

Test Report

INTENTIONAL RADIATOR TESTS ACCORDING TO ARIB STD-T66 REQUIREMENTS

Equipment Under Test: Bluetooth Smart Module

Model: BGM113

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



Date: 15 March 2016

Issued by:

Niko Kotsalo
Testing Engineer

Date: 15 March 2016

Checked by:

Rauno Repo
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Equipment Under Test (EUT)

| | |
|------------------------|----------------------|
| Bluetooth Smart module | |
| Brand: | Silicon Laboratories |
| Model: | BGM113 |
| Type: | - |
| Serial no: | - |
| HW version: | - |
| SW version: | - |

Description of the EUT

BGM113 is Bluetooth Smart Module (Bluetooth 4.1) targeted for Bluetooth Smart applications. BGM113 integrates all of the necessary elements required for a Bluetooth Smart application: Bluetooth radio, software stack and GATT based profiles.

Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

Ratings and declarations

| | |
|----------------------------------|-----------------|
| Operating Frequency Range (OFR): | 2402 – 2480 MHz |
| Channels: | 37 |
| Advertising channels: | 3 |
| Channel separation: | 2 MHz |
| Conducted power: | 1.20 mW |
| Modulation: | GFSK |
| Antenna gain: | 0.5 dBi |

Power Supply

The BGM113 has an Energy Management Unit and efficient integrated regulators to generate internal supply voltages. Only a single external supply voltage is required, from which all internal voltages are created. An integrated DC-DC buck regulator is utilized to further reduce the current consumption. All the testing were made with 3.3VDC voltage.

According to the customers declaration the internal supply voltages of the EUT are regulated. Therefore tests were performed using only the nominal input voltage level.

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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.

SUMMARY OF TESTING

| Description of Test | Result |
|---|--------|
| Antenna power, tolerances for antenna power | PASS |
| Frequency tolerance | PASS |
| Occupied Bandwidth (99%) | PASS |
| Transmission spurious emissions | PASS |
| Receiver spurious emissions | PASS |

Test methods

| | |
|-------------|---|
| References: | Tests were performed according to the methods presented in standards EN 300 328-1 v1.7.1. |
|-------------|---|

EUT Test Conditions during Testing

The EUT was in continuous transmit or receiving mode during all the tests.

The EUT was configured into the wanted channel and set to transmit continuously on the channel under test. Normal modulation and duty cycle was applied in all tests except for frequency tolerance measurement that was performed with unmodulated signal.

According to the customers declaration the internal supply voltages of the EUT are regulated. Therefore tests were performed using only the nominal input voltage level.

Following channels were used during the tests when the hopping was stopped:

Channel LOW (CH 37) = 2402 MHz

Channel MID (CH 38) = 2426 MHz

Channel HIGH (CH 39) = 2480 MHz

The EUT was controlled by using BGTool software supplied by the customer.

Test Facility

| | |
|--|--|
| <input type="checkbox"/> Testing Location / address: FCC registration number: 90598 | SGS Fimko Ltd Särkiniementie 3 FI-00210, HELSINKI FINLAND |
| <input checked="" type="checkbox"/> Testing Location / address: FCC registration number: 178986 Industry Canada registration number: 8708A-2 | SGS Fimko Ltd Karakaarenkuja 4 FI-02610, ESPOO FINLAND |

Antenna Power and Tolerances

| | | |
|--------------------------------|---------------------------------------|----------------------------------|
| Standard: | EN 300 328 | |
| Limit: | ARIB-T66 | |
| Tested by: | NKO | |
| Date: | 7 March 2016 | |
| Temperature: | 21 °C | |
| Humidity: | 22 % RH | |
| Measurement uncertainty | ± 0.49 dB | Level of confidence 95 % (k = 2) |
| Limits: | 10 mW or less; 2 400 – 2483.5 MHz | |
| | Antenna POWER TOLERANCE: -80% to +20% | |

Test procedure

Antenna power was measured using spectrum analyzer. First the maximum peak power frequency was searched for channel under measurement. This frequency was used as a center frequency for zero span measurements to measure the Average Burst Power (= Antenna Power (W)).

The Average Burst Power level was measured in continuous modulated mode.

Test Results

Table 1. Measured antenna power

| Channel | Reading [dBm/MHz] | Result [mW] | Limit [mW] | Margin [mW] | Result |
|---------|-------------------|-------------|------------|-------------|--------|
| Low | -0.24 | 0.95 | 10 | 9.05 | PASS |
| Mid | -0.35 | 0.92 | 10 | 9.08 | PASS |
| High | -0.65 | 0.86 | 10 | 9.14 | PASS |

Table 2. Tolerances of antenna power

| Channel | Declared antenna power [mW] | -80% limit | +20% limit | Maximum measured power [mW] | Deviation [%] | Result |
|---------|-----------------------------|------------|------------|-----------------------------|---------------|--------|
| Low | 1.200 | 0.240 | 1.440 | 0.950 | -20.833 | PASS |
| Mid | 1.200 | 0.240 | 1.440 | 0.920 | -23.333 | PASS |
| High | 1.200 | 0.240 | 1.440 | 0.860 | -28.333 | PASS |

Power tolerance is calculated by using the following formula:

$$\text{Power tolerance} = \{[(\text{Measured power}) - (\text{Rated Cond. P})] / (\text{Rated Cond. P})\} \times 100$$

Frequency Tolerance

Standard: EN 300 328
Limit: ARIB-T66
Tested by: NKO
Date: 11 March 2016
Temperature: 22 °C
Humidity: 18 % RH
Measurement uncertainty $\pm 4.758 \times 10^{-8}$ Level of confidence 95 % (k = 2)
Limit: ± 50 ppm

Test procedure

Frequency tolerance was measured by using frequency counter function of the spectrum analyzer.

Test Results

Table 3. Test Results for Frequency Tolerance

| Channel | Low | Mid | High |
|-------------------------|-------------|-------------|-------------|
| Channel Frequency [MHz] | 2402 | 2426 | 2480 |
| Reading Frequency [MHz] | 2402 | 2426 | 2480 |
| Frequency error [kHz] | 2401.962281 | 2425.961565 | 2479.959477 |
| Frequency error [ppm] | -37.719 | -38.435 | -40.523 |
| Margin [ppm] | -15.703 | -15.843 | -16.340 |
| Result | 34.297 | 34.157 | 33.660 |

99% Occupied Bandwidth

Standard: EN 300 328
Limit: ARIB-T66
Tested by: NKO
Date: 7 March 2016
Temperature: 21 °C
Humidity: 22 % RH
Measurement uncertainty ± 1.78 dB

Level of confidence 95 % (k = 2)

99% Occupied bandwidth test procedure

99% Occupied Bandwidth was measured with the occupied bandwidth function of the test receiver.
 The limit for 99% occupied bandwidth is ≤ 26 MHz.

Test Results

Table 4. Test results for 99% Occupied Bandwidth

| Channel | Limit [MHz] | 99% BW [MHz] | Result |
|---------|-------------|--------------|--------|
| Low | ≤ 26 | 1.063675832 | PASS |
| Mid | ≤ 26 | 1.063675832 | PASS |
| High | ≤ 26 | 1.063675832 | PASS |

Transmission Spurious Emissions

| | |
|--------------------------------|--|
| Standard: | EN 300 328 |
| Limit: | ARIB-T66 |
| Tested by: | NKO |
| Date: | 7 March 2016 |
| Temperature: | 21 °C |
| Humidity: | 22% |
| Measurement uncertainty | ± 2.96 dB Level of confidence 95 % (k = 2) |
| Limits: | -26.02 dBm (< 2387 MHz) -16.02 dBm (2387 MHz – 2400 MHz) -16.02 dBm (2483.5 MHz – 2496.5 MHz) -26.02 dBm (> 2496.5 MHz) |

Unwanted spurious emissions are measured in the frequency range of 30 MHz – 12.75 GHz. The resolution bandwidth is 1 MHz and the video bandwidth 1 MHz for all measurements.

