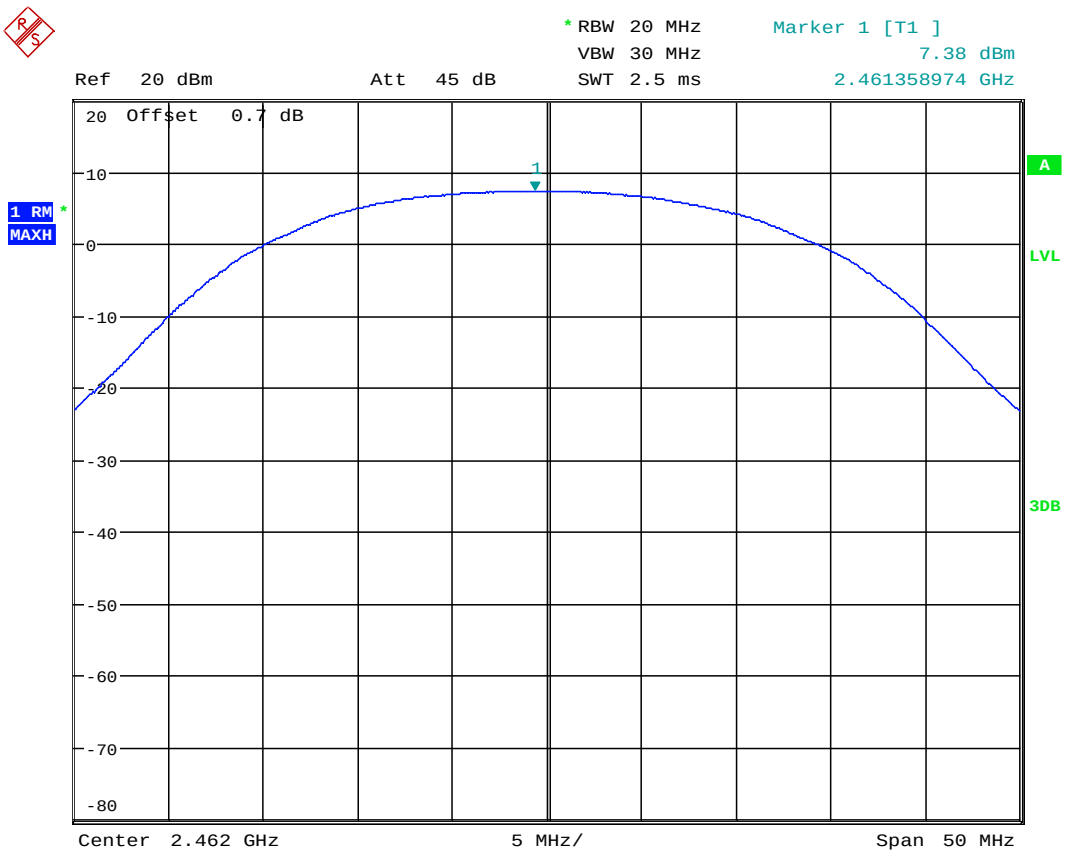


Date: 7.MAR.2012 15:12:17

8.2.3 Peak power output operating mode 3

Op. Mode

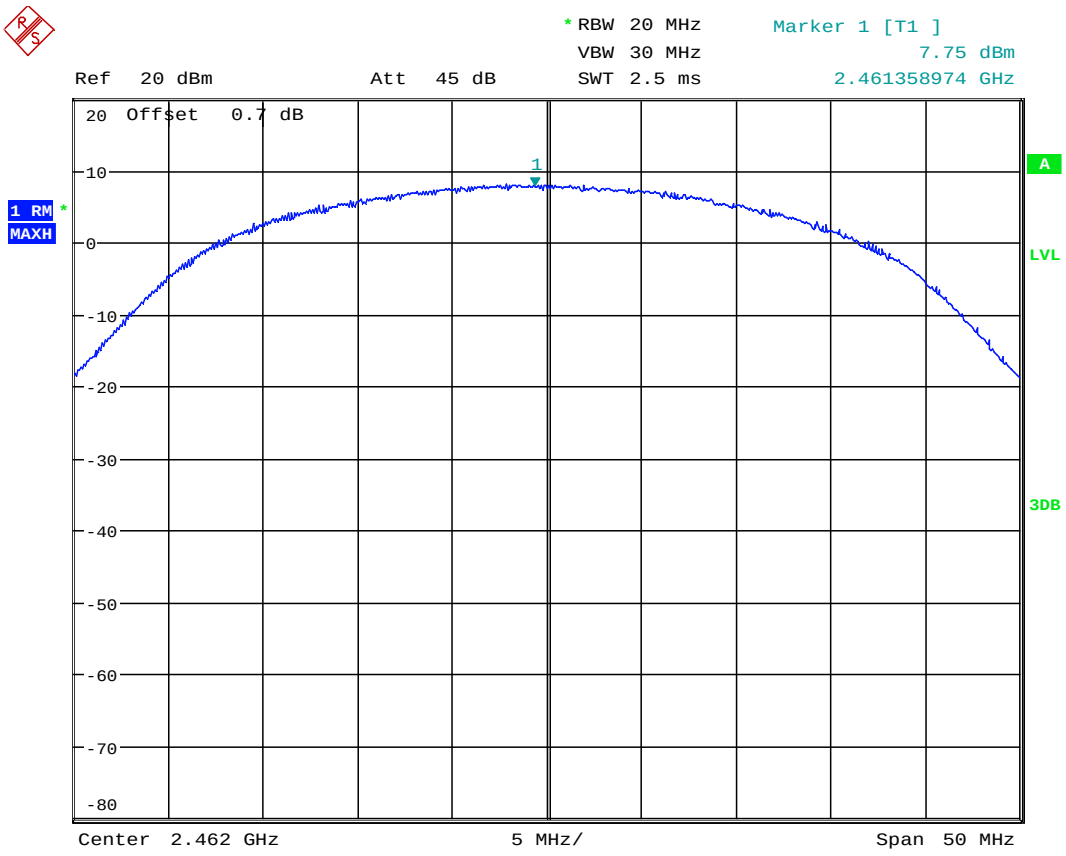
op-mode 3b



Date: 7.MAR.2012 15:14:29

Op. Mode

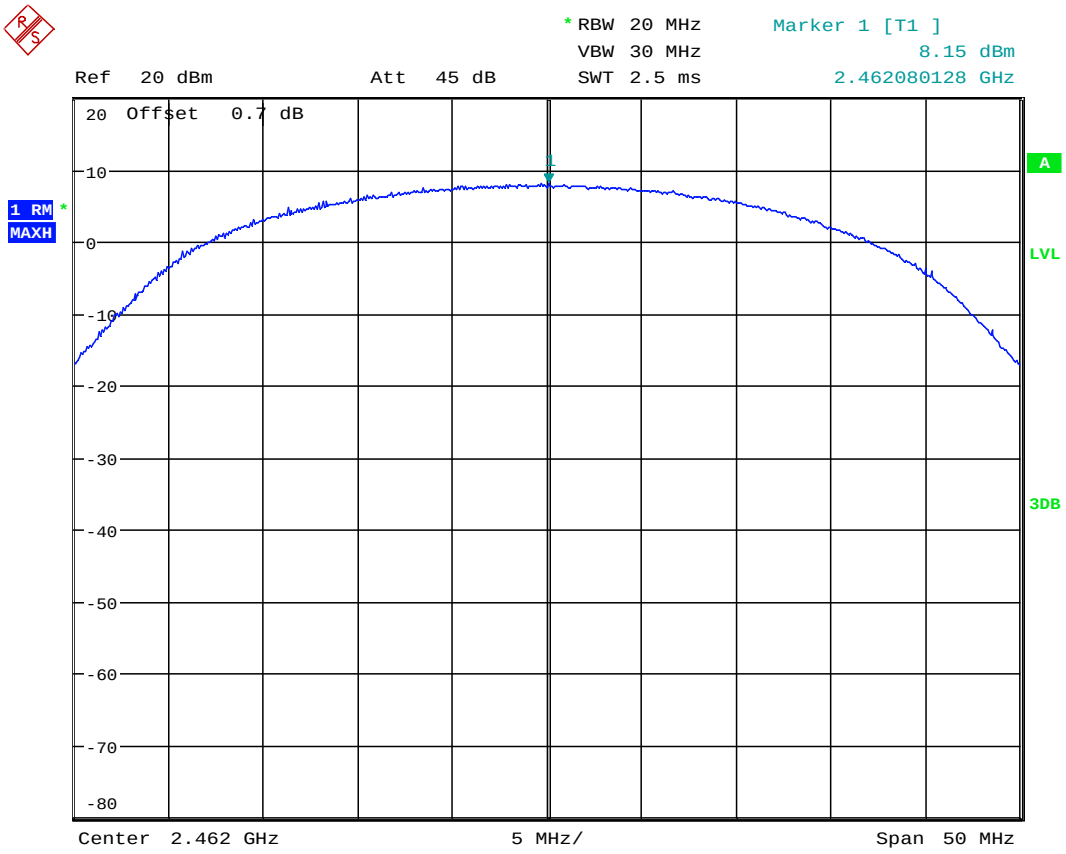
op-mode 3g



Date: 7.MAR.2012 15:18:12

Op. Mode

op-mode 3n



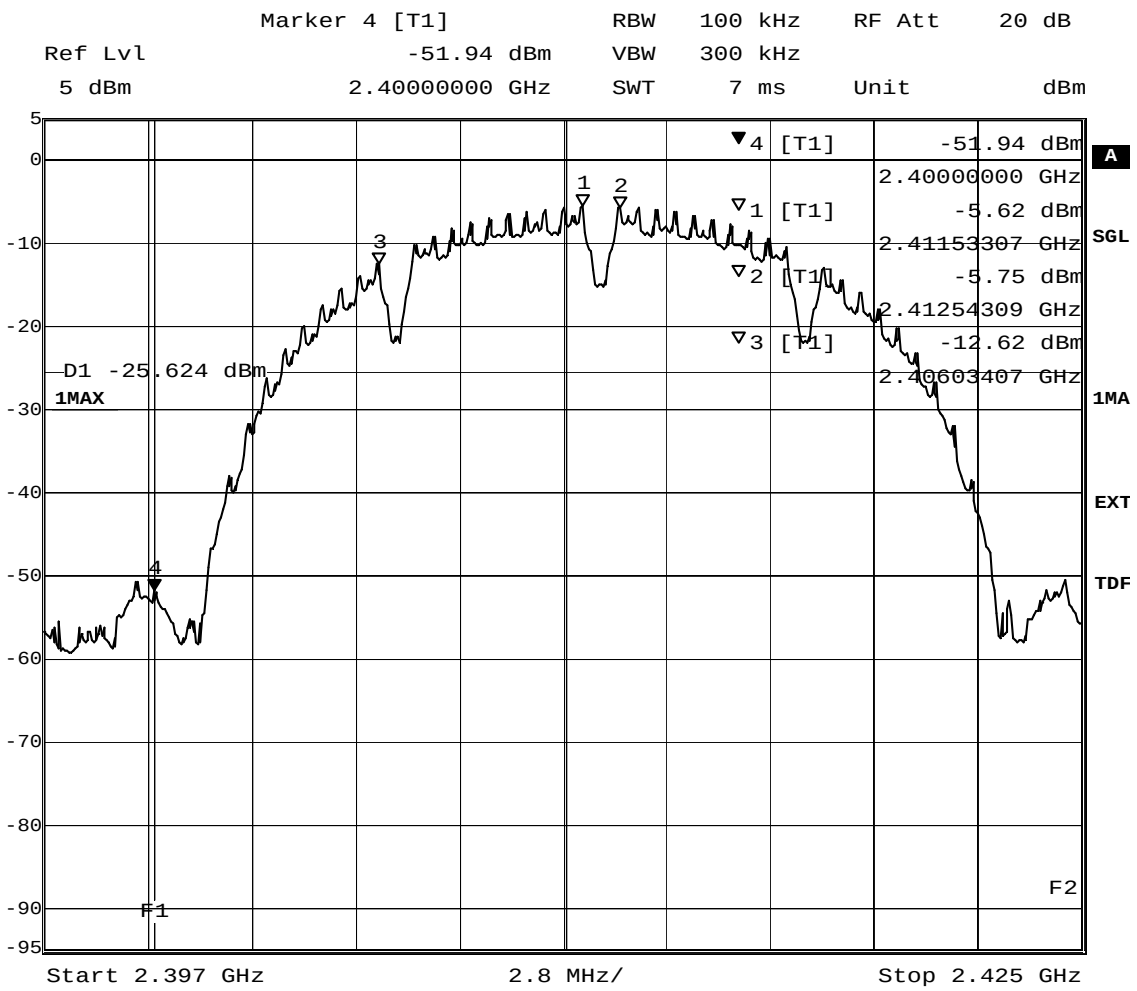
Date: 7.MAR.2012 15:19:17

8.3 Band edge compliance conducted and Spurious RF conducted emissions

8.3.1 Band edge compliance conducted operating mode 1b

Op. Mode

op-mode 1b

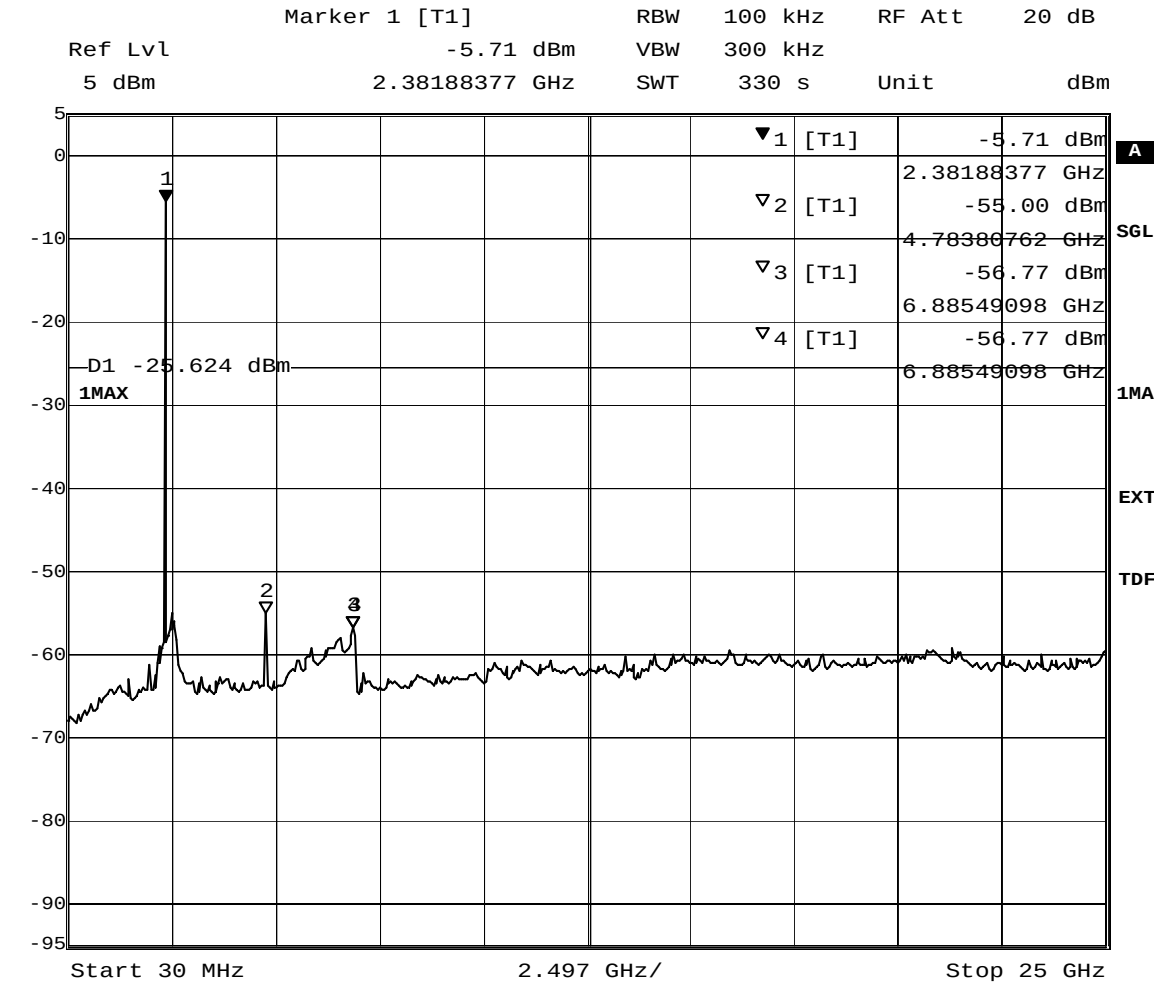


Title: Band Edge Compliance
Comment A: CH B: 2412 MHz
Date: 1.MAR.2012 19:35:51

8.3.2 Spurious RF conducted emission operating mode 1b

Op. Mode

op-mode 1b

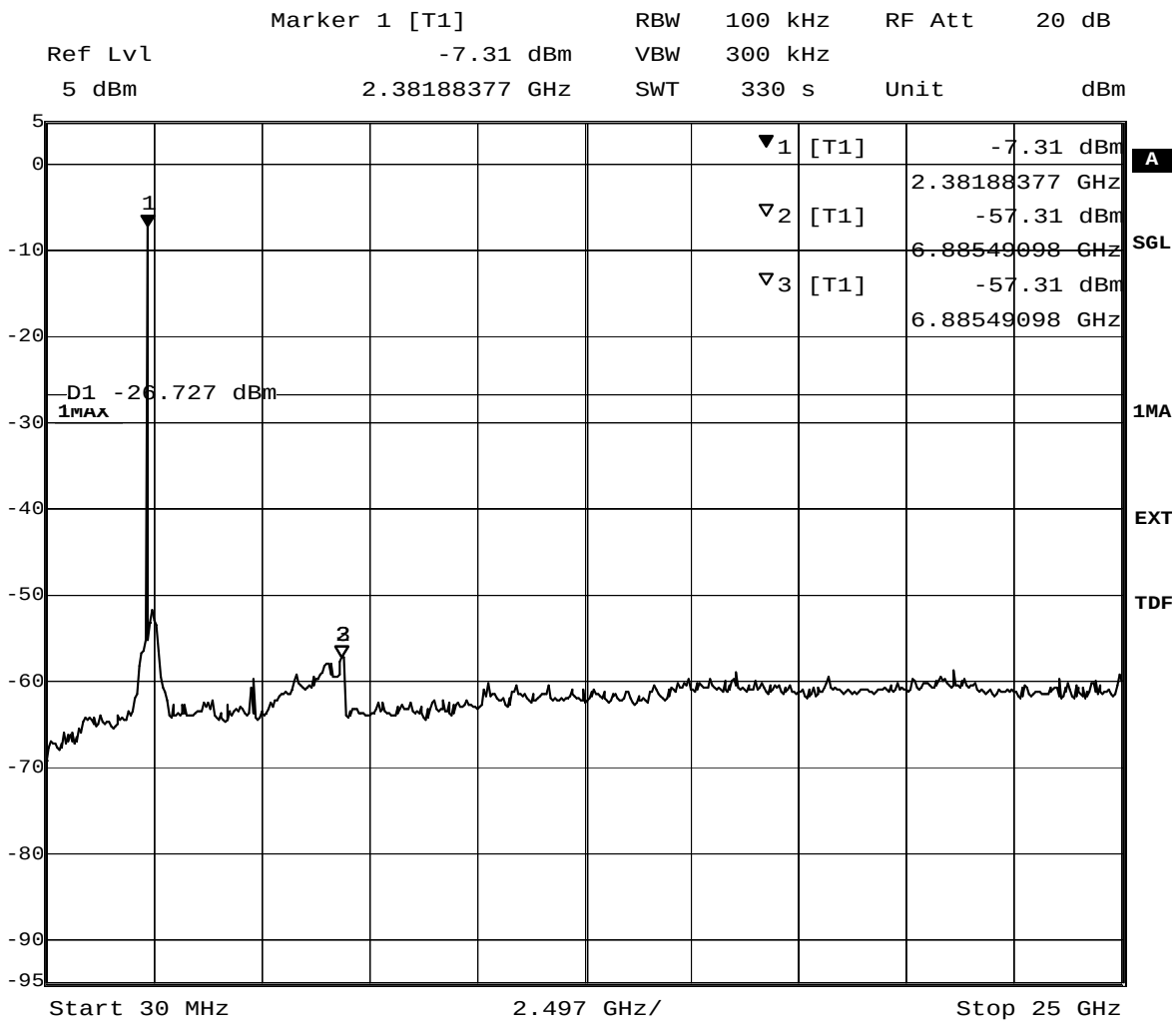


