

Prüfbericht-Nr.: <i>Test report no.:</i>	60359814 001	Auftrags-Nr.: <i>Order no.:</i>	238134508	Seite 1 von 37 Page 1 of 37
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	2020.02.10	
Auftraggeber: <i>Client:</i>	LAPIS Semiconductor Co.,Ltd. 2-4-8 Shinyokohama,Kouhoku-ku, 222-8575, Yokohama, Japan			
Prüfgegenstand: <i>Test item:</i>	Bluetooth low energy wireless module			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	MK71521, MK71521A			
Auftrags-Inhalt: <i>Order content:</i>	FCC Part 15C / ISED RSS-247 Test report Test report (BLE)			
Prüfgrundlage: <i>Test specification:</i>	FCC 47CFR Part 15: Subpart C Section 15.247 ISED RSS-247 (02-2017)			
Wareneingangsdatum: <i>Date of sample receipt:</i>	2020.02.12			
Prüfmuster-Nr.: <i>Test sample no.:</i>	A001062667-008, A002803673-017			
Prüfzeitraum: <i>Testing period:</i>	2020.02.18 - 2020.04.14			
Ort der Prüfung: <i>Place of testing:</i>	EMC/RF Laboratory Taipei			
Prüflaboratorium: <i>Testing laboratory:</i>	TUV Rheinland Taiwan Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
überprüft von: <i>reviewed by:</i>		genehmigt von: <i>authorized by:</i>		
Datum: 2020.04.23 <i>Date:</i>	Jack H.C. Chang	Datum: 2020.04.23 <i>Date:</i>	Arvin Ho	
Stellung / Position:	Project Manager	Stellung / Position:	Vice General Manager	
Sonstiges / Other:				
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>		Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>		
* Legende:	1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n)	2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	3 = befriedigend N/A = nicht anwendbar	4 = ausreichend N/T = nicht getestet
* Legend:	1 = very good P(ass) = passed a.m. test specification(s)	2 = good F(ail) = failed a.m. test specification(s)	3 = satisfactory N/A = not applicable	4 = sufficient N/T = not tested
<p>Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i></p>				

TEST SUMMARY

5.1.1 ANTENNA REQUIREMENT*RESULT: Passed***5.1.2 PEAK OUTPUT POWER***RESULT: Passed***5.1.3 6dB BANDWIDTH AND 99% BANDWIDTH***RESULT: Passed***5.1.4 POWER DENSITY***RESULT: Passed***5.1.5 CONDUCTED SPURIOUS EMISSIONS AND FREQUENCY BAND EDGE MEASURED IN
100kHz BANDWIDTH***RESULT: Passed***5.1.6 SPURIOUS EMISSION***RESULT: Passed***5.2.1 MAINS CONDUCTED EMISSIONS***RESULT: Passed***6.1.1 ELECTROMAGNETIC FIELDS***RESULT: Passed*

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1. General Remarks

1.1 Complementary Materials

The following attachments are integral parts of this test report:

Appendix P: Photo Documentation internal view
(File Name: 60359814 001 APPENDIX P)

Appendix D: Test Result of Radiated Emissions
(File Name: 60359814 001 APPENDIX D)

Appendix X: Photographs of the Test Set-Up
(File Name: 60359814 001 APPENDIX X)

Test Specifications

The following standards were applied.

Table 1: Applied Standard and Test Levels

Radio
FCC 47CFR Part 15: Subpart C Section 15.247
FCC 47CFR Part 2: Subpart J Section 2.1093
ISED RSS-247 Issue 2, Feb 2017
ISED RSS-102 Issue 5, March 2015
ISED RSS-Gen, Issue 5, March 2019
ANSI C63.10:2013
KDB558074 D01 DTS Meas Guidance v05r02
KDB447498 D01 General RF Exposure Guidance v06

1.2 Decision Rule of conformity

The decision rule of conformity of this test report is following the requirements of the requested standard in the quotation, and agreed among testing laboratory and manufacturer (applicant) to exclude the consideration of Measurement Uncertainty, unless it is required by the specific standard.

2. Test Sites

2.1 Test Laboratory

TUV Rheinland Taiwan Ltd.

11F. No.758, Sec. 4, Bade Rd., Songshan Dist.
Taipei City 105
Taiwan (R.O.C.)

2.2 Test Facility

TUV Rheinland Taiwan Ltd.

AC Mains Conduction:
11F. No.758, Sec. 4, Bade Rd., Songshan Dist.
Taipei City 105
Taiwan (R.O.C.)
FCC Registration No.: 180491
IC Canada Registration No.: 9465A

Conducted Test / Radiated Test:
No. 458-18, Sec 2, Fenliao., Linkou Dist.
New Taipei City 244
Taiwan (R.O.C.)
FCC Registration No.: 226631
IC Canada Registration No.: 25563

TAF Accredited NCC Test Lab. No.:3567
TAF ISO17025 Certification effective period: 6th-May-2019 to 05th-May-2022



Testing Laboratory
3567

2.3 List of Test and Measurement Instruments

Table 2: List of Test and Measurement Equipment

Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due Date
EMI Test Receiver	R&S	ESR7	102109	2019/4/17	2020/4/16
Spectrum Analyzer	R&S	FSV40	101112	2019/10/15	2020/10/15
Pre-Amplifier	Agilent	8447D	2727A05146	2020/2/17	2021/2/16
Pre-Amplifier	EMCI	EMC051845SE	980635	2020/2/11	2021/2/10
Pre-Amplifier	EMCI	EMC184045SE	980656	2020/2/11	2021/2/10
Bilog Antenna	SCHWARZBECK	VULB-9168	00950	2020/1/20	2021/1/19
Horn Antenna	ETS-Lindgren	3117	00218929	2019/11/27	2020/11/26
Horn Antenna	SCHWARZBECK	BBHA 9170	00890	2019/4/12	2020/4/30
Loop Antenna	EMCI	LPA600	287	2019/12/20	2020/12/19
Test Software	Audix	e3	Ver. 9	N/A	N/A
Test Cable	HUBER+SUHNER	SUCOFLEX 104EA	800057/4EA	2019/4/11	2020/4/30
Test Cable	HUBER+SUHNER	SUCOFLEX 104	802244/4	2019/4/11	2020/4/30
Test Cable	HUBER+SUHNER	SUCOFLEX 104	MY37203/4	2019/4/11	2020/4/30
Test Cable	HUBER+SUHNER	SUCOFLEX 102EA	800897/2EA	2019/4/11	2020/4/30
Test Cable	HUBER+SUHNER	SUCOFLEX 102EA	800902/2EA	2019/4/11	2020/4/30
Test Cable	HUBER+SUHNER	SUCOFLEX 102EA	801026/2EA	2019/4/11	2020/4/30
Two-Line V-Network (for EUT)	Rohde & Schwarz	ENV216	101243	2019/06/23	2020/06/23
Two-Line V-Network	Rohde & Schwarz	ENV216	101262	2019/07/16	2020/07/16
Telecom ISN 4 Line	Fischer Custom Communications	FFCC-TLISN- T4-02-09	101168	2020/02/03	2021/02/03
Impedance Stabilization Network	TESEQ	ISN T800	51949	2020/02/25	2021/02/25
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	0357.8810.54- 102102-HN	2019/07/25	2020/07/25
Test Software	Audix	e3	Ver. 9	N/A	N/A

2.4 Traceability

All measurement equipment calibrations are traceable to NML(Taiwan)/NIST(USA) or where calibration is performed outside Taiwan, to equivalent nationally recognized standards organizations.

