

Test Report

INTENTIONAL RADIATOR TESTS ACCORDING TO ARIB STD-T66 REQUIREMENTS

Equipment Under Test: Bluetooth Smart Module

Model: BGM111E

Brand: Silicon Labs

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

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

Date: 30 September 2016

Issued by:



Emil Haverinen
Testing Engineer

Date: 30 September 2016

Checked by:



Rauno Repo
Testing Engineer

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Equipment Under Test (EUT)

Brand:	Silicon Labs
Model:	BGM111E
Type:	Bluetooth Smart Module
Serial no:	-
HW version:	-
SW version:	-

Description of the EUT

BGM111E is a Bluetooth 4.1 compliant Bluetooth smart beacon module with RF connector.

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:	3.85 mW
Modulation:	GFSK
Antenna gain:	2.0 dBi

Power Supply

The BGM111E 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 was made with 3.3 VDC supply 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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SUMMARY OF TESTING

Description of Test	Result
Antenna power, tolerances for antenna power	PASS
Frequency tolerance	N/T
Occupied Bandwidth (99%)	N/T
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 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.

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 1) = 2402 MHz

Channel MID (CH 20) = 2442 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:	EHA	
Date:	30.9.2016	
Temperature:	23 °C	
Humidity:	40 % RH	
Measurement uncertainty	± 0.49 dB	Level of confidence 95 % (k = 2)
Limits:	Antenna Power: 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 for final antenna power measurements. 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	3.70	2.34	10	7.66	PASS
Mid	3.26	2.12	10	7.88	PASS
High	2.74	1.88	10	8.12	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	0.77	4.62	3.70	-3.89	PASS
Mid	3.85	0.77	4.62	3.26	-15.32	PASS
High	3.85	0.77	4.62	2.74	-28.83	PASS

Power tolerance is calculated by using the following formula:

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

Table 3. EIRP evaluation

Antenna Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP= Antenna Power (dBm) + Antenna Gain (dBi)
3.70	2.0	5.70	

Antenna gain and beamwidth measurements are not required because the EIRP power is less than 12.14 dBm.

Transmission Spurious Emissions

Standard:	EN 300 328
Limit:	ARIB-T66
Tested by:	EHA
Date:	29.9.2016
Temperature:	23 °C
Humidity:	47 % RH
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 4. Channel low

Frequency [MHz]	Detector	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dBm/MHz]	Result
2399.99	Peak	-25.230	-16.02	9.21	PASS
4803.63	Peak	-39.156	-26.02	13.136	PASS
12483.48	Peak	-39.656	-26.02	13.636	PASS

Table 5. Channel mid

Frequency [MHz]	Detector	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dBm/MHz]	Result
4883.520	Peak	-39.052	-26.02	13.032	PASS
11824.850	Peak	-39.449	-26.02	13.429	PASS
12531.980	Peak	-38.007	-26.02	11.987	PASS

Table 6. Channel high

Frequency [MHz]	Detector	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dBm/MHz]	Result
4959.840	Peak	-38.444	-26.02	12.424	PASS
11819.280	Peak	-39.507	-26.02	13.487	PASS
12499.780	Peak	-39.102	-26.02	13.082	PASS

Receiver Spurious Emissions

Limitation of Collateral Emission of Receiver

Standard:	EN 300 328
Limit:	ARIB-T66
Tested by:	EHA
Date:	29.9.2016
Temperature:	23 °C
Humidity:	47 % RH
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 7. Channel Low

Frequency (MHz)	Detector	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dBm/MHz]	Result
6960.550	Peak	-73.42	-46.99	26.43	PASS

Table 8. Channel Mid

Frequency (MHz)	Detector	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dBm/MHz]	Result
6988.090	Peak	-73.69	-46.99	26.70	PASS

Table 9. Channel High

Frequency (MHz)	Detector	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dBm/MHz]	Result
6972.670	Peak	-73.23	-46.99	26.24	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

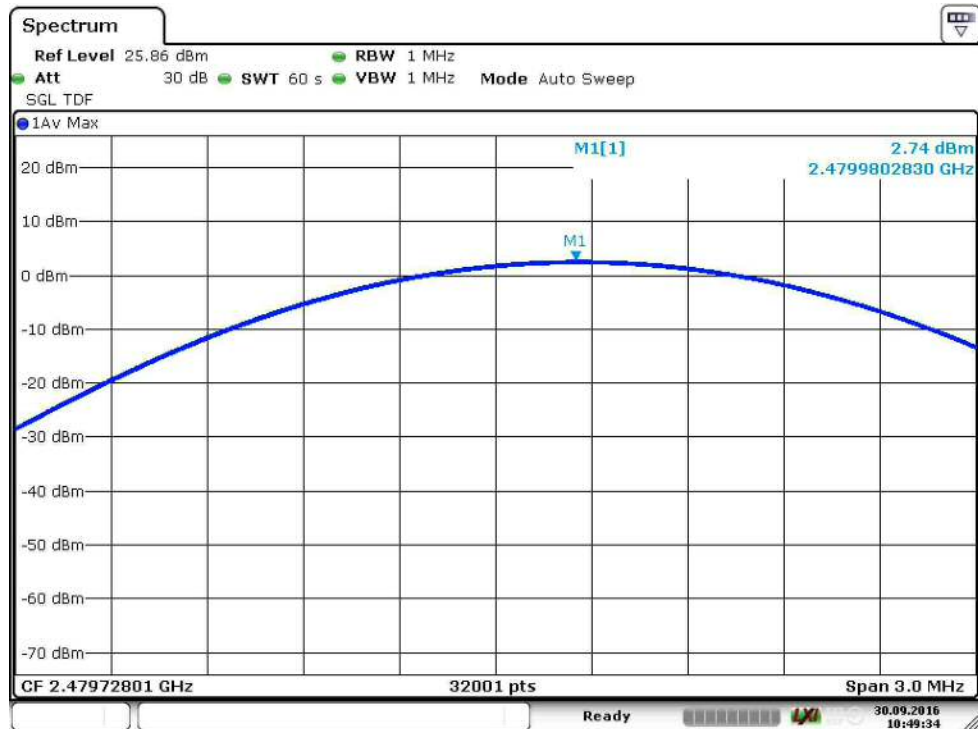
This annex contains the graphical data recorded during the tests and the pictures of the EUT.