Title: spurious emissions
Comment A: CH B: 2412 MHz
Date: 1.MAR.2012 19:47:30

8.3.3 Band edge compliance conducted operating mode 1g

Op. Mode

op-mode 1g

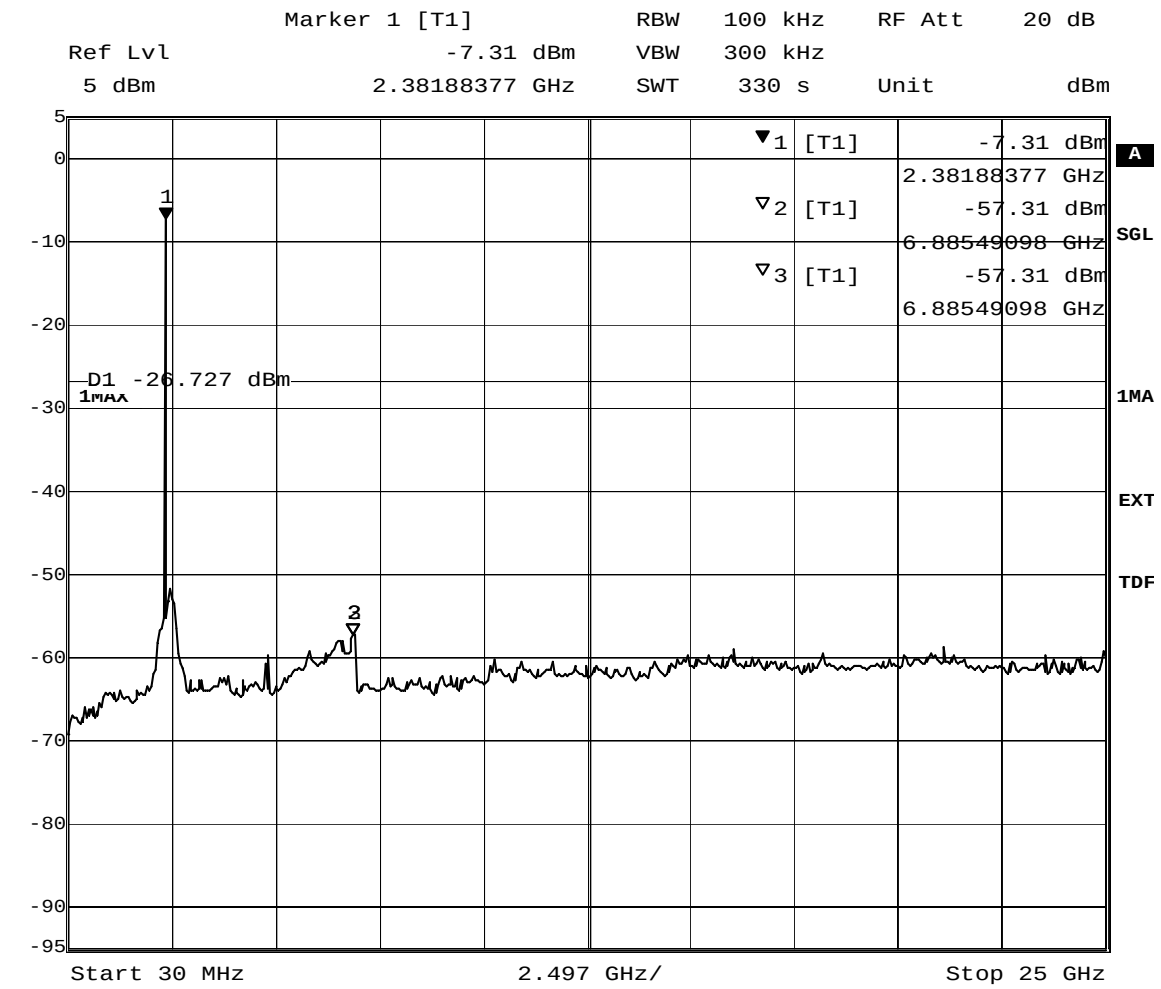


Title: spurious emissions
Comment A: CH B: 2412 MHz
Date: 1.MAR.2012 21:31:59

8.3.4 Spurious RF conducted emission operating mode 1g

Op. Mode

op-mode 1g

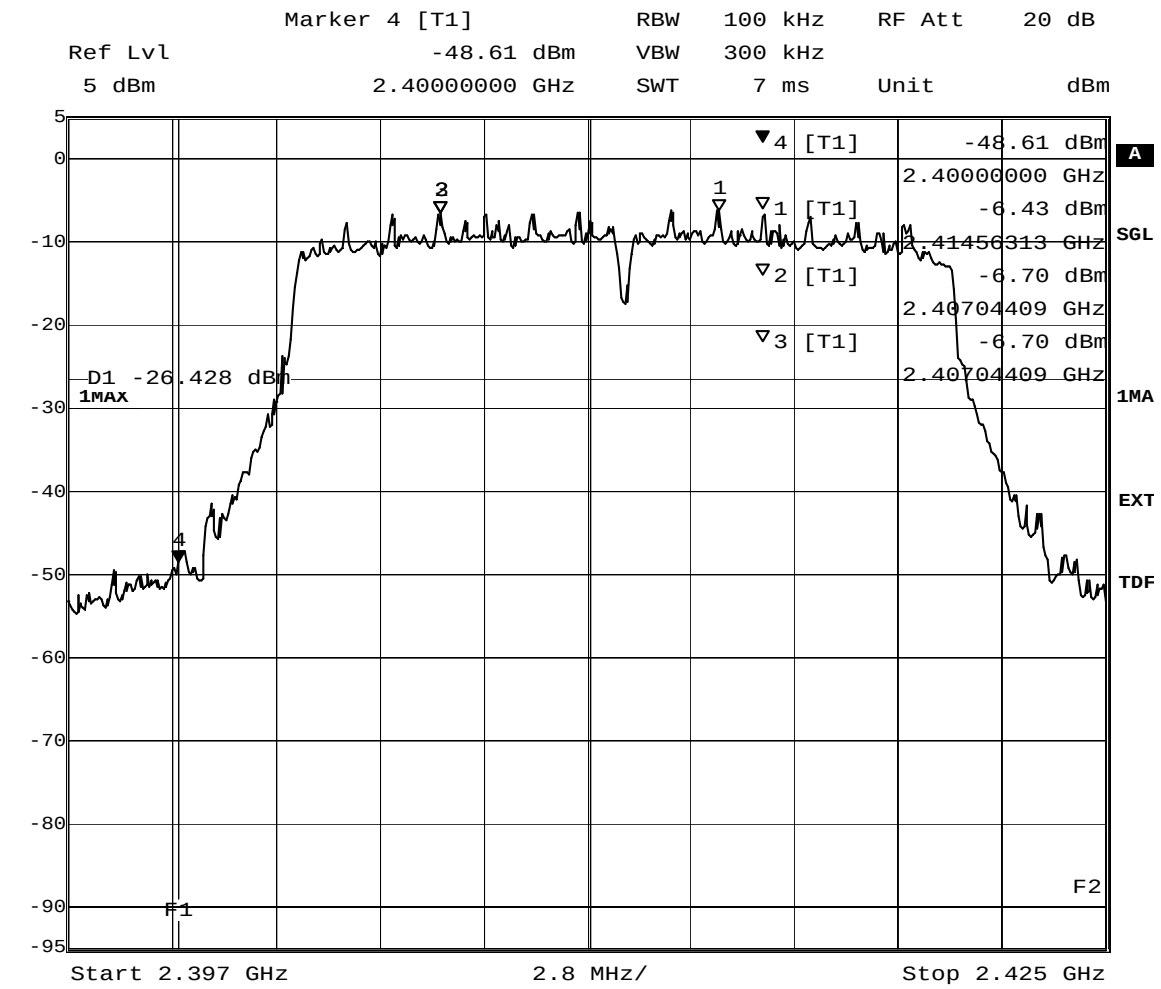


Title: spurious emissions
Comment A: CH B: 2412 MHz
Date: 1.MAR.2012 21:31:59

8.3.5 Band edge compliance conducted operating mode 1n

Op. Mode

op-mode 1n

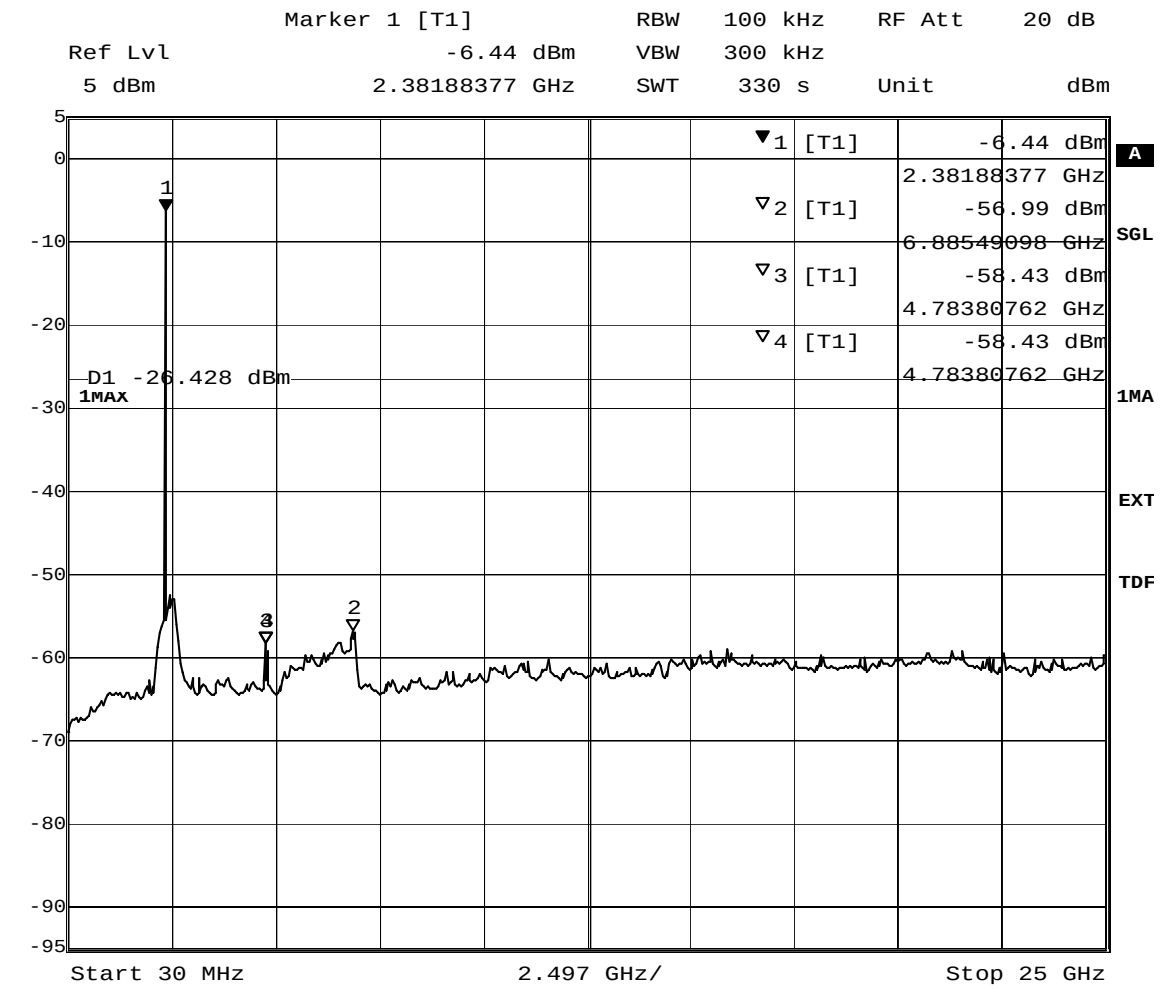


Title: Band Edge Compliance
Comment A: CH B: 2412 MHz
Date: 1.MAR.2012 23:06:20

8.3.6 Spurious RF conducted emission operating mode 1n

Op. Mode

op-mode 1n

