



FCC ID:S5H-WRCII

EMI -- TEST REPORT

- FCC Part 15.247 FHSS -

Test Report No. :	T33355-00-01HS	10. July 2009 Date of issue
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Type / Model Name : WRCII

Product Description : Wireless remote control unit

Applicant : Siemens AG Healthcare Section

Address : Allee am Roethelheimpark 2
91052 ERLANGEN, GERMANY

Manufacturer : Siemens AG Healthcare Section

Address : Allee am Roethelheimpark 2
91052 ERLANGEN, GERMANY

Licence holder : Siemens AG Healthcare Section

Address : Allee am Roethelheimpark 2
91052 ERLANGEN, GERMANY

Test Result according to the standards listed in clause 1 test standards:	POSITIVE
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DAT-P-207/05-00

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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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
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.
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ANSI C95.1: 1992	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
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CISPR 16-4-2: 2003	Uncertainty in EMC measurement
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CISPR 22: 2005 EN 55022: 2006	Information technology equipment
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2 SUMMARY

GENERAL REMARKS:

The EUT is a wireless control module for several remote purposes incorporates a Bluetooth module demonstrates the compliance to the Bluetooth conformance test and shows the typical characteristics of common Bluetooth devices.

The EUT is installed in hand held remote controls with following variants:

- Hand control NRF (Model No. 10096785)
- Hand control Aristos (Model No. 07263791)

All variants consist of the same controlling and transceiving module.

Items	Description
BT Module type	WML-C46NBR, WML-C46NHR
Power type	100 VAC to 240 VAC
Modulation	FHSS (GFSK)
Frequency range	2402 MHz to 2480 MHz
Channel numbers	79
Data rate (kbps)	741 (GFSK)
Antenna type	Integrated
Bluetooth version compliant to	V2.0
Bluetooth Product listing ident.	QPLN Ref. No Q20706_WMLC46_SGS_1.2

Operation modes:

- asynchronous mode (ACL traffic, for DM or DH packets) for transmitting data.

The most important mode is the ACL mode at a data rate of 741 kbps for the worst case.

Packets:

A summary of the packets in ACL mode and their characteristics is shown in the following table:

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Symmetric Max. Rate (kb/s)	Asymmetric Max. Rate (kb/s)	
						Forward	Reverse
DM1	1	0-17	2/3	yes	108.8	108.8	108.8

The packets DM1 are used only because the Bluetooth stack is modified by the manufacturer and reduced on generic function with a special algorithm for booking in. This makes sure that the EUT can only connect to the appropriate transceiver. No other common Bluetooth device is able to connect to the EUT or to the system, what is needed for its safety.

Modulation types:

For the DM1 packet the pay load modulation is GFSK and is used for the final test.

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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 : 17 March 2009

Testing concluded on : 03 April 2009

Checked by:

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

Tested by:

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

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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: : 100 VAC to 240 VAC and 4.8 VDC (NiMH Battery)

3.3 Short description of the EUT

The EUT is a wireless control module installed in a hand control for remote an X-Ray system. It uses the Bluetooth physical layer for connection as common Bluetooth devices. The control unit use a modified Bluetooth stack allows connecting with the appropriate station only due to the focus on to satisfy high safety requirements.

Number of tested samples: 1 final product each type and 1 test sample with test software for special test modes
Serial number: 1201, 1313, Prototype

EUT operation mode:

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

- TX mode

- Standby 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:

- AC mains charger 100 VAC to 240 VAC Model : 07263783
- _____ 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.

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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 Determination 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 radiated measurements the EUT "Hand control NRF (Model No. 10096785)" is chosen as the worst case and set in X position with the following settings:

Bluetest3 test software settings:

Power setting max = 63

Packet type 3

Byte length 17

The frequency range was scanned from the lowest frequency generated to 25,000 MHz. All emissions not reported in this test report were more than 20 dB below the specified limit.

5 TEST CONDITIONS AND RESULTS

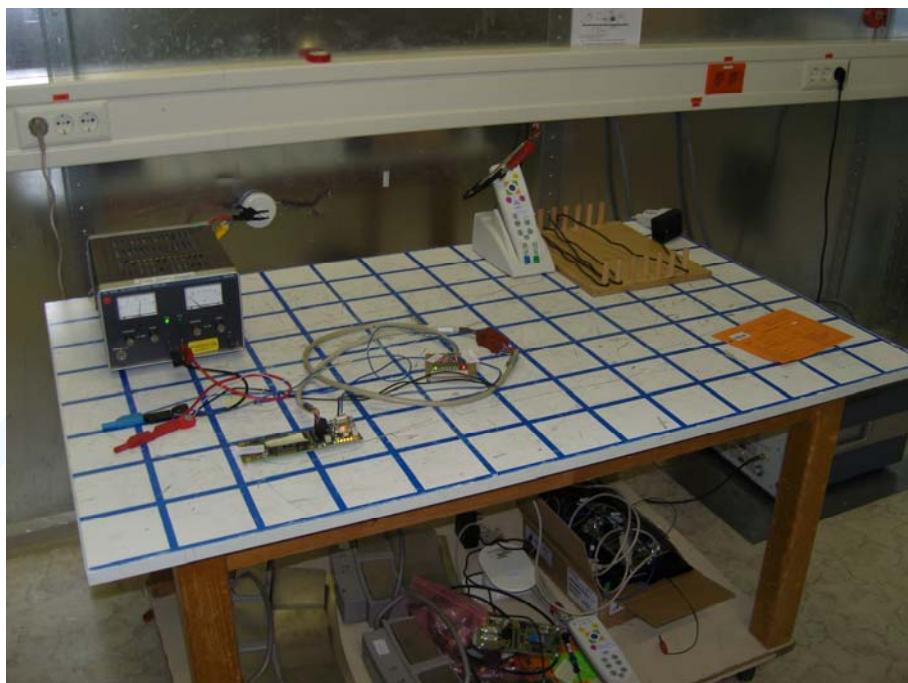
5.1 Conducted emissions

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 $50\Omega/50\ \mu\text{H}$ (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 $\text{dB}\mu\text{V}$ and μV , the following conversions apply:

$$\text{dB}\mu\text{V} = 20 \log \mu\text{V}$$

$$\mu\text{V} = 10^{(\text{dB}\mu\text{V}/20)}$$

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5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin 24.9 dB at 1.52 MHz

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

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	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**.

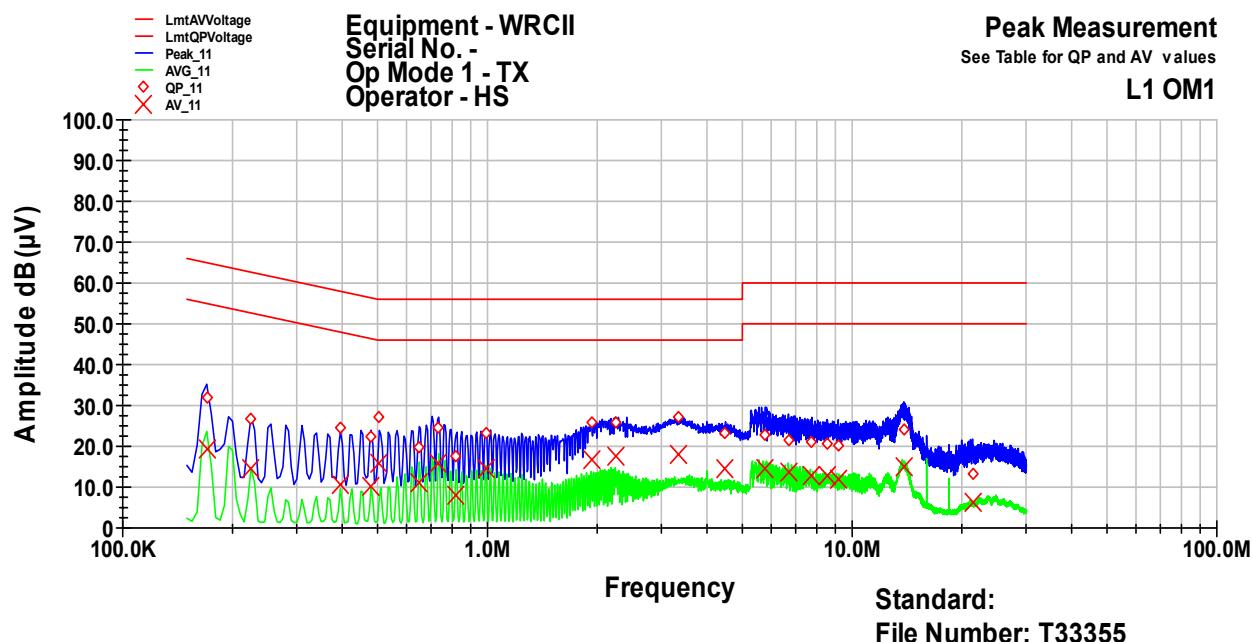
Remarks: For detailed test result please see to following test protocols. The RX- mode can be set only at test device therefore the normal mode "Standby" was chosen for measurement to demonstrate the compliance to Section 15.207(a).

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5.1.6 Test protocol

Test point L1
Operation mode: TX mode
Remarks: Battery is charging while measured!

Result: passed

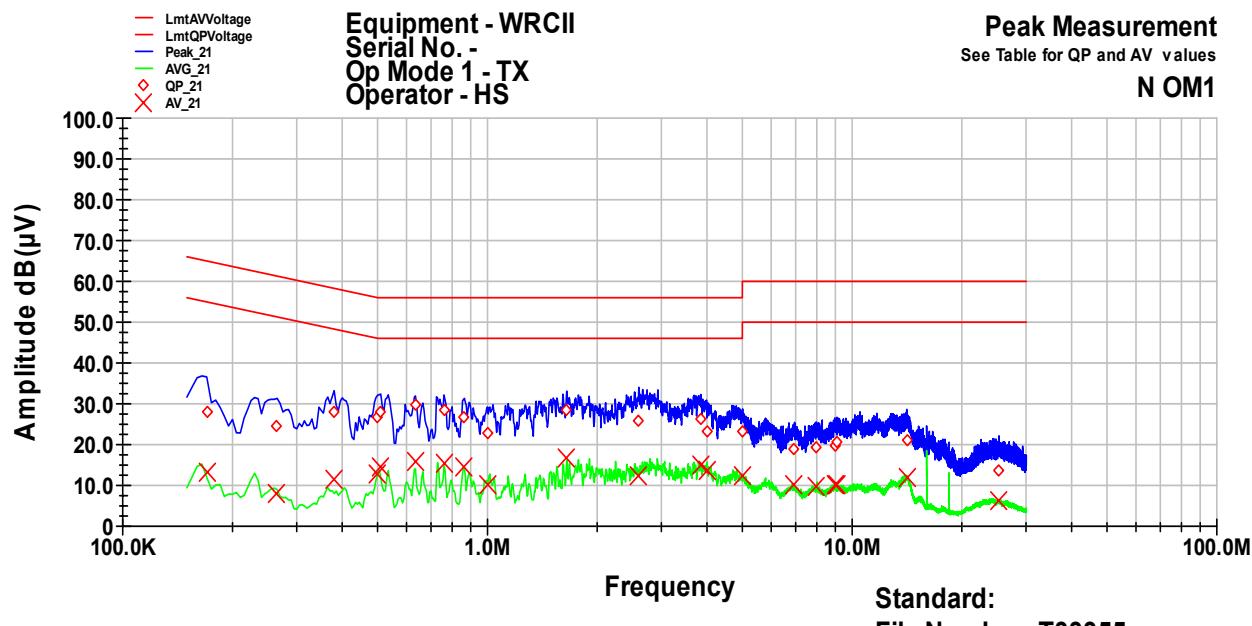


Frequency MHz	QP Level dB(μ V)	QP Delta dB	QP Limit dB	AV Level dB(μ V)	AV Delta dB	AV Limit dB
0.17	31.9	-33.1	65.0	19.5	-35.5	55.0
0.225	26.8	-35.8	62.6	14.5	-38.1	52.6
0.395	24.5	-33.5	58.0	10.5	-37.5	48.0
0.48	22.3	-34.1	56.3	10.1	-36.3	46.3
0.505	27.1	-28.9	56.0	15.7	-30.3	46.0
0.65	19.6	-36.4	56.0	10.9	-35.1	46.0
0.735	24.5	-31.5	56.0	15.7	-30.3	46.0
0.82	17.5	-38.5	56.0	7.8	-38.2	46.0
0.99	23.4	-32.6	56.0	14.5	-31.5	46.0
1.925	26.0	-30.0	56.0	16.6	-29.4	46.0
2.245	25.8	-30.2	56.0	17.7	-28.3	46.0
3.325	27.1	-28.9	56.0	17.9	-28.1	46.0
4.495	23.3	-32.7	56.0	14.5	-31.5	46.0
5.78	22.8	-37.2	60.0	14.8	-35.3	50.0
6.685	21.7	-38.3	60.0	13.5	-36.5	50.0
7.75	21.3	-38.8	60.0	12.9	-37.2	50.0
8.545	20.5	-39.5	60.0	12.6	-37.4	50.0
9.155	20.1	-39.9	60.0	11.9	-38.1	50.0
13.86	24.2	-35.8	60.0	15.1	-34.9	50.0
21.365	13.1	-46.9	60.0	6.2	-43.8	50.0

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Test point N
Operation mode: TX mode
Remarks: Battery is charging while measured!

