



Inter**Lab**[®]

FCC Measurement/Technical Report on
WLAN transceiver
Vehicle Communication Interface
PACCAR DAF-VCI/HW

Report Reference: MDE_SOFT_0601_FCCb

Test Laboratory:

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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 testing 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 (10-1-06 Edition) and 15 (10-1-06 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”

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

2003

OP-Mode	Setup	Port	Final Result
			N/A

FCC Part 15, Subpart C § 15.247 (a) (1)

Occupied bandwidth

The measurement was performed according to FCC § 15.31

10-1-06

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_b01	Temp.ant.connector	passed
op-mode 1g	Setup_b01	Temp.ant.connector	passed
op-mode 2b	Setup_b01	Temp.ant.connector	passed
op-mode 2g	Setup_b01	Temp.ant.connector	passed
op-mode 3b	Setup_b01	Temp.ant.connector	passed
op-mode 3g	Setup_b01	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

10-1-06

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_b01	Temp.ant.connector	passed
op-mode 1g	Setup_b01	Temp.ant.connector	passed
op-mode 2b	Setup_b01	Temp.ant.connector	passed
op-mode 2g	Setup_b01	Temp.ant.connector	passed
op-mode 3b	Setup_b01	Temp.ant.connector	passed
op-mode 3g	Setup_b01	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

10-1-06

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_b01	Temp.ant.connector	passed
op-mode 1g	Setup_b01	Temp.ant.connector	passed
op-mode 2b	Setup_b01	Temp.ant.connector	passed
op-mode 2g	Setup_b01	Temp.ant.connector	passed
op-mode 3b	Setup_b01	Temp.ant.connector	passed
op-mode 3g	Setup_b01	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

2003

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_a01	Enclosure	passed
op-mode 2b	Setup_a01	Enclosure	passed
op-mode 3b	Setup_a01	Enclosure	passed
op-mode 1g	Setup_a01	Enclosure	passed
op-mode 2g	Setup_a01	Enclosure	passed
op-mode 3g	Setup_a01	Enclosure	passed

FCC Part 15, Subpart C
§ 15.247 (d)

Band edge compliance

The measurement was performed according to FCC § 15.31 (10-1-06) / ANSI C63.4 (2003) 10-1-06 / 2003

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_b01	Temp.ant.connector	passed
op-mode 1g	Setup_b01	Temp.ant.connector	passed
op-mode 3b	Setup_b01	Temp.ant.connector	passed
op-mode 3g	Setup_b01	Temp.ant.connector	passed
op-mode 3b	Setup_a01	Enclosure	passed
op-mode 3g	Setup_a01	Enclosure	passed

FCC Part 15, Subpart C
§ 15.247 (e)

Power density

The measurement was performed according to FCC § 15.31 10-1-06

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_b01	Temp.ant.connector	passed
op-mode 1g	Setup_b01	Temp.ant.connector	passed
op-mode 2b	Setup_b01	Temp.ant.connector	passed
op-mode 2g	Setup_b01	Temp.ant.connector	passed
op-mode 3b	Setup_b01	Temp.ant.connector	passed
op-mode 3g	Setup_b01	Temp.ant.connector	passed

N/A – not applicable

This report replaces the test report MDE_SOFT_0601_FCCa



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Responsible for
Accreditation Scope:

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for Test Report:

Ch. Reib



1 Administrative Data

1.1 Testing Laboratory

Company Name: 7 Layers 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:
- Deutscher Akkreditierungs Rat DAR-Registration no. DAT-P-192/99-01

Responsible for Accreditation Scope: Dipl.-Ing. Bernhard Retka
Dipl.-Ing. Robert Machulec
Dipl.-Ing. Thomas Hoell

Report Template Version: 2006-12-18

1.2 Project Data

Responsible for testing and report: Dipl.-Ing. Andreas Petz
Date of Test(s): 2007-04-03 – 2007-07-16
Date of Report: 2007-07-16

1.3 Applicant Data

Company Name: Softing AG
Address: Richard-Reitzner-Allee 6
85540 Haar
Germany
Contact Person: Hermann Weigl

1.4 Manufacturer Data

Company Name: GEMAC
Gesellschaft für
Mikroelektronikanwendung Chemnitz
GmbH
Address: Zwickauer Straße 227
09116 Chemnitz
Germany
Contact Person: Peter Siegel



2 Product labeling

2.1 FCC ID label:

At the time of the report there was no FCC label available.

2.2 Location of the label on the EUT:

see above

3 Testobject Data

3.1 General EUT Description

Equipment under Test:	WLAN transceiver Vehicle Communication Interface
Type Designation:	PACCAR DAF-VCI/HW
Kind of Device: (optional)	Diagnostic Tool for Trucks with WLAN and USB Interface
Voltage Type:	DC (Car)
Voltage level:	24 V

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 supports the modes 802.11b (max. 11Mbps) and 802.11g (max. 54Mbps)

The EUT provides the following ports:

Ports

Enclosure

DC Port (power line)

Temp.ant.connector - covered by plastic housing, for conducted measurements the plastic cover and the antenna were removed and the antenna connector was used.

The main components of the EUT are listed and described in Chapter 3.2

3.2 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	WLAN transceiver	PACCAR DAF-VCI/HW	Test sample 1	V0.93	V0.80.001 (Firmware)	2007-04-03
Remark: equipped with an integral (covert by plastic housing) antenna (gain= 2.15 dBi).						
EUT B	WLAN transceiver	PACCAR DAF-VCI/HW	Test sample 2	V0.93	V0.80.001 (Firmware)	2007-07-12
Remark: equipped with an integral (covert by plastic housing) antenna (gain= 2.15 dBi).						

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

3.3 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
-	-	-	-	-	-	-

3.4 EUT Setups

This chapter describes the combination of EUTs and ancillary equipment used for testing.

Setup No.	Combination of EUT's	Description
Setup a01	EUT A	setup for radiated measurements
Setup b01	EUT B	setup for conducted measurements

3.5 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 for conducted measurement 11 Mbps for radiated measurement
op-mode 1g	TX-mode, the EUT transmits on the lowest channel (2412 MHz)	Worst case data rate 6 Mbps for conducted measurement 54 Mbps for radiated measurement
op-mode 2b	TX-mode, the EUT transmits on the mid channel (2437 MHz)	Worst case data rate 1 Mbps for conducted measurement 11 Mbps for radiated measurement
op-mode 2g	TX-mode, the EUT transmits on the mid channel (2437 MHz)	Worst case data rate 6 Mbps for conducted measurement 54 Mbps for radiated measurement
op-mode 3b	TX-mode, the EUT transmits on the highest channel (2462 MHz)	Worst case data rate 1 Mbps for conducted measurement 11 Mbps for radiated measurement
op-mode 3g	TX-mode, the EUT transmits on the highest channel (2462 MHz)	Worst case data rate 6 Mbps for conducted measurement 54 Mbps for radiated measurement

4 Test Results

4.1 Occupied bandwidth

Standard FCC Part 15, 10-1-06
Subpart C

The test was performed according to: FCC §15.31, 10-1-06

4.1.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room 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

4.1.2 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.

4.1.3 Test Protocol

Temperature: 25 °C
Air Pressure: 1017 hPa
Humidity: 52 %

Op. Mode	Setup	Port
op-mode 1b	Setup_b01	Temp.ant.connector

6 dB bandwidth MHz	Remarks
10.086	-

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_b01	Temp.ant.connector

6 dB bandwidth MHz	Remarks
16.626	-

Remark: Please see annex for the measurement plot.



Op. Mode	Setup	Port
op-mode 2b	Setup_b01	Temp.ant.connector

6 dB bandwidth MHz	Remarks
10.086	-

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2g	Setup_b01	Temp.ant.connector

6 dB bandwidth MHz	Remarks
16.626	-

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3b	Setup_b01	Temp.ant.connector

6 dB bandwidth MHz	Remarks
10.086	-

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_b01	Temp.ant.connector

6 dB bandwidth MHz	Remarks
16.626	-

Remark: Please see annex for the measurement plot.

4.1.4 Test result: Occupied bandwidth

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

4.2 Peak power output

Standard FCC Part 15, 10-1-06
Subpart C

The test was performed according to: FCC §15.31, 10-1-06

4.2.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the output power measurements.

The results recorded were measured with the modulation which produces the worst-case (highest) output power.

The EUT was connected to the power meter via a short coax cable with a known loss.

4.2.2 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

4.2.3 Test Protocol

Temperature: 21 °C
Air Pressure: 1005 hPa
Humidity: 37 %

Op. Mode	Setup	Port
op-mode 1b	Setup_b01	Temp.ant.connector

Output power dBm	Remarks
4.1	The EIRP including antenna gain (2.15 dBi) is 6.25 dBm

Remark: -

Op. Mode	Setup	Port
op-mode 1g	Setup_b01	Temp.ant.connector

Output power dBm	Remarks
3.4	The EIRP including antenna gain (2.15 dBi) is 5.55 dBm

Remark: -



Op. Mode	Setup	Port
op-mode 2b	Setup_b01	Temp.ant.connector

Output power dBm	Remarks
6.2	The EIRP including antenna gain (2.15 dBi) is 8.45 dBm

Remark: -

Op. Mode	Setup	Port
op-mode 2g	Setup_b01	Temp.ant.connector

Output power dBm	Remarks
4.5	The EIRP including antenna gain (2.15 dBi) is 6.65 dBm

Remark: -

Op. Mode	Setup	Port
op-mode 3b	Setup_b01	Temp.ant.connector

Output power dBm	Remarks
8.2	The EIRP including antenna gain (2.15 dBi) is 10.35 dBm

Remark: -

Op. Mode	Setup	Port
op-mode 3g	Setup_b01	Temp.ant.connector

Output power dBm	Remarks
6.8	The EIRP including antenna gain (2.15 dBi) is 8.95 dBm

Remark: -

4.2.4 Test result: Peak power output

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

4.3 Spurious RF conducted emissions

Standard FCC Part 15, 10-1-06
Subpart C

The test was performed according to: FCC §15.31, 10-1-06

4.3.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room 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

4.3.2 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.

4.3.3 Test Protocol

Temperature: 21 °C
Air Pressure: 1005 hPa
Humidity: 37 %

Op. Mode	Setup	Port
op-mode 1b	Setup_b01	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Delta to limit dB
4784	-41.44	-1.42	-21.42	20.02

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_b01	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Delta to limit dB
6585	-41.30	-3.13	-23.13	18.17

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_b01	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Delta to limit dB
6585	-40.77	0.80	-19.20	21.57

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_b01	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Delta to limit dB
6585	-41.63	-2.76	-22.76	18.87

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_b01	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Delta to limit dB
18294	-41.75	1.36	-18.64	23.11

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_b01	Temp.ant.connector

Frequency MHz	Corrected measurement value dBm	Reference value dBm	Limit dBm	Delta to limit dB
6936	-41.55	-2.81	-22.81	18.74

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

4.3.4 Test result: Spurious RF conducted emissions

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

4.4 Spurious radiated emissions

Standard FCC Part 15, 10-1-06
Subpart C

The test was performed according to: ANSI C 63.4, 2003

4.4.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.4-2003. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m in the semi-anechoic chamber. The test was performed at the distance of 3 m between the EUT and the receiving antenna.

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.

1. Measurement up to 30 MHz

The test set-up was made in accordance to the general provisions of ANSI C 63.4-2003. 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: 10m
- 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

Measurement up to 1 GHz

Step 1: Preliminary scan

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

Settings for step 1:

- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 μ s
- Turntable angle range: –180 to 180 °

- Turntable step size: 90°
- Height variation range: 1 – 3m
- Height variation step size: 2m
- 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: 100ms
- Turntable angle range: –180 to 180 °
- Turntable step size: 45°
- Height variation range: 1 – 4m
- Height variation step size: 0.5m
- 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: 0.5m

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 the turntable azimuth and antenna height, which was determined in step 3, 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 in step 3. 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: 100ms
- Turntable angle range: –22.5° to + 22.5 ° around the value determined in step 2
- Height variation range: -0.25m to + 0.25m around the value determined in step 2

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(< 1GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1s

Measurement above 1GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

The measurement distance was reduced to 1m. 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
- RBW = VBW = 100 kHz

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.

4.4.2 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 Range (MHz)	Class B Limit (dBµV/m)
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
above 960	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: $\text{Limit (dBµV/m)} = 20 \log (\text{Limit (µV/m)}/1\mu\text{V/m})$

4.4.3 Test Protocol

Temperature: 25 °C
 Air Pressure: 1015 hPa
 Humidity: 36 %

4.4.3.1 Measurement up to 30 MHz

Op. Mode	Setup	Port
op-mode 1b	Setup_a01	Enclosure

Polarisation	Frequency MHz	Corrected value dBµV / m			Limit dBµV / m	Limit dBµV / m	Limit dBµV / m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
0°	-	-	-	-	-	-	-	-	-
90°	-	-	-	-	-	-	-	-	-

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

The found peak at 91.2kHz is emission from loop antenna power supply.

4.4.3.2 Measurement above 30 MHz

Op. Mode **Setup** **Port**
op-mode 1b Setup_a01 Enclosure

Polarisation	Frequency MHz	Corrected value dBµV / m			Limit dBµV / m	Limit dBµV / m	Limit dBµV / m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Vertical + horizontal	4824		40.98	29.17		74	54	33.02	24.83

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

Op. Mode **Setup** **Port**
op-mode 2b Setup_a01 Enclosure

Polarisation	Frequency MHz	Corrected value dBµV / m			Limit dBµV / m	Limit dBµV / m	Limit dBµV / m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Vertical + horizontal	4874		39.56	27.68		74	54	34.44	26.32

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

Op. Mode **Setup** **Port**
op-mode 3b Setup_a01 Enclosure

Polarisation	Frequency MHz	Corrected value dBµV / m			Limit dBµV / m	Limit dBµV / m	Limit dBµV / m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Vertical + horizontal	4922		38.50	26.81		74	54	35.50	27.19

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

Op. Mode	Setup	Port
op-mode 1g	Setup_a01	Enclosure

Polarisation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Vertical + horizontal	2400		52.59	38.80		74	54	21.41	15.20

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

Op. Mode	Setup	Port
op-mode 2g	Setup_a01	Enclosure

Polarisation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Vertical + horizontal	-	-	-	-	-	-	-	-	-

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

Op. Mode	Setup	Port
op-mode 3g	Setup_a01	Enclosure

Polarisation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Vertical + horizontal	-	-	-	-	-	-	-	-	-

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

4.4.4 Test result: Spurious radiated emissions

Tested with maximum data rate op mode b with 11 Mbps and mode g with 54 Mbps

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



4.5 Band edge compliance

Standard FCC Part 15, 10-1-06
Subpart C

The test was performed according to: ANSI C 63.4, 2003
FCC §15.31, 10-1-06

4.5.1 Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements: 1. Show compliance of the lower band edge by a conducted measurement and 2. show compliance of the higher band edge by a radiated measurement.

For the first measurement the EUT is set to transmit on the lowest channel (2402 MHz). The lower band edge is 2400 MHz.

Analyzer settings:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

For the second measurement the EUT is set to transmit on the highest channel (2462 MHz). The higher band edge is 2483.5 MHz.

Analyzer settings:

- Detector: Peak, Average
- RBW = VBW = 100 kHz

4.5.2 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.

...

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 measurement of the **lower band edge** 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 measurement of the **higher band edge** the limit is "specified in Section 15.209(a)".

4.5.3 Test Protocol

4.5.3.1 Lower band edge

Temperature: 21 °C
Air Pressure: 1005 hPa
Humidity: 37 %

Op. Mode	Setup	Port
op-mode 1b	Setup_b01	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Delta to limit dB
2400.00	-45.95	-1.42	-21.42	24.53

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_b01	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Delta to limit dB
2400.00	-30.46	-3.13	-23.13	7.33

Remark: Please see annex for the measurement plot.