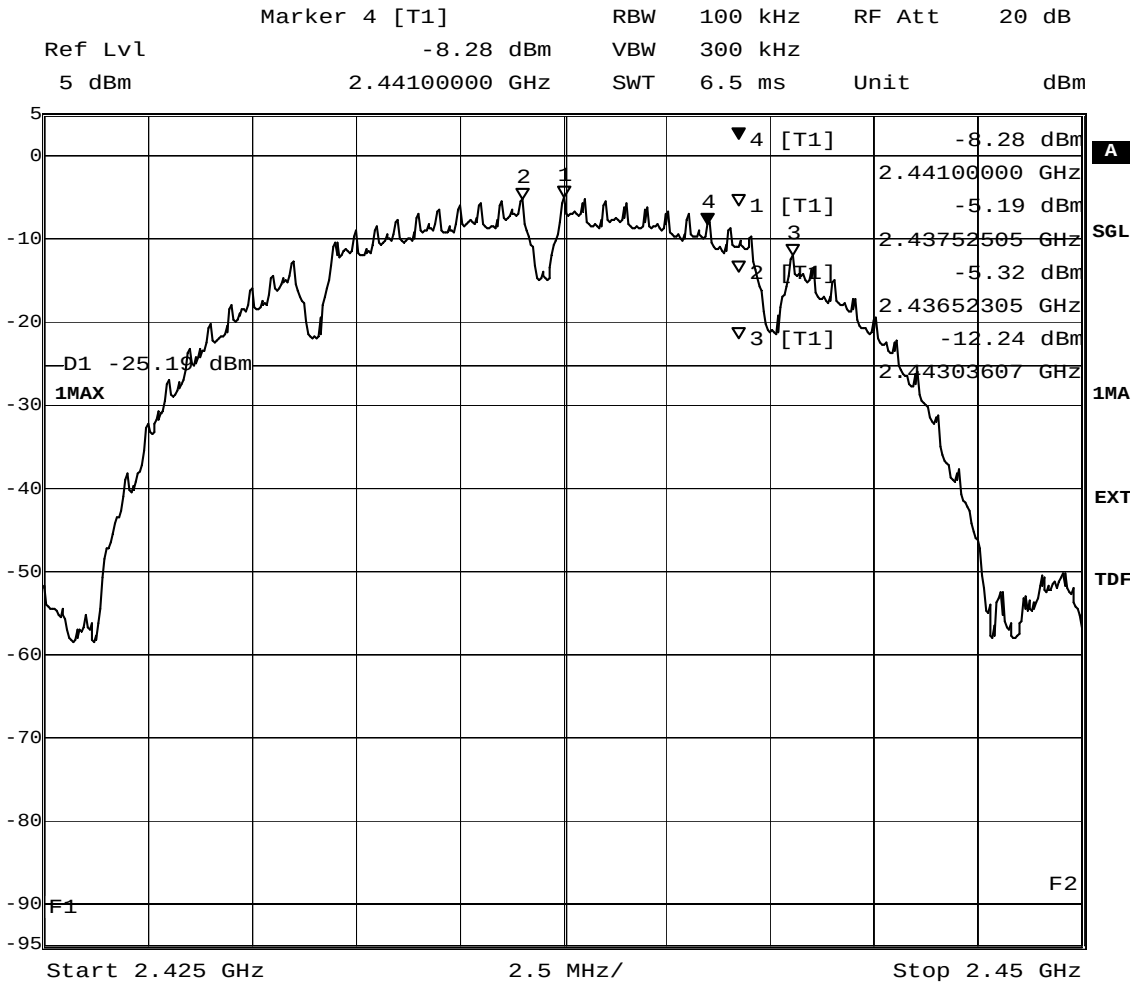


Title: spurious emissions
Comment A: CH B: 2412 MHz
Date: 1.MAR.2012 23:17:58

8.3.7 Spurious RF conducted emissions operating mode 2b

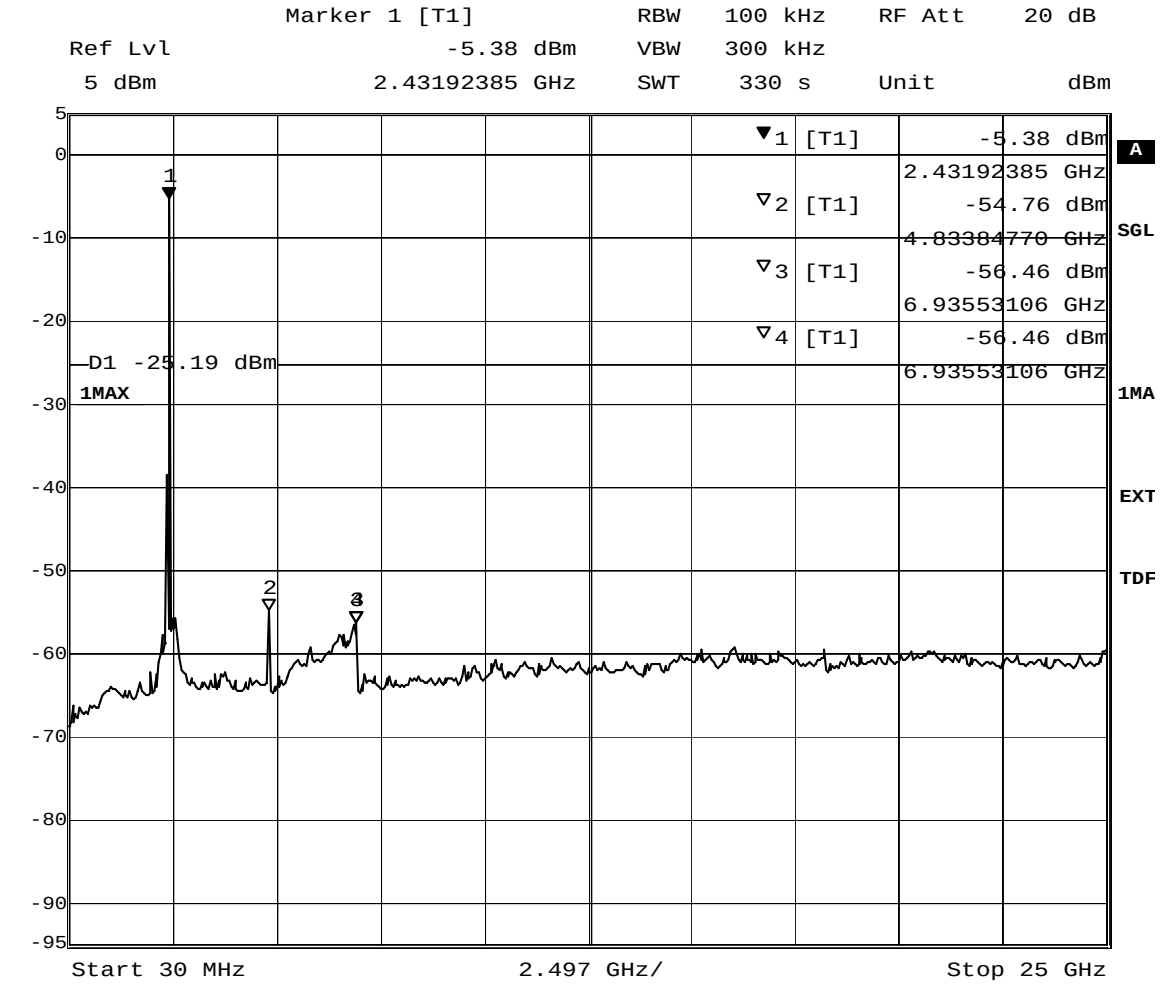
Op. Mode

op-mode 2b



Title: Band Edge Compliance
Comment A: CH M: 2437 MHz
Date: 1.MAR.2012 20:12:15

(determination of reference value for spurious emissions measurement)

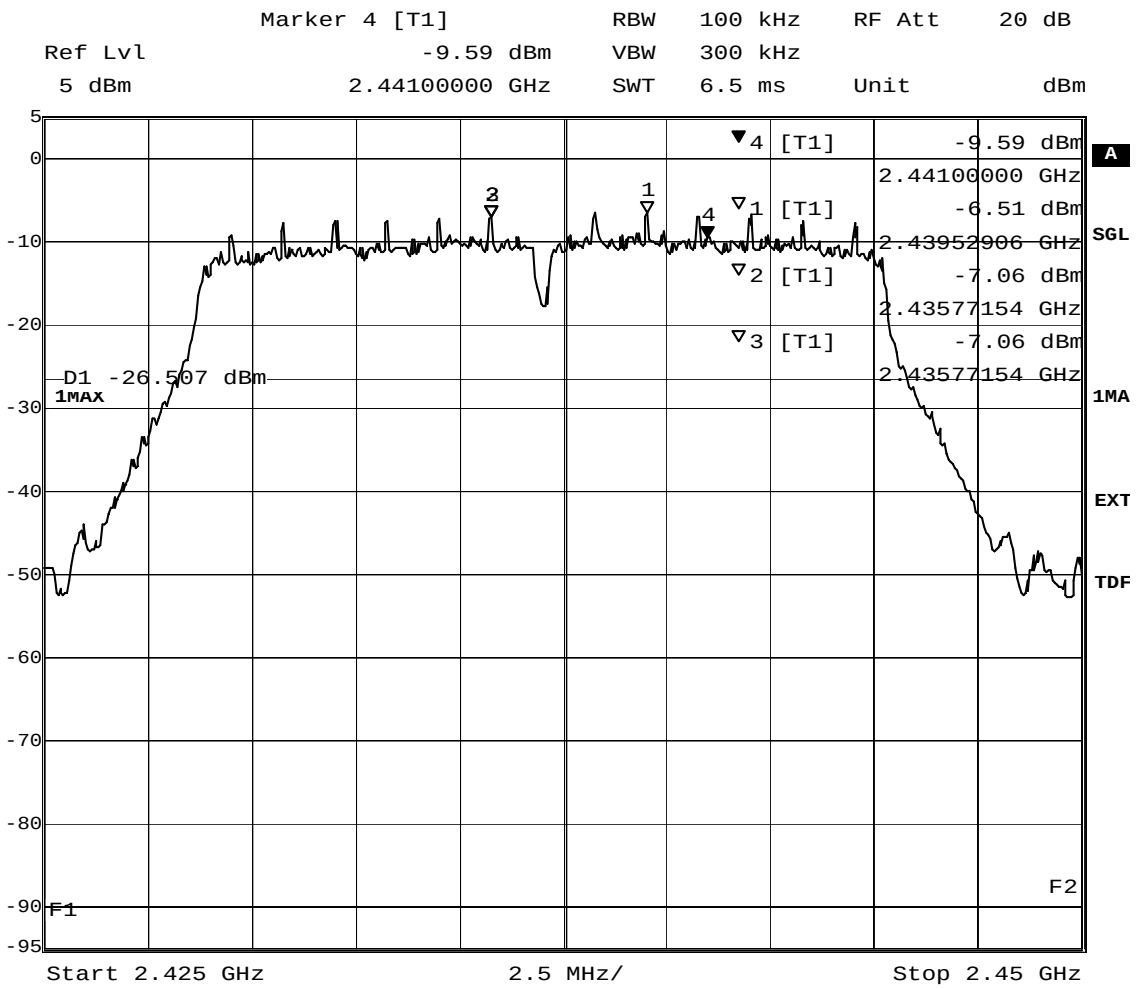


Title: spurious emissions
Comment A: CH M: 2437 MHz
Date: 1.MAR.2012 20:23:54

8.3.8 Spurious RF conducted emissions operating mode 2g

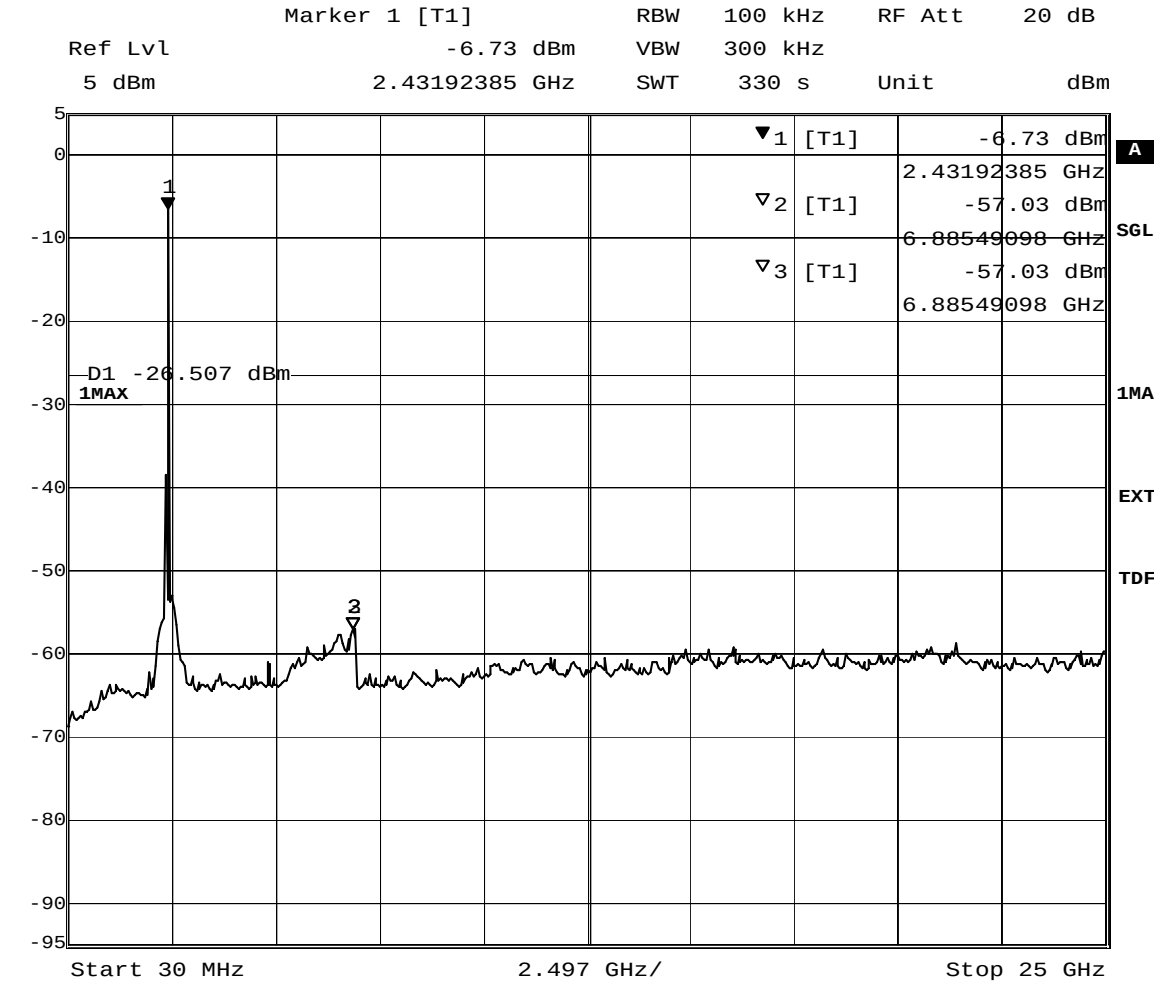
Op. Mode

op-mode 2g



Title: Band Edge Compliance
Comment A: CH M: 2437 MHz
Date: 1.MAR.2012 21:54:45

(determination of reference value for spurious emissions measurement)

