Registration No. DAT-P-207/05

FCC ID:W7H-HXPO1000

EMI -- TEST REPORT

- FCC Part 15.247 -

Test Report No. :	**T32643-05-05HS**	07 April 2009 Date of issue

Type / Model Name	:	VCI (Vehicle communication interface), HX-PO-1000
Product Description	:	Car diagnosis monitor with WLAN interface (2.4 GHz)
Applicant	**:**	samtec automotive software & electronics gmbh
Address	:	Saarstr. 27
		70794 FILDERSTADT, GERMANY
Manufacturer	**:**	Lüdtke Elektronic GmbH & Co KG
Address	:	Luitpoldstrasse 59
		76863 HERXHEIM, GERMANY
Licence holder	**:**	samtec automotive software & electronics gmbh
Address	:	Saarstr. 27
		70794 FILDERSTADT, GERMANY

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Deutscher Akkreditierungs Rat
DAR
DAT-P-207/05-00

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (October, 2008)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (October, 2008)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits ☐ Class A device ☒ Class B device
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.247	Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

FCC Rules and Regulations Part 1, Subpart I - Procedures Implementing the National Environmental Policy Act of 1969

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable device

OET Bulletin 65, 65A, 65B, 65C Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

ANSI C63.4: 2003	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C95.1:1992	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
CISPR 16-4-2: 2003	Uncertainty in EMC measurement
CISPR 22: 2005 EN 55022: 2006	Information technology equipment

2 SUMMARY

GENERAL REMARKS:

The EUT consists of a WLAN-Module. The EUT has a TX mode and a RX mode but in RX mode the EUT is searching for an AP and transmits therefore randomly TX beacons. This makes it impossible to measure in RX mode only. Therefore the measurements were performed in TX mode only. The USB connection can be used to transmit data and is evaluated in a separate test report. The frequency range was scanned from 30 MHz to 25000 MHz. All emissions not reported in this test report are more than 20 dB below the specified limit.

Available Features in WLAN:

The WLAN module is compatible with WLAN Standard 802.11b and 802.11g. It supports the 2.4 GHz frequency band only.
- 802.11b/g mode 2.400 GHz – 2.4835 GHz

The module use DSSS or OFDM modulation and is capable to provide following data rates:
- 802.11b mode 11, 5.5, 2, 1 Mbps (Mbps = *megabits per second)*
- 802.11g mode 54, 48, 36, 24, 18, 12, 9, 6 Mbps

There is only one internally antenna on a PCB-Board in the upper part of the housing. Determination of the the antenna structure gain see 5.9

Pre-scan has been performed to determine the worst-case mode from all possible combinations between available modulations and data rates. The maximum output power depends on used data rate.

As worst case the following data rates are used:
- **802.11b: 1 Mbps, max. Power set 18**
- **802.11g: 54 Mbps, max. Power set 18**

The firmware supports the following listed channels and is fixed to a maximum output power setting for WLAN Standard 802.11b and WLAN Standard 802.11g on 18:

WLAN Standard 802.11b/g:

Channel	Frequency
1	2412 MHz
2	2417 MHz
3	2422 MHz
4	2427 MHz
5	2432 MHz
6	2437 MHz
7	2442 MHz
8	2447 MHz
9	2452 MHz
10	2457 MHz
11	2462 MHz

The test software for the EUT provides free power setting and the test mode TX continuous mode, modulated. The EUT was set with test modulation to transmit data during the tests with a duty cycle (X) of assumed X = 1.

Following channels were selected for the final test:

WLAN Standard	Available Channel	Tested Channel	Modulation	Modulation Type	Data Rate (Mbps)
802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
802.11g	1 to 11	1, 6, 11	OFDM	BPSK	54

FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 16 February 2009

Testing concluded on : 25 February 2009

Checked by:

Klaus Gegenfurtner
Ich bestätige die Richtigkeit und Integrität dieses Dokuments
2009.04.07 10:29:20 +02'00'

Klaus Gegenfurtner
Dipl.-Ing.(FH)
Manager: Radio Group

Tested by:

Digital unterschrieben von Hermann Smetana
Grund: Ich bin der Verfasser dieses Dokuments
Datum: 2009.04.07 09:45:39 +02'00'

Hermann Smetana
Dipl.-Ing.(FH)
Radio Expert

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EUT – Detailed photos see Attachment A

3.2 Power supply system utilised

Power supply voltage : 12 VDC (car application)

3.3 Short description of the Equipment under Test (EUT)

Vehicle communication interface (VCI), heavy duty version with USB and WLAN interface for supporting the maintenance and service of cars.

Number of tested samples: 1
Serial number: Prototype 1

EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- TX continuous mode

EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

The following peripheral devices and interface cables were connected during the measurements:

- Note book Panasonic — Model : tough book CF 30
- USB cable, self manufactured, 2.95 m — Model :
- OBD2 cable, 1 m — Model :
- — Model :

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

mikes-testingpartners gmbh
Ohmstrasse 2-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader may notice that tolerances within the calibration of the equipment and facilities may cause additional uncertainty. The measurement uncertainty is calculated for all measurements listed in this test report acc. to CISPR 16-4-2 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurement“ and documented in the mikes-testingpartners gmbh quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, mikes-testingpartners gmbh, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component diversity and modifications in production process of devices may result in additional deviation. If necessary, refer to the test lab for the actual measurement uncertainty for the specific test. The manufacturer has the sole responsibility of continued compliance of the EUT.

4.4 Measurement Protocol for FCC, VCCI and AUSTEL

4.4.1 GENERAL INFORMATION

4.4.1.1 Test Methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.
The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."
In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.1.2 Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.5 Discovery of worst case measurement conditions

Measurements have been made in all three orthogonal axes and the settings of the EUT were changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in Y position.

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Photo documentation of the test set-up

5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):
Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a line impedance stabilization network (LISN) with 50Ω/50 μH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 cm above the floor and is positioned 40 cm from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

To convert between dBμV and μV, the following conversions apply:

dBμV = 20 log μV
μV = 10^(dBμV/20)

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin 7.5 dB at 1.105 MHz

Limit according to FCC Part 15, Section 15.207(a):

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

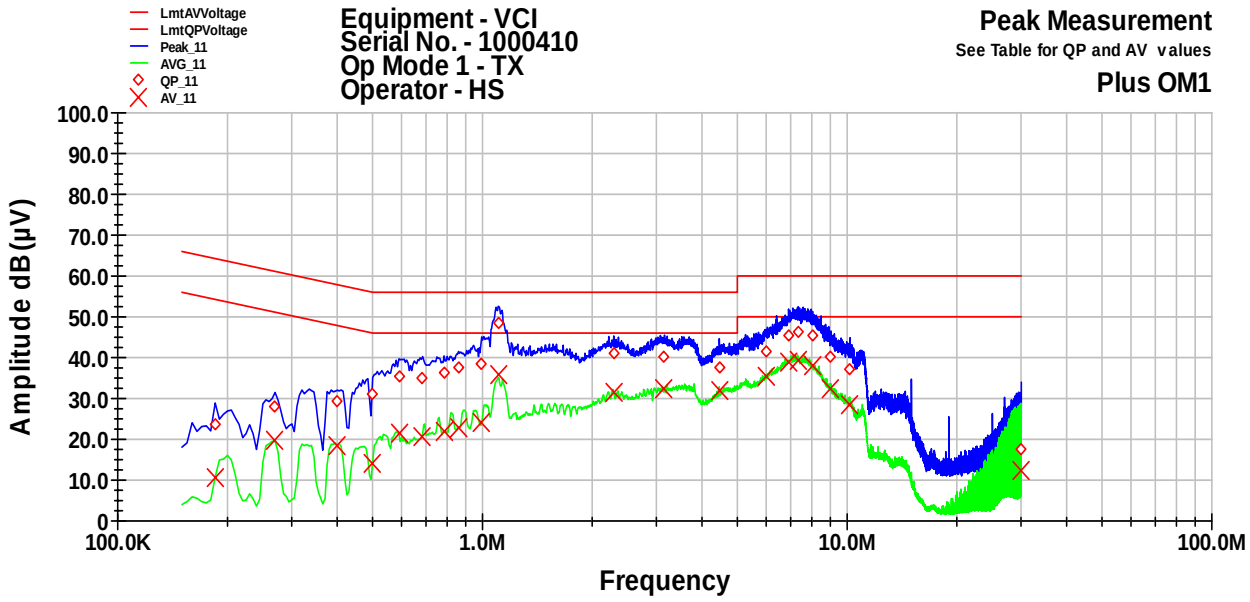
* Decreases with the logarithm of the frequency

The requirements are **FULFILLED.**

Remarks: For detailed test result please see to following test protocols

5.1.6 Test protocol

Test point Plus Result: passed
Operation mode: TX continuous mode
Remarks:

