

# Test Report

## INTENTIONAL RADIATOR TESTS ACCORDING TO ARIB STD-T66 REQUIREMENTS

Equipment Under Test: Bluetooth Low Energy Module

Model: BGM111


Brand: Silicon Laboratories Finland Oy

Manufacturer: Silicon Laboratories Finland Oy  
Sinikalliontie 5A, 5<sup>th</sup> floor  
FI-02630 Espoo  
FINLAND


Customer: Silicon Laboratories Finland Oy  
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Date: 23 November 2015

Issued by:   
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Testing Engineer

Date: 23 November 2015

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## Equipment Under Test (EUT)

Bluetooth Low Energy module	
Brand:	Silicon Laboratories
Model:	BGM111
Type:	-
Serial no:	-
HW version:	-
SW version:	-

## 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.

## 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:	4.01 mW
Transmission technique:	FHSS for data channels DSSS for advertising channels
Modulation:	GFSK
Antenna gain:	1 dBi

## Power Supply

BGM111 is powered by a single, nominally 3.3V supply. The module is designed to operate with supply voltages between 2.4 and 3.8 V.

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.

## Disclaimer

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## 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.
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### EUT Test Conditions during Testing

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

The hopping was stopped and the EUT was configured into the wanted channel or the EUT was hopping continuously between the channels depending of the 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 software supplied by the customer.

### Test Facility

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

## Antenna Power and Tolerances

<b>Standard:</b>	EN 300 328	
<b>Limit:</b>	ARIB-T66	
<b>Tested by:</b>	NKO	
<b>Date:</b>	20 October 2015	
<b>Temperature:</b>	21 °C	
<b>Humidity:</b>	32 % RH	
<b>Measurement uncertainty</b>	± 0.49 dB	Level of confidence 95 % (k = 2)
<b>Limits:</b>	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/MHz)	Limit (mW/MHz)	Margin (mW/MHz)	Result
Low	3.85	2.43	10	7.57	PASS
Mid	3.83	2.42	10	7.58	PASS
High	3.46	2.22	10	7.78	PASS

**Table 2.** Tolerances of antenna power

Channel	Declared antenna power (mW)	-80% limit	+20% limit	Maximum measured power (mW)	Deviation (%)	Result
Low	3.85	0.770	4.620	3.850	0.000	PASS
Mid	3.85	0.770	4.620	3.830	-0.519	PASS
High	3.85	0.770	4.620	3.460	-10.130	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:** 20 November 2015  
**Temperature:** 21 °C  
**Humidity:** 27 % RH  
**Measurement uncertainty**  $\pm 4.758 \times 10^{-8}$  Level of confidence 95 % (k = 2)  
**Limit:**  $\pm 50$  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]	2401.989157	2425.988493	2479.986574
Frequency error [kHz]	-10.843	-11.507	-13.426
Frequency error [ppm]	-4.514	-4.743	-5.414
Margin [ppm]	45.486	45.257	44.586
Result	PASS	PASS	PASS

## 99% Occupied Bandwidth

**Standard:** EN 300 328  
**Limit:** ARIB-T66  
**Tested by:** NKO  
**Date:** 20 October 2015  
**Temperature:** 21 °C  
**Humidity:** 32 % RH  
**Measurement uncertainty**  $\pm 1.78$  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  $\leq 26$  MHz.

### Test Results

**Table 4.** Test results for 99% Occupied Bandwidth

Channel	Limit [MHz]	99% BW [MHz]	Result
Low	$\leq 26$	1.0593	PASS
Mid	$\leq 26$	1.0593	PASS
High	$\leq 26$	1.0593	PASS



## Transmission Spurious Emissions

<b>Standard:</b>	EN 300 328
<b>Limit:</b>	ARIB-T66
<b>Tested by:</b>	NKO
<b>Date:</b>	16 November 2015
<b>Temperature:</b>	22 °C
<b>Humidity:</b>	29%
<b>Measurement uncertainty</b>	$\pm 2.96$ dB Level of confidence 95 % (k = 2)
<b>Limits:</b>	-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 – 12.5 GHz. The resolution bandwidth is 1 MHz for all measurements.

### Test Result

**Table 5.** Channel low

Frequency [MHz]	Detector	Level [dBm]	Limit [dBm]	Margin [dBm]	Result
2400.00	Peak	-22.60	-16.02	6.58	PASS
4803.54	Peak	-33.14	-26.02	7.12	PASS
9251.23	Peak	-33.61	-26.02	7.59	PASS

**Table 6.** Channel mid

Frequency [MHz]	Detector	Level [dBm]	Limit [dBm]	Margin [dBm]	Result
4852.29	Peak	-37.18	-26.02	11.16	PASS
12159.08	Peak	-35.84	-26.02	9.82	PASS

**Table 7.** Channel high

Frequency [MHz]	Detector	Level [dBm]	Limit [dBm]	Margin [dBm]	Result
2483.50	Peak	-30.77	-16.02	14.75	PASS
2953.83	Peak	-36.96	-26.02	10.94	PASS
4959.54	Peak	-45.03	-26.02	19.01	PASS
12483.86	Peak	-51.90	-26.02	25.88	PASS

## Limitation of Collateral Emission of Receiver

<b>Standard:</b>	EN 300 328
<b>Limit:</b>	ARIB-T66
<b>Tested by:</b>	NKO
<b>Date:</b>	16 November 2015
<b>Temperature:</b>	22 °C
<b>Humidity:</b>	29%
<b>Measurement uncertainty</b>	$\pm 2.96$ dB Level of confidence 95 % (k = 2)
<b>Limits:</b>	-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)	Limit (dBm)	Margin (dBm)	Result
6952.84	Peak	-56.78	-46.99	9.79	PASS
12602.33	Peak	-58.40	-46.99	11.41	PASS

**Table 9.** Channel Mid

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
6797.82	Peak	-58.79	-46.99	11.80	PASS
12574.51	Peak	-62.01	-46.99	15.02	PASS

**Table 10.** Channel High

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
6351.84	Peak	-57.62	-46.99	10.63	PASS
12510.51	Peak	-59.51	-46.99	12.52	PASS

**LIST OF TEST EQUIPMENT**

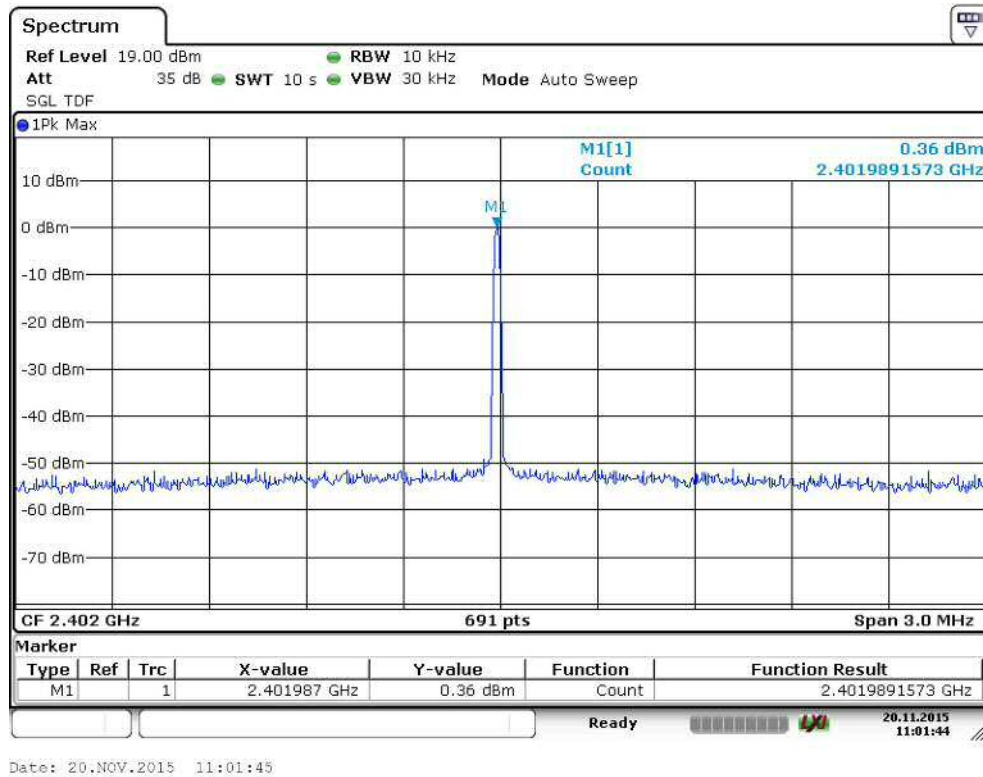
Type	Manufacturer	Model	Serial No.	Inv. No.
Attenuator 10dB	Huber-+ Suhner	6810.17B	-	-
Spectrum analyzer	Rohde&Schwarz	FSV40	101068	9093
Frequency standard	Pendulum	GPS-88	SM 968615	-

All used measurement equipment was calibrated (if required).