Test Result

Table 5. Channel low

| Frequency [MHz] | Detector | Level [dBm/MHz] | Limit [dBm/MHz] | Margin [dBm/MHz] | Result |
|-----------------|----------|-----------------|-----------------|------------------|--------|
| 341.70 | Peak | -45.84 | -26.02 | 19.82 | PASS |
| 2400.00 | Peak | -26.50 | -16.02 | 10.48 | PASS |
| 3820.50 | Peak | -40.46 | -26.02 | 14.44 | PASS |
| 4803.95 | Peak | -44.04 | -26.02 | 18.02 | PASS |
| 11835.22 | Peak | -50.66 | -26.02 | 24.64 | PASS |

Table 6. Channel mid

| Frequency [MHz] | Detector | Level [dBm/MHz] | Limit [dBm/MHz] | Margin [dBm/MHz] | Result |
|-----------------|----------|-----------------|-----------------|------------------|--------|
| 237.16 | Peak | -47.58 | -26.02 | 21.56 | PASS |
| 2400.00 | Peak | -44.12 | -16.02 | 28.10 | PASS |
| 2483.50 | Peak | -45.28 | -16.02 | 29.26 | PASS |
| 3774.45 | Peak | -40.29 | -26.02 | 14.27 | PASS |
| 4851.78 | Peak | -45.21 | -26.02 | 19.19 | PASS |
| 12149.62 | Peak | -51.11 | -26.02 | 25.09 | PASS |

Table 7. Channel high

| Frequency [MHz] | Detector | Level [dBm/MHz] | Limit [dBm/MHz] | Margin [dBm/MHz] | Result |
|-----------------|----------|-----------------|-----------------|------------------|--------|
| 358.24 | Peak | -47.19 | -26.02 | 21.17 | PASS |
| 2483.50 | Peak | -34.64 | -16.02 | 18.62 | PASS |
| 3814.14 | Peak | -39.64 | -26.02 | 13.62 | PASS |
| 4959.99 | Peak | -45.89 | -26.02 | 19.87 | PASS |
| 12177.62 | Peak | -51.50 | -26.02 | 25.48 | PASS |

Limitation of Collateral Emission of Receiver

| | |
|--------------------------------|---|
| Standard: | EN 300 328 |
| Limit: | ARIB-T66 |
| Tested by: | NKO |
| Date: | 7 March 2016 |
| Temperature: | 21 °C |
| Humidity: | 22% |
| Measurement uncertainty | ± 2.96 dB Level of confidence 95 % (k = 2) |
| Limits: | -53.98 dBm (<1000 MHz) -46.99 dBm (>1 GHz) |

Unwanted spurious emissions are measured in the frequency range of 30 MHz – 12.5 GHz. The resolution bandwidth for measurements is 1 MHz.

Test Results

Table 8. Channel Low

| Frequency (MHz) | Detector | Level [dBm/MHz] | Limit [dBm/MHz] | Margin [dBm/MHz] | Result |
|-----------------|----------|-----------------|-----------------|------------------|--------|
| 4805.61 | Peak | -67.81 | -46.99 | 20.82 | PASS |
| 12402.00 | Peak | -72.13 | -46.99 | 25.14 | PASS |

Table 9. Channel Mid

| Frequency (MHz) | Detector | Level [dBm/MHz] | Limit [dBm/MHz] | Margin [dBm/MHz] | Result |
|-----------------|----------|-----------------|-----------------|------------------|--------|
| 4805.61 | Peak | -63.92 | -46.99 | 16.93 | PASS |
| 12488.65 | Peak | -71.58 | -46.99 | 24.59 | PASS |

Table 10. Channel High

| Frequency (MHz) | Detector | Level [dBm/MHz] | Limit [dBm/MHz] | Margin [dBm/MHz] | Result |
|-----------------|----------|-----------------|-----------------|------------------|--------|
| 4853.71 | Peak | -65.70 | -46.99 | 18.71 | PASS |
| 12179.80 | Peak | -71.06 | -46.99 | 24.07 | PASS |

TEST EQUIPMENT

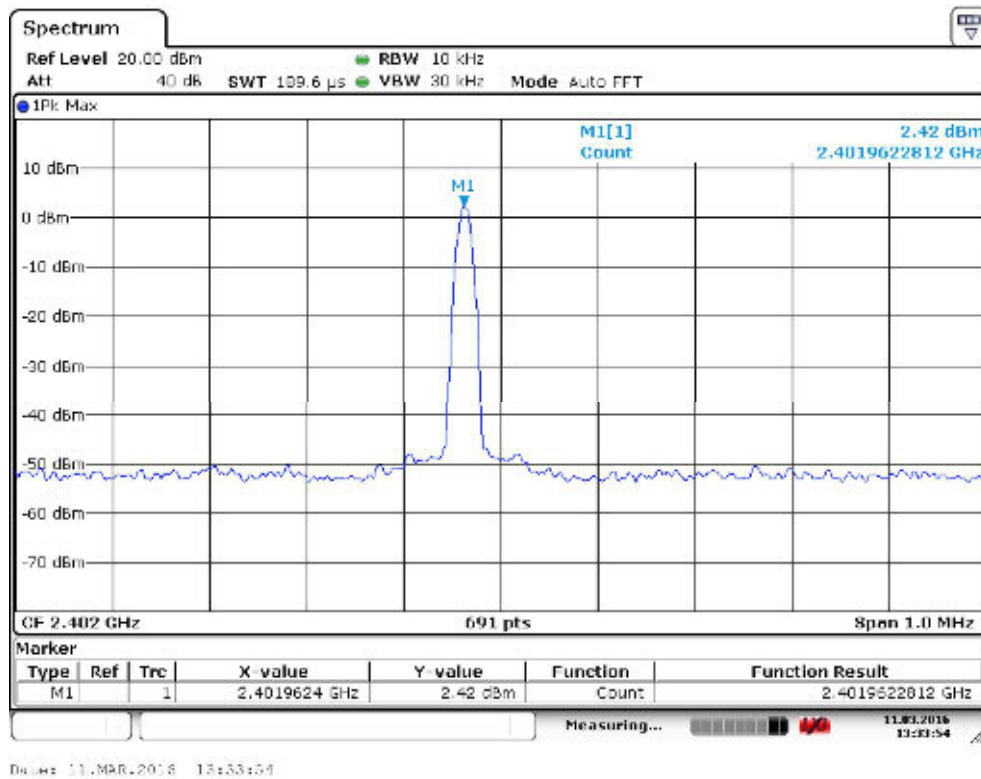
| Type | Manufacturer | Model | Serial No. | Inv. No. |
|--------------------|----------------|----------|------------|----------|
| Attenuator 10dB | Huber-+ Suhner | 6810.17B | - | - |
| Spectrum analyzer | Rohde&Schwarz | FSV40 | 101068 | 9093 |
| Frequency standard | Pendulum | GPS-88 | SM 968615 | - |

All used measurement equipment was calibrated (if required).