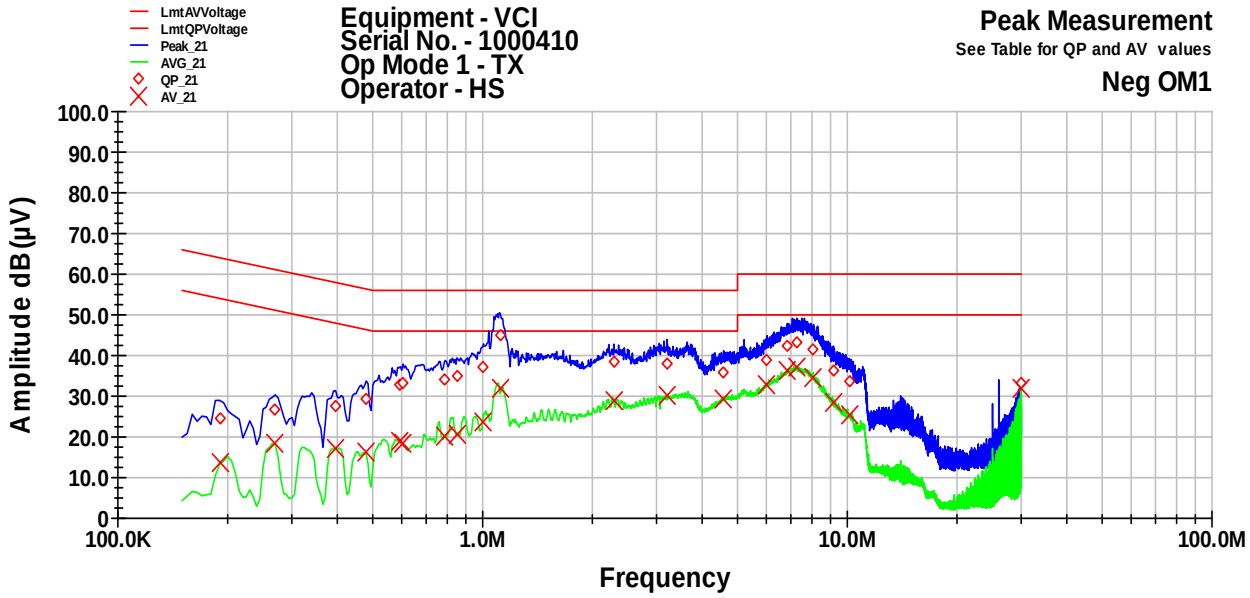


File Number: T32643

Frequency MHz	QP Level dB(µV)	QP Delta dB	QP Limit dB	AV Level dB(µV)	AV Delta dB	AV Limit dB
0.185	23.5	-40.8	64.3	10.7	-43.5	54.3
0.27	28.0	-33.2	61.1	19.5	-31.6	51.1
0.4	29.3	-28.6	57.9	18.5	-29.4	47.9
0.5	30.9	-25.1	56.0	14.3	-31.7	46.0
0.59	35.6	-20.4	56.0	21.5	-24.5	46.0
0.685	34.9	-21.1	56.0	20.6	-25.4	46.0
0.785	36.1	-19.9	56.0	21.9	-24.1	46.0
0.86	37.4	-18.6	56.0	22.8	-23.2	46.0
0.995	38.3	-17.7	56.0	24.2	-21.8	46.0
1.105	48.5	-7.5	56.0	35.7	-10.3	46.0
2.29	41.1	-14.9	56.0	31.6	-14.4	46.0
3.155	40.2	-15.8	56.0	32.4	-13.6	46.0
4.46	37.8	-18.2	56.0	31.7	-14.3	46.0
5.995	41.6	-18.4	60.0	35.5	-14.5	50.0
6.91	45.6	-14.4	60.0	38.9	-11.1	50.0
7.345	46.3	-13.7	60.0	39.5	-10.5	50.0
8.03	45.2	-14.8	60.0	38.1	-11.9	50.0
9.015	40.0	-20.0	60.0	32.2	-17.8	50.0
10.185	37.3	-22.7	60.0	28.5	-21.5	50.0
29.935	17.8	-42.2	60.0	12.3	-37.7	50.0

FCC ID:W7H-HXPO1000

Test point Minus Result: passed
Operation mode: TX continuous mode
Remarks:



File Number: T32643

Frequency MHz	QP Level dB(µV)	QP Delta dB	QP Limit dB	AV Level dB(µV)	AV Delta dB	AV Limit dB
0.19	24.6	-39.4	64.0	13.7	-40.3	54.0
0.27	26.7	-34.4	61.1	18.6	-32.6	51.1
0.395	27.6	-30.3	58.0	17.0	-30.9	48.0
0.48	29.4	-26.9	56.3	16.1	-30.2	46.3
0.595	32.8	-23.2	56.0	19.0	-27.0	46.0
0.605	33.3	-22.8	56.0	18.6	-27.4	46.0
0.79	34.0	-22.0	56.0	20.1	-25.9	46.0
0.85	34.8	-21.2	56.0	20.5	-25.5	46.0
1	37.1	-18.9	56.0	23.6	-22.4	46.0
1.115	44.8	-11.2	56.0	31.9	-14.1	46.0
2.29	38.6	-17.4	56.0	29.0	-17.0	46.0
3.2	38.2	-17.8	56.0	30.0	-16.0	46.0
4.58	35.9	-20.1	56.0	29.5	-16.5	46.0
5.975	38.9	-21.1	60.0	32.8	-17.3	50.0
6.84	42.5	-17.5	60.0	36.3	-13.7	50.0
7.26	43.3	-16.7	60.0	37.0	-13.0	50.0
8.075	41.6	-18.4	60.0	34.6	-15.4	50.0
9.135	36.1	-23.9	60.0	28.5	-21.5	50.0
10.11	33.5	-26.5	60.0	25.4	-24.6	50.0
29.97	33.0	-27.0	60.0	32.1	-17.9	50.0

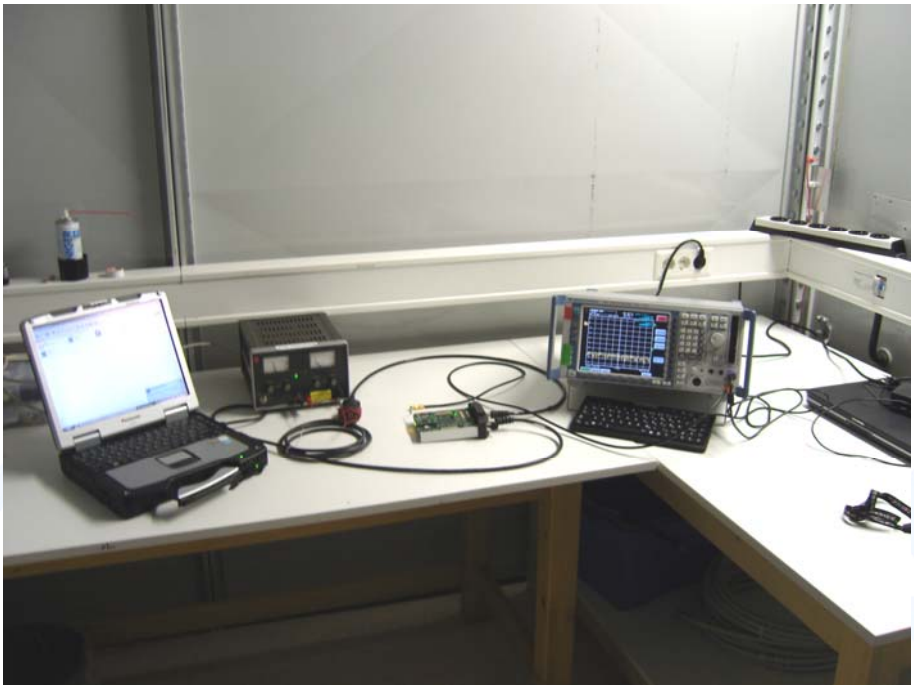
5.2 Emission bandwidth

For test instruments and accessories used see section 6 Part **MB**.

5.2.1 Description of the test location

Test location: AREA4

5.2.2 Photo documentation of the test set-up



5.2.3 Applicable standard

According to FCC Part 15, Section 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.

5.2.4 Description of Measurement

The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -6 dB. The reference level is the level of the highest signal amplitude observed at the transmitter at either the fundamental frequency or the first order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. An alternative is to use the bandwidth measurement of the analyzer.

Spectrum analyzer settings:

RBW	1 MHz
VBW	3 MHz
Detector	Peak
Sweep time	auto

The table below shows the settings according to ANSI C63.4:

Fundamental frequency	Minimum resolution bandwidth
9 kHz to 30 MHz	1kHz
30 to 1000 MHz	10 kHz
1000 MHz to 40 GHz	100 kHz

5.2.5 Test result

WLAN Standard 802.11b

Channel number	Fundamental frequency (MHz)	6 dB Bandwidth (MHz)	Minimum limit (MHz)
1	2412	10.56	0.5
6	2437	10.48	0.5
11	2462	10.40	0.5

WLAN Standard 802.11g

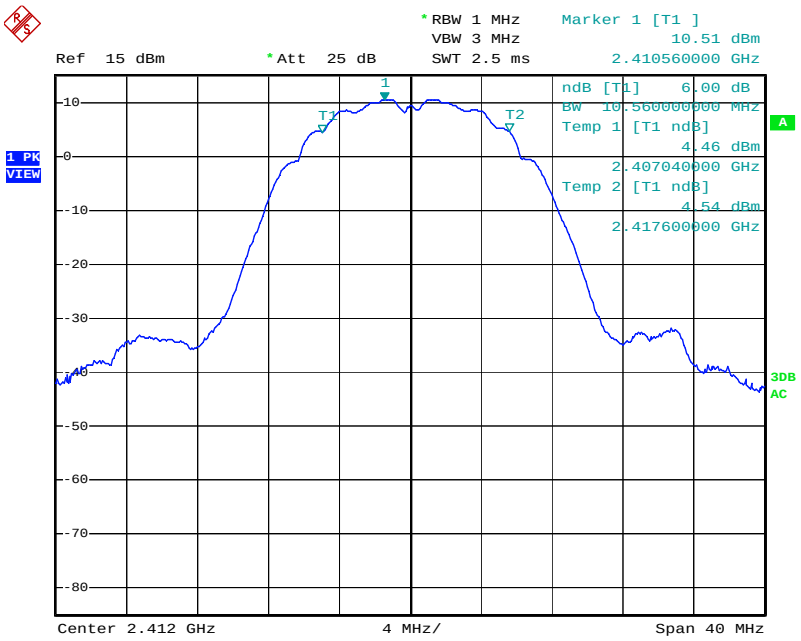
Channel number	Fundamental frequency (MHz)	6 dB Bandwidth (MHz)	Minimum limit (MHz)
1	2412	16.80	0.5
6	2437	16.88	0.5
11	2462	16.88	0.5

The requirements are **FULFILLED.**

Remarks: For detailed test results please refer to following test protocols.