2.5 Calibration

Equipment requiring calibration is calibrated periodically in a suitably accredited Calibration Lab. Additionally all equipment is verified for proper performance on a regular schedule using in house standards or comparisons.

2.6 Measurement Uncertainty

The estimated combined standard uncertainty for radiated emissions and conducted emissions measurements .

Table 3: Emission Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	± 0.1 ppm
RF power/RF Exposure(MPE), conducted	± 1.5 dB
RF power density, conducted	± 3 dB
spurious emissions, conducted	± 3 dB
all emissions, radiated	± 6 dB
Temperature	± 1 °C
Humidity	± 5 %
DC and low frequency voltages	±3 %

3. General Product Information

3.1 Product Function and Intended Use

The EUT is a Bluetooth low energy wireless module.
MK71521/MK71521A is a wireless module which is integrating Bluetooth Specification v5.1 compliant LSI(nRF52811), 32MHz/ 32.768kHz crystal oscillator, 2.4GHz PCB pattern antenna and passive components.
MK71521/MK71521A is suitable for applications such as Healthcare, fitness device, security device, IoT devices (industrial / consumer).
For details refer to the User Guide, Data Sheet and Circuit Diagram.

3.2 System Details and Ratings

Table 4: Basic Information of EUT

Item	EUT information
Kind of Equipment/Test Item	Bluetooth low energy wireless module
Type Identification	MK71521/MK71521A
FCC ID	2ACIJ71521
IC ID	20971-71521
HVIN	MK71521, MK71521A

Table 5: Technical Specification of EUT

Technical Specification	Value
Operating Frequencies	2402MHz ~ 2480MHz
Channel Spacing	2 MHz
Channel number	40
Operation Voltage	1.7 to 3.6Vdc (Tested by 3Vdc)
Modulation	GFSK
Antenna gain	-1.3dBi

3.3 Independent Operation Modes

Basic operation modes are:

- A. Transmitting
 - 1. Low channel
 - 2. Middle channel
 - 3. High channel
- B. Receiving
 - 1. Low channel
 - 2. Middle channel
 - 3. High channel
- C. Normal
- D. Off

3.4 Noise Generating and Noise Suppressing Parts

Refer to the Circuit Diagram.

3.5 Submitted Documents

- Circuit Diagram
- Instruction Manual
- Rating Label
- Technical Description

4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The test modes were adapted accordingly in reference to the instructions for use.

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Table 6: Table for Parameters of Test Software Setting

Mode, Data Rate	Channel Frequency		
	2402 MHz	2440 MHz	2480 MHz
BLE 1M	4	4	4
BLE 2M	4	4	4

4.2 Test Operation and Test Software

Setup for testing: The test sample itself is equipped with a touch screen, It was used to enable the operation modes listed in section 3.3 as appropriate by the screen.

The samples were used as follows:

Conducted: A001062667-008

Radiation: A002803673-017

Full test was applied on all test modes, but only worst case was shown

MK71521 was tested as the primary.

MK71521A does not built-in a 32.768kHz crystal oscillator(Y2).

The clock (32.768kHz) is for the system sleep, during which time the module does not transmit anything. The clock is used when system is sleeping and with it (MK71521) the system wakes up faster than the system without the clock (MK71521A). Both models have same electrically identical.

4.3 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

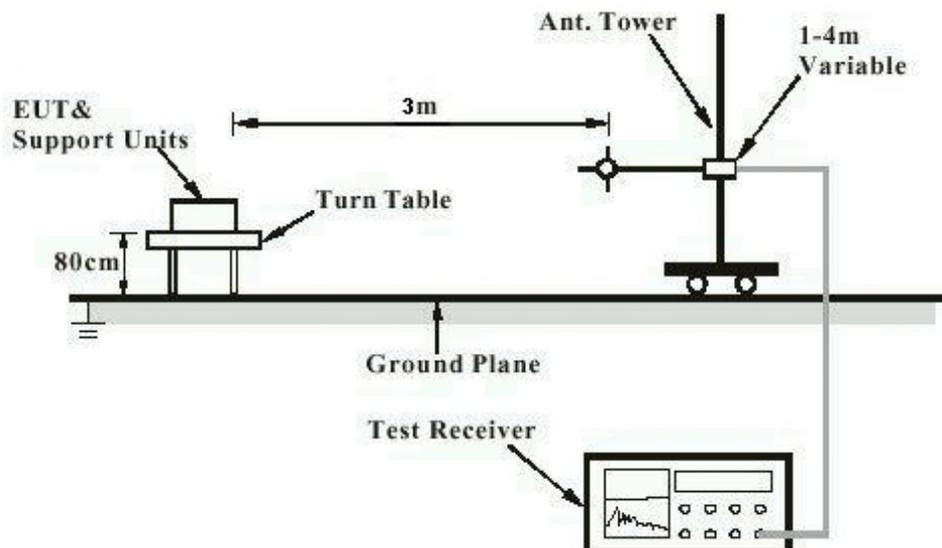
Kind of Equipment	Manufacturer	Model Name
Notebook (Setup)	HP	TPN-C139

4.4 Countermeasures to achieve EMC Compliance

The test sample which has been tested contained the noise suppression parts as described in the Constructional Data Form or the Technical Construction File. No additional measures were employed to achieve compliance.

4.5 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1 GHz are done with a table height of 1.5m

Diagram of Measurement Equipment Configuration for Mains Conduction Measurement (if applicable)

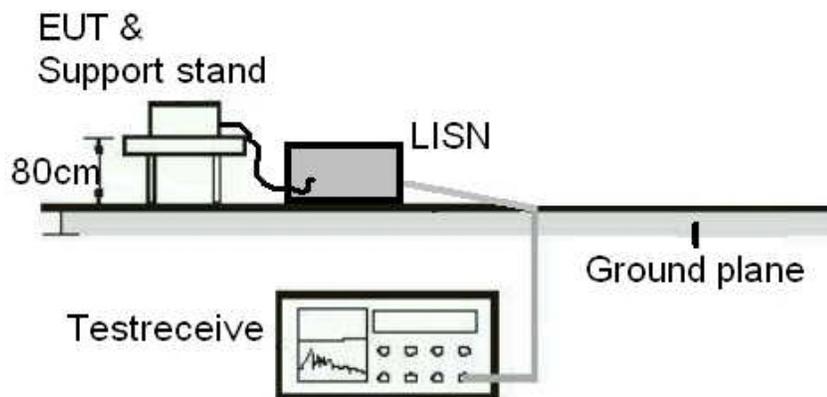
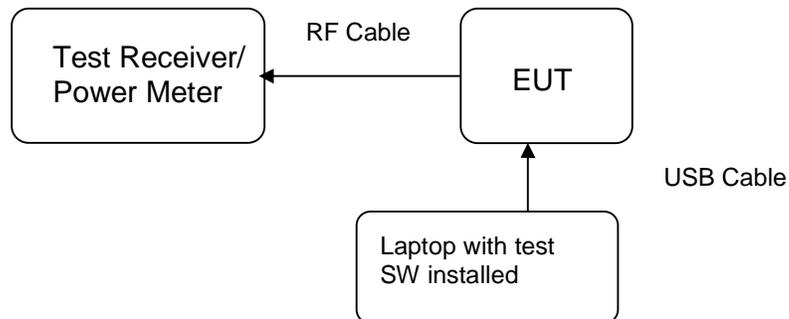


Diagram of Measurement Equipment Configuration for Conducted Transmitter Measurement



Note: The output power is measured by power meter according to 8.3.1.3 KDB558074 D01 Meas Guidance v05r02 8.3.1.3.

5. Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

RESULT: **Passed**

Test standard : FCC Part 15.247(b)(4), Part 15.203 and ISED
RSS-Gen 8.3

Requirement : use of approved antennas only with directional gains that
do not exceed 6 dBi

According to the manufacturer declaration, the EUT has an antenna with a directional gain of -1.3dBi. The antenna is a printed trace with no possibility of replacement with a non-approved antenna by the end-user. Therefore, the EUT is considered to comply with this provision.

Refer to EUT photo for details.

5.1.2 Peak Output Power

RESULT:
Passed

Test standard : FCC Part 15.247(b)(3), ISED RSS-247 5.4(4)
 Basic standard : ANSI C63.10:2013, KDB558074
 Limit : 1 Watt
 Kind of test site : Shielded room

Test setup

Test Channel : Low/ Middle/ High
 Operation Mode : A

 Ambient temperature : 20-24 °C
 Relative humidity : 50-65 %
 Atmospheric pressure : 100-103 kPa

Table 7: Test result of Peak Output Power, Bluetooth Low Energy 1Mbps

Channel	Channel Frequency (MHz)	Output Power		Limit
		(dBm)	(W)	(W)
Low Channel	2402	4.13	0.00259	1
Middle Channel	2440	4.12	0.00258	1
High Channel	2480	4.22	0.00264	1

Table 8: Test result of Peak Output Power, Bluetooth Low Energy 2Mbps

Channel	Channel Frequency (MHz)	Output Power		Limit
		(dBm)	(W)	(W)
Low Channel	2402	4.13	0.00259	1
Middle Channel	2440	4.11	0.00258	1
High Channel	2480	4.22	0.00264	1

5.1.3 6dB Bandwidth and 99% Bandwidth

RESULT:
Passed

Test standard : FCC Part 15.247(a)(2)
 Basic standard : ANSI C63.10:2013, KDB558074
 Kind of test site : Shielded room

Test setup

Test Channel : Low/ Middle/ High
 Operation Mode : A

Ambient temperature : 20-24°C
 Relative humidity : 50-65%
 Atmospheric pressure : 100-103 kPa

Table 9: Test result of 6dB Bandwidth, Bluetooth Low Energy 1Mbps

Channel	Channel Frequency (MHz)	6dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	719.3	>500	Pass
Middle Channel	2440	728.3	>500	Pass
High Channel	2480	734.3	>500	Pass

Table 10: Test result of 6dB Bandwidth, Bluetooth Low Energy 2Mbps

Channel	Channel Frequency (MHz)	6dB Bandwidth (MHz)	Limit (kHz)	Result
Low Channel	2402	1.3248	>500	Pass
Middle Channel	2440	1.3636	>500	Pass
High Channel	2480	1.2935	>500	Pass

Prüfbericht - Nr.: 60359814 001
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Page 17 of 37**Table 11: Test result of 99% Bandwidth, Bluetooth Low Energy 1Mbps**

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2402	1.0639
Middle Channel	2440	1.0669
High Channel	2480	1.0669

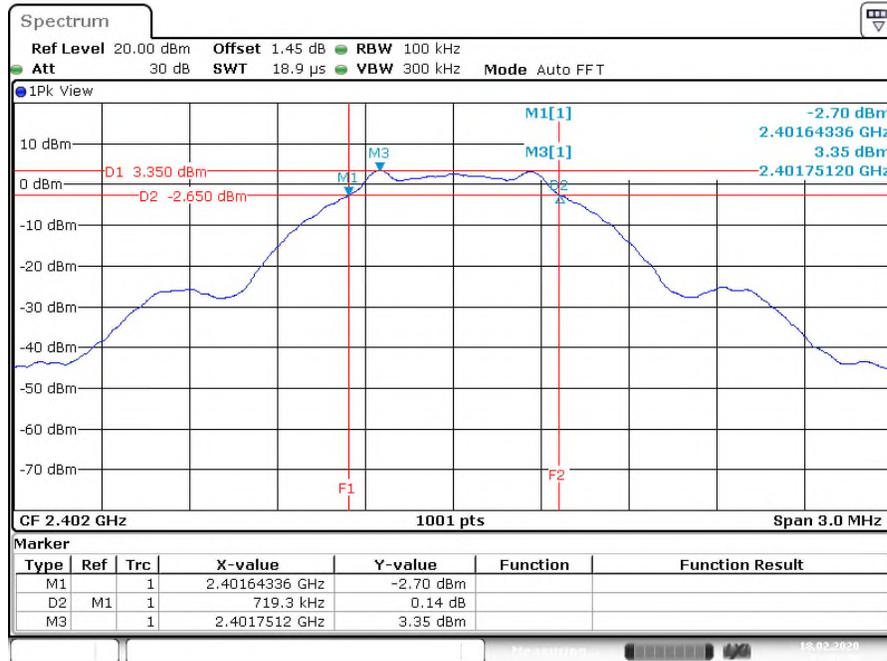
Table 12: Test result of 99% Bandwidth, Bluetooth Low Energy 2Mbps

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2402	2.0926
Middle Channel	2440	2.0919
High Channel	2480	2.0952