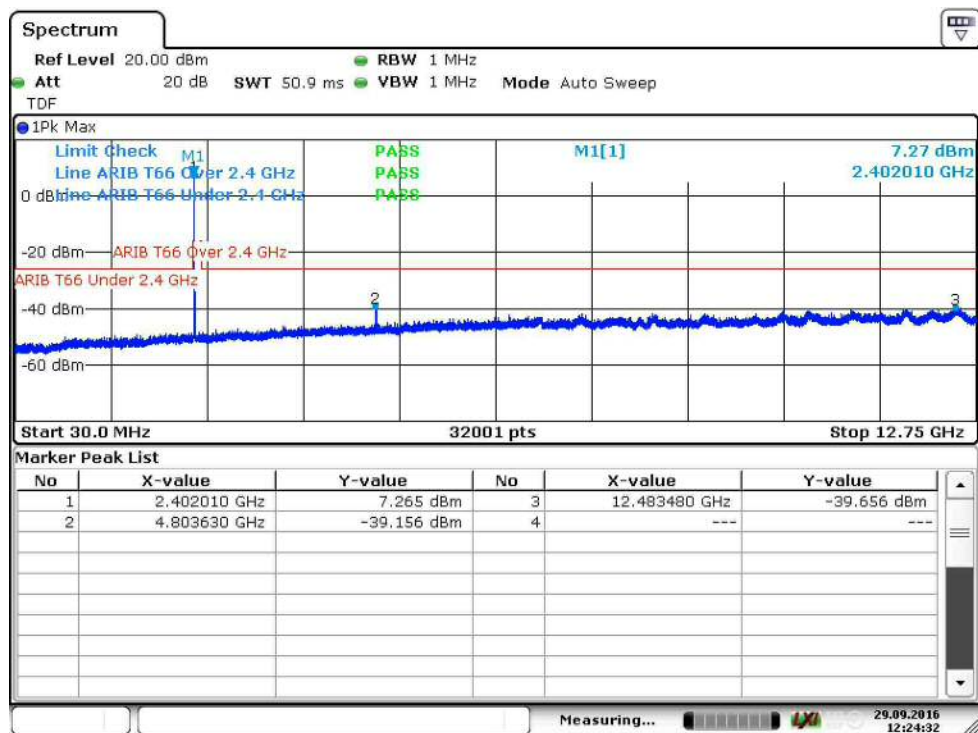
Graph 1. Antenna Power Channel Low



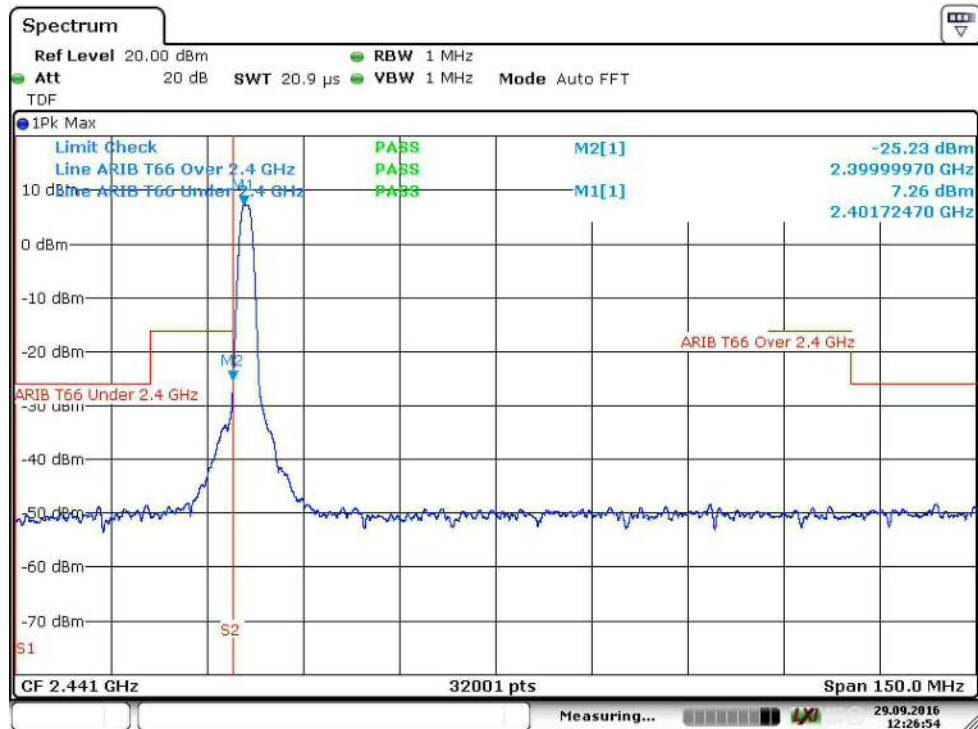
Graph 2. Antenna Power Channel Mid