5.2.6 Test protocols

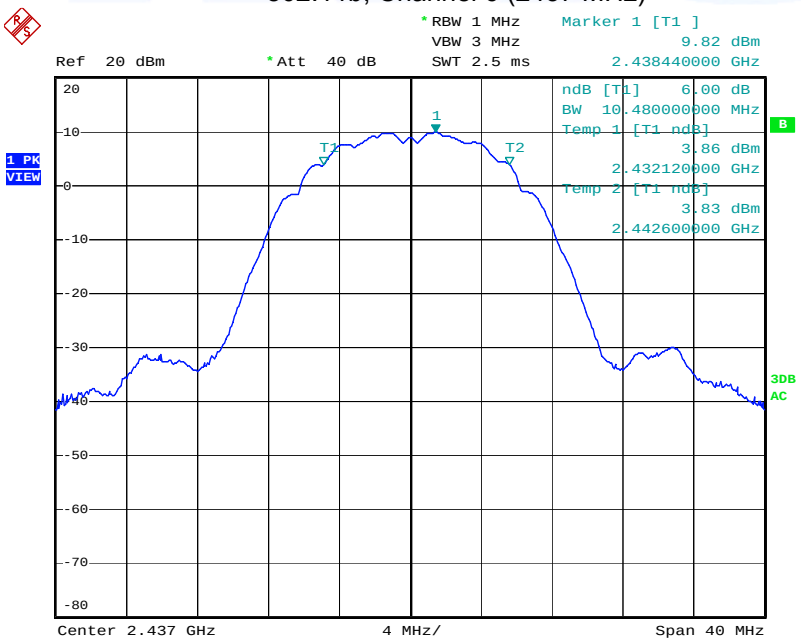
802.11b, Channel 1 (2412 MHz)



VCI, CH1B

Date: 24.FEB.2009 08:10:03

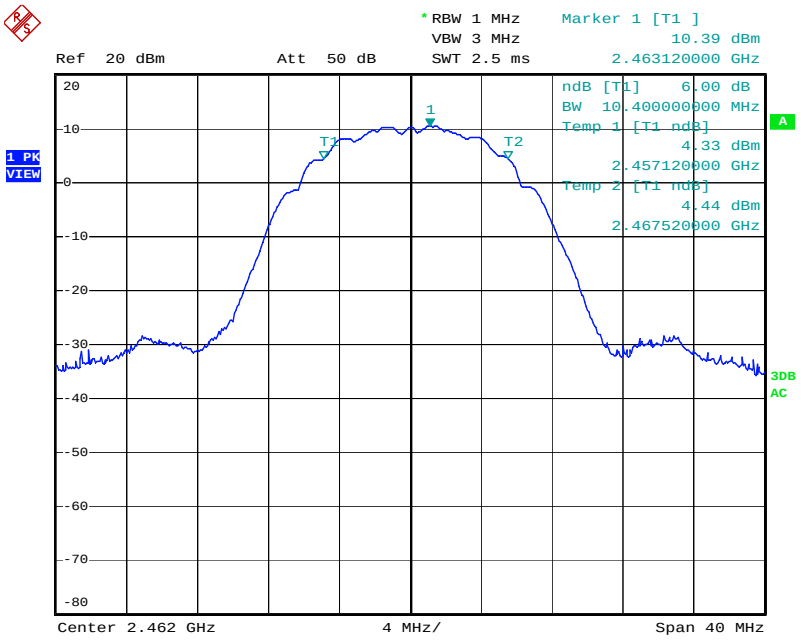
802.11b, Channel 6 (2437 MHz)



VCI, CH6B, NC, Power set 18

Date: 24.FEB.2009 08:25:00

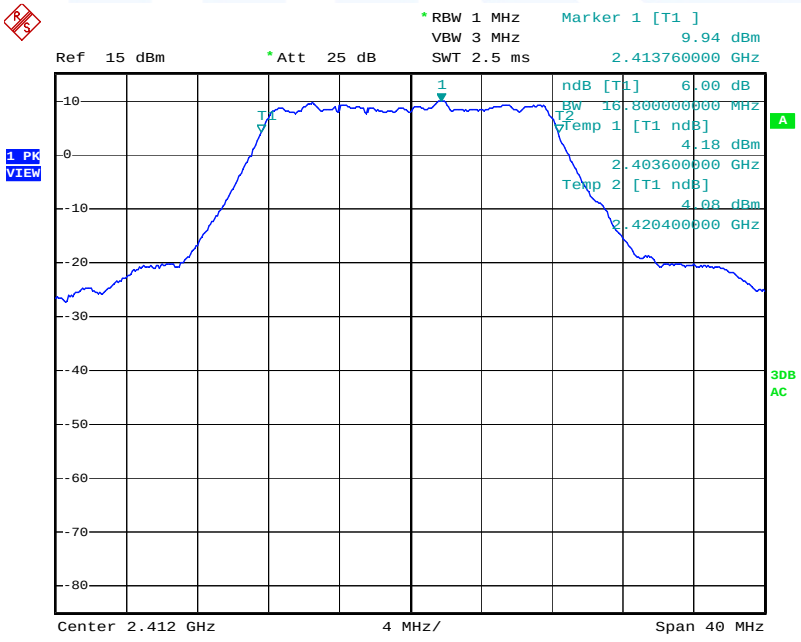
802.11b, Channel 11 (2462 MHz)



VCI, CH11B

Date: 24.FEB.2009 08:03:37

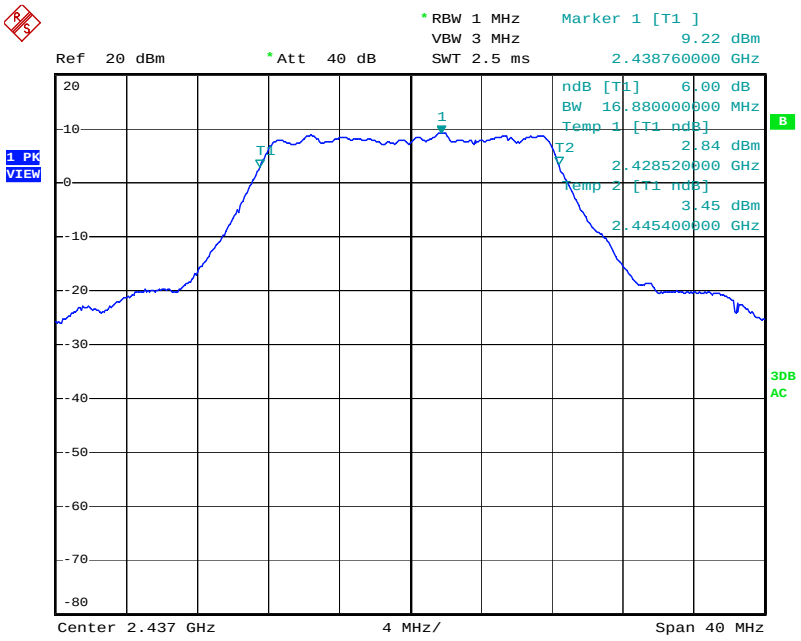
802.11g, Channel 1 (2412 MHz)



VCI, CH1G

Date: 24.FEB.2009 08:08:32

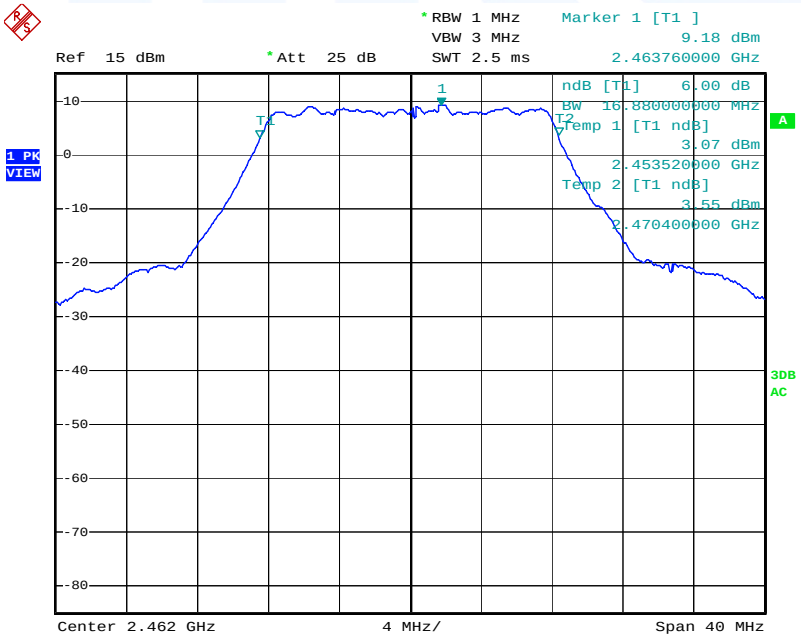
802.11g, Channel 6 (2437 MHz)



VCI, CH6G, NC, Power set 18

Date: 24.FEB.2009 08:23:36

802.11g, Channel 11 (2462 MHz)



VCI, CH11G

Date: 24.FEB.2009 08:06:24

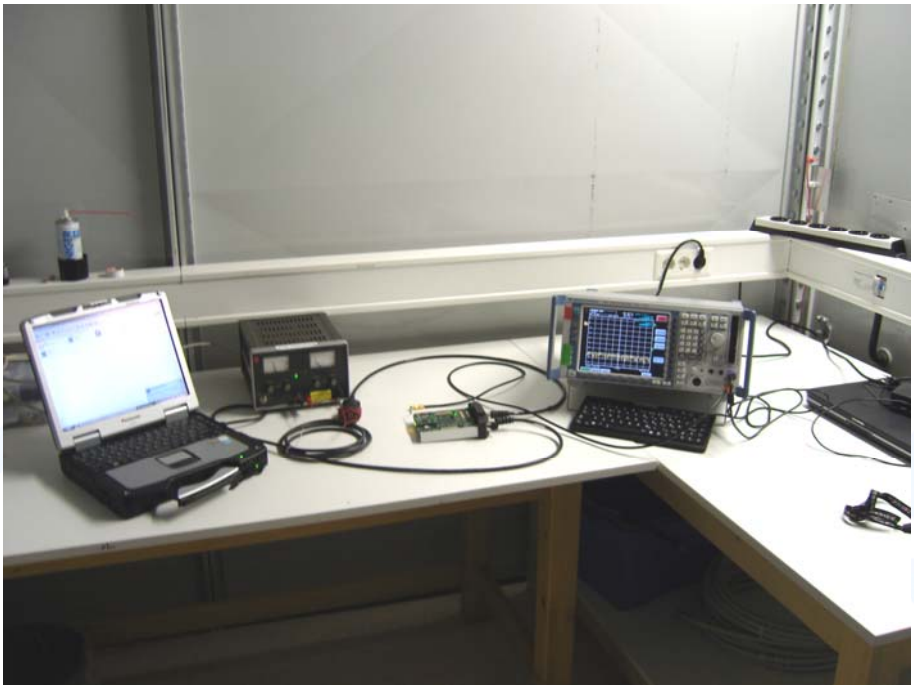
5.3 Maximum peak conducted output power

For test instruments and accessories used see section 6 Part **CPC 3**.