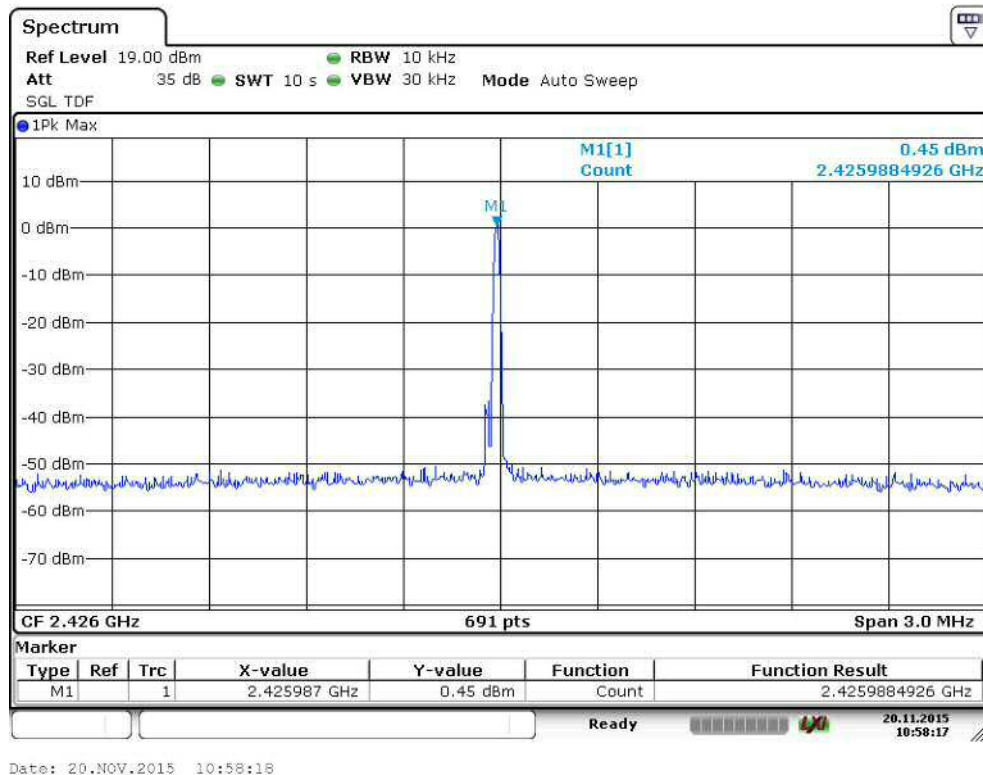
# ANNEX A

## Graphical data

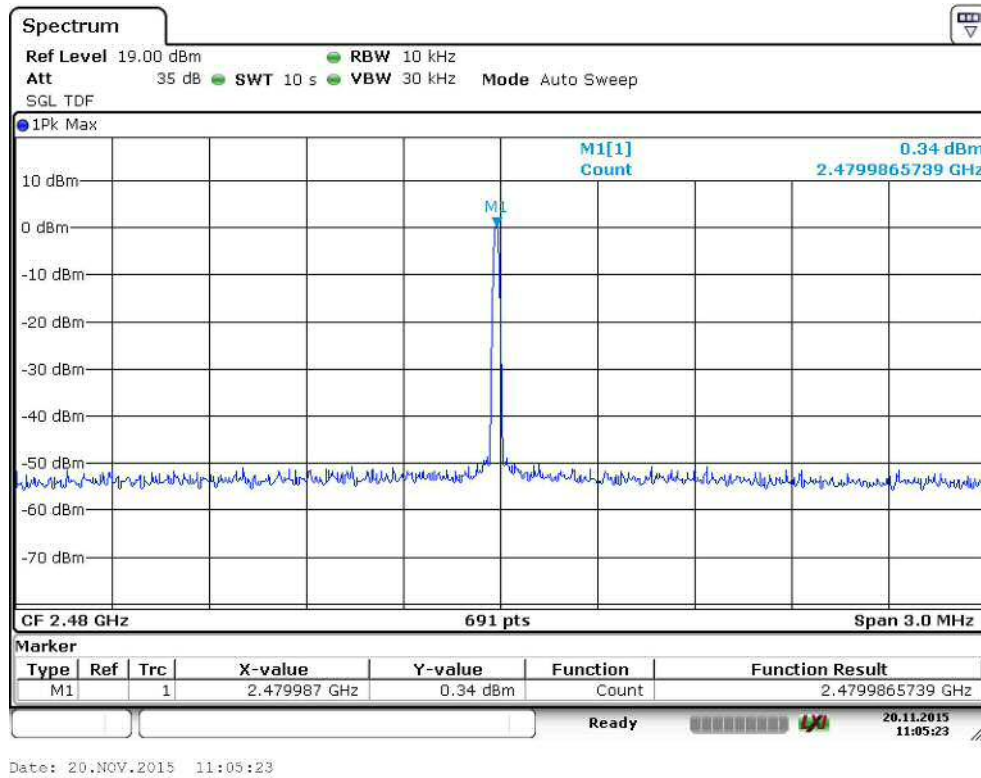
This annex contains the graphical data recorded during the tests and the pictures of the EUT.



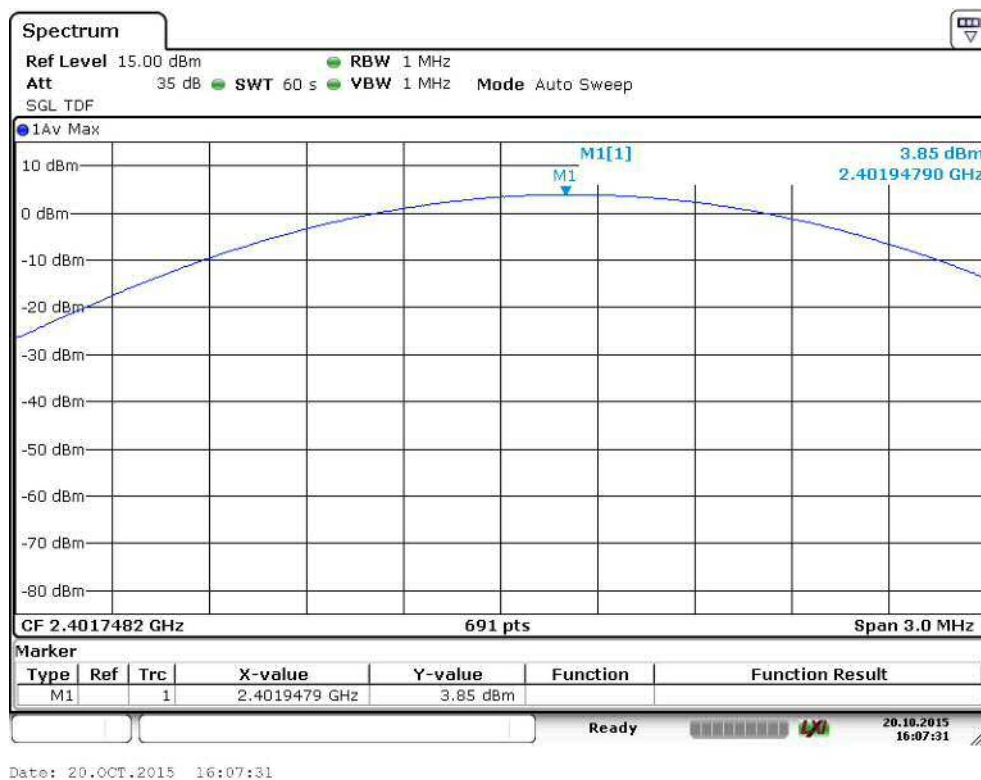
Graph 1. Frequency Tolerance Channel Low.