Test Plot of 6dB Bandwidth

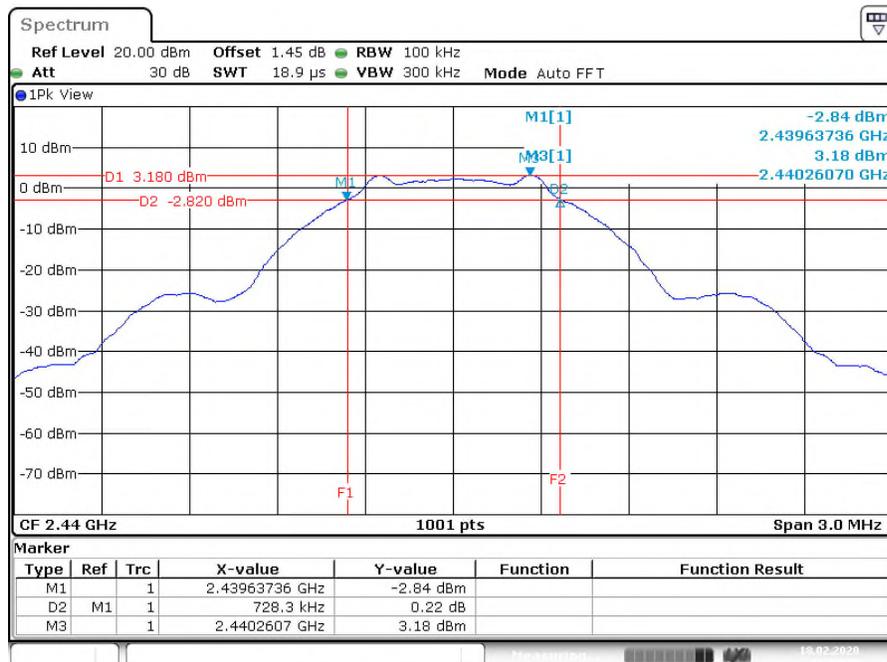
Bluetooth Low Energy 1Mbps

Low Channel

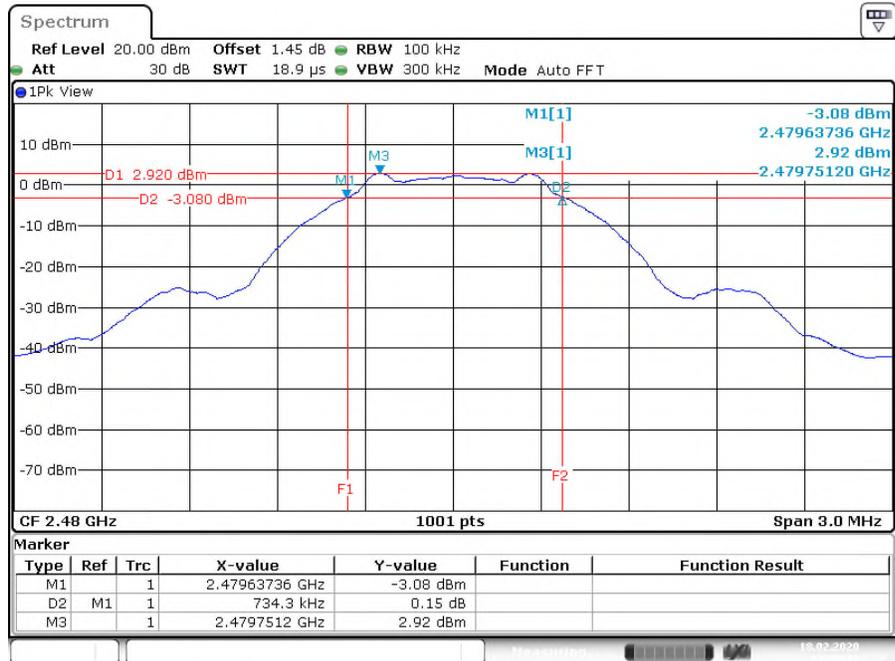


Date: 18.FEB.2020 11:01:51

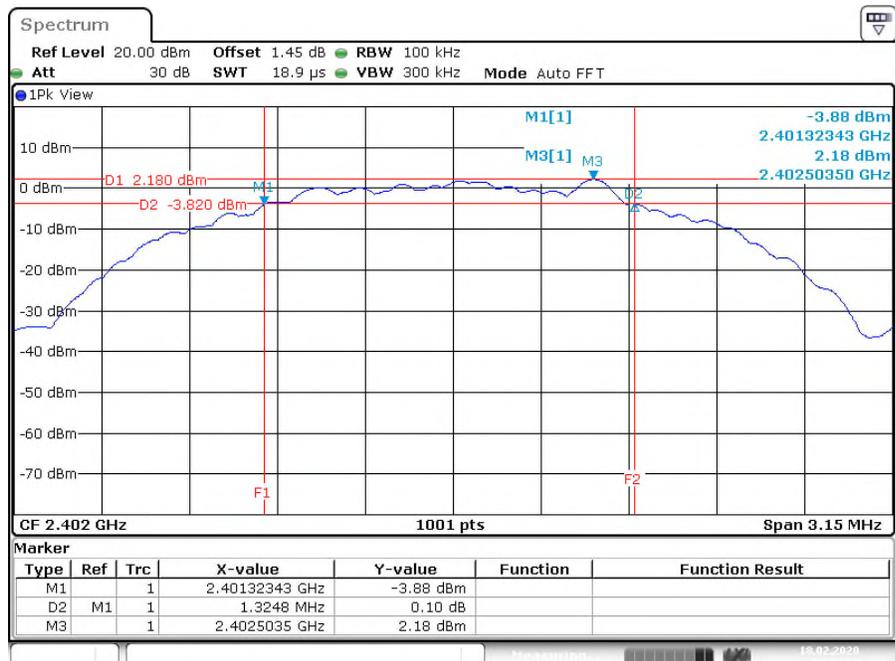
Middle Channel



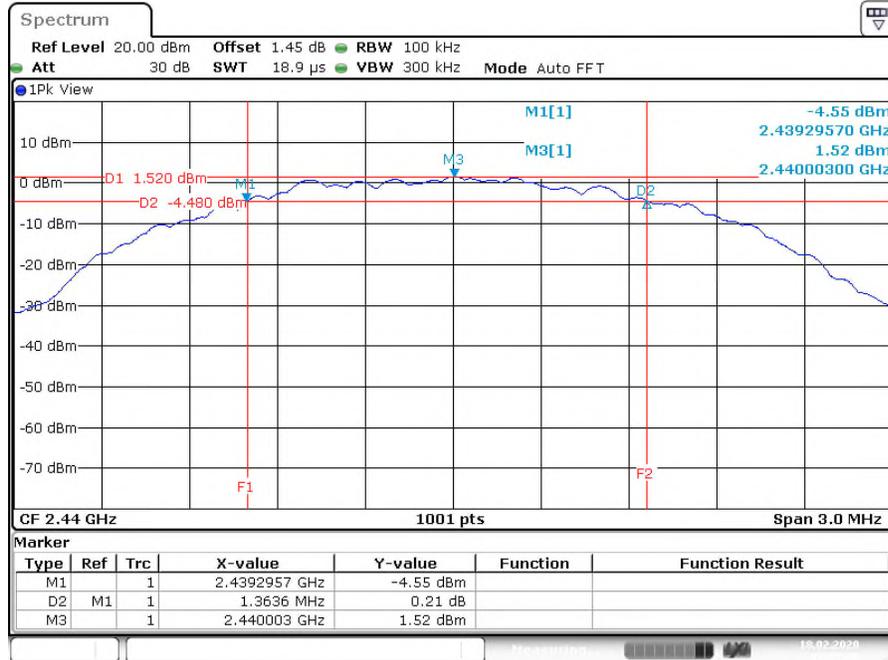
Date: 18.FEB.2020 11:04:19

High Channel


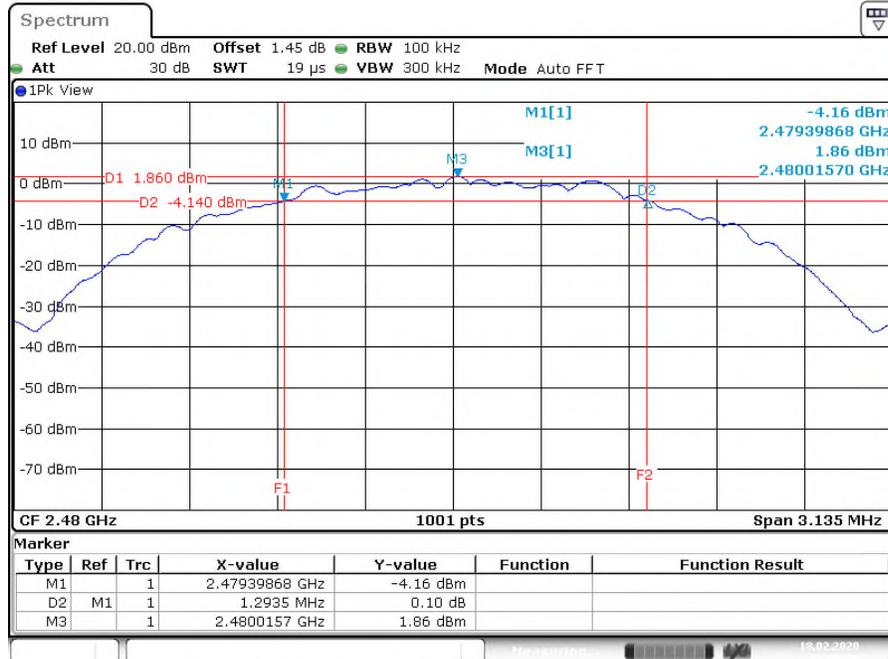
Date: 18.FEB.2020 11:08:11

Bluetooth Low Energy 2Mbps
Low Channel


Date: 18.FEB.2020 11:33:34

Middle Channel


Date: 18.FEB.2020 11:27:31

