

**Electromagnetic compatibility
and Radio Spectrum Matters ERM
ERM TEST REPORT
281857-1**

Test Report

*Electromagnetic compatibility
and Radio spectrum Matters (ERM)*



Equipment Under Test: Bluetooth Smart Module

Model: BGM111

Brand: Silicon Laboratories Finland Oy

Manufacturer: Silicon Laboratories Finland Oy
Sinikalliontie 5A
FI-02630 Espoo
FINLAND

Customer: Silicon Laboratories Finland Oy
Sinikalliontie 5A
FI-02630 Espoo
FINLAND

The equipment under test was tested according following standard(s)

Title of the standard	Reference standard	Version (Date)
Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive	ETSI EN 300 328	v1.9.1 (2015-02)

Date: 23.11.2015

Issued by:

A blue ink signature of Niko Kotsalo.

Niko Kotsalo
Testing Engineer

Date: 23.11.2015

Checked by:

A blue ink signature of Timo Hietala.

Timo Hietala
Testing Engineer

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Equipment Under Test (EUT)

Bluetooth Smart Module
Model: BGM111

Description of the EUT

BGM111 is a Bluetooth 4.1 compliant Bluetooth smart module. BGM111 integrates: Bluetooth radio, software stack, GATT based profiles and it can host end user applications. Module is targeted at applications requiring high RF performance with low power consumption and can be operated using standard 3 V coin cell battery.

Power Requirements

Operating voltage range: 2.4 – 3.8 VDC

Mechanical Size of the EUT

Height: 2.2 mm	Width: 15.0 mm	Length: 15.0 mm
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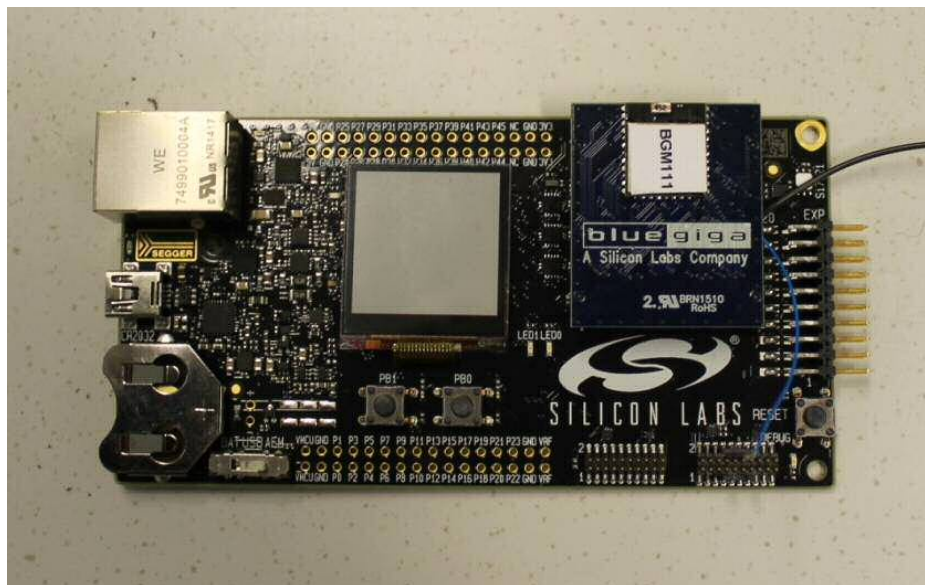
Equipment category and characteristics

Operating Frequency Range (OFR):	2402 – 2480 MHz
Channels:	40
Channel separation:	2 MHz
Channel bandwidth:	1.050119 MHz
Effective conducted power:	9.6 dBm
Transmission technique:	DSSS
Modulation:	GFSK
Integral Antenna gain:	1 dBi
Geo-location capability:	None

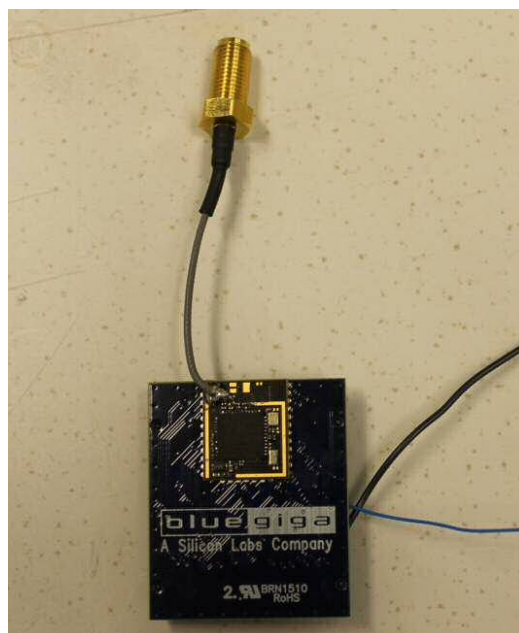
Peripherals

External DC power supply Thandar TS3021S.