Graph 2. Frequency Tolerance Channel Mid.



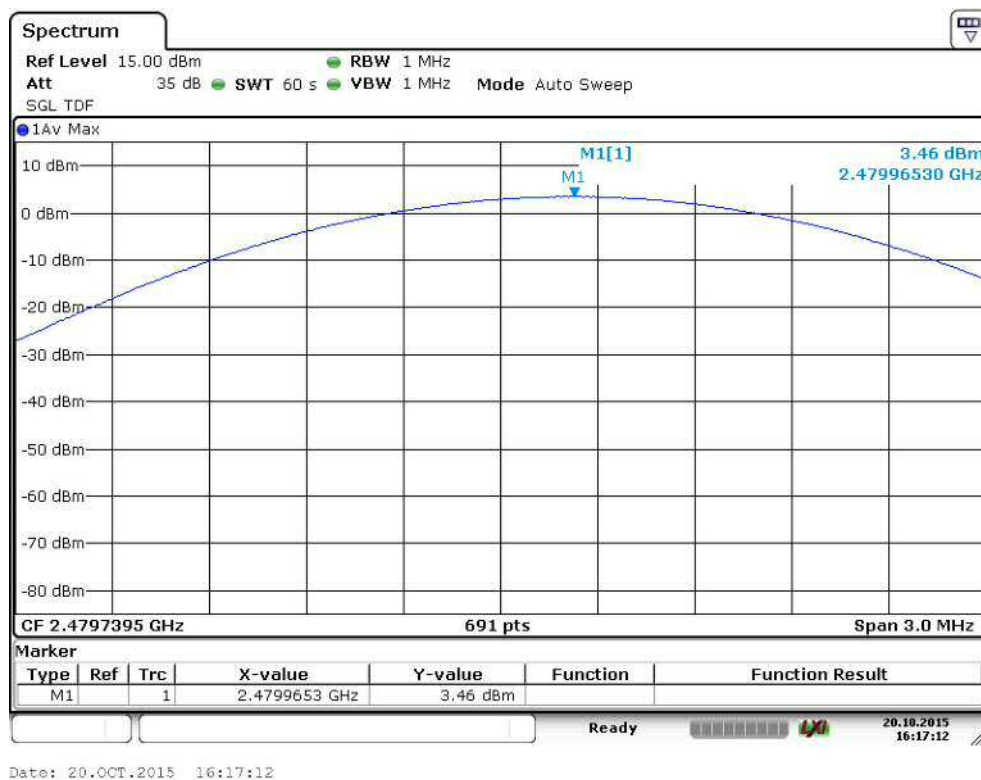
Graph 3. Frequency Tolerance Channel High.



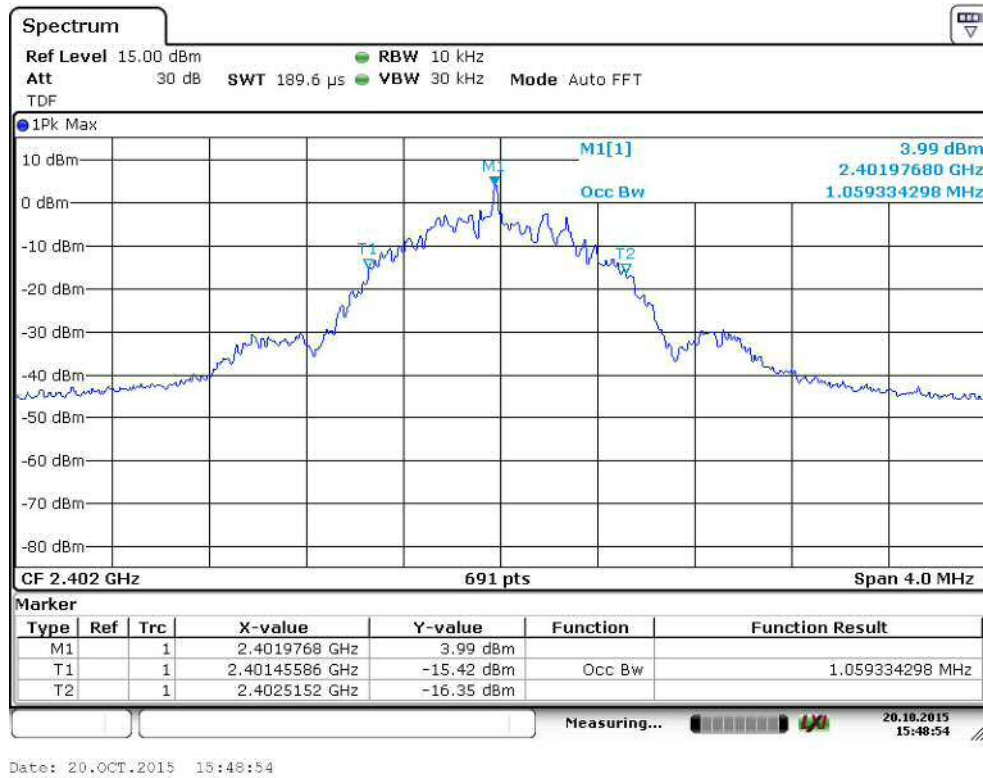
Graph 4. Antenna Power Channel Low.



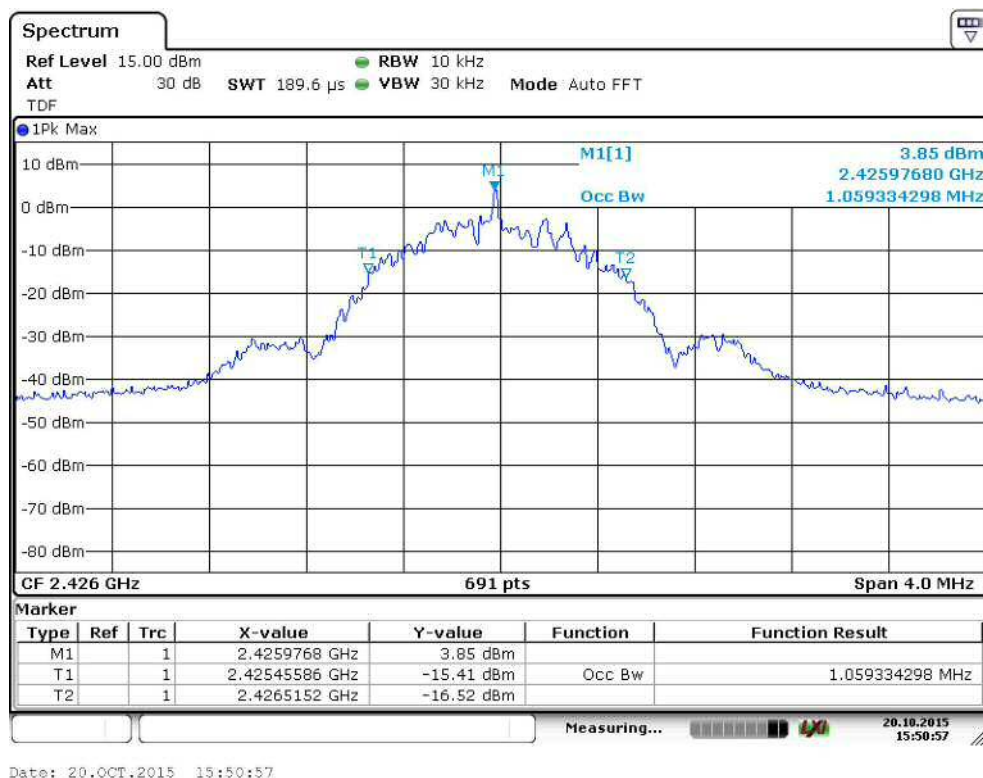
**Graph 5.** Antenna Power Channel Mid.