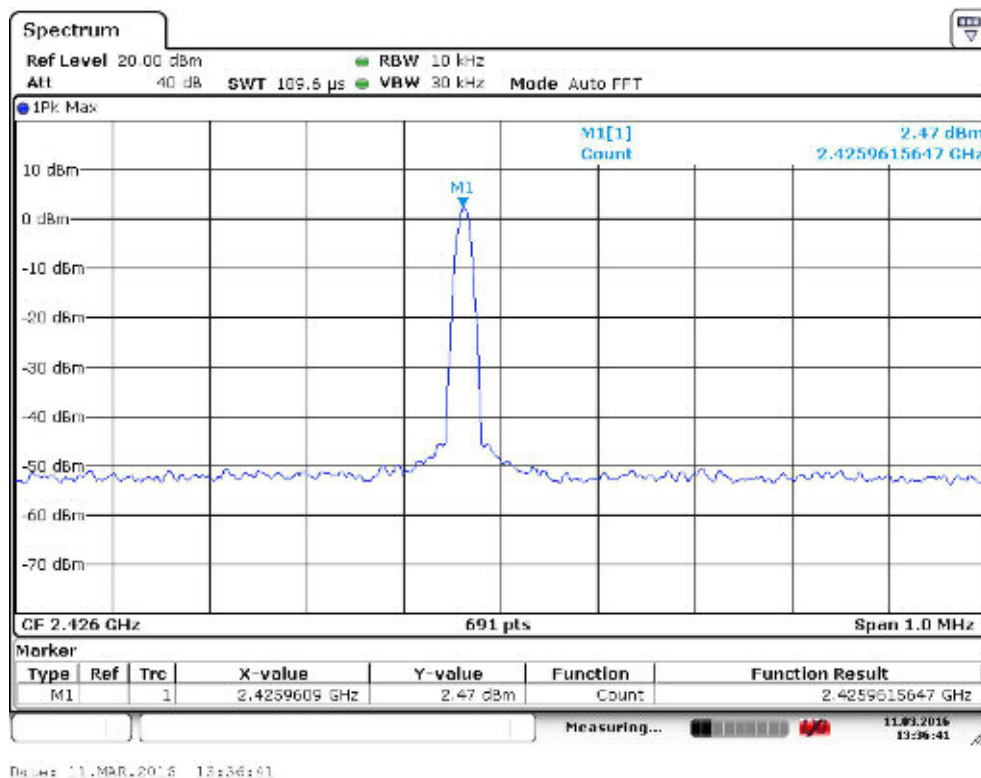
ANNEX A

Graphical data

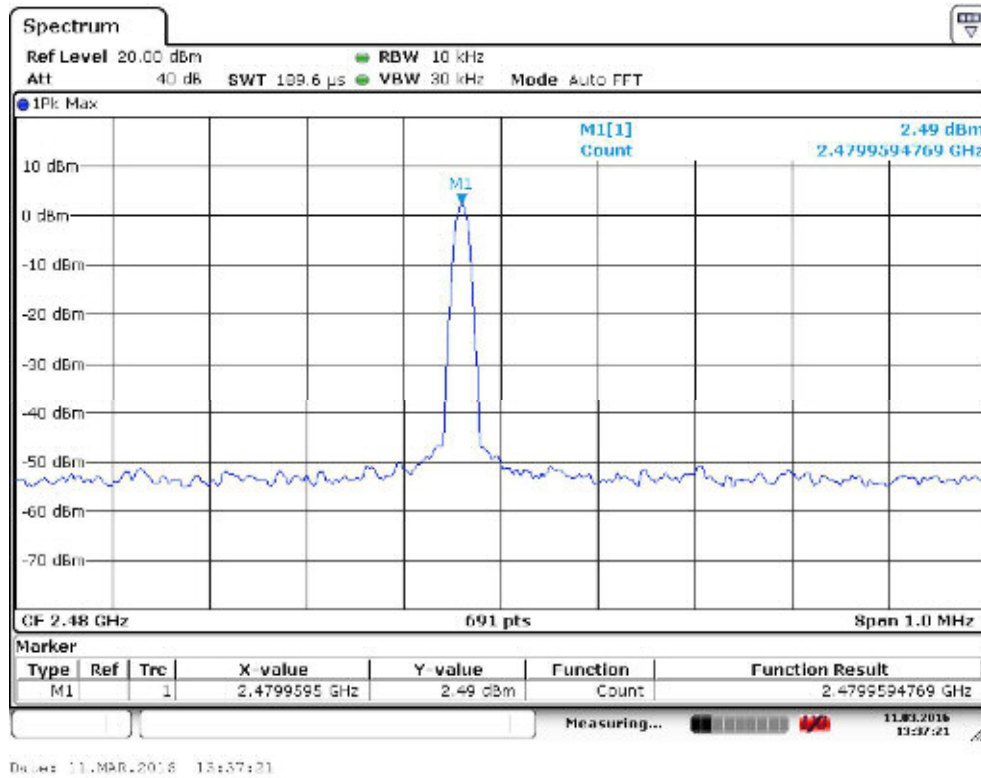
This annex contains the graphical data recorded during the tests and the pictures of the EUT.



Graph 1. Frequency Tolerance Channel Low.



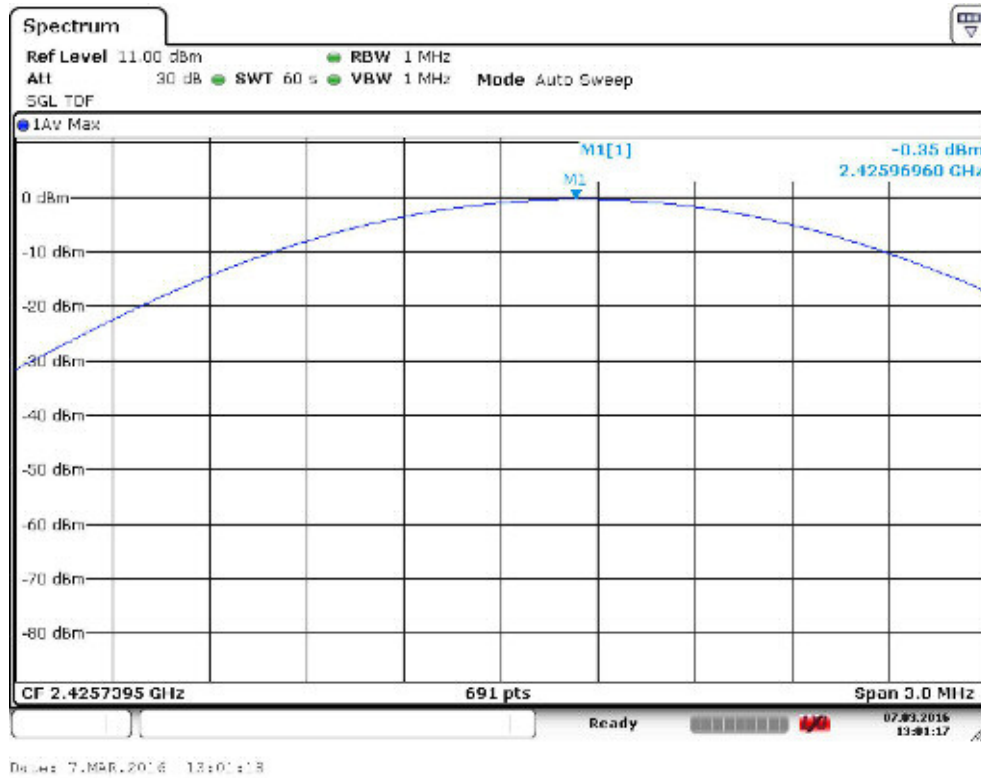
Graph 2. Frequency Tolerance Channel Mid.



Graph 3. Frequency Tolerance Channel High.



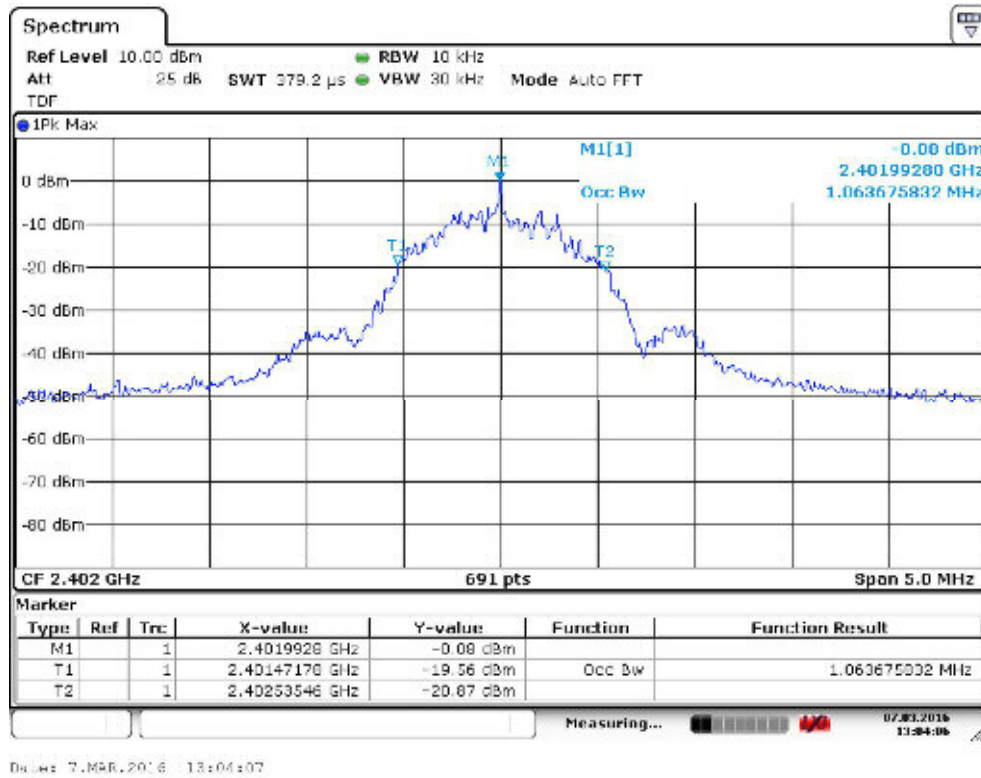
Graph 4. Antenna Power Channel Low.