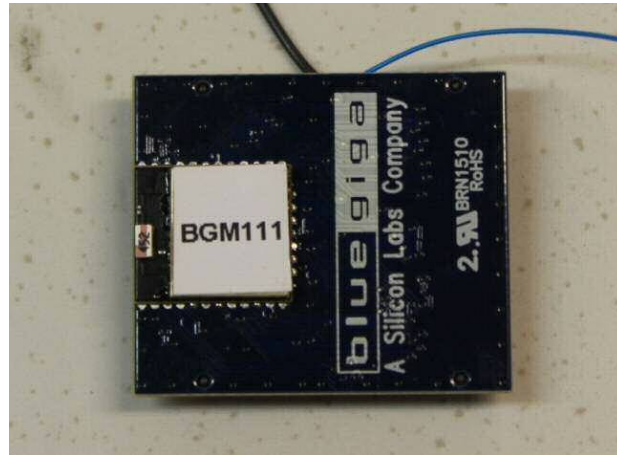
Photographs of the EUT



Picture 1. BGM111 radiated test sample connected to the development board



Picture 2. BGM111 sample for conducted RF tests



Picture 3. The EUT

Disclaimer

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only. This document cannot be reproduced except in full, without prior approval of the Company.

EUT Test Conditions During Testing

During the tests EUT was set to continuous transmit or receive mode and to the channel under test. Normal modulation and maximum transmit power was used in all tests. The EUT was set on to the wanted test channel and transmit/receive mode with Silicon Labs BGTool software.

Table 1. Normal and extreme test conditions

Test conditions:		Temperature [°C]:	Voltage [V]:
Normal		+20 – 25	3.3
Extreme	Minimum	-40	2.4
	Maximum	+85	3.8

Extreme temperature and voltage ranges were provided by the customer.

Table 2. The test frequencies used in the tests

Frequency [MHz]:	Channel:
2402	Low
2442	Middle
2480	High

Test Suite

Test	Test Specification	Applicable	Test Result
RF Output Power	EN 300 328 V.1.9.1 (2015-02)	YES	PASS
Power Spectral Density	EN 300 328 V.1.9.1 (2015-02)	YES	PASS
Duty cycle, Tx-sequence, Tx-gap	EN 300 328 V.1.9.1 (2015-02)	N/A	-(1)
Accumulated Transmit Time, Frequency Occupation and Hopping Sequence	EN 300 328 V.1.9.1 (2015-02)	N/A	-(2)
Hopping Frequency Separation	EN 300 328 V.1.9.1 (2015-02)	N/A	-(2)
Medium Utilisation (MU) factor	EN 300 328 V.1.9.1 (2015-02)	N/A	-(3)
Adaptivity	EN 300 328 V.1.9.1 (2015-02)	N/A	-(4)
Occupied Channel Bandwidth	EN 300 328 V.1.9.1 (2015-02)	YES	PASS
Transmitter unwanted spurious emissions in the out-of-band domain	EN 300 328 V.1.9.1 (2015-02)	YES	PASS
Transmitter unwanted spurious emissions in the spurious domain	EN 300 328 V.1.9.1 (2015-02)	YES	PASS
Receiver spurious emissions	EN 300 328 V.1.9.1 (2015-02)	YES	PASS
Receiver blocking	EN 300 328 V.1.9.1 (2015-02)	N/A	-(5)

- 1) These requirements apply to non-adaptive frequency hopping equipment or to adaptive frequency hopping equipment operating in a non-adaptive mode. Also these requirements do not apply for equipment with a maximum declared RF Output power of less than 10 dBm E.I.R.P.
- 2) This requirement applies to all types of frequency hopping equipment.
- 3) This requirement applies to adaptive equipment unless operating in a non-adaptive mode. Also this requirement does not apply for equipment with a maximum declared RF Output power of less than 10 dBm E.I.R.P.
- 4) This requirement do not apply to non-adaptive equipment or to adaptive equipment operating in a non-adaptive mode providing the equipment complies with the requirements and/or restrictions applicable to non-adaptive equipment. Also this requirement does not apply for equipment with a maximum declared RF Output power of less than 10 dBm E.I.R.P.
- 5) This requirement does not apply to non-adaptive equipment or to adaptive equipment operating in a non-adaptive mode. Also this requirement does not apply for equipment with a maximum declared RF Output power of less than 10 dBm E.I.R.P.

