InterLab®

FCC Measurement/Technical Report on

WLAN transceiver build in Intrinsically Safe PDA i.roc® Ci70

Report Reference: MDE_ECOM_1202_FCCh

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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 (09-10-12 Edition) and 15 (09-10-12 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

Applicable KDBs

KDB 558074 (April 9, 2013)

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 1b	Setup_03	AC Port (power line)	passed

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 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

This test report replaces the 7 Layers test report with the reference MDE_ECOM_1203_FCCf.

Responsible for Accreditation Scope:

Digitally signed by Andreas Petz
DN: cn=Andreas Petz, sn=Petz, givenName=Andreas, o=7Layers AG, serialNumber=001000000012029180001, email=andreas.petz@7layers.de
Reason: I am approving this document
Date: 2013.08.01 17:07:05 +02'00'

Responsible for Test Report:

Digitally signed by Marco Kullik
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Reason: I am the author of this document
Date: 2013.08.01 15:08:43 +02'00'

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. Marco Kullik
Date of Test(s):	2012-12-23 to 2013-03-07
Date of Report:	2013-07-29

1.3 Applicant Data

Company Name:	ECOM Instruments GmbH
Address:	Industriestraße 2 97959 Assamstadt Germany
Contact Person:	Mr. H. Fiederlein

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
Type Designation:	Ci70
Kind of Device:	Intrinsically Safe PDA i.roc®
(optional)	
Voltage Type:	DC (internal battery)
Voltage Level:	3.7 V
Tested Modulation Type:	OFDM, BPSK

General product description:

The EUT is a WLAN transceiver, part of the Intrinsically Safe i.roc® Ci70 –Ex. It is a handheld PDA, which contains the wireless technologies WLAN 2.4 GHz with **b**,**g** and **n** modes, WLAN 5 GHz with **a** and **n** modes and Bluetooth. The EUT can be additionally equipped with different RFID modules in combinations with laser scanner.

Specific product description for the EUT:

The WLAN (Wireless Local Area Network) Transceiver is operating in the 2.4 GHz band in the range 2400 – 2483.5 MHz and uses the Direct Sequence Spread Spectrum (DSSS) Modulation.
It supports the modes IEE802.11b, IEE802.11g and IEE802.11n (up to 72.2 Mbps data rate / MCS7) in the 2.4 GHz band.
The EUT cannot be charged directly via an AC/DC adapter, this is only possible via an additional docking station.

The EUT provides the following ports:

Ports
Temporary antenna connector
Enclosure
System Port (incl. DC power)
AC-Mains Port (AE 1)

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: 4E000a01)	Intrinsically Safe PDA (numeric)	Ci70	22321245032	P5.2	1.50.19.0013	–
Remark: Gain of integral antenna = 3.3 dBi						
EUT B (Code: 4E000d01)	Intrinsically Safe PDA (numeric)	Ci70	22321245055	P5.2	1.50.19.0013	–
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
AE 1 (Code: 4E000ACD)	AC/DC adapter	9004AE01	01	–	34351101811	–
AE 2 (Code: 4E000DSDnew)	Dual Dock	1002UU02	01	–	222D1100216	–

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
-	-	-	-	–	-	–

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	setup for radiated measurements
Setup_02	EUT B	setup for conducted measurements
Setup_03	EUT A + AE 1 + AE 2	setup for the test AC Mains conducted

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 54 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 54 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 54 Mbps

2.6.1 Special software used for testing

The WLAN mode of the EUT is set as local TX mode via the program "rtt-wicne" installed on the PDA. The software is provided by the applicant.

2.7 Product labelling

2.7.1 FCC ID label

Please refer to the documentation of the applicant.

2.7.2 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 Conducted emissions (AC power line)

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

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

3.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4–2009. The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50µH || 50 Ohm Line Impedance Stabilization Network (LISN) which meets the requirements of ANSI C63.4–2009, Annex B, in the frequency range of the measurements. The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into the EMI test software ES-K1 from R&S.

Step 1: Preliminary scan
Intention of this step is, to determine the conducted EMI-profile of the EUT.
EMI receiver settings:
- Detector: Peak - Maxhold
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF–Bandwidth: 9 kHz
- Measuring time / Frequency step: 20 ms
- Measurement on phase + neutral lines of the power cords

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement
Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.
EMI receiver settings:
- Detector: Quasi-Peak
- IF - Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:
1) Neutral lead - reference ground (PE grounded)
2) Phase lead - reference ground (PE grounded)
3) Neutral lead - reference ground (PE floating)
4) Phase lead - reference ground (PE floating)

The highest value is reported.

3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.207

Frequency Range (MHz)	QP Limit (dBµV)	AV Limit (dBµV)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

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

3.1.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1012 hPa
Humidity: 37 %

Op. Mode	Setup	Port
op-mode 1b	Setup_01	AC Port (power line)

Power line	Frequency MHz	Measured value QP dBµV	Measured value AV dBµV	QP Limit dBµV	AV Limit dBµV	Margin QP dB	Margin AV dB
N	–	–	–	–	–	–	–
L	–	–	–	–	–	–	–

Remark: No final measurement was performed because no frequencies (peaks) were found within the offset for acceptance analysis during the preliminary scan. Please see annex for the measurement plot.
The chosen operating mode is selected as representative mode to generate "worst-case" conditions, i.e. high power consumption.

3.1.4 Test result: Conducted emissions (AC power line)

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

3.2 Occupied bandwidth

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 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

3.2.2 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)

3.2.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1018 hPa
Humidity: 37 %

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

6 dB bandwidth MHz	Remarks
9.144	–

Remark: -

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

6 dB bandwidth MHz	Remarks
15.696	–

Remark: -

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

6 dB bandwidth MHz	Remarks
15.636	–

Remark: -

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

6 dB bandwidth MHz	Remarks
9.144	–

Remark: -

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

6 dB bandwidth MHz	Remarks
15.756	–

Remark: -

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

6 dB bandwidth MHz	Remarks
15.996	–

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
9.624	–

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
15.756	–

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
15.756	–

Remark: -

3.2.4 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

3.3 Peak power output

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 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.

3.3.2 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

3.3.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1018 hPa
Humidity: 37 %

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

Output power dBm	Remarks
23.7	The EIRP including antenna gain (3.3 dBi) is 27.0 dBm. Detector PEAK.

Remark: -

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

Output power dBm	Remarks
26.8	The EIRP including antenna gain (3.3 dBi) is 30.1 dBm. Detector PEAK.

Remark: -

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

Output power dBm	Remarks
26.8	The EIRP including antenna gain (3.3 dBi) is 30.1 dBm. Detector PEAK.

Remark: -

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

Output power dBm	Remarks
24.2	The EIRP including antenna gain (3.3 dBi) is 27.5 dBm. Detector PEAK.

Remark: -

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

Output power dBm	Remarks
27.1	The EIRP including antenna gain (3.3 dBi) is 30.4 dBm. Detector PEAK.

Remark: -

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

Output power dBm	Remarks
27.0	The EIRP including antenna gain (3.3 dBi) is 30.3 dBm. Detector PEAK.

Remark: -

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

Output power dBm	Remarks
24.4	The EIRP including antenna gain (3.3 dBi) is 27.7 dBm. Detector PEAK.

Remark: Please see annex for the measurement plot.

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

Output power dBm	Remarks
27.3	The EIRP including antenna gain (3.3 dBi) is 30.6 dBm. Detector PEAK..

Remark: Please see annex for the measurement plot.

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

Output power dBm	Remarks
27.3	The EIRP including antenna gain (3.3 dBi) is 30.6 dBm. Detector PEAK.

Remark: Please see annex for the measurement plot.

3.3.4 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

3.4 Spurious RF conducted emissions

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

The test was performed according to: FCC §15.31

3.4.1 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 3.6). This value is used to calculate the 20 dBc limit.

3.4.2 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.

3.4.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1018 hPa
Humidity: 37 %

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.

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.

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.

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.

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.

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.

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.

3.4.4 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

3.5 Spurious radiated emissions

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

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

3.5.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4 in a typical installation configuration.
The measurement procedure is implemented into the EMI test software ES-K1 from R&S. 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 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 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: -0.25 m to + 0.25 m 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.

3.5.2 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)+59.1dB
0.49 – 1.705	24000/F(kHz)	30	Limit (dBµV/m)+19.1dB
1.705 – 30	30	30	Limit (dBµV/m)+19.1dB

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)

3.5.3 Test Protocol

Temperature: 22 – 24 °C
Air Pressure: 1005 – 1027hPa
Humidity: 27 – 38 %

3.5.3.1 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.

3.5.3.2 Measurement above 30 MHz

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

Polarisation	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.	2383	–	53.3	42.5	–	74.0	54.0	20.7	11.5
	2495	–	57.7	38.1	–	74.0	54.0	16.3	15.9
	2814	–	52.6	41.2	–	74.0	54.0	21.4	12.8

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

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

Polarisation	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.	–	–	–	–	–	74.0	54.0	–	–

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

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

Polarisation	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.	2489	–	52.9	42.5	–	74.0	54.0	21.1	11.6

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

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

Polarisation	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.	2387	–	59.0	42.3	–	74.0	54.0	15.0	11.7
	2494	–	54.4	38.1	–	74.0	54.0	19.6	15.9
	2814	–	51.6	41.1	–	74.0	54.0	22.4	12.9

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 8 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

Polarisation	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.	–	–	–	–	–	-	-	–	–

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 8 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

Polarisation	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	–	60.8	44.8	–	74.0	54.0	13.2	9.2

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 8 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.	2390	–	62.0	41.6	–	74.0	54.0	12.0	12.4
	2492	–	55.5	38.0	–	74.0	54.0	18.5	16.0
	2814	–	51.0	40.9	–	74.0	54.0	23.0	13.1

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 8 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.	–	–	–	–	–	-	-	–	–

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

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.	2484	–	61.5	43.7	–	74.0	54.0	12.5	10.3

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

3.5.4 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

3.6 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

3.6.1 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

3.6.2 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)".

3.6.3 Test Protocol

3.6.3.1 Lower band edge

Conducted measurement

Temperature: 23 °C
Air Pressure: 1018 hPa
Humidity: 37 %

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	-38.0	12.8	-7.2	30.8

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	-24.6	7.0	-13.0	11.6

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	-23.0	6.8	-13.2	9.8

Remark: Please see annex for the measurement plot.

3.6.3.2 Higher band edge

Conducted measurement

Temperature: 23 °C
Air Pressure: 1018 hPa
Humidity: 37 %

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	-41.8	13.2	-6.8	35.0

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	-32.6	7.6	-12.4	20.2

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	-34.0	7.2	-12.8	21.2

Remark: Please see annex for the measurement plot.

Radiated measurement

Temperature: 23 °C
Air Pressure: 1017 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.	53.0	42.5	74.0	54.0	21.0	11.5

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.	60.8	44.8	74.0	54.0	13.2	9.2

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.	61.5	43.7	74.0	54.0	12.5	10.3

Remark: Please see annex for the measurement plot.

3.6.4 Test result: Band edge compliance

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

3.7 Power density

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

The test was performed according to: FCC §15.31

3.7.1 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

3.7.2 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.

3.7.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1018 hPa
Humidity: 37 %

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

Power density dBm / 3 kHz	Remarks
1.0	–

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
-6.3	–

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
-5.7	–

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
0.4	–

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
-5.7	–

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
-4.7	–

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
1.6	–

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
-5.4	–

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
-4.9	–

Remark: Please see annex for the measurement plot.