4.5.3.2 Higher band edge

Conducted measurement

Temperature: 21 °C
Air Pressure: 1005 hPa
Humidity: 37 %

Op. Mode	Setup	Port
op-mode 3b	Setup_b01	Temp.ant.connector

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Delta to limit dB
2483.50	-46.61	1.36	-18.64	27.97

Op. Mode	Setup	Port
op-mode 3g	Setup_b01	Temp.ant.connector

Remark: Please see annex for the measurement plot.

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Delta to limit dB
2483.50	-39.82	-2.81	-22.81	17.01

Remark: Please see annex for the measurement plot.



Radiated measurement

Temperature: 25 °C
Air Pressure: 1015 hPa
Humidity: 36 %

Op. Mode	Setup	Port
op-mode 3b	Setup_a01	Enclosure

Frequency MHz	Polarisation	Corrected value dBµV / m		Limit Peak dBµV / m	Limit AV dBµV / m	Delta to Peak limit / dB	Delta to AV limit dB
		Peak	AV				
2483.50	Vertical + horizontal	47.50	35.93	74.00	54.00	26.50	18.07

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_a01	Enclosure

Frequency MHz	Polarisation	Corrected value dBµV / m		Limit Peak dBµV / m	Limit AV dBµV / m	Delta to Peak limit / dB	Delta to AV limit dB
		Peak	AV				
2483.50	Vertical + horizontal	46.97	35.20	74.00	54.00	27.03	18.80

Remark: Please see annex for the measurement plot.

4.5.4 Test result: Band edge compliance

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

4.6 Power density

Standard FCC Part 15, 10-1-06
Subpart C

The test was performed according to: FCC §15.31, 10-1-06

4.6.1 Test Description

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:

- Detector: Peak-Maxhold
- Span: 300 kHz
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

4.6.2 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.

4.6.3 Test Protocol

Temperature: 25 °C
Air Pressure: 1017 hPa
Humidity: 52 %

Op. Mode	Setup	Port
op-mode 1b	Setup_b01	Temp.ant.connector

Power density dBm / 3 kHz	Remarks
-17.33	-

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 1g	Setup_b01	Temp.ant.connector

Power density dBm / 3 kHz	Remarks
-17.45	-27.74

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2b	Setup_b01	Temp.ant.connector

Power density dBm / 3 kHz	Remarks
-16.64	-27.72

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 2g	Setup_b01	Temp.ant.connector

Power density dBm / 3 kHz	Remarks
-17.16	-26.60

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3b	Setup_b01	Temp.ant.connector

Power density dBm / 3 kHz	Remarks
-16.91	-27.09

Remark: Please see annex for the measurement plot.

Op. Mode	Setup	Port
op-mode 3g	Setup_b01	Temp.ant.connector

Power density dBm / 3 kHz	Remarks
-17.03	-26.94

Remark: Please see annex for the measurement plot.

4.6.4 Test result: Power density

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

5 Test Equipment

EUT Digital Signalling System

Equipment	Type	Serial No.	Manufacturer
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz
Signalling Unit for Bluetooth Spurious Emissions	PTW60	100004	Rohde & Schwarz
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz

EMI Test System

Equipment	Type	Serial No.	Manufacturer
Comparison Noise Emitter	CNE III	99/016	York
EMI Analyzer	ESI 26	830482/004	Rohde & Schwarz
Signal Generator	SMR 20	846834/008	Rohde & Schwarz

EMI Radiated Auxiliary Equipment

Equipment	Type	Serial No.	Manufacturer
Antenna mast 4m	MA 240	240/492	HD GmbH H. Deisel
Biconical dipole	VUBA 9117	9117108	Schwarzbeck
Broadband Amplifier 18MHz-26GHz	JS4-18002600-32	849785	Miteq
Broadband Amplifier 30MHz-18GHz	JS4-00101800-35	896037	Miteq
Broadband Amplifier 45MHz-27GHz	JS4-00102600-42	619368	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-Microcoax
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic
KUEP pre amplifier	Kuep 00304000	001	7layers
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz
Pyramidal Horn Antenna 26.5 GHz	Model 3160-09	9910-1184	EMCO



EMI Conducted Auxiliary Equipment

Equipment	Type	Serial No.	Manufacturer
Cable "LISN to ESI"	RG214	W18.03+W48.03	Huber+Suhner
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz

Auxiliary Test Equipment

Equipment	Type	Serial No.	Manufacturer
Broadband Resist. Power Divider N	1506A / 93459	LM390	Weinschel
Broadband Resist. Power Divider SMA	1515 / 93459	LN673	Weinschel
Digital Multimeter 01	Voltcraft M-3860M	IJ096055	Conrad
Digital Multimeter 02	Voltcraft M-3860M	IJ095955	Conrad
Digital Oscilloscope	TDS 784C	B021311	Tektronix
Fibre optic link Satellite	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver	FO RS232 Link	182-018	Pontis
I/Q Modulation Generator	AMIQ-B1	832085/018	Rohde & Schwarz
Notch Filter ultra stable	WRCA800/960-6E	24	Wainwright
Spectrum Analyzer 9 kHz to 3 GHz	FSP3	838164/004	Rohde & Schwarz
Temperature Chamber	VT 4002	58566002150010	Vötsch
Temperature Chamber	KWP 120/70	59226012190010	Weiss
ThermoHygro Datalogger 03	Opus10 THI (8152.00)	7482	Lufft Mess- und Regeltechnik GmbH

Anechoic Chamber

Equipment	Type	Serial No.	Manufacturer
Air Compressor (pneumatic)			Atlas Copco
Controller	CO 2000	CO2000/328/12470406 /L	Innco innovative constructions GmbH
EMC Camera	CE-CAM/1		CE-SYS
EMC Camera for observation of EUT	CCD-400E	0005033	Mitsubishi
Filter ISDN	B84312-C110-E1		Siemens&Matsushita
Filter telephone systems / modem	B84312-C40-B1		Siemens&Matsushita
Filter Universal 1A	B84312-C30-H3		Siemens&Matsushita
Fully/Semi AE Chamber	10.58x6.38x6		Frankonia
Turntable	DS 420S	420/573/99	HD GmbH, H. Deisel
Valve Control Unit (pneum.)	VE 615P	615/348/99	HD GmbH, H. Deisel



*7 layers Bluetooth Full RF Test
Solution*

*Bluetooth RF Conformance
Test System TS8960*

Equipment	Type	Serial No.	Manufacturer
10 MHz Reference	MFS	5489/001	Efratom
Power Meter 832025/059	NRVD	832025/059	Rohde & Schwarz
Power Sensor A 832279/013	NRV-Z1	832279/013	Rohde & Schwarz
Power Sensor B 832279/015	NRV-Z1	832279/015	Rohde & Schwarz
Power Supply	E3632A	MY40003776	Agilent
Power Supply	PS-2403D	-	Conrad
RF Step Attenuator 833695/001	RSP	833695/001	Rohde & Schwarz
Rubidium Frequency Normal	MFS	002	Efratom
Signal Analyzer FSIQ26 832695/007	FSIQ26	832695/007	Rohde & Schwarz
Signal Generator 833680/003	SMP 03	833680/003	Rohde & Schwarz
Signal Generator A 834344/002	SMIQ03B	834344/002	Rohde & Schwarz
Signal Generator B 832870/017	SMIQ03B	832870/017	Rohde & Schwarz
Signal Switching and Conditioning Unit	SSCU	338826/005	Rohde & Schwarz
Signalling Unit PTW60 838312/014	PTW60 for TS8960	838312/014	Rohde & Schwarz
System Controller 829323/008	PSM12	829323/008	Rohde & Schwarz

6 Photo Report



PHOTO No. 1: Setup for radiated measurements below 30 MHz

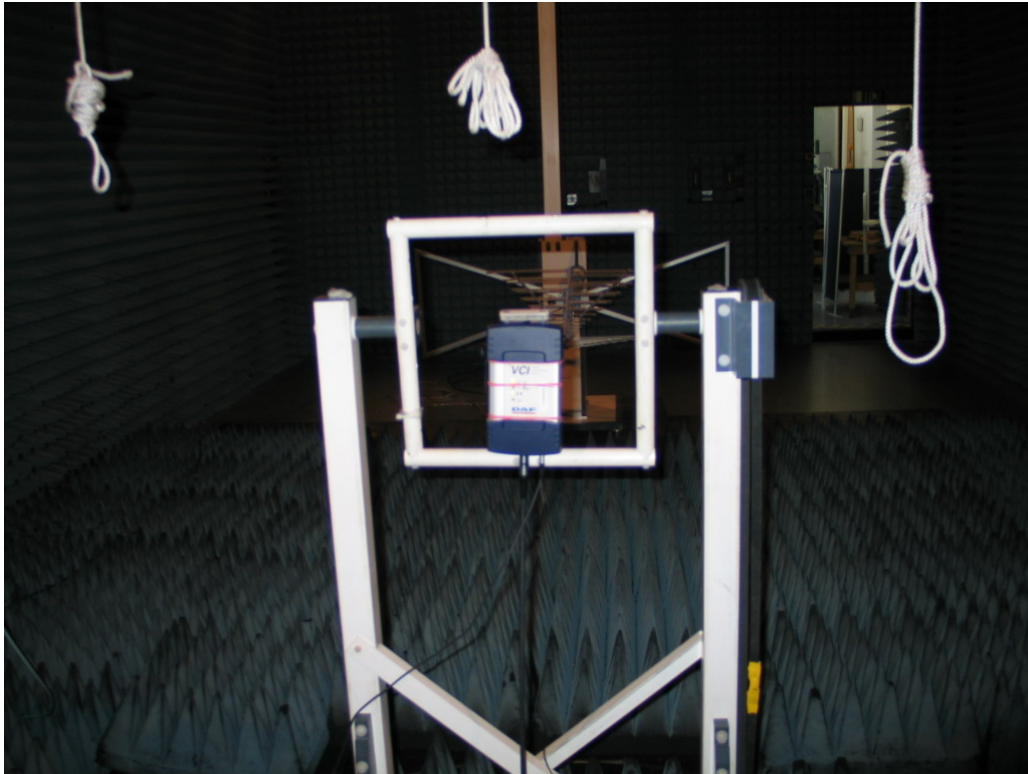
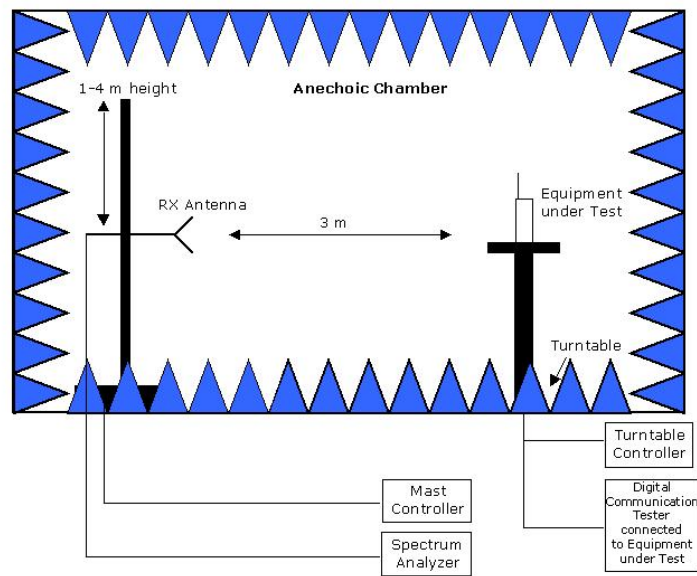


PHOTO No. 2: Setup for radiated measurements above 1 GHz

7 Setup Drawings



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

Drawing 1: Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting groundplane.