**Graph 6.** Antenna Power Channel High.

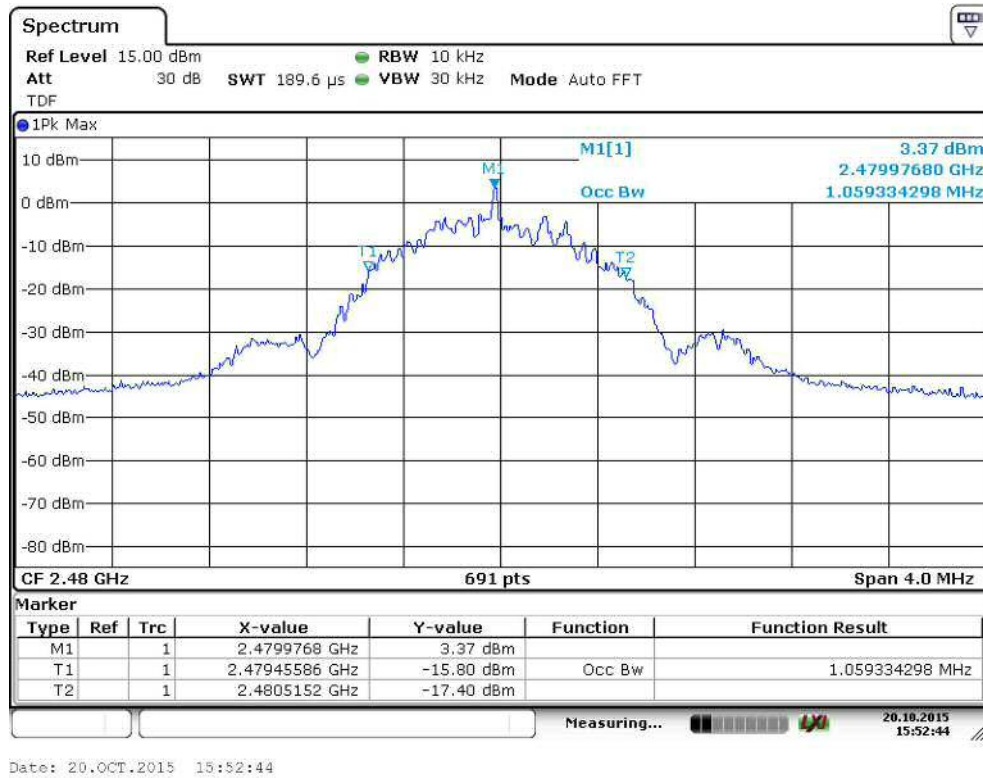


Graph 7. 99% Occupied Bandwidth Channel Low.

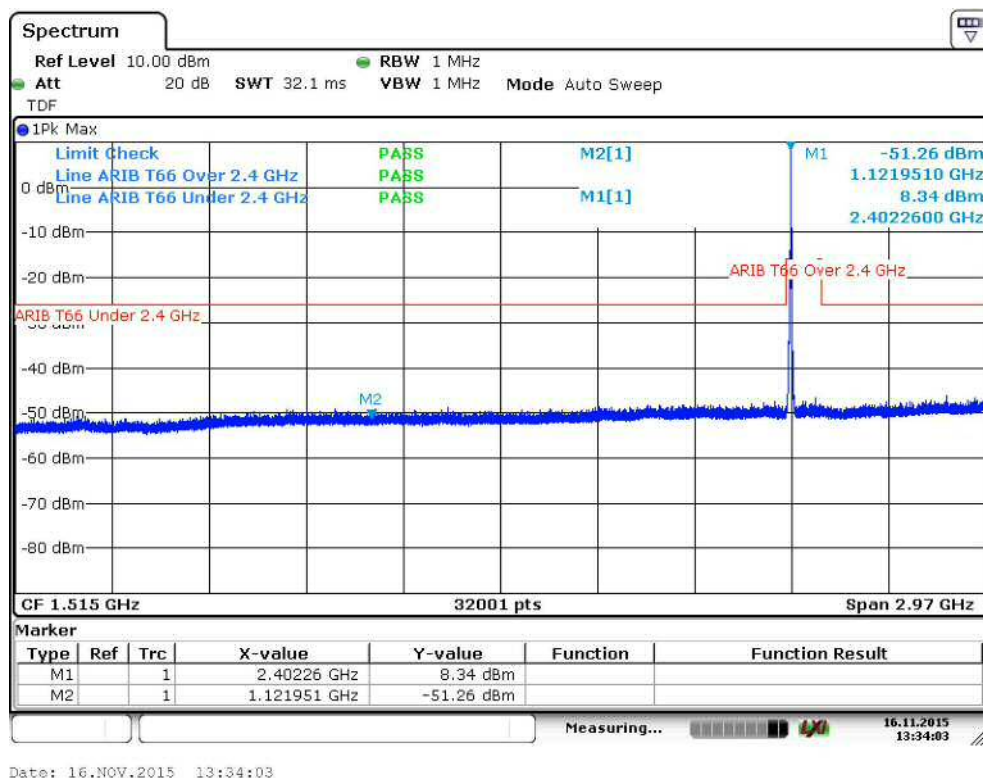


Graph 8. 99% Occupied Bandwidth Channel Mid.