3.7.4 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 2014/01/10 2011/02/07 2014/02/06
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 Conducted emissions

Lab ID:	**Lab 1**
Manufacturer:	Rohde & Schwarz GmbH & Co.KG
Description:	EMI Conducted Auxiliary Equipment

Single Devices for Auxiliary Equipment for Conducted emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
AC Power Source	Chroma 6404	64040001304	Chroma ATE INC.
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG
	Calibration		2013/03/01 2015/02/28
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG
	Calibration		2013/03/01 2015/02/28

The above listed Two-Line V-Networks ESH 3-Z5 were also calibrated in the time frame 2011/01/20 to 2013/03/01

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	9117-108	Schwarzbeck	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/01/18	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	
	Standard Calibration		2012/05/18	2015/05/17
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2012/06/26	2015/06/25
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	
Horn Antenna Schwarzbeck 15-26 GHz BBHA 9170	BBHA 9170			
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2012/12/14	2015/12/13
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 40 GHz	3160-10	00086675	EMCO Elektronik GmbH	

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5-10kg/024/3790709	Maturo GmbH

Test Equipment Auxiliary Test Equipment

Lab ID:	**Lab 3, Lab 4**
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
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.
	Customized calibration		2011/10/19 2013/10/18
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
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID:	**Lab 1, Lab 3, Lab 4**
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
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Initial factory calibration		2012/01/26	2014/01/25
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
			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	

Test Equipment Emission measurement devices

Lab ID:	**Lab 1, 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 Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/22 2013/05/21
Power Sensor	NRV-Z1	836219/005	Rohde & Schwarz GmbH & Co. KG
Powermeter	NRVS	836333/064	Rohde & Schwarz GmbH & Co. KG
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/21 2013/05/20
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	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 Radio Lab Test Equipment

Lab ID: **Lab 4**
Description: Radio Lab Test Equipment

Single Devices for Radio Lab Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Broadband Power Divider SMA	WA1515	A856	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	4T-10	F9401	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	56-10	W3702	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	56-10	W3711	Weinschel Associates	
Coax Cable Huber&Suhner	Sucotest 2,0m		Rosenberger Micro-Coax	
Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m	FA210A0010003030	54491-2	Rosenberger Micro-Coax	
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/22	2013/05/21
Power Sensor	NRV-Z1	836219/005	Rohde & Schwarz GmbH & Co. KG	
Powermeter	NRVS	836333/064	Rohde & Schwarz GmbH & Co. KG	
RF Step Attenuator RSP	RSP	833695/001	Rohde & Schwarz GmbH & Co.KG	
Rubidium Frequency Standard	Datum, Model: MFL	2689/001	Datum-Beverly	
	Standard calibration		2012/06/21	2013/06/20
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/21	2013/05/20
Signal Generator	SMY02	829309/018	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/11/04	2014/11/03
Signal Generator SME	SME03	827460/016	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2011/11/25	2014/11/24
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG	
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2013/02/12	2015/02/11
Temperature Chamber Vötsch 03	VT 4002	58566002150010	Vötsch	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2012/03/12	2014/03/11

Single Devices for Radio Lab Test Equipment (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Vector Signal Generator	SMIQ 03B	837747/020	Rohde & Schwarz GmbH & Co. KG

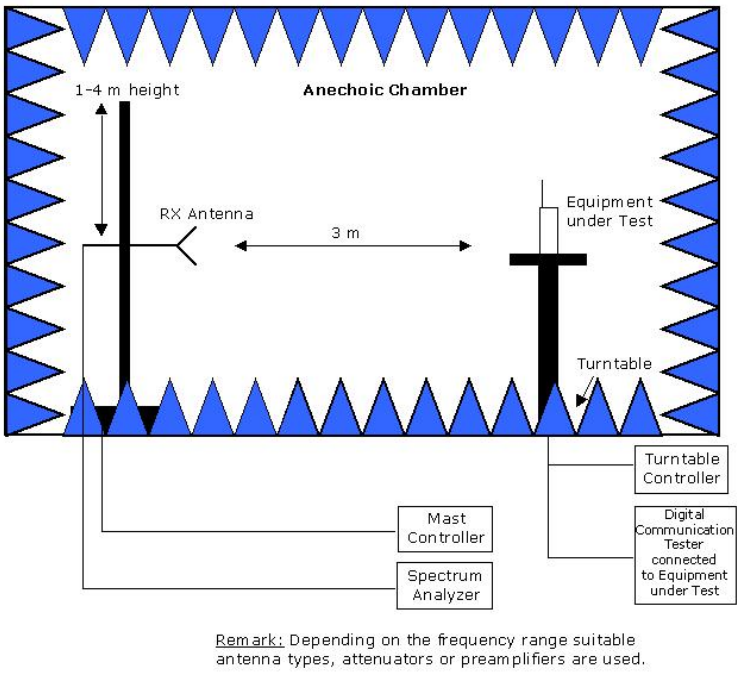
Test Equipment Shielded Room 02

Lab ID:	**Lab 1**
Manufacturer:	Frankonia
Description:	Shielded Room for conducted testing
Type:	12 qm
Serial Number:	none

5 Photo Report

Photos are included in an external report.

6 Setup Drawings



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

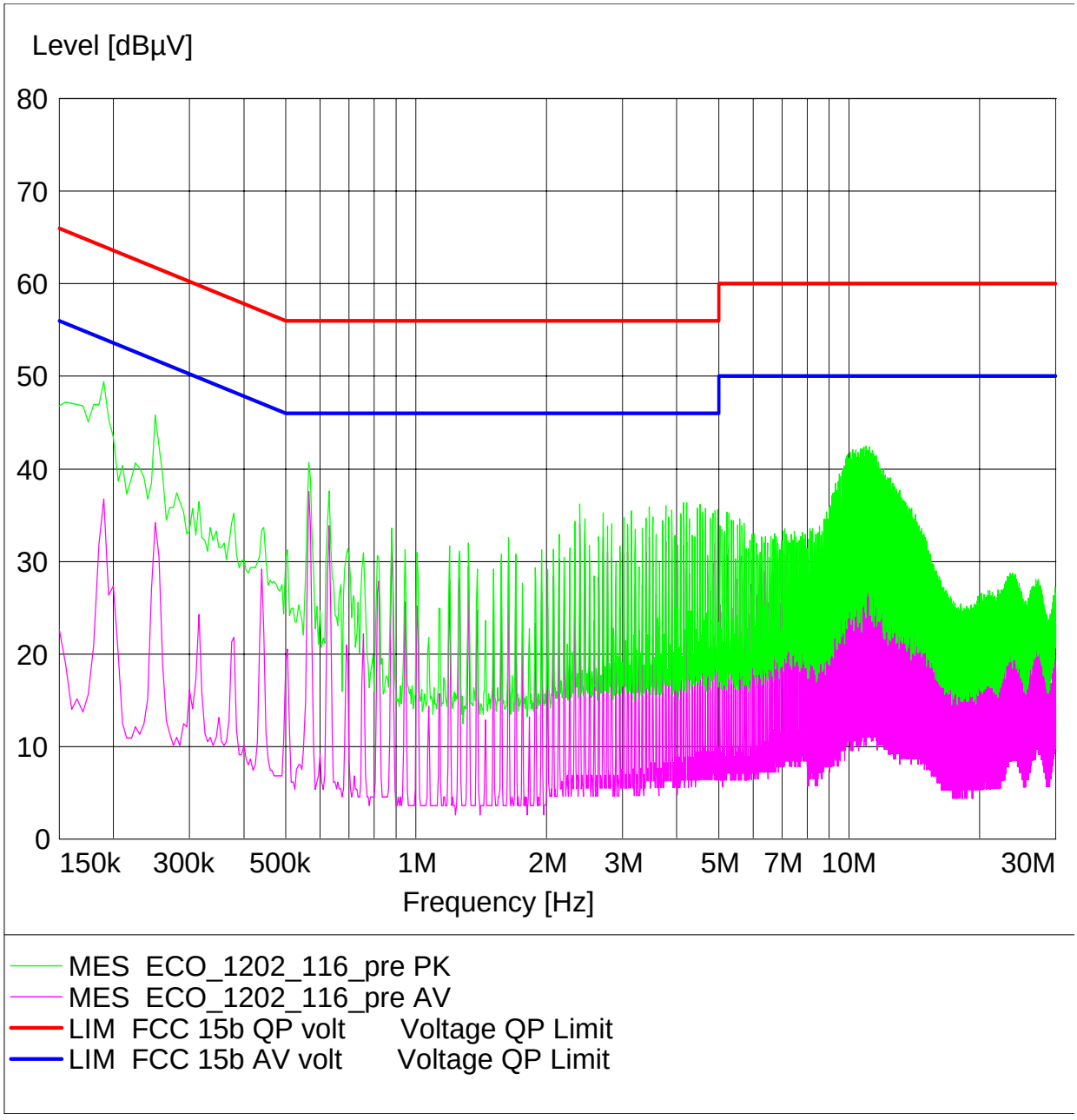
8 Annex measurement plots

8.1 AC Mains conducted

Op. Mode

op-mode 1b

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
150.0 kHz	30.0 MHz	5.0 kHz	MaxPeak Average	20.0 ms	9 kHz	ESH3-Z5