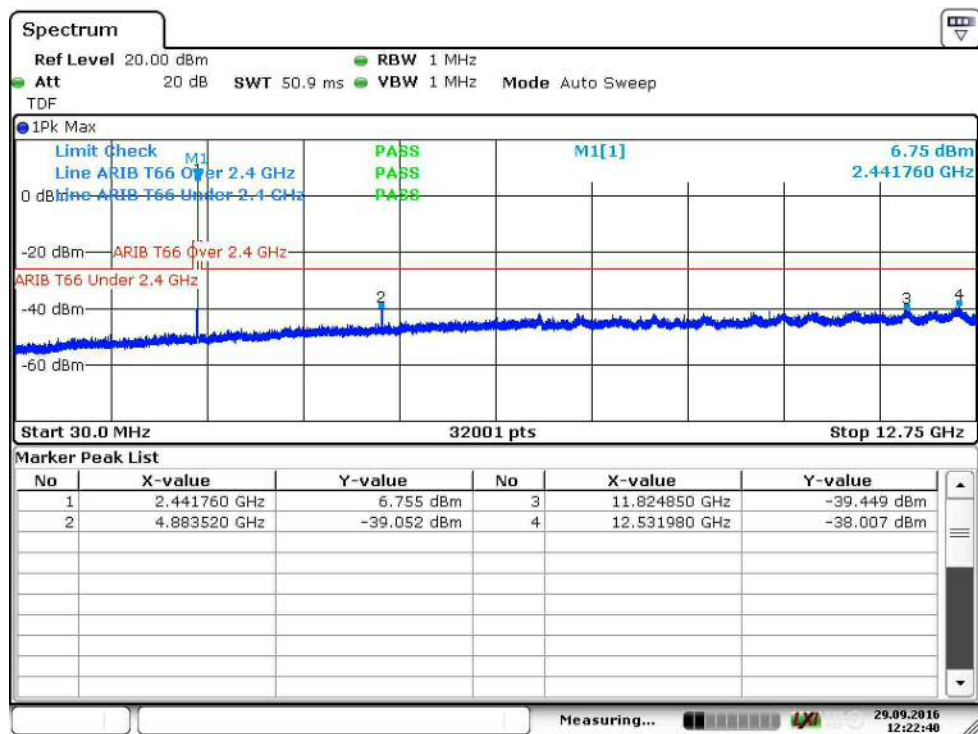
Graph 3. Antenna Power Channel High



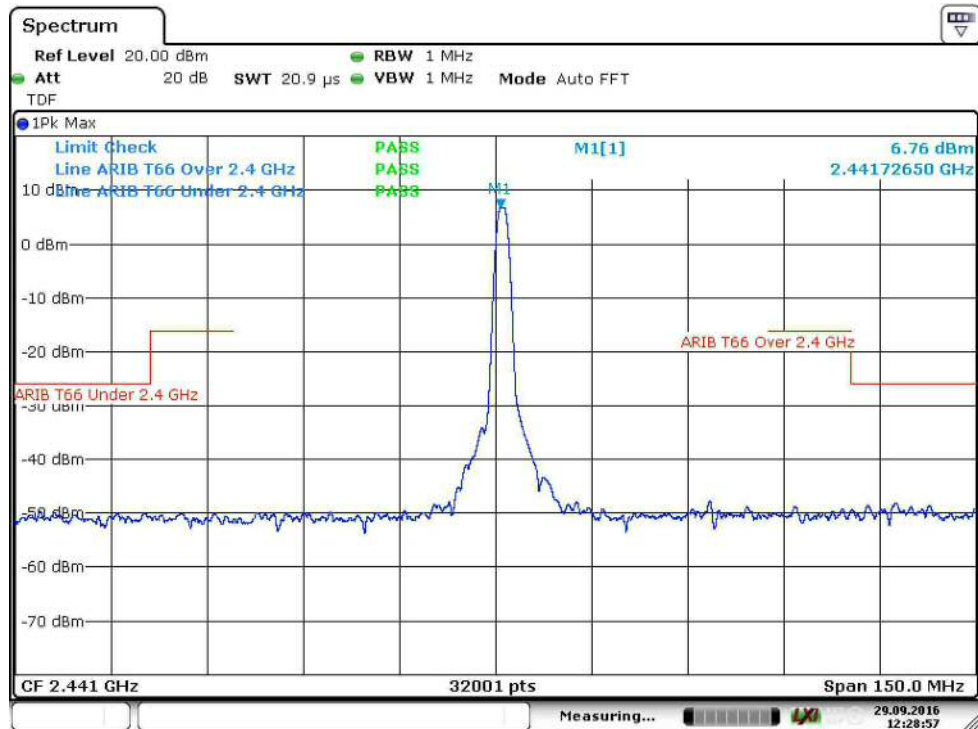
Graph 4. Tx Spurious Emissions Channel Low 30 - 12750 MHz