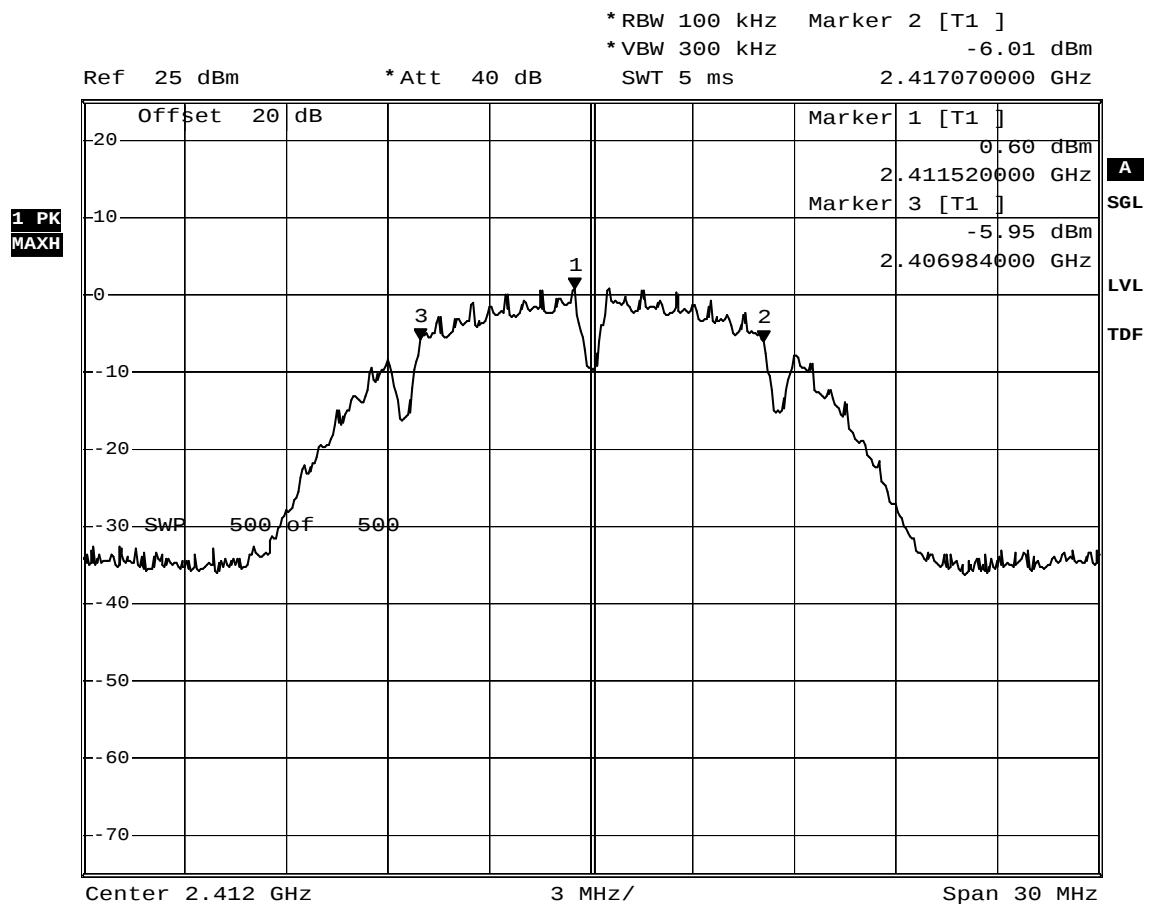
8 Annex measurement plots

8.1 Occupied bandwidth

8.1.1 Occupied bandwidth operating mode 1

Op. Mode

op-mode 1b



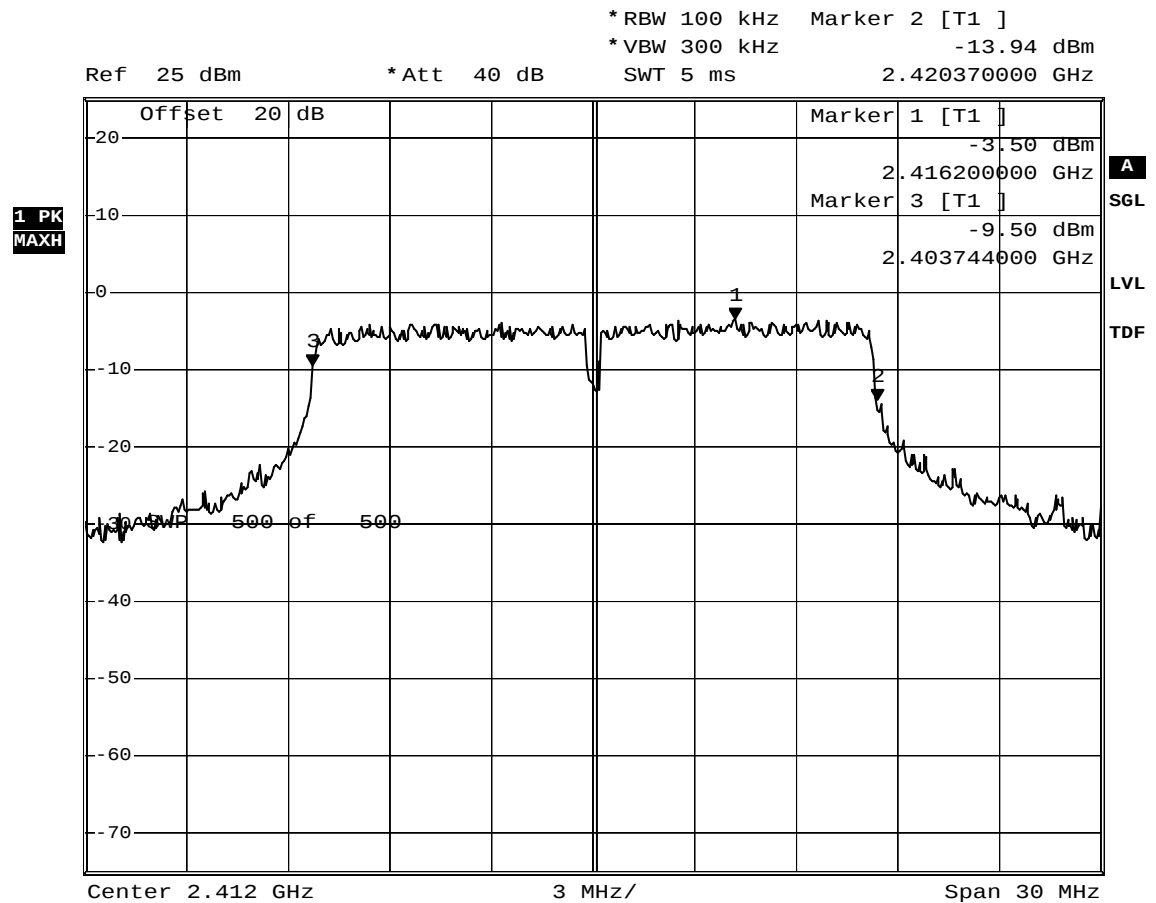
Comment: CH B: 2412 MHz; 6dB bandwidth (kHz):10086

Date: 13.JUL.2007 10:41:55



Op. Mode

op-mode 1g



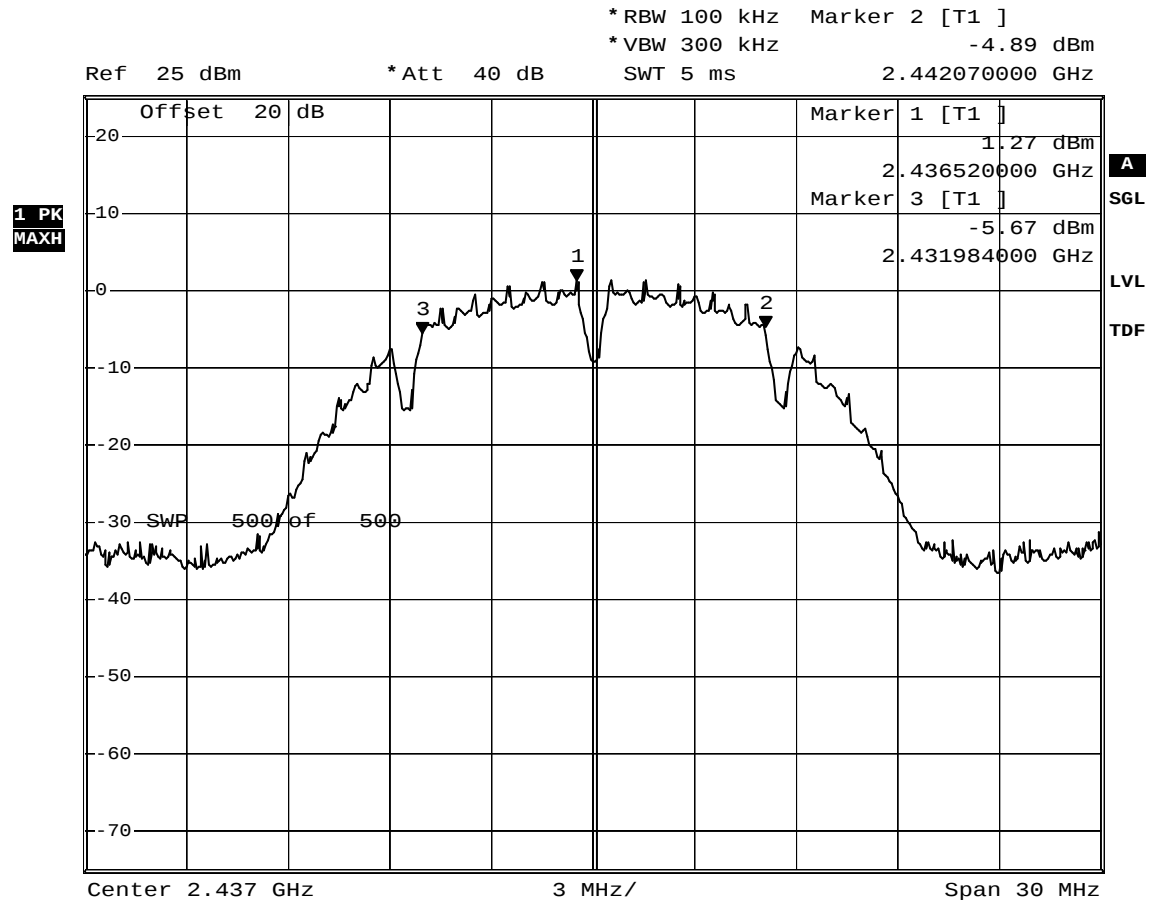
Comment: CH B: 2412 MHz; 6dB bandwidth (kHz):16626