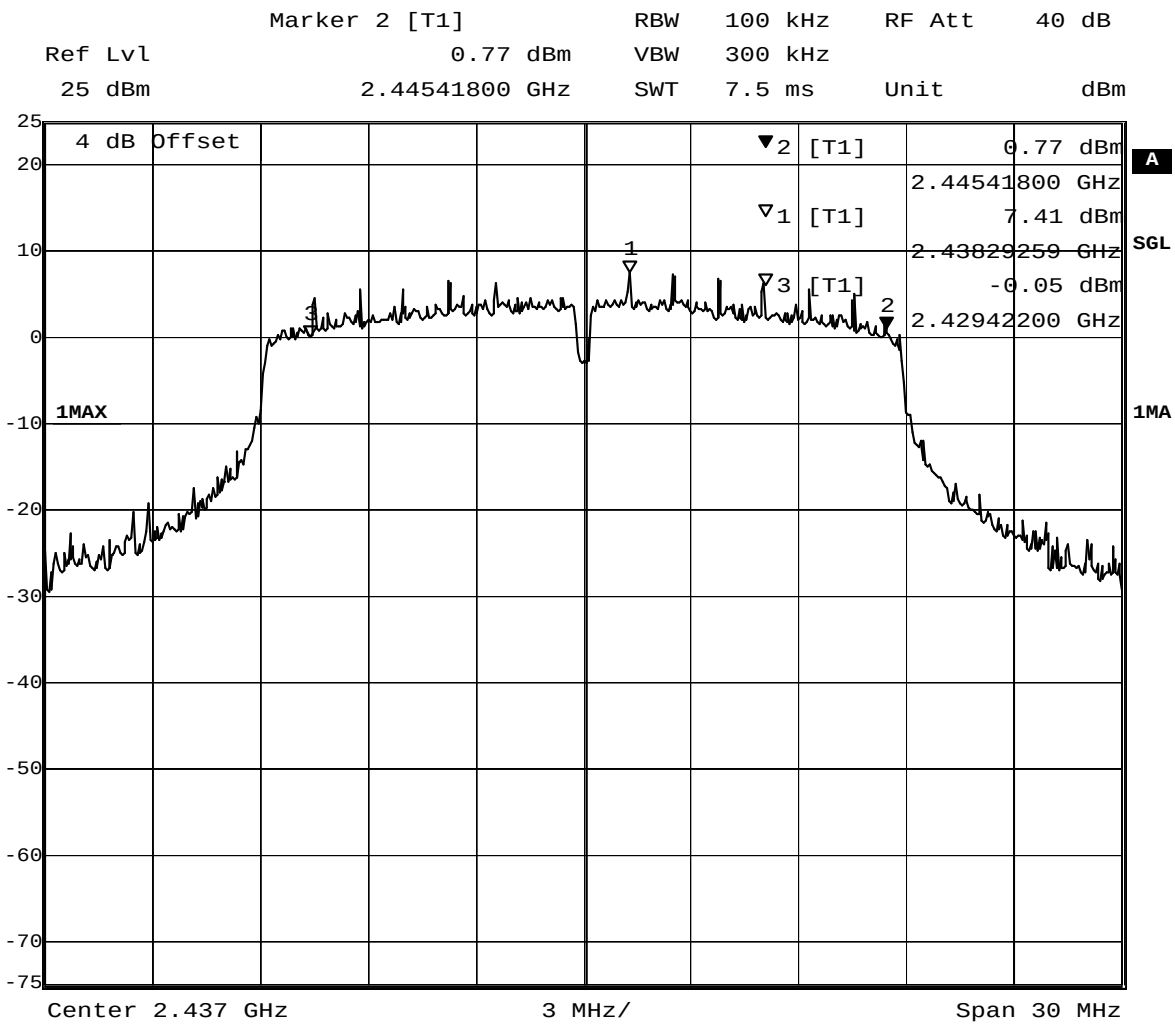


8.2 Occupied bandwidth

8.2.1 Occupied bandwidth operating mode 2

Op. Mode

op-mode 2n

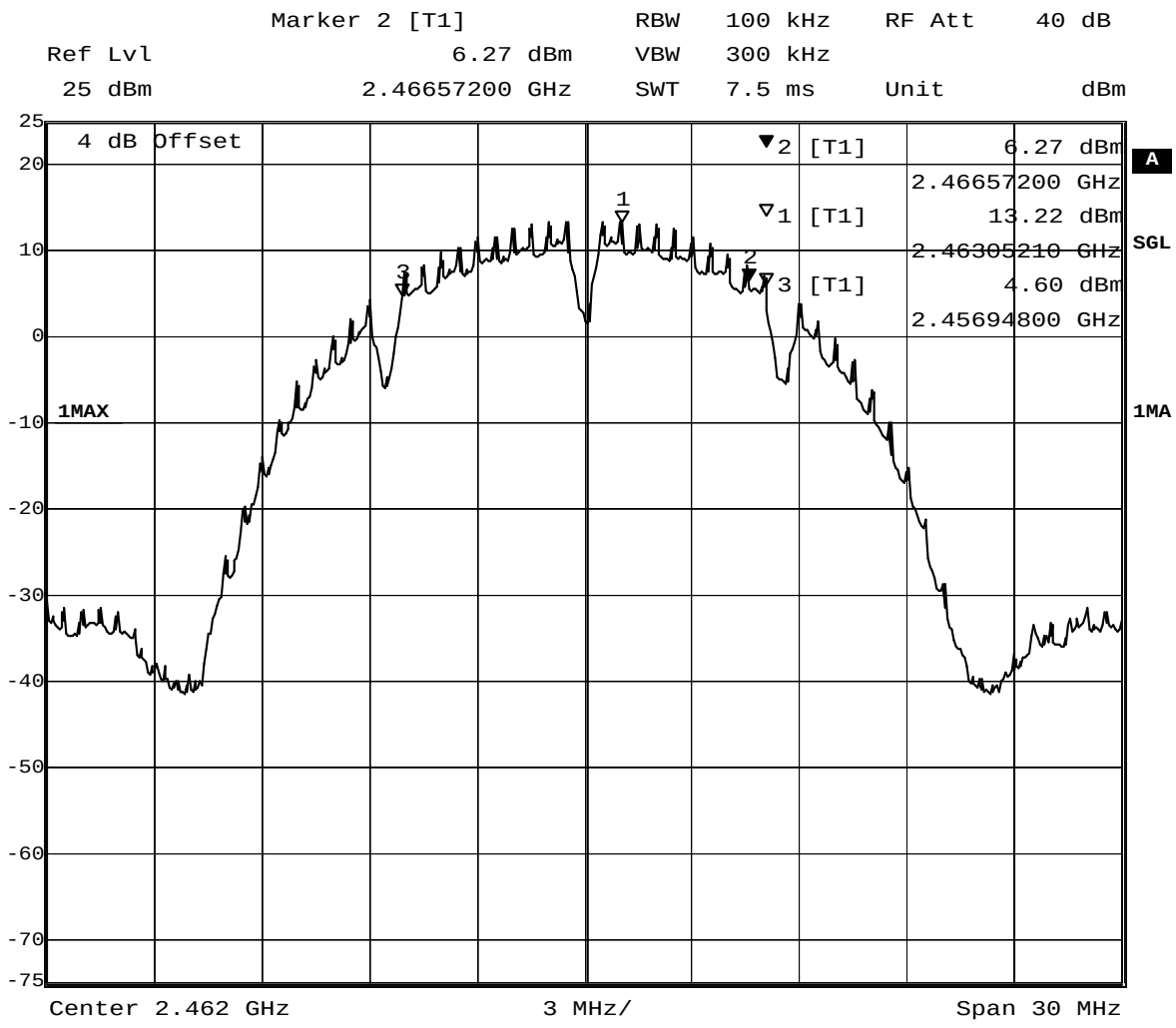


Title: 6dB Bandwidth
Comment A: CH M: 2437 MHz; 6dB bandwidth (kHz):15996
Date: 24.JAN.2013 09:15:45

8.2.2 Occupied bandwidth operating mode 3

Op. Mode

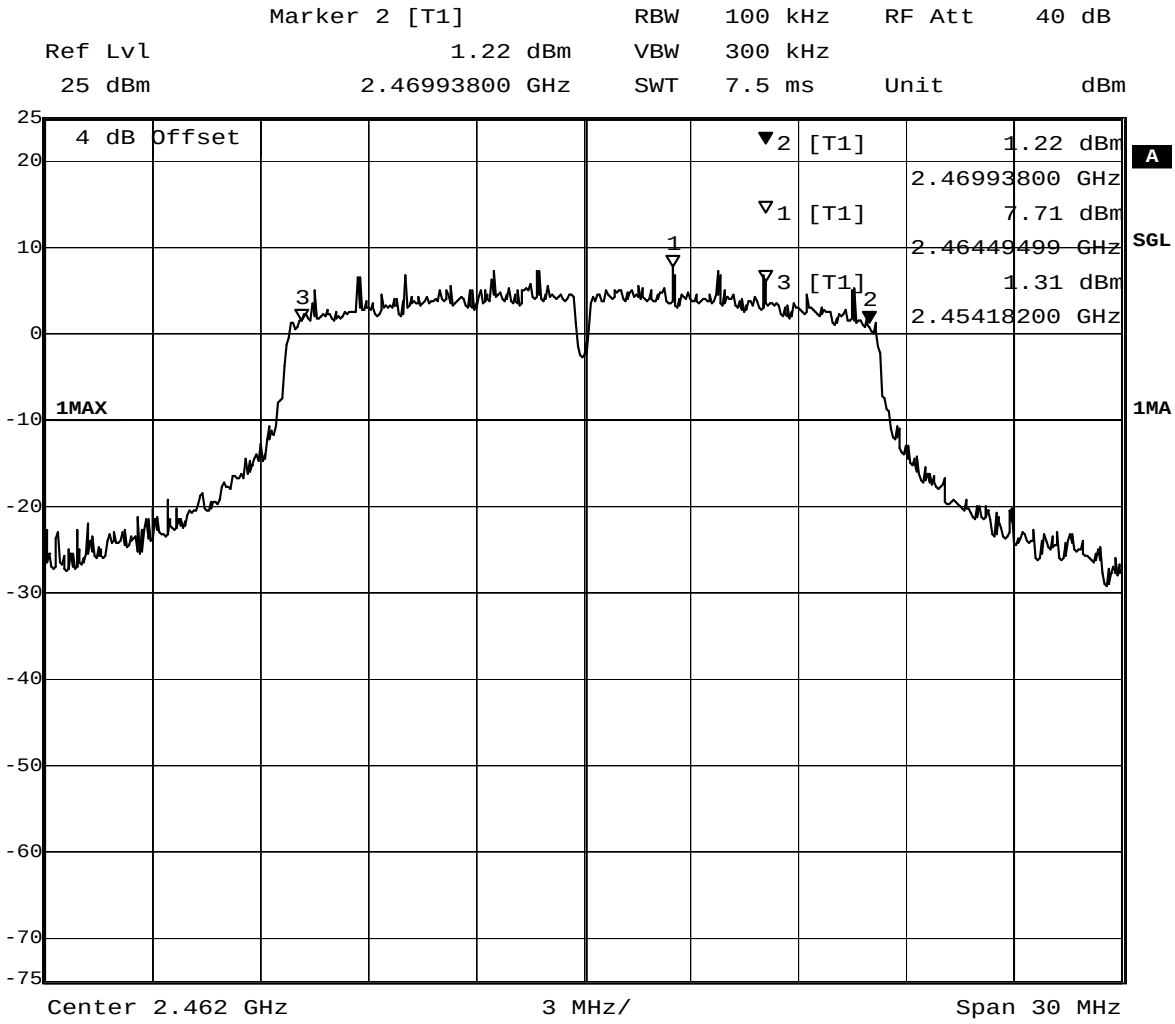
op-mode 3b



Title: 6dB Bandwidth
Comment A: CH T: 2462 MHz; 6dB bandwidth (kHz):9624
Date: 23.JAN.2013 16:06:23

Op. Mode

op-mode 3g



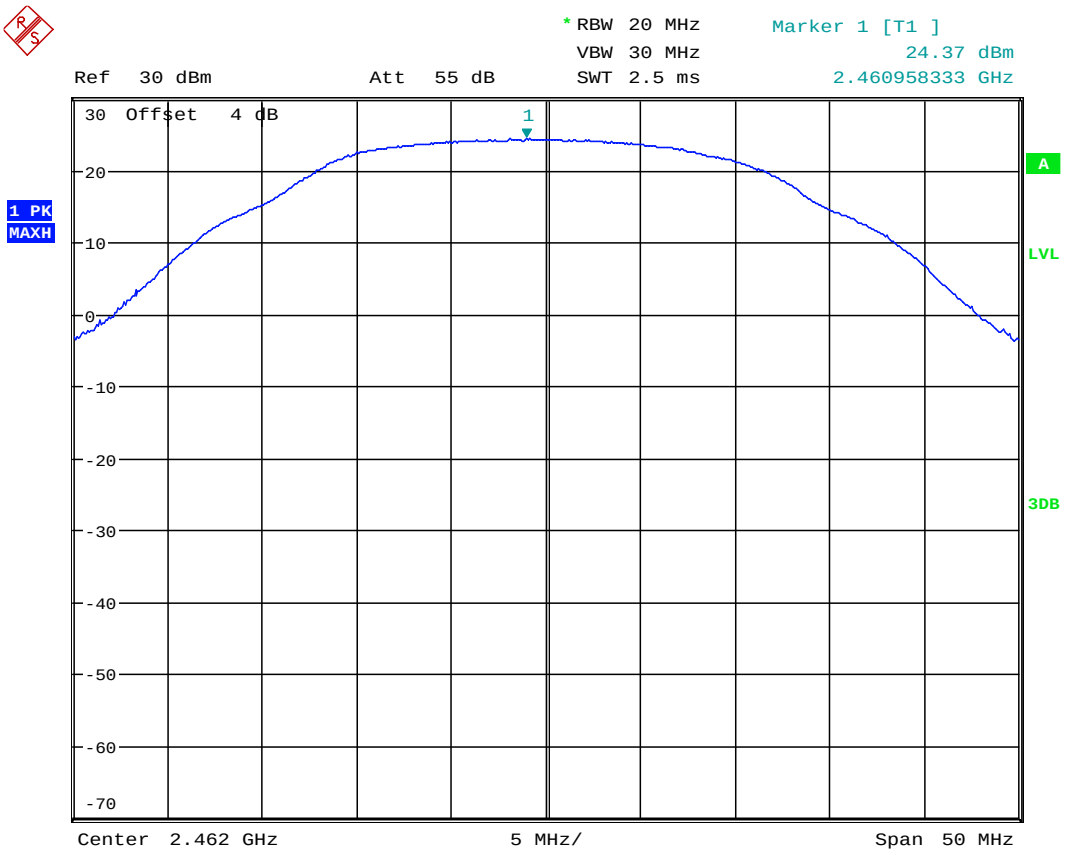
Title: 6dB Bandwidth
Comment A: CH T: 2462 MHz; 6dB bandwidth (kHz):15756
Date: 23.JAN.2013 18:10:35