Result: passed

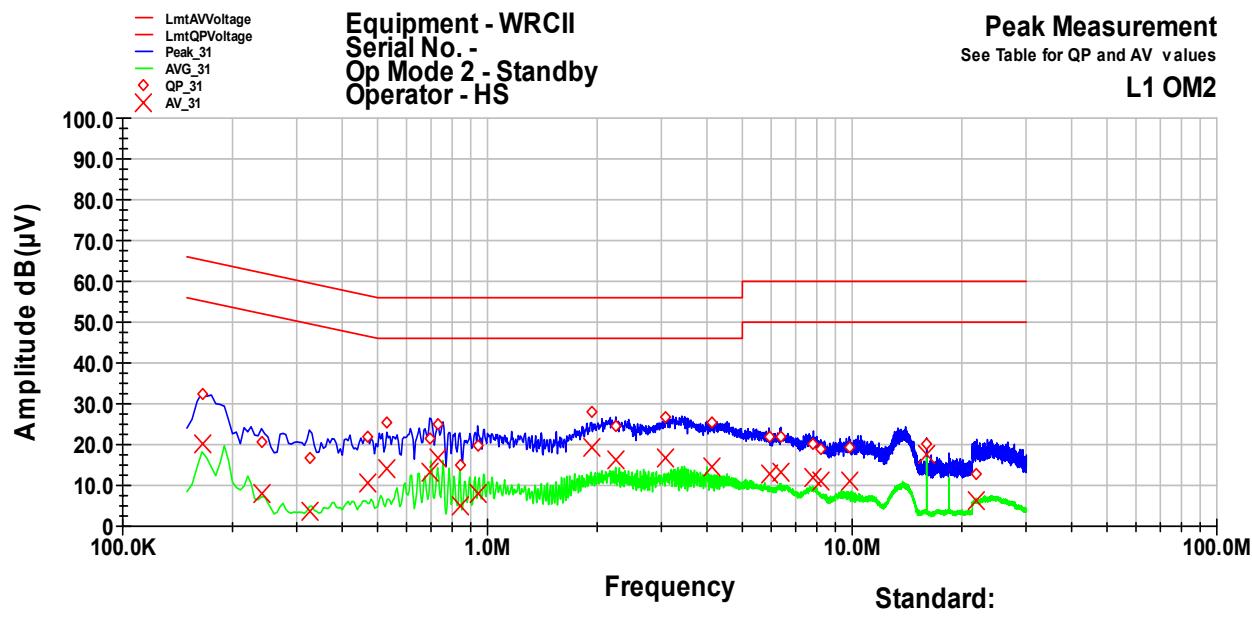


Frequency MHz	QP Level dB(μV)	QP Delta dB	QP Limit dB	AV Level dB(μV)	AV Delta dB	AV Limit dB
0.17	28.1	-36.8	65.0	13.2	-41.8	55.0
0.265	24.7	-36.6	61.3	8.2	-43.1	51.3
0.38	27.8	-30.5	58.3	11.6	-36.7	48.3
0.5	26.7	-29.3	56.0	12.9	-33.1	46.0
0.51	28.0	-28.0	56.0	14.5	-31.5	46.0
0.635	29.9	-26.1	56.0	16.0	-30.0	46.0
0.76	28.3	-27.8	56.0	15.2	-30.8	46.0
0.865	26.8	-29.2	56.0	14.3	-31.7	46.0
1	22.8	-33.2	56.0	10.1	-35.9	46.0
1.65	28.5	-27.5	56.0	16.7	-29.3	46.0
2.6	25.7	-30.3	56.0	12.5	-33.5	46.0
3.845	26.4	-29.6	56.0	15.2	-30.8	46.0
4.02	23.4	-32.6	56.0	13.6	-32.4	46.0
5.005	23.0	-37.0	60.0	12.3	-37.7	50.0
6.945	19.1	-40.9	60.0	10.2	-39.8	50.0
7.965	19.4	-40.6	60.0	9.8	-40.2	50.0
8.955	19.6	-40.4	60.0	10.0	-40.0	50.0
9.065	20.5	-39.5	60.0	10.2	-39.8	50.0
14.105	21.2	-38.8	60.0	11.9	-38.1	50.0
25.26	13.6	-46.3	60.0	6.2	-43.8	50.0

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Test point: L1
Operation mode: Standby mode
Remarks: Battery is charging while measured!

Result: passed

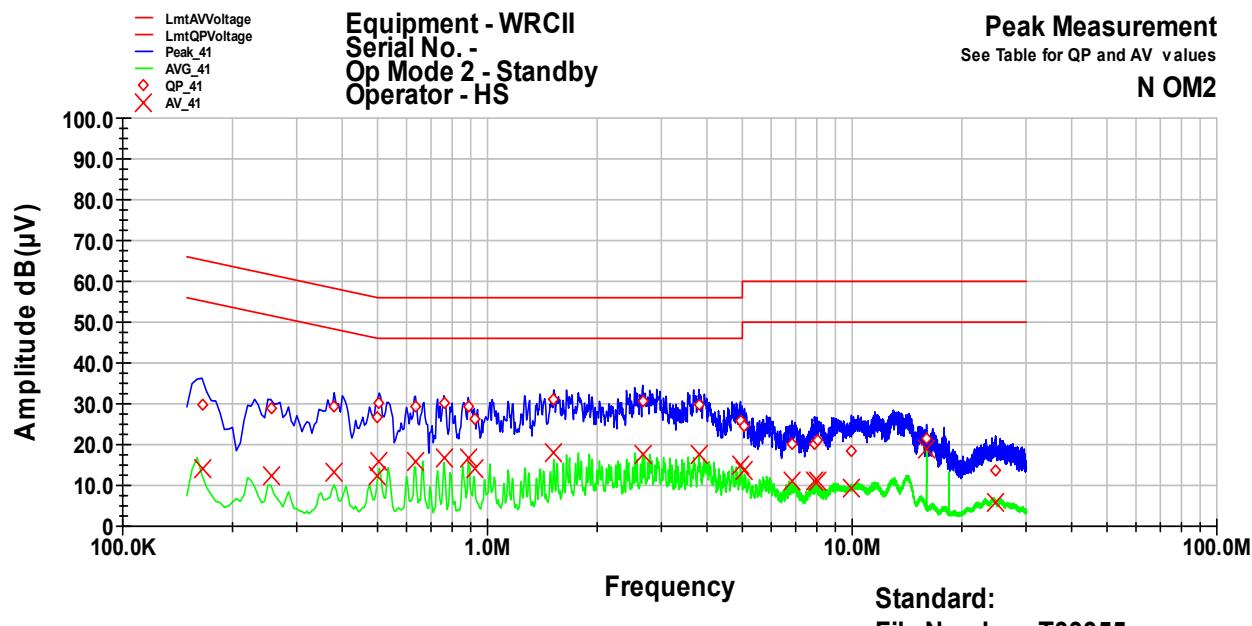


Frequency MHz	QP Level dB(µV)	QP Delta dB	QP Limit dB	AV Level dB(µV)	AV Delta dB	AV Limit dB
0.165	32.3	-32.9	65.2	20.0	-35.2	55.2
0.24	20.7	-41.4	62.1	8.0	-44.1	52.1
0.325	16.9	-42.7	59.6	3.5	-46.1	49.6
0.47	21.9	-34.6	56.5	10.6	-35.9	46.5
0.53	25.5	-30.5	56.0	14.1	-31.9	46.0
0.695	21.4	-34.6	56.0	13.1	-32.9	46.0
0.73	24.8	-31.2	56.0	16.8	-29.2	46.0
0.84	15.0	-41.0	56.0	5.0	-41.0	46.0
0.94	19.8	-36.2	56.0	7.9	-38.1	46.0
1.93	28.0	-28.0	56.0	19.1	-26.9	46.0
2.25	24.6	-31.4	56.0	16.4	-29.6	46.0
3.08	26.9	-29.1	56.0	16.6	-29.4	46.0
4.12	25.2	-30.8	56.0	14.6	-31.4	46.0
5.91	21.9	-38.1	60.0	12.8	-37.2	50.0
6.37	21.8	-38.2	60.0	13.1	-36.9	50.0
7.825	20.1	-39.9	60.0	12.1	-37.9	50.0
8.2	19.0	-41.0	60.0	11.1	-38.9	50.0
9.82	19.4	-40.6	60.0	11.2	-38.8	50.0
16	20.0	-40.0	60.0	17.4	-32.6	50.0
21.95	13.0	-47.0	60.0	6.2	-43.8	50.0

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Test point N
Operation mode: Standby mode
Remarks: Battery is charging while measured!

Result: passed



Frequency MHz	QP Level dB(μV)	QP Delta dB	QP Limit dB	AV Level dB(μV)	AV Delta dB	AV Limit dB
0.165	29.6	-35.6	65.2	14.0	-41.2	55.2
0.255	28.9	-32.7	61.6	12.4	-39.1	51.6
0.38	29.5	-28.8	58.3	13.2	-35.1	48.3
0.5	26.6	-29.4	56.0	12.3	-33.7	46.0
0.505	30.1	-25.9	56.0	16.0	-30.0	46.0
0.635	29.3	-26.7	56.0	15.8	-30.2	46.0
0.76	30.2	-25.8	56.0	16.7	-29.3	46.0
0.885	29.2	-26.8	56.0	16.9	-29.1	46.0
0.92	26.4	-29.6	56.0	14.0	-32.0	46.0
1.52	31.1	-24.9	56.0	17.8	-28.2	46.0
2.665	30.8	-25.2	56.0	17.5	-28.5	46.0
3.8	29.9	-26.1	56.0	17.8	-28.2	46.0
4.94	25.9	-30.1	56.0	14.9	-31.1	46.0
5.065	24.6	-35.4	60.0	13.6	-36.4	50.0
6.835	20.4	-39.6	60.0	11.1	-38.9	50.0
7.88	20.1	-39.9	60.0	11.0	-39.0	50.0
8.005	20.9	-39.1	60.0	11.0	-39.0	50.0
9.95	18.4	-41.6	60.0	9.3	-40.7	50.0
16	21.6	-38.4	60.0	19.0	-31.0	50.0
24.715	13.5	-46.5	60.0	6.0	-44.0	50.0

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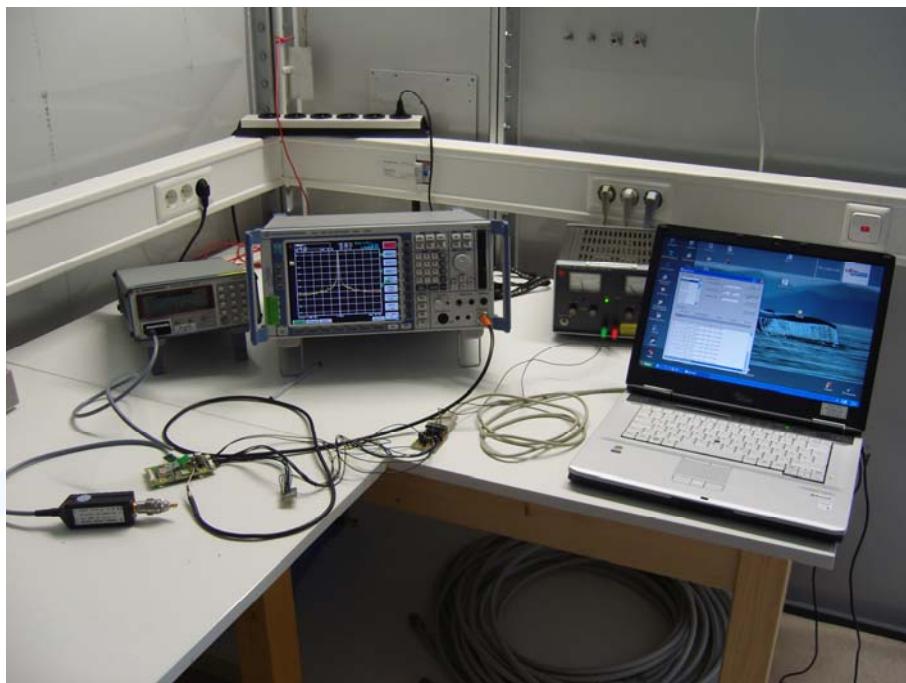
5.2 Emission bandwidth

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

5.2.1 Description of the test location

Test location: Shielded Room S4

5.2.2 Photo documentation of the test set-up



5.2.1 Applicable standard

According to FCC Part 15C, Section 15.247(a):

Frequency hopping systems shall have hopping carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

5.2.2 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio of -20 dB. The reference level is the level of the highest signal amplitude observed from the transmitter at either the fundamental frequency or the first-order modulation products in all typical modes of operation.