Date: 13.JUL.2007 10:53:48

8.1.2 Occupied bandwidth operating mode 2

Op. Mode

op-mode 2b

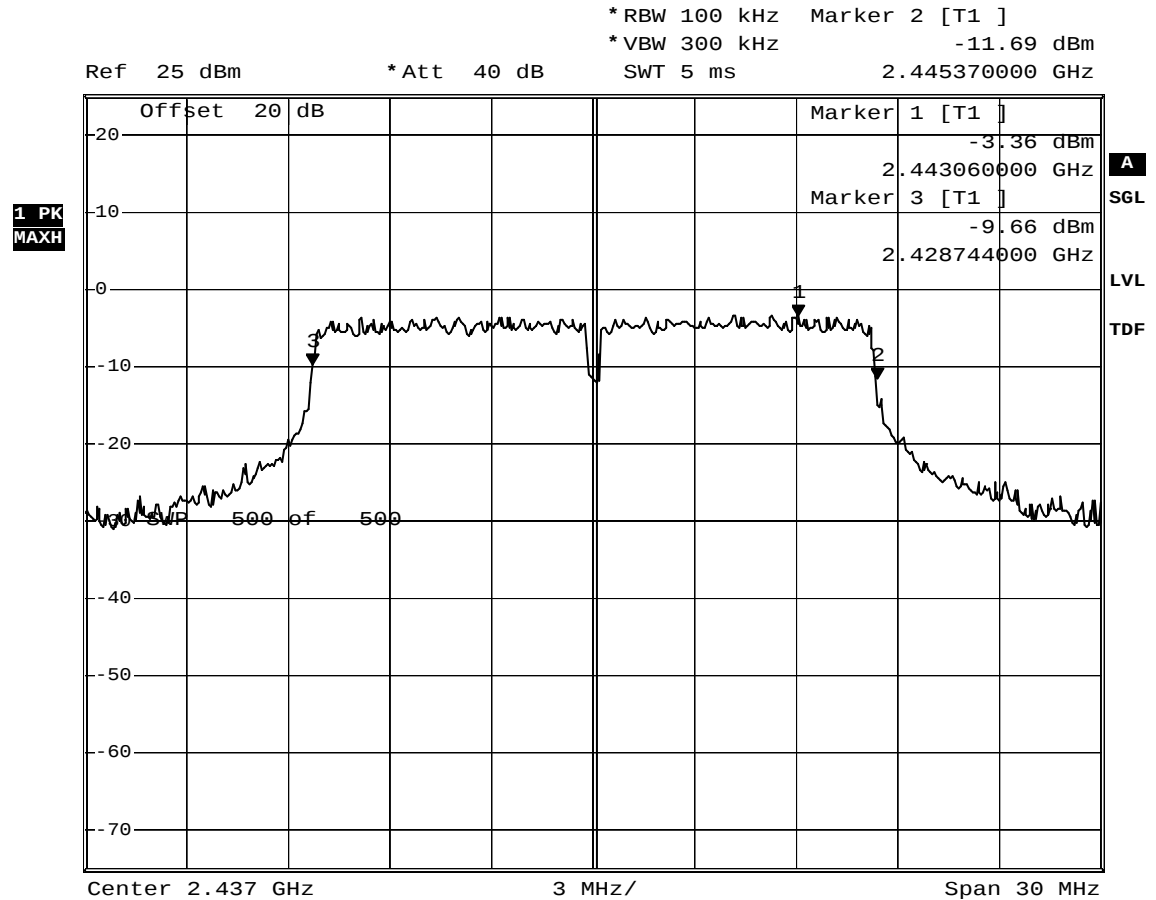


Comment: CH M: 2437 MHz; 6dB bandwidth (kHz):10086

Date: 13.JUL.2007 12:09:22

Op. Mode

op-mode 2g

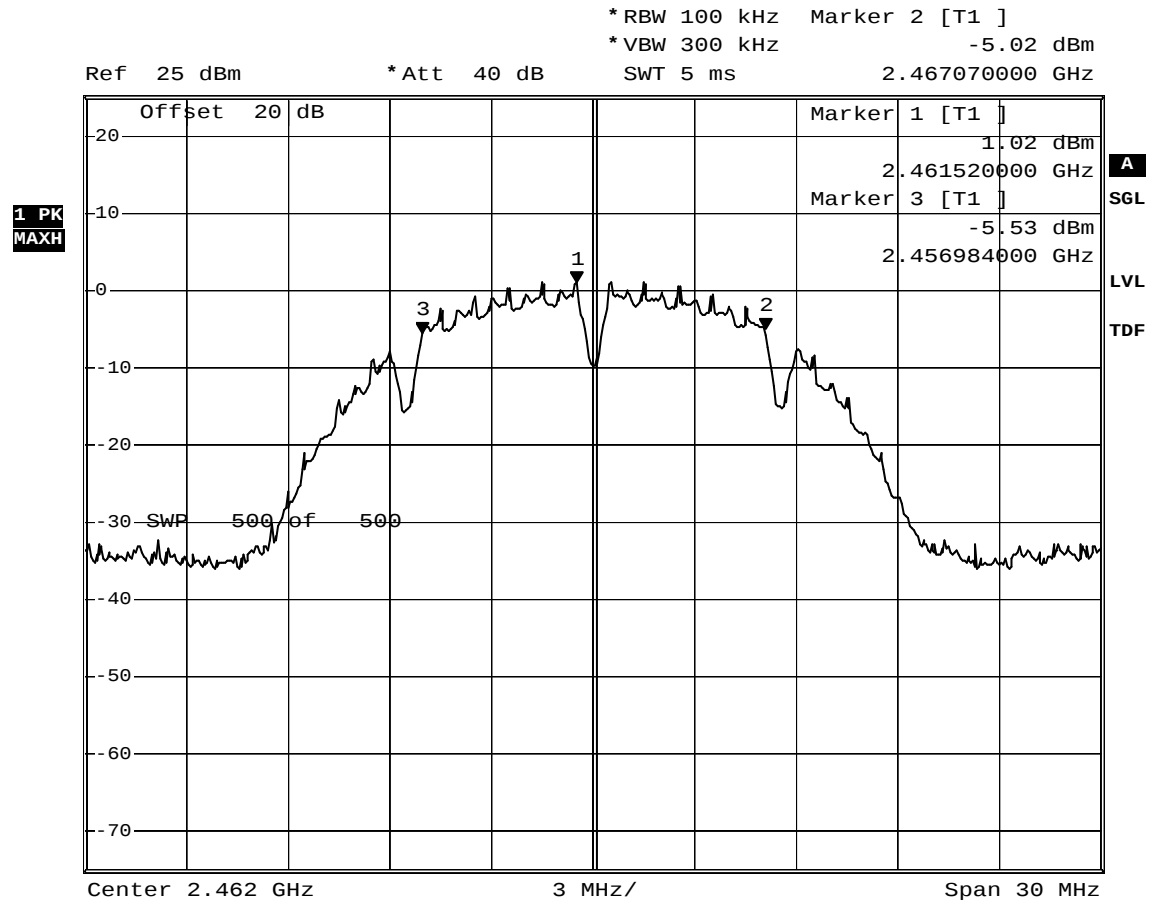


Comment: CH M: 2437 MHz; 6dB bandwidth (kHz):16626
 Date: 13.JUL.2007 11:58:24

8.1.3 Occupied bandwidth operating mode 3

Op. Mode

op-mode 3b

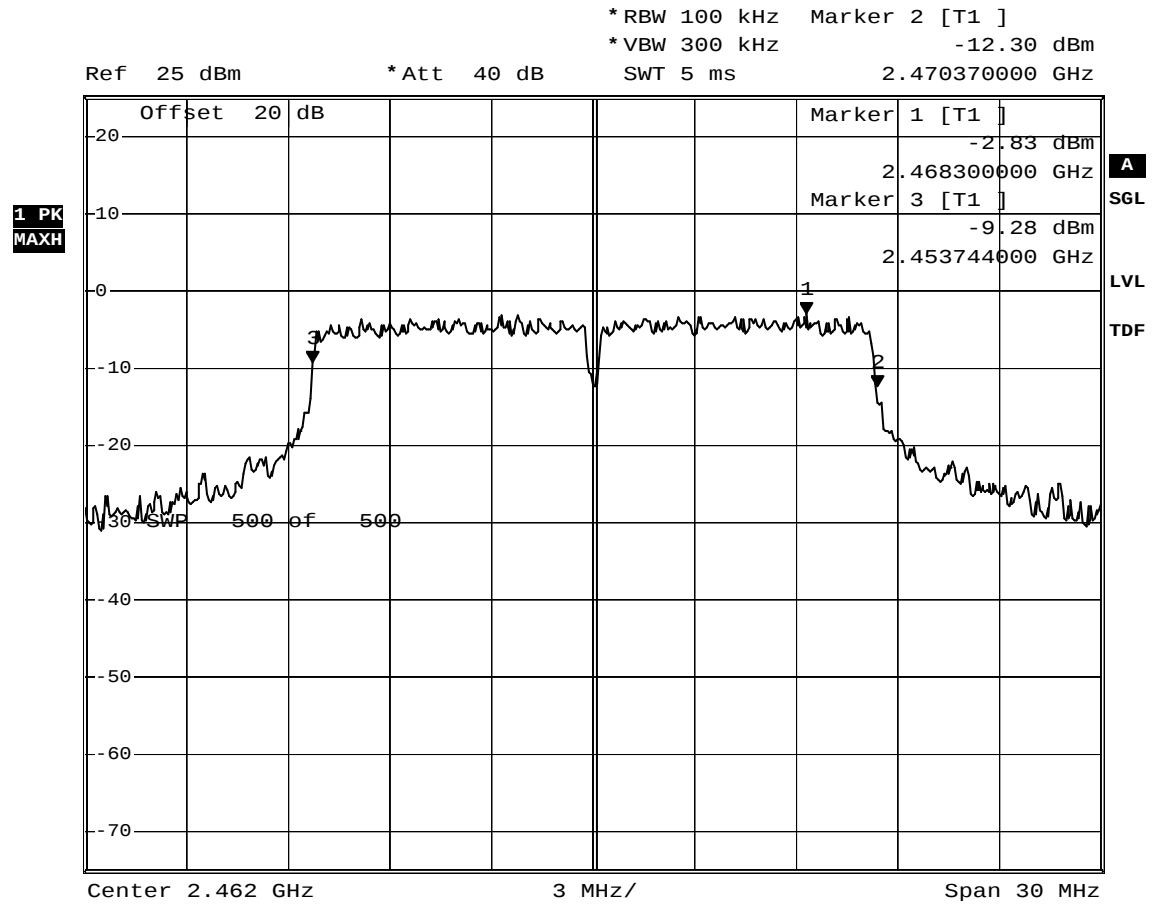


Comment: CH T: 2462 MHz; 6dB bandwidth (kHz):10086

Date: 13.JUL.2007 12:21:23

Op. Mode

op-mode 3g



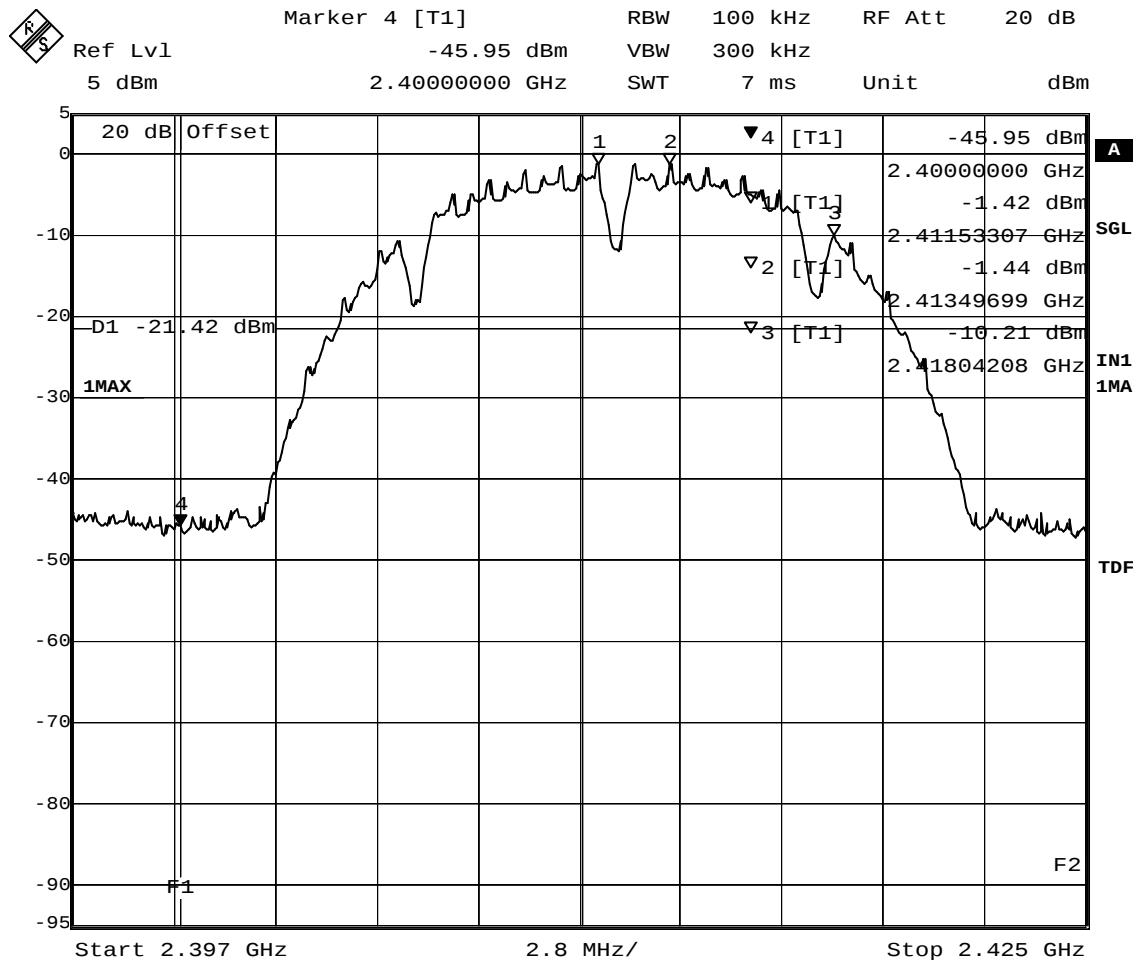
Comment: CH T: 2462 MHz; 6dB bandwidth (kHz):16626
 Date: 13.JUL.2007 12:30:09

8.2 Band edge compliance conducted and Spurious RF conducted emission

8.2.1 Band edge compliance conducted operating mode 1

Op. Mode

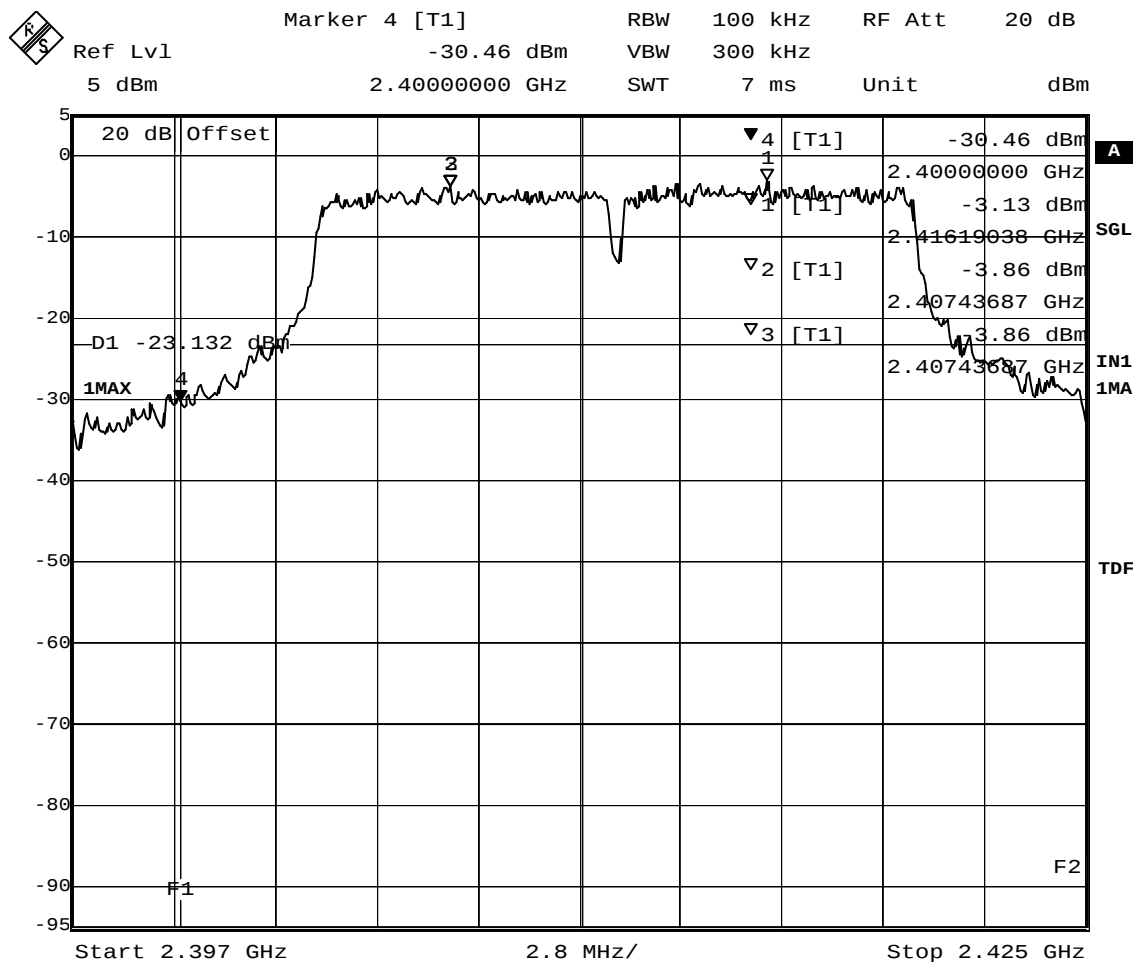
op-mode 1b



Title: Band Edge Compliance
 Comment A: CH B: 2412 MHz
 Date: 16.JUL.2007 05:19:22