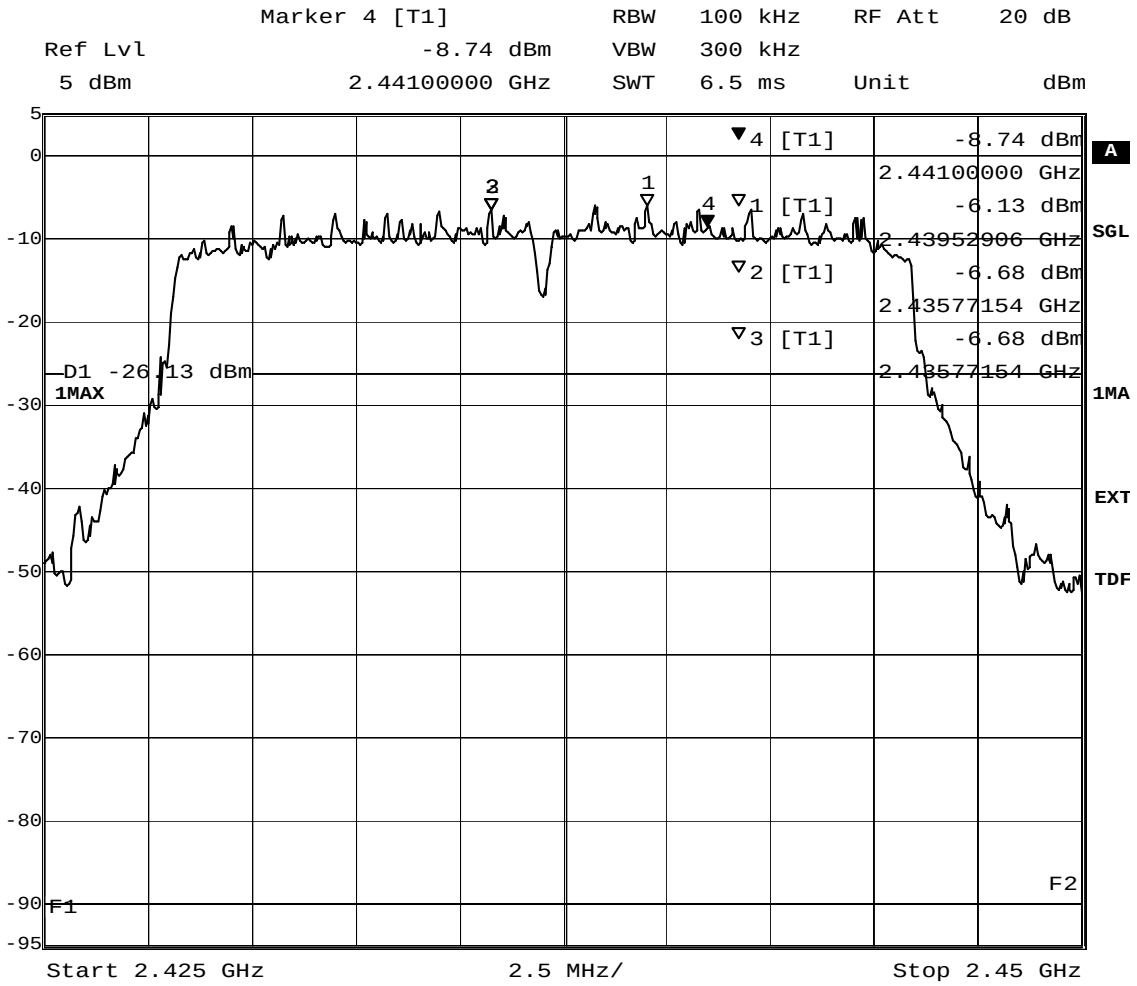


Title: spurious emissions
Comment A: CH M: 2437 MHz
Date: 1.MAR.2012 22:06:23

8.3.9 Spurious RF conducted emission operating mode 2n

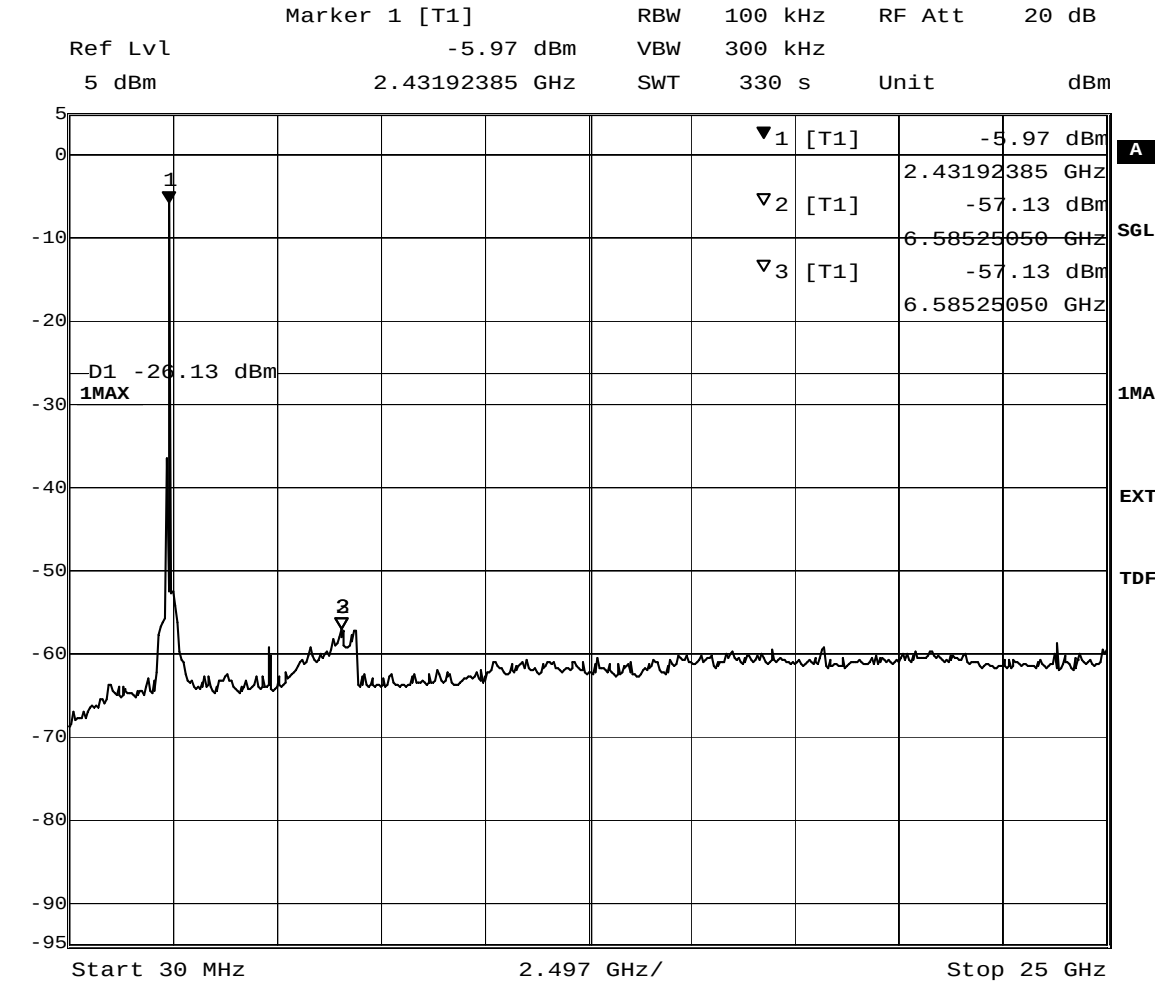
Op. Mode

op-mode 2n



Title: Band Edge Compliance
Comment A: CH M: 2437 MHz
Date: 1.MAR.2012 23:38:52

(determination of reference value for spurious emissions measurement)