5.2.3 Test result

DM1 packet:

Channel No.	20 dB Bandwidth (kHz)
CH0	1112
CH39	1124
CH78	1128

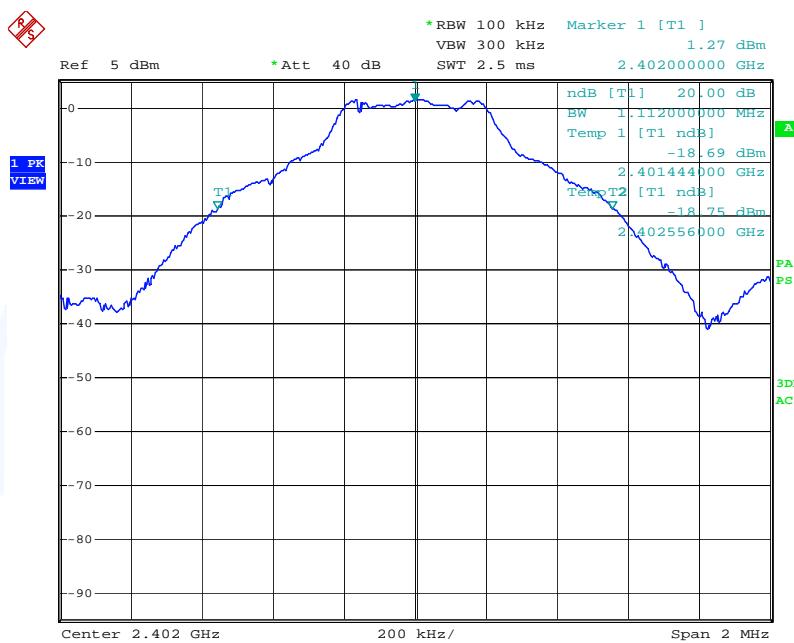
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There is no bandwidth limit according to FCC Part15C, Section 15.247(a).

Remarks: For detailed test result please refer to following test protocol.

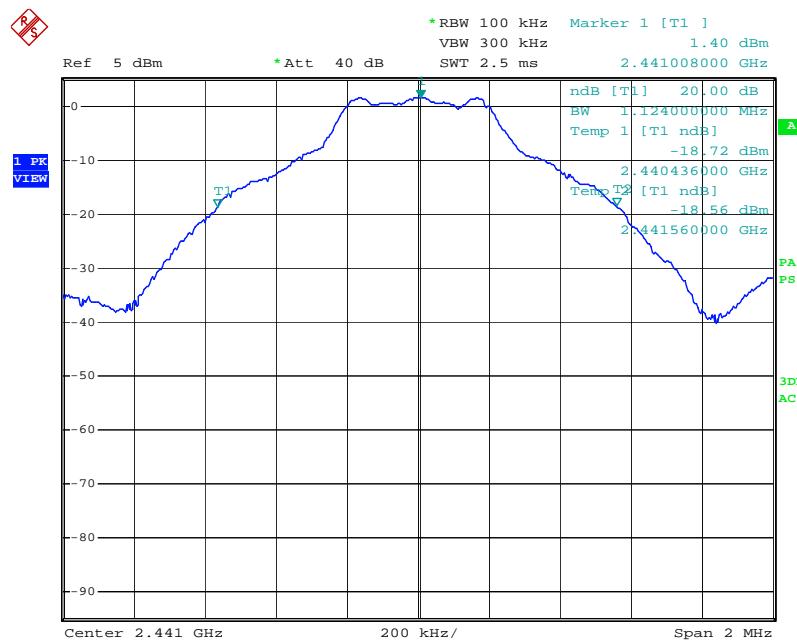
5.2.4 Test protocol

Emission bandwidth, channel 0, DM1 packet

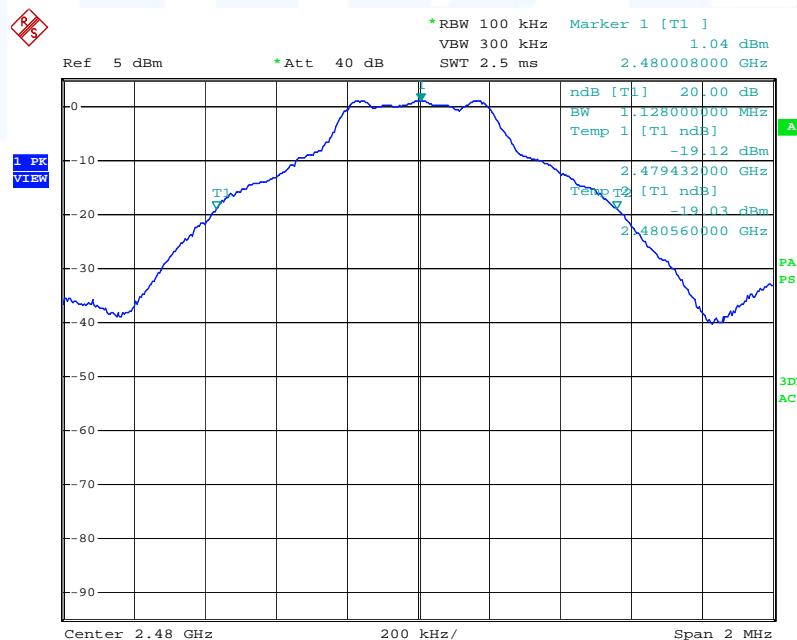


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Emission bandwidth, channel 39, DM1 packet



Emission bandwidth, channel 78, DM1 packet



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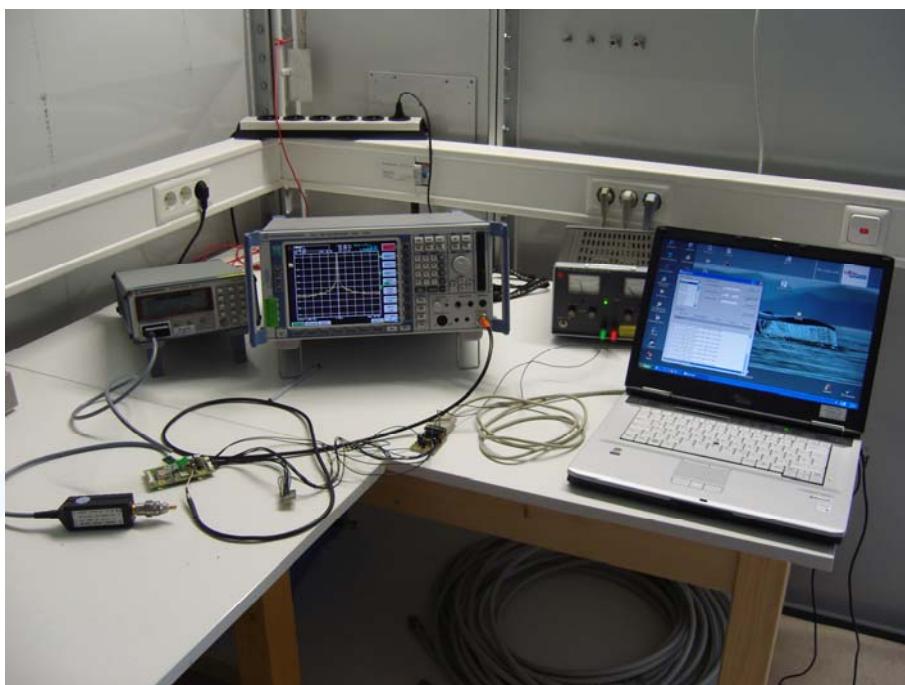
5.3 Maximum peak conducted output power

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

5.3.1 Description of the test location

Test location: Shielded Room S4

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15C, Section 15.247(b)(1, 2):

The maximum peak output power of an intentional radiator shall not exceed the limit defined in dependency of the channel separation and of the number of hopping channels.

5.3.4 Description of Measurement

A power meter with thermal sensor was connected to the output of the transmitter while EUT was operating in transmit mode using the assigned frequency.

5.3.5 Test result

DM1 Packet

Channel	Frequency (MHz)	Peak Power (dBm)	Correct. (dB)	Corr. peak power (dBm)	Limit (dBm)	Delta (dB)
0	2402	-2.7	0.7	-2.0	21	-23.0
39	2441	-2.6	0.7	-1.9	21	-22.9
78	2480	-2.9	0.7	-2.2	21	-23.2

The measurement cable (10 cm) with SMX-connectors was taken into account with 0.7 dB at 2.45 GHz.

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Peak Power Limit according to FCC Part 15C, Section 15.247(b)(1):

Frequency (MHz)	Channel separation	Hop Channels	Peak power limit	
			(dBm)	(Watt)
902-928			30	1.0
902-928			24	0.25
2400-2483.5	20 dB bandwidth	≥ 75	30	1.0
2400-2483.5	2/3 20 dB bandwidth	≥ 75	21	0.125
5725-5850			30	1.0

The requirements are **FULFILLED**.

Remarks:

mikes

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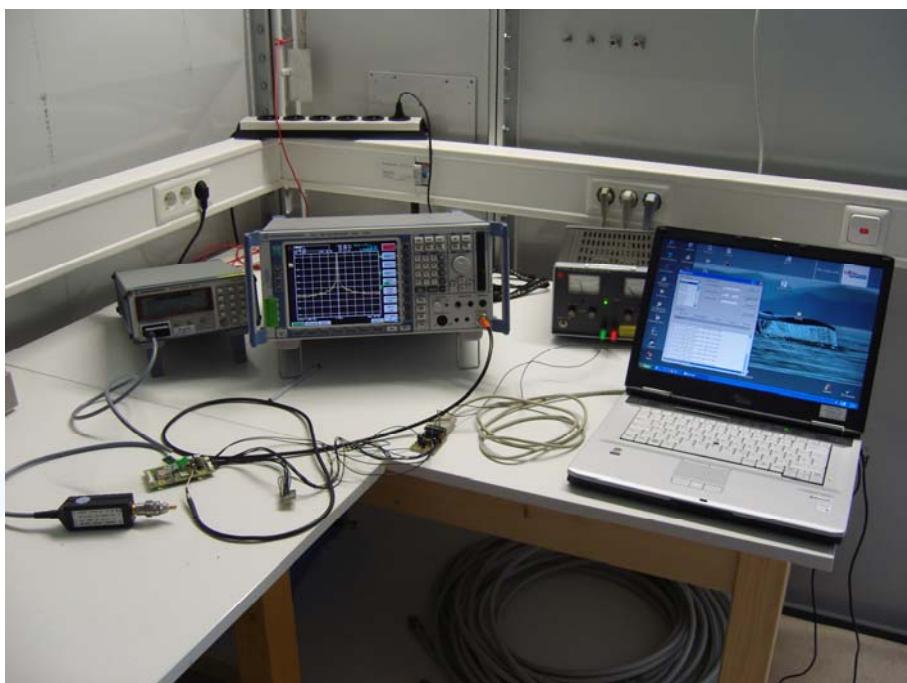
5.4 Peak power density

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

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 15C, Section 15.247(f):

Hybrid systems shall comply with the power spectral density requirements of Section 15.247(e)

5.4.4 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 using 3 kHz RBW and 30 kHz VBW, 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.

