

**Electromagnetic compatibility
and Radio Spectrum Matters ERM
ERM TEST REPORT
285525-2-1**

Test Report

*Electromagnetic compatibility
and Radio spectrum Matters (ERM)*



Equipment Under Test: Bluetooth Smart Module

Model: BGM121A
BGM121N
BGM123A
BGM123N

Trade Mark: Silicon Labs

Manufacturer/Customer: Silicon Laboratories Finland Oy
Bertel Jungin aukio 3
FI-02600, ESPOO
FINLAND

Tests have been performed according to the following standard(s)

| Title of the standard | Reference standard | Version |
|---|--------------------|---------|
| 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 the essential requirements of article 3.2 of the R&TTE Directive | EN 300 328 | V1.9.1 |

Date: 27 October 2016

Issued by:

A blue ink signature of Emil Haverinen.

Emil Haverinen
Testing Engineer

Date: 27 October 2016

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Equipment under test (EUT)

| | |
|-------------|------------------------------------|
| Trade mark: | Silicon Labs |
| Model: | BGM121A, BGM121N, BGM123A, BGM123N |
| Type: | Bluetooth Smart Module |
| Serial no: | - |

General description

BGM121 and BGM123 are Bluetooth 4.1 compliant Bluetooth smart beacon modules. The only difference between A-variant and N-variant modules is that A has integrated antenna and N has RF connector for use of external antenna. Difference between BGM121 and BGM123 is that BGM123 has its transmit power limited to nominal of 3 dBm while BGM121 transmits at full power.

Samples and modifications incorporated in the EUT

Two samples were used in the testing. During the tests the EUT was set into continuous transmit and was set to the channel under test. Normal test modulation and maximum transmit power was used in all tests.

Specifications of the EUT

| | |
|-----------------|---|
| Antenna type: | Integrated chip antenna (BGM121A) Removable whip antenna (BGM121N) |
| Antenna gain: | 1 dBi (BGM121A) 2.14 dBi (BGM121N) |
| EUT dimensions: | 20 x 6 x 2mm |

The EUT does not have beamforming capabilities.

Power requirements

| | |
|------------------|---|
| Rated voltage: | 2.0 - 3.8 V (tested with 3.3V regulated by the development board) |
| Rated Frequency: | DC |

The EUT was powered from the development board which was powered by PC. During radiated measurements the development board was powered by laboratory power supply.

Equipment category and characteristics

| | |
|----------------------------------|--|
| Operating Frequency Range (OFR): | 2402 - 2480 MHz |
| Channels: | 40 |
| Channel separation: | 2 MHz |
| Channel bandwidth: | 1.076616 MHz (channel low) |
| Effective conducted power: | 8.9 dBm (BGM121A) 7.7 dBm (BGM121N) |
| Transmission technique: | DSSS |
| Modulation: | GFSK |
| Geo-location capability: | None |