5.3.1 Description of the test location

Test location: AREA4

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15, Section 15.247(b)(3):
For systems using digital modulation in the 2400-2483.5 MHz and 5725 – 5850 MHz bands, the maximum peak output power of the transmitter shall not exceed 1 Watt. The limit is based on transmitting antennas of directional gain that do not exceed 6 dBi.

5.3.4 Description of Measurement

The transmitter output was connected to the power meter with thermal test head. To determine the max output power the worst case power setting is used. The cable loss or other external attenuation was taken into account and expressed in a correction factor. The absolute maximum peak output power is calculated by adding the reading of the meter plus correction and compared with the limit.

5.3.5 Test result

WLAN Standard 802.11b

Channel	Frequency (MHz)	Power settings (∆dB)	Measured power (dBm)	Cable loss correction (dB)	Corrected peak power (dBm)	Peak power limit (dBm)	Delta (dB)
1	2412	18	14.9	1.3	16.2	30	-13.8
6	2437	18	15.4	1.3	16.7	30	-13.3
11	2462	18	14.9	1.3	16.2	30	-13.8

Remark: The cable loss correction take account of the overall loss of the measurement cable: 10 cm U-FL-Cable + Adaptor UFL-SMA + 1.5 m Measurement cable SMA-N = 1.3 dB at 2.45 GHz (see section 5.8)

WLAN Standard 802.11g

Channel	Frequency (MHz)	Power settings (∆dB)	Measured power (dBm)	Cable loss correction (dB)	Corrected peak power (dBm)	Peak power limit (dBm)	Delta (dB)
1	2412	18	12.4	1.3	13.7	30	-16.3
6	2437	18	12.0	1.3	13.3	30	-16.7
11	2462	18	11.7	1.3	13.0	30	-17.0

Peak Power Limit according to FCC Part 15, Section 15.247(b)(3):

Frequency (MHz)	Peak Power Limit	
	(dBm)	(Watt)
902-928	30	1.0
2400-2483.5	**30**	**1.0**
5725-5850	30	1.0

The requirements are **FULFILLED.**

Remarks: _____

_____

_____

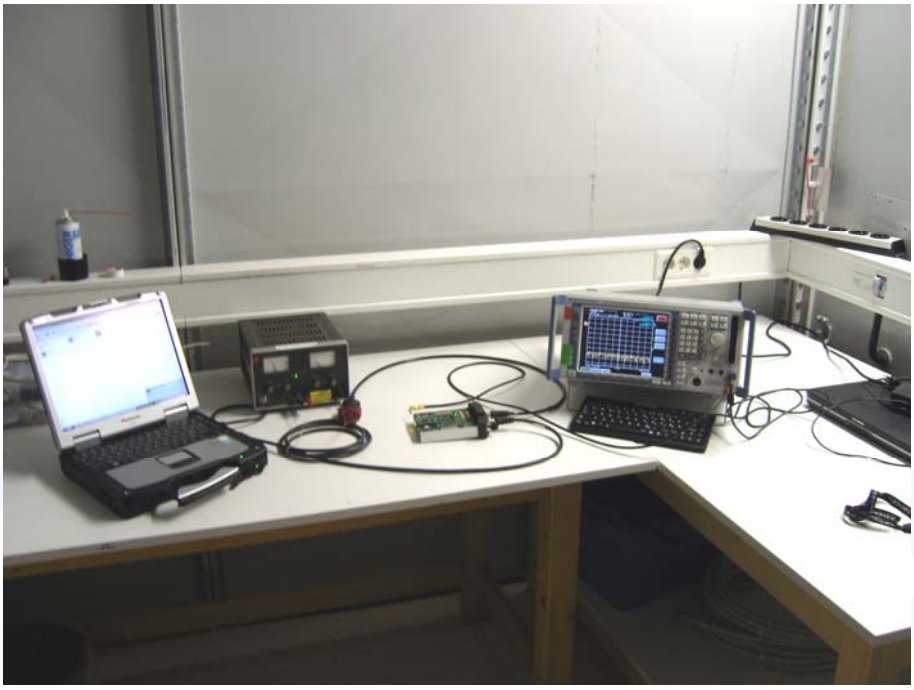
5.4 Spurious emissions conducted

For test instruments and accessories used see section 6 Part **SEC 1, SEC 2** and **SEC 3**.

5.4.1 Description of the test location

Test location: AREA4

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to FCC Part 15, Section 15.247(d):
In any 100 kHz bandwidth outside the operating frequency band of intentional radiator spouriuos emissions shall exceed the appropriate based on an RF conducted measurement.

5.4.4 Description of measurement

The spurious emissions have been measured conducted using a spectrum analyser. The measurement has been made while the transmitter was set to the lowest operating frequency (CH1), the middle of the band (CH6) and to the highest operating frequency (CH11). The frequency spectrum outside from the operating frequency range (2400 - 2483.5 MHz) has been scanned for emissions that exceed the defined limit. In the frequency range below 1 GHz a low pass filter has been used and above 3 GHz a highpass filter. The measurement has been performed at normal test conditions in modulated TX continuous mode.

Spectrum analyzer search setting:

RBW:	100 kHz	VBW:	300 kHz
Detector:	Max peak	Trace Mode:	Max hold
Level:	Adjust to the middle of the range	Sweep time:	1 s

5.4.5 Test result

WLAN Standard 802.11b
Highest level of the desired power: 16.7 dBm

SPURIOUS EMISSIONS								
CH1 (2412 MHz)			CH6 (2437 MHz)			CH11 (2462 MHz)		
f (MHz)	Level PK (dBm)	Limit (dBm)	f (MHz)	Level PK (dBm)	Limit (dBm)	f (MHz)	Level PK (dBm)	Limit (dBm)
Measurement uncertainty			± 3 dB					

Bandwidth (kHz); refers to the bandwidth of the measuring receiver

WLAN Standard 802.11g
Highest level of the desired power: 13.7 dBm

SPURIOUS EMISSIONS								
CH1 (2412 MHz)			CH6 (2437 MHz)			CH11 (2462 MHz)		
f (MHz)	Level PK (dBm)	Limit (dBm)	f (MHz)	Level PK (dBm)	Limit (dBm)	f (MHz)	Level PK (dBm)	Limit (dBm)
Measurement uncertainty			± 3 dB					

Bandwidth (kHz); refers to the bandwidth of the measuring receiver

Limit according to FCC Part 15, Section 15.247(d):
In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.5 MHz and 5725 – 5850 MHz, the digitally modulated 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 an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

Frequency (MHz)	spurious emission limit
Below 1000	20 dB below the highest level of the desired power
Above 1000	20 dB below the highest level of the desired power

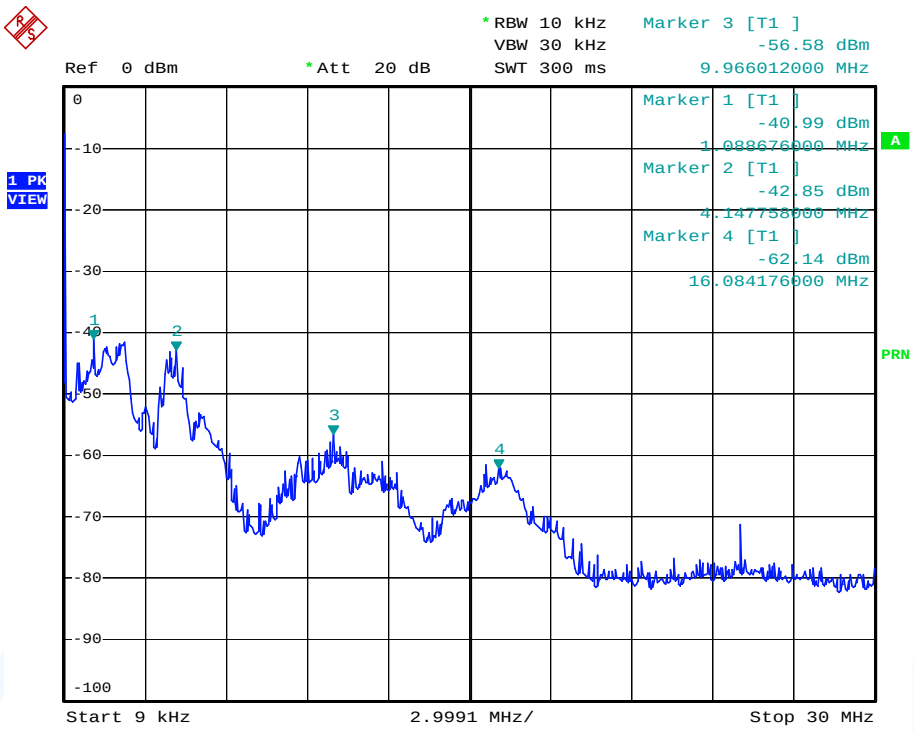
The requirements are **FULFILLED.**

Remarks: All emissions not reported are more than 20 dB below the specified limit.