8.3 Peak power output

8.3.1 Peak power output operating mode 3

Op. Mode

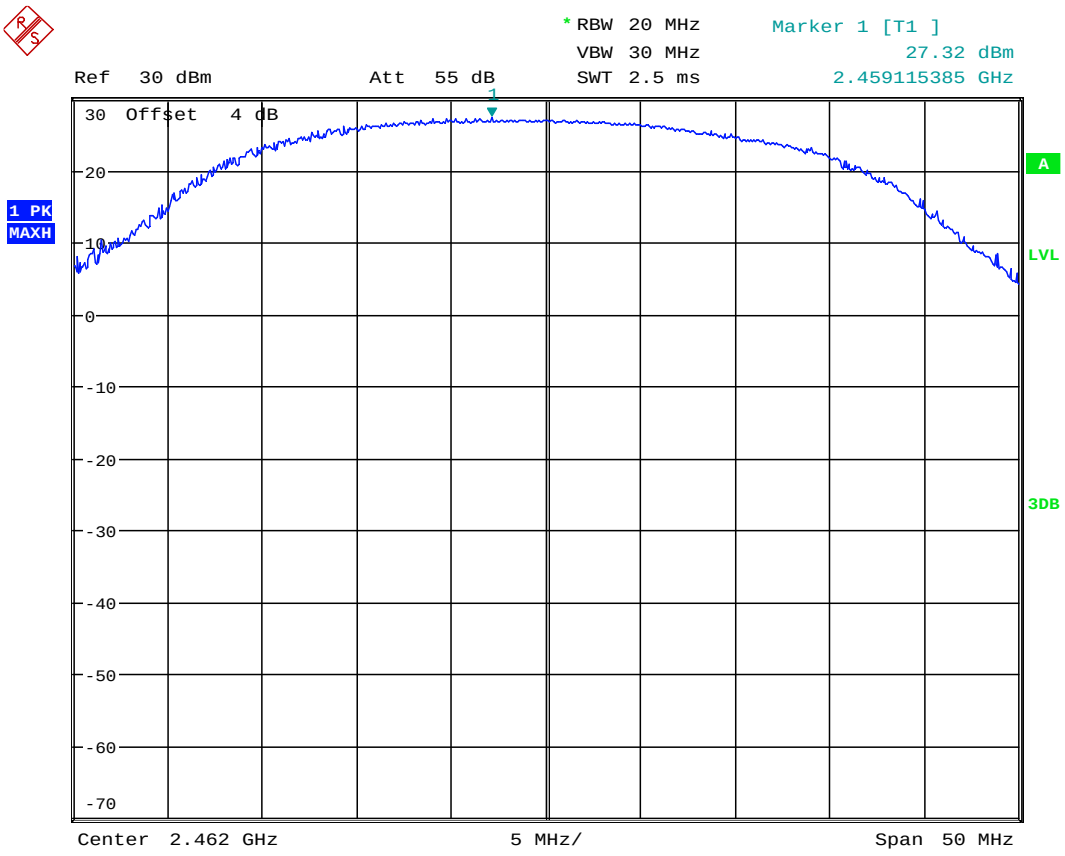
op-mode 3b



Date: 25.FEB.2013 10:02:14

Op. Mode

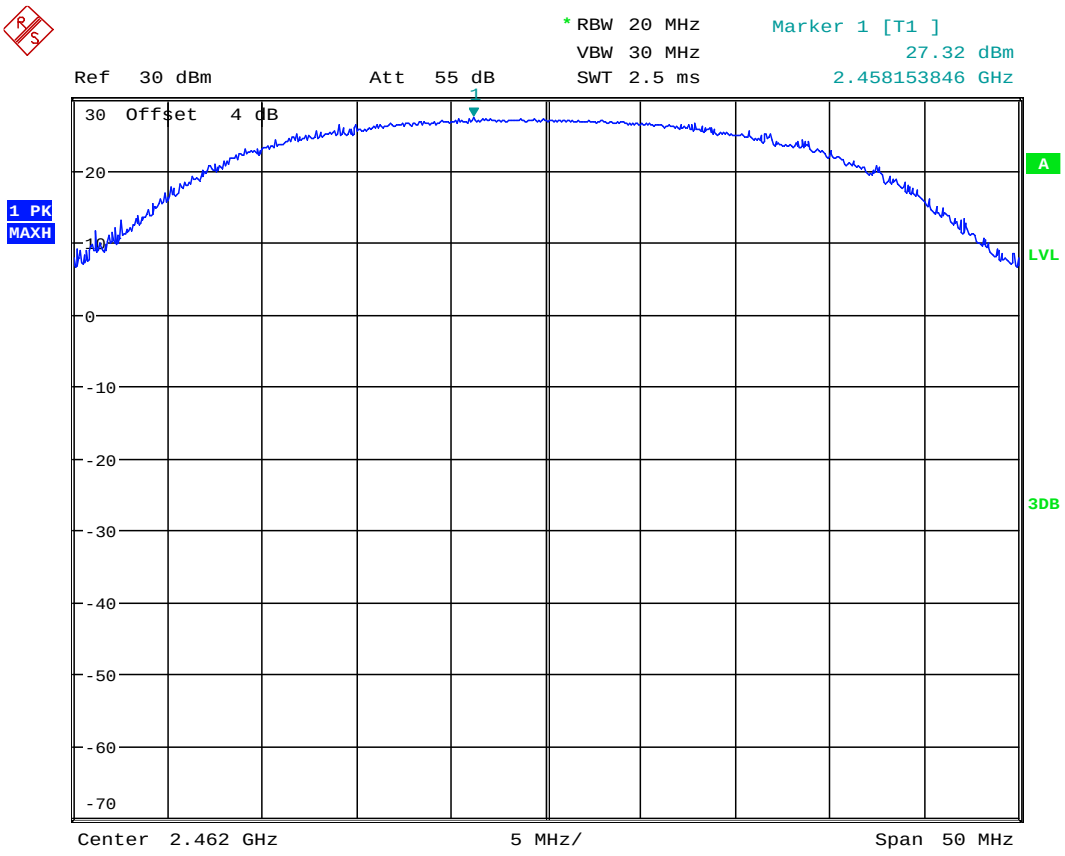
op-mode 3g



Date: 25.FEB.2013 10:03:37

Op. Mode

op-mode 3n



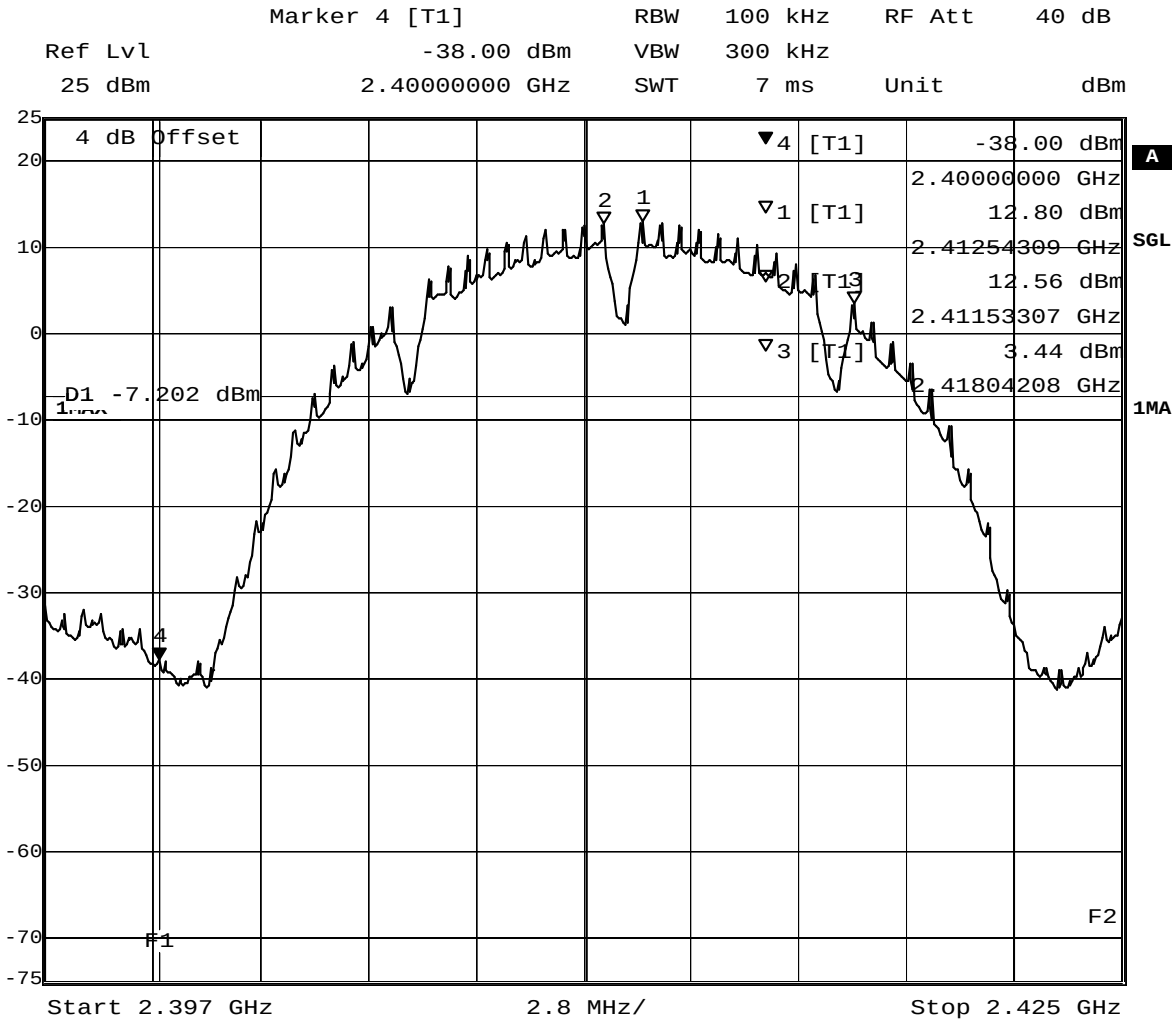
Date: 25.FEB.2013 10:14:58

8.4 Band edge compliance conducted and Spurious RF conducted emissions

8.4.1 Band edge compliance conducted operating mode 1b

Op. Mode

op-mode 1b

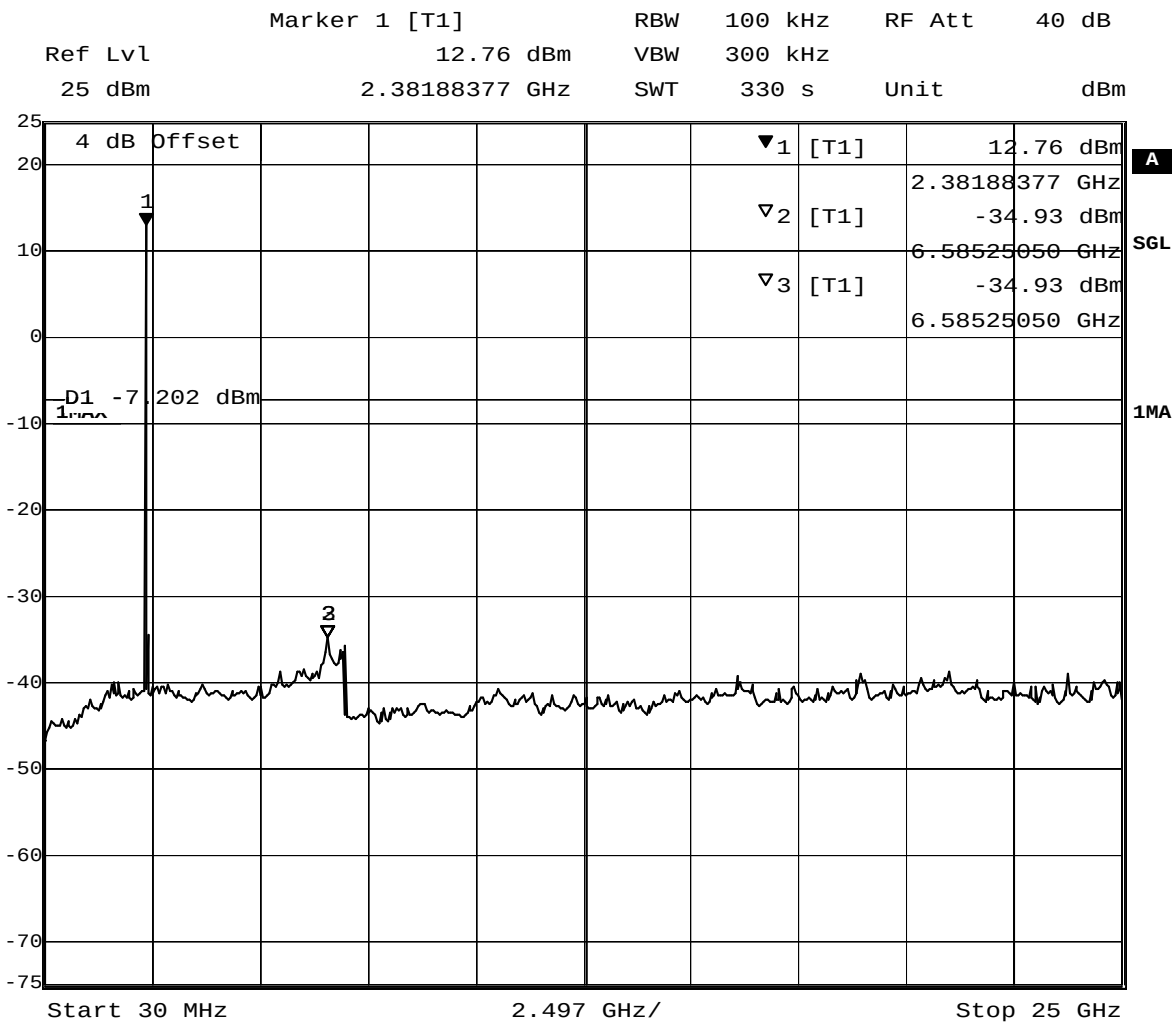