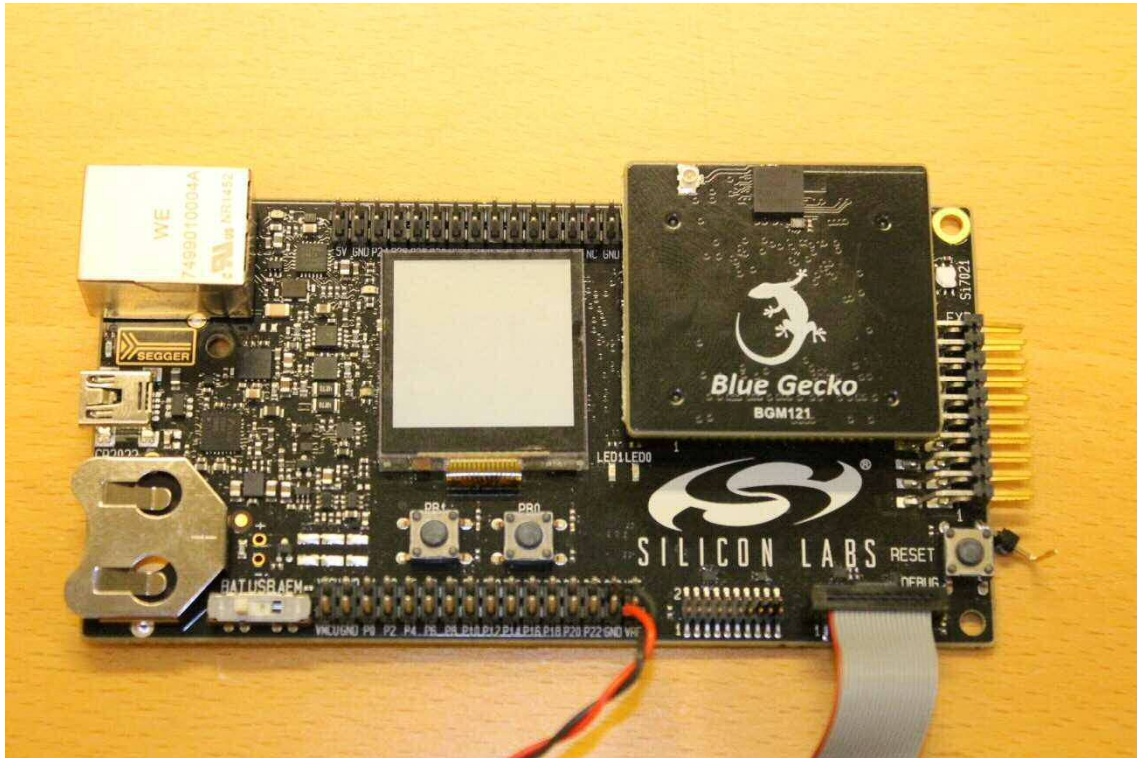
Cables

| | | |
|-----------|----|--|
| USB cable | 1m | Twisted pair, shielded, from supply to dev board |
|-----------|----|--|