5.4.6 Test protocols

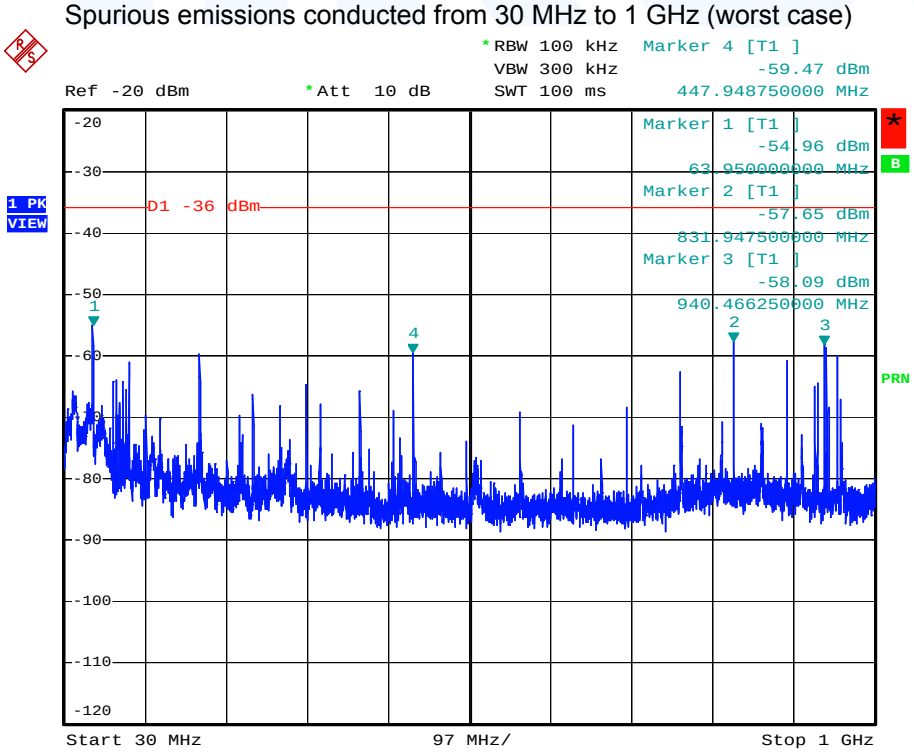
Plots of spurious emissions conducted out of operating frequency bands (-20 dBc)

Spurious emissions conducted from 9 kHz to 30 MHz (worst case)



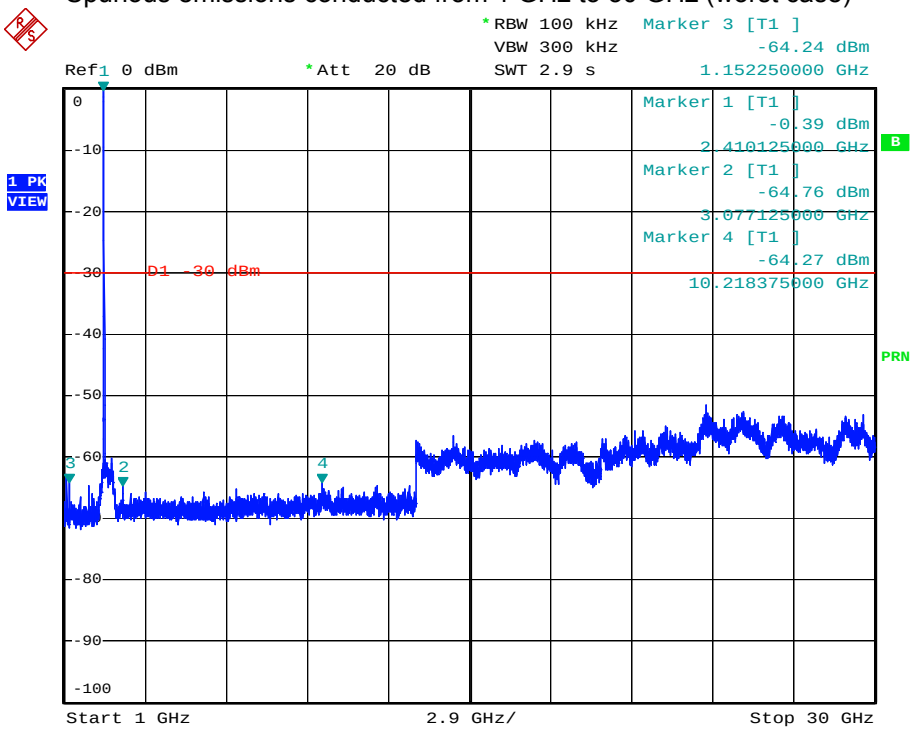
Comment: SEC1, Ch1B
Date: 17.FEB.2009 14:33:58

Spurious emissions conducted from 30 MHz to 1 GHz (worst case)



Comment: SEC2, Ch1G
Date: 17.FEB.2009 14:28:50

Spurious emissions conducted from 1 GHz to 30 GHz (worst case)



Comment: SEC3, Ch1B
Date: 17.FEB.2009 14:09:38

5.5 Spurious emissions radiated

For test instruments and accessories used see section 6 Part **SER 3**.

5.5.1 Description of the test location

Test location: Anechoic Chamber A2

Test distance: 3 metres

5.5.2 Photo documentation of the test set-up

Anechoic chamber

5.5.3 Applicable standard

According to FCC Part 15, Section 15.247(d):
In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.50 MHz and 5725 – 5850 MHz, the digitally modulated 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 an radiated measurement. 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 limit specified in Section 15.209(a) (see Section 15.205(c)).

5.5.4 Description of Measurement

Radiated spurious emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linear polarized antennas. The EUT is placed on a 1.0 X 1.5 m non-conducting table 80 cm above the ground plane. The set up of the equipment under test will be in accordance to ANSI C63.4. To locate maximum emissions from the EUT the antenna is shifted in height from 1 to 4 m, after the EUT is rotated 360 degrees. The measurement scan is made in horizontal and vertical polarization of the antenna.
For the radiated measurement up from 1 GHz to maximum frequency as specified in Section 15.33, a spectrum analyzer and appropriate linear polarized antennas are used. The EUT is placed on a 1.0 X 1.5 m non-conducting table 80 cm above the ground plane. The set up of the EUT will be in accordance to ANSI C63.4. To locate maximum emissions the EUT was rotated vertically 360 degrees in the fully anechoic chamber. The measurement scan is made in horizontal and vertical polarization of the antenna. For testing above 1 GHz, if the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise, the emission will be measured in average mode again and reported.

5.5.5 Test result

5.5.5.1 Radiated emissions

The emissions were measured conducted. Due to all emissions are at least 20 dB below the limit no further radiated measurement is necessary.

5.5.5.2 Radiated emissions in restricted bands

WLAN Standard 802.11b

Channel 1 (2412 MHz)
Nearest restricted band: 2310 - 2390 MHz

Antenna		Power	Frequency	Peak		Average	
Type	Gain (dBi)	Setting (∆dB)	(MHz)	Value dB(µV/m)	Limit dB(µV/m)	Value dB(µV/m)	Limit dB(µV/m)
Integrated	-3.6	18	-				

Channel 11 (2462 MHz)
Nearest restricted band: 2483.5 - 2500 MHz

Antenna		Power	Frequency	Peak		Average	
Type	Gain (dBi)	Setting (∆dB)	(MHz)	Value dB(µV/m)	Limit dB(µV/m)	Value dB(µV/m)	Limit dB(µV/m)
Integrated	-3.6	18	-				

WLAN Standard 802.11g

Channel 1 (2412 MHz)
Nearest restricted band: 2310 - 2390 MHz

Antenna		Power	Frequency	Peak		Average	
Type	Gain (dBi)	Setting (∆dB)	(MHz)	Value dB(µV/m)	Limit dB(µV/m)	Value dB(µV/m)	Limit dB(µV/m)
Integrated	-3.6	18	-				

Channel 11 (2462 MHz)
Nearest restricted band: 2483.5-2500 MHz

Antenna		Power	Frequency	Peak		Average	
Type	Gain (dBi)	Setting (∆dB)	(MHz)	Value dB(µV/m)	Limit dB(µV/m)	Value dB(µV/m)	Limit dB(µV/m)
Integrated	-3.6	18	2.484			53.6	54.0

Radiated limits according to FCC Part 15 Section 15.209(a) for spurious emissions which fall in restricted bands:

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009-0.490	2400/F (kHz)		300
0.490-1.705	24000/F (kHz)		30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

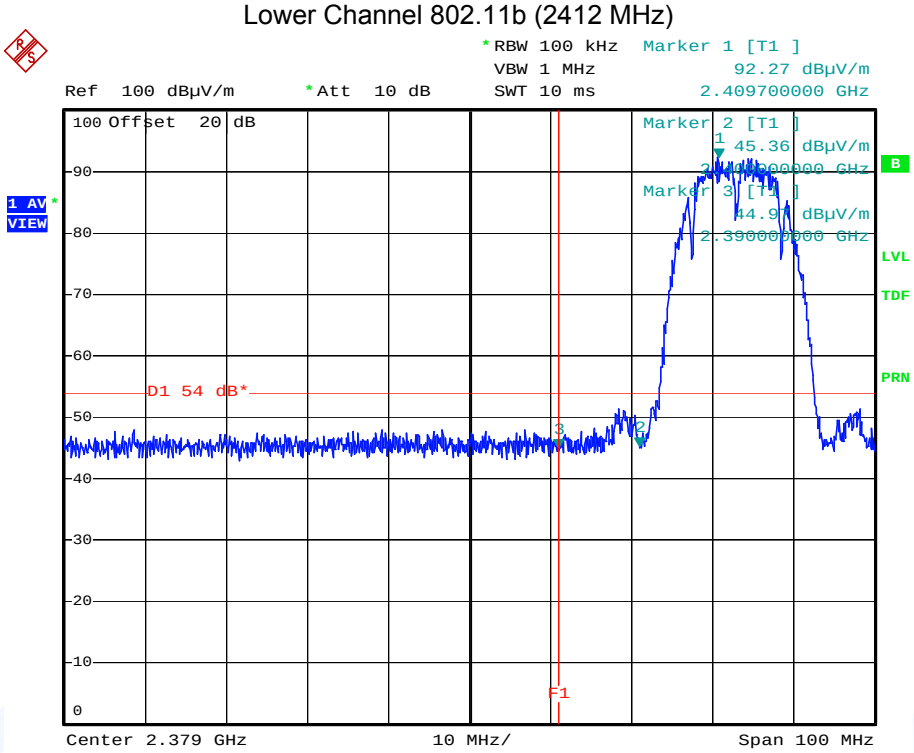
The requirements are **FULFILLED.**

Remarks: The measurement was performed up to the 10th harmonic. All emissions not reported are more than 20 dB below the specified limit. For detailed test results please see to following test protocols.