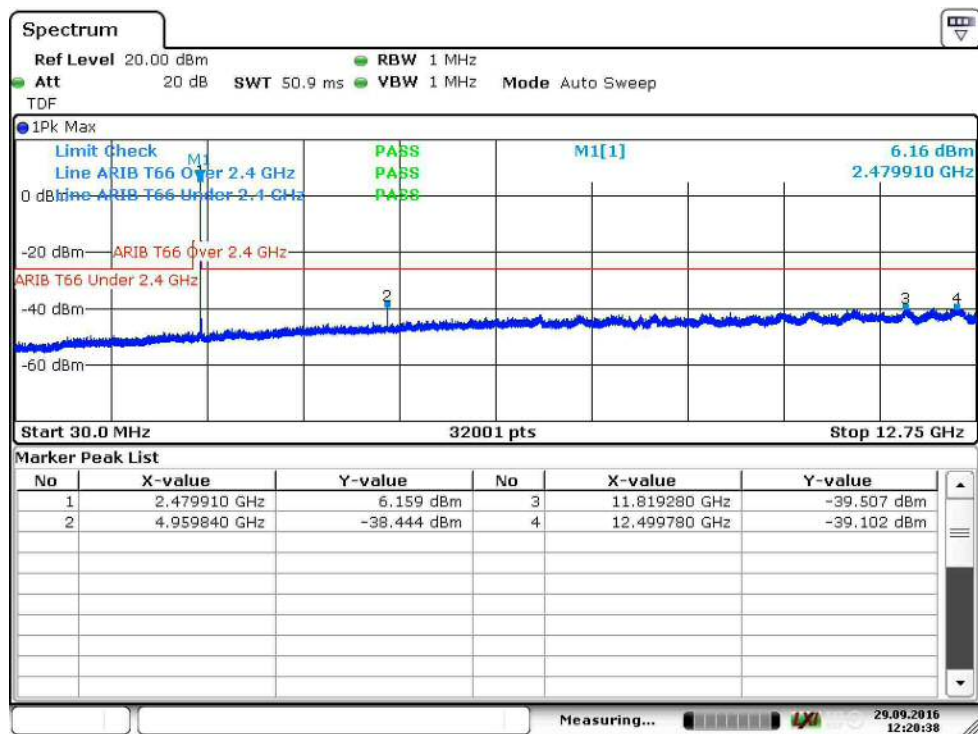
Graph 5. Tx spurious Emissions Channel Low 2.4 GHz



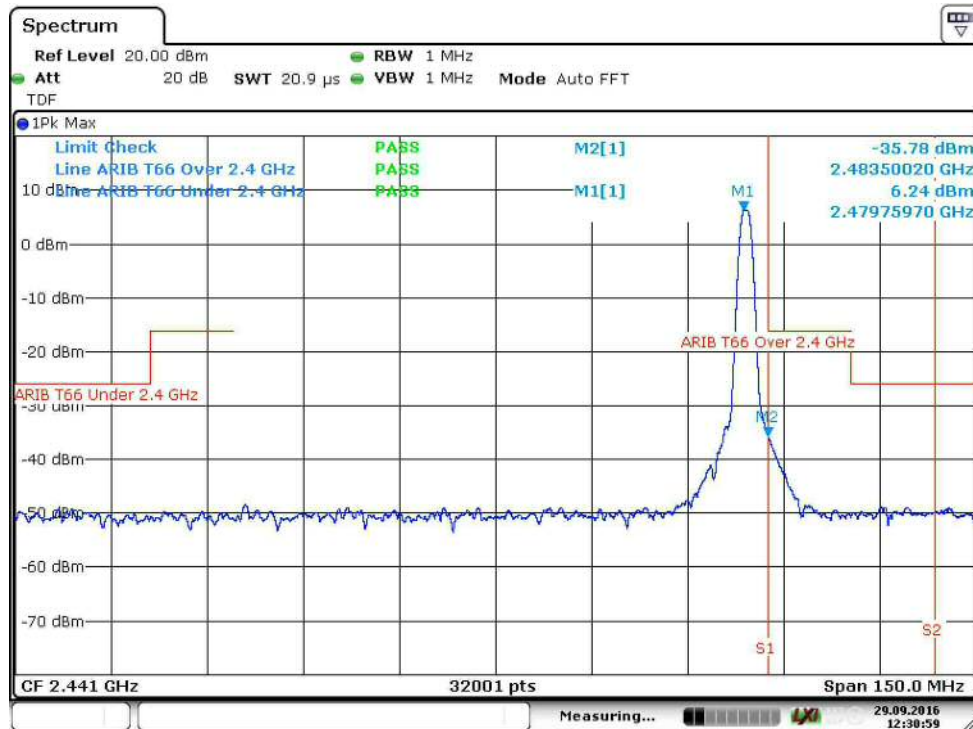
Graph 6. Tx Spurious Emissions Channel Mid 30 - 12750 MHz



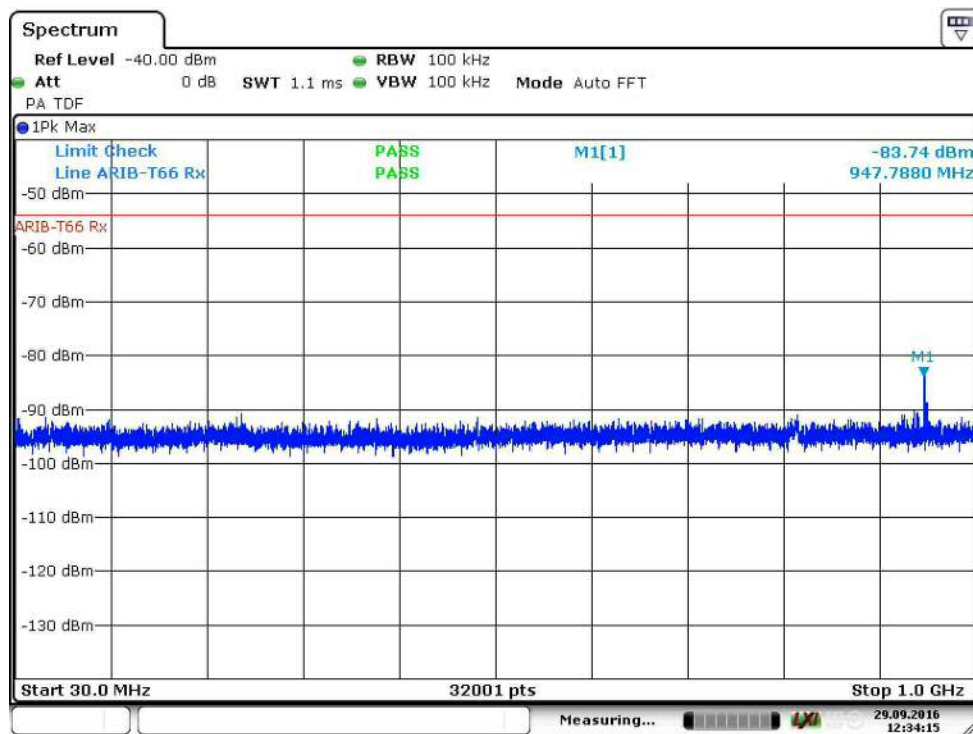
Graph 7. Tx spurious Emissions Channel Mid 2.4 GHz