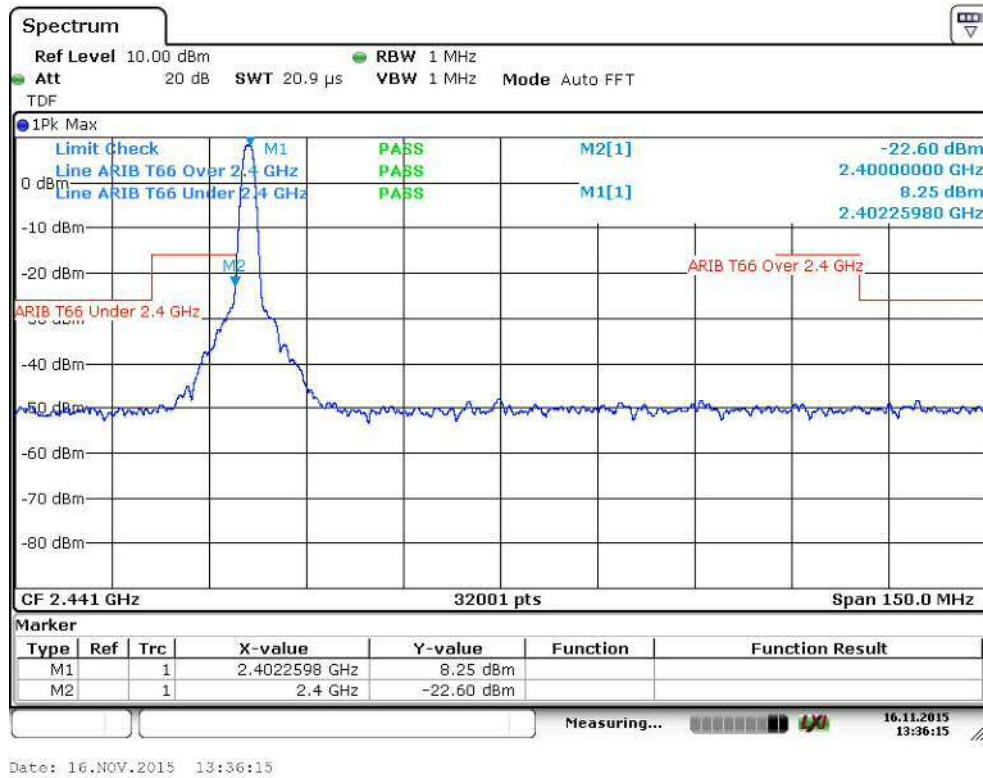




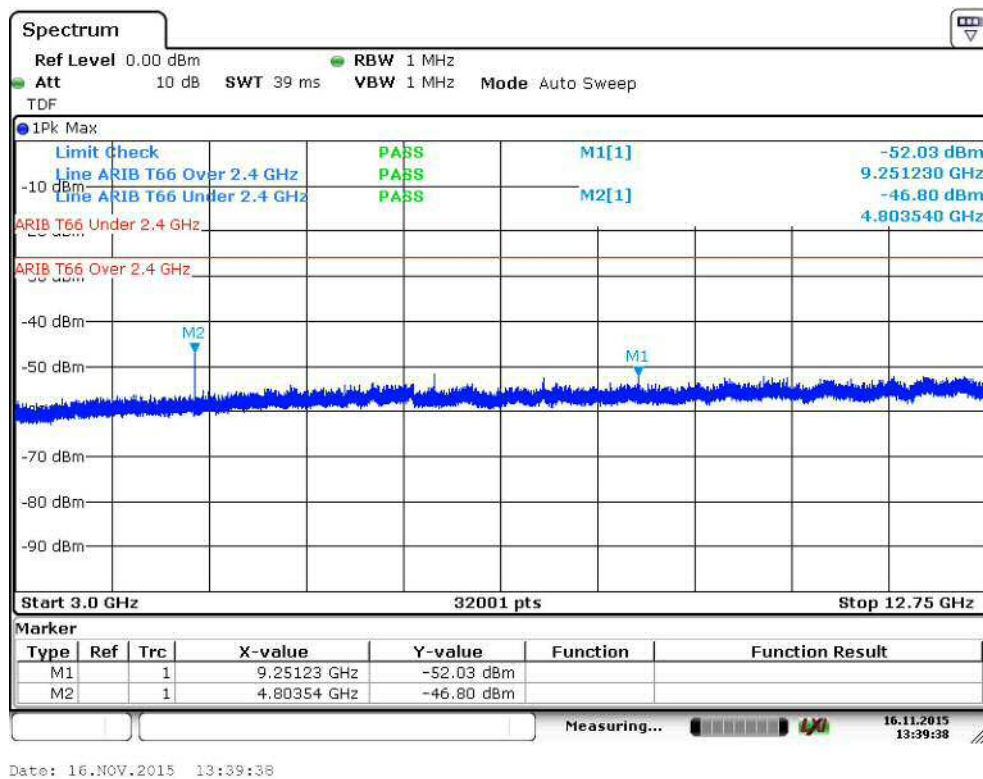
**Graph 9.** 99% Occupied Bandwidth Channel High.



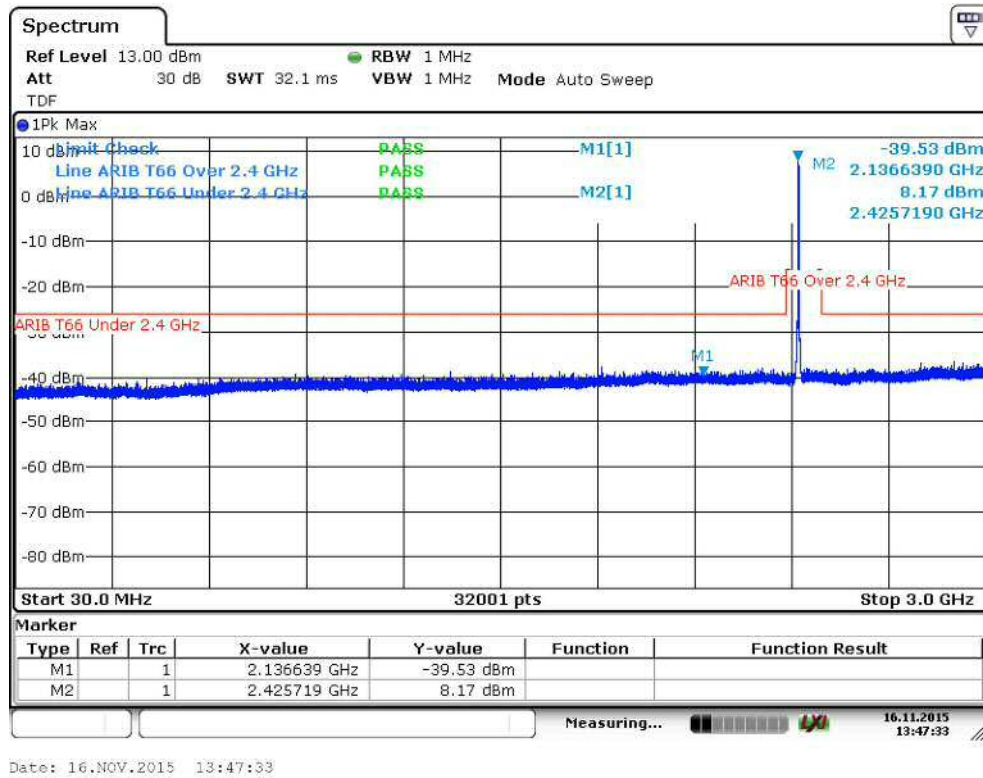
**Graph 10.** Tx Spurious Emissions Channel Low 30 – 3000 MHz.



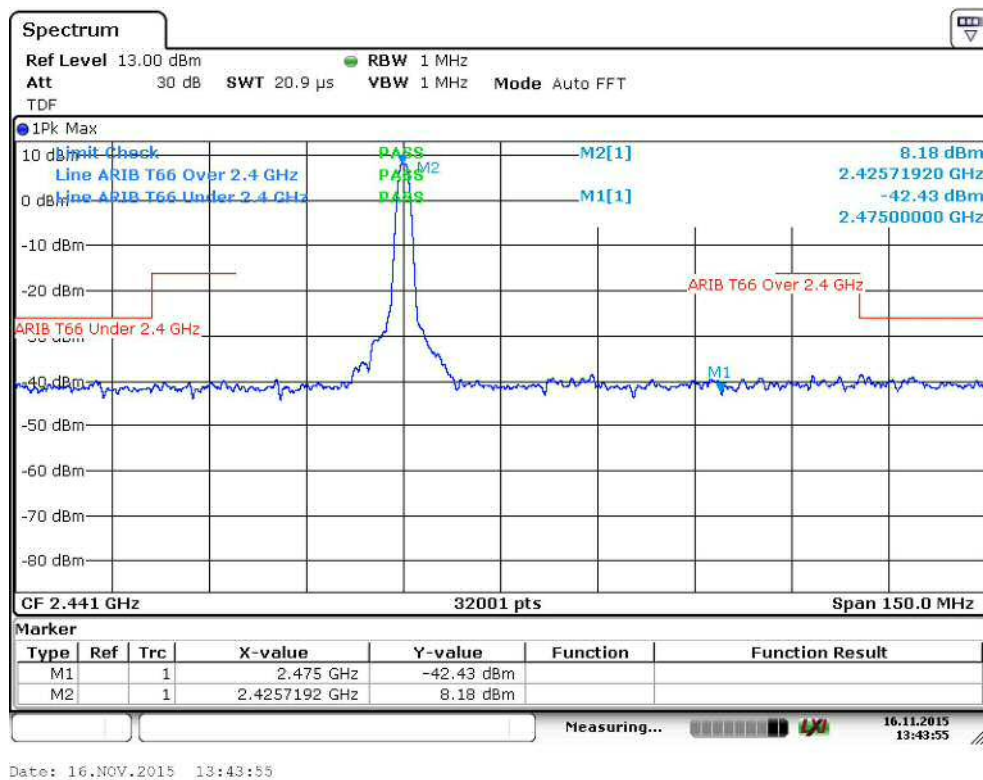
**Graph 11.** Tx spurious Emissions Channel Low 2.4 GHz.