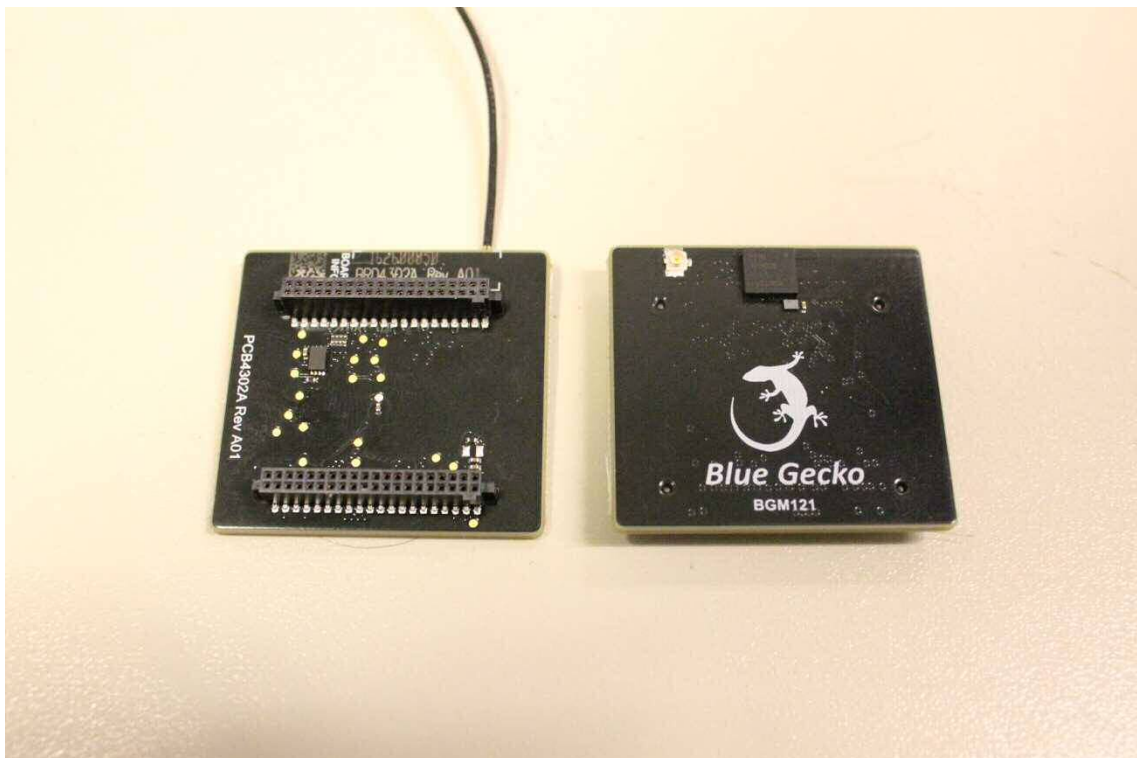
Peripherals

| | |
|----|------------|
| PC | HP ProBook |
|----|------------|

Photographs of the EUT



Photograph 1: The equipment under test (EUT) and supportive development board



Photograph 2: The EUT

Test conditions

During radiated measurements, configuration of the EUT was made to correspond to the actual assembling conditions as far as possible. The EUT was set on 150 cm table in semi anechoic chamber with floor absorbers. All tests were performed while the EUT was connected to the development board.

The EUT's radio was configured with software provided by the manufacturer. Normal modulation and maximum transmit power was used during the tests.

All tests were performed to BGM121A or BGM121N modules since the only difference is the transmit power which is higher in tested models.

The power settings:

BGM121A: 93

BGM121N: 85

Radiated spurious emission measurements were performed with power setting 95 for both models.

Table 1: Normal and extreme test

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

Extreme temperature and voltage ranges were provided by the customer.

Table 2: The test frequencies used in the tests

| Frequency [MHz]: | Channel: |
|------------------|----------|
| 2402 | Low |
| 2440 | Middle |
| 2480 | High |

Test suite

| Measurement/Test | Test Specification | Result |
|--|---------------------------------|--------------------|
| RF Output Power | EN 300 328 V.1.9.1 (2015-02) | PASS |
| Power Spectral Density | EN 300 328 V.1.9.1 (2015-02) | 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) | PASS |
| Transmitter unwanted spurious emissions in the out-of-band domain | EN 300 328 V.1.9.1 (2015-02) | PASS |
| Transmitter unwanted spurious emissions in the spurious domain | EN 300 328 V.1.9.1 (2015-02) | PASS |
| Receiver spurious emissions | EN 300 328 V.1.9.1 (2015-02) | PASS |
| Receiver blocking | EN 300 328 V.1.9.1 (2015-02) | N/A ⁽⁵⁾ |
| Possible test case verdicts: Test case does not apply to the EUT: N/A EUT does meet the requirement: P (Pass) EUT does not meet the requirement: F (Fail) Test was not performed by SGS Fimko: N/T 1) These requirements apply to non-adaptive equipment or to adaptive 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 does not apply 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. | | |

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: EHA
Date: 21.9.2016
Temperature: 23 ± 3 °C
Humidity: 30 - 60 % 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. $E.I.R.P. = P + G + Y$

Test results

Table 3: Test results and calculations of RF output power, BGM121A

| Antenna gain (G): | | 1 | | dBi |
|---|---------|-------------------------------|-----|------|
| Test conditions | | Transmit power E.I.R.P. [dBm] | | |
| Temperature | Voltage | Low | Mid | High |
| -40 °C | 3.3 V | 9.9 | 9.7 | 9.6 |
| +20 – 25 °C | 3.3 V | 9.3 | 9.2 | 9.0 |
| +85 °C | 3.3 V | 8.5 | 8.3 | 8.1 |
| Limit: | | +20 dBm | | |
| Maximum transmit power E.I.R.P. | | 9.9 dBm | | |
| Measurement uncertainty (Level of confidence 95 % k = 2) | | ±0.349 dBm | | |