Settings on the spectrum analyzer:

RBW:	3 kHz	VBW:	30 kHz
Sweep:	auto	Detector:	Peak

FCC ID:S5H-WRCII**5.4.5 Test result**

Packet DM1

Channel	Frequency (MHz)	Reading (dBm/Hz)	Correction to 3 kHz (dB)	PSD (dBm)	Limit (dBm)
0	2402	-64.8	35	-29.8	8
39	2441	-64.9	35	-29.9	8
78	2480	-65.2	35	-30.2	8

Limit according to FCC Part 15C, Section 15.247(e):

The transmitter 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 requirements are **FULFILLED**.

Remarks:

FCC ID:S5H-WRCII

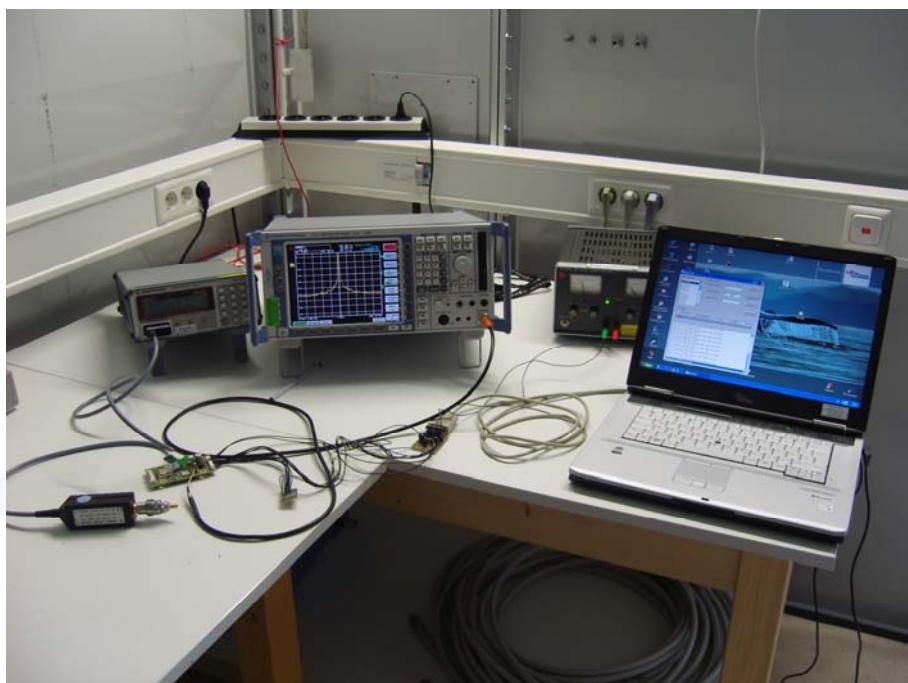
5.5 Spurious emissions conducted

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

5.5.1 Description of the test location

Test location: Shielded Room S4

5.5.2 Photo documentation of the test set-up



5.5.3 Applicable standard

According to FCC Part 15C, 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.

5.5.4 Description of Measurement

A spectrum analyzer is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode at the assigned frequency. All frequency bands outside of the operating frequency are scanned for unwanted emissions and recorded. Emissions not recorded are at least 20 dB below of the limit.

Spectrum analyzer settings:

RBW:	100 kHz	VBW:	100 kHz
Detector:	Max peak	Trace:	Max hold
Sweep:	auto		

FCC ID:S5H-WRCII

5.5.5 Test result

DM1 Packet

SPURIOUS EMISSIONS								
Channel 0, max. level -2.7 dBm			Channel 39, max. level -2.6 dBm			Channel 78, max. level -2.9 dBm		
f (MHz)	Level PK (dBm)	Limit (-20 dB) (dBm)	f (MHz)	Level PK (dBm)	Limit (-20 dB) (dBm)	f (MHz)	Level PK (dBm)	Limit (-20 dB) (dBm)
4804	-60.1	-22.7	4848	-58.1	-22.8	4936	-57.9	-22.9
7180	-63.1	-22.7	7312	-64.7	-22.8	7444	-61.1	-22.9
Measurement uncertainty					± 3 dB			

Peak-Limit according to FCC Part 15C, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency band 2400 – 2483.50 MHz, 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. 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).

The requirements are **FULFILLED**.

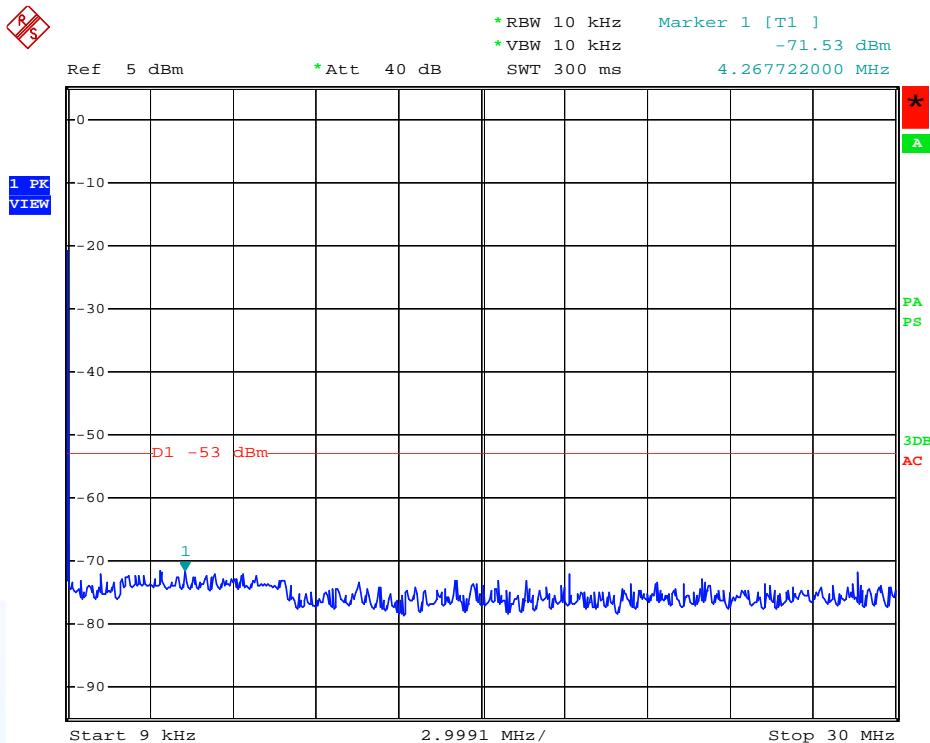
Remarks: In the frequency range 9 kHz to 30 MHz and 30 MHz to 1 GHz were no emissions found. For detailed test results please refer to following test protocol.