Op. Mode

op-mode 1g



Title: Band Edge Compliance

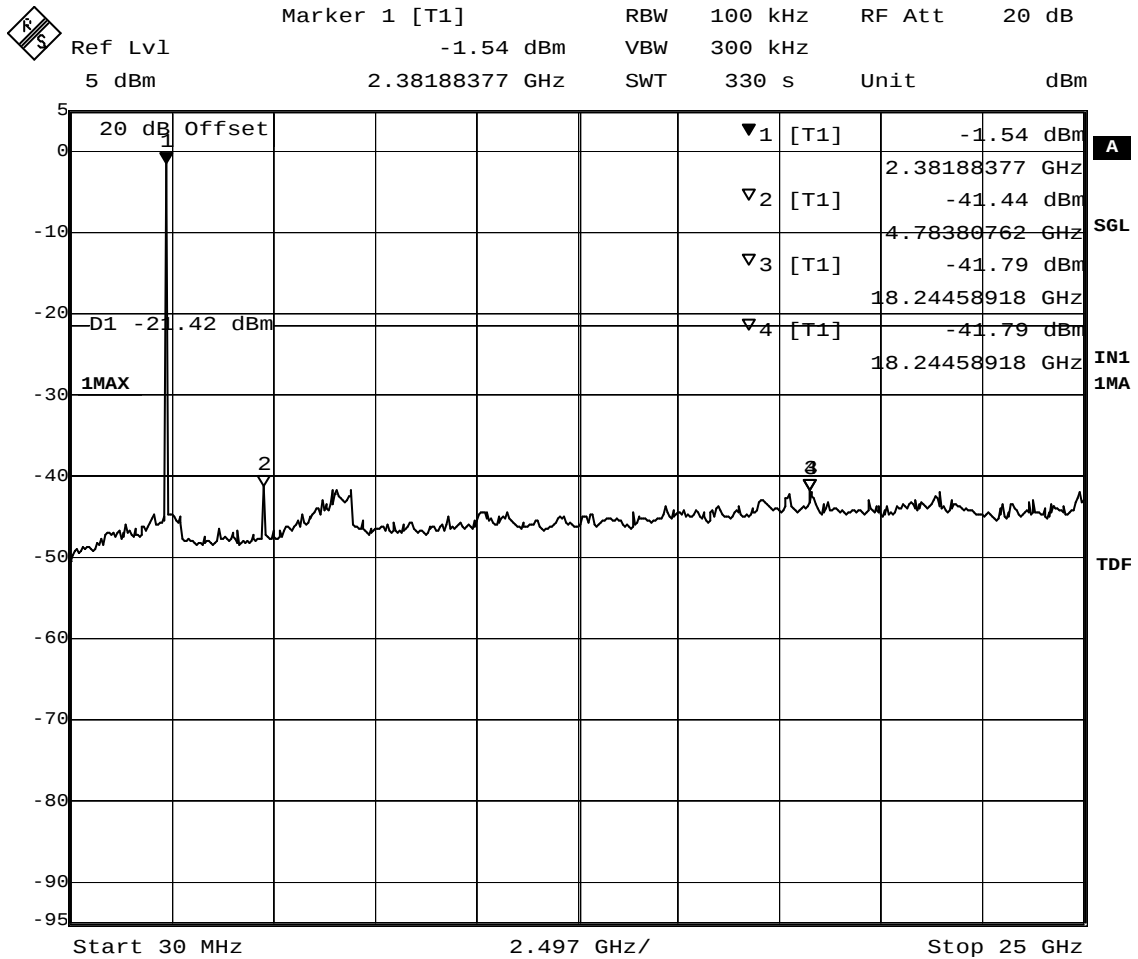
Comment A: CH B: 2412 MHz

Date: 16.JUL.2007 06:32:44

8.2.2 Spurious RF conducted emission operating mode 1

Op. Mode

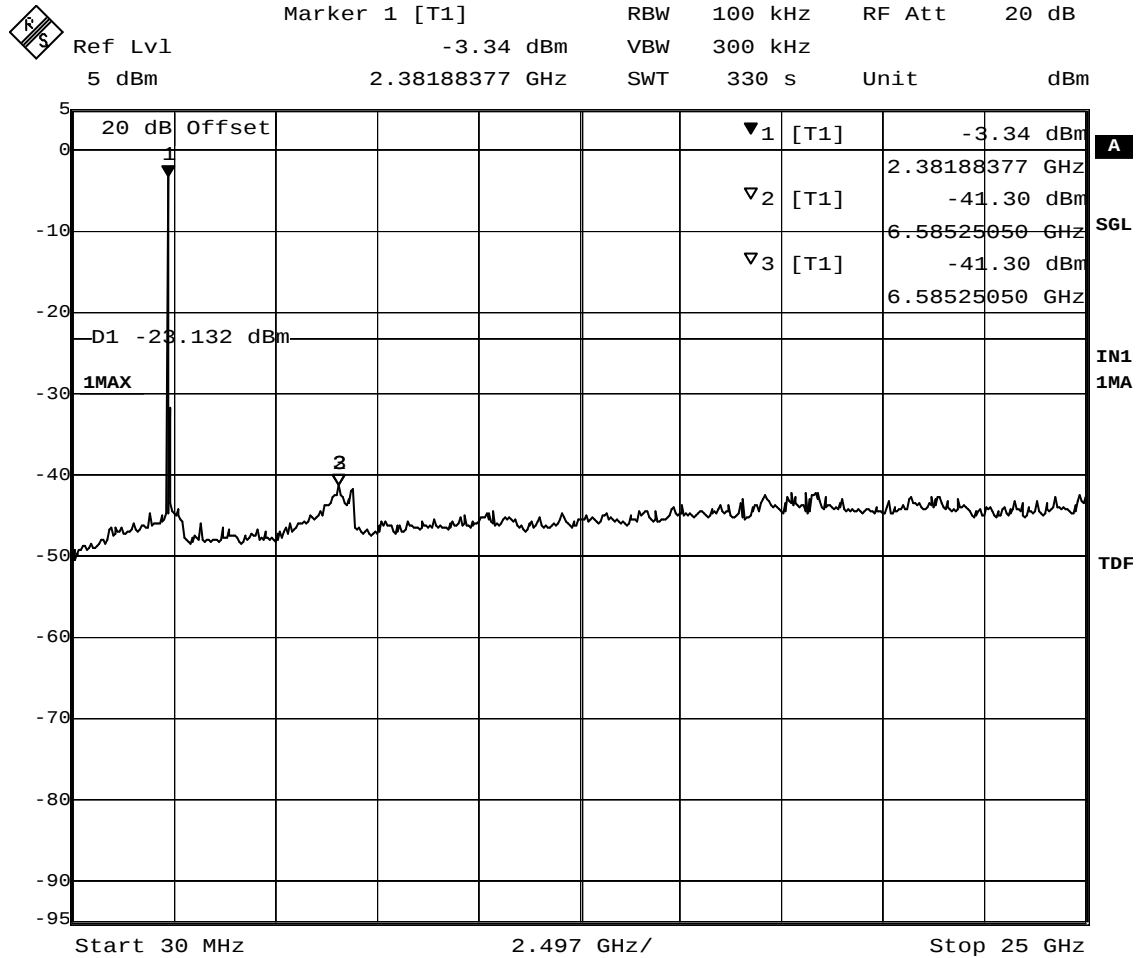
op-mode 1b



Title: spurious emissions
 Comment A: CH B: 2412 MHz
 Date: 16.JUL.2007 05:31:05

Op. Mode

op-mode 1g

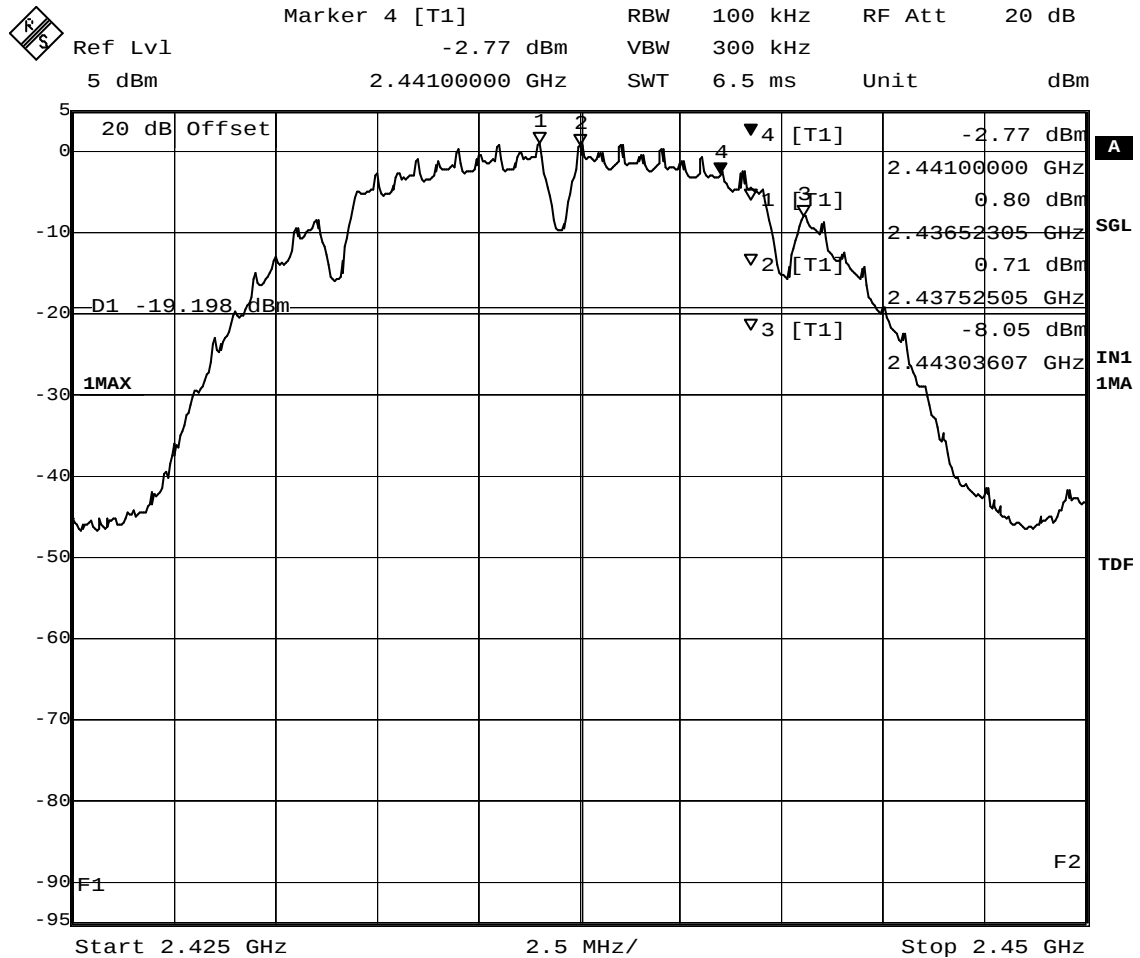


Title: spurious emissions
 Comment A: CH B: 2412 MHz
 Date: 16.JUL.2007 06:44:28

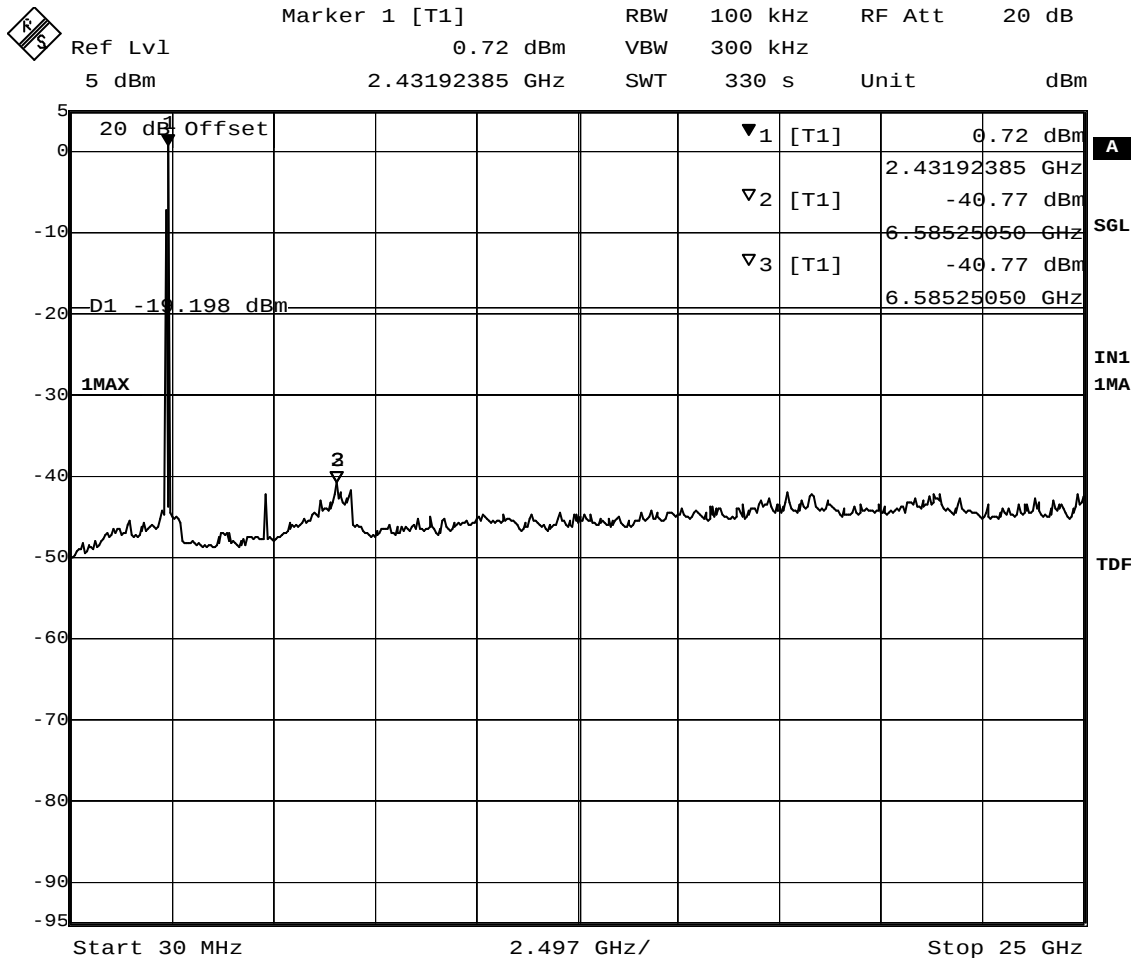
8.2.3 Spurious RF conducted emission operating mode 2

Op. Mode

op-mode 2b



Title: Band Edge Compliance
 Comment A: CH M: 2437 MHz
 Date: 16.JUL.2007 05:33:29