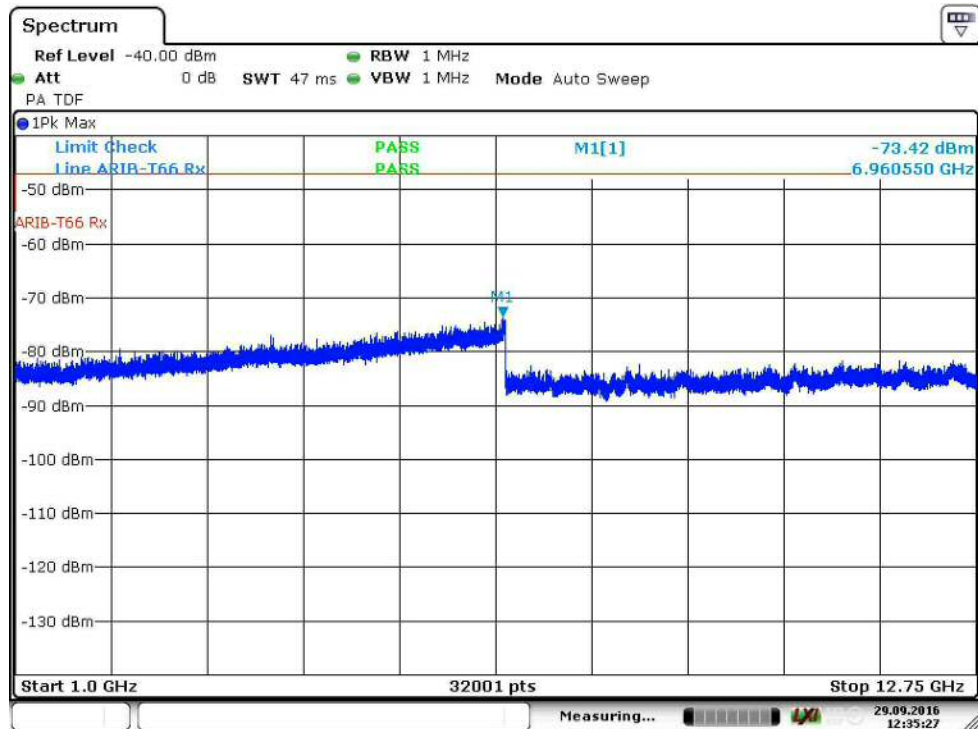
Graph 8. Tx Spurious Emissions Channel High 30 - 12750 MHz



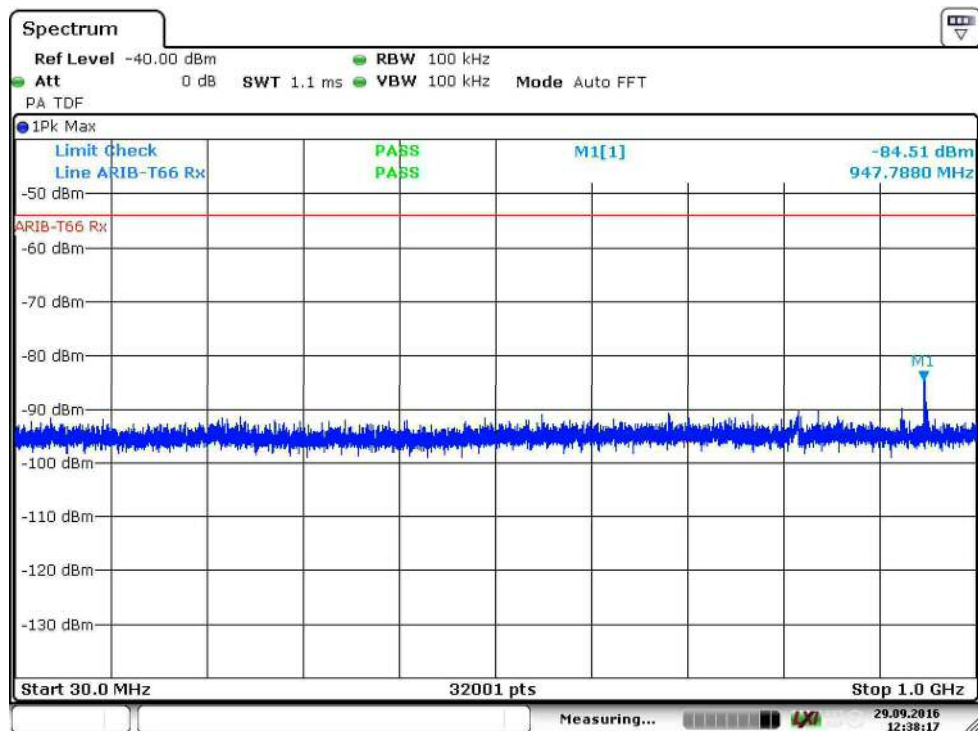
Graph 9. Tx Spurious Emissions Channel High 2.4 GHz