Table 4: Test results and calculations of RF output power, BGM121N

| Antenna gain (G): | | 2.14 | | dBi |
|---|---------|-------------------------------|-----|------|
| Test conditions | | Transmit power E.I.R.P. [dBm] | | |
| Temperature | Voltage | Low | Mid | High |
| -40 °C | 3.3 V | 9.8 | 9.6 | 9.5 |
| +20 – 25 °C | 3.3 V | 9.1 | 8.9 | 8.8 |
| +85 °C | 3.3 V | 8.6 | 8.4 | 8.1 |
| Limit: | | +20 dBm | | |
| Maximum transmit power E.I.R.P. | | 9.8 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: EHA
Date: 21.9.2016
Temperature: 23 ± 3 °C
Humidity: 30 - 60 % 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

Table 5: Power spectral density, BGM121A

| DUT Frequency (MHz) | Center Frequency of Segment (MHz) | Level (dBm) | Limit (dBm) | Result |
|---------------------|-----------------------------------|-------------|-------------|--------|
| 2402.000000 | 2401.982353 | 9.3 | <= 10.0 | PASS |
| 2440.000000 | 2439.985104 | 9.1 | <= 10.0 | PASS |
| 2480.000000 | 2479.982738 | 8.9 | <= 10.0 | PASS |

Table 6: Power spectral density, BGM121N

| DUT Frequency (MHz) | Center Frequency of Segment (MHz) | Level (dBm) | Limit (dBm) | Result |
|---------------------|-----------------------------------|-------------|-------------|--------|
| 2402.000000 | 2401.987353 | 9.0 | <= 10.0 | PASS |
| 2440.000000 | 2439.985104 | 8.9 | <= 10.0 | PASS |
| 2480.000000 | 2479.982738 | 8.7 | <= 10.0 | PASS |

Occupied Channel Bandwidth

Standard: EN 300 328 V.1.9.1
Tested by: EHA
Date: 21.9.2016
Temperature: 23 ± 3 °C
Humidity: 30 - 60 % RH

Test result: **PASS**

Measurement uncertainty: ± 2.24E+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

Table 7: Occupied Channel Bandwidth

| 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 | 2401.995626 | 1.076616 | 2401.457318 | 2402.533933 |
| 2480.000000 | 1.000000 | 2479.994126 | 1.070116 | 2479.459068 | 2480.529184 |

| DUT Frequency (MHz) | Limit Occupied Channel Bandwidth (MHz) | Result | Comment |
|---------------------|--|--------|-----------------------------|
| 2402.000000 | --- | PASS | < 10 dBm EIRP (no BW limit) |
| 2480.000000 | --- | PASS | < 10 dBm EIRP (no BW limit) |