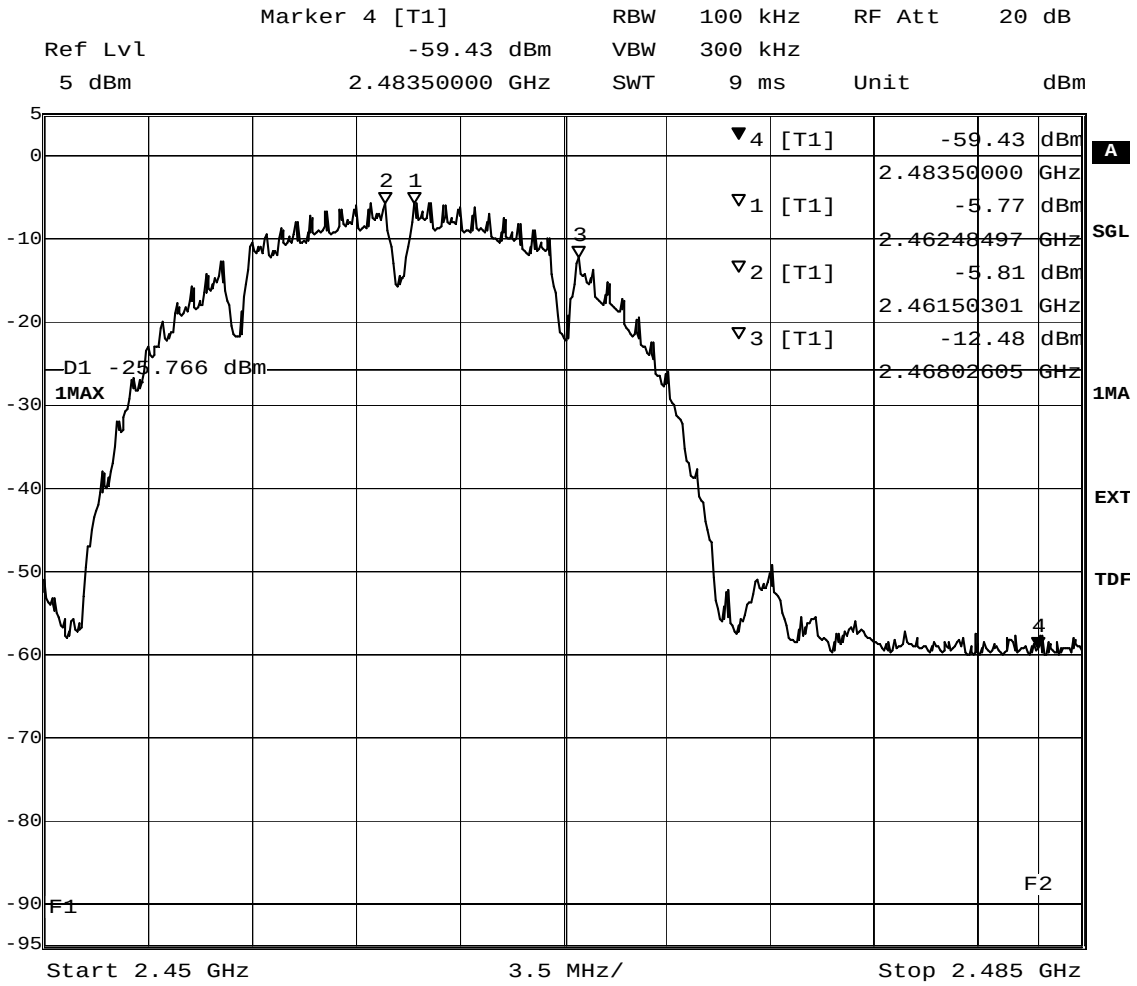


Title: spurious emissions
Comment A: CH M: 2437 MHz
Date: 1.MAR.2012 23:50:30

8.3.10 Band edge compliance conducted operating mode 3b

Op. Mode

op-mode 3b

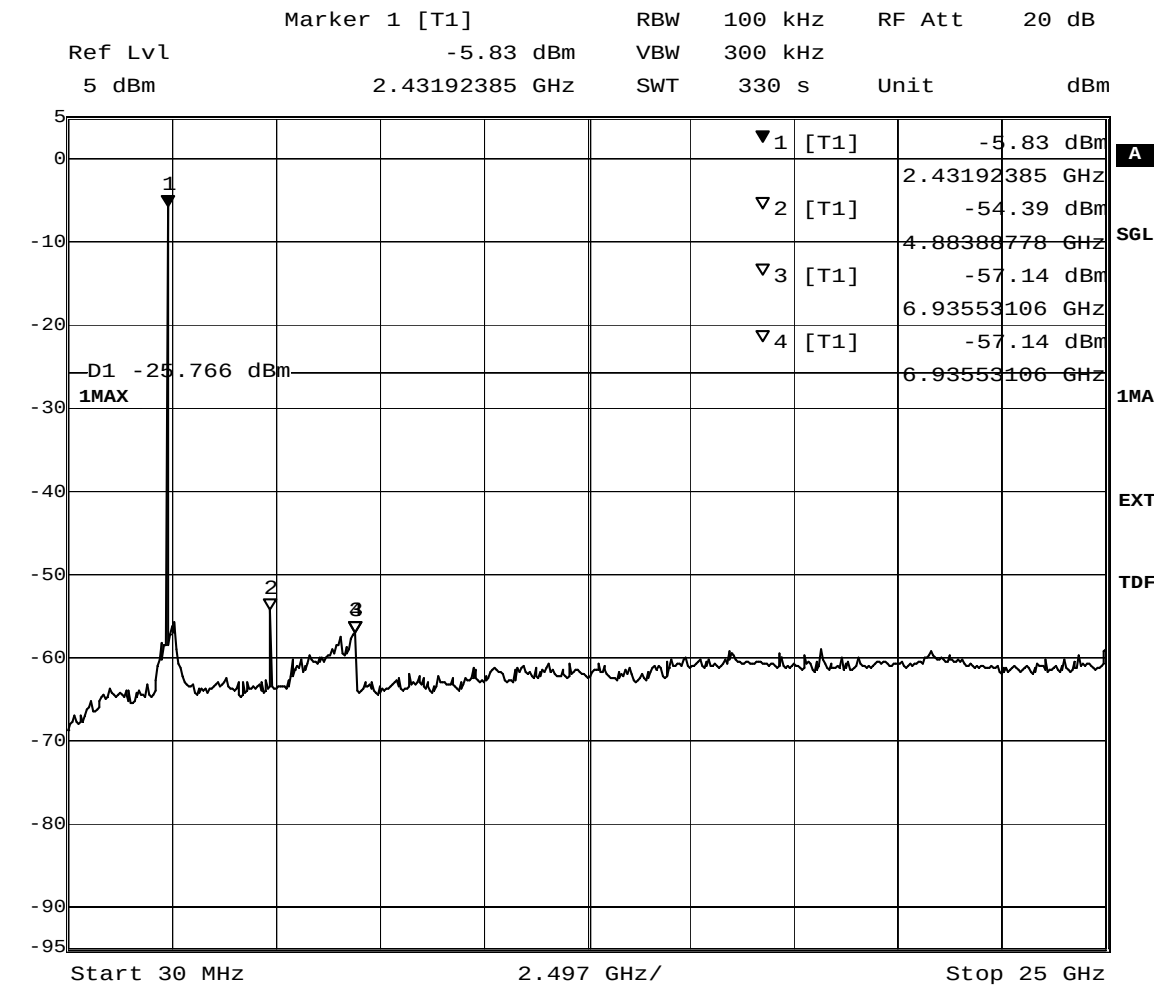


Title: Band Edge Compliance
Comment A: CH T: 2462 MHz
Date: 1.MAR.2012 20:46:26

8.3.11 Spurious RF conducted emission operating mode 3b

Op. Mode

op-mode 3b

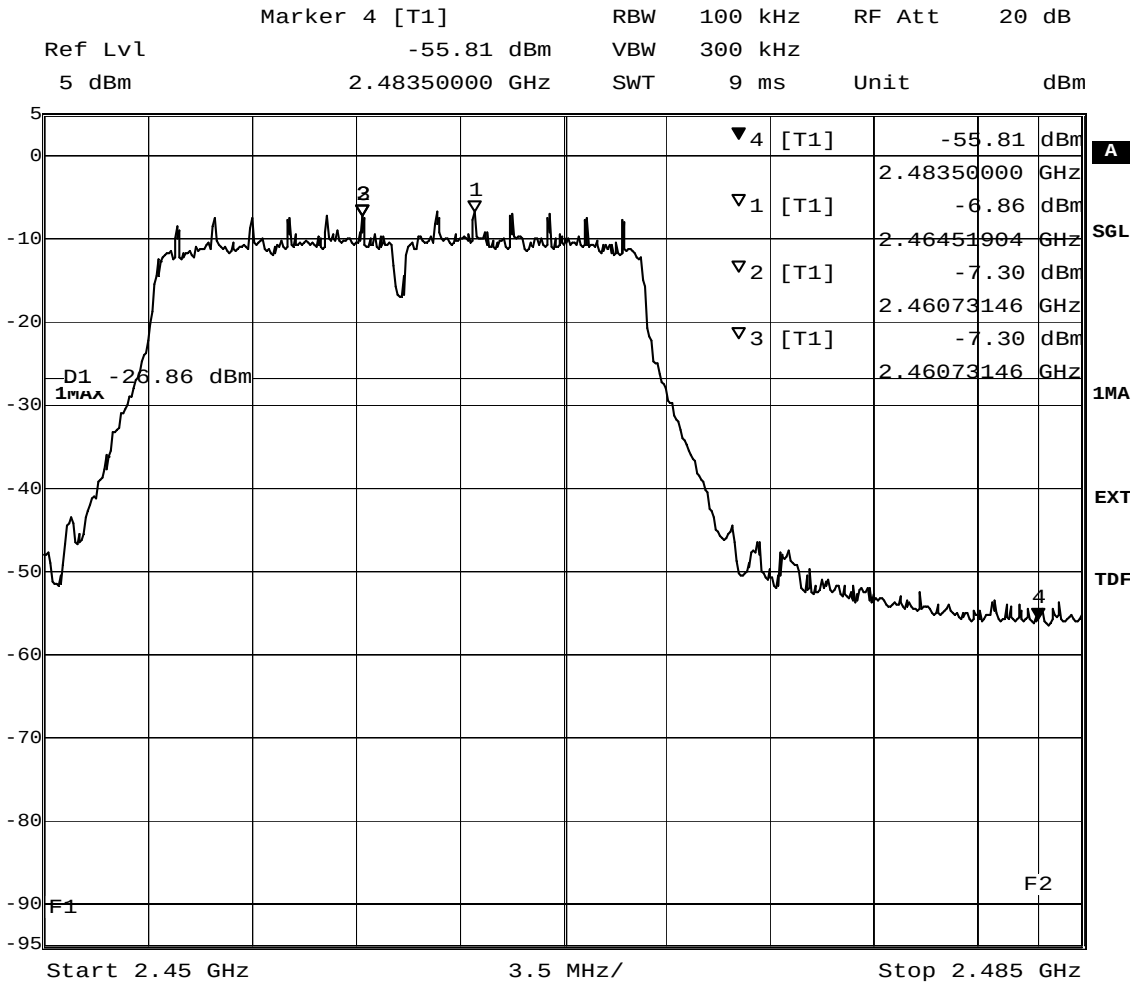


Title: spurious emissions
Comment A: CH T: 2462 MHz
Date: 1.MAR.2012 20:58:04

8.3.12 Band edge compliance conducted operating mode 3g

Op. Mode

op-mode 3g

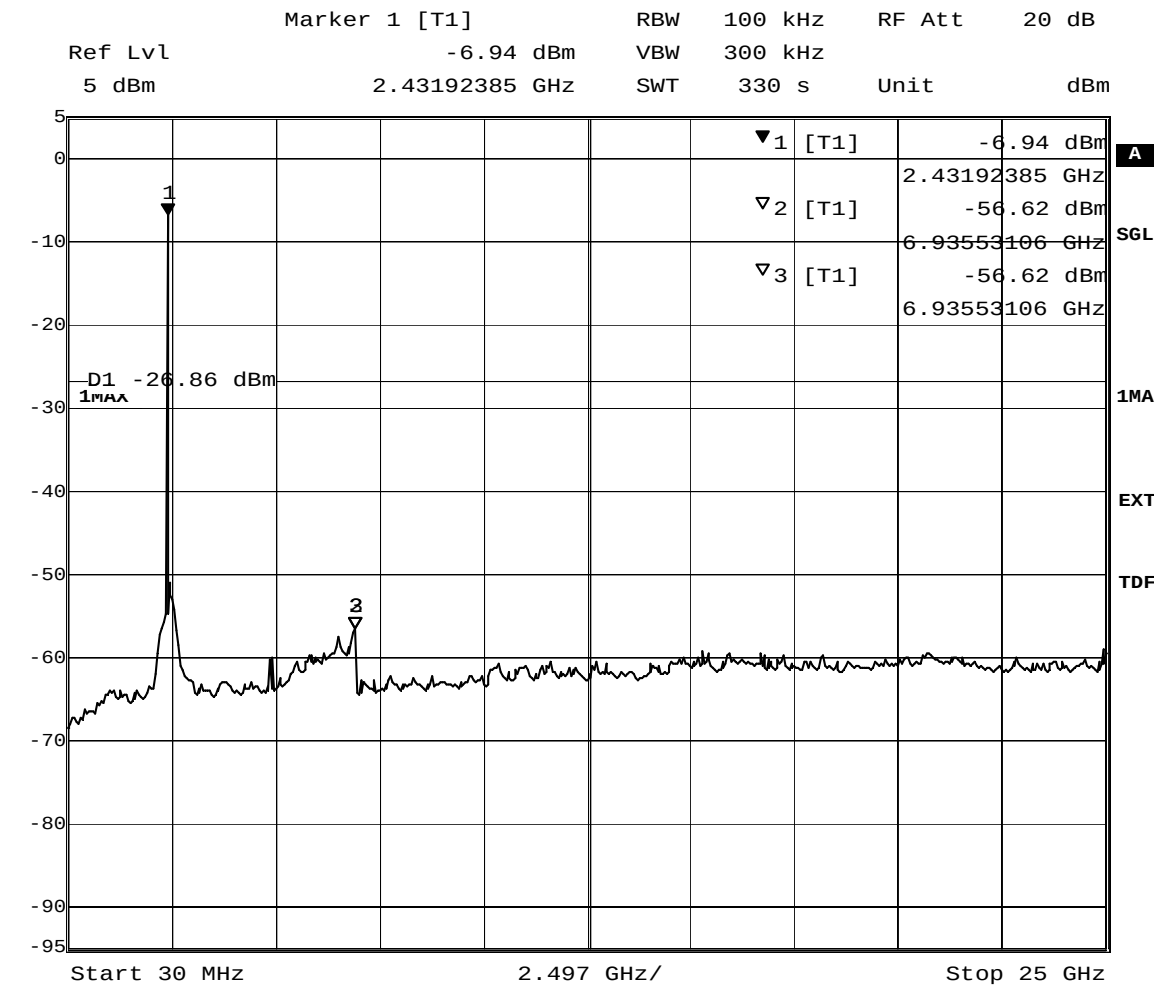


Title: Band Edge Compliance
Comment A: CH T: 2462 MHz
Date: 1.MAR.2012 22:30:15

8.3.13 Spurious RF conducted emission operating mode 3g

Op. Mode

op-mode 3g

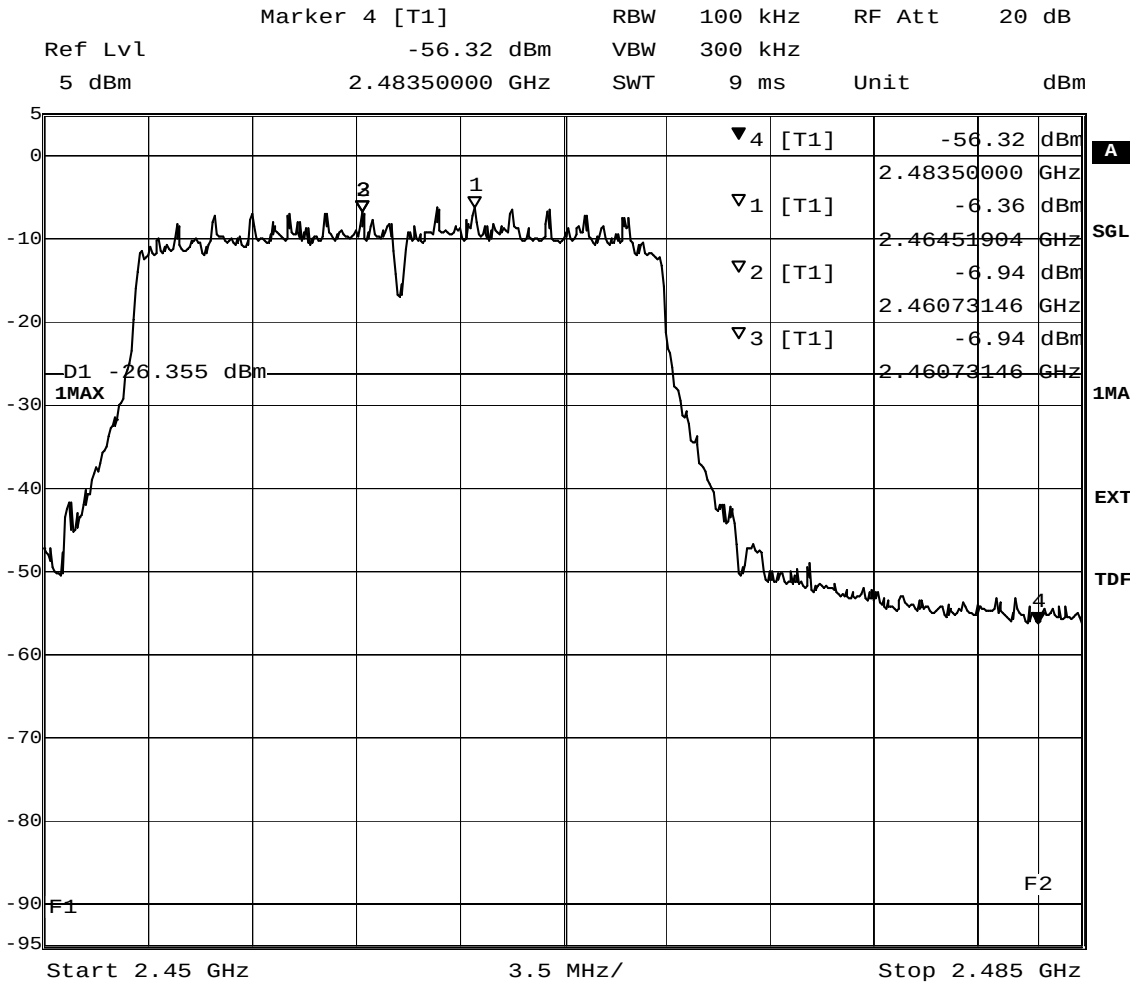


Title: spurious emissions