According to the standard the measurement results have been compared directly with the limits without considering measurement uncertainties.

Explanations:

PASS The EUT passed that particular test.
 FAIL The EUT failed that particular test.
 N/A Not Applicable
 N/T Not Tested

Testing location:
☐ CB Testing Laboratory:

☐ Testing Location / address:

SGS Fimko Ltd
Särkiniementie 3
FI-00210, HELSINKI
FINLAND

☒ Testing Location / address:

SGS Fimko Ltd
Karakaarenkuja 4
FI-02610, ESPOO
FINLAND

RF Output Power

Standard: EN 300 328 v.1.9.1.
Tested by: NKO
Date: 2.10 – 17.11.2015
Temperature: 22 °C
Humidity: 35 % RH
Test result: **PASS**

Measurement uncertainty: ± 0.349 dB

Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 v.1.9.1 clause 5.3.2.2.1.2.

The RF output power is defined as the mean equivalent isotropically radiated power (E.I.R.P.) of the equipment during a transmission burst.

The transmitter is connected via the 50 Ω -power attenuator to the measuring equipment. The power is measured with the highest operating power level. The maximum isotropic radiated power of the equipment is calculated from the measured power (P) added by antenna gain (G) and beamforming gain (Y).

The measurements are done under normal and extreme test conditions. For systems using FHSS modulation, the measurements shall be performed during normal operation (hopping). For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest, the middle, and the highest channel on which the equipment can operate.

$$\text{E.I.R.P} = P + G + Y$$

Test results

Antenna gain (G):	1	dBi
Beamforming gain (Y):	0	dBi

Test conditions		Transmit power E.I.R.P. [dBm]		
Temperature	Voltage	Low	Mid	High
-40 °C	2.4 VDC	9.6	9.4	9.1
-40 °C	3.8 VDC	9.5	9.3	8.9
+20 – 25 °C	3.3 VDC	8.8	8.6	8.1
+85 °C	2.4 VDC	8.0	7.8	7.4
+85 °C	3.8 VDC	7.9	7.6	7.2
Limit:		+20 dBm		
Maximum transmit power E.I.R.P		+9.6 dBm		
Measurement uncertainty (Level of confidence 95 % k = 2)		±0.349 dBm		

Power Spectral Density

Standard: EN 300 328 v.1.9.1.
Tested by: NKO
Date: 2.10 – 17.11.2015
Temperature: 22 °C
Humidity: 35 % RH
Test result: **PASS**

Measurement uncertainty: ± 0.372 dB

Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 v.1.9.1 clause 5.3.3.2.1.

The Power spectral density is the mean equivalent isotropically radiated power (e.i.r.p) spectral density during a transmission burst. The maximum power spectral density is limited to 10 dBm per MHz.

Test results

DUT Frequency (MHz)	Center Frequency of Segment (MHz)	Level (dBm)	Limit (dBm)	Result	Comment
2402.000000	2401.977353	8.7	≤ 10.0	PASS	
2442.000000	2441.974986	8.5	≤ 10.0	PASS	
2480.000000	2479.967738	8.0	≤ 10.0	PASS	

Transmitter Spurious Emissions in the Out-Of-Band Domain

Standard: EN 300 328 v.1.9.1.
Tested by: NKO
Date: 2.10 – 17.11.2015
Temperature: 22 °C
Humidity: 35 % RH
Test result: **PASS**

Measurement uncertainty: ± 1.39 dB

Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 v.1.9.1 clause 5.3.9.2.1.

Transmitter unwanted emissions in the out-of-band domain are emissions when the equipment is in Transmit mode, on frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious.

The transmitter is connected via the 50 Ω -power attenuator to a spectrum analyzer. The out-of-band spurious emissions are measured by using the time domain power function of the spectrum analyzer.