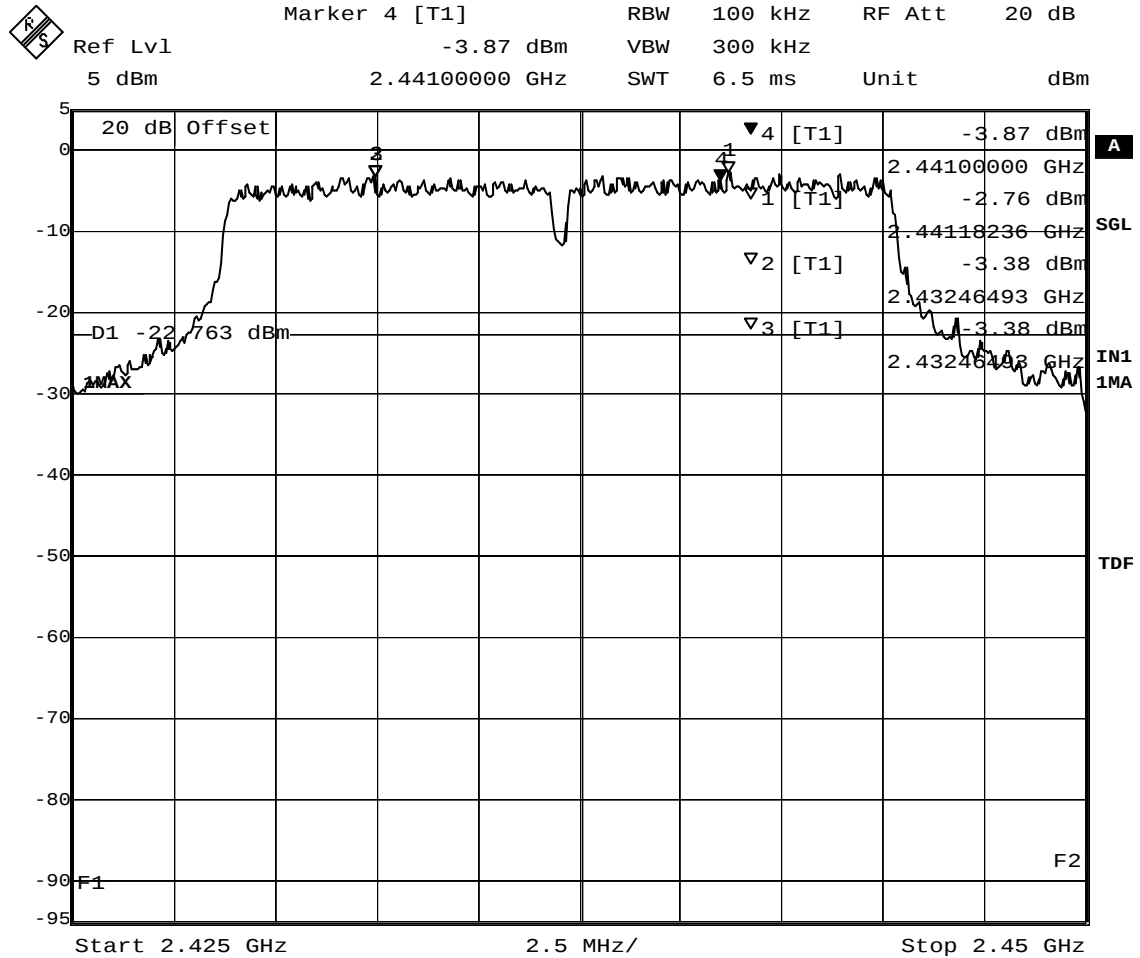


Title: spurious emissions
 Comment A: CH M: 2437 MHz
 Date: 16.JUL.2007 05:45:13

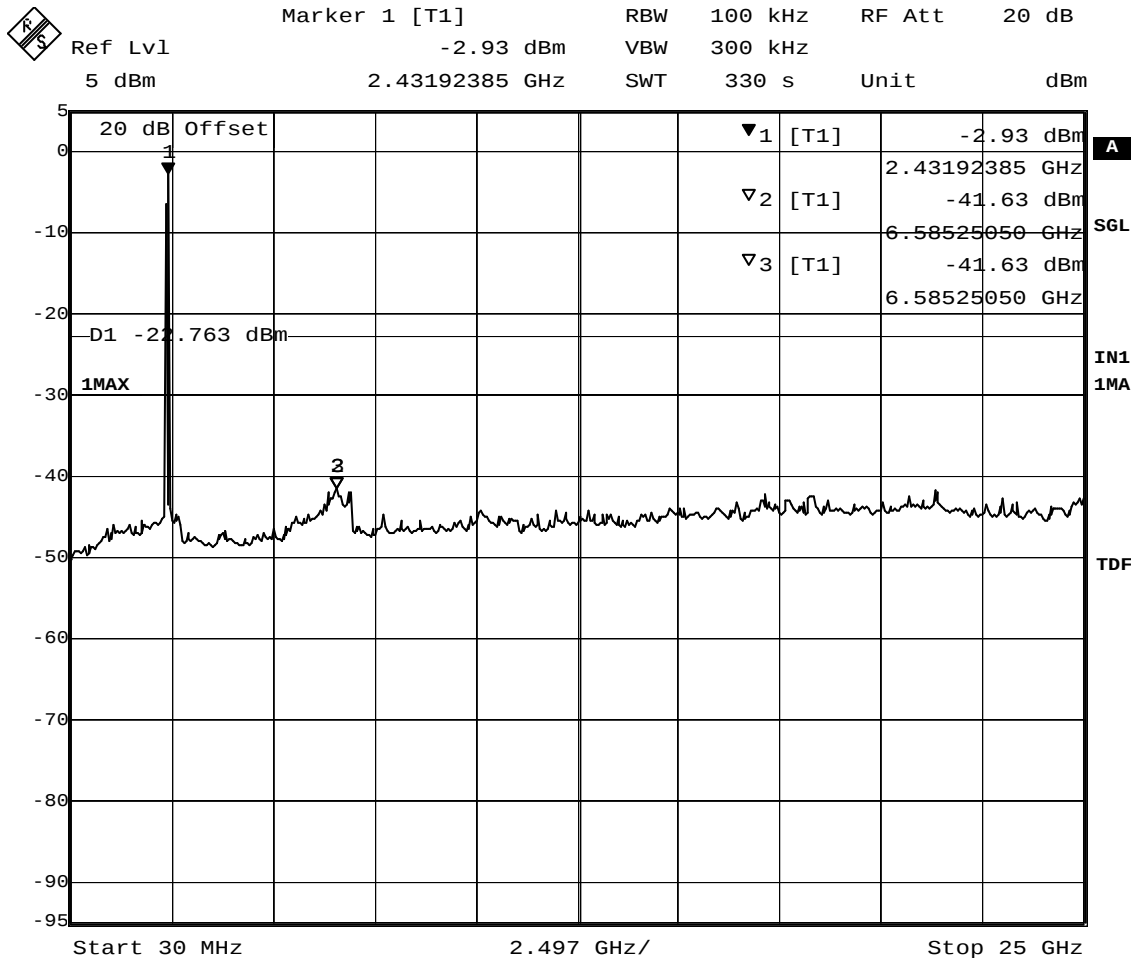


Op. Mode

op-mode 2g



Title: Band Edge Compliance
Comment A: CH M: 2437 MHz
Date: 16.JUL.2007 06:16:36

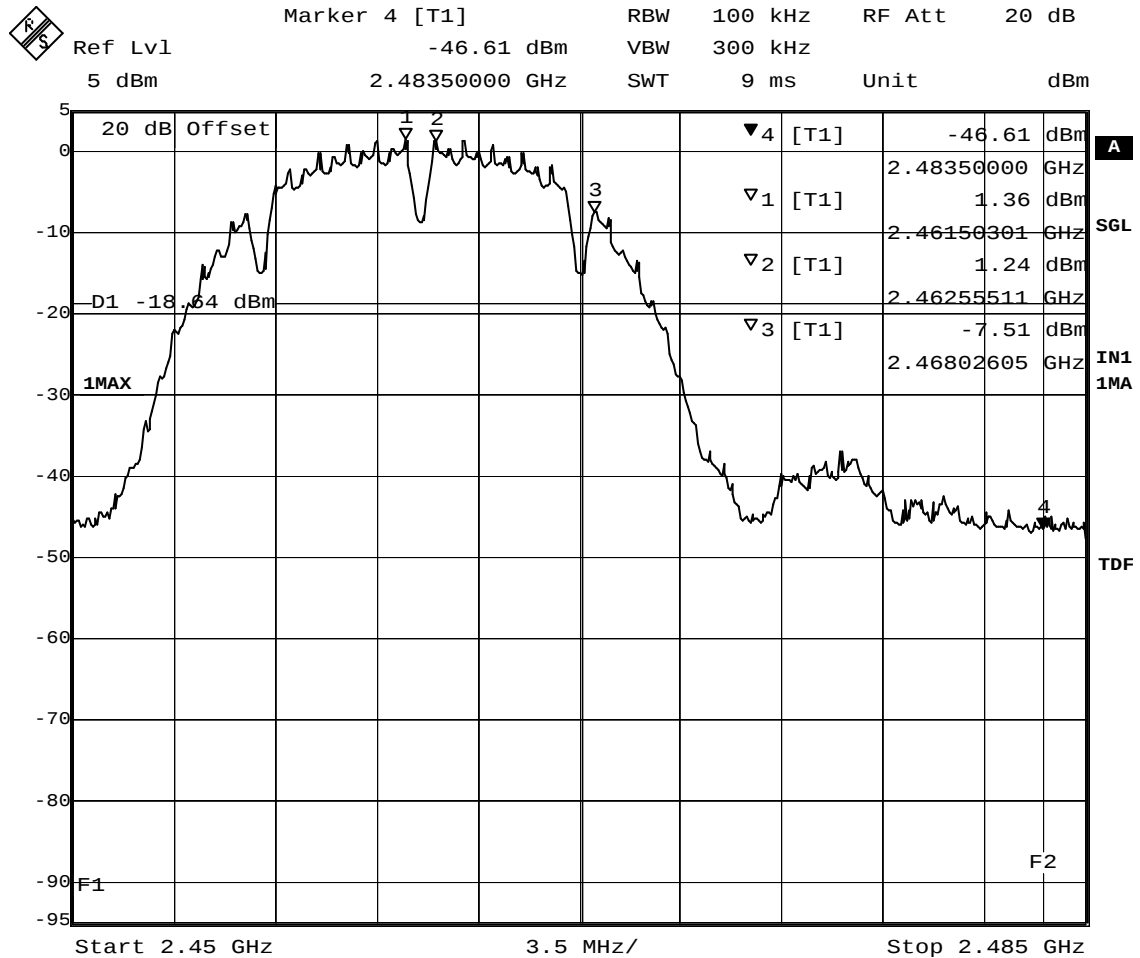


Title: spurious emissions
Comment A: CH M: 2437 MHz
Date: 16.JUL.2007 06:28:20

8.2.4 Band edge compliance conducted operating mode 3

Op. Mode

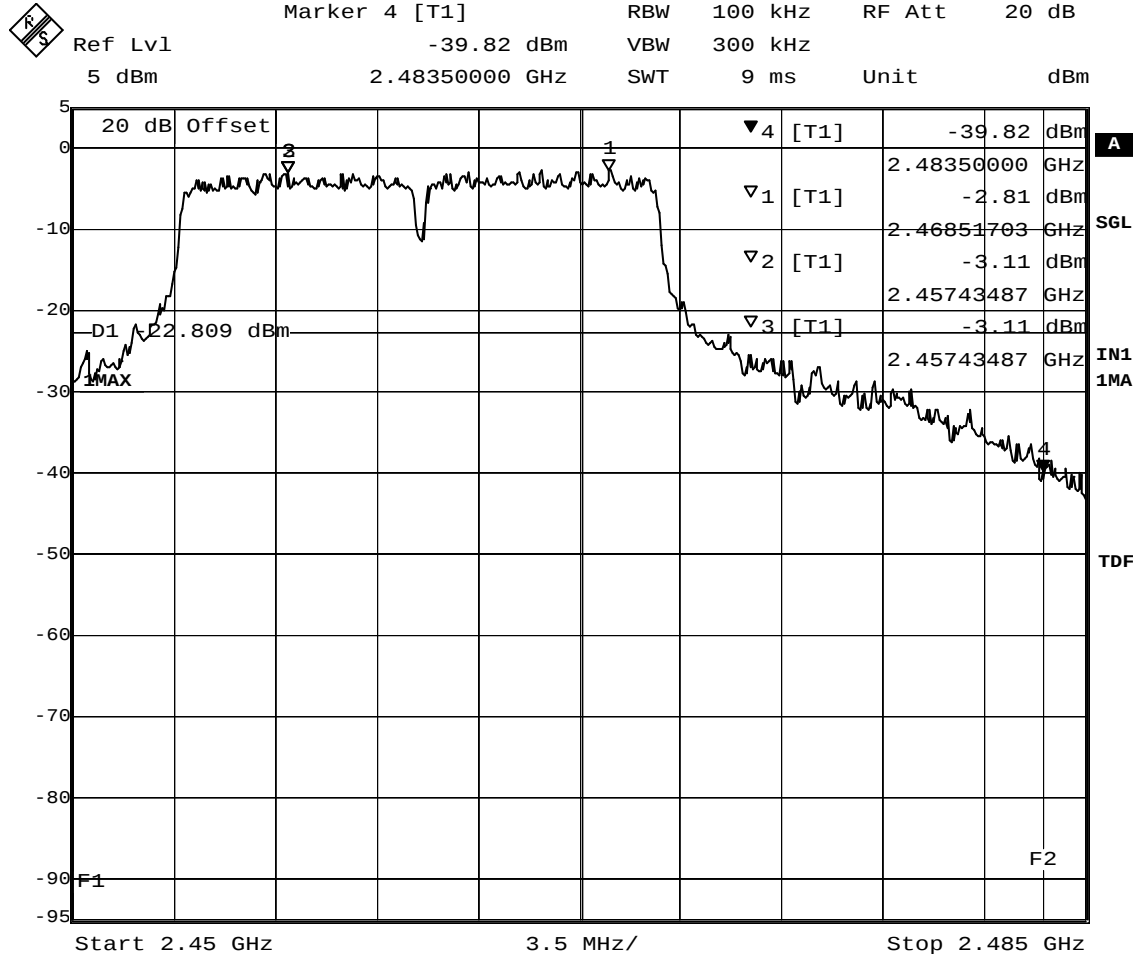
op-mode 3b



Title: Band Edge Compliance
 Comment A: CH T: 2462 MHz
 Date: 16.JUL.2007 05:49:34

Op. Mode

op-mode 3g

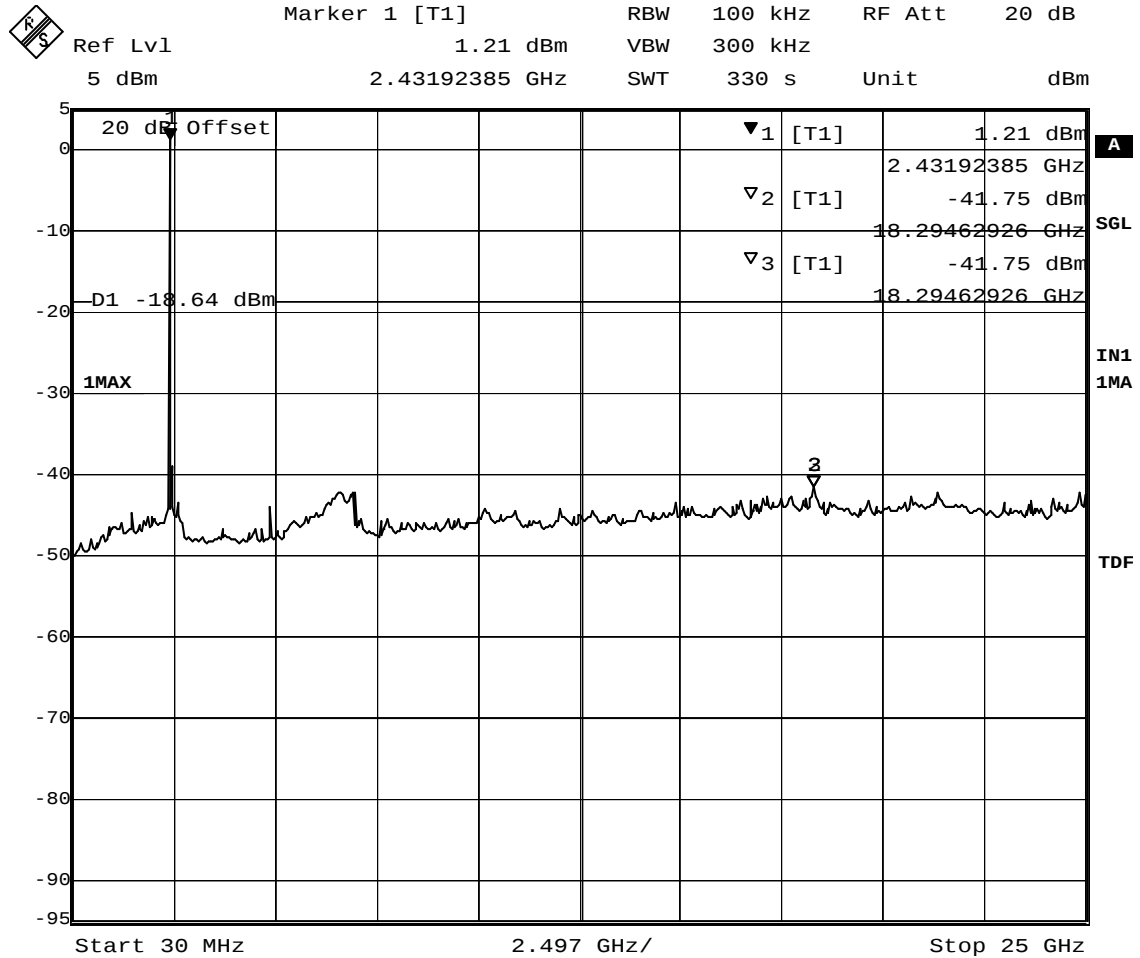


Title: Band Edge Compliance
 Comment A: CH T: 2462 MHz
 Date: 16.JUL.2007 06:03:02