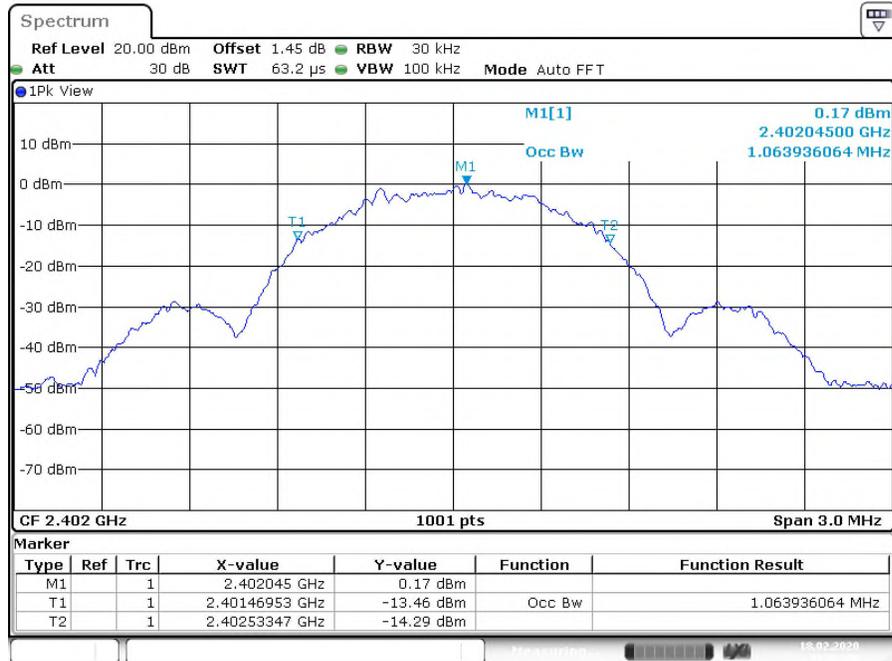
High Channel


Date: 18.FEB.2020 11:30:00

Test Plot of 99% Bandwidth

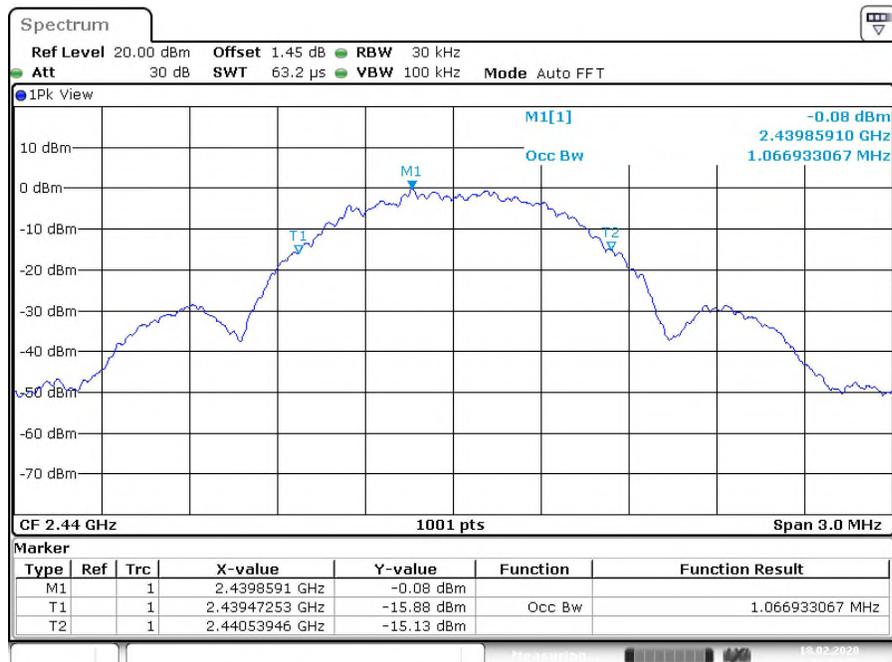
Bluetooth Low Energy 1Mbps

Low Channel

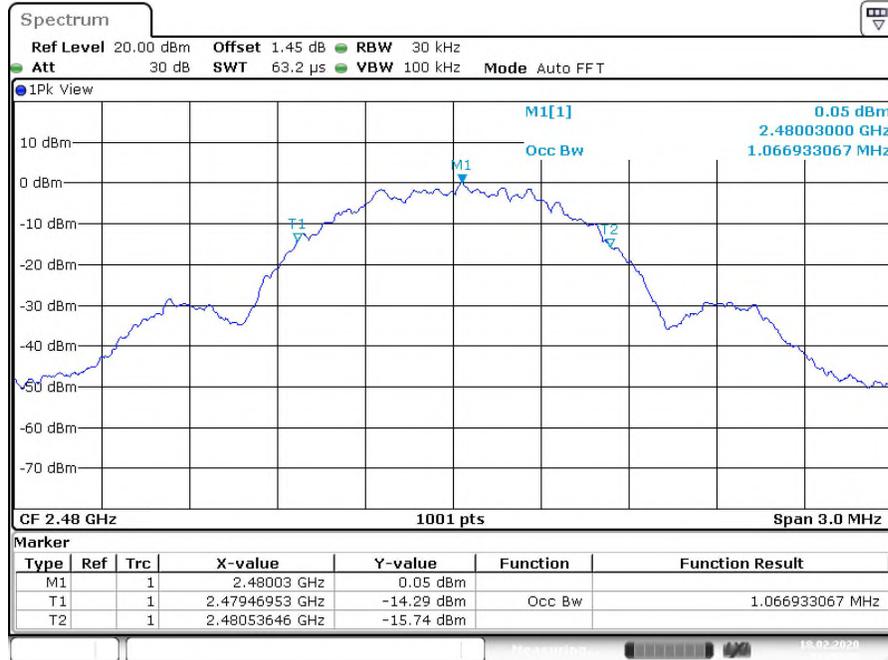
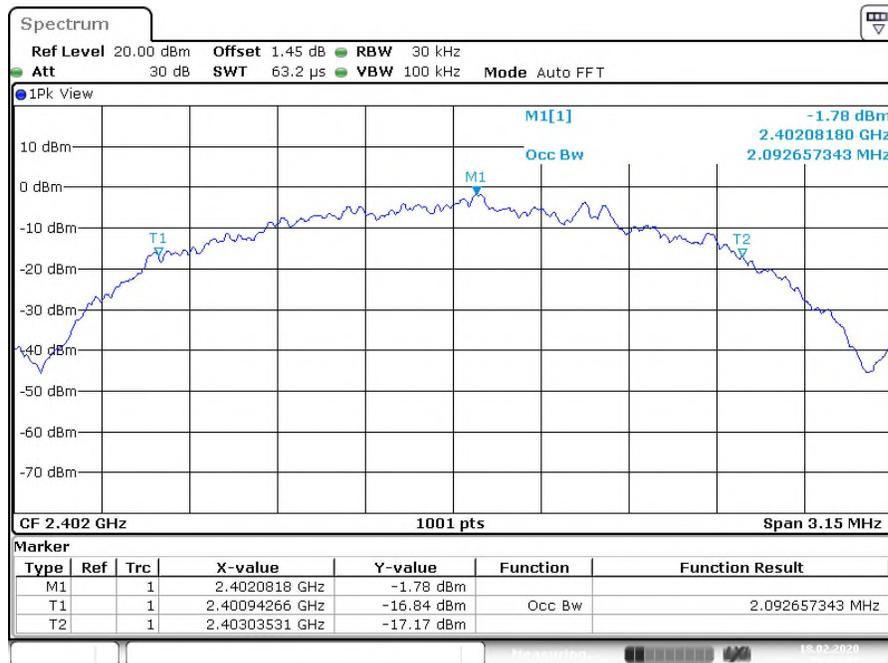


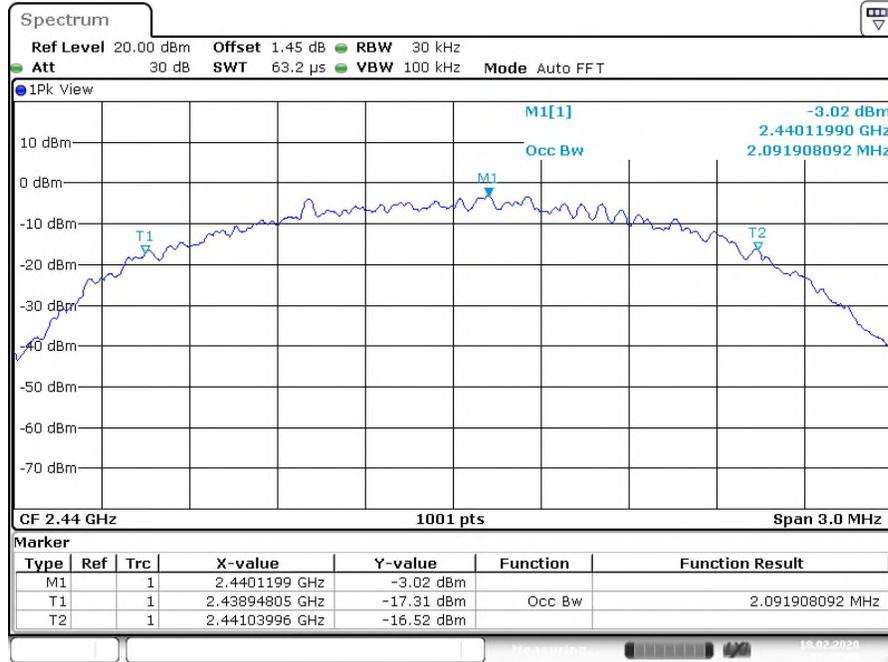
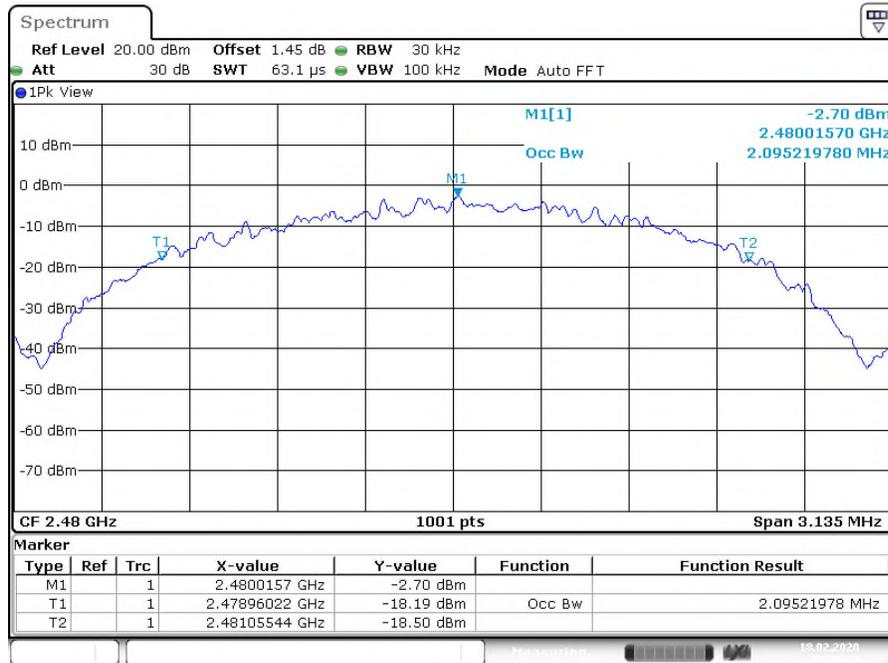
Date: 18.FEB.2020 11:02:08

Middle Channel



Date: 18.FEB.2020 11:04:36

High Channel

Bluetooth Low Energy 2Mbps
Low Channel


Middle Channel

High Channel


5.1.4 Power Density

RESULT:
Passed

Test standard : FCC Part 15.247(e), ISED RSS-247 5.2(2)
 Basic standard : ANSI C63.10:2013, KDB558074
 Kind of test site : Shielded room

Test setup

Test Channel : Low/ Middle/ High
 Operation Mode : A
 Ambient temperature : 20-24°C
 Relative humidity : 50-65%
 Atmospheric pressure : 100-103 kPa

Table 13: Test result of Power Density, Bluetooth Low Energy 1Mbps

Channel	Channel Frequency (MHz)	Power Density	Limit
		(dBm)	(dBm)
Low Channel	2402	-10.22	8
Middle Channel	2440	-10.10	8
High Channel	2480	-9.96	8