Test results

Table 3. Test results under normal condition

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Temperature (°C)	Frequency (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	1.000000	22.0	2398.399763	-38.9	-20.0	PASS
2402.000000	1.000000	22.0	2398.449881	-39.1	-20.0	PASS
2402.000000	1.000000	22.0	2399.449881	-36.3	-10.0	PASS
2402.000000	1.000000	22.0	2399.500000	-36.1	-10.0	PASS
2402.000000	1.000000	22.0	2484.000000	-60.5	-10.0	PASS
2402.000000	1.000000	22.0	2484.050119	-60.2	-10.0	PASS
2402.000000	1.000000	22.0	2485.050119	-60.4	-20.0	PASS
2402.000000	1.000000	22.0	2485.100237	-60.3	-20.0	PASS
2480.000000	1.000000	22.0	2398.397763	-60.9	-20.0	PASS
2480.000000	1.000000	22.0	2398.448881	-60.9	-20.0	PASS
2480.000000	1.000000	22.0	2399.448881	-61.0	-10.0	PASS
2480.000000	1.000000	22.0	2399.500000	-60.9	-10.0	PASS
2480.000000	1.000000	22.0	2484.000000	-40.3	-10.0	PASS
2480.000000	1.000000	22.0	2484.051119	-39.8	-10.0	PASS
2480.000000	1.000000	22.0	2485.051119	-41.5	-20.0	PASS
2480.000000	1.000000	22.0	2485.102237	-41.1	-20.0	PASS

Table 4. Test results with maximum temperature and maximum voltage level.

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Temperature (°C)	Frequency (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	1.000000	85.0	2398.408761	-44.4	-20.0	PASS
2402.000000	1.000000	85.0	2398.454381	-44.1	-20.0	PASS
2402.000000	1.000000	85.0	2399.454381	-40.9	-10.0	PASS
2402.000000	1.000000	85.0	2399.500000	-40.4	-10.0	PASS
2402.000000	1.000000	85.0	2484.000000	-60.4	-10.0	PASS
2402.000000	1.000000	85.0	2484.045619	-60.3	-10.0	PASS
2402.000000	1.000000	85.0	2485.045619	-59.9	-20.0	PASS
2402.000000	1.000000	85.0	2485.091239	-60.2	-20.0	PASS
2480.000000	1.000000	85.0	2398.408262	-60.9	-20.0	PASS
2480.000000	1.000000	85.0	2398.454131	-61.0	-20.0	PASS
2480.000000	1.000000	85.0	2399.454131	-60.8	-10.0	PASS
2480.000000	1.000000	85.0	2399.500000	-61.1	-10.0	PASS
2480.000000	1.000000	85.0	2484.000000	-46.4	-10.0	PASS
2480.000000	1.000000	85.0	2484.045869	-46.4	-10.0	PASS
2480.000000	1.000000	85.0	2485.045869	-50.2	-20.0	PASS
2480.000000	1.000000	85.0	2485.091738	-50.6	-20.0	PASS

Transmitter Spurious Emissions

Table 5. Test results with maximum temperature and minimum voltage level

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Temperature (°C)	Frequency (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	1.000000	85.0	2398.408761	-44.1	-20.0	PASS
2402.000000	1.000000	85.0	2398.454381	-43.9	-20.0	PASS
2402.000000	1.000000	85.0	2399.454381	-40.8	-10.0	PASS
2402.000000	1.000000	85.0	2399.500000	-40.7	-10.0	PASS
2402.000000	1.000000	85.0	2484.000000	-60.2	-10.0	PASS
2402.000000	1.000000	85.0	2484.045619	-60.2	-10.0	PASS
2402.000000	1.000000	85.0	2485.045619	-60.2	-20.0	PASS
2402.000000	1.000000	85.0	2485.091239	-60.2	-20.0	PASS
2480.000000	1.000000	85.0	2398.409261	-60.9	-20.0	PASS
2480.000000	1.000000	85.0	2398.454631	-60.9	-20.0	PASS
2480.000000	1.000000	85.0	2399.454631	-60.8	-10.0	PASS
2480.000000	1.000000	85.0	2399.500000	-61.1	-10.0	PASS
2480.000000	1.000000	85.0	2484.000000	-45.9	-10.0	PASS
2480.000000	1.000000	85.0	2484.045369	-46.2	-10.0	PASS
2480.000000	1.000000	85.0	2485.045369	-50.0	-20.0	PASS
2480.000000	1.000000	85.0	2485.090739	-50.1	-20.0	PASS