Title: Band Edge Compliance
Comment A: CH B: 2412 MHz
Date: 23.JAN.2013 14:43:18

8.4.2 Spurious RF conducted emission operating mode 1b

Op. Mode

op-mode 1b

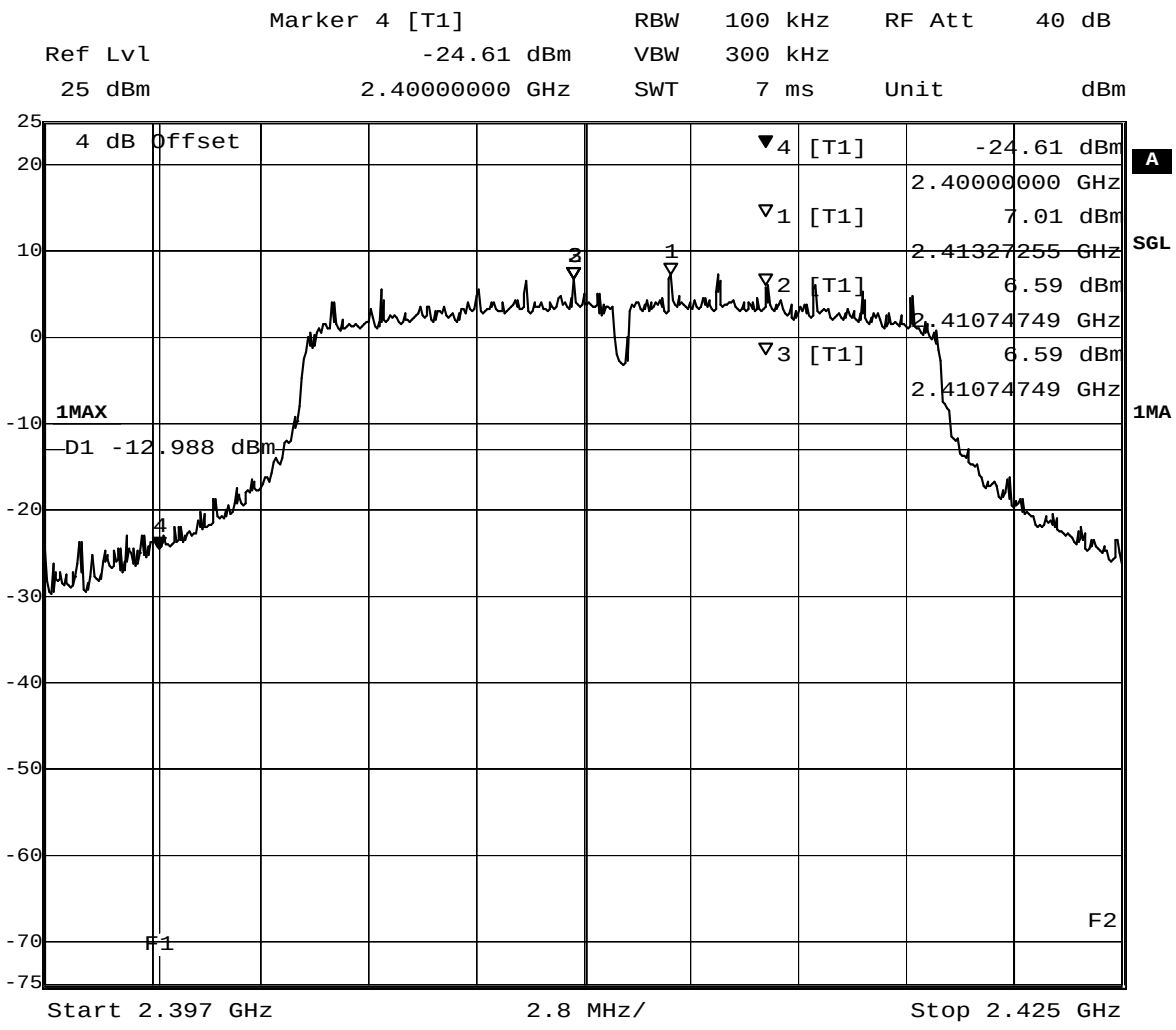


Title: spurious emissions
Comment A: CH B: 2412 MHz
Date: 23.JAN.2013 14:54:39

8.4.3 Band edge compliance conducted operating mode 1g

Op. Mode

op-mode 1g

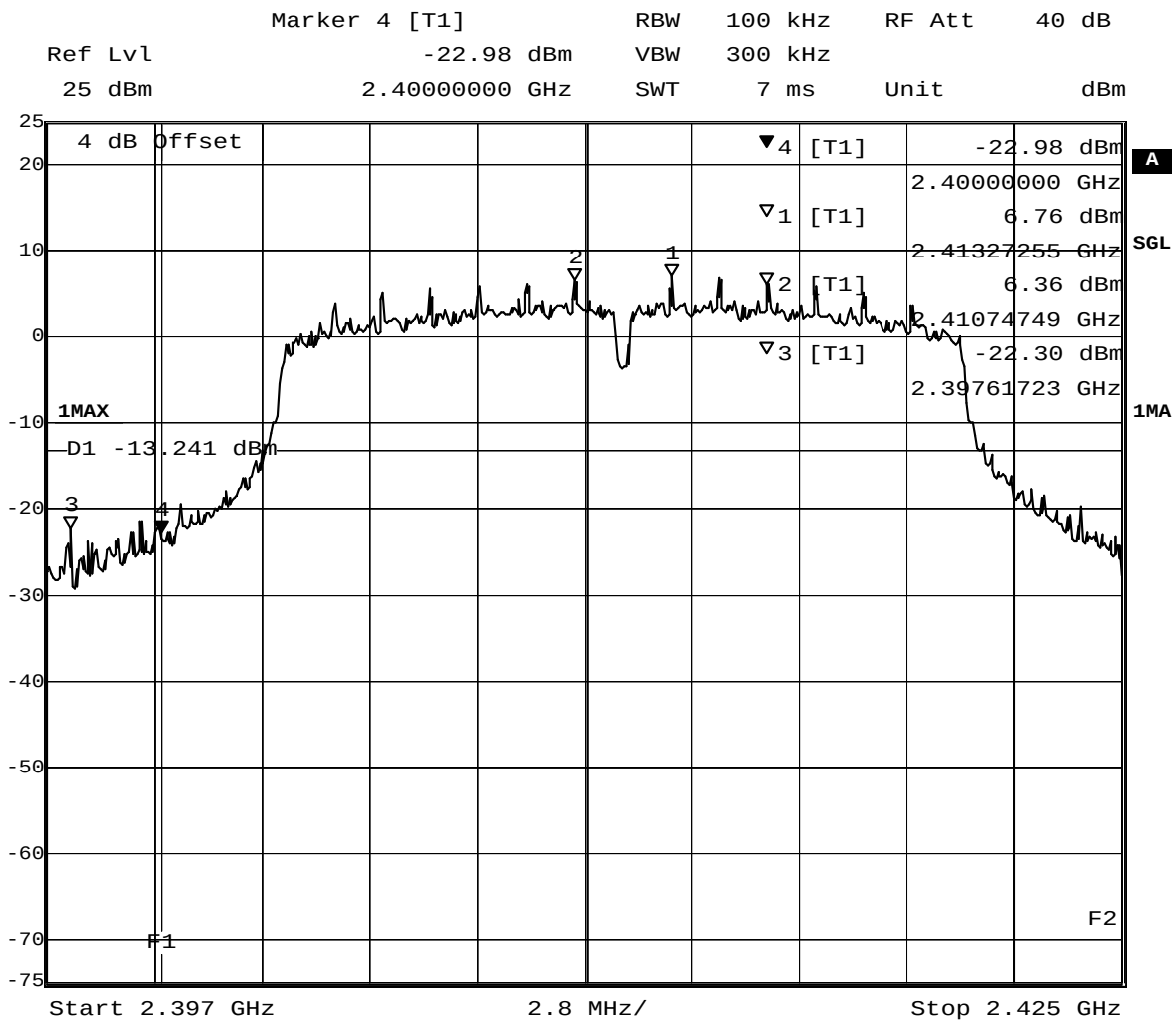


Title: Band Edge Compliance
Comment A: CH B: 2412 MHz
Date: 23.JAN.2013 16:49:58

Band edge compliance conducted operating mode 1n