Comment A: CH T: 2462 MHz
Date: 1.MAR.2012 22:41:53

8.3.14 Band edge compliance conducted operating mode 3n

Op. Mode

op-mode 3n

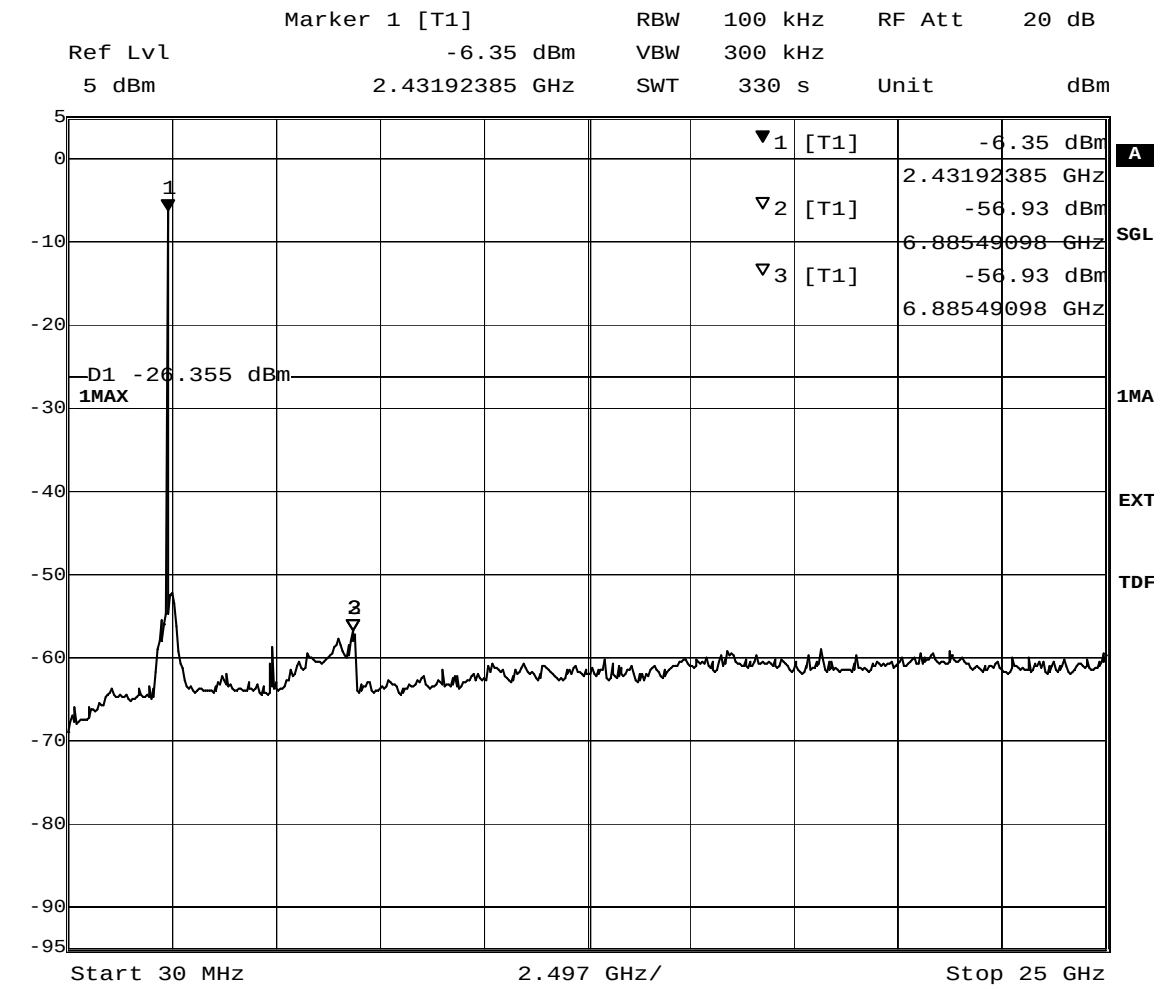


Title: Band Edge Compliance
Comment A: CH T: 2462 MHz
Date: 2.MAR.2012 00:11:28

8.3.15 Spurious RF conducted emission operating mode 3n

Op. Mode

op-mode 3n

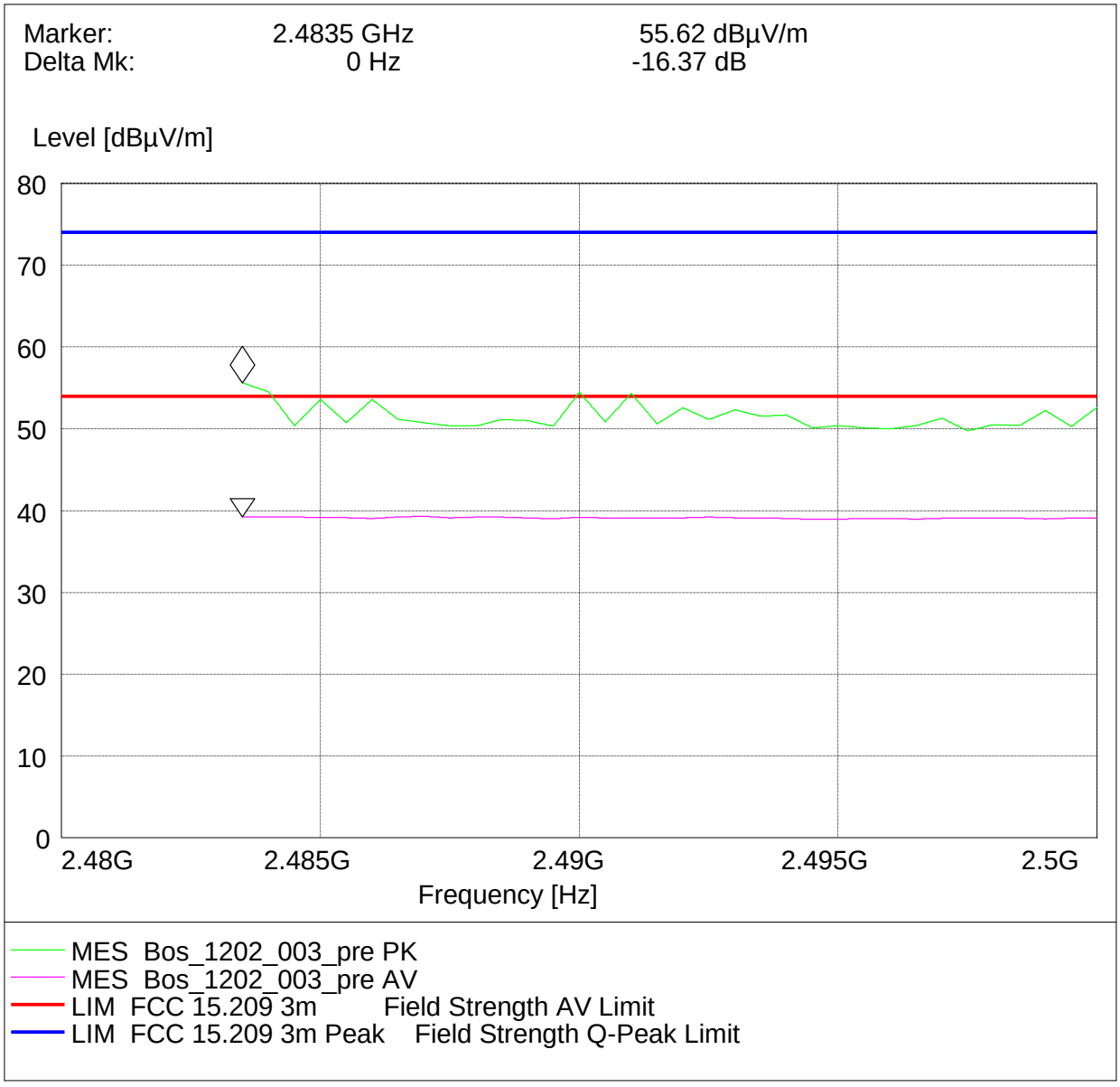


Title: spurious emissions
Comment A: CH T: 2462 MHz
Date: 2.MAR.2012 00:23:06

8.3.16 Band edge compliance radiated operating mode 3

Op. Mode higher band edge

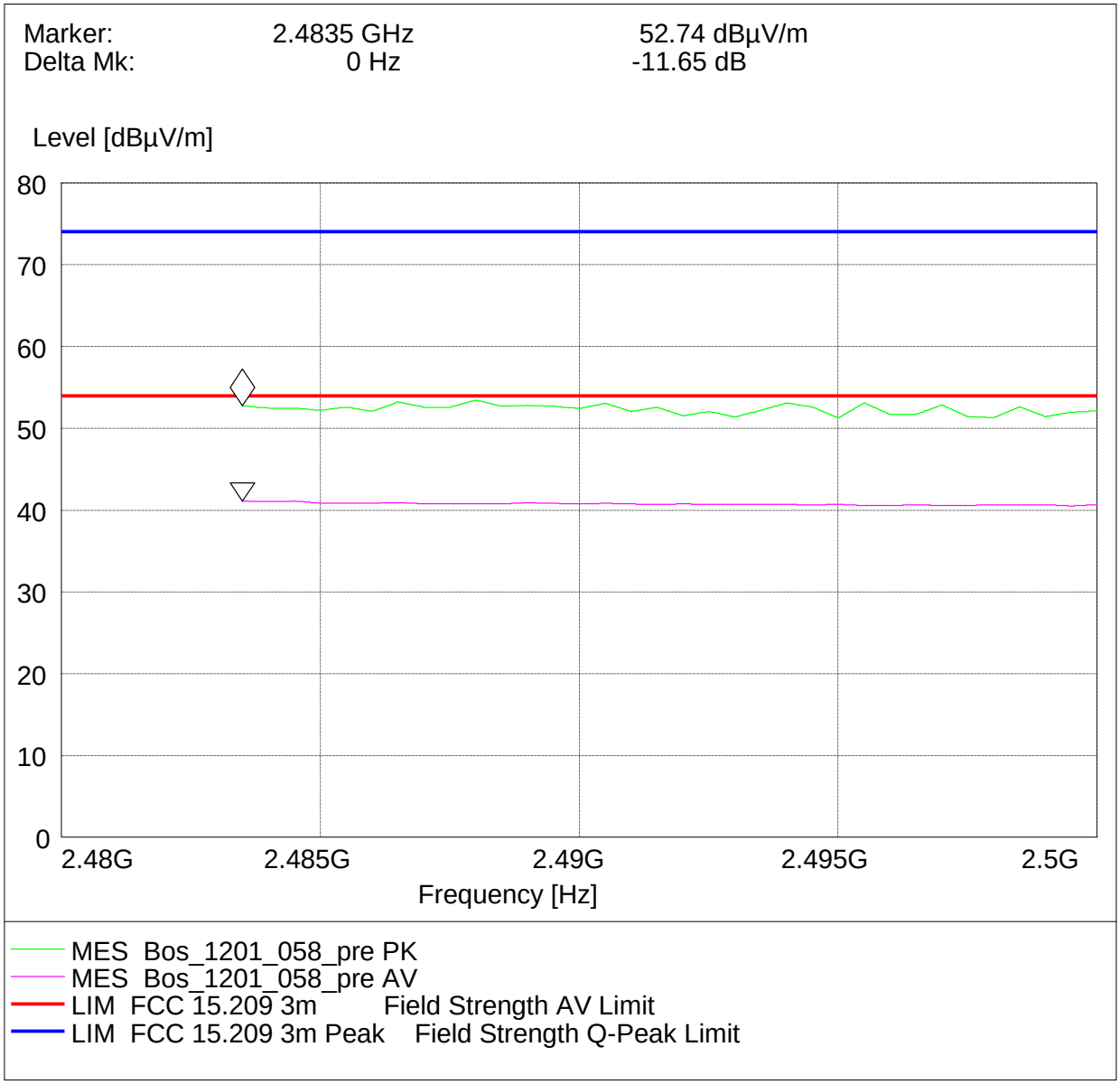
op-mode 3b



Radiated measurement (higher band edge)

Op. Mode higher band edge

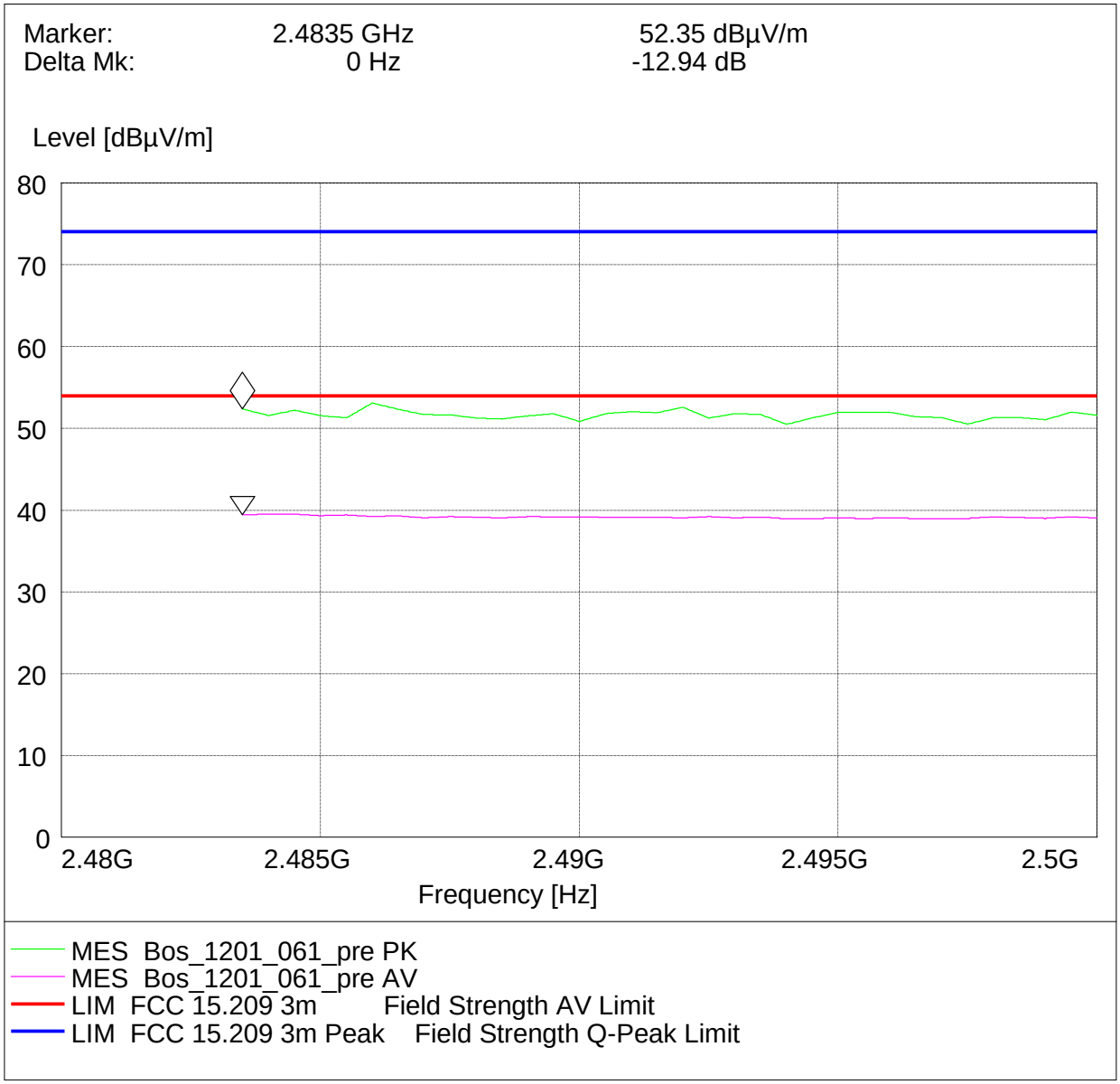
op-mode 3g



Radiated measurement (higher band edge)

Op. Mode higher band edge

op-mode 3n

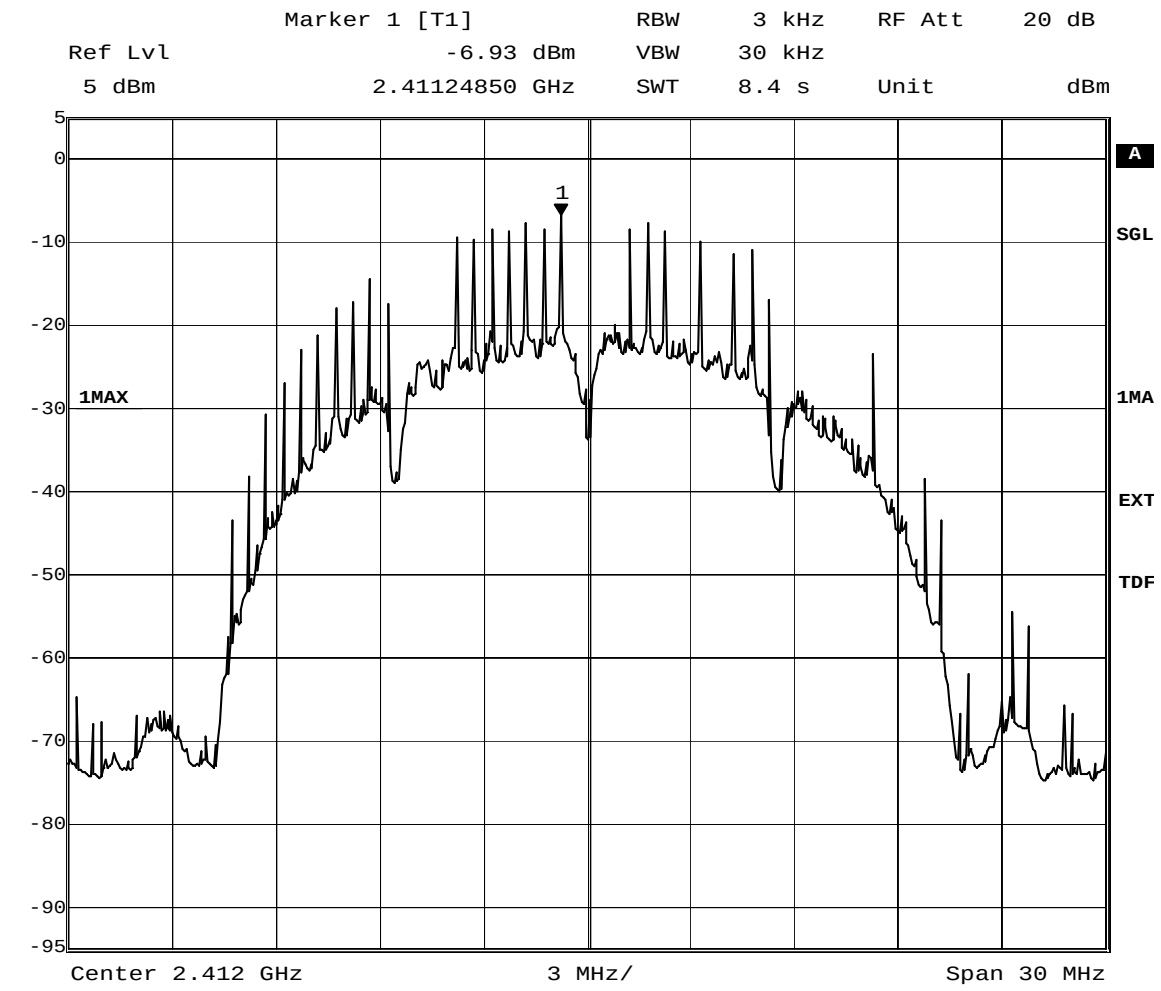


Radiated measurement (higher band edge)