Table 6. Test results with minimum temperature and maximum voltage level

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Temperature (°C)	Frequency (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	1.000000	-40.0	2398.404762	-40.7	-20.0	PASS
2402.000000	1.000000	-40.0	2398.452381	-40.2	-20.0	PASS
2402.000000	1.000000	-40.0	2399.452381	-38.0	-10.0	PASS
2402.000000	1.000000	-40.0	2399.500000	-38.0	-10.0	PASS
2402.000000	1.000000	-40.0	2484.000000	-50.3	-10.0	PASS
2402.000000	1.000000	-40.0	2484.047619	-50.3	-10.0	PASS
2402.000000	1.000000	-40.0	2485.047619	-50.4	-20.0	PASS
2402.000000	1.000000	-40.0	2485.095238	-50.5	-20.0	PASS
2480.000000	1.000000	-40.0	2398.404262	-51.1	-20.0	PASS
2480.000000	1.000000	-40.0	2398.452131	-51.2	-20.0	PASS
2480.000000	1.000000	-40.0	2399.452131	-51.1	-10.0	PASS
2480.000000	1.000000	-40.0	2399.500000	-51.2	-10.0	PASS
2480.000000	1.000000	-40.0	2484.000000	-43.3	-10.0	PASS
2480.000000	1.000000	-40.0	2484.047869	-44.1	-10.0	PASS
2480.000000	1.000000	-40.0	2485.047869	-46.5	-20.0	PASS
2480.000000	1.000000	-40.0	2485.095738	-46.3	-20.0	PASS

Table 7. Test results with minimum temperature and minimum voltage level

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Temperature (°C)	Frequency (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	1.000000	-40.0	2398.405262	-40.9	-20.0	PASS
2402.000000	1.000000	-40.0	2398.452631	-40.5	-20.0	PASS
2402.000000	1.000000	-40.0	2399.452631	-37.9	-10.0	PASS
2402.000000	1.000000	-40.0	2399.500000	-37.6	-10.0	PASS
2402.000000	1.000000	-40.0	2484.000000	-50.2	-10.0	PASS
2402.000000	1.000000	-40.0	2484.047369	-50.6	-10.0	PASS
2402.000000	1.000000	-40.0	2485.047369	-50.6	-20.0	PASS
2402.000000	1.000000	-40.0	2485.094738	-61.5	-20.0	PASS
2480.000000	1.000000	-40.0	2398.404762	-50.9	-20.0	PASS
2480.000000	1.000000	-40.0	2398.452381	-51.2	-20.0	PASS
2480.000000	1.000000	-40.0	2399.452381	-51.0	-10.0	PASS
2480.000000	1.000000	-40.0	2399.500000	-50.8	-10.0	PASS
2480.000000	1.000000	-40.0	2484.000000	-43.1	-10.0	PASS
2480.000000	1.000000	-40.0	2484.047619	-43.3	-10.0	PASS
2480.000000	1.000000	-40.0	2485.047619	-46.7	-20.0	PASS
2480.000000	1.000000	-40.0	2485.095238	-46.8	-20.0	PASS

Transmitter Unwanted Emissions in the Spurious Domain

Standard: EN 300 328 v.1.9.1
Tested by: NKO
Date: 20.10. – 22.10.2015
Temperature: 20 °C
Humidity: 35 %
Test result: **PASS**

Measurement uncertainty: ± 5.29 dB

Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 v.1.9.1 clause 5.3.10.2.2.

Transmitter unwanted emissions in the spurious domain are emissions outside the allocated band and outside the Out-of-band Domain when the equipment is in transmit mode.

The transmitter is operating at the maximum rated carrier power. First all frequencies where a spurious emission component is detected are recorded in both measuring antenna polarization. Then each spurious frequency level is measured. The highest level of the spurious component is searched by rotating transmitter 360° with both measuring antenna polarization.

The spurious emissions are measured under normal conditions. Test will be made in lowest and highest operation frequencies. Emissions are measured in the frequency range 30 – 12 750 MHz.