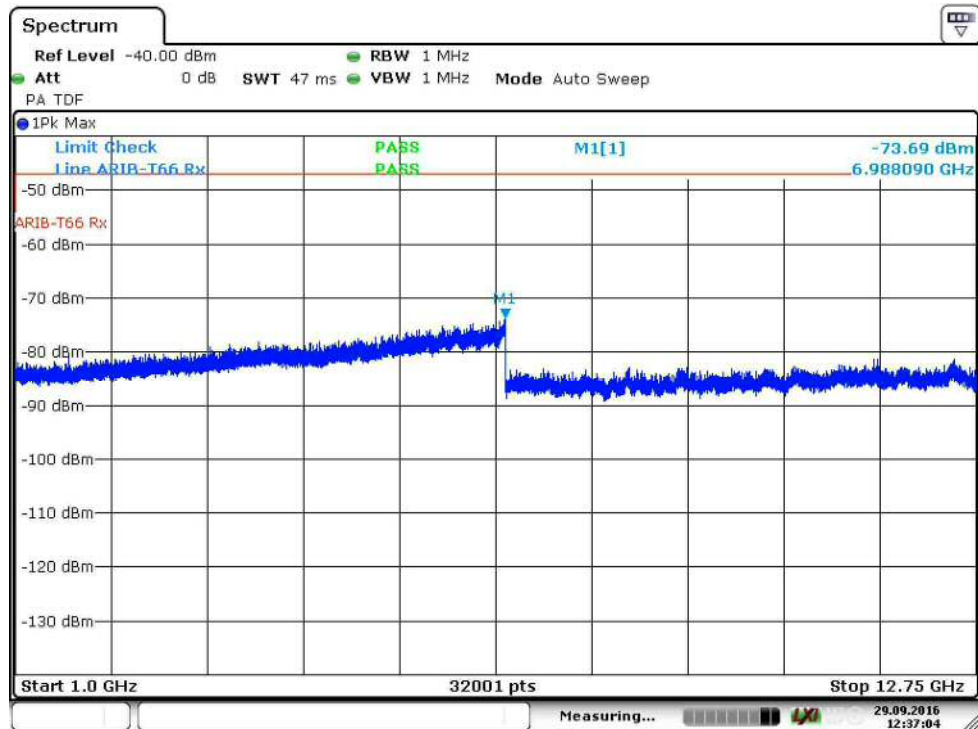
Graph 10. Rx Spurious Emissions Channel Low 30 MHz - 1 GHz



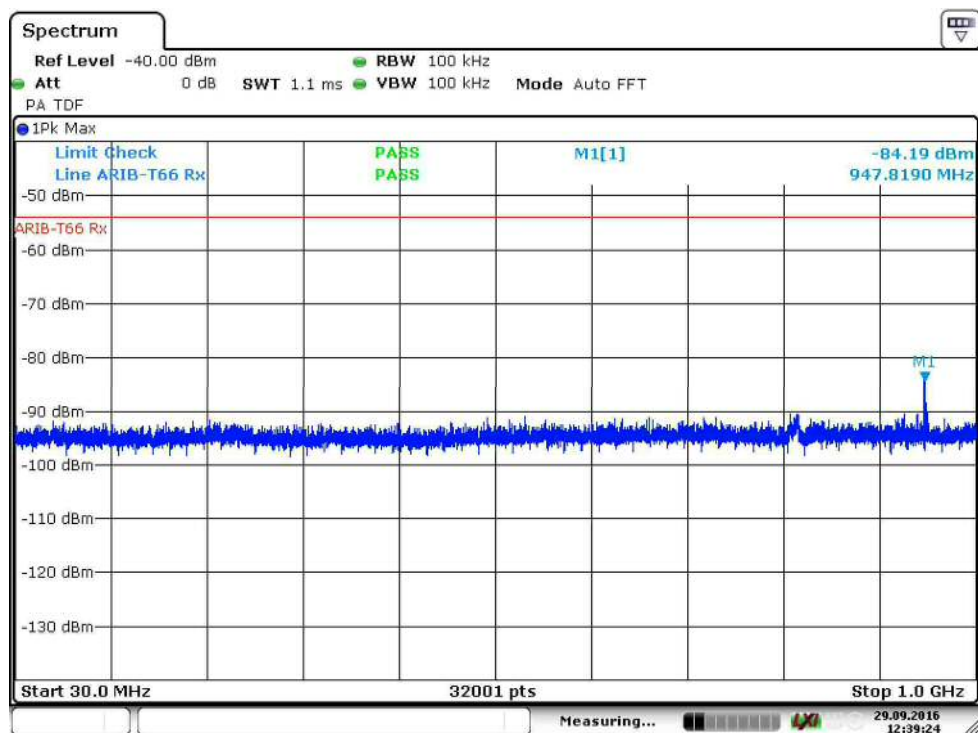
Graph 11. Rx Spurious Emissions Channel Low 1 - 12.75 GHz