8.4 Power density

Op. Mode

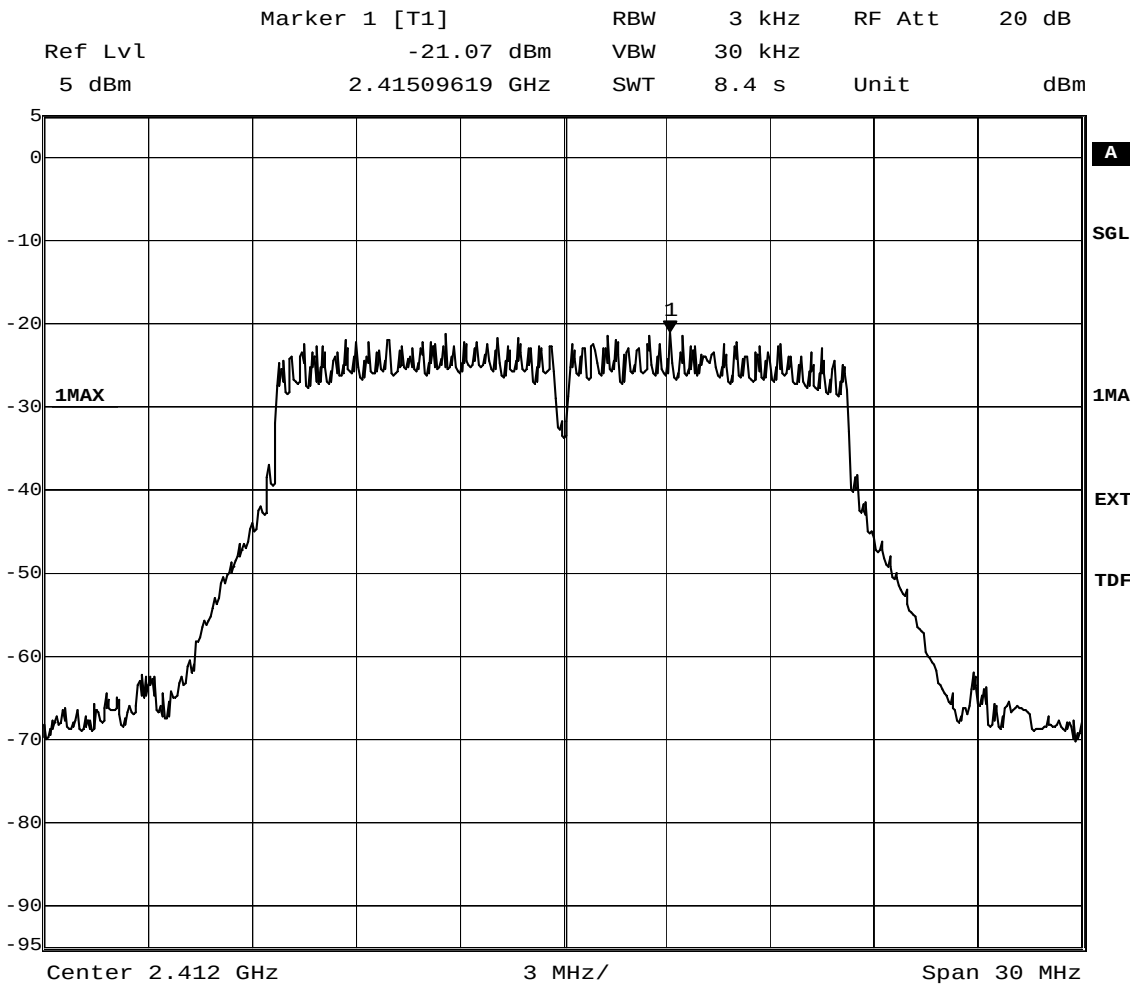
op-mode 1b



Title: Power Density
Comment A: CH B: 2412 MHz;
Date: 1.MAR.2012 20:04:41

Op. Mode

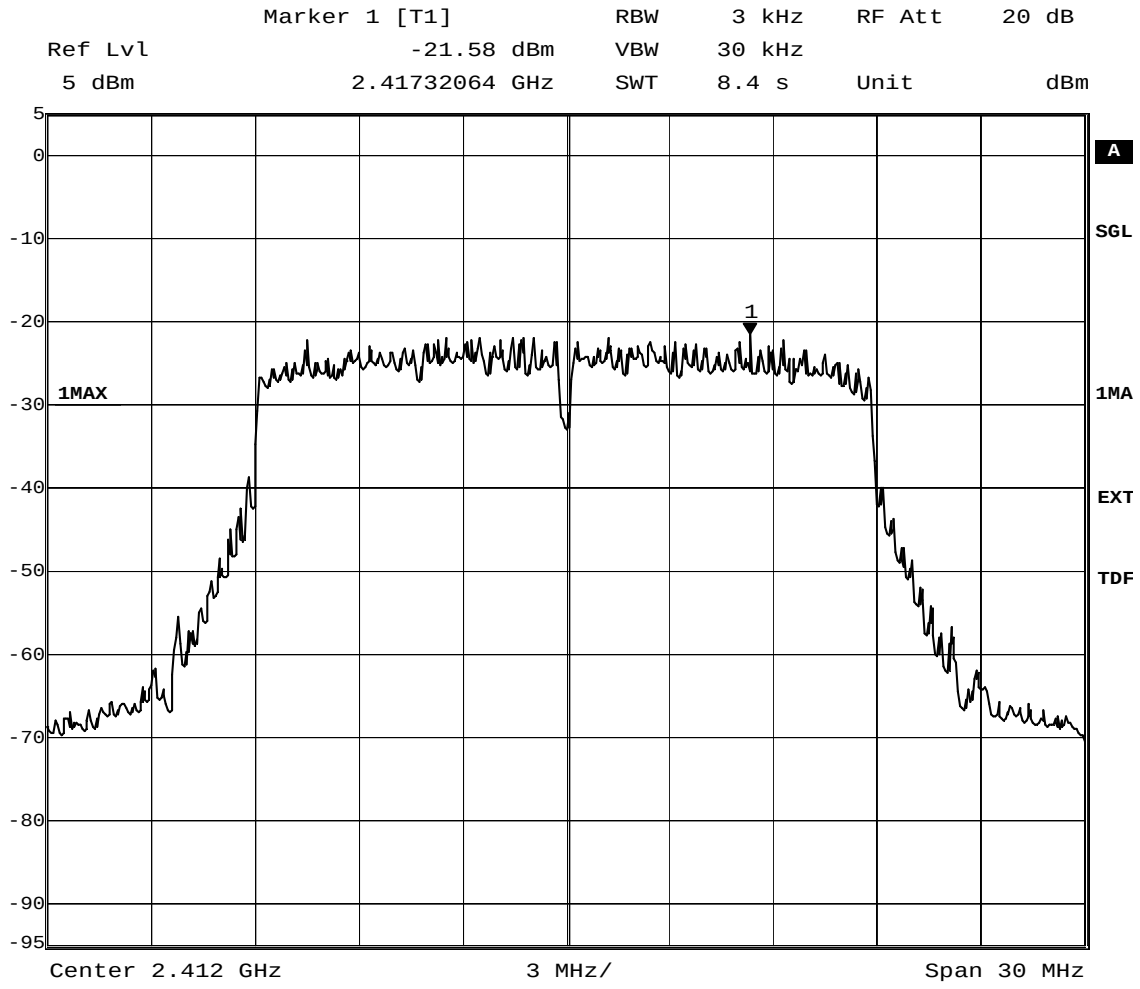
op-mode 1g



Title: Power Density
Comment A: CH B: 2412 MHz;
Date: 1.MAR.2012 21:48:35

Op. Mode

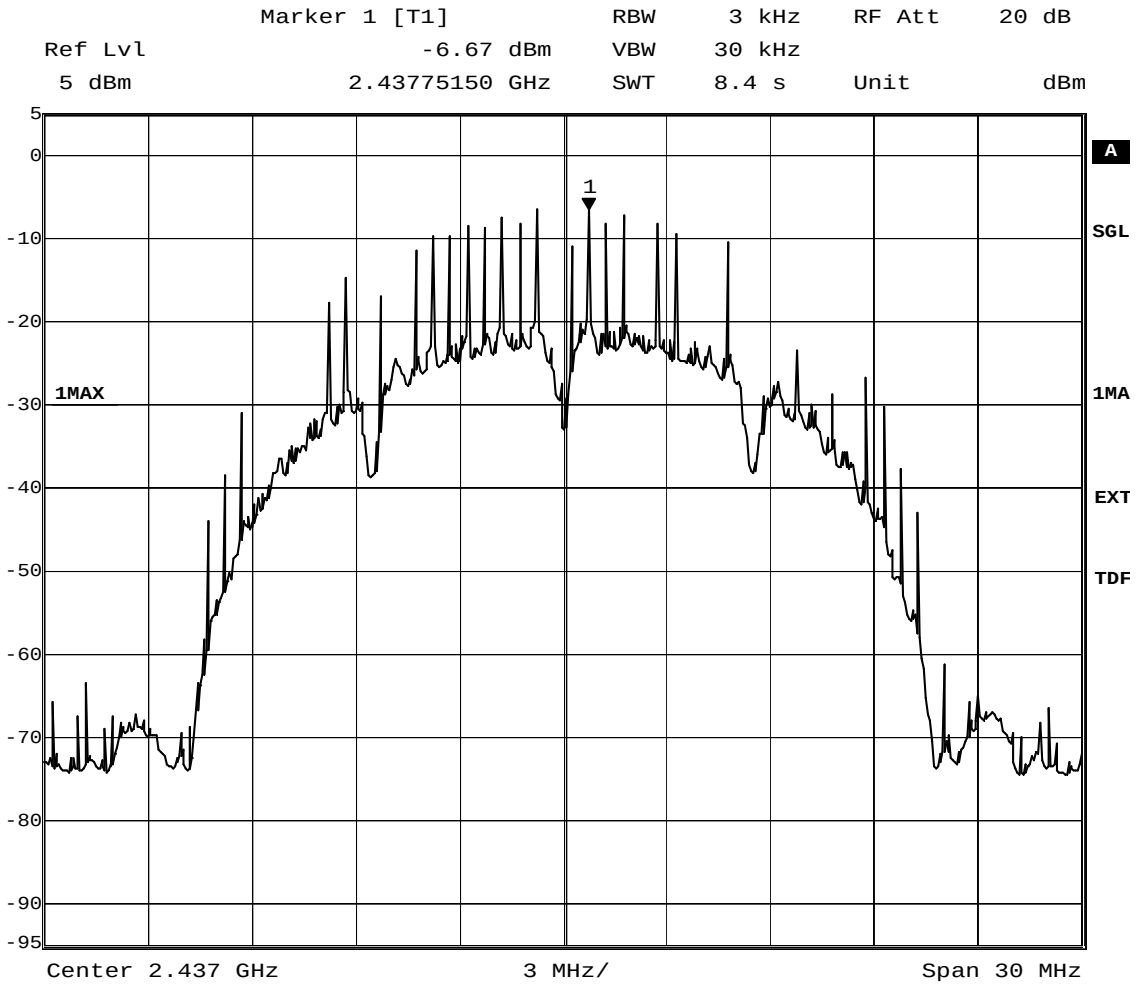
op-mode 1n



Title: Power Density
Comment A: CH B: 2412 MHz;
Date: 1.MAR.2012 23:34:28

Op. Mode

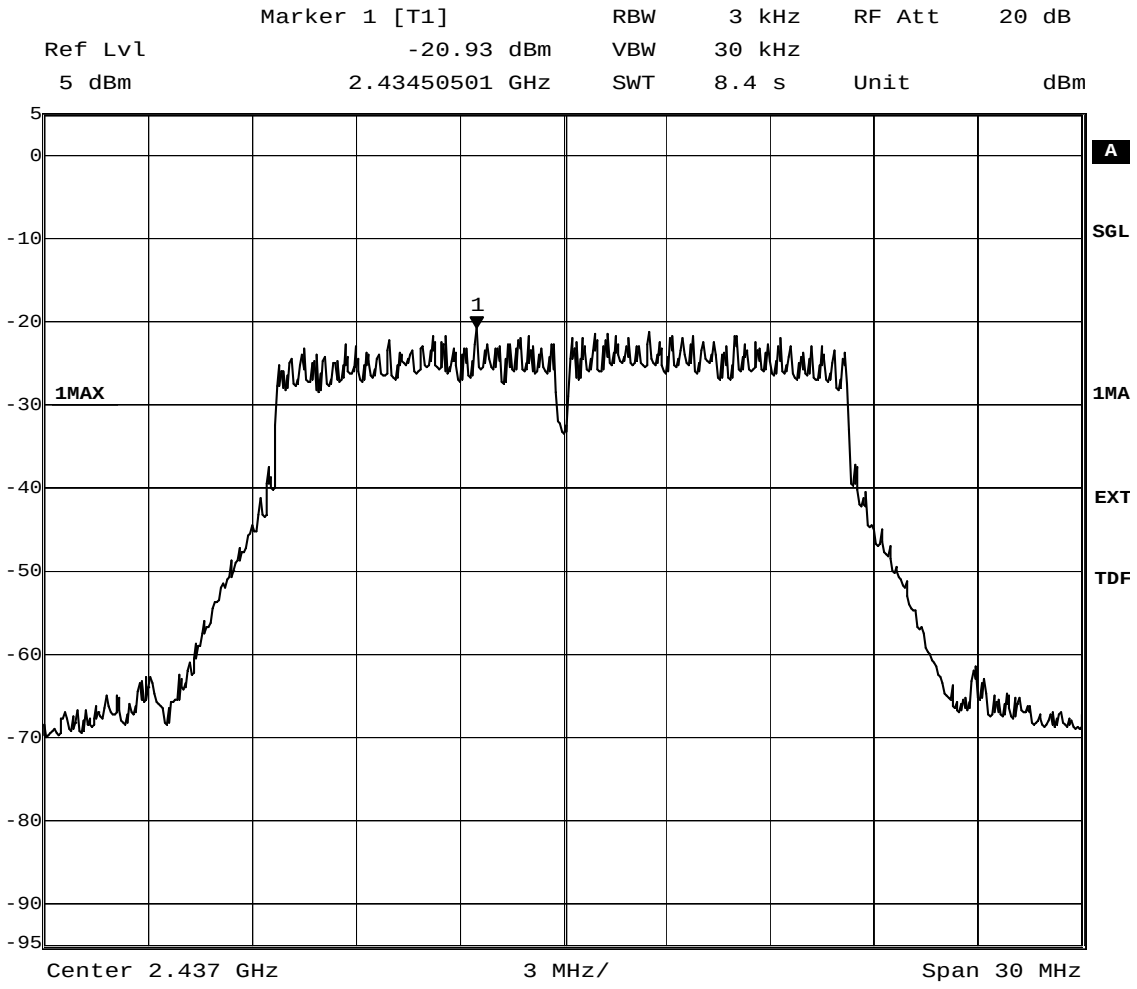
op-mode 2b



Title: Power Density
Comment A: CH M: 2437 MHz;
Date: 1.MAR.2012 20:41:05

Op. Mode

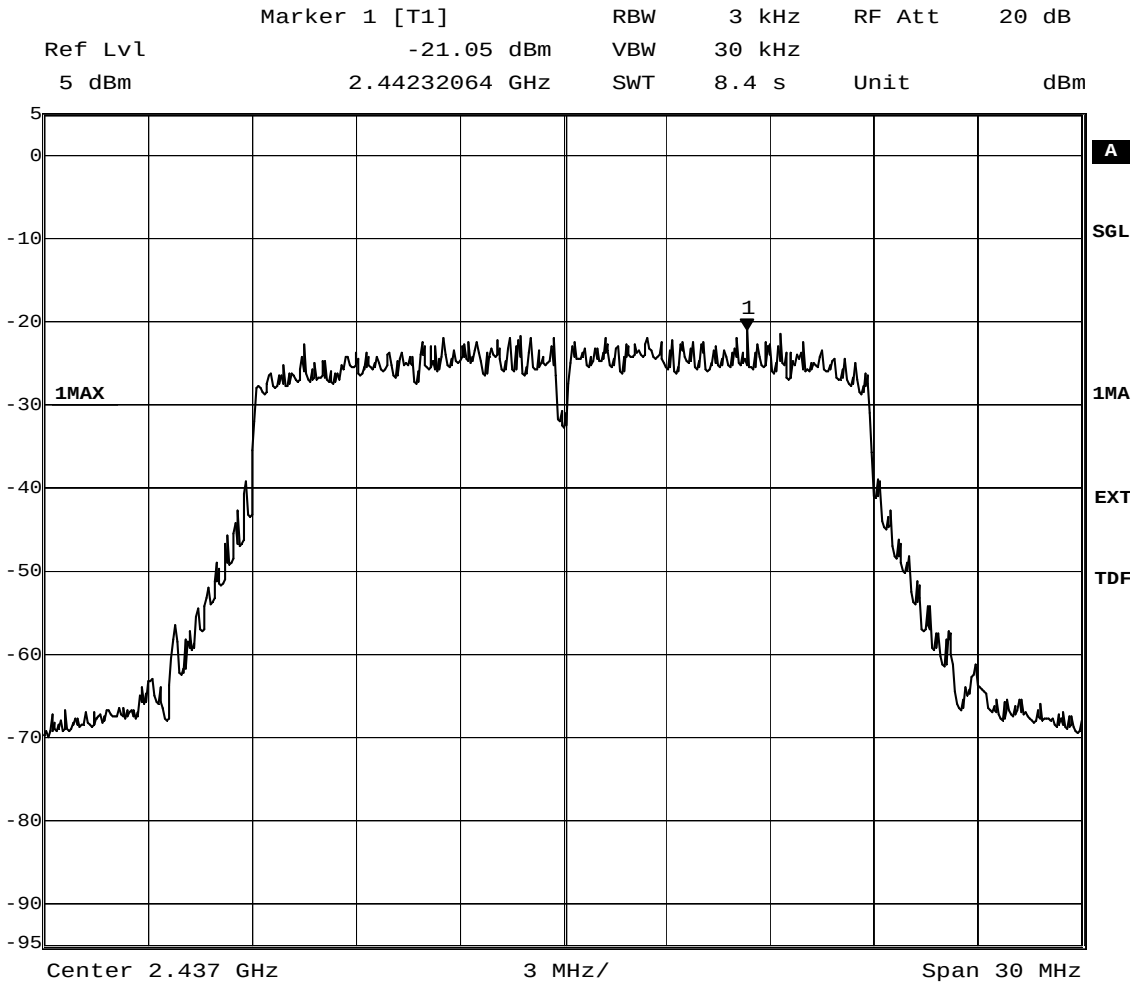