5.5.1 Test protocols

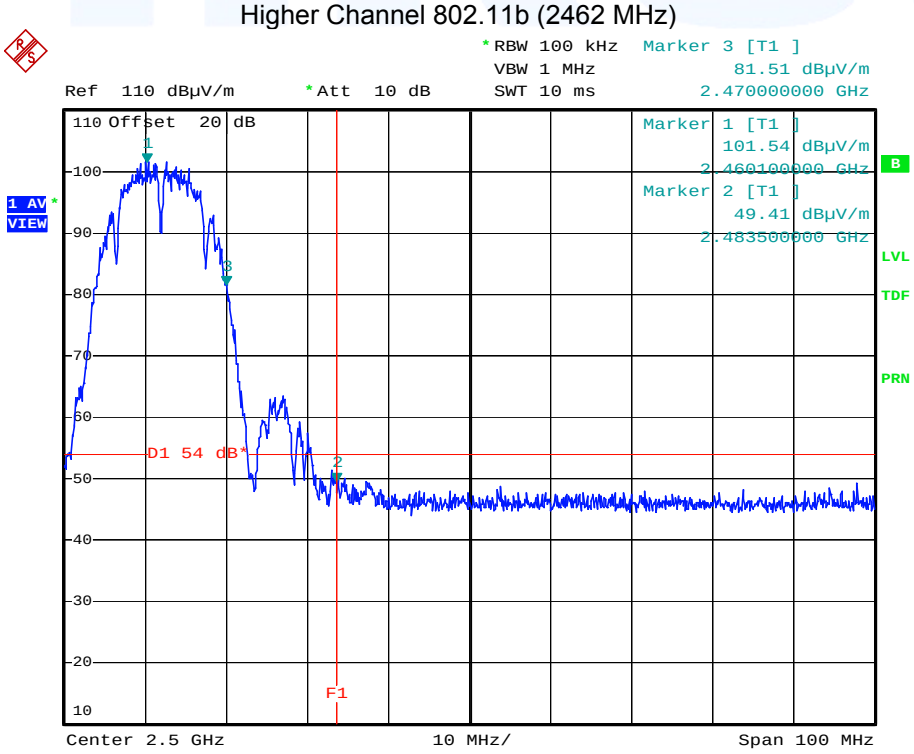
Plots of spurious emissions in the nearest restricted bands:

Lower Channel 802.11b (2412 MHz)



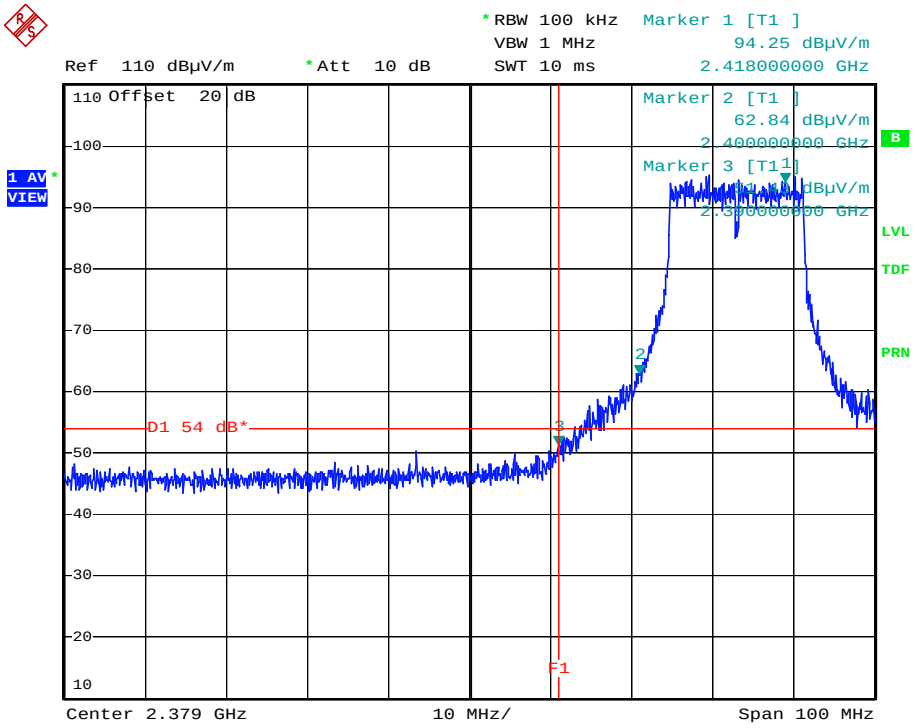
Comment: SER3, CH1B, Band edge, Y Position, hor
Date: 20.FEB.2009 14:51:38

Higher Channel 802.11b (2462 MHz)



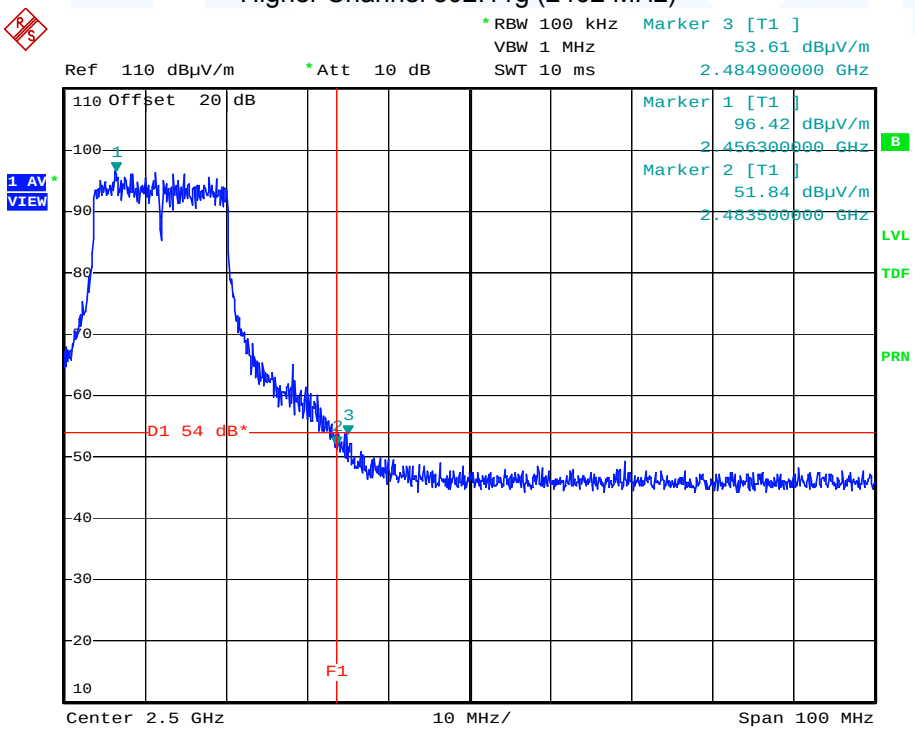
Comment: SER3, CH13B, Band edge, Y Position, ver
Date: 20.FEB.2009 15:04:16

Lower Channel 802.11g (2412 MHz)



Comment: SER3, CH1G, Band edge, Y Position, ver
Date: 20.FEB.2009 14:57:52

Higher Channel 802.11g (2462 MHz)



Comment: SER3, CH13G, Band edge, Y Position, ver
Date: 20.FEB.2009 15:01:06

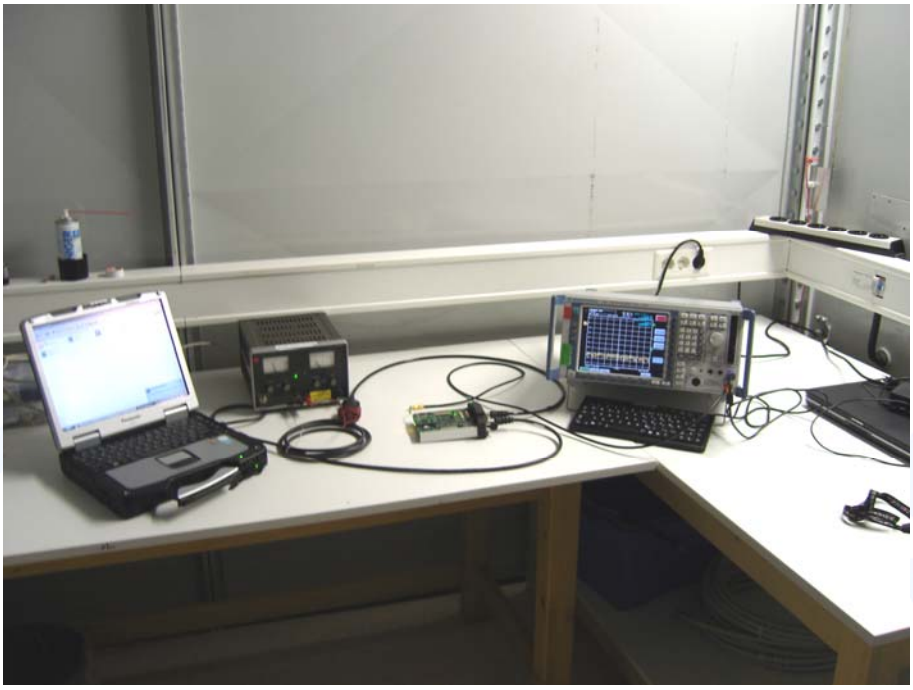
5.6 Power spectral density

For test instruments and accessories used see section 6 Part **CPC 3**.