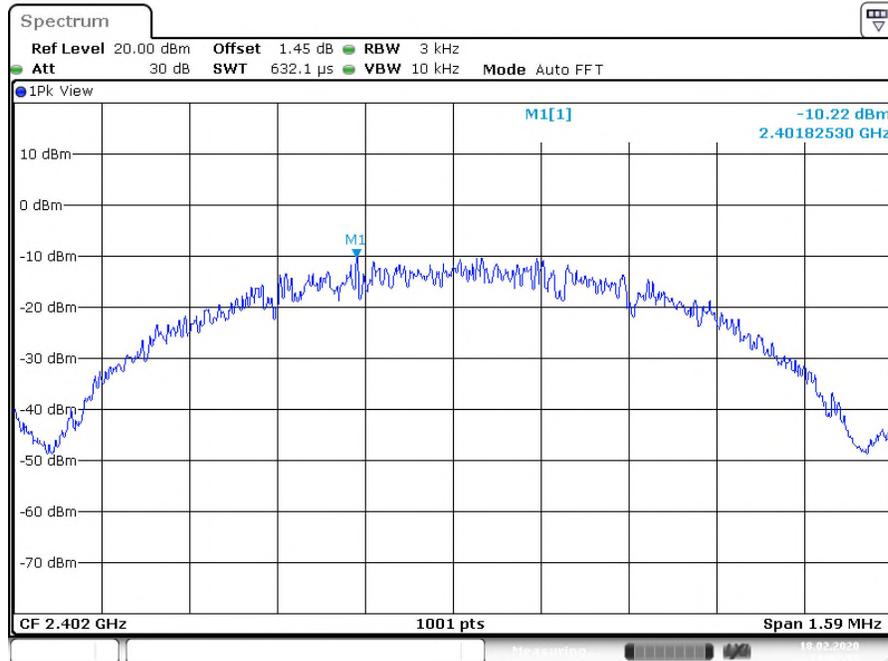
Table 14: Test result of Power Density, Bluetooth Low Energy 2Mbps

Channel	Channel Frequency (MHz)	Power Density	Limit
		(dBm)	(dBm)
Low Channel	2402	-11.66	8
Middle Channel	2440	-12.55	8
High Channel	2480	-12.72	8

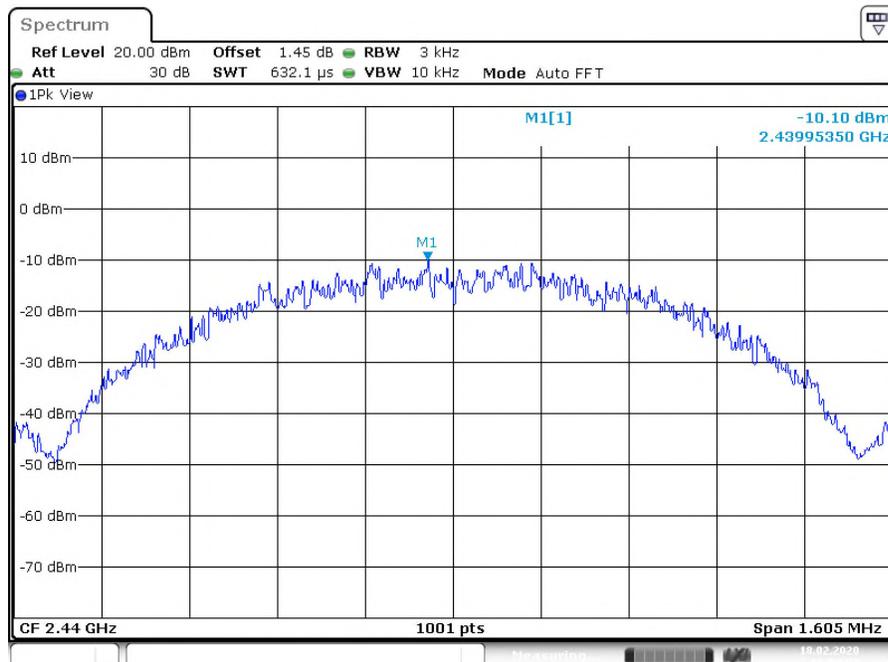
Test Plot of Power Density

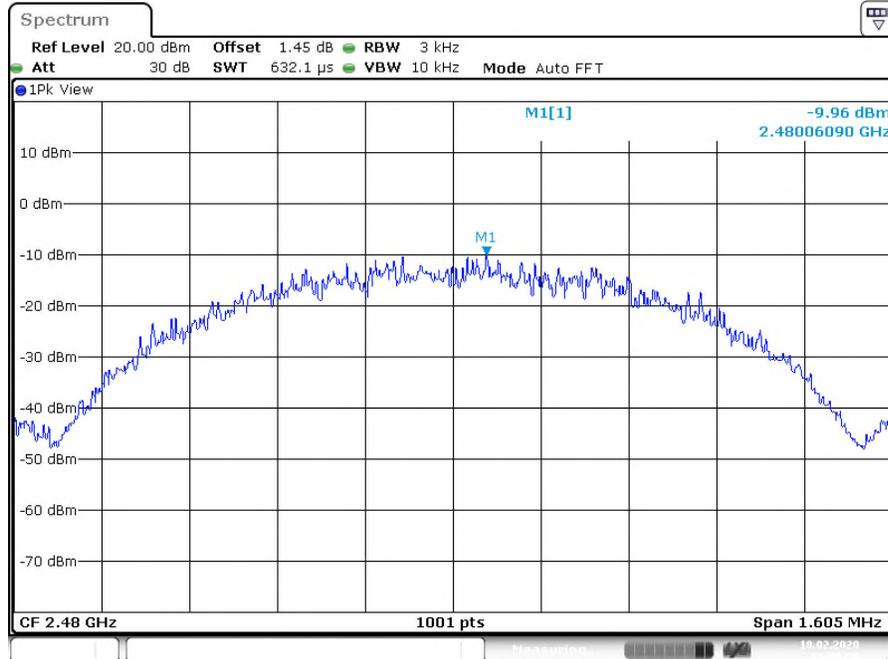
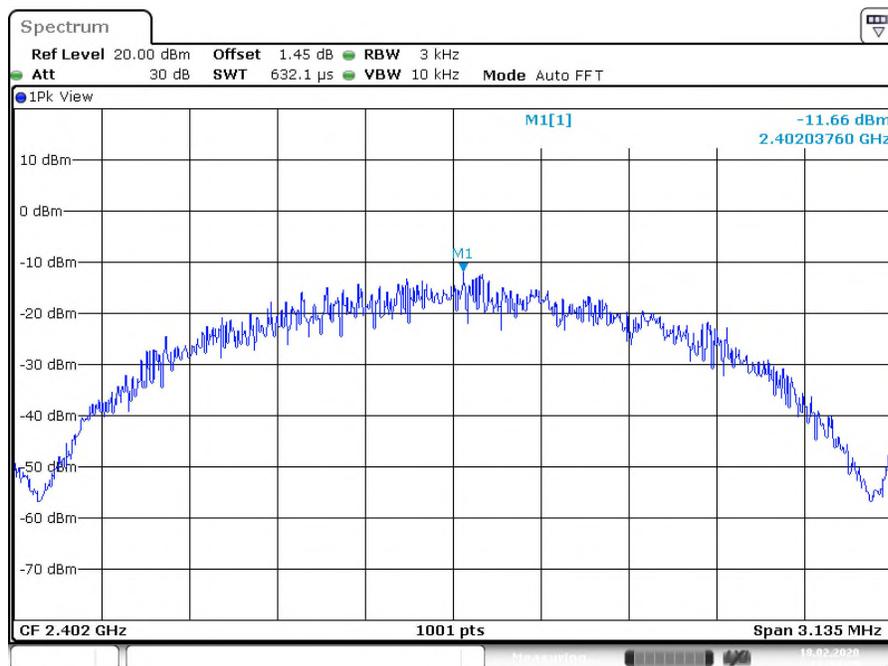
Bluetooth Low Energy 1Mbps