Test results

Ch Low

Frequency (MHz)	RMS (dBm)	Bandwidth (kHz)	Height (cm)	Polarization	Margin (dB)	Limit (dBm)	Comment
2400.0000	-61.6	1000.000	150.0	V	31.6	-30.0	
2493.5000	-65.0	1000.000	150.0	V	35.0	-30.0	

Ch High

Frequency (MHz)	RMS (dBm)	Bandwidth (kHz)	Height (cm)	Polarization	Margin (dB)	Limit (dBm)	Comment
108.3145	-79.7	100.000	150.0	V	25.7	-54.0	

Occupied Channel Bandwidth

Occupied Channel Bandwidth

Standard: EN 300 328 v.1.9.1
Tested by: NKO
Date: 17.11.2015
Temperature: 22 °C
Humidity: 35 % RH
Test result: **PASS**

Measurement uncertainty: $\pm 2.24\text{E}+05$ Hz

Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 v.1.9.1 clause 5.3.8.2.1.

The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal. The Occupied Channel Bandwidth shall fall completely within the assigned band.

In addition, for non-adaptive systems using wide band modulations other than FHSS and with E.I.R.P greater than 10 dBm, the occupied channel bandwidth shall be less than 20 MHz.

The measurements are done under normal test conditions. The transmitter is connected via the 50 Ω -power attenuator to the measuring equipment.

Test results

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Channel Center Frequency (MHz)	Occupied Channel Bandwidth (MHz)	Lower Band Edge (MHz)	Upper Band Edge (MHz)
2402.000000	1.000000	2401.988627	1.050119	2401.463567	2402.513686
2480.000000	1.000000	2479.980627	1.051119	2479.455068	2480.506187

Limit (MHz)	Result	Comment
---	PASS	< 10 dBm EIRP (no BW limit)
---	PASS	< 10 dBm EIRP (no BW limit)

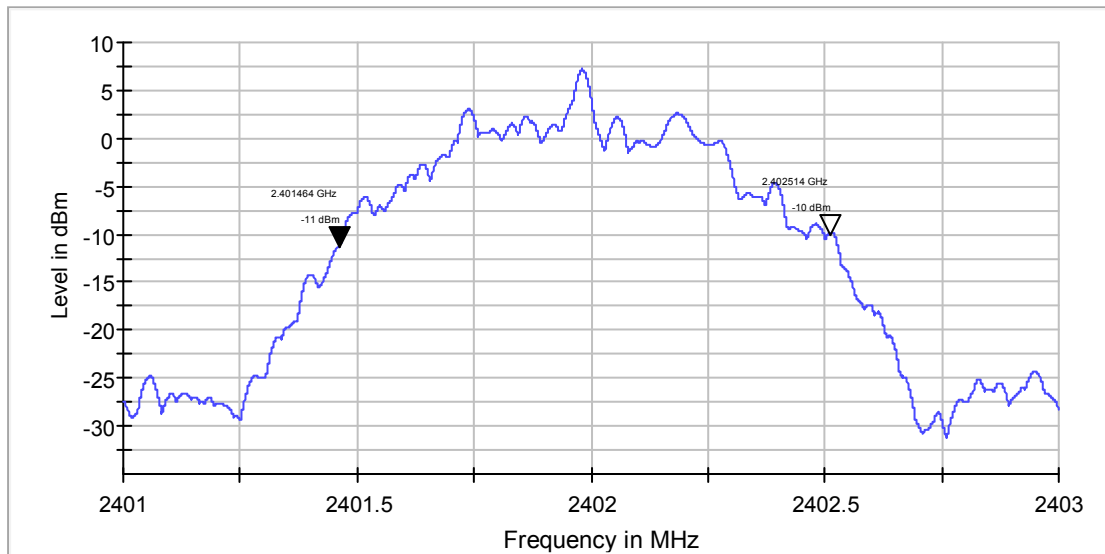


Figure 1. 99% OBW Channel Low.