Op. Mode

op-mode 1n

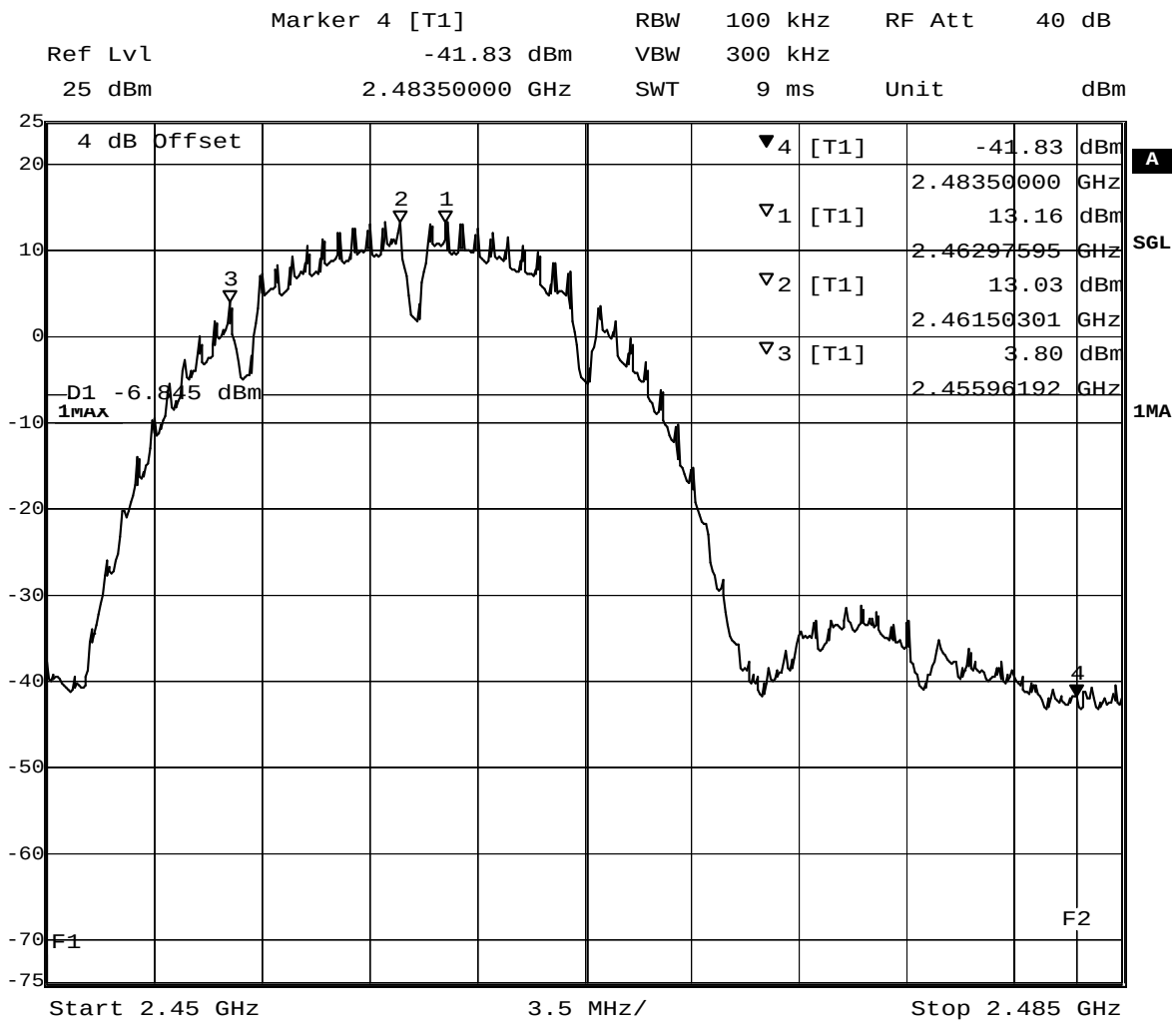


Title: Band Edge Compliance
Comment A: CH B: 2412 MHz
Date: 24.JAN.2013 09:33:43

8.4.4 Band edge compliance conducted operating mode 3b

Op. Mode

op-mode 3b

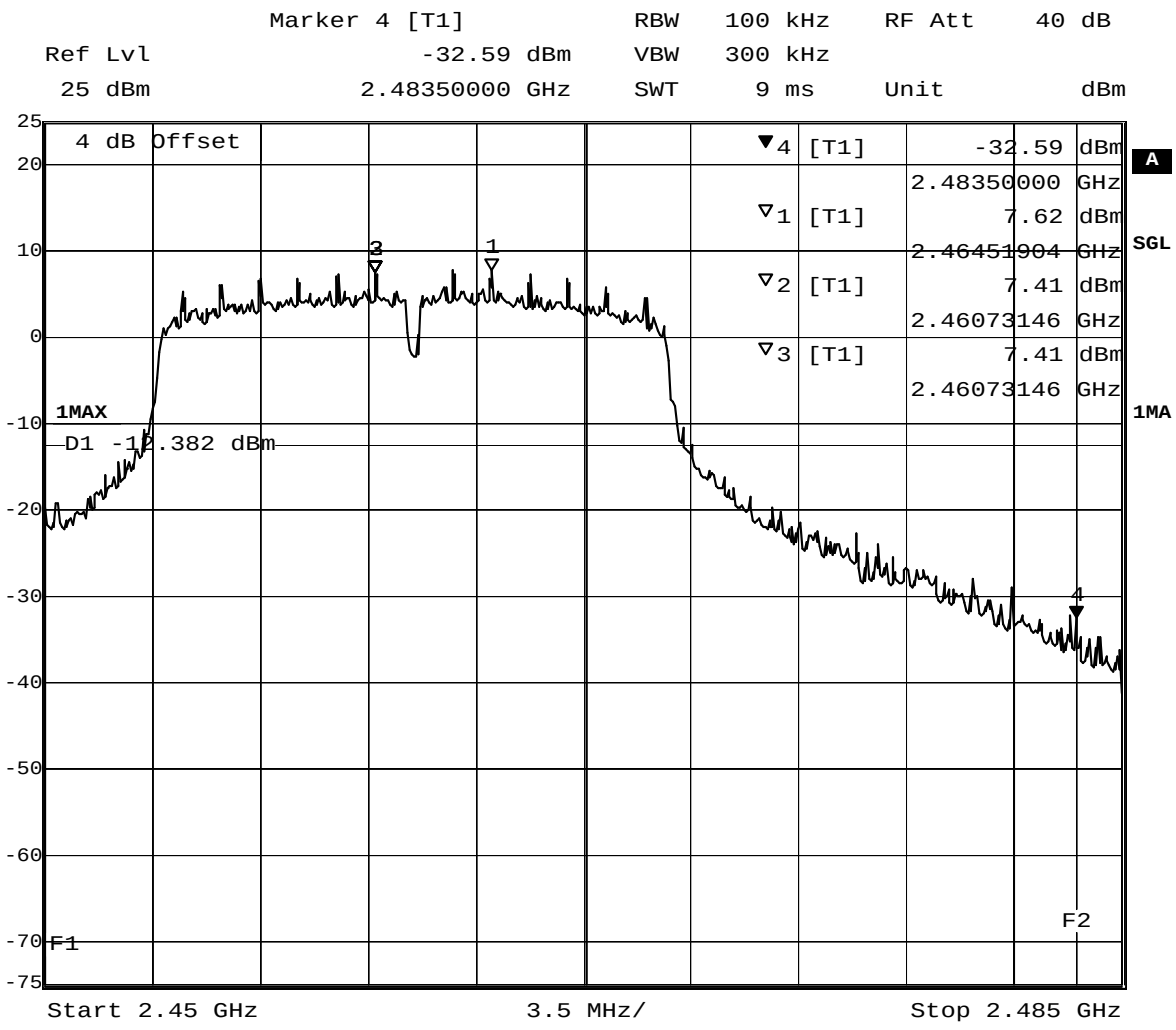


Title: Band Edge Compliance
Comment A: CH T: 2462 MHz
Date: 23.JAN.2013 15:52:26

8.4.5 Band edge compliance conducted operating mode 3g

Op. Mode

op-mode 3g

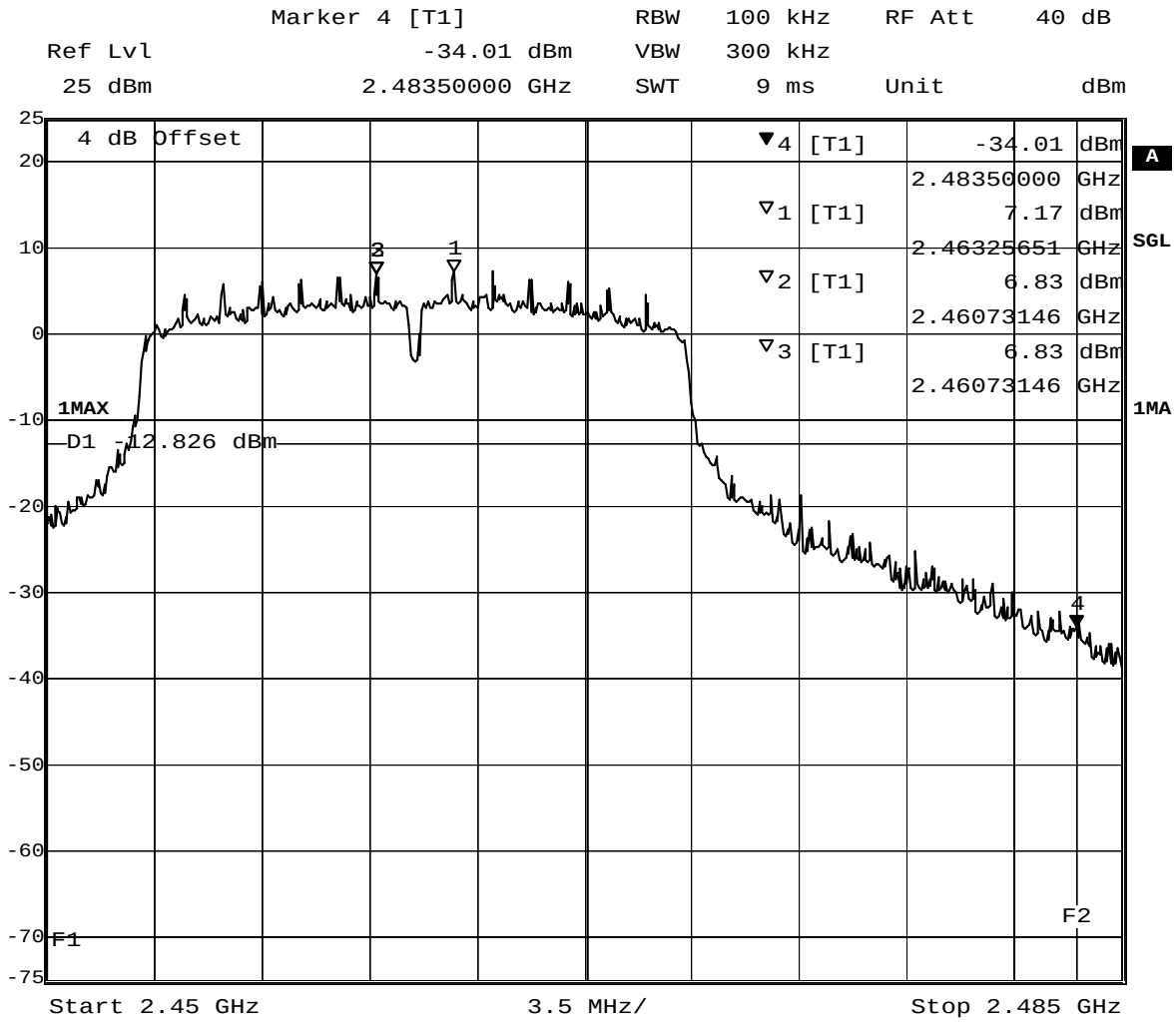


Title: Band Edge Compliance
Comment A: CH T: 2462 MHz