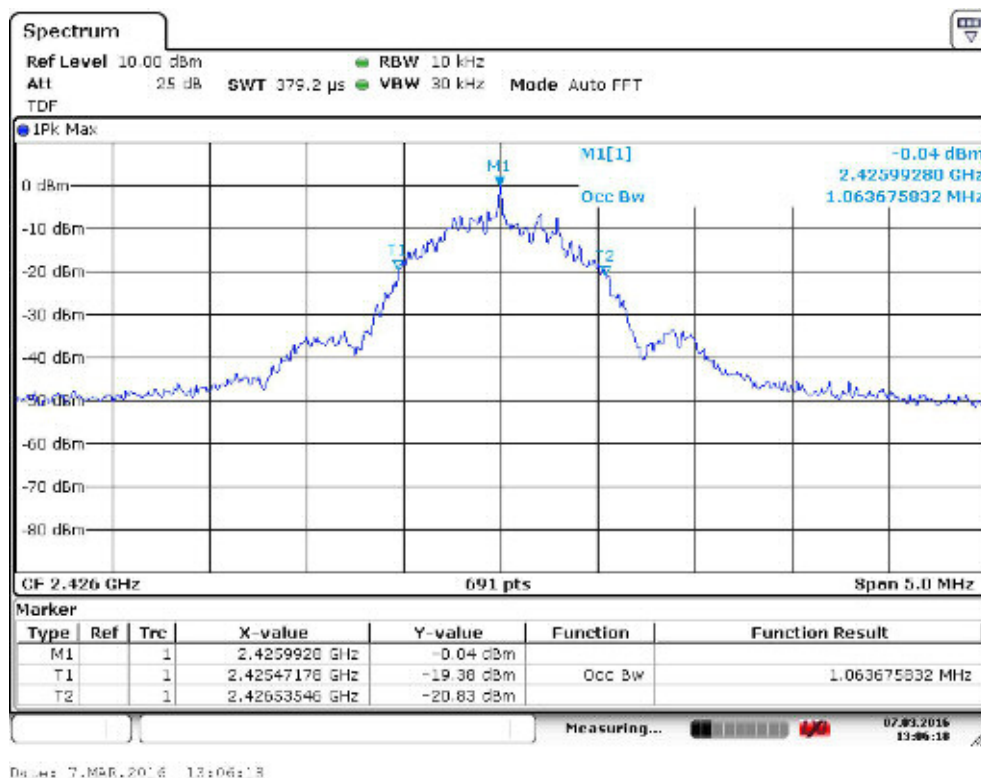
Graph 5. Antenna Power Channel Mid.



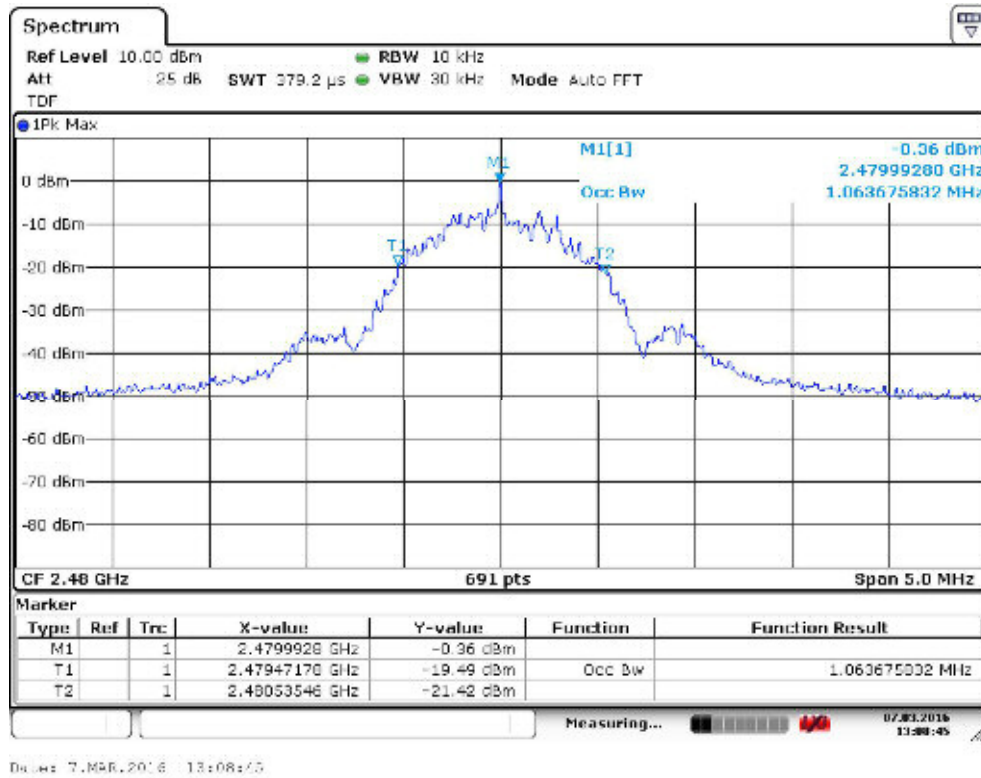
Graph 6. Antenna Power Channel High.



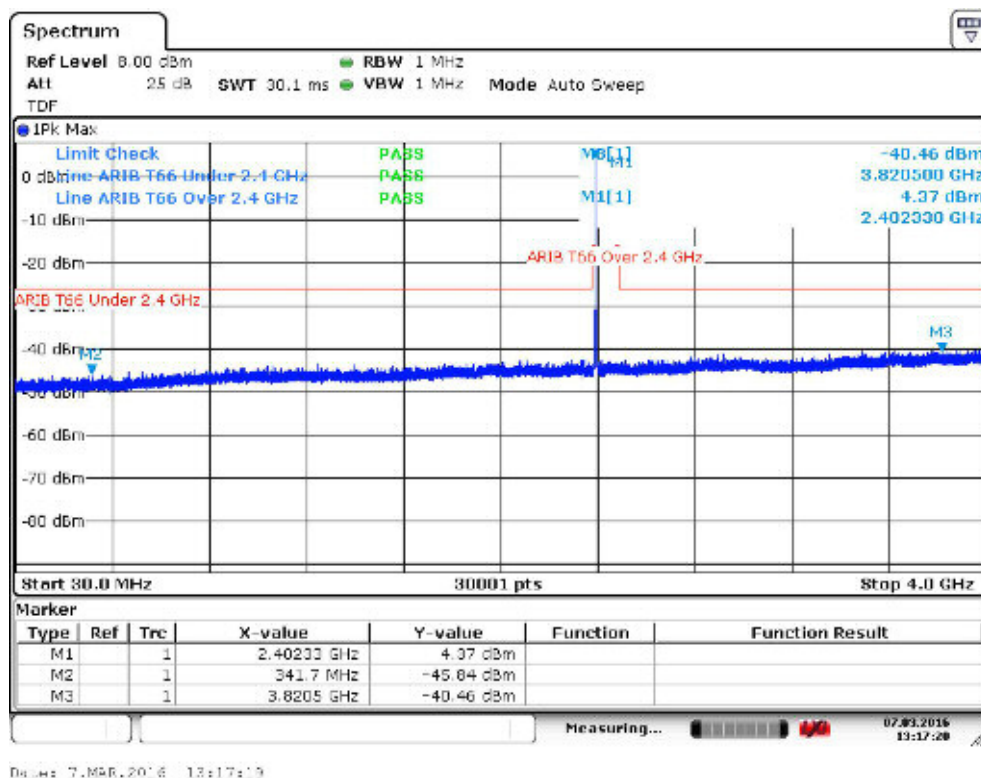
Graph 7. 99% Occupied Bandwidth Channel Low.