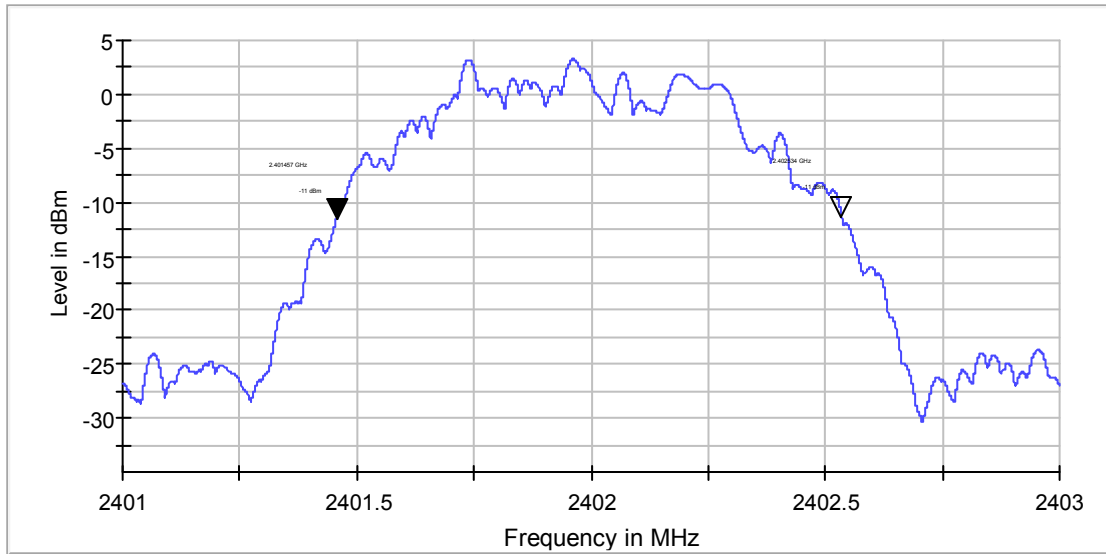


Figure 1: 99% OBW Channel Low

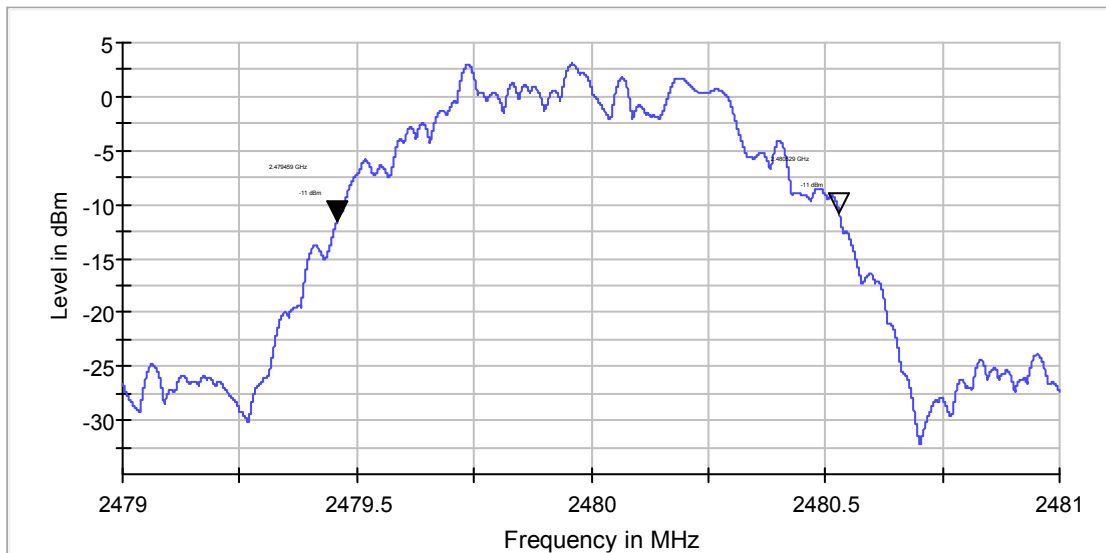


Figure 2: 99% OBW Channel High

Transmitter unwanted spurious emissions in the out-of-band domain

Transmitter unwanted spurious emissions in the out-of-band domain

Standard: EN 300 328 V.1.9.1
Tested by: EHA
Date: 21.9.2016
Temperature: 23 ± 3 °C
Humidity: 30 - 60 % 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 8: Transmitter unwanted emissions in the out-of-band domain