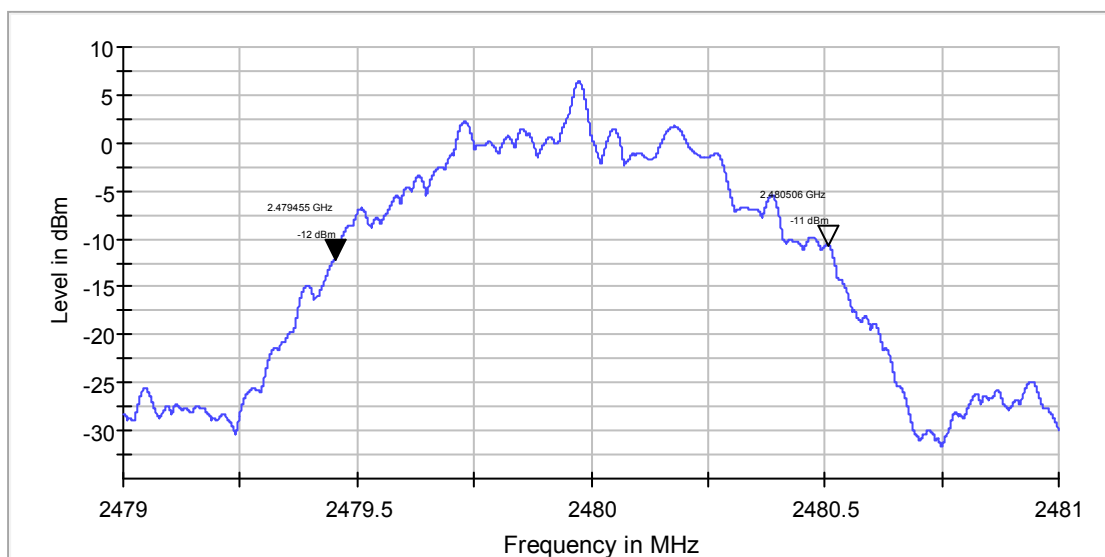


Figure 2. 99% OBW Channel High

Receiver Spurious Emissions

Standard: EN 300 328 v.1.9.1
Tested by: NKO
Date: 20.10. – 22.10.2015
Temperature: 20 °C
Humidity: 35 %
Test result: **PASS**

Measurement uncertainty: ± 5.29 dB

Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 v.1.9.1 clause 5.3.11.2.2.

The receiver is connected to its integrated or dedicated antenna and oriented to its normal usage position and height on the turntable in the anechoic chamber. The measurements are made with the receiver on the receiving state. First all frequencies where a spurious emission component are detected are recorded in both measuring antenna polarization. Then each spurious frequency level is measured. The highest level of the spurious component is searched by rotating transmitter 360° with both measuring antenna polarization.

The receiver spurious emissions are measured under normal conditions.

Test will be made in lowest and highest operation frequencies.

Test results

Ch Low

Frequency (MHz)	RMS (dBm)	Bandwidth (kHz)	Height (cm)	Polarization	Margin (dB)	Limit (dBm)	Comment
125.740500	-65.3	100.000	150.0	V	8.3	-57.0	

Ch High

Frequency (MHz)	RMS (dBm)	Bandwidth (kHz)	Height (cm)	Polarization	Margin (dB)	Limit (dBm)	Comment
125.423000	-68.6	100.000	150.0	V	11.6	-57.0	
128.916500	-69.2	100.000	150.0	V	12.2	-57.0	

RF-Test Equipment

Equipment	Manufacturer	Type	Serial no	Inv.no
TEST RECEIVER	ROHDE & SCHWARZ	ESU 26	100185	8453
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-
ANTENNA (30-1000 MHz)	SCHWARZBECK	VULB 9168	8168-503	8911
ANTENNA MAST	DEISEL	MA240	240/455	5017
TURNTABLE	DEISEL	DS420	-	5015
CONTROLLER	COMTEST	HD100	100/457	5018
ANTENNA (1-18 GHz)	EMCO	3117	29617	7293
ANTENNA (18-26.5 GHz)	EMCO	3160- 09	030232-022	7294
PREAMPLIFIER (0.5-26GHz)	HP	83017A	3950M00102	5226
ATTENUATOR 10 dB	HUBER & SUHNER	6810.17B	-	-
HIGH PASS FILTER	WAINWRIGHT	WHKX	10	8267
SIGNAL ANALYZER	ROHDE & SCHWARZ	FSV40	101068	9093
SWITCH UNIT WITH OSP-B157	ROHDE & SCHWARZ	OSP120	101208	9289
SIGNAL GENERATOR	ROHDE & SCHWARZ	SMB100A	177561	9288
VECTOR SIGNAL GENERATOR	ROHDE & SCHWARZ	SMBV100A	260355	9290
PRECISION DC POWER SUPPLY	THANDAR	TS3021S	099609	3484

All used measurement equipment was calibrated (if required).