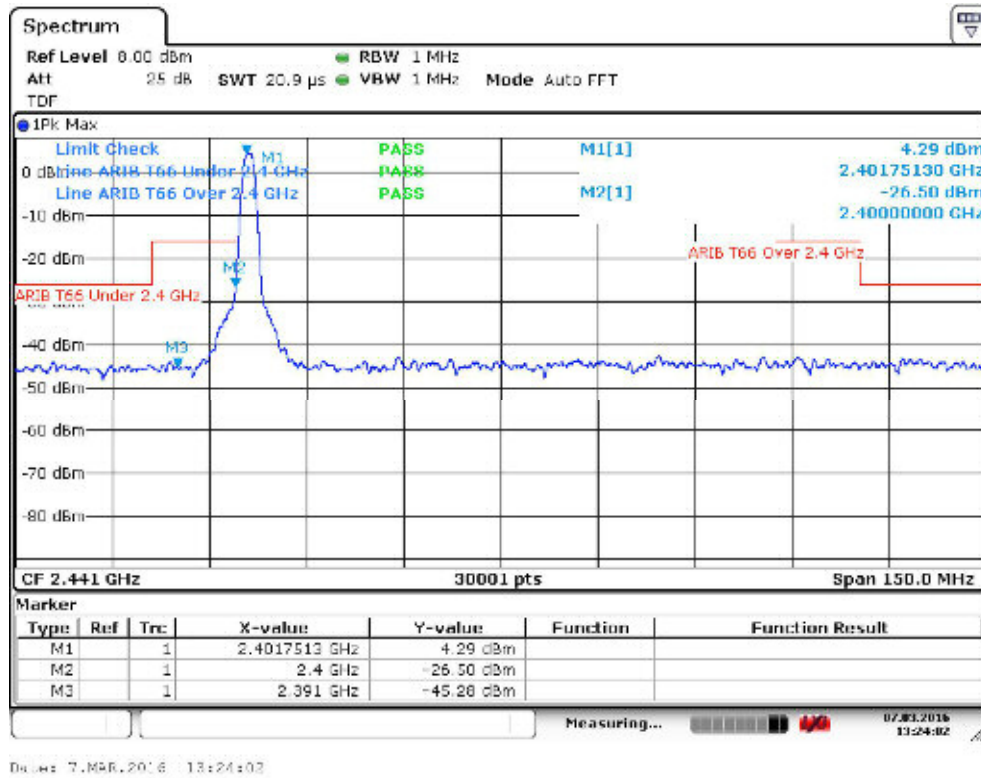
Graph 8. 99% Occupied Bandwidth Channel Mid.



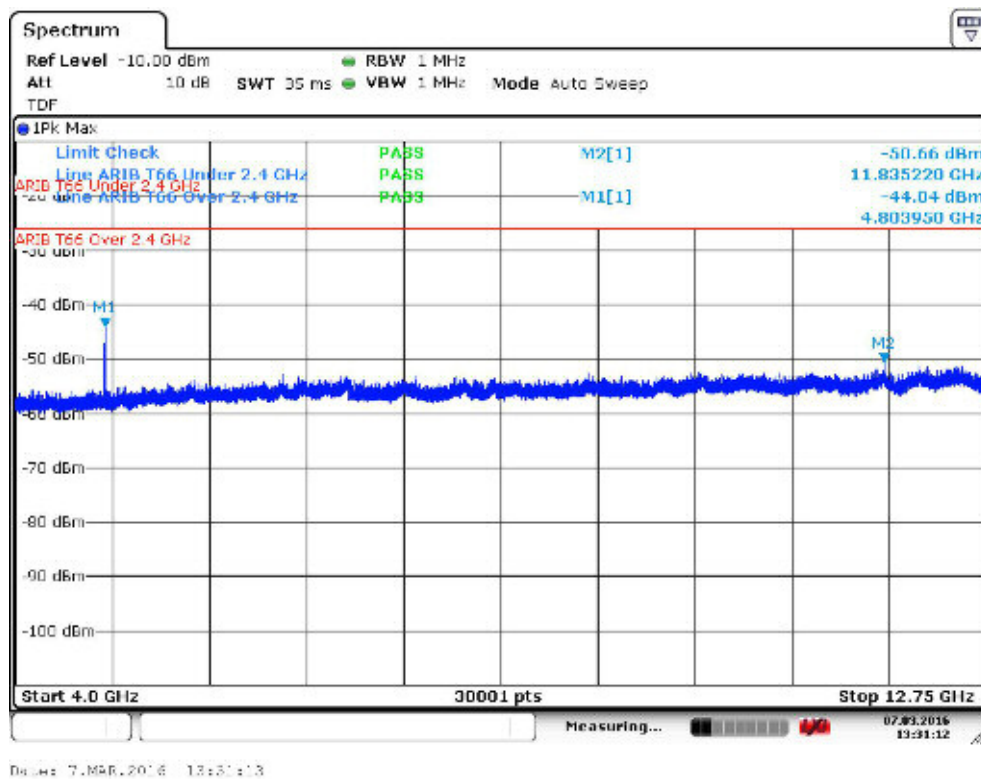
Graph 9. 99% Occupied Bandwidth Channel High.



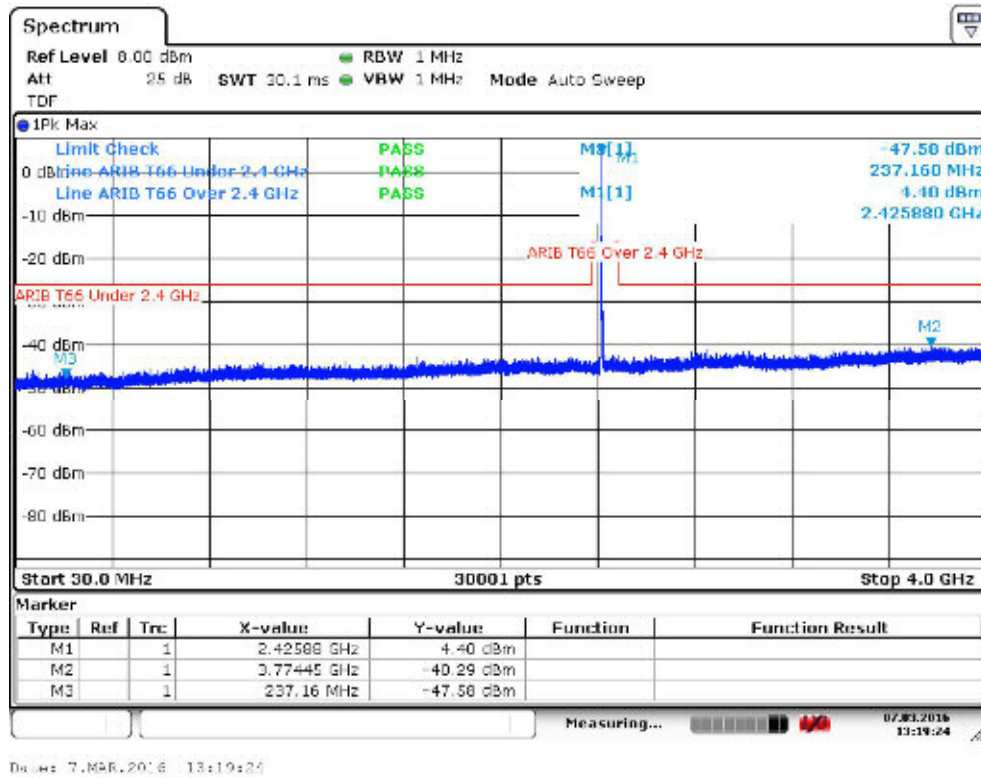
Graph 10. Tx Spurious Emissions Channel Low 30 – 4000 MHz.