FCC ID:S5H-WRCII

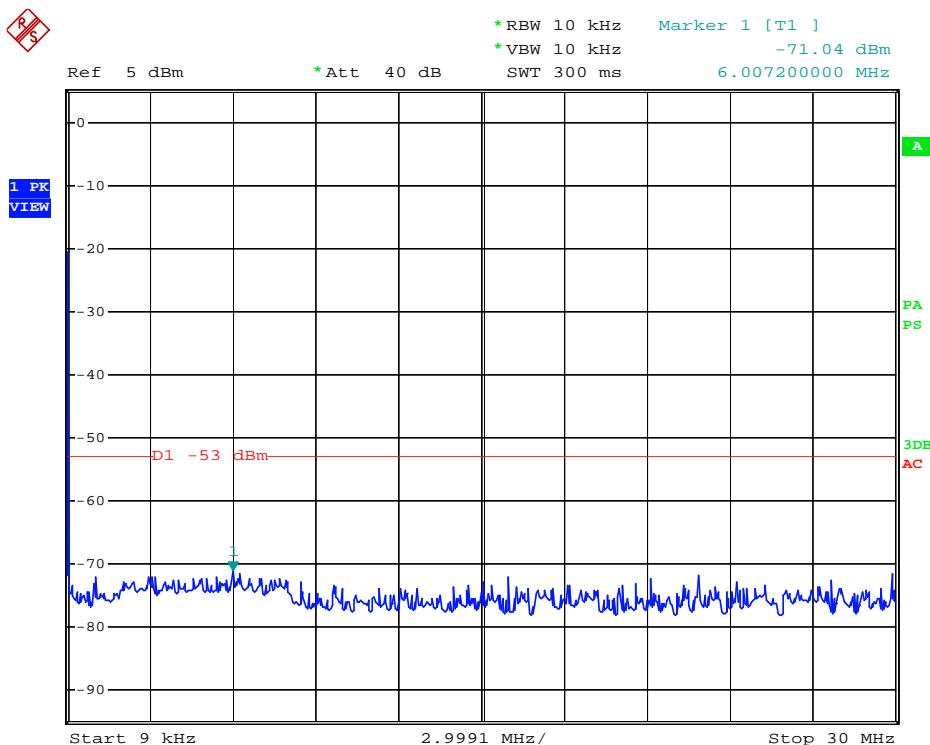
5.5.6 Test protocol

Spurious emissions conducted

9 kHz – 30 MHz, Channel 0

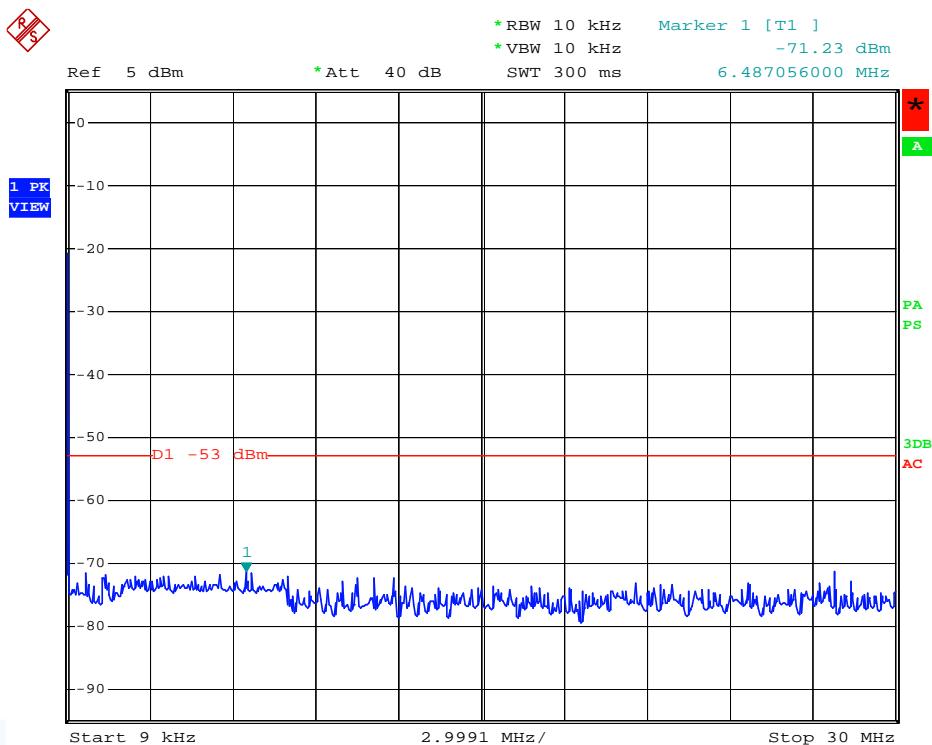


9 kHz – 30 MHz, Channel 39

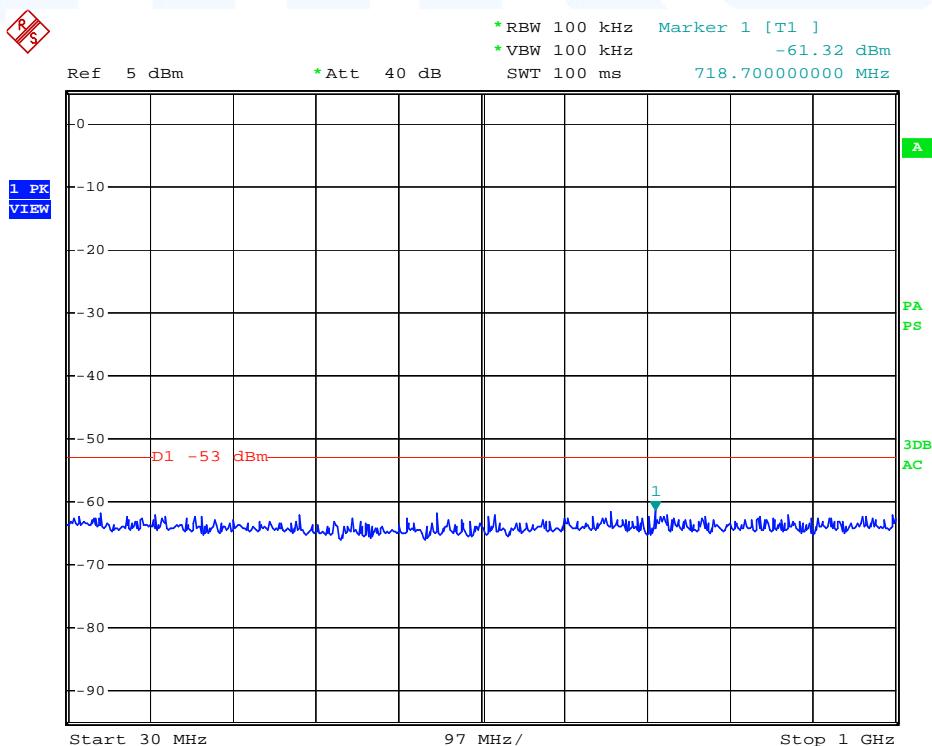


FCC ID:S5H-WRCII

9 kHz – 30 MHz, Channel 78

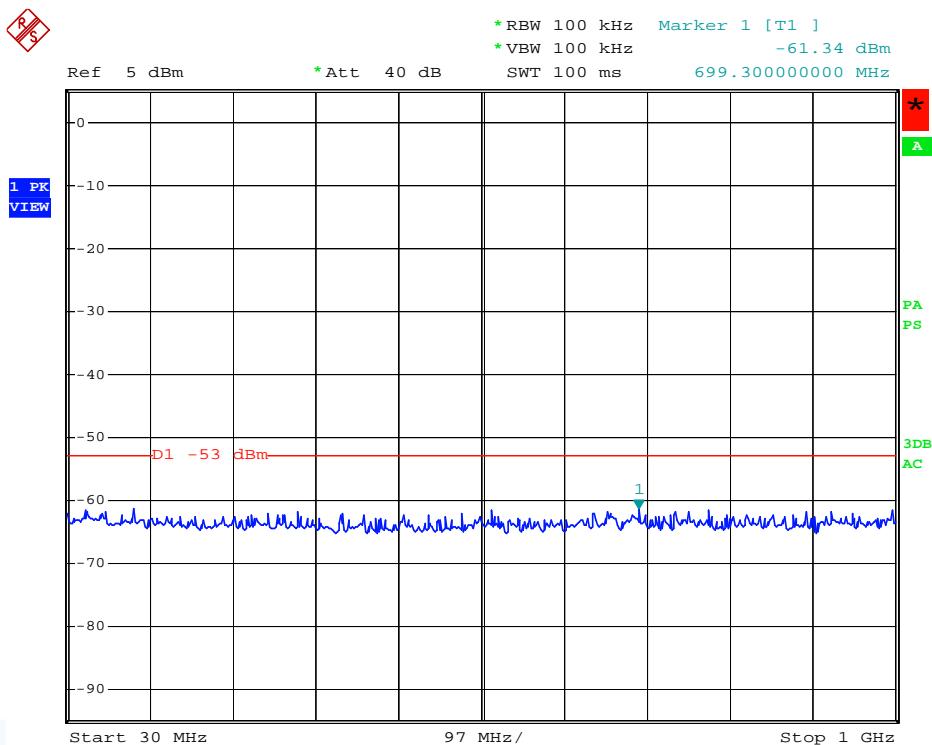


30 MHz – 1 GHz, Channel 0

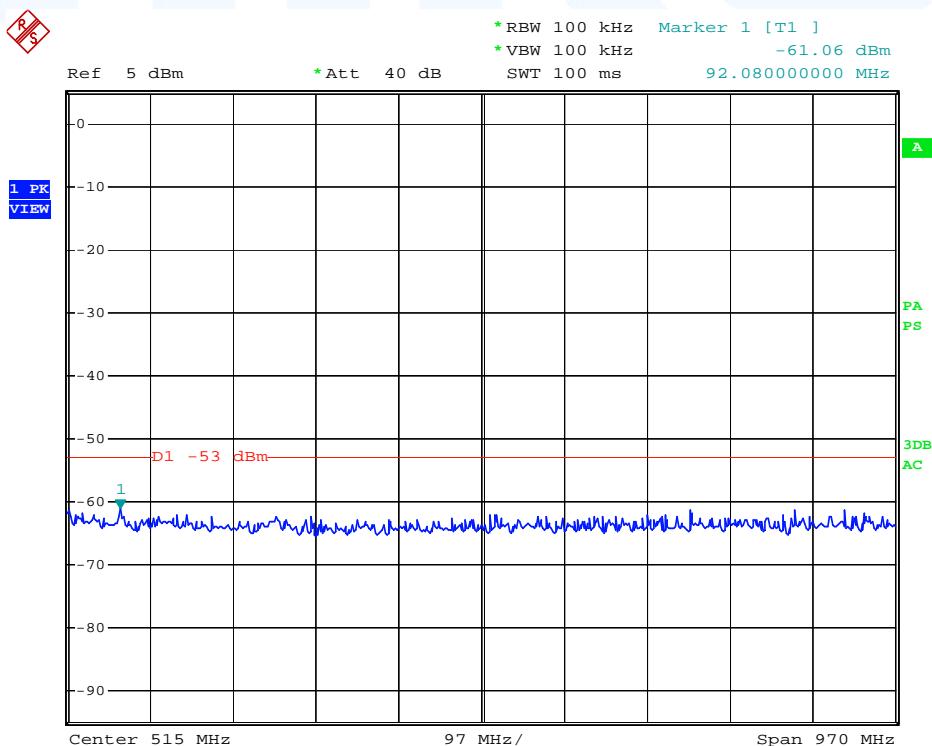


FCC ID:S5H-WRCII

30 MHz – 1 GHz, Channel 39

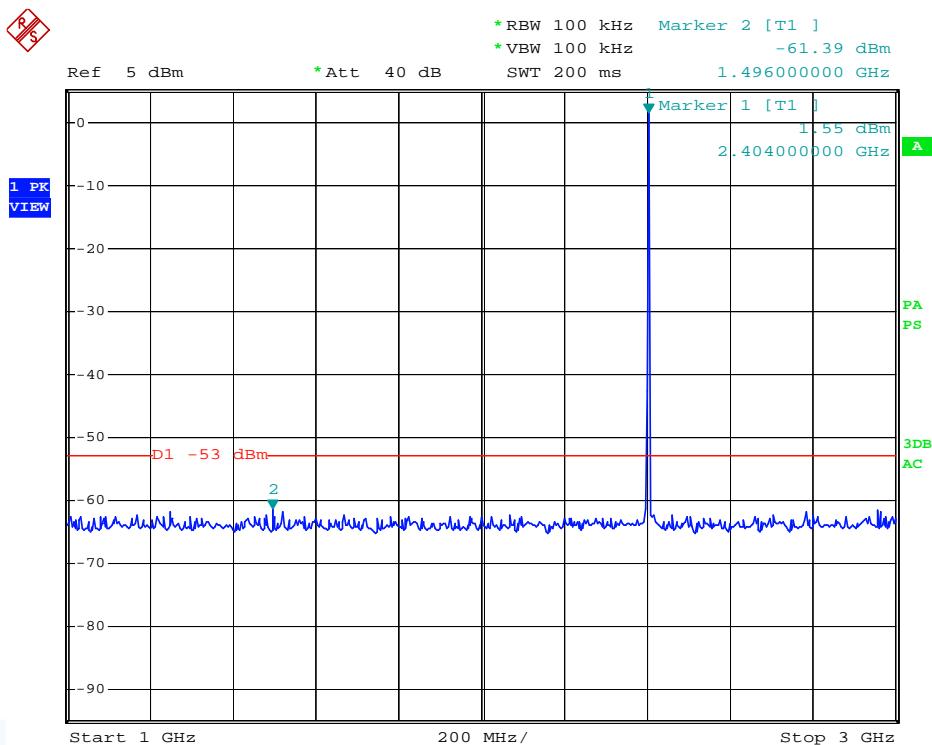


30 MHz – 1 GHz, Channel 78

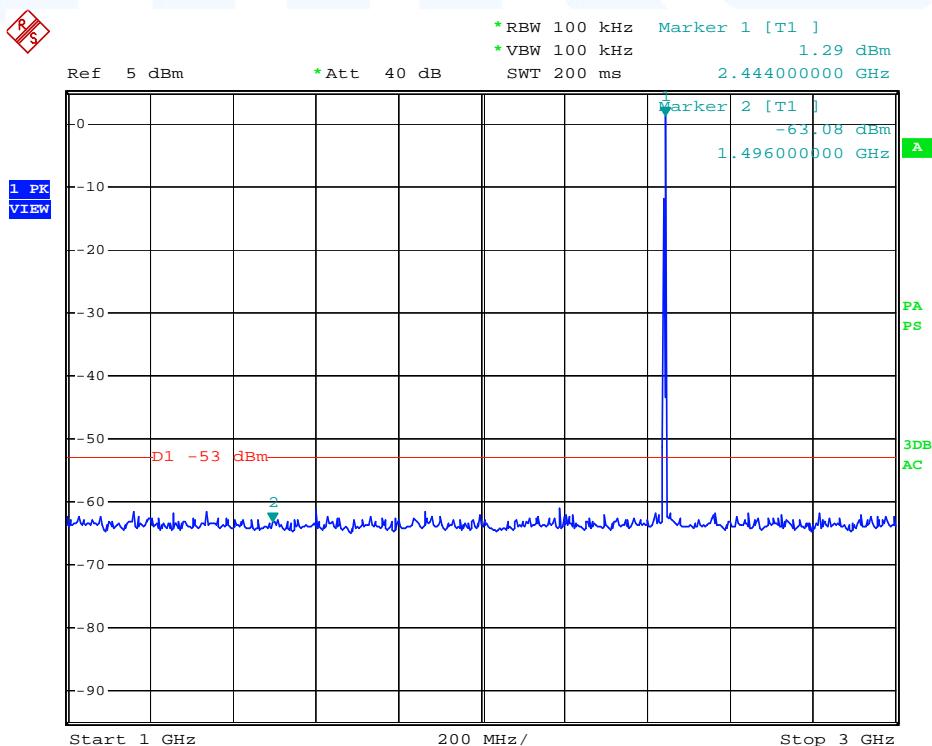


FCC ID:S5H-WRCII

1 GHz – 3 GHz, Channel 0

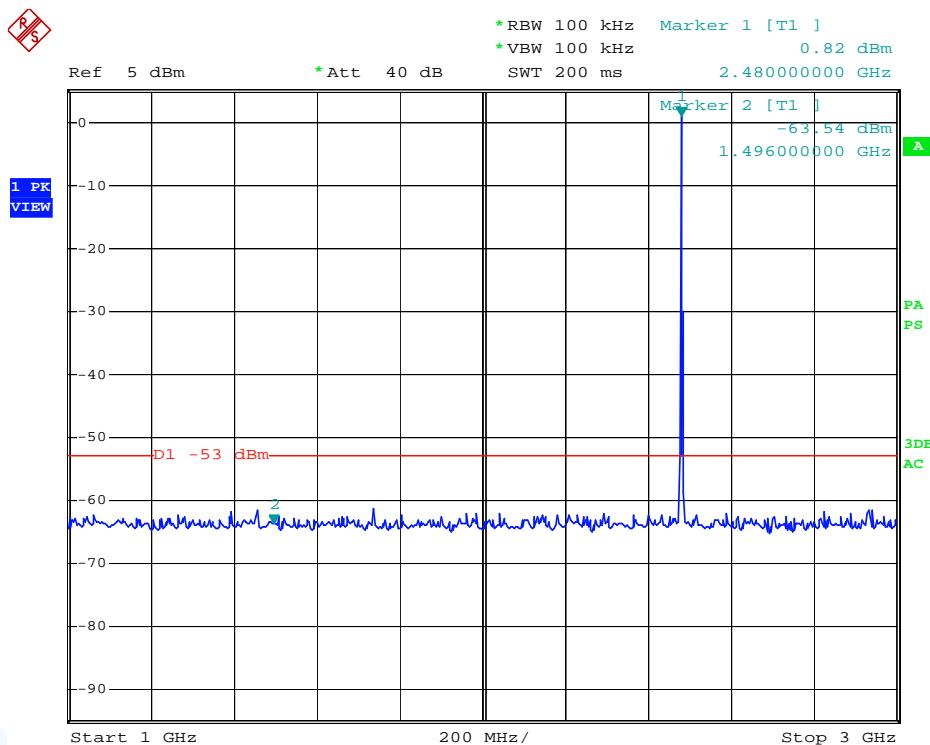


1 GHz – 3 GHz, Channel 39

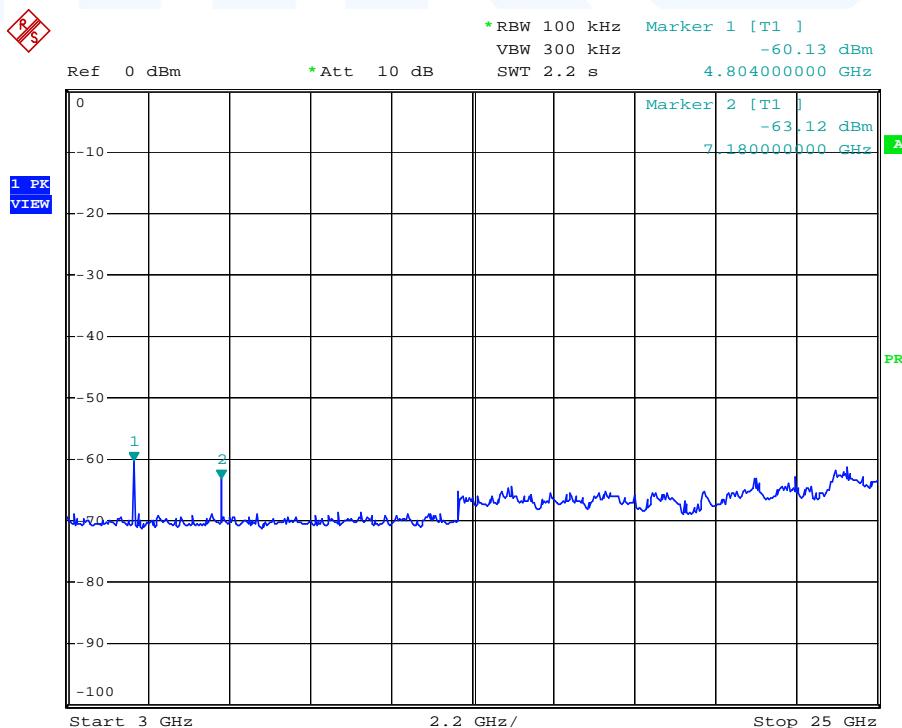


FCC ID:S5H-WRCII

1 GHz – 3 GHz, Channel 78

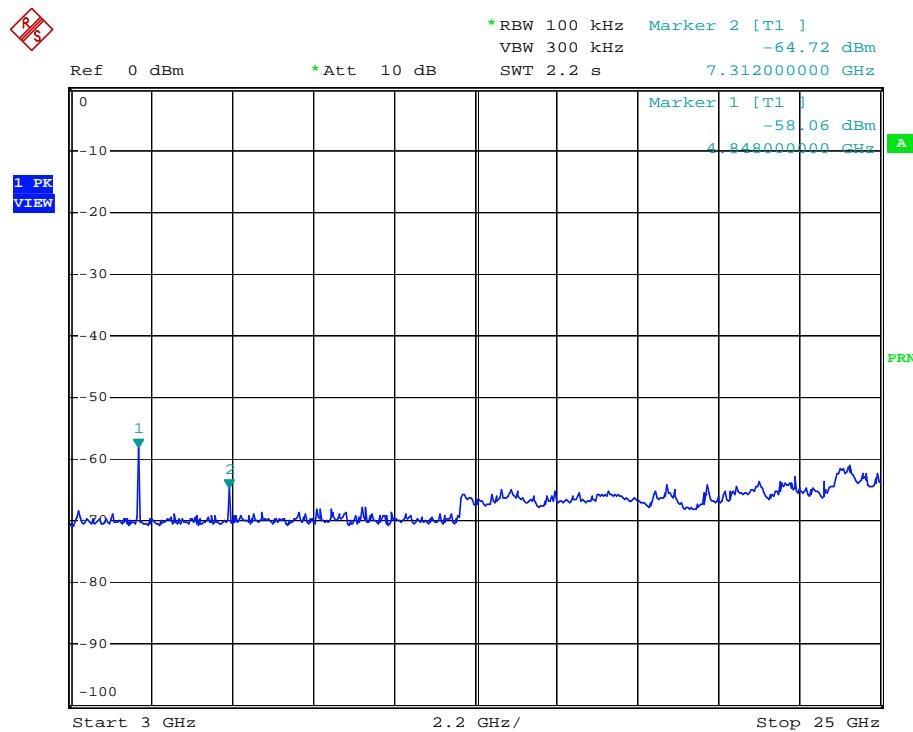


3 GHz – 25 GHz, Channel 0

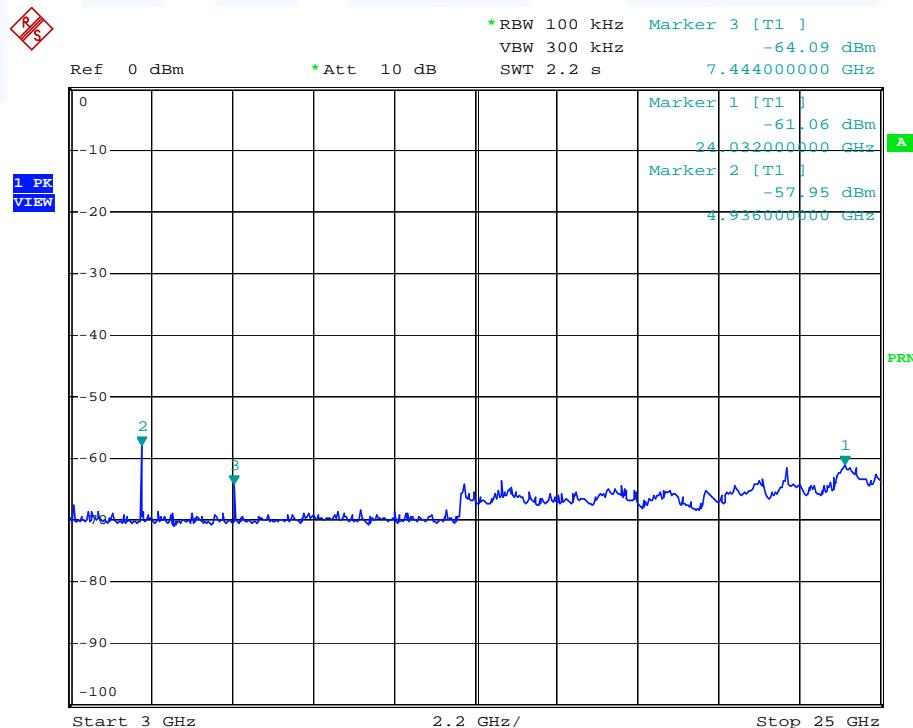


FCC ID:S5H-WRCII

3 GHz – 25 GHz, Channel 38



3 GHz – 25 GHz, Channel 79



FCC ID:S5H-WRCII

5.6 Spurious emissions radiated

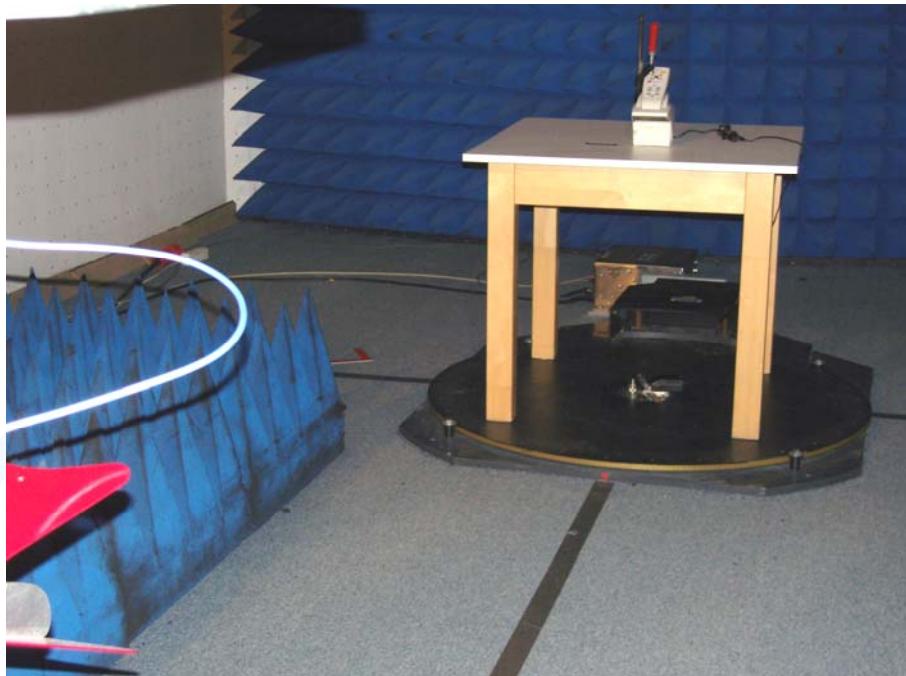
For test instruments and accessories used see section 6 Part **SER 3**.

5.6.1 Description of the test location

Test location: Anechoic Chamber A2
Test distance: 3 metres

5.6.2 Photo documentation of the test set-up

Anechoic chamber



5.6.3 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 the highest level of the desired power.

5.6.4 Description of Measurement

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 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.

Spectrum analyzer settings:

RBW: 1 MHz for $f > 1$ GHz

VBW: 3 MHz for $f > 1$ GHz

Detector: Max. peak

Trace: Max. hold

Sweep: Auto

FCC ID:S5H-WRCII

5.6.5 Radiated emission test f < 1 GHz)

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

5.6.6 Radiated emission test f > 1GHz

Channel 0