8.2.5 Spurious RF conducted emission operating mode 3

Op. Mode

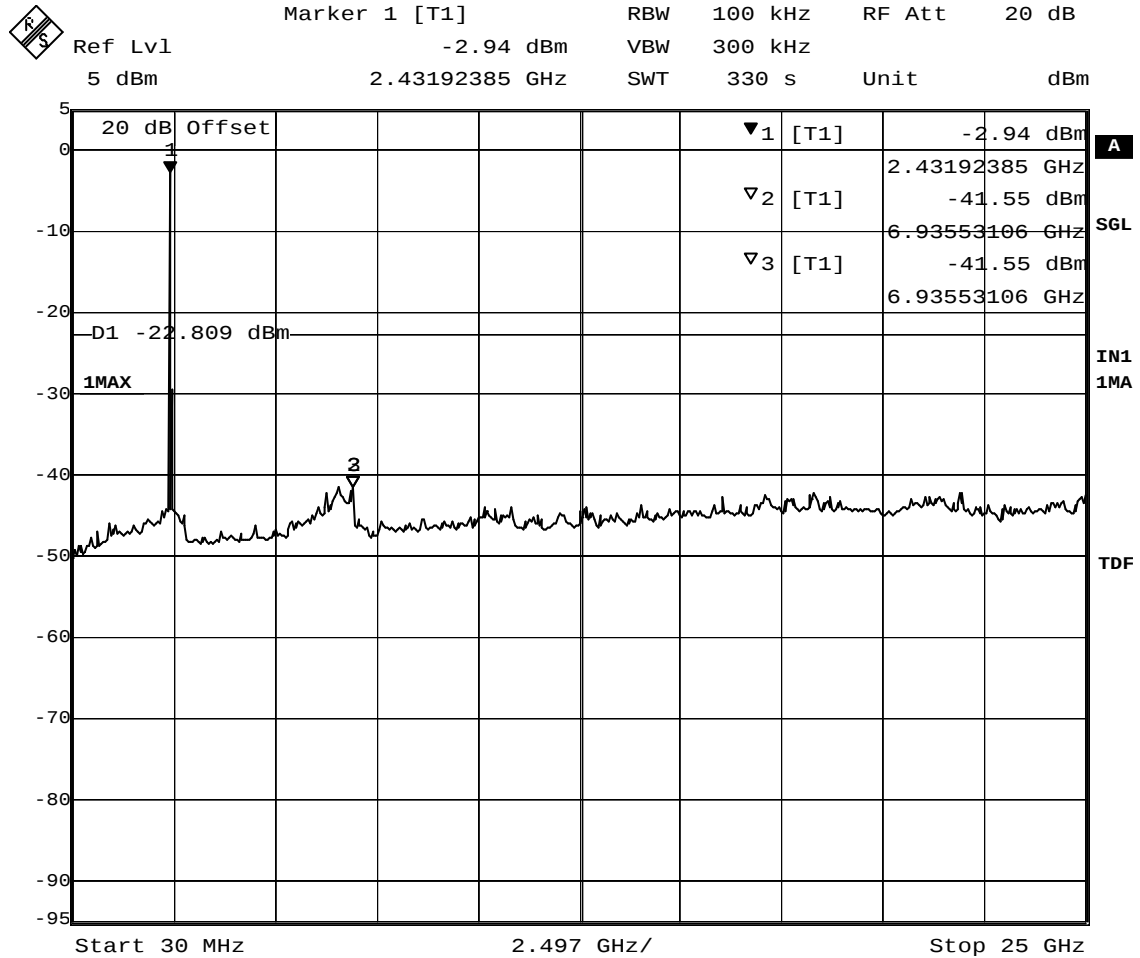
op-mode 3b



Title: spurious emissions
 Comment A: CH T: 2462 MHz
 Date: 16.JUL.2007 06:01:20

Op. Mode

op-mode 3g

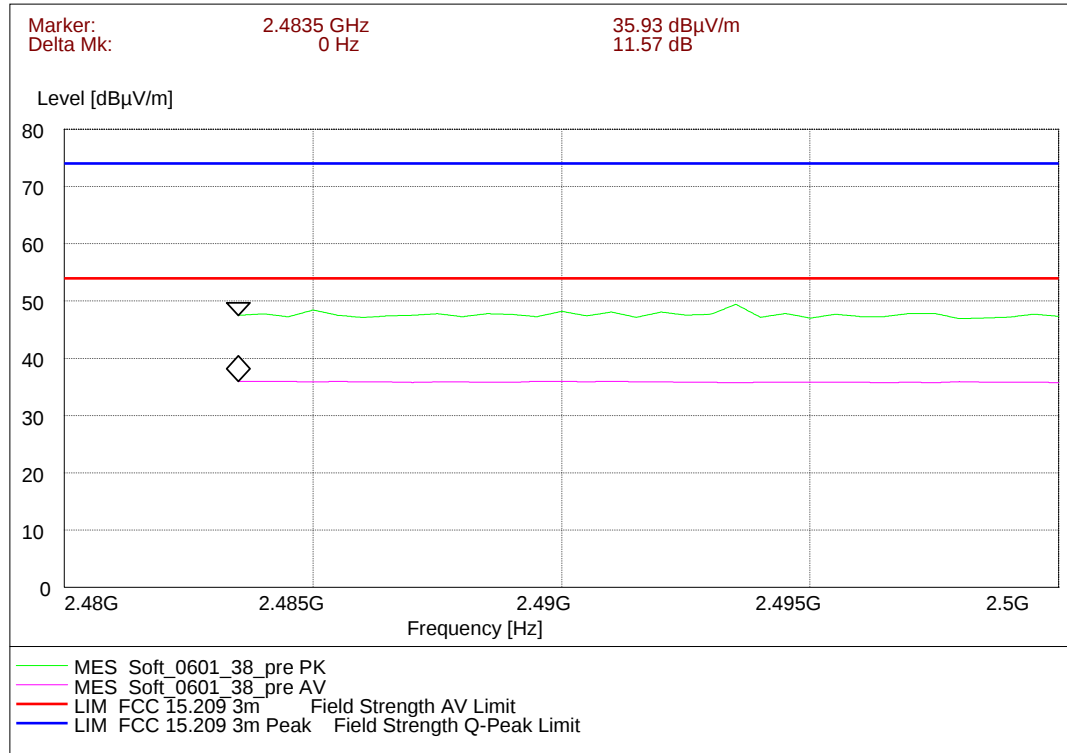


Title: spurious emissions
 Comment A: CH T: 2462 MHz
 Date: 16.JUL.2007 06:14:46

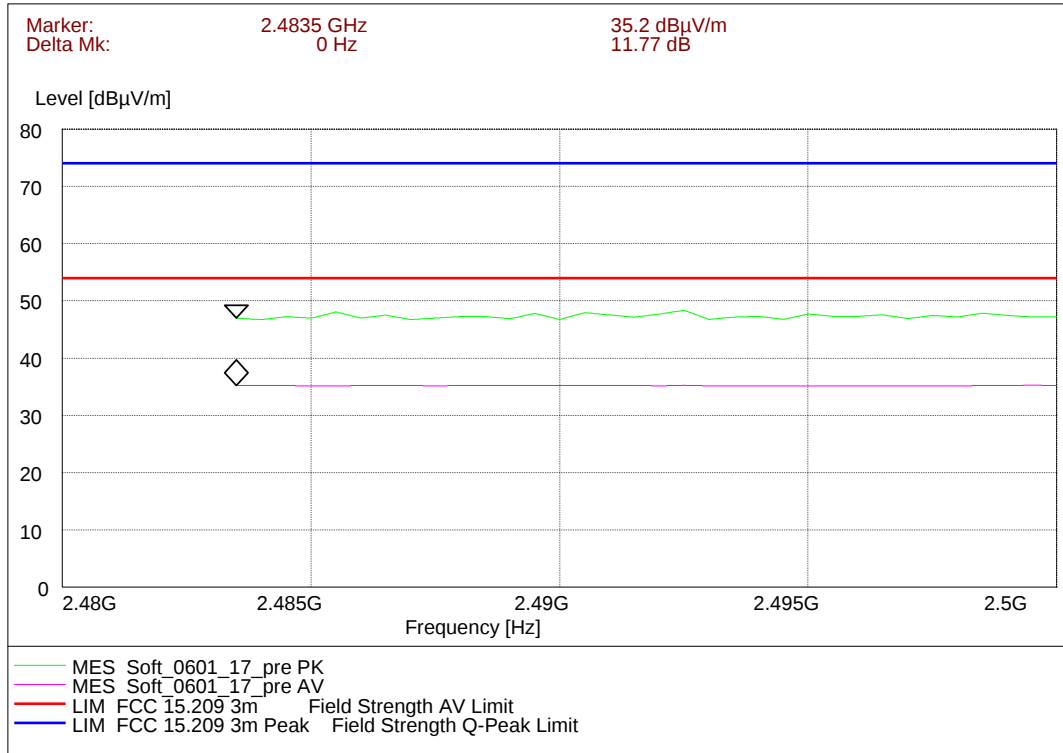
8.2.6 Band edge compliance radiated operating mode 3

Op. Mode **higher band edge**
op-mode 3b **TX on 2462 MHz**

Radiated measurement



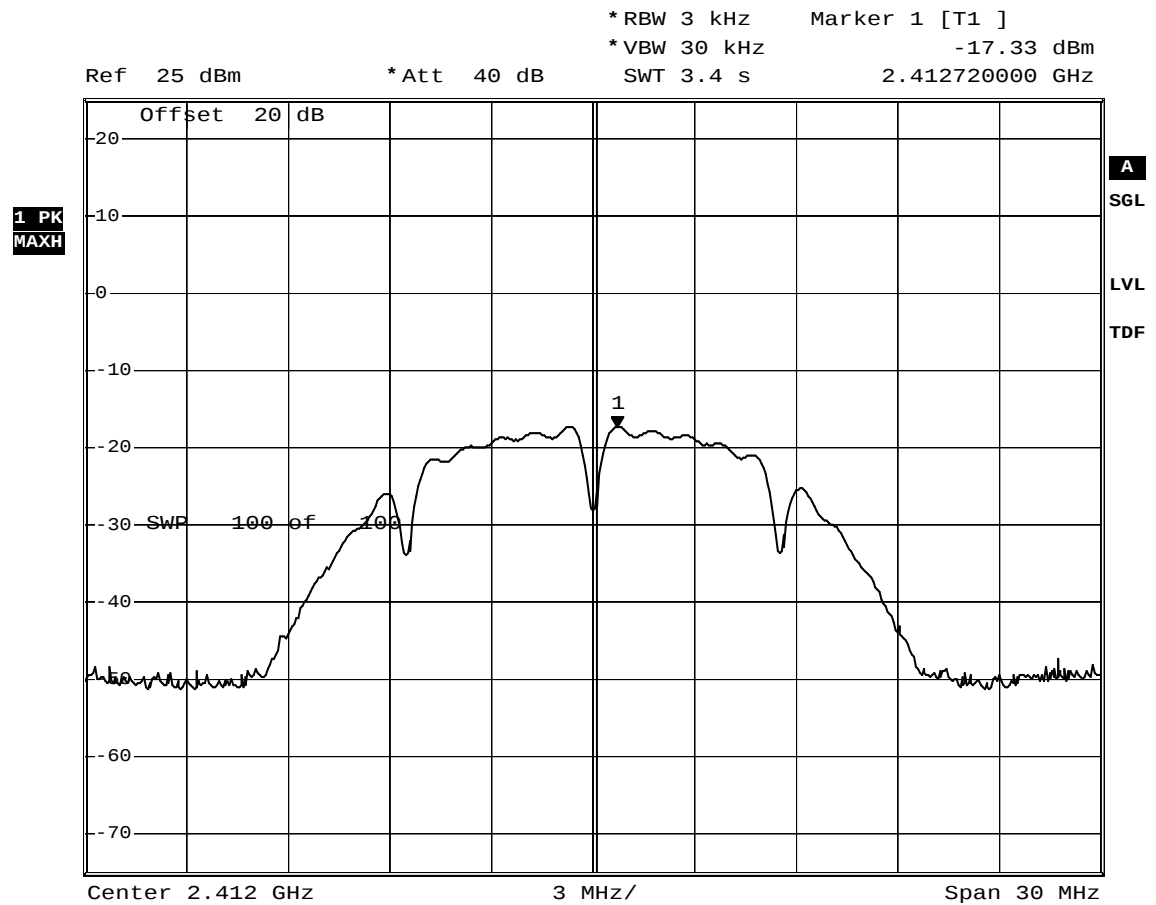
Op. Mode **higher band edge**
op-mode 3g **TX on 2462 MHz**