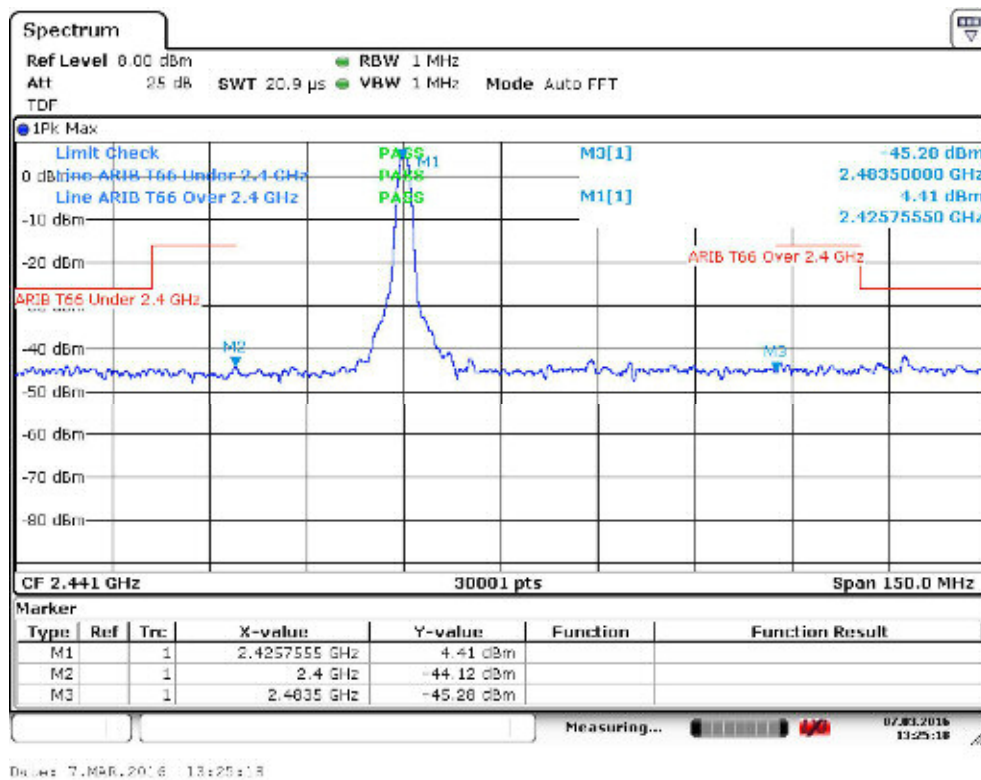
Graph 11. Tx spurious Emissions Channel Low 2.4 GHz.



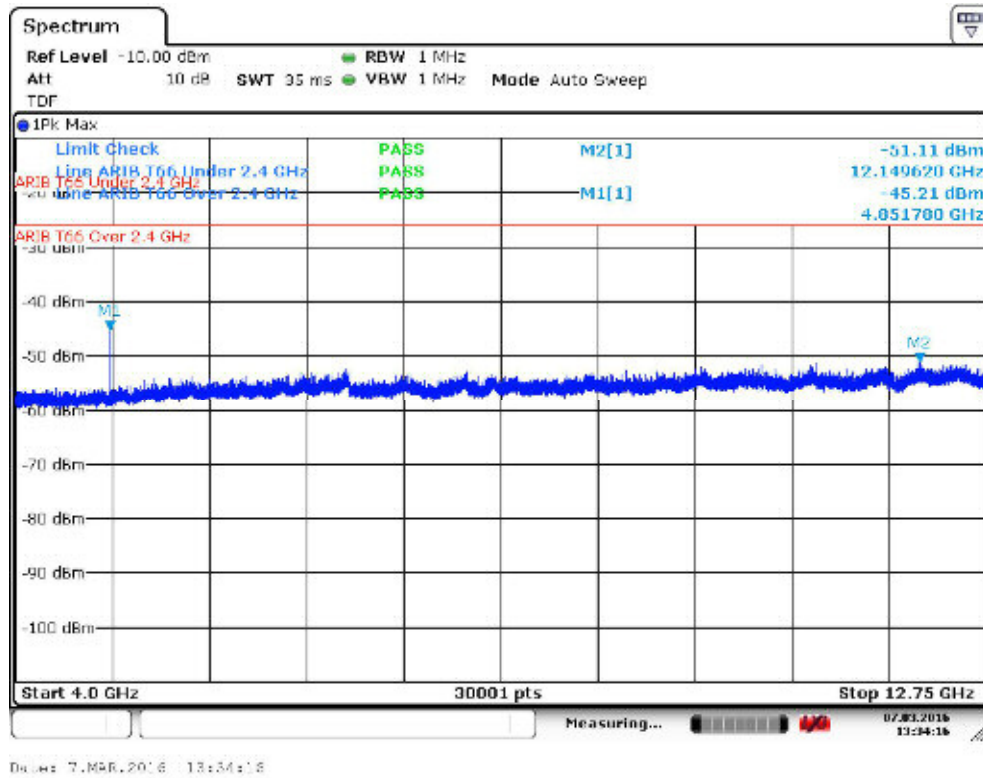
Graph 12. Tx Spurious Emissions Channel Low 4.0 – 12.75 GHz.



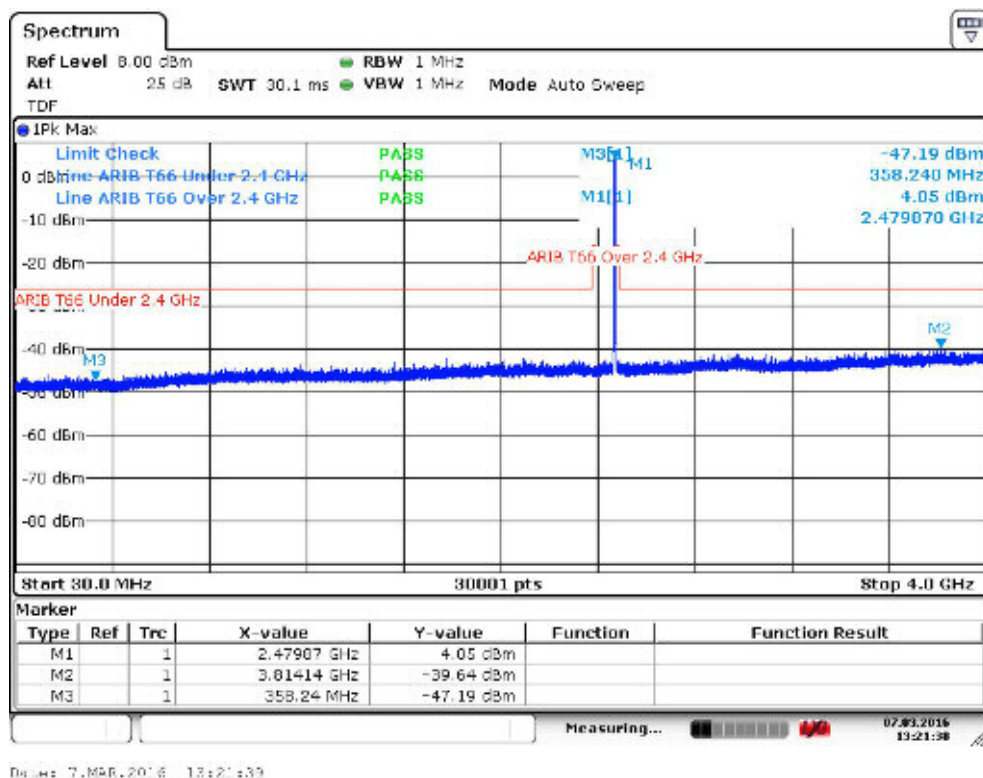
Graph 13. Tx Spurious Emissions Channel Mid 30 – 4000 MHz.



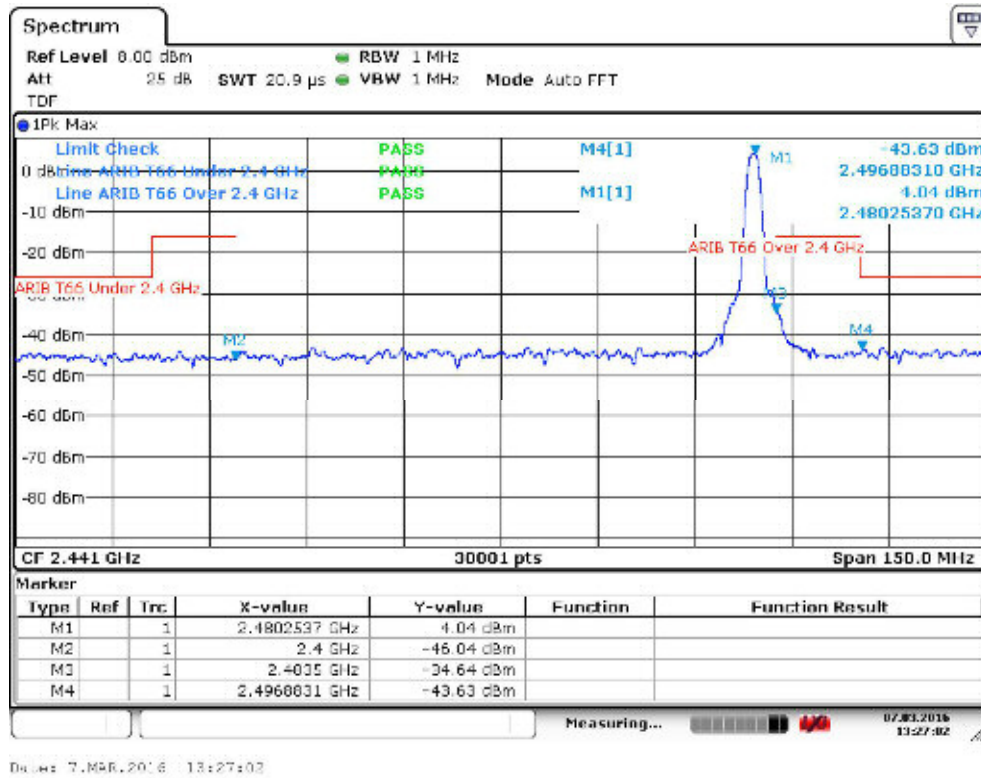
Graph 14. Tx spurious Emissions Channel Mid 2.4 GHz.