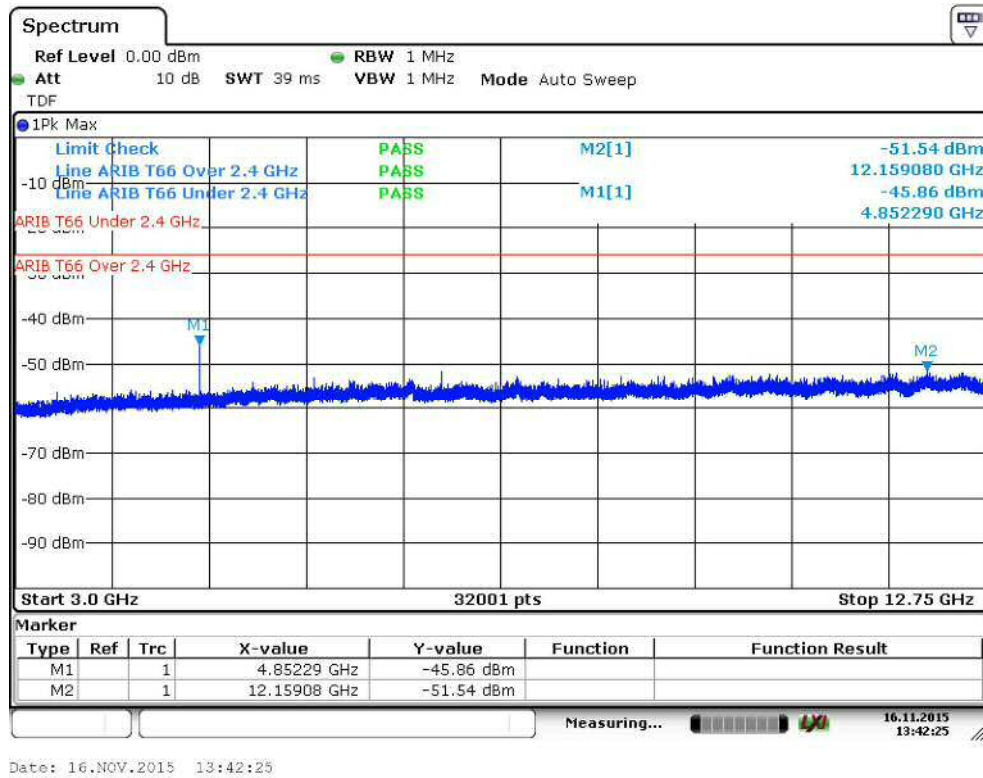
**Graph 12.** Tx Spurious Emissions Channel Low 3.0 – 12.75 GHz.



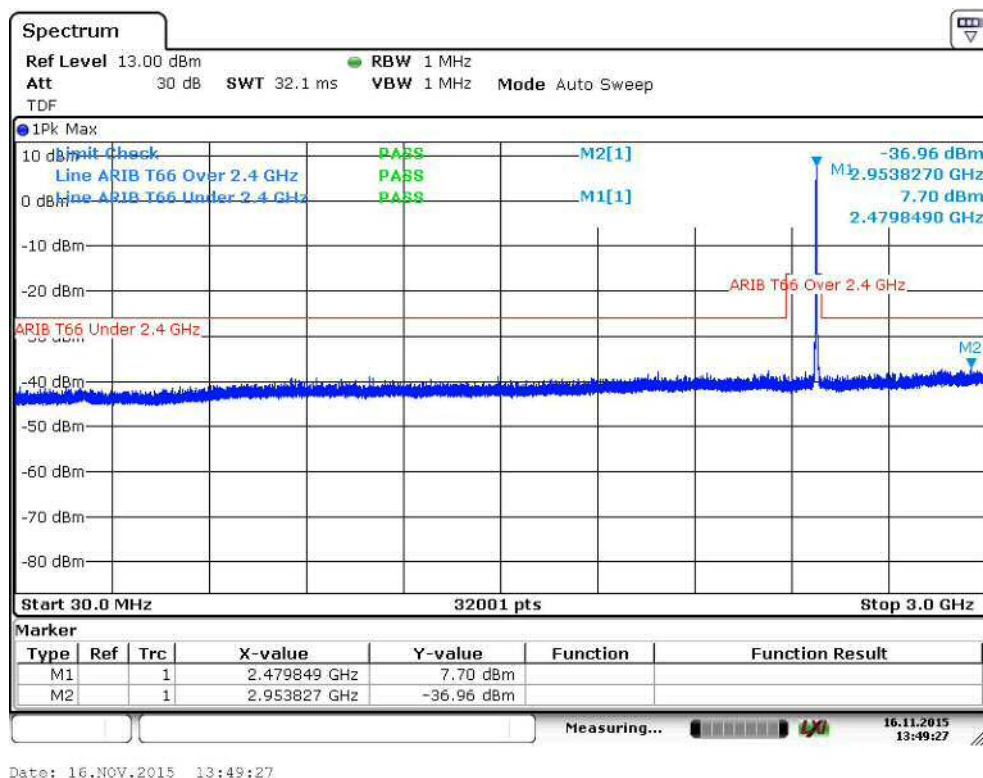
**Graph 13.** Tx Spurious Emissions Channel Mid 30 – 3000 MHz.