8.3 Power density

Op. Mode

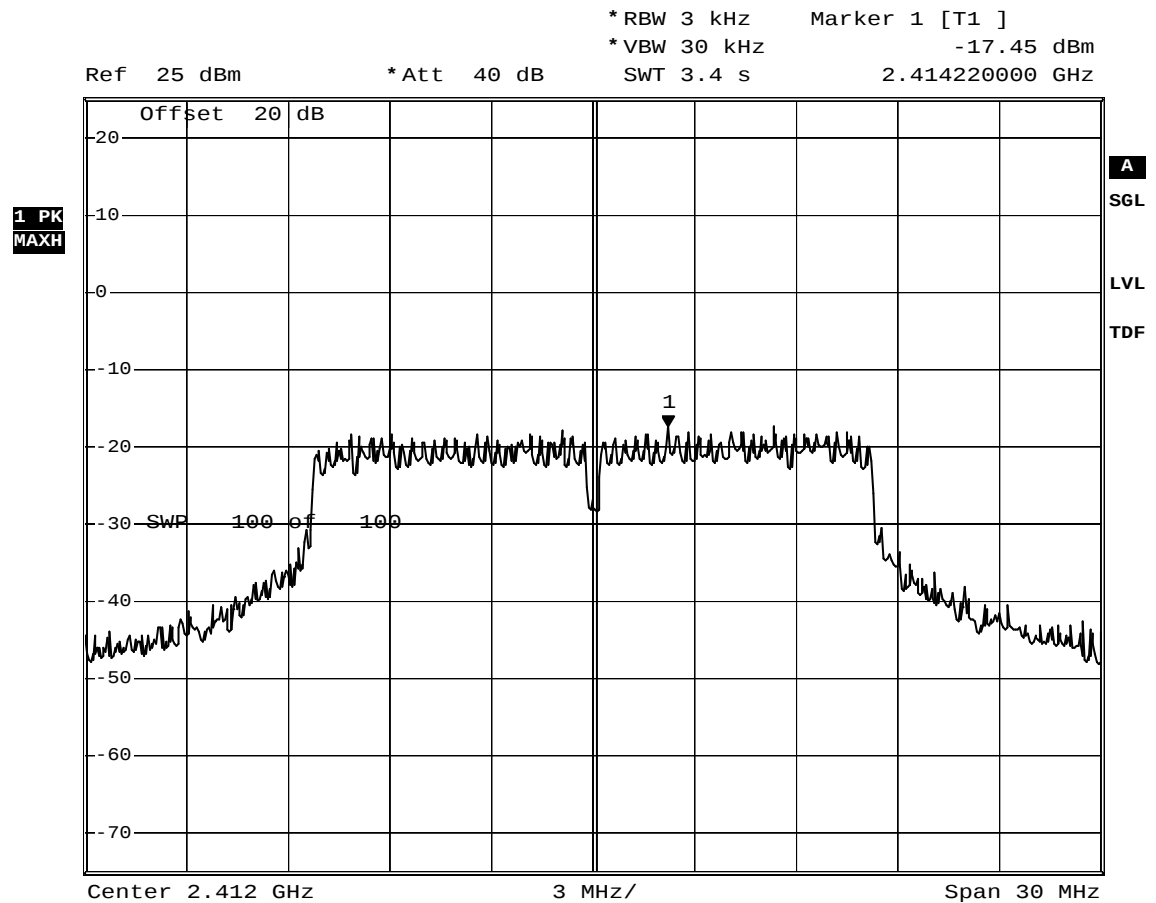
op-mode 1b



Comment: CH B: 2412 MHz;
 Date: 13.JUL.2007 10:48:00

Op. Mode

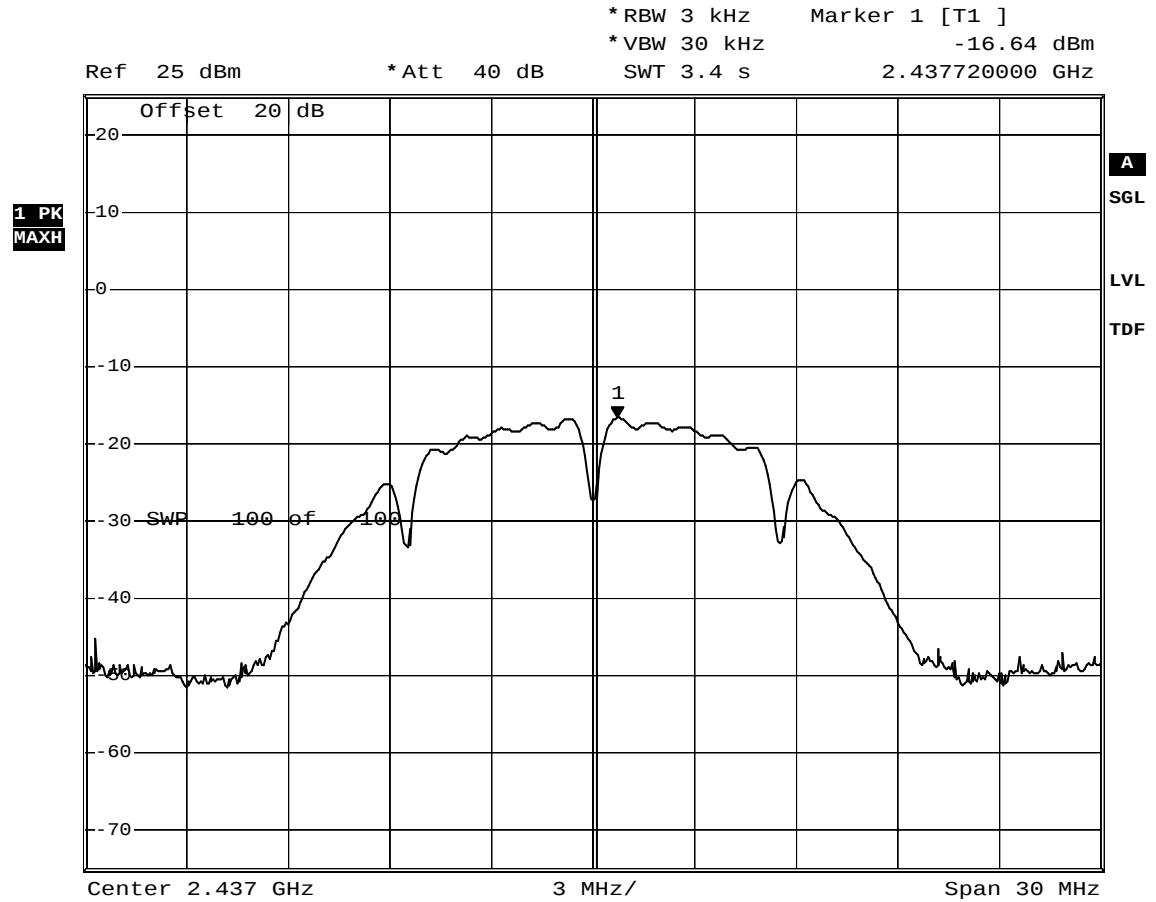
op-mode 1g



Comment: CH B: 2412 MHz;
 Date: 13.JUL.2007 10:59:53

Op. Mode

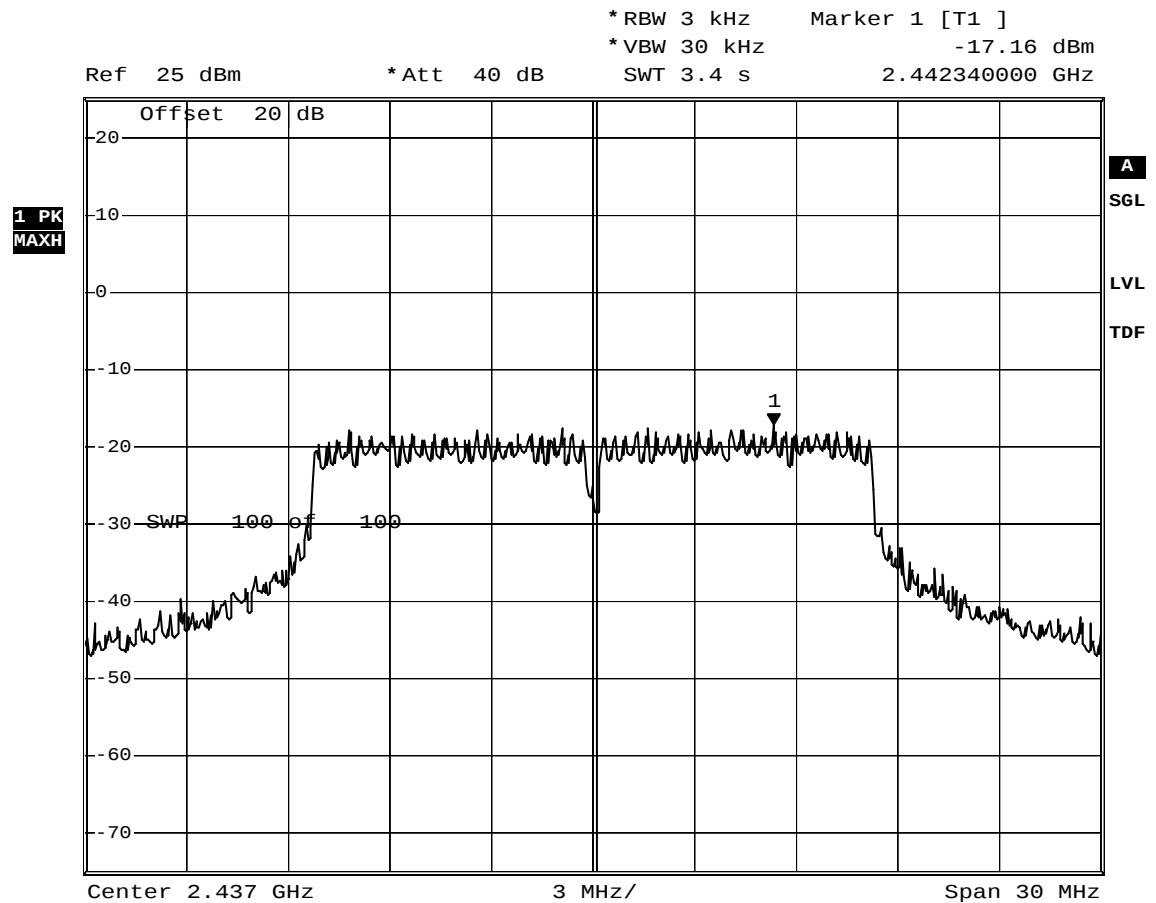
op-mode 2b



Comment: CH M: 2437 MHz;
 Date: 13.JUL.2007 12:15:25

Op. Mode

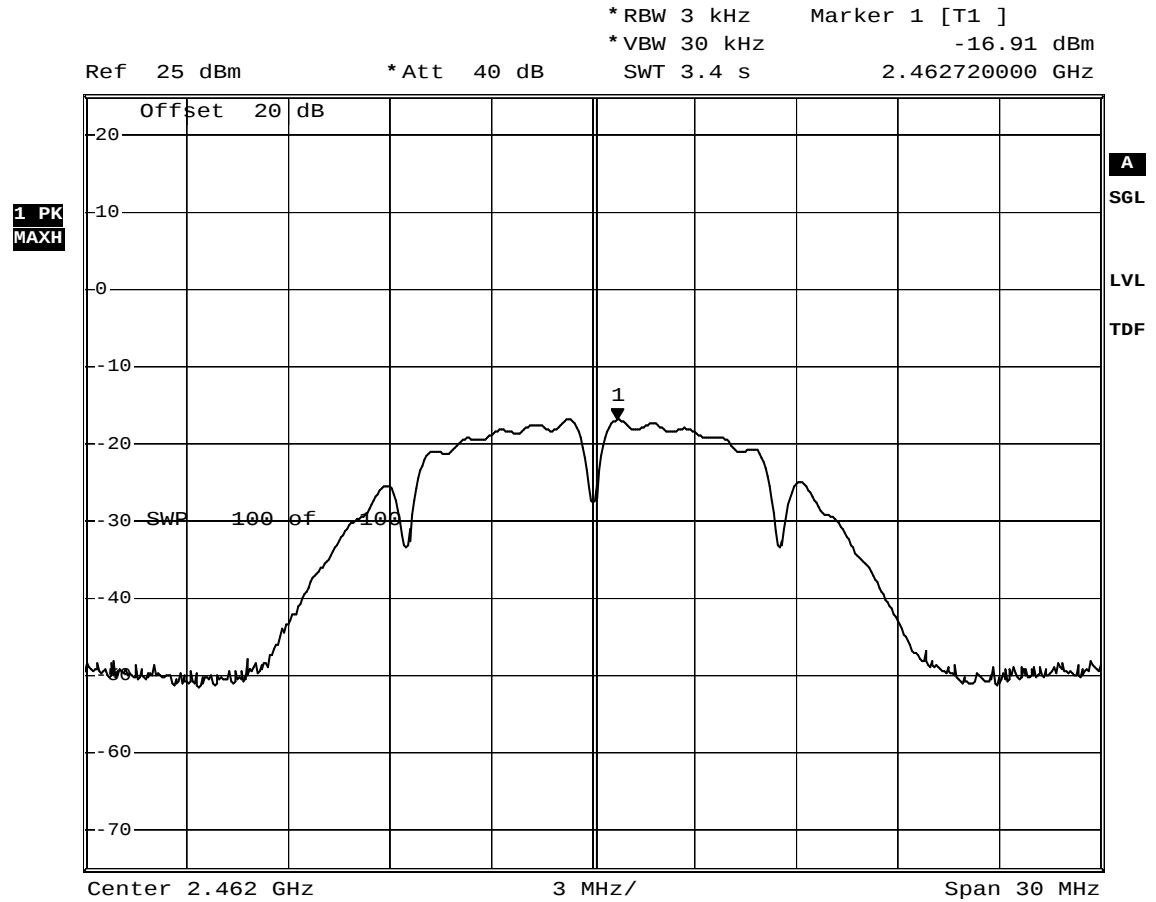
op-mode 2g



Comment: CH M: 2437 MHz;
 Date: 13.JUL.2007 12:04:26

Op. Mode

op-mode 3b

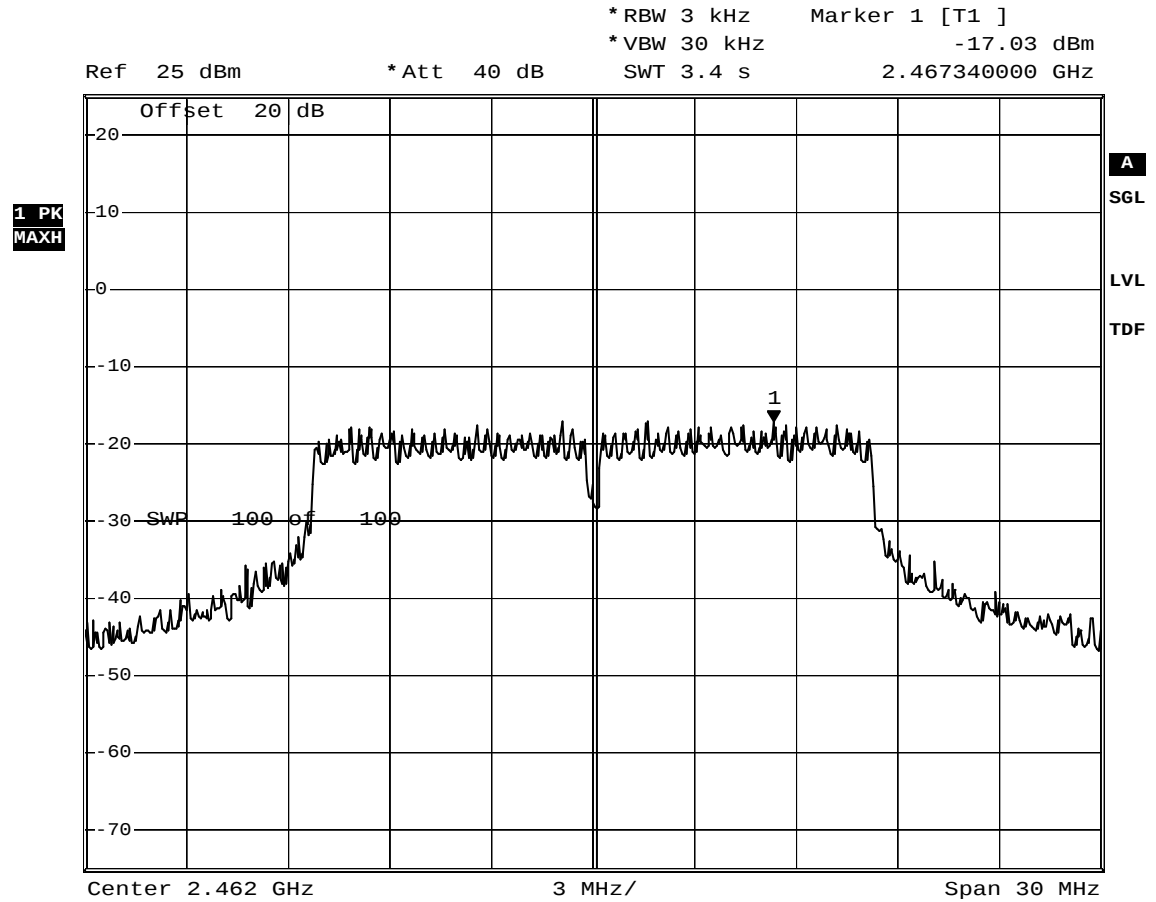


Comment: CH T: 2462 MHz;
 Date: 13.JUL.2007 12:27:25



Op. Mode

op-mode 3g



Comment: CH T: 2462 MHz;
Date: 13.JUL.2007 12:36:10

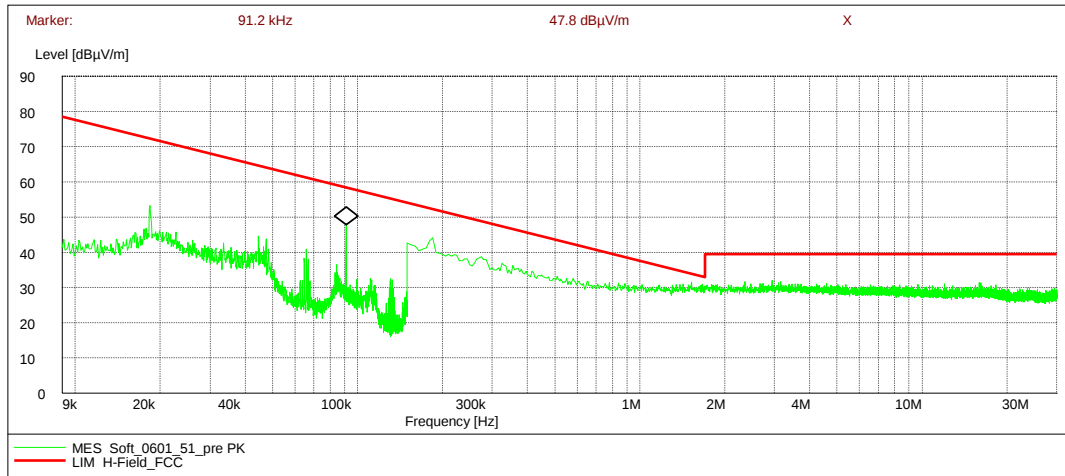
8.4 Radiated emissions ($f < 30\text{MHz}$)

Op. Mode

op-mode 1b

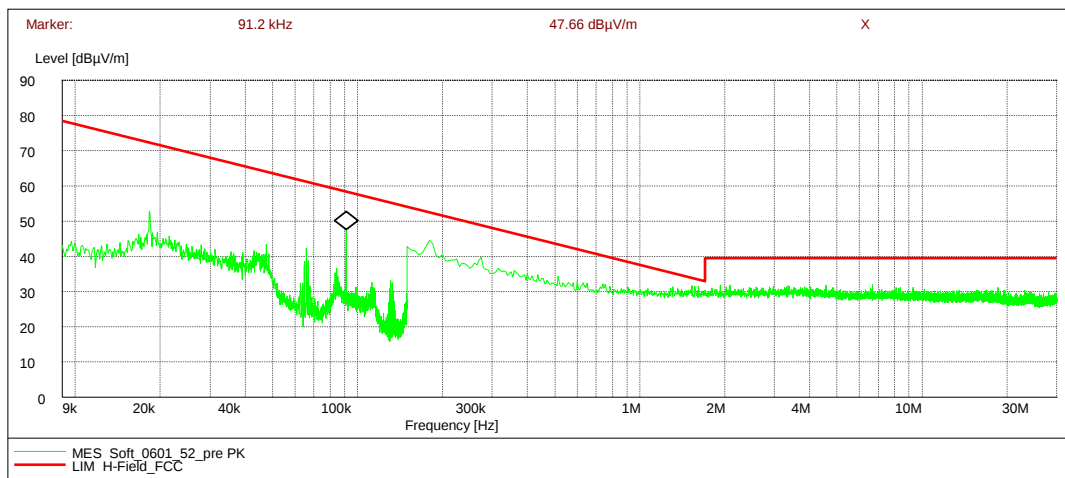
Antenna position 90°

EUT position front side



Antenna position 90°

EUT position right side

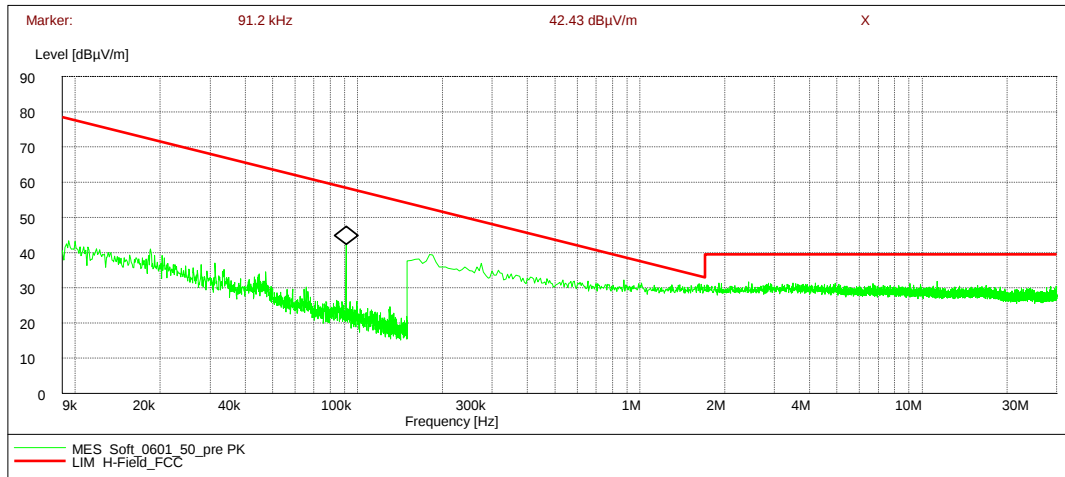


Op. Mode

op-mode 1

Antenna position 0°

EUT position front side



Antenna position 0°

EUT position right side