Corrected field strength of fundamental wave as reference for radiated emissions: 103.5 dB μ V/m

Frequency (MHz)	Restricted band	Duty Cycle (dB)	L: AV (dB μ V)	Correction (dB)	L: PK dB(μ V/m)	L: AV dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
1168	X				38.0		54	16.0
1576	X				38.8		54	15.2

Channel 39

Corrected field strength of fundamental wave as reference for radiated emissions: 101.8 dB μ V/m

Frequency (MHz)	Restricted band	Duty Cycle (dB)	L: AV (dB μ V)	Correction (dB)	L: PK dB(μ V/m)	L: AV dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
1168	X				38.2		54	15.8
1576	X				38.9		54	15.1

Channel 78

Corrected field strength of fundamental wave as reference for radiated emissions: 104.4 dB μ V/m

Frequency (MHz)	Restricted band	Duty Cycle (dB)	L: AV (dB μ V)	Correction (dB)	L: PK dB(μ V/m)	L: AV dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
1168	X				38.4		54	15.6
1576	X				38.7		54	15.3

Peak-limit according to FCC Part 15C, Section 15.247(d) for emissions falling not in restricted bands:

In any 100 kHz bandwidth outside the frequency band 2400 – 2483.5 MHz, 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. Attenuation below the general limits specified in §15.209(a) is not required.

Limits dB(μ V/m)		
Ch0	Ch39	Ch78
83.5	81.8	84.4

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).

FCC ID:S5H-WRCII

Radiated limits for spurious emissions fall in the restricted bands:

Frequency (MHz)	Limits acc. 15.209 (μ V/m)	dB(μ V/m)	Measurement distance (m)
0.009-0.490	2400/f (kHz)	2400/f (kHz)	300
0.490-1.705	24000/f (kHz)	24000/f (kHz)	30
1.705-30	30	30	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: During the test the EUT was set into TX continuous mode with normal modulation.

The measurement was performed up to the 10th harmonic (25000 MHz). Emissions not recorded

are more than 20 dB below the limit.