**Graph 14.** Tx spurious Emissions Channel Mid 2.4 GHz.

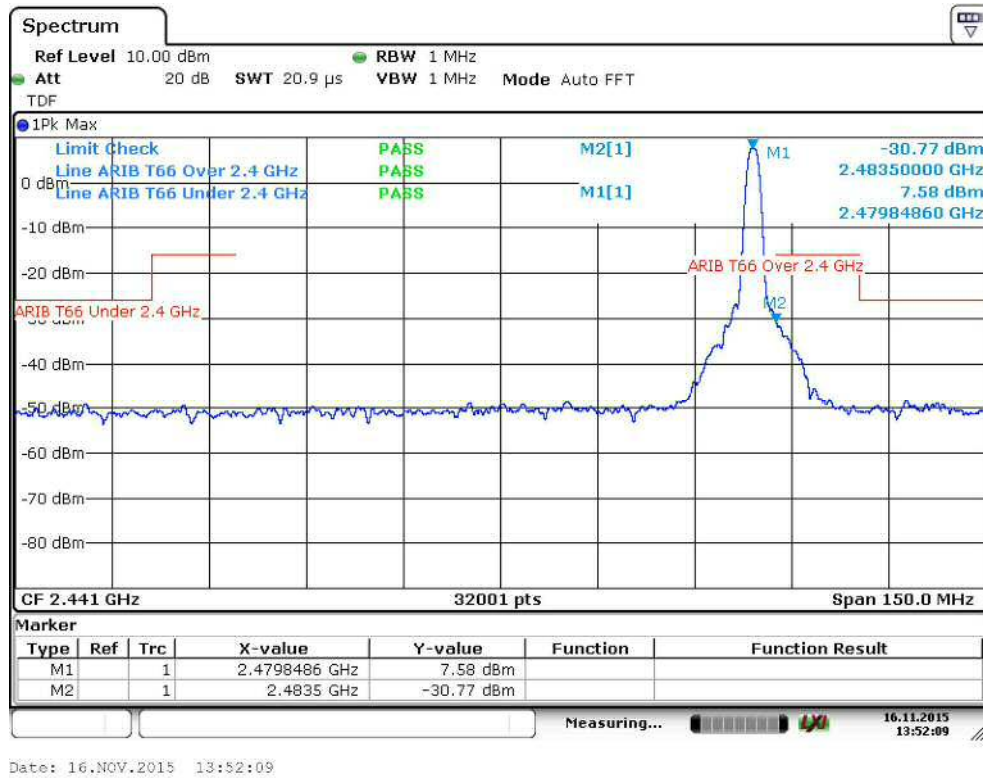


**Graph 15.** Tx Spurious Emissions Channel Mid 3 – 12.75 GHz

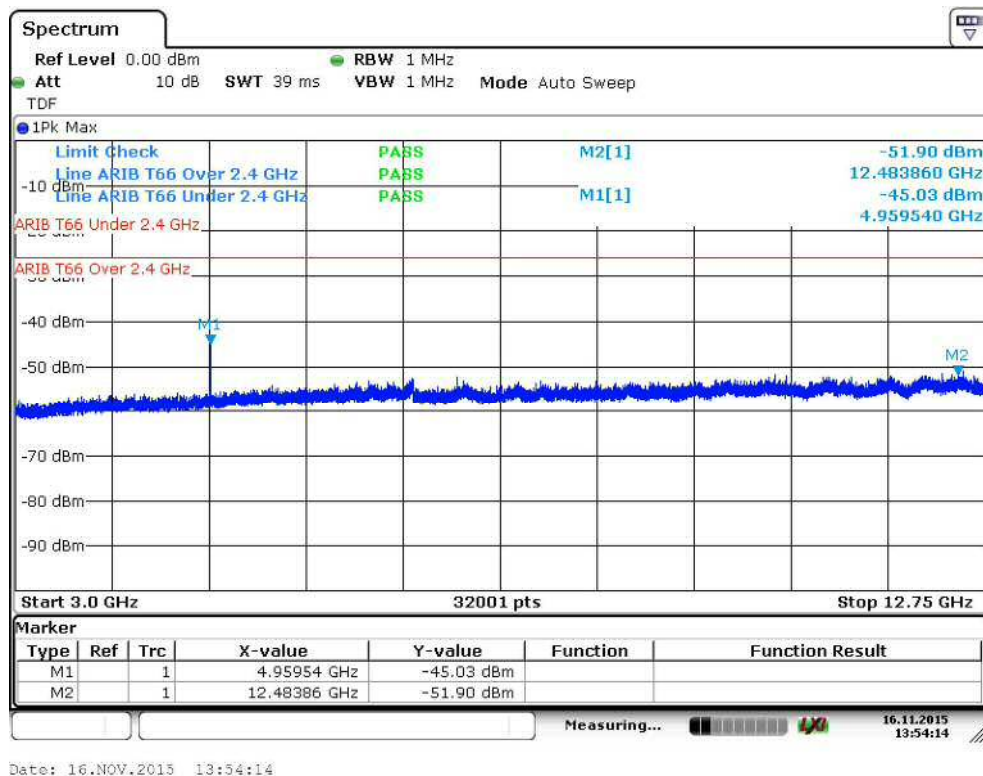


**Graph 16.** Tx Spurious Emissions Channel High 30 MHz – 3000 MHz.

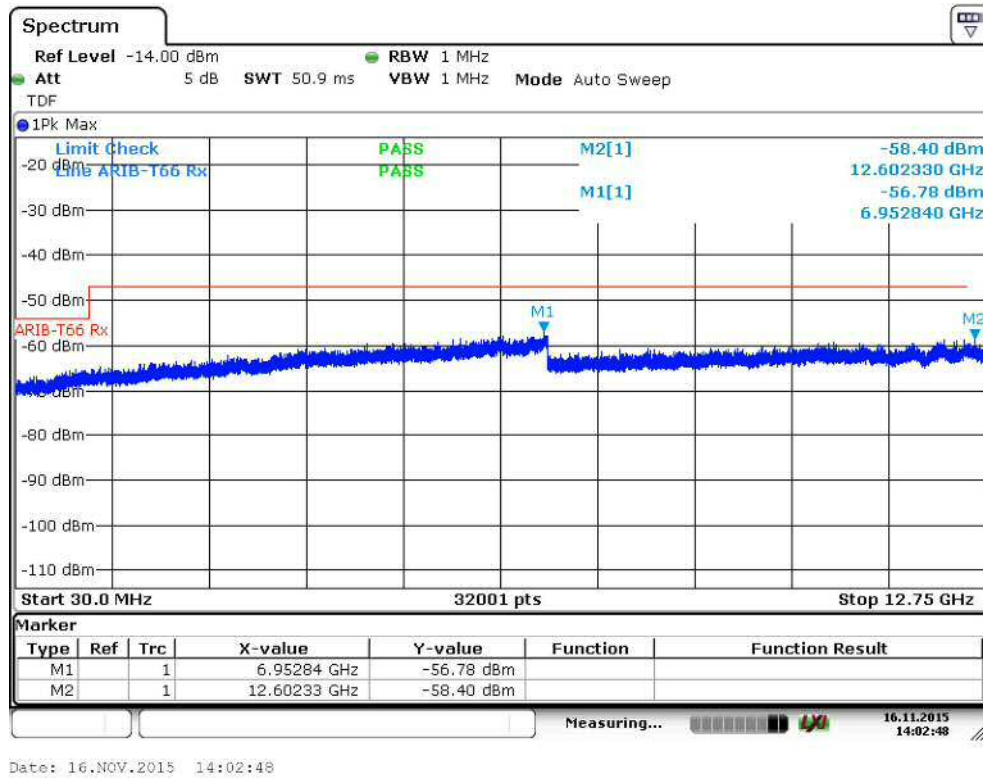




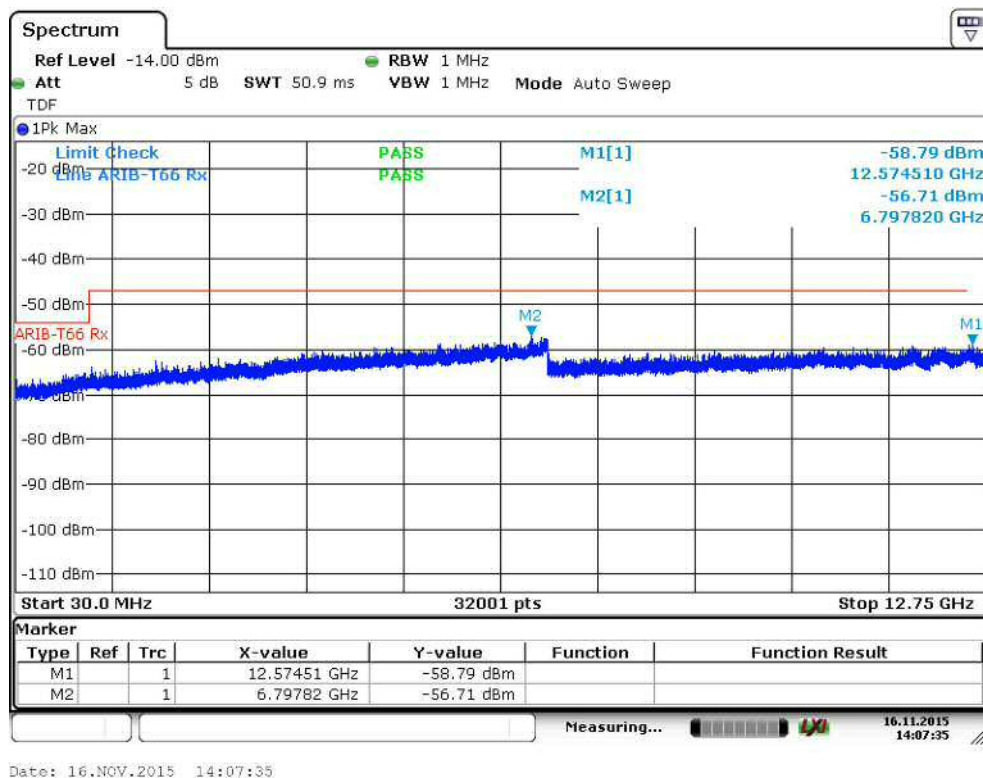
**Graph 17.** Tx Spurious Emissions Channel High 2.4 GHz.