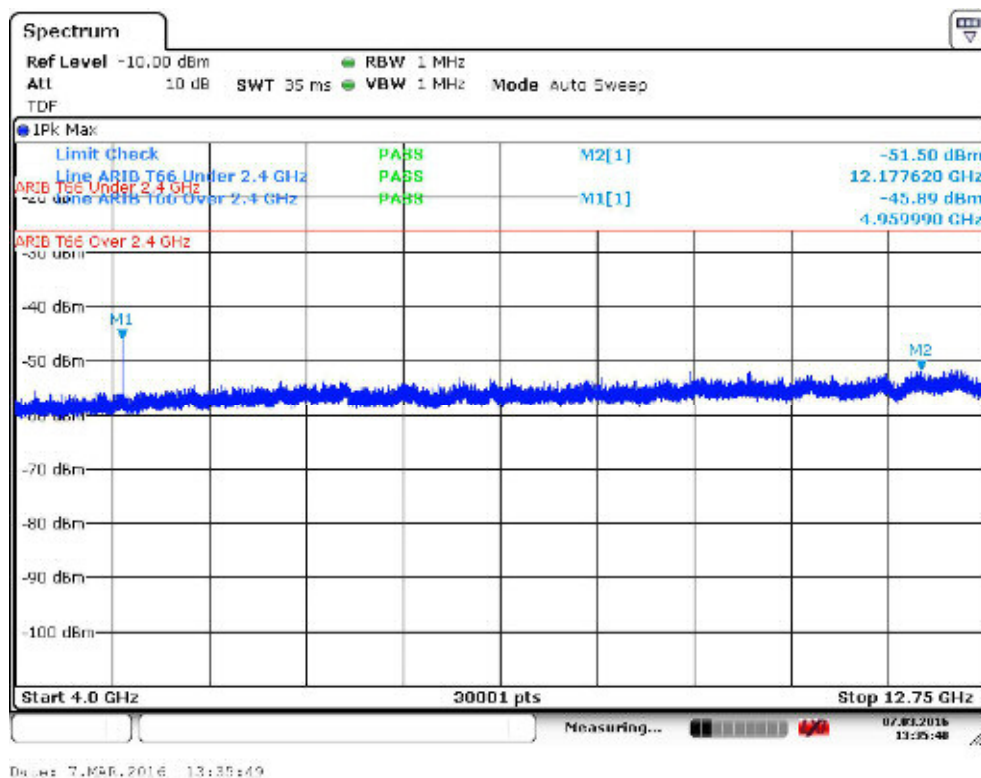
Graph 15. Tx Spurious Emissions Channel Mid 4 – 12.75 GHz



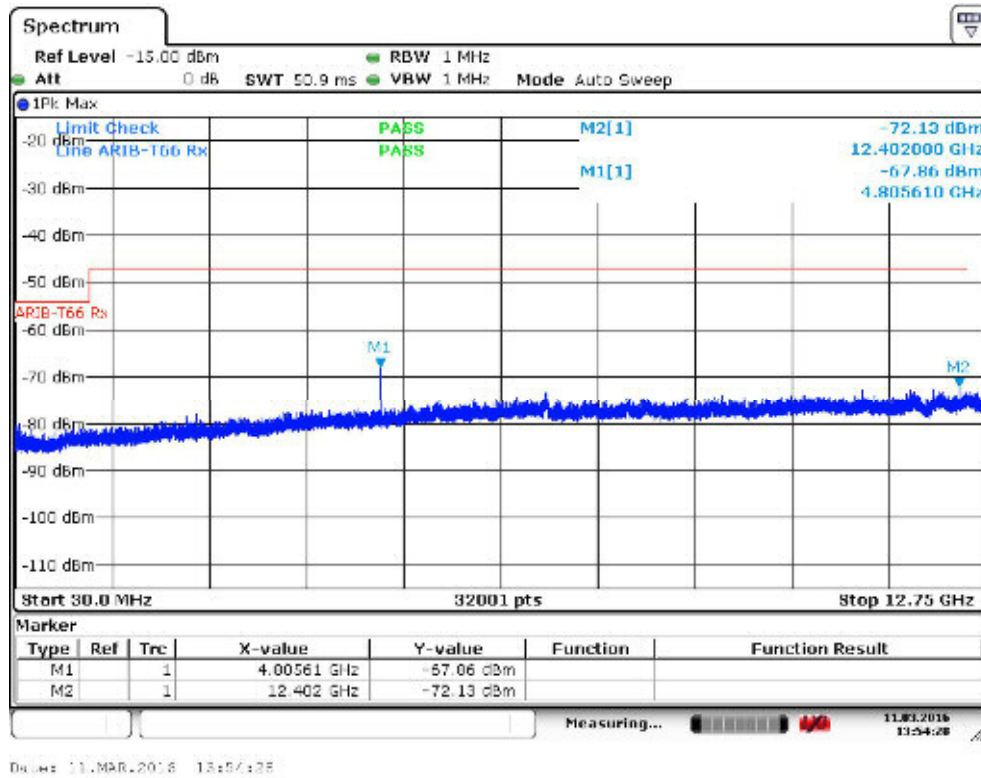
Graph 16. Tx Spurious Emissions Channel High 30 MHz – 4000 MHz.



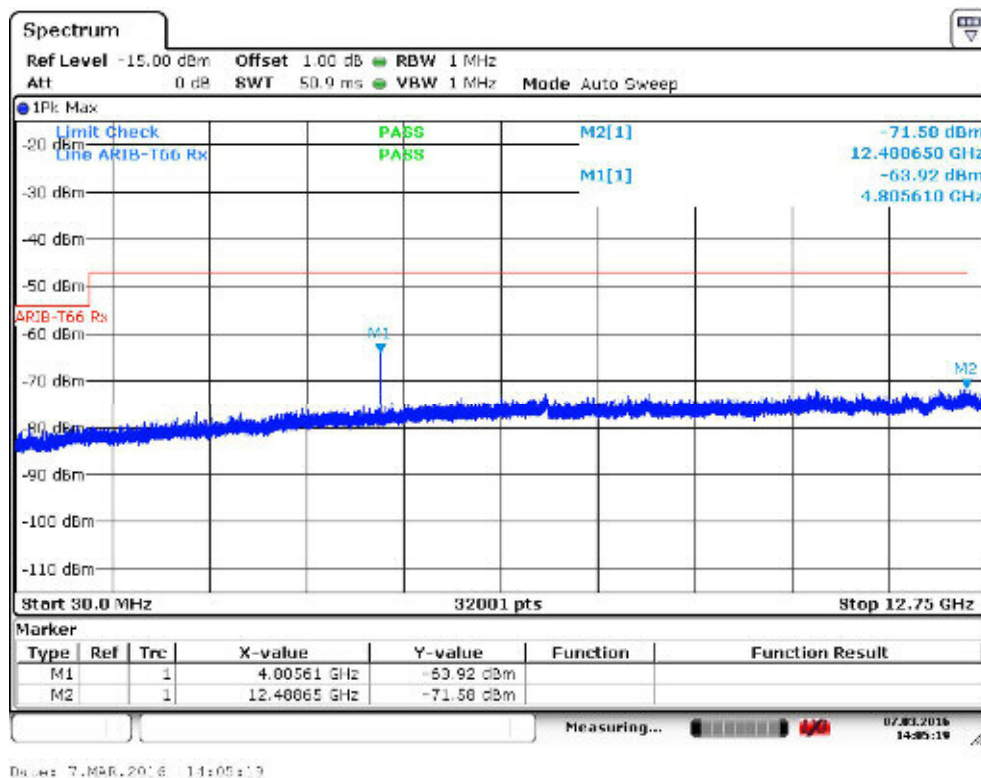
Graph 17. Tx Spurious Emissions Channel High 2.4 GHz.