5.6.1 Description of the test location

Test location: AREA4

5.6.2 Photo documentation of the test set-up



5.6.3 Applicable standard

According to FCC Part 15, Section 15.247(e):
For digitally modulated systems, the 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.6.4 Description of Measurement

The EUT was connected to the spectrum analyzer with a suitable attenuator. The bandwidth of the fundamental frequency was measured with the spectrum analyzer, set sweep time equal to span/3 kHz. The power spectral density was measured using the analyzer function “Channel Power” in dBm/Hz. The result is calculated by adding 35 dB (10 log 3000 Hz/Hz) as bandwidth correction factor to the analyzer reading.

Spectrum analyzer settings:

RBW	1 MHz	VBW	1 MHz
Detector	AV	Sweep time	auto
Function: Channel power measurement		Channel bandwidth	10 MHz

5.6.5 Test result

WLAN Standard 802.11b

Channel	Frequency (MHz)	Reading (dBm/Hz)	Correction to 3 kHz (dB)	PSD (dBm)	Limit (dBm/Hz)
1	2412	-55.3	35	-20.3	8
6	2437	-55.5	35	-20.5	8
11	2462	-56.4	35	-21.4	8

WLAN Standard 802.11g

Channel	Frequency (MHz)	Reading (dBm/Hz)	Correction to 3 kHz (dB)	PSD (dBm)	Limit (dBm/Hz)
1	2412	-60,5	35	-25.5	8
6	2437	-61.5	35	-26.5	8
11	2462	-62.3	35	-27.3	8

Power spectral density limit according to FCC Part 15, Section 15.247(e):

Frequency (MHz)	Power spectral density limit (dBm/3kHz)
2400 - 2483.5	8

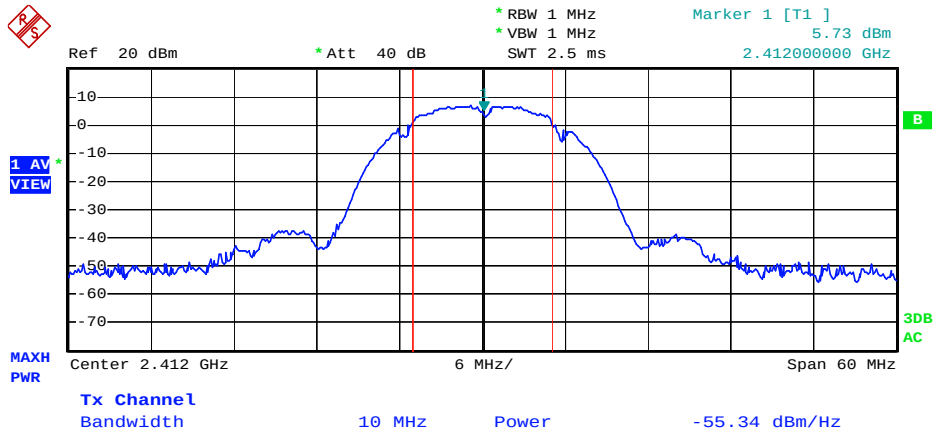
The requirements are **FULFILLED.**

Remarks: For detailed test results please refer to following test protocols.

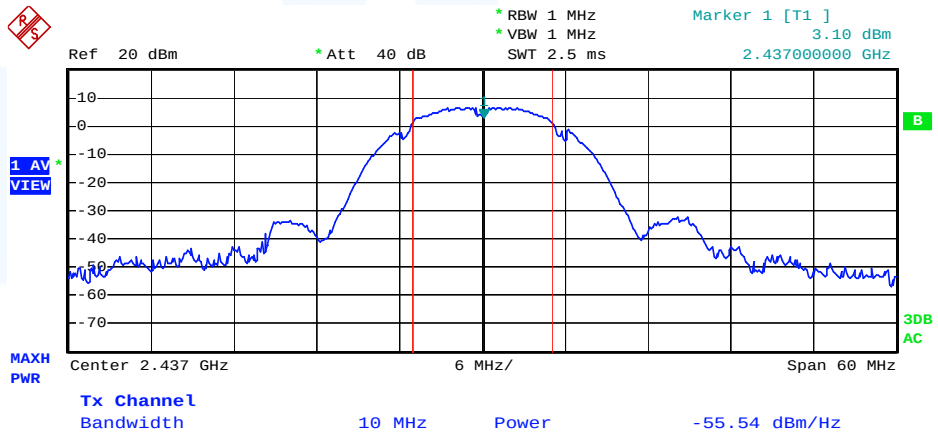
5.6.6 Test protocols

Power spectral density plots

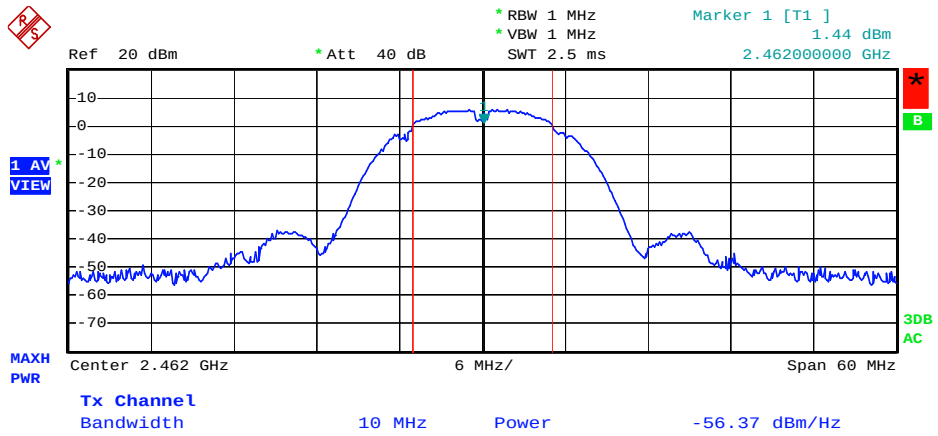
802.11b Channel 1 (2412 MHz)



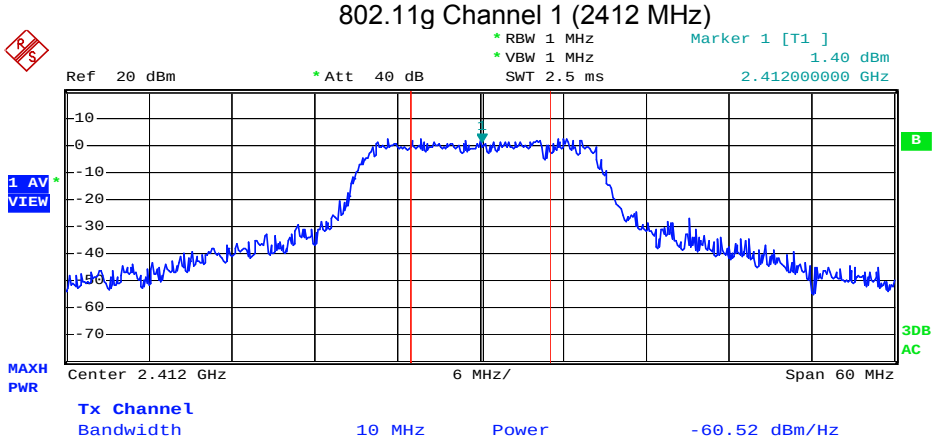
802.11b Channel 6 (2437 MHz)



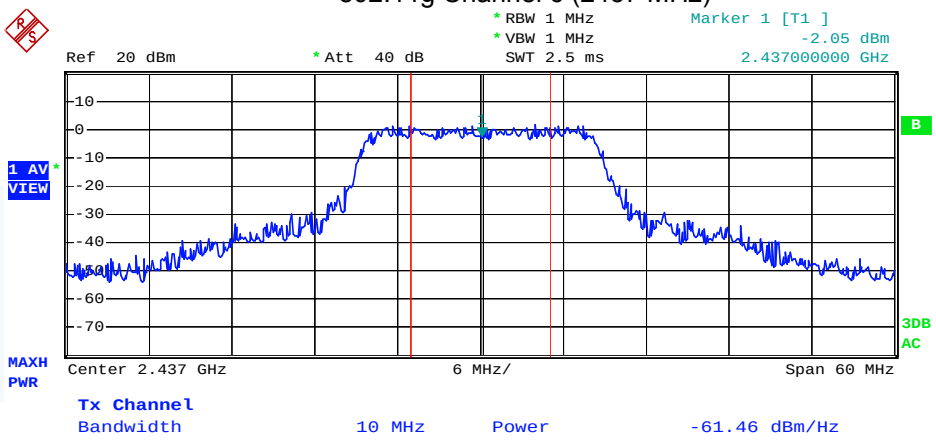
802.11b Channel 11 (2462 MHz)



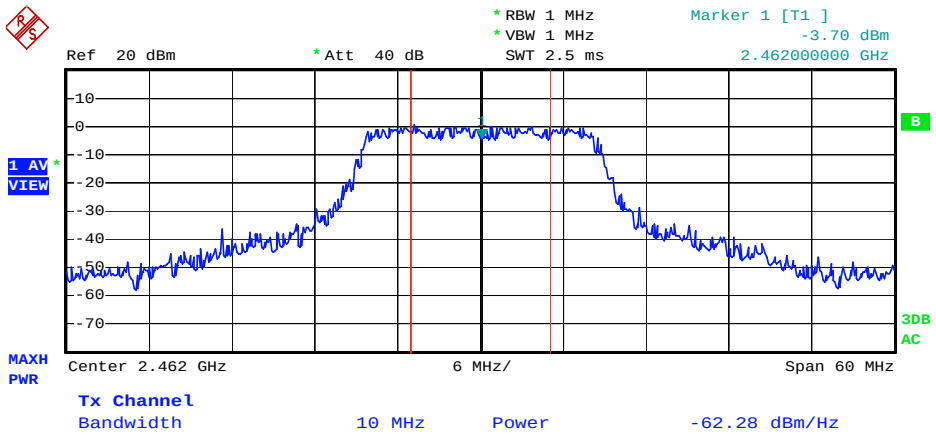
802.11g Channel 1 (2412 MHz)



802.11g Channel 6 (2437 MHz)



802.11g Channel 11 (2462 MHz)



5.7 Maximum permissible exposure (MPE)

For test instruments and accessories used see section 6 Part **CPC 3**.