FCC ID:S5H-WRCII

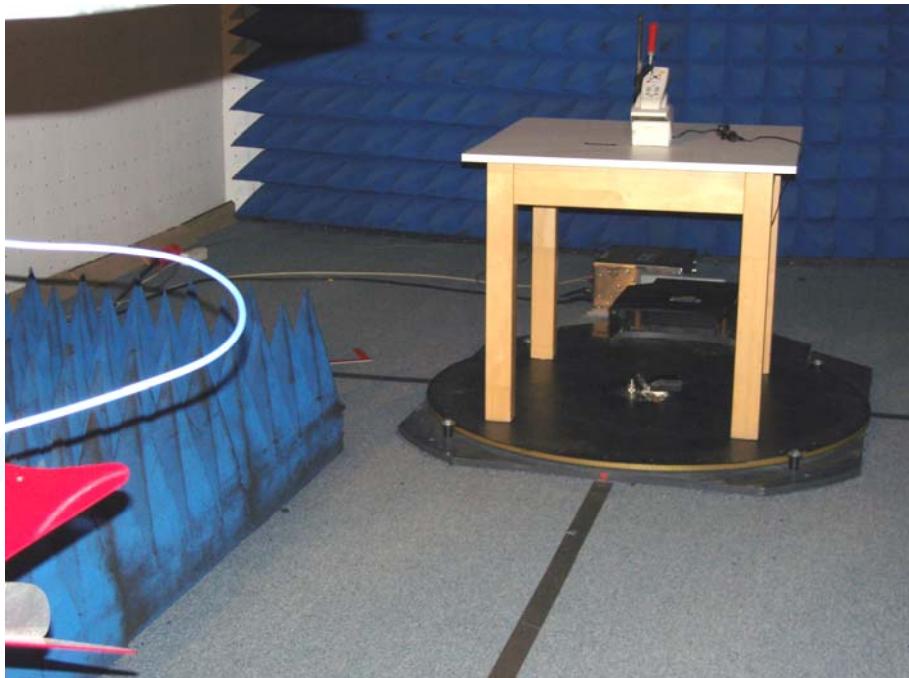
5.7 Band edge compliance

For test instruments and accessories used see section 6 Part **SER3**.

5.7.1 Description of the test location

Test location: Anechoic Chamber A2
Test distance: 3 metres

5.7.2 Photo documentation of the test set-up



5.7.3 Applicable standard

According to FCC Part 15, Section 15.205(a):

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).

5.7.4 Description of Measurement

The band edge was measured radiated. The span of the spectrum analyzer was set wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

Spectrum analyzer settings:

RBW: 100 kHz
VBW: 100 kHz
Sweep: Auto
Detector function: Peak

FCC ID:S5H-WRCII

5.7.5 Test result

DM1 packet:

Channel 0, nearest restricted band: 2310 – 2390 MHz:

Frequency (MHz)	Restricted band	L: PK dB(µV/m)	L: AV dB(µV/m)	Limit AV dB(µV/m)	Delta (dB)
2321	X	31.4		54	22.6

DM1 packet:

Channel 78, nearest restricted band: 2483.5 – 2500 MHz:

Frequency (MHz)	Restricted band	L: PK dB(µV/m)	L: AV dB(µV/m)	Limit AV dB(µV/m)	Delta (dB)
2483.5	X	42.0		54	12.0
2484	X	42.8		54	11.2

Peak-Limit according to FCC Part 15C, Section 15.205(a):

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).

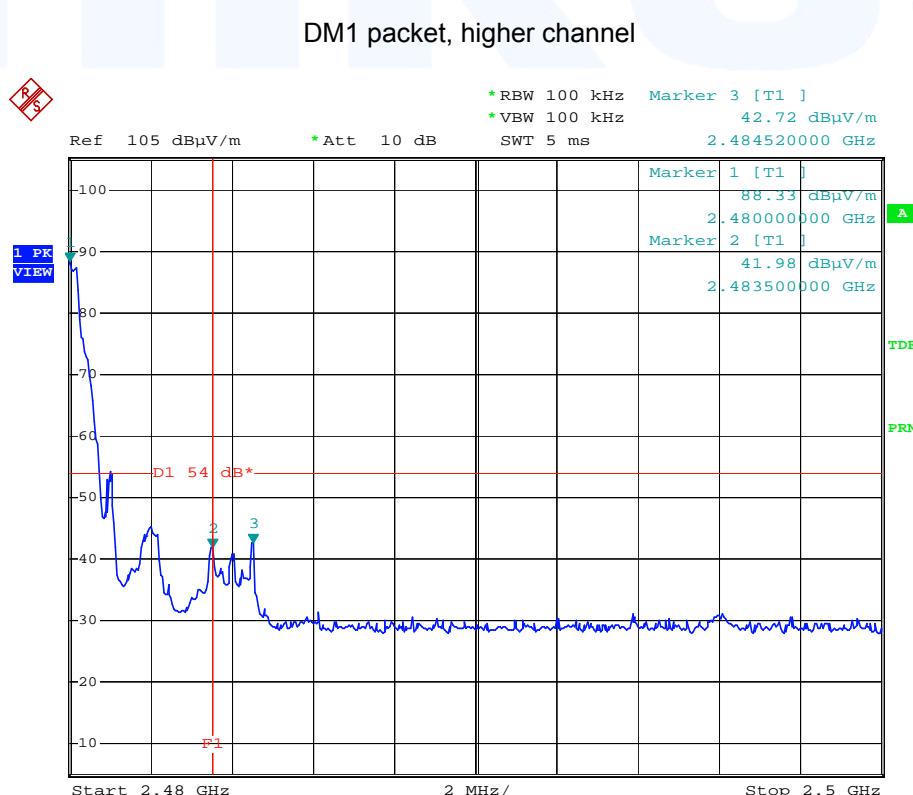
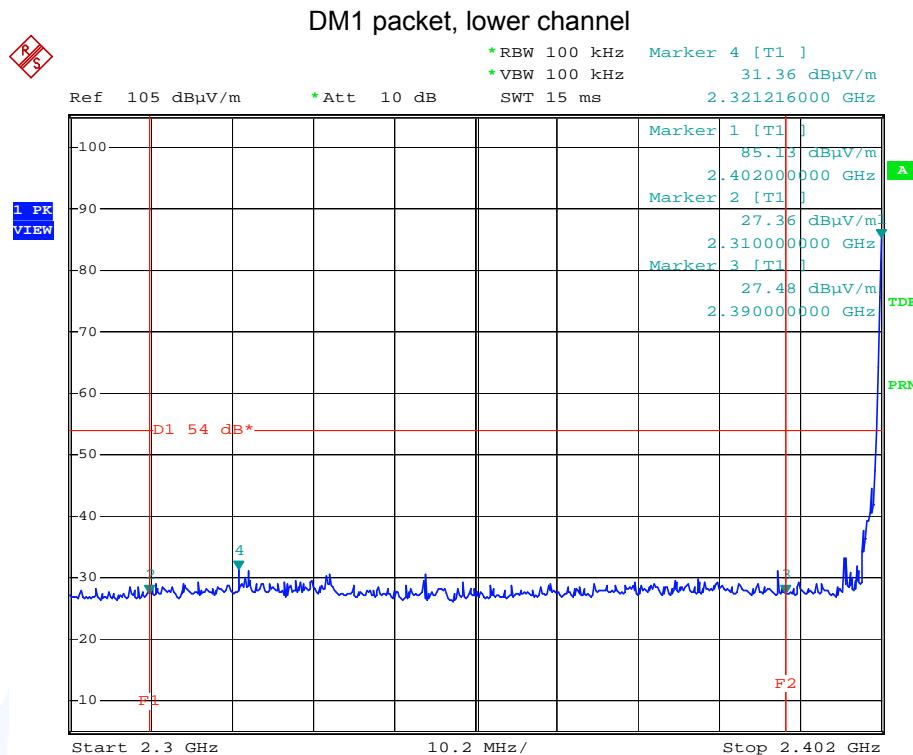
The requirements are **FULFILLED**.

Remarks: For detailed test result please refer to following test protocol.

FCC ID:S5H-WRCII

5.7.6 Test protocol

Band edge compliance



FCC ID:S5H-WRCII

5.8 Pseudorandom frequency hopping sequence

Requirement according to FCC Part 15C, Section 15.247(a):

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies.

The hopping to channel frequencies is generated as usual for a Bluetooth device to a pseudo randomly ordered list of hopping frequencies.

Remarks: This item is part of the Bluetooth Core Specifications V2.0 compliance and approved.

5.9 Equal hopping frequency use

Requirement according to FCC Part 15C, Section 15.247(a):

Each frequency must be used equally on the average by each transmitter.

The generation of the hopping sequence in connection mode depends essentially on two input values:

1. LAP/UAP of the master of the connection.
2. Internal master clock.

This circumstance is always the same therefore the average of the frequency use is the same on all transmitters.

Remarks: This item is part of the Bluetooth Core Specifications V2.0 compliance and approved.

5.10 Receiver input bandwidth

Requirement according to FCC Part 15C, Section 15.247(a):

The system receivers shall have input bandwidth that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signal.

The receiver bandwidth is equal to the transmitter bandwidth in the 79 hopping channel mode, which is 1 MHz.

Remarks: This item is part of the Bluetooth Core Specifications V2.0 compliance and approved.

FCC ID:S5H-WRCII

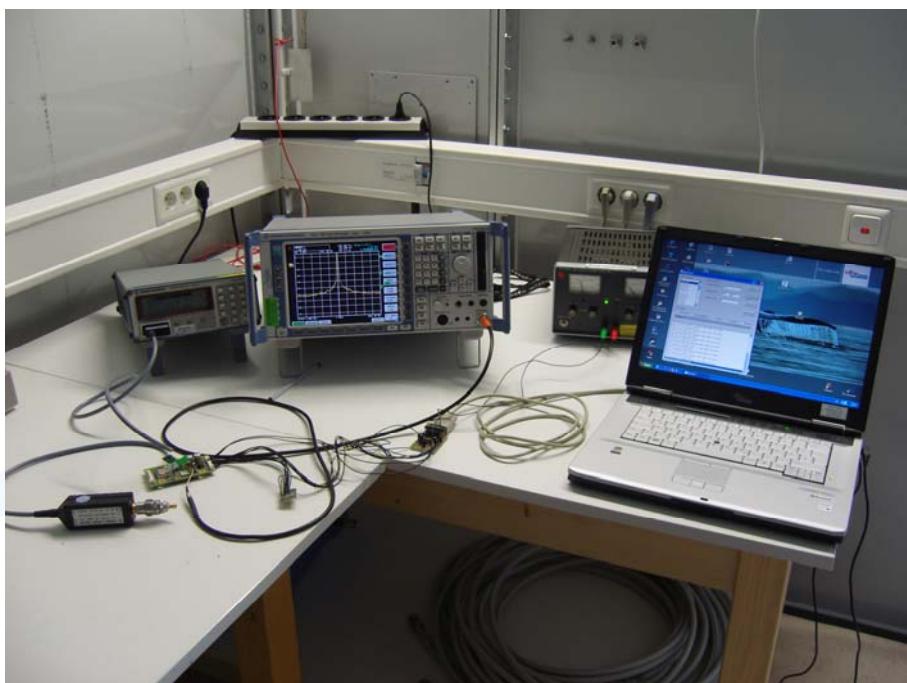
5.11 Dwell time

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

5.11.1 Description of the test location

Test location: AREA4

5.11.2 Photo documentation of the test set-up



5.11.3 Applicable standard

According to FCC Part 15, Section 15.247(a):

In Section 15.247(a)(1i)(1ii) and (1iii) are dwell times defined for the special frequency ranges should not exceed by a frequency hopping system.

5.11.4 Description of Measurement

The measurement was done using a spectrum analyser in time domain function on one channel frequency. A trigger takes care of display the dwell time of this channel when the hop set applies the channel at once. The measurement has been done again for the occupancy of one channel over the whole period. The particular time intervals are added over the value of occupancy and recorded.

FCC ID:S5H-WRCII

5.11.5 Test result

Operation modes:

DM1 Packet mode permits maximum 1600 hops per second in each channel, supporting 1 TX- and 1 RX-channel.