| DUT Frequency (MHz) | Nominal Bandwidth (MHz) | Frequency (MHz) | Level (dBm) | Limit (dBm) | Result |
|---------------------|-------------------------|-----------------|-------------|-------------|--------|
| 2402.000000 | 1.000000 | 2398.346769 | -41.4 | -20.0 | PASS |
| 2402.000000 | 1.000000 | 2398.423385 | -41.4 | -20.0 | PASS |
| 2402.000000 | 1.000000 | 2399.423385 | -40.1 | -10.0 | PASS |
| 2402.000000 | 1.000000 | 2399.500000 | -40.0 | -10.0 | PASS |
| 2402.000000 | 1.000000 | 2484.000000 | -60.0 | -10.0 | PASS |
| 2402.000000 | 1.000000 | 2484.076616 | -60.2 | -10.0 | PASS |
| 2402.000000 | 1.000000 | 2485.076616 | -60.0 | -20.0 | PASS |
| 2402.000000 | 1.000000 | 2485.153231 | -60.1 | -20.0 | PASS |
| 2480.000000 | 1.000000 | 2398.359767 | -61.0 | -20.0 | PASS |
| 2480.000000 | 1.000000 | 2398.429884 | -60.9 | -20.0 | PASS |
| 2480.000000 | 1.000000 | 2399.429884 | -60.9 | -10.0 | PASS |
| 2480.000000 | 1.000000 | 2399.500000 | -60.7 | -10.0 | PASS |
| 2480.000000 | 1.000000 | 2484.000000 | -45.3 | -10.0 | PASS |
| 2480.000000 | 1.000000 | 2484.070116 | -45.7 | -10.0 | PASS |
| 2480.000000 | 1.000000 | 2485.070116 | -48.6 | -20.0 | PASS |
| 2480.000000 | 1.000000 | 2485.140233 | -48.7 | -20.0 | PASS |

Transmitter unwanted spurious emissions in the spurious domain

Transmitter unwanted spurious emissions in the spurious domain

Standard: EN 300 328 V.1.9.1
Tested by: EHA / RRE
Date: 17.8 - 16.9.2016
Temperature: 23 ± 3 °C
Humidity: 30 - 60 % RH

Test result: **PASS**

Measurement uncertainty: Radiated: ± 5.29 dB Level of confidence 95 % (k = 2)
 Conducted: ± 2.05dB

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

Radiated test results, BGM121A:

Table 9: Radiated transmitter unwanted spurious emissions in the spurious domain (ch low)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|-------|
| 4960.50 | RMS | -46.9 | H | 16.9 | -30 | PASS | |

Table 10: Radiated transmitter unwanted spurious emissions in the spurious domain (ch high)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|-------|
| 4804.70 | RMS | -46.7 | H | 16.7 | -30 | PASS | |

Conducted test results, BGM121A:

No final measurements were made; no emissions near the limit.

Transmitter unwanted spurious emissions in the spurious domain

Radiated test results, BGM121N:

Table 11: Radiated transmitter unwanted spurious emissions in the spurious domain (ch low)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|---------|
| 2402.25 | Peak | 6.8 | V | 3.2 | 10 | PASS | Carrier |
| 2752.72 | Peak | -53.5 | V | 23.5 | -30 | PASS | |
| 4804.50 | Peak | -43.4 | V | 13.4 | -30 | PASS | |

Table 12: Radiated transmitter unwanted spurious emissions in the spurious domain (ch high)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|---------|
| 2480.32 | Peak | 6.70 | V | 3.3 | 10 | PASS | Carrier |
| 2646.31 | Peak | -50.50 | V | 20.5 | -30 | PASS | |
| 2973.99 | Peak | -56.40 | V | 26.4 | -30 | PASS | |
| 4960.44 | Peak | -45.20 | V | 15.2 | -30 | PASS | |

Conducted test results, BGM121N:

No final measurements were made; no emissions near the limit.

Receiver spurious emissions

Standard: EN 300 328 V.1.9.1
Tested by: EHA / RRE
Date: 17.8 - 16.9.2016
Temperature: 23 ± 3 °C
Humidity: 30 - 60 % RH

Test result: **PASS**

Measurement uncertainty: Radiated: ± 5.29 dB Level of confidence 95 % (k = 2)
Conducted: ± 2.90 dB

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. Emissions are measured in the frequency range 30 - 12 750 MHz.