op-mode 2g



Title: Power Density
Comment A: CH M: 2437 MHz;
Date: 1.MAR.2012 22:23:00

Op. Mode

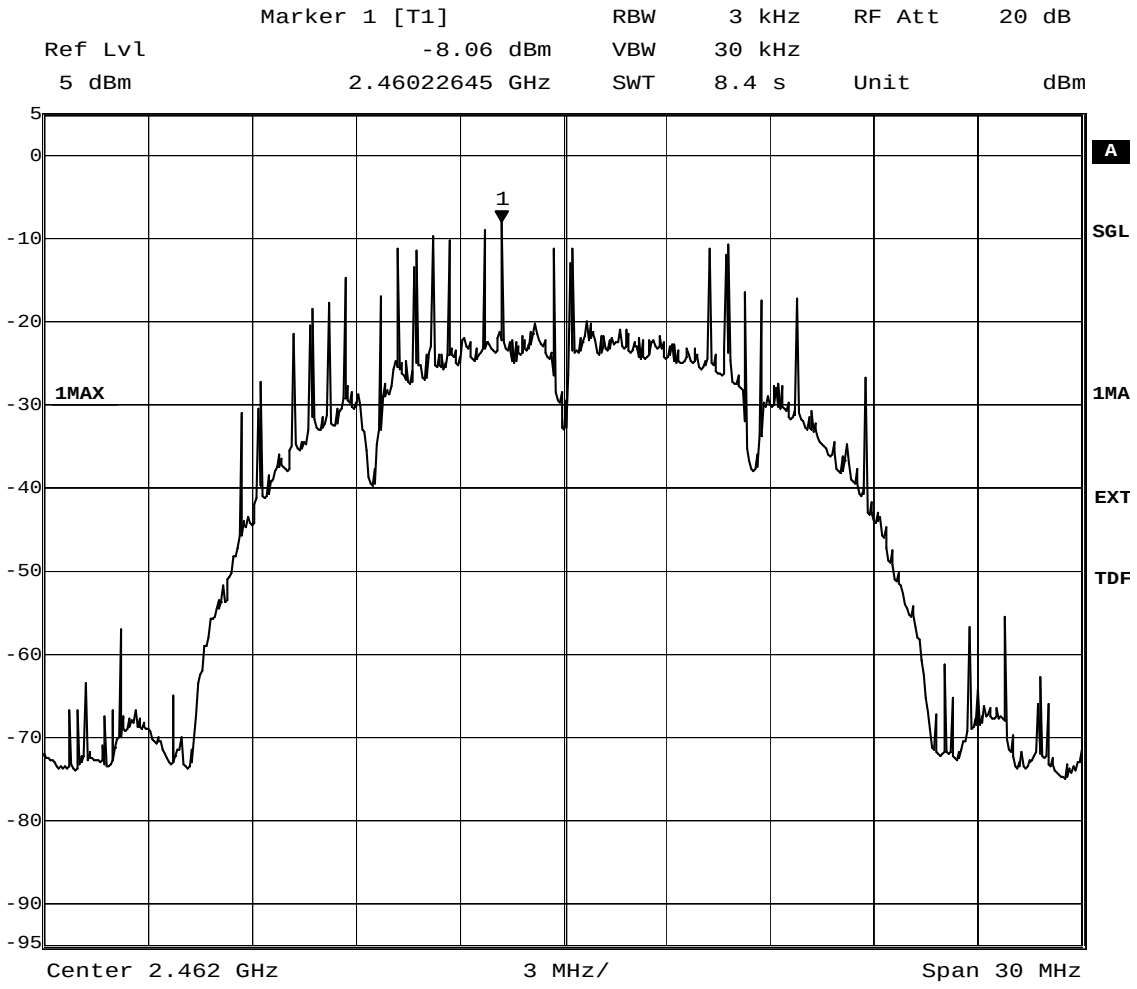
op-mode 2n



Title: Power Density
Comment A: CH M: 2437 MHz;
Date: 2.MAR.2012 00:07:01

Op. Mode

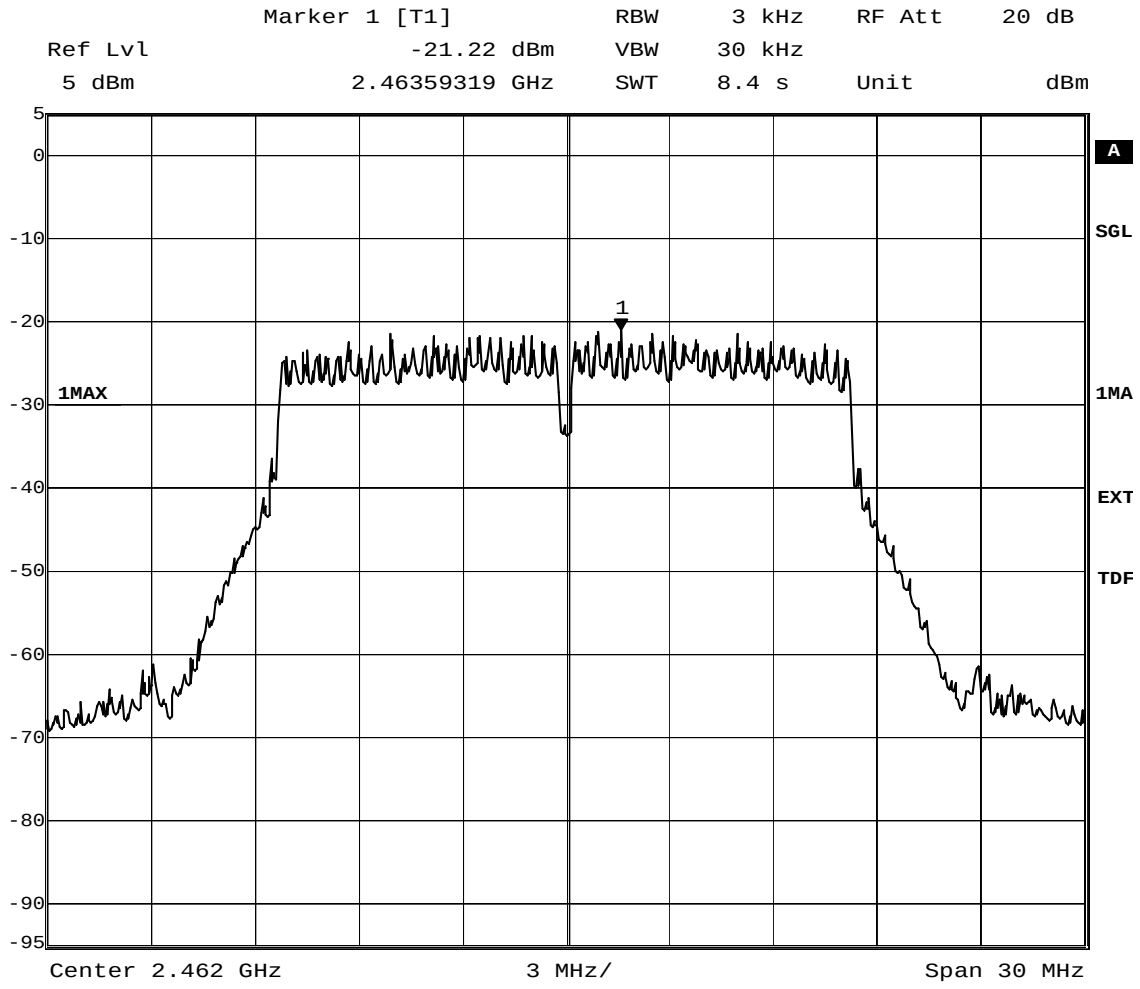
op-mode 3b



Title: Power Density
Comment A: CH T: 2462 MHz;
Date: 1.MAR.2012 21:15:15

Op. Mode

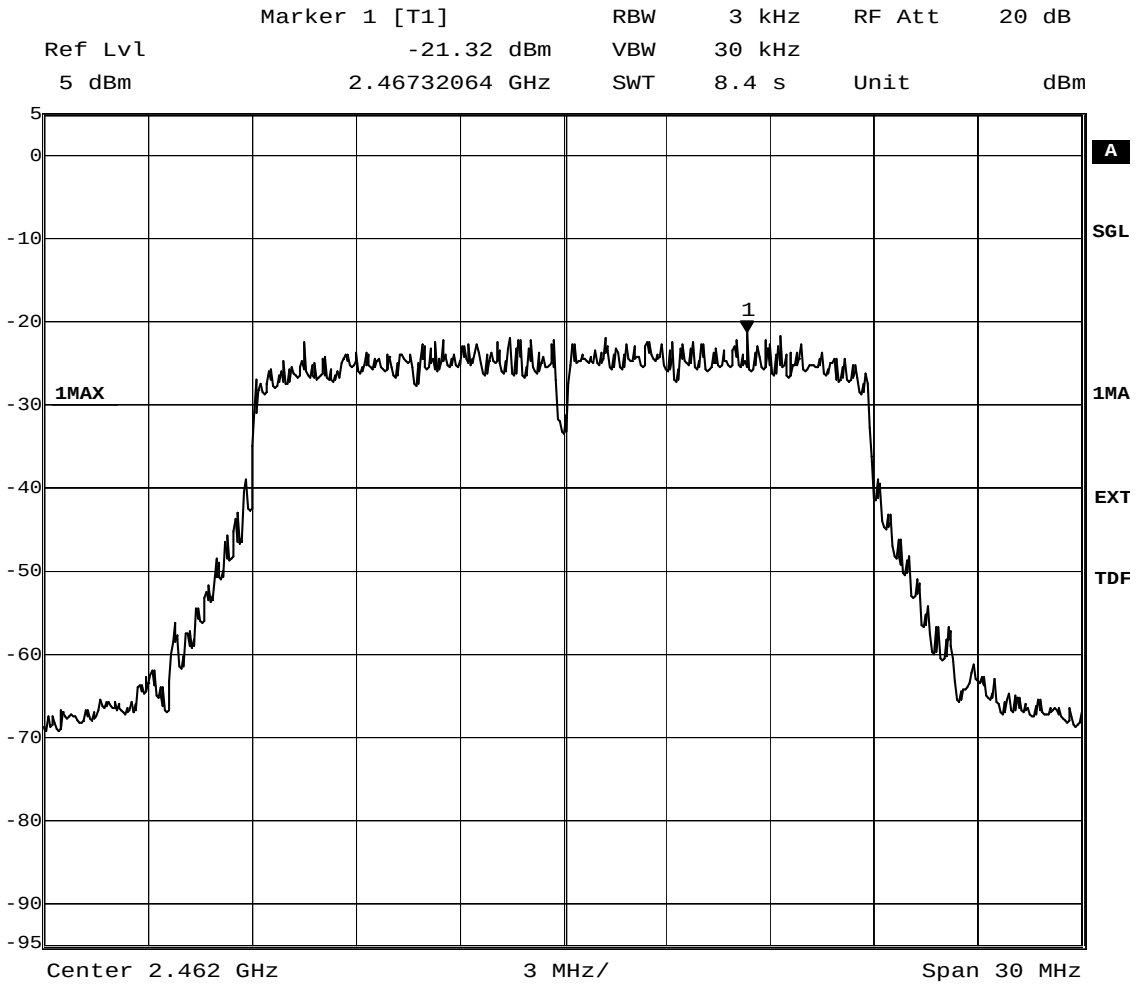
op-mode 3g



Title: Power Density
Comment A: CH T: 2462 MHz;
Date: 1.MAR.2012 22:58:30

Op. Mode

op-mode 3n



Title: Power Density
Comment A: CH T: 2462 MHz;
Date: 2.MAR.2012 00:39:35