5.7.1 Description of the test location

Test location: AREA4

5.7.2 Applicable standard

According to FCC Part 15, Section 15.247(i):
Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.
The test methods used comply with ANSI/IEEE C95.1, "IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz".
This test report shows the compliance with the limits for Maximum Permissible Exposure (MPE) specified in FCC Part 1, Section 1.1310 and the criteria to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in FCC Part 1, Section 1.1307(b).

5.7.3 Description of Measurement

The maximum total power input to the antenna has been measured conducted as described in clause 5.3 of this document. Through the Friis transmission formula, the known maximum gain of the antenna and the maximum power, can be calculated the MPE in a defined distance away from the product.

Friis transmission formula: $P_d = \frac{P_{out} * G}{4 * \Pi * r^2}$

where

P_d =power density (mW/cm^2)
P_{out} = output power to antenna (mW)
G = gain of antenna (linear scale)
r = distance between antenna and observation point (cm)

According to FCC Rules 47CFR 2.1093(b) the EUT is not a portable device. The EUT is designed to be used that radiating structures are 20 cm outside of the body of the user. (r = 20 cm)

5.7.4 Test result

WLAN Standard 802.11b

Worst case: Integrated Antenna with an antenna structure gain of -3.6 dBi, Power setting: 18

Channel No.	Frequency	Max power output to antenna		Antenna gain	Power density	Limit of power density
	(MHz)	(dBm)	(mW)	(linear scale)	(mW/cm^2)	(mW/cm^2)
1	2412	16.2	41.7	0.44	0.0036	1.0
6	2437	16.7	46.8	0.44	0.0040	1.0
11	2462	16.2	41.7	0.44	0.0036	1.0

WLAN Standard 802.11g

Worst case: Integrated Antenna with an antenna structure gain of -3.6 dBi, Power setting: 18

Channel No.	Frequency	Max power output to antenna		Antenna gain	Power density	Limit of power density
	(MHz)	(dBm)	(mW)	(linear scale)	(mW/cm^2)	(mW/cm^2)
1	2412	13.7	23.4	0.44	0.0020	1.0
6	2437	13.3	21.4	0.44	0.0018	1.0
11	2462	13.0	20.0	0.44	0.0017	1.0

Limits for maximum permissible exposure (MPE):

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 3.0	614	1.63	100	30
3.0 – 30	824/*f*	2.19/*f*	180/ f^2	30
30 - 300	27.5	0.073	0.2	30
300-1500	---	---	*f*/1500	30
1500-100000	**---**	**---**	**1.0**	**30**

f = Frequency in MHz

The requirements are **FULFILLED.**

Remarks: _____

5.8 Co-location and Co-transmission

Applicable standard:
OET Bulletin 65, Edition 97-01, Section 2: Multiple-transmitter sites and Complex Environments

The FCC's MPE limits vary with frequency. Therefore, in mixed or broadband RF fields where several sources and frequencies are involved, the fraction of the recommended limit (in terms of power density or square of the electric or magnetic field strength) incurred within each frequency interval should be determined, and the sum of all fractional contributions should not exceed 1.0, or 100 % in terms of percentage.

5.8.1 Test result

The EUT consists of only one transmitter therefore is no issue for Co-location and Co-transmission.

The requirements are **FULFILLED.**

Remarks: _____

5.9 Antenna structure Gain

For test instruments and accessories used see section 6 Part **CPR 3**.

5.9.1 Description of the test location

Test location: Anechoic Chamber A2

5.9.2 Description of the measurement

The antenna structure is composed of Adaptor SMA-UFL, UFL cable 10 cm, UFL plug socket to PCB, Antenna PCB, and Chip antenna (WE-MCA). A generator with output power of -20 dBm is used to determine the radiation ability of the antenna structure. The radiated power is determined with a substitution antenna. The measured power is set into relation of the known power and so the gain of the structure determined.

5.9.3 Test result

Determination of the output power of the generator with a power meter, reading:	f = 2.45 GHz P_{ref} = -20.3 dBm
Determination of the loss of the measurement cable (inclusive Adaptor SMA-N):	P = -21.6 dBm
Measurement cable loss = 1.27 dB;	
Radiated power of the antenna structure:	P_{ant} = -27.3 dBm
Correction dBd to dBi:	$Corr_{eirp}$ = 2.1

Antenna structure gain G:

$$G = P_{ant} - P_{ref} + Corr_{eirp} + \text{Cable loss}$$
$$G = -27.3 – (-20.3) + 2.1 + 1.3$$
G = -3.6 dBi

Remarks: _____

5.10 Antenna application

5.10.1 Applicable standard

According to FCC Part 15C, Section 15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has an integrated antenna supplied by the manufacturer.

5.10.2 Antenna requirements

According to FCC Part 15C, Section 15.247(b)(4):
The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

An output power reduction on the used chip antenna structure is not necessary. See point 5.8.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model / Type	Kind of Equipment	Manufacturer	Equipment No.
A 4	ESHS 30	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-002
	NNB-5 µH / 100 A-115 V	LISN	SBF electronic	02-02/20-05-008
	NNBM 8125	LISN	Schwarzbeck Mess-Elektron	02-02/20-07-001
	N-4000-BNC	RF Cable	mikes-testingpartners gmbh	02-02/50-05-138
	N-1500-N	RF Cable	mikes-testingpartners gmbh	02-02/50-05-140
	ESH 3 - Z 2	Pulse Limiter	Rohde & Schwarz München	02-02/50-05-155
	PE1540	Power Supply	Phillips Fluke GmbH	02-02/50-07-033
CPC 3	ESCI	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-004
	NRVS	Single Channel Power M	Rohde & Schwarz München	02-02/07-05-005
	NRV-Z51	Thermal Power Sensor	Rohde & Schwarz Memming	02-02/07-06-006
	PE1540	Power Supply	Phillips Fluke GmbH	02-02/50-07-033
CPR 3	FSP 30	Spectrum Analyzer	Rohde & Schwarz München	02-02/11-05-001
	AFS4-01000400-10-10P-4	RF Amplifier 1-4 GHz	PARZICH GMBH	02-02/17-05-003
	BBHA 9120 E 251	Broadband Horn Antenna	Schwarzbeck Mess-Elektron	02-02/24-05-006
	Sucoflex N-2000-SMA	RF Cable	novotronik Signalverarbeitung	02-02/50-05-075
	Sucoflex N-2000-SMA	RF Cable	novotronik Signalverarbeitung	02-02/50-05-088
MB	ESCI	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-004
	PE1540	Power Supply	Phillips Fluke GmbH	02-02/50-07-033
SEC 1-3	ESCI	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-004
	FSP 30	Spectrum Analyzer	Rohde & Schwarz München	02-02/11-05-001
	PE1540	Power Supply	Phillips Fluke GmbH	02-02/50-07-033
SER 3	FSP 30	Spectrum Analyzer	Rohde & Schwarz München	02-02/11-05-001
	AFS4-01000400-10-10P-4	RF Amplifier 1-4 GHz	PARZICH GMBH	02-02/17-05-003
	AMF-4F-04001200-15-10P	RF Amplifier 4-12 GHz	PARZICH GMBH	02-02/17-05-004
	AFS5-12001800-18-10P-6	RF Amplifier 12-18 GHz	PARZICH GMBH	02-02/17-06-002
	3117	Horn Antenna 1-18 GHz	EMCO Elektronik GmbH	02-02/24-05-009
	Sucoflex N-1600-SMA	RF Cable	novotronik Signalverarbeitung	02-02/50-05-073
	Sucoflex N-2000-SMA	RF Cable	novotronik Signalverarbeitung	02-02/50-05-075

Equipment No.	Next Calibration	Last Calibration	Next Verification	Last Verification
02-02/03-05-002	04/30/2009	04/30/2008		
02-02/20-05-001	06/18/2009	12/18/2008		
02-02/20-05-004	03/13/2011	03/13/2008	04.08.2009	10.08.2008
02-02/20-05-008	12/23/2009	12/23/2008		
02-02/20-07-001	02.10.2010	02.10.2009		
02-02/50-05-138				
02-02/50-05-140				
02-02/50-05-155	04.06.2009	10.06.2008		
02-02/50-07-033				
02-02/03-05-004	01/19/2010	01/19/2009		
02-02/07-05-005				
02-02/07-06-006	12.09.2009	12.09.2008		
02-02/50-07-033				
02-02/11-05-001	04.08.2009	04.08.2008		
02-02/17-05-003				
02-02/24-05-006	05/17/2009	11/17/2008		
02-02/50-05-075				
02-02/50-05-088				
02-02/03-05-004	01/19/2010	01/19/2009		
02-02/50-07-033				
02-02/03-05-004	01/19/2010	01/19/2009		
02-02/11-05-001	04.08.2009	04.08.2008		
02-02/50-07-033				
02-02/11-05-001	04.08.2009	04.08.2008		
02-02/17-05-003				
02-02/17-05-004				
02-02/17-06-002				
02-02/24-05-009	02.04.2010	02.04.2009		
02-02/50-05-073				
02-02/50-05-075				