Test results**Radiated test results, BGM121A:**

Table 13: Radiated receiver spurious emissions (ch low)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|-------|
| 300.00 | Peak | -69.20 | H | 12.2 | -57 | PASS | |

Table 14: Radiated receiver spurious emissions (ch high)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|-------|
| 300.02 | Peak | -69.00 | H | 12.0 | -57 | PASS | |

Conducted test results:

No final measurements were made; no emissions near the limit.

Radiated test results, BGM121N:

Table 15: Radiated receiver spurious emissions (ch low)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|-------|
| 180.01 | Peak | -69.60 | V | 12.6 | -57 | PASS | |
| 300.02 | Peak | -63.00 | H | 6.0 | -57 | PASS | |
| 312.03 | Peak | -67.20 | H | 10.2 | -57 | PASS | |
| 4805.56 | RMS | -60.39 | H | 13.4 | -47 | PASS | |

Table 16: Radiated receiver spurious emissions (ch high)

| Frequency (MHz) | Detector | Result (dBm) | Polarization | Margin (dB) | RMS Limit (dBm) | Result | Notes |
|-----------------|----------|--------------|--------------|-------------|-----------------|--------|-------|
| 300.02 | Peak | -63.50 | H | 6.5 | -57 | PASS | |

Conducted test results:

No final measurements were made; no emissions near the limit.

RF Test Equipment

| Equipment | Manufacturer | Type | Inv or serial | Prev Calib | Next Calib |
|------------------------------|------------------------|-------------------|---------------|------------|------------|
| MONITORING ANTENNA | A.H. SYSTEMS | SAS-200/518 | inv:7873 | - | - |
| MONITORING SPECTRUM ANALYZER | AGILENT | E7405A | inv:9746 | 2016-01-07 | 2018-01-07 |
| ANTENNA MAST | MATURO | TAM 4.0E | inv:10181 | - | - |
| TURNTABLE | MATURO | DS430 UPGRADED | inv:10182 | - | - |
| MAST & TURNTABLE CONTROLLER | MATURO | NCD | inv:10183 | - | - |
| PREAMPLIFIER | ALC MICROWAVE | AWB-2018-40-08 | sn:14 | 2016-08-30 | 2017-08-30 |
| PREAMPLIFIER | MERCURY SYSTEMS | ALS1826-41-12 | - | 2016-09-02 | 2017-09-02 |
| TEST SOFTWARE | ROHDE & SCHWARZ | EMC-32 | - | - | - |
| EMI TEST RECEIVER | ROHDE & SCHWARZ | ESU 26 | inv:8453 | 2016-06-10 | 2017-06-10 |
| SIGNAL ANALYZER | ROHDE & SCHWARZ | FSV40 | inv:9093 | 2016-06-10 | 2017-06-10 |
| ANTENNA | SCHWARZBECK | VULB 9168 | inv:8911 | 2014-11-04 | 2016-11-04 |
| ANTENNA | EMCO | 3117 | inv:7293 | 2016-03-16 | 2018-03-06 |
| ANTENNA | EMCO | 3160-09 | inv:7294 | 2016-03-16 | 2017-03-16 |
| HIGH PASS FILTER | WAINWRIGHT | WHKX4.0/18G-10SS | sn:10 | 2016-01-22 | 2017-01-22 |
| ATTENUATOR 10 dB | HUBER & SUHNER | 6610.19.AA | sn:7 | 2016-02-02 | 2017-02-02 |
| AC POWER SOURCE | CALIFORNIA INSTRUMENTS | 5001 iX Series II | inv:7826 | - | - |
| LISN | ROHDE & SCHWARZ | ENV216 | inv:9611 | 2016-02-24 | 2017-02-24 |
| SWITCH UNIT | ROHDE & SCHWARZ | OSP 120 | inv:9289 | 2016-03-14 | 2019-03-14 |
| RF SIGNAL GENERATOR | ROHDE & SCHWARZ | SMB100A | inv:9288 | 2014-03-18 | 2017-03-18 |
| VECTOR SIGNAL GENERATOR | ROHDE & SCHWARZ | SMBV100A | inv:9290 | 2014-03-13 | 2017-03-17 |