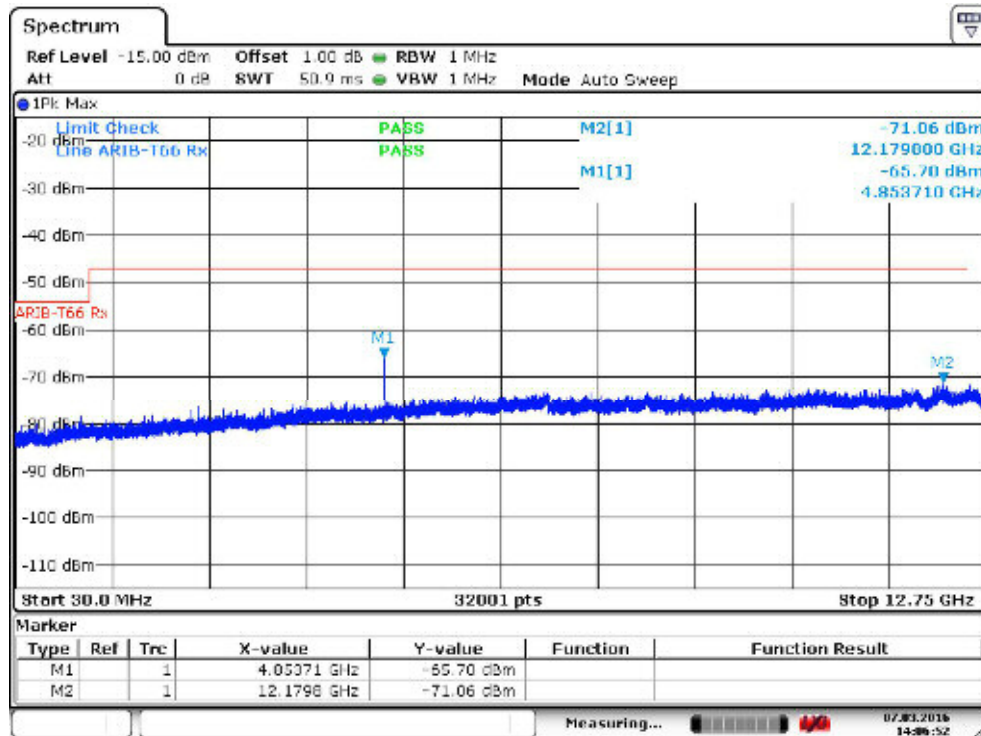
Graph 18. Tx Spurious Emissions Channel High 4 – 12.75 GHz.



Graph 19. Rx Spurious Emissions Channel Low 30 MHz – 12.75 GHz.



Graph 20. Rx Spurious Emissions Channel Mid 30 MHz – 12.75 GHz.



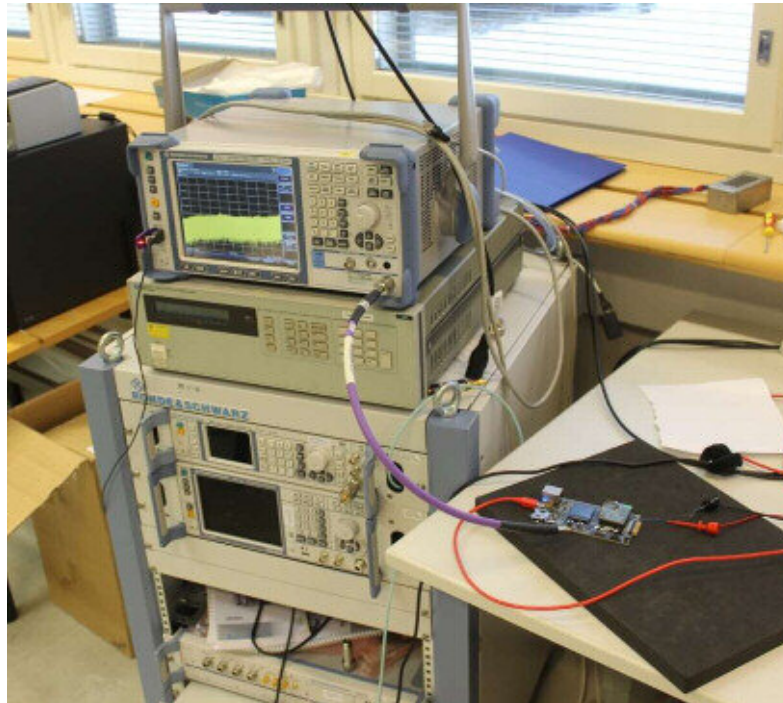
Data: 7.MAR.2016 14:06:52

Graph 21. Rx Spurious Emissions Channel High 30 MHz – 12.75 GHz.

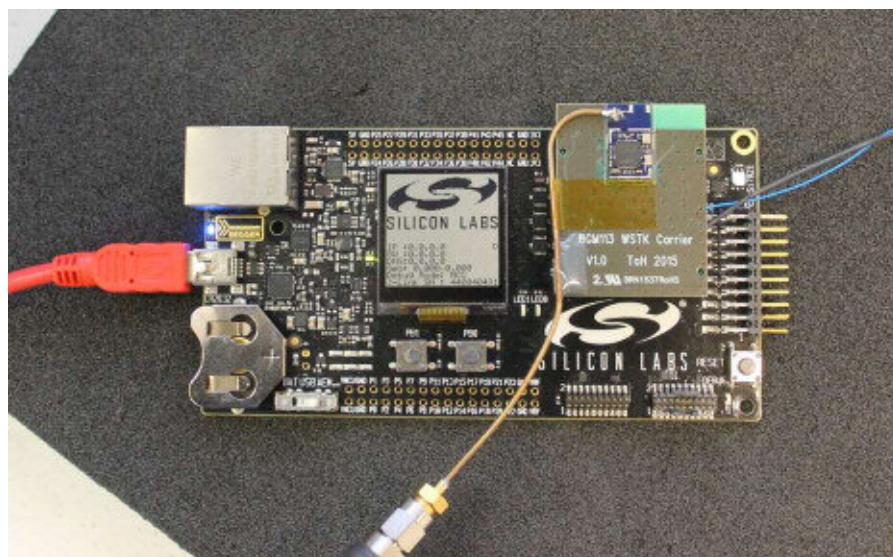
ANNEX B

Photographs

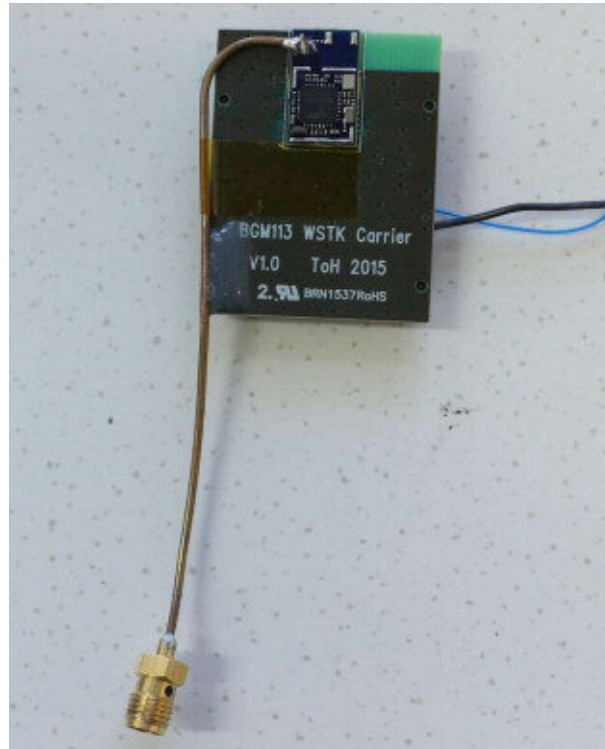
This annex contains the photographs of the EUT and test setup.



Photograph 1. Test setup.



Photograph 2. The EUT attached to the evaluation board.



Photograph 3. The EUT.