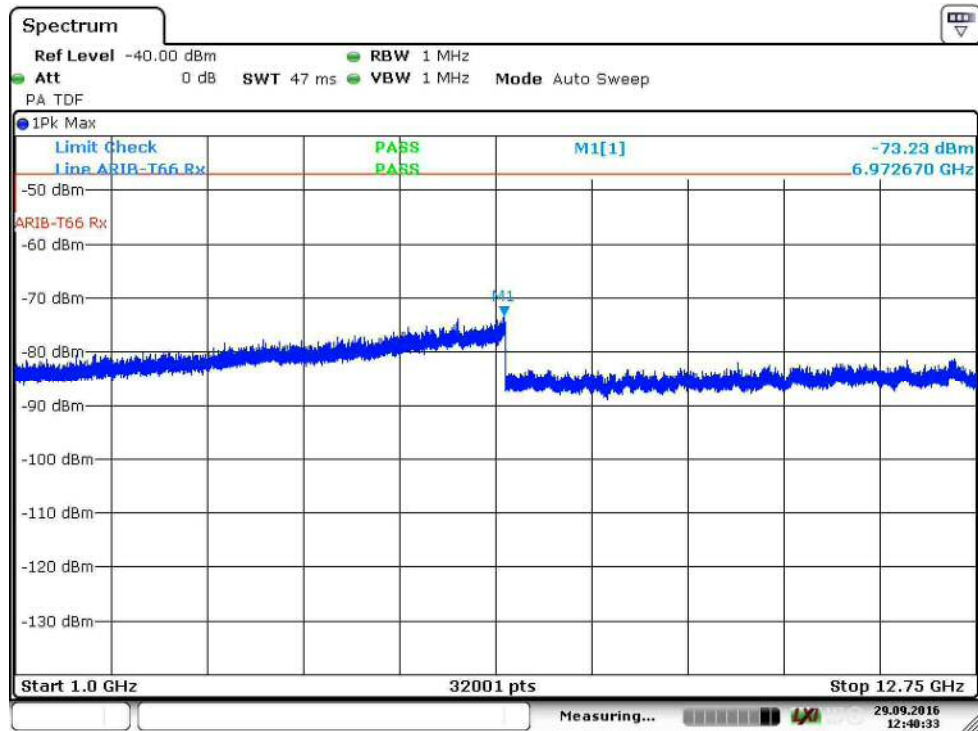
Graph 12. Rx Spurious Emissions Channel Mid 30 MHz - 1 GHz