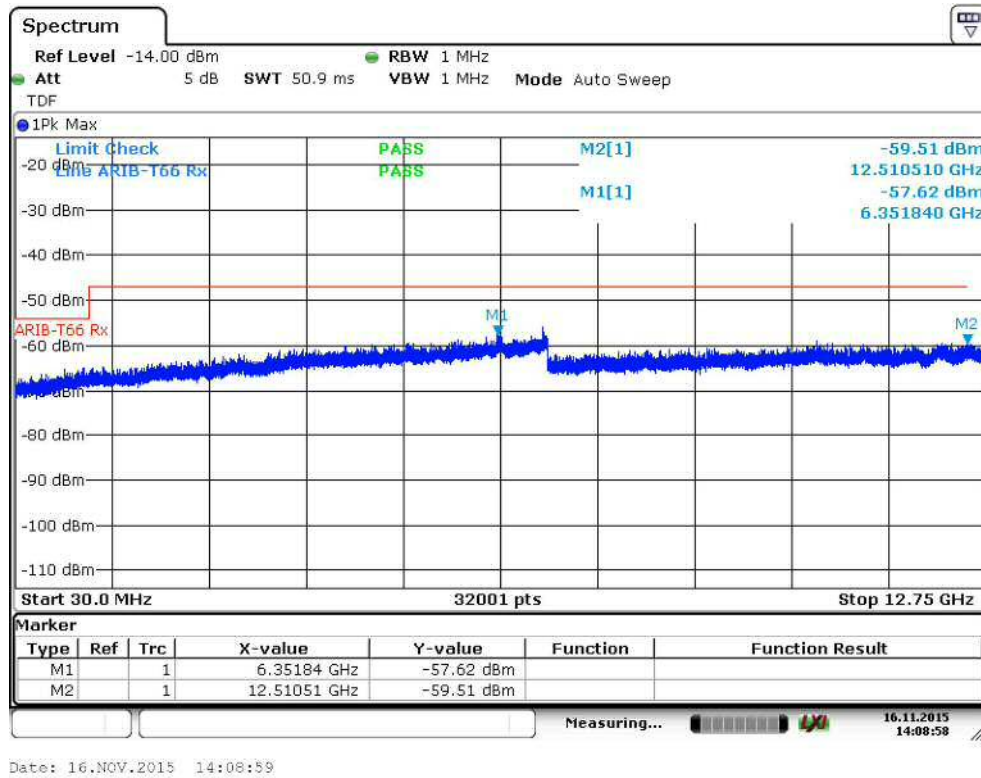
**Graph 18.** Tx Spurious Emissions Channel High 3 – 12.75 GHz.



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



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



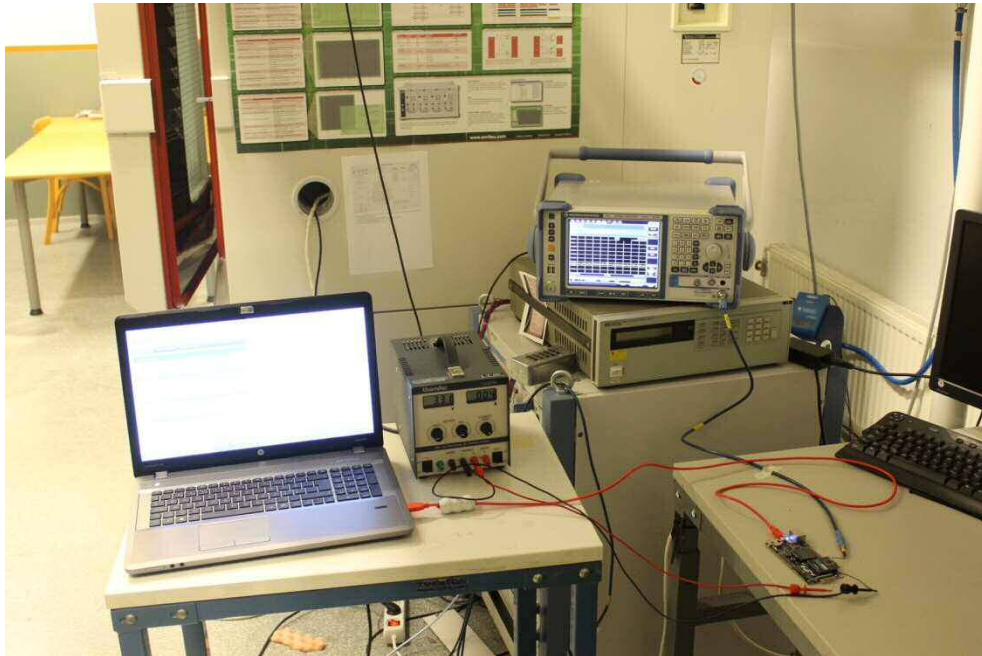
**Graph 21.** Rx Spurious Emissions Channel High 30 MHz – 12.75 GHz.

# **ANNEX B**

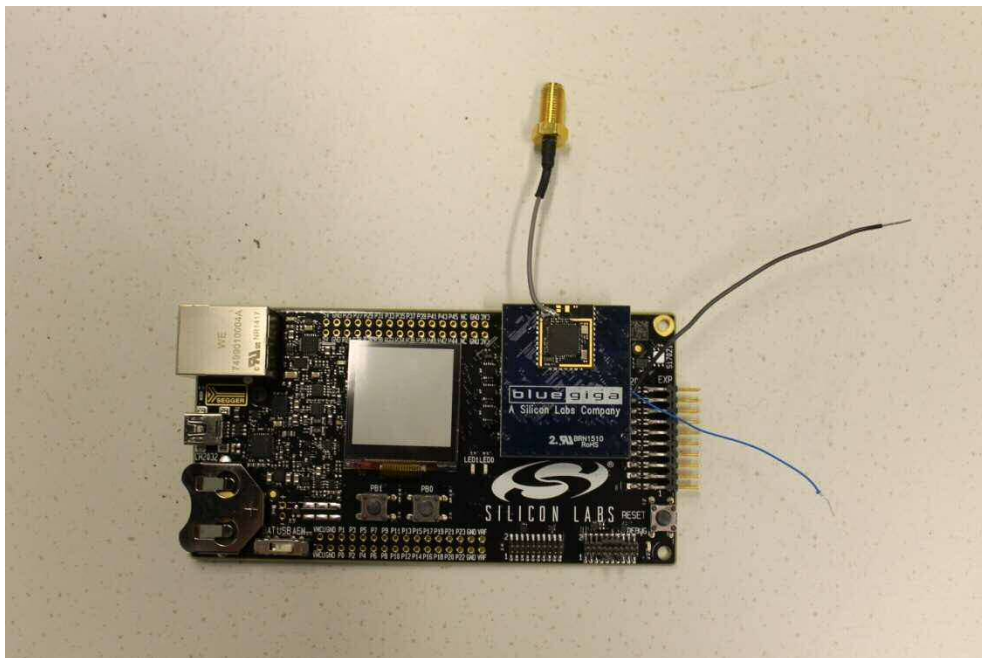


## Photographs

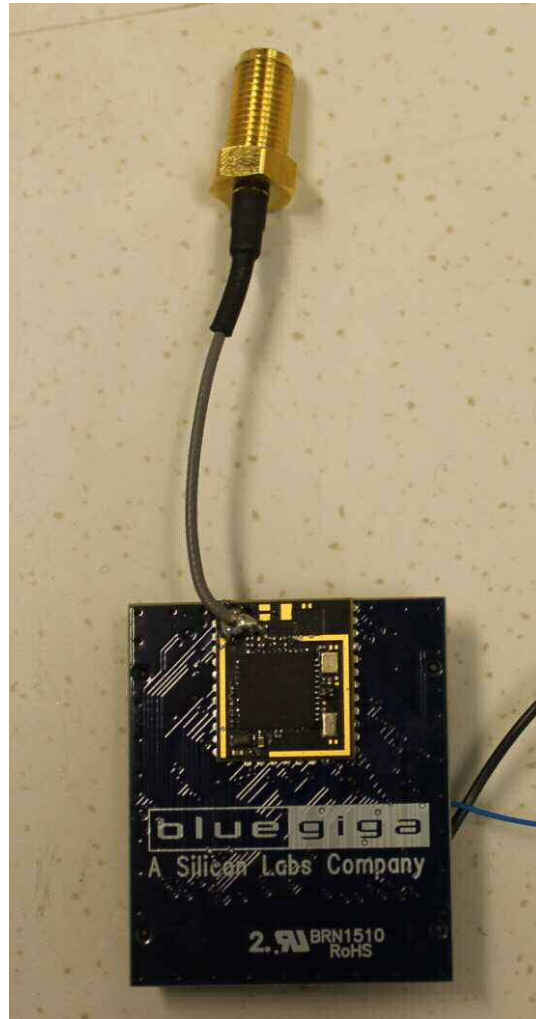
This annex contains the photographs of the EUT and test setup.



**Photograph 1.** Test setup.



**Photograph 2.** The EUT attached to the evaluation board.



**Photograph 3.** The EUT.