Date: 23.JAN.2013 17:57:09

8.4.6 Band edge compliance conducted operating mode 3n

Op. Mode

op-mode 3n

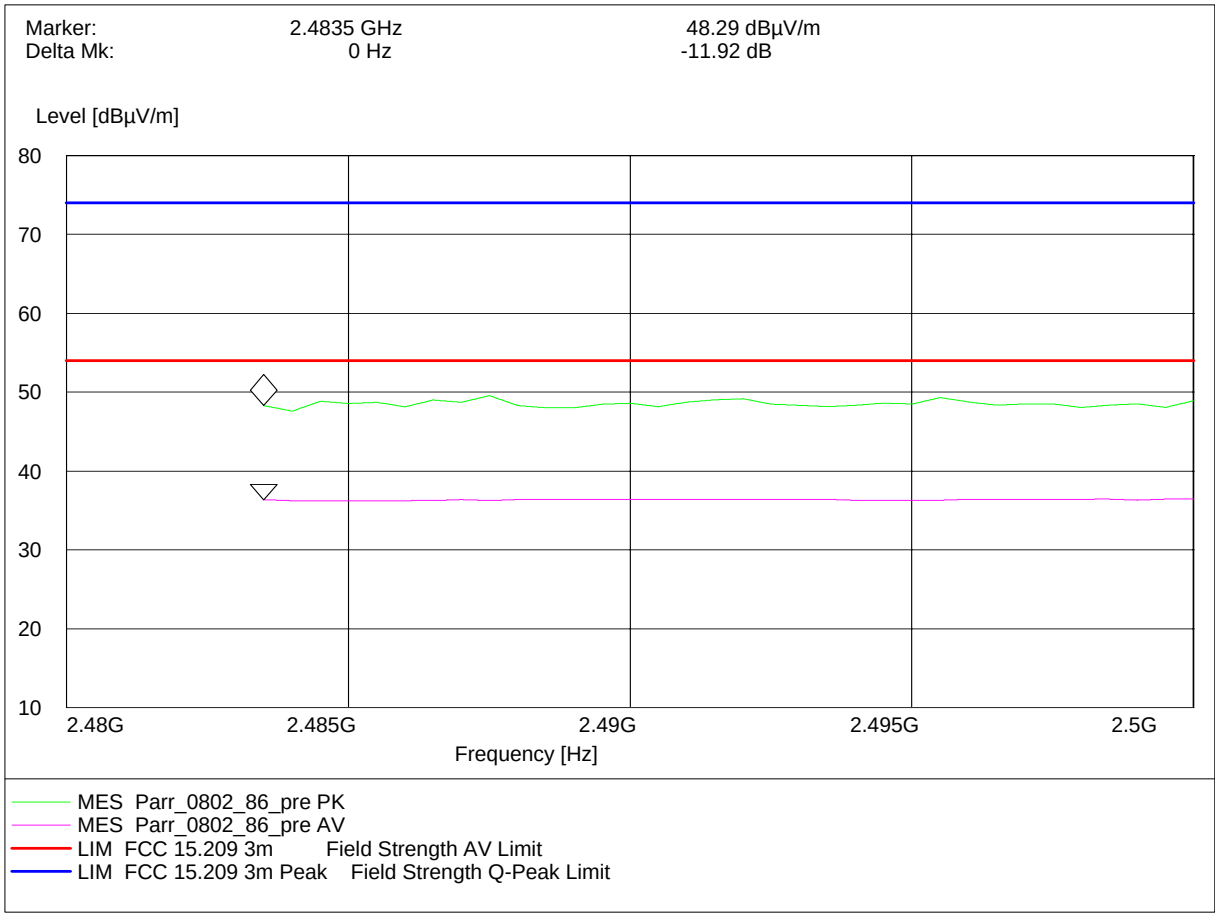


Title: Band Edge Compliance
Comment A: CH T: 2462 MHz
Date: 24.JAN.2013 08:28:02

8.4.7 Band edge compliance radiated operating mode 3

Op. Mode higher band edge

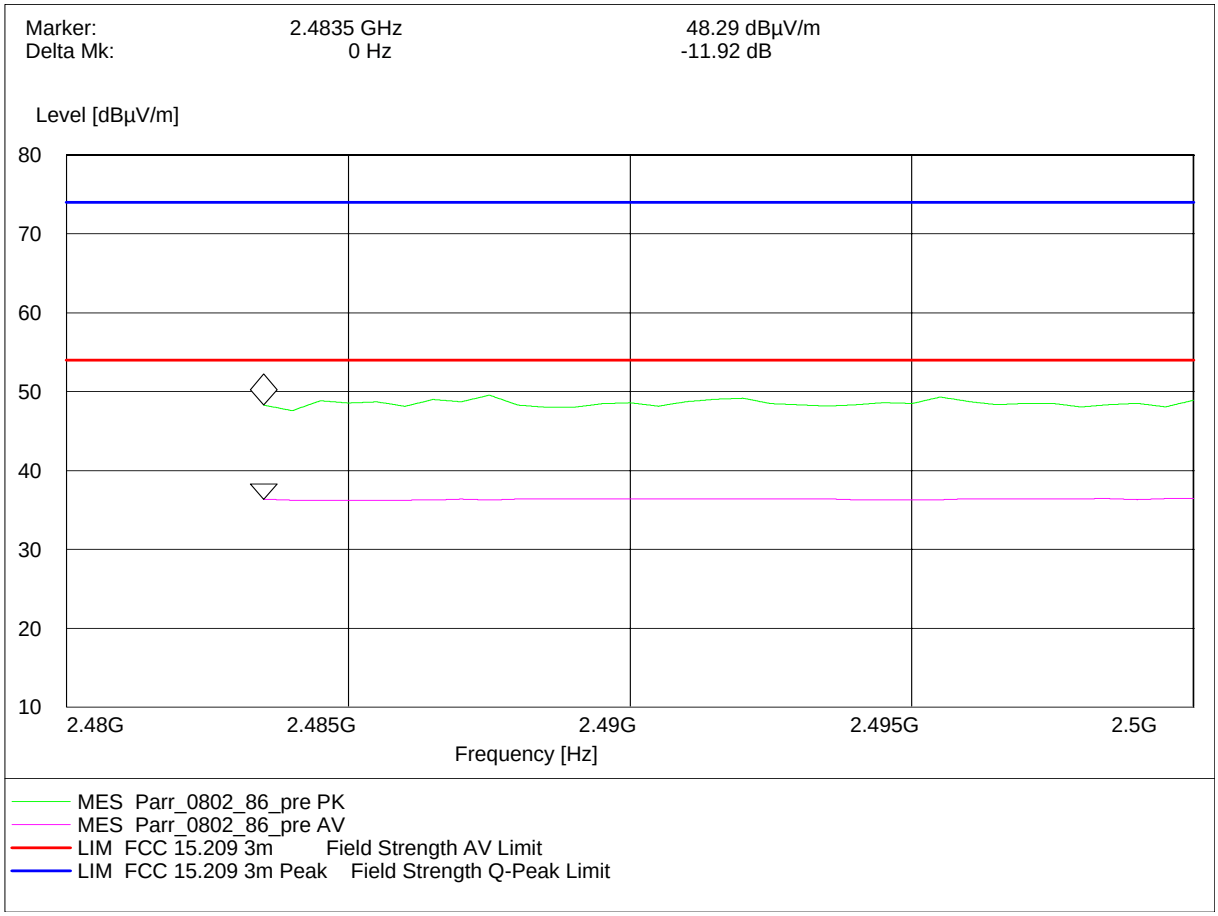
op-mode 3b



Radiated measurement (higher band edge)

Op. Mode higher band edge

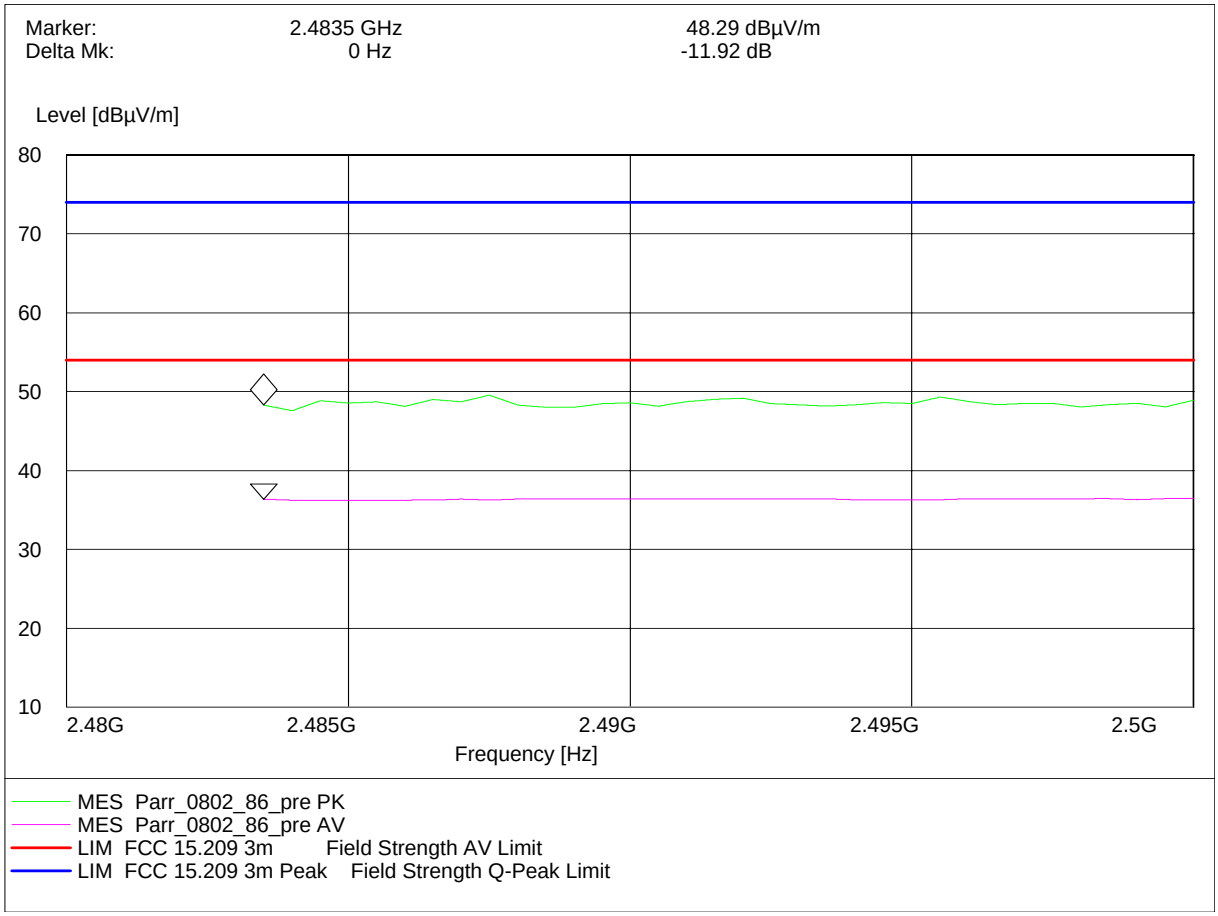
op-mode 3g



Radiated measurement (higher band edge)