Graph 13. Rx Spurious Emissions Channel Mid 1 - 12.75 GHz



Graph 14. Rx Spurious Emissions Channel High 30 MHz – 1 GHz



Graph 15. Rx Spurious Emissions Channel High 1 - 12.75 GHz

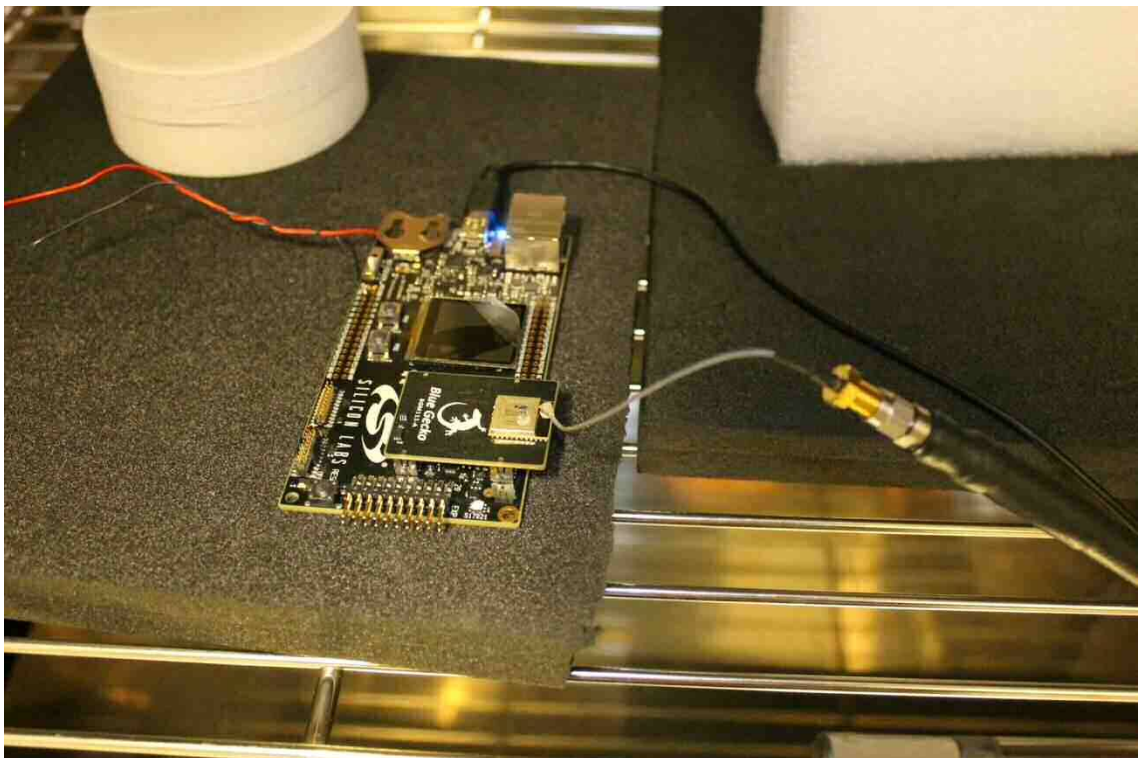
ANNEX B

Photographs

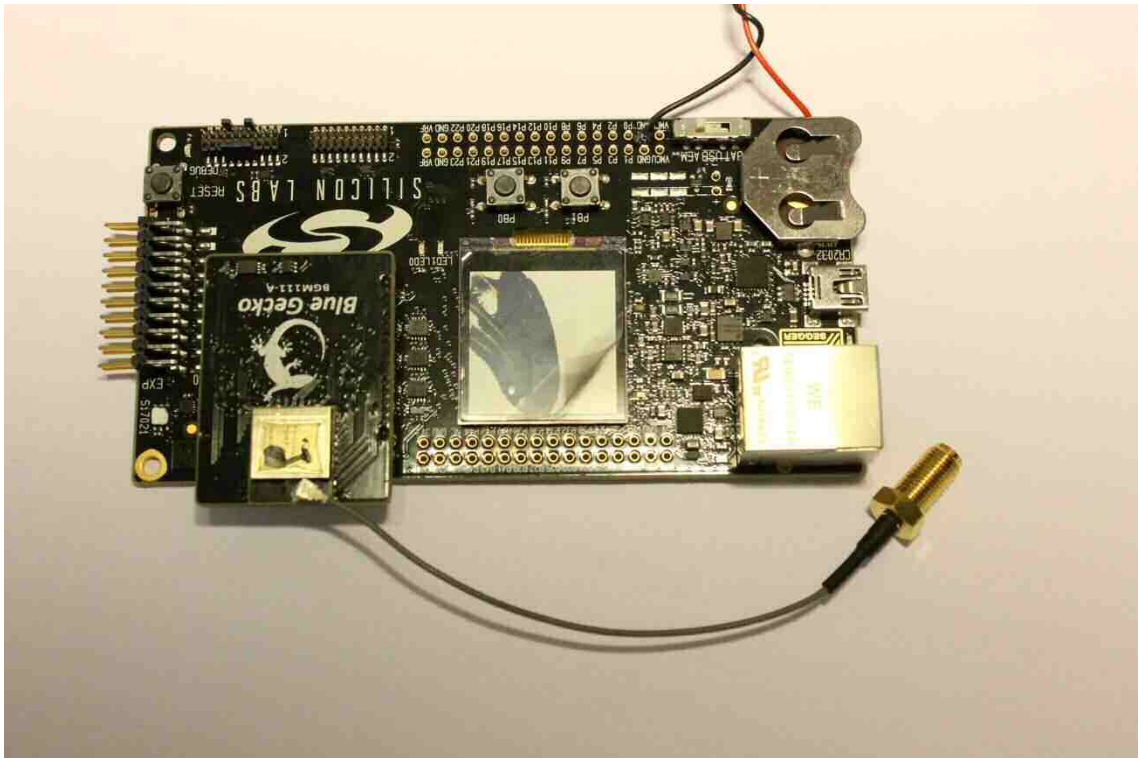
This annex contains the photographs of the EUT and test setup.



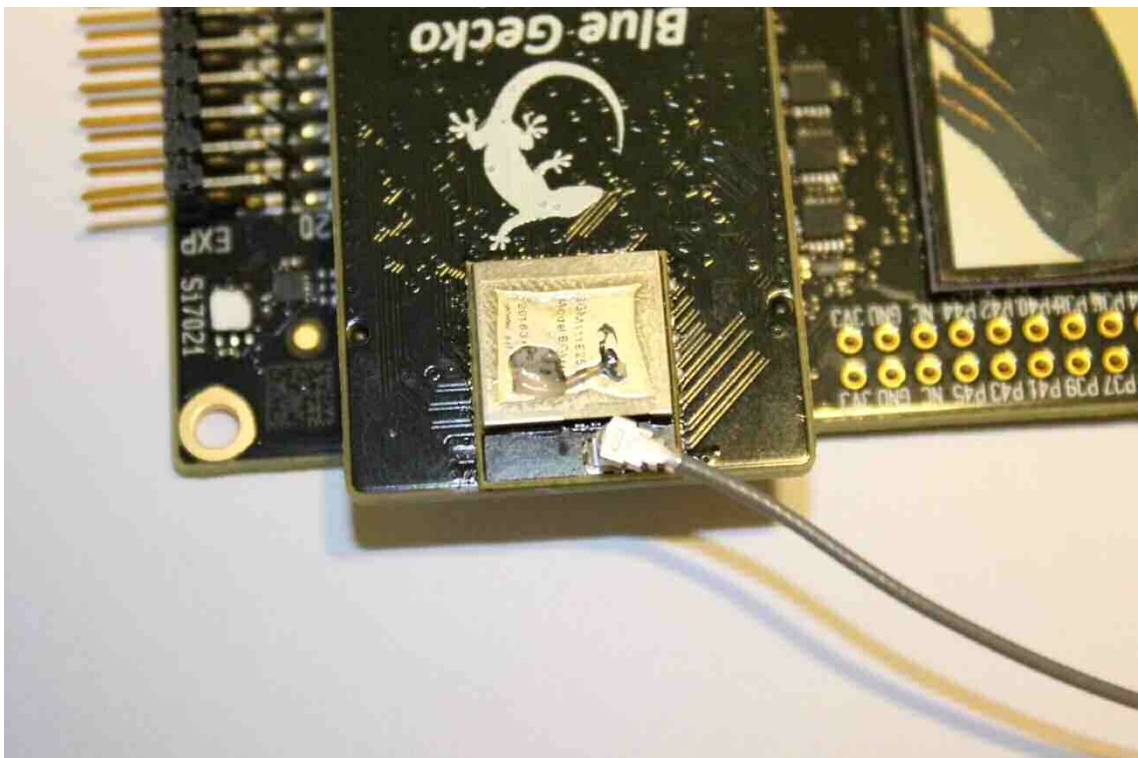
Photograph 1. Test setup



Photograph 2. Test setup closer



Photograph 3. The EUT attached to the evaluation board.



Photograph 4. The EUT.