Hops per second

$$1600/79/2 = 10.13$$

Occupancy per period:

$$10.13 * 31.6 = 320.10 \text{ times}$$

Operating mode	Time of period (s)	Time of 1 burst (ms)	Number of Bursts (per period)	Dwell time per period (ms)
DM1	0.4 ms * 79 = 31.6	0.44	320	140

Requirement according to FCC Part15C, Section 15.247(a):

Frequency (MHz)	Hopping channels	time of one period (s)	Limit dwell time, AV (ms)
902-928	≥ 50	20	< 400
902-928	25 - < 50	10	< 400
2400-2483.5	≥ 15	0.4*(number of channels)	< 400
5725-5850	≥ 75	30	< 400

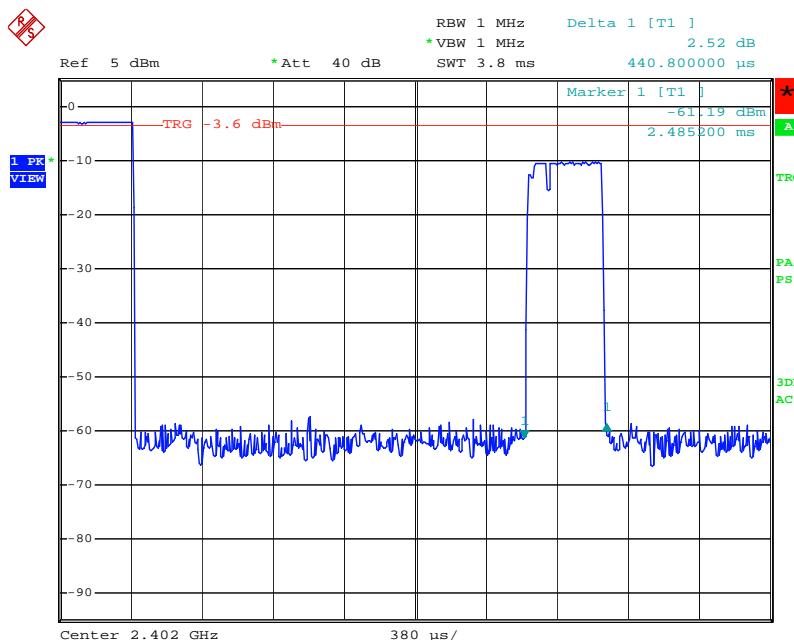
The requirements are **FULFILLED**.

Remarks: For detailed test result please refer to following test protocol. This item is part of the Bluetooth Core Specifications V2.0 compliance and approved.

FCC ID:S5H-WRCII

5.11.6 Test protocol

Time of occupancy of one burst



FCC ID:S5H-WRCII

5.12 Carrier frequency separation

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

5.12.1 Description of the test location

Test location: NONE

5.12.2 Applicable standard

According to FCC Part 15, Section 15.247(a):

Frequency hopping systems operating in the frequency band of 2400 MHz – 2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or 2/3 of the 20 dB bandwidth of the hopping channel.

5.12.3 Description of Measurement

The measurement is performed using a spectrum analyser in single sweep mode. A part of the operating frequency was used for better resolution. In normal application mode all the channels of the part of operating frequency are displayed and the separation is measured. The 20 dB OBW has to be measured before to compare whether the OBW requirement is fulfilled.

5.12.4 Test result

Channel	20 dB bandwidth (kHz)	Hopping channels	Channel frequency separation (kHz)	Limit 2/3 20 dB bandwidth (kHz)
0	1112	79	1000	> 741
39	1124	79	1000	> 749
78	1128	79	1000	> 752

Limit according to FCC Part 15C, Section 15.247(a):

Frequency (MHz)	Hopping channels	Limit channel separation (kHz)
All systems		> 25 kHz or 2/3 of 20 dB bandwidth, which ever is greater
2400-2483.5	≥ 15	

The requirements are **FULFILLED**.

Remarks: This item is part of the Bluetooth Core Specifications V2.0 compliance and approved.

FCC ID:S5H-WRCII

5.13 Number of hopping channels

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

5.13.1 Description of the test location

Test location: **NONE**

5.13.2 Test result

Hopping channel frequency range	Number of all available hopping channels	Minimum limit
2402 MHz to 2480 MHz	79	15

Limit according to FCC Part 15C, Section 15.247(1):

Frequency range (MHz)	LIMIT (Number of Hopping Channels)			
	20dB Bandwidth < 250kHz	20dB Bandwidth > 250kHz	20dB Bandwidth < 1 MHz	20dB Bandwidth > 1MHz
902 - 928	50	25	---	---
2400 – 2483,5	15	15	15	15
5725 - 5850	n.A	n.A	75	---

The requirements are **FULFILLED**.

Remarks: The EUT is conforming to Bluetooth Standard and use 79 hopping channels. The EUT don't use the adaptive frequency hopping.

FCC ID:S5H-WRCII

5.14 Determination of the antenna gain

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

5.14.1 Description of the test location

Test location: Anechoic Chamber A2

5.14.2 Description of the measurement

The antenna structure is composed of an antenna feeder cable (10 cm) SMX(m)-SMX(m), SMX socket to antenna PCB, antenna PCB, antenna matching devices and chip antenna. A generator with output power of $P_{ref} = -30$ 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 to determine the gain of the structure.

5.14.3 Test result

Determination of the output power of the generator with a power meter, reading:

$f = 2.45$ GHz

$P_{ref} = -30.0$ dBm

$P_{ant} = -35.6$ dBm

$Corr_{eirp} = 2.1$

Radiated power of the antenna structure:

Correction dBd to dBi:

Antenna structure gain G_s :

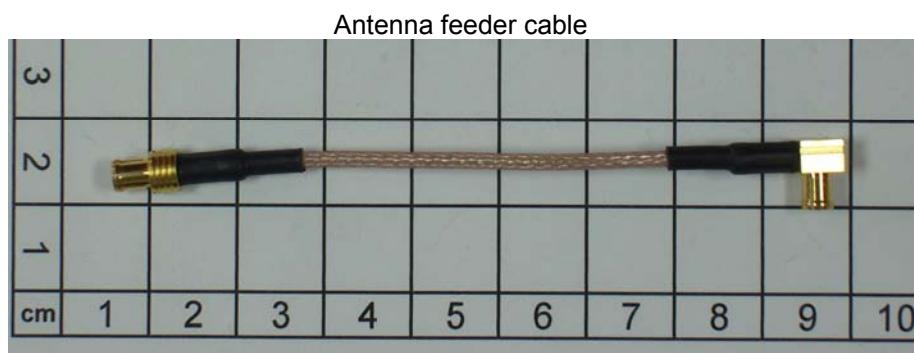
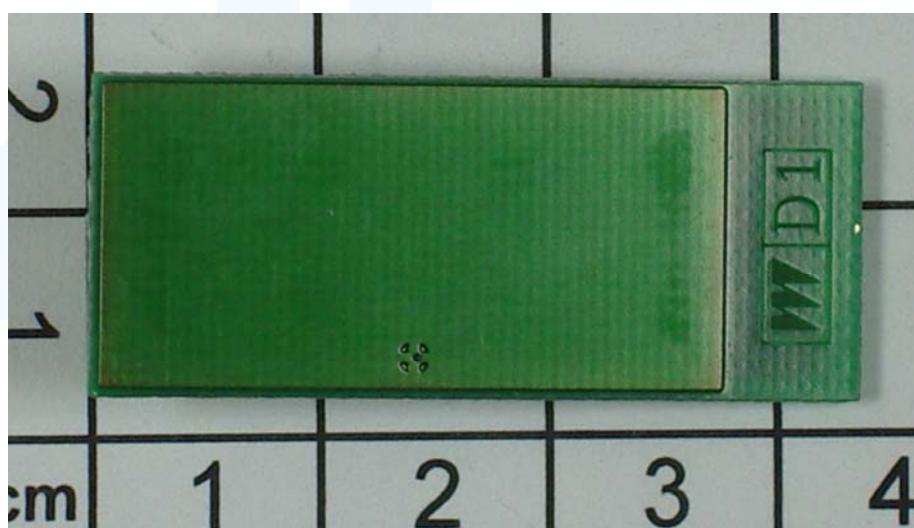
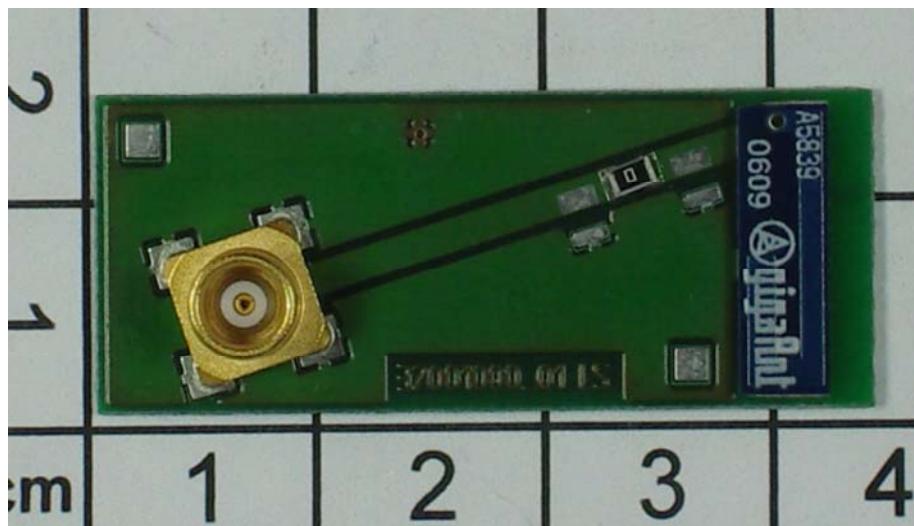
$$G_s = P_{ant} - P_{ref} + Corr_{eirp}$$
$$G_s = -35.6 - (-30.0) + 2.1$$
$$G_s = -3.5 \text{ dBi}$$

Remarks: _____

FCC ID:S5H-WRCII

5.15 Antenna application

Photograph of the internal antenna PCB with chip antenna



FCC ID:S5H-WRCII

5.15.1 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 use a permanently attached antenna. The feeder is internally connected with a SMX connector that the antenna can be replaced if necessary.

All supplied antennas meet the requirements of part 15.203 and 15.204.

5.15.2 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 antenna structure is not necessary. See point 5.13.

FCC ID:S5H-WRCII

5.16 Receiver conducted disturbances

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

5.16.1 Description of the test location

Test location: **NONE**

Remarks: The measurement is not applicable. Due to the TDD-Method of transmission in the Bluetooth specification a RX time slot is followed by a TX time slot and so a RX only measurement not possible.

5.17 Receiver radiated emissions

For test instruments and accessories used see section 6 Part **SER2** and **SER3**.

5.17.1 Description of the test location

Test location: **NONE**

Remarks: The measurement is not applicable. Due to the TDD-Method of transmission in the Bluetooth specification a RX time slot is followed by a TX time slot and so a RX only measurement not possible.

5.18 Maximum permissible exposure (MPE)

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

5.18.1 Description of the test location

Test location: **NONE**

Remarks: The measurement is not applicable. Due to the low output power of the Bluetooth device the MPE calculation is not required.

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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
	NNLK 8129	LISN	Schwarzbeck Mess-Elektron	02-02/20-05-001
	ESH 2 - Z 5	LISN	Rohde & Schwarz München	02-02/20-05-004
	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
CPC 3	NRVS	Single Channel Power M	Rohde & Schwarz München	02-02/07-06-003
	NRV-Z51	Thermal Power Sensor	Rohde & Schwarz Memmingen	02-02/07-06-006
	PE1540	Power Supply	Phillips Fluke GmbH	02-02/50-07-033
CPR 3	SMBV100A	Vector Signal Generator	Rohde & Schwarz	02-02/05-09-001
	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
DC	ESCI	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-004
	PE1540	Power Supply	Phillips Fluke GmbH	02-02/50-07-033
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	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
	FSP 30	Spectrum Analyzer	Rohde & Schwarz München	02-02/11-05-001

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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
02-02/50-05-138				
02-02/50-05-140				
02-02/50-05-155	04.06.2009	10.06.2008		
02-02/07-06-003				
02-02/07-06-006	12.09.2009	12.09.2008		
02-02/50-07-033				
02-02/05-09-001	03/12/2012	03/12/2009	03/12/2010	03/12/2009
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				
02-02/17-05-003				
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				
02-02/11-05-001	04.08.2009	04.08.2008		