Op. Mode higher band edge

op-mode 3n

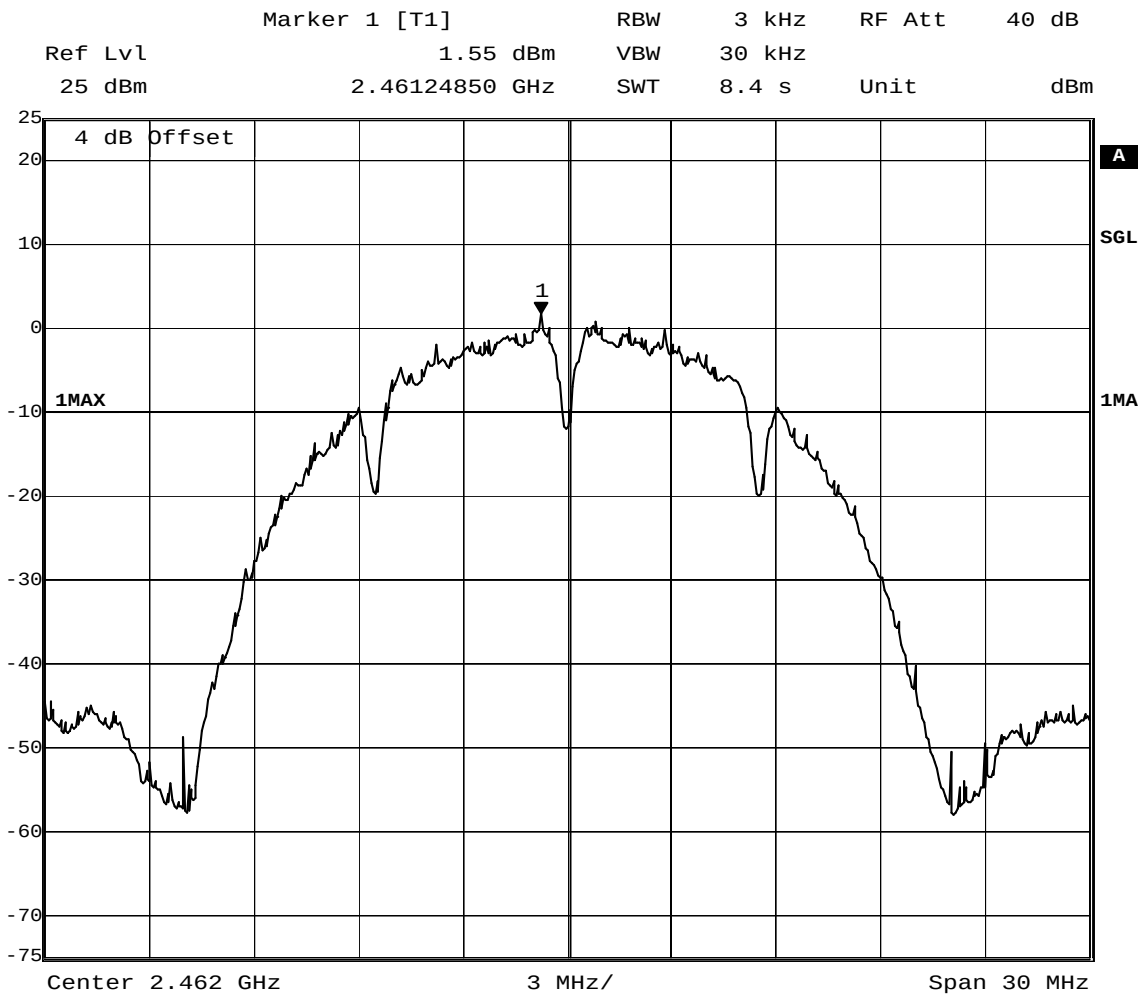


Radiated measurement (higher band edge)

8.5 Power density

Op. Mode

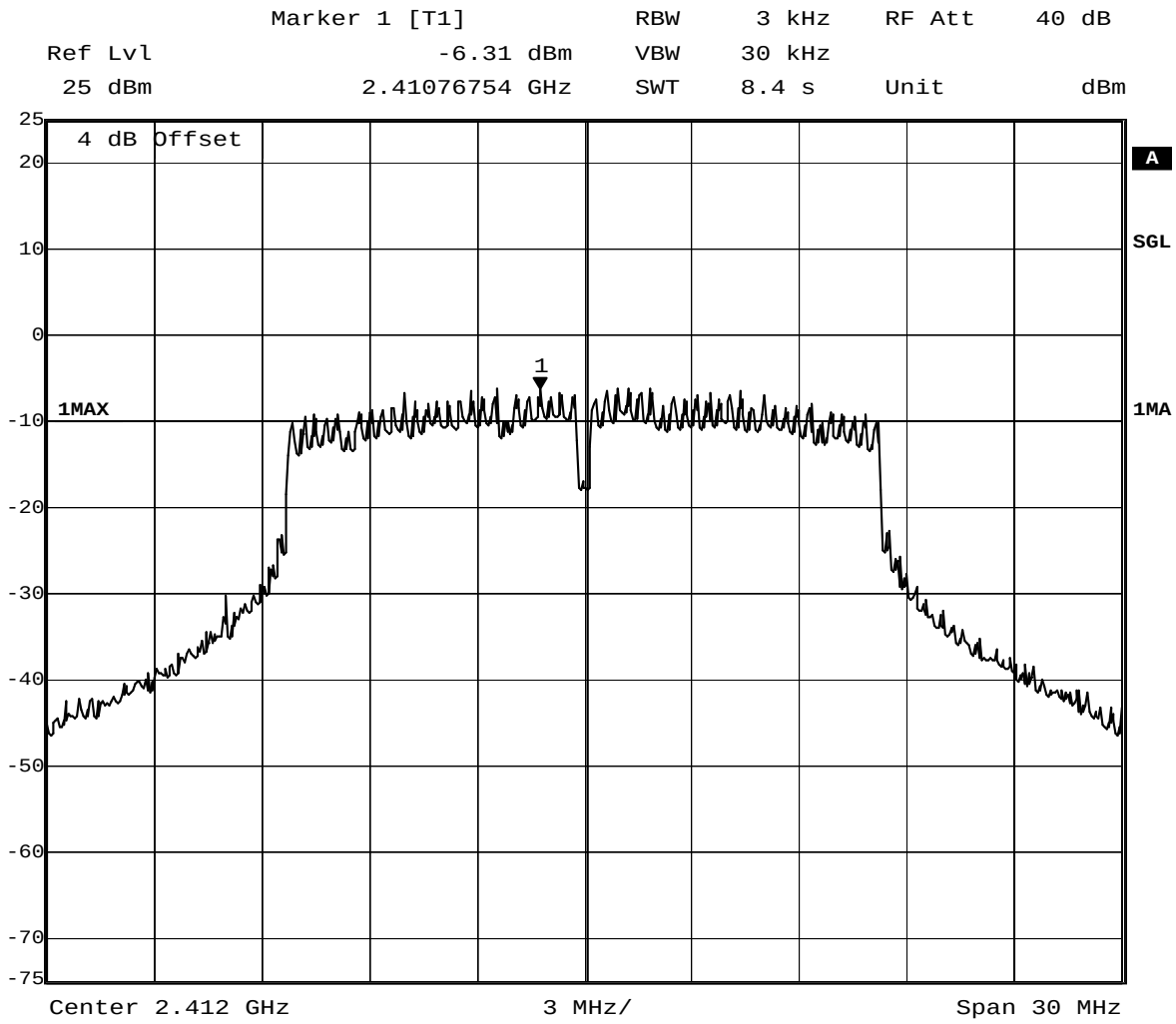
op-mode 3b



Title: Power Density
Comment A: CH T: 2462 MHz;
Date: 23.JAN.2013 16:20:48

Op. Mode

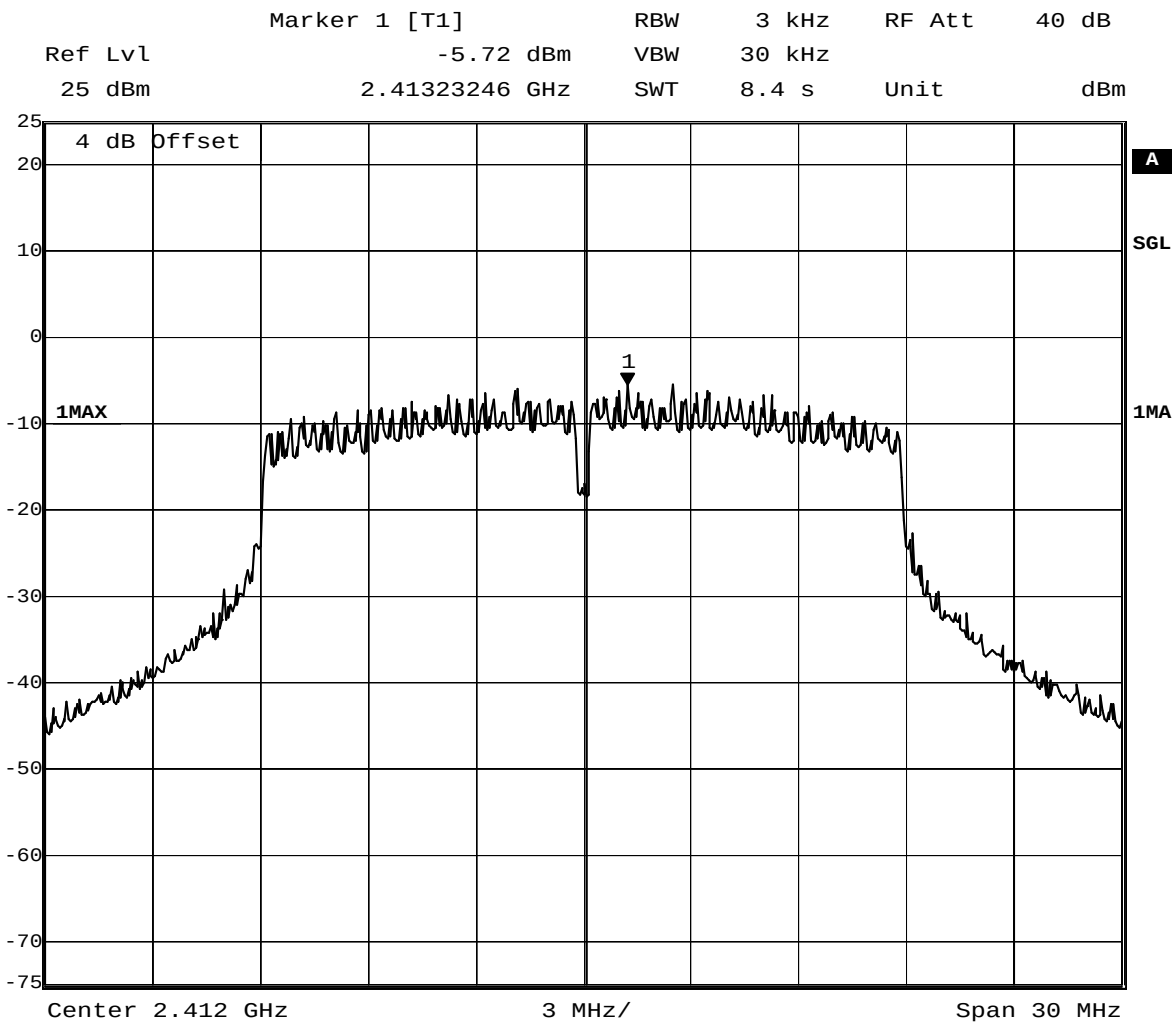
op-mode 1g



Title: Power Density
Comment A: CH B: 2412 MHz;
Date: 23.JAN.2013 17:17:47

Op. Mode

op-mode 1n



Title: Power Density
Comment A: CH B: 2412 MHz;
Date: 24.JAN.2013 10:01:33