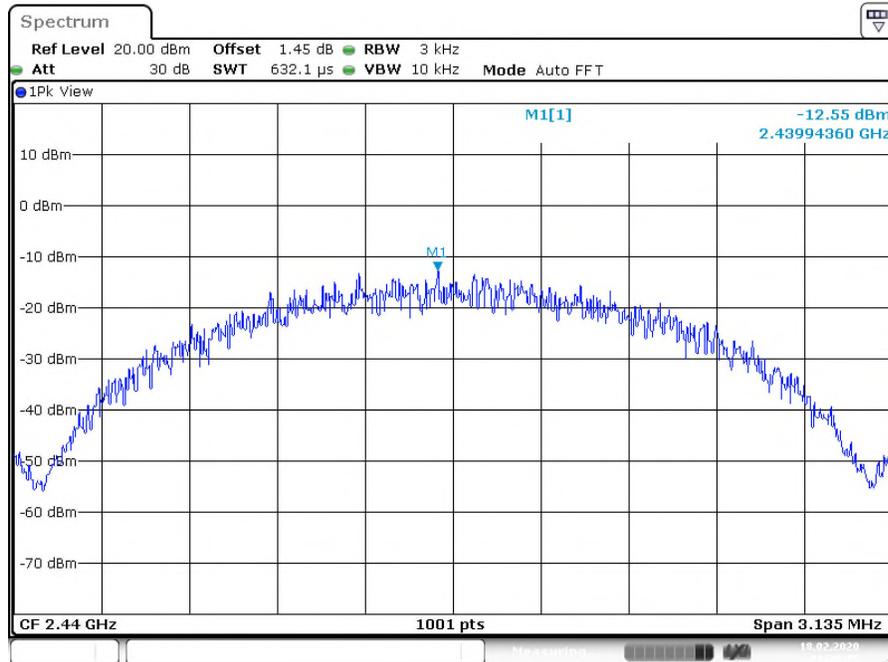
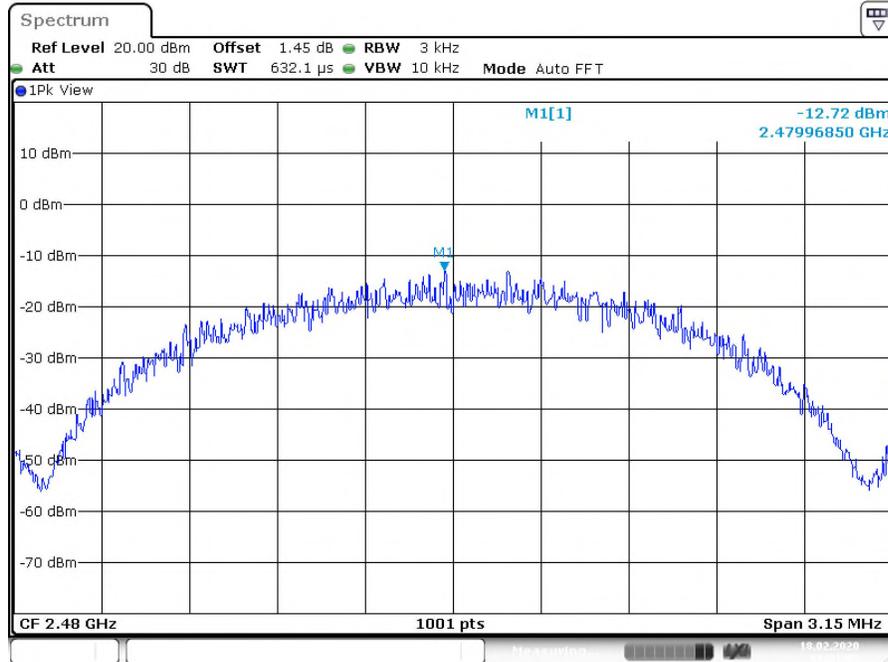
Low Channel



Middle Channel



High Channel

Bluetooth Low Energy 2Mbps
Low Channel


Middle Channel

High Channel


5.1.5 Conducted spurious emissions and Frequency Band Edge measured in 100kHz Bandwidth

RESULT:**Passed**

Test standard	:	FCC part 15.247(d), ISED RSS-247 5.5
Basic standard	:	ANSI C63.10:2013, KDB558074
Limit	:	20dB (below that in the 100kHz bandwidth within the band that contains the highest level of the desired power)
Kind of test site	:	Shielded room

Test setup

Test Channel	:	Low/ Middle/ High for Conducted Spurious Emissions Low/ High for Frequency Band Edge
Operation Mode	:	A
Ambient temperature	:	20-24°C
Relative humidity	:	50-65%
Atmospheric pressure	:	100-103 kPa

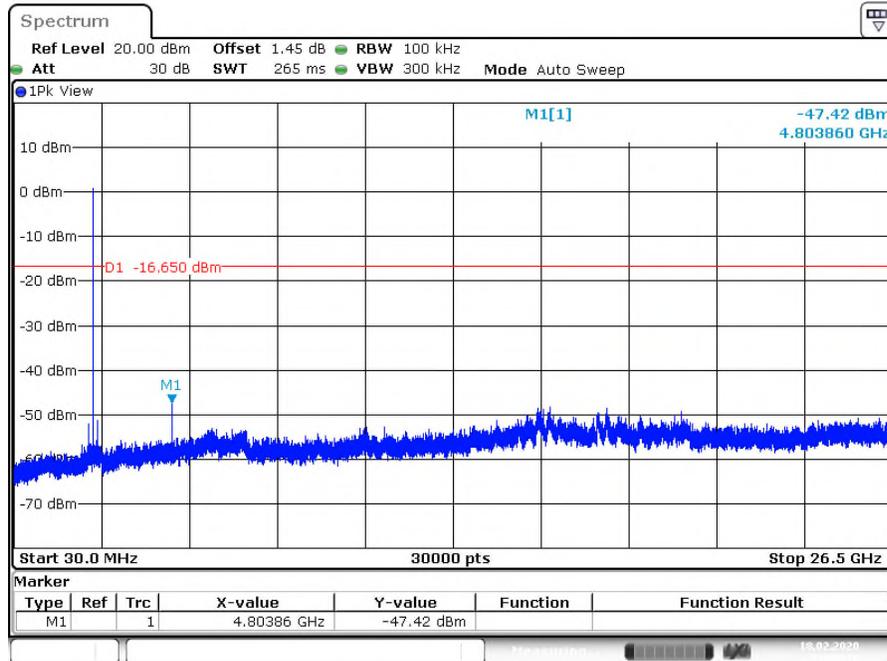
All emissions are more than 20dB below fundamental, details refer to following test plot, and compliance is achieved as well.

Due to the small size of the RF circuit and that there are no inductive components of significant size connected to the antenna port, 9kHz to 30MHz frequency range is not tested based on technical judgment.

Test Plot 100kHz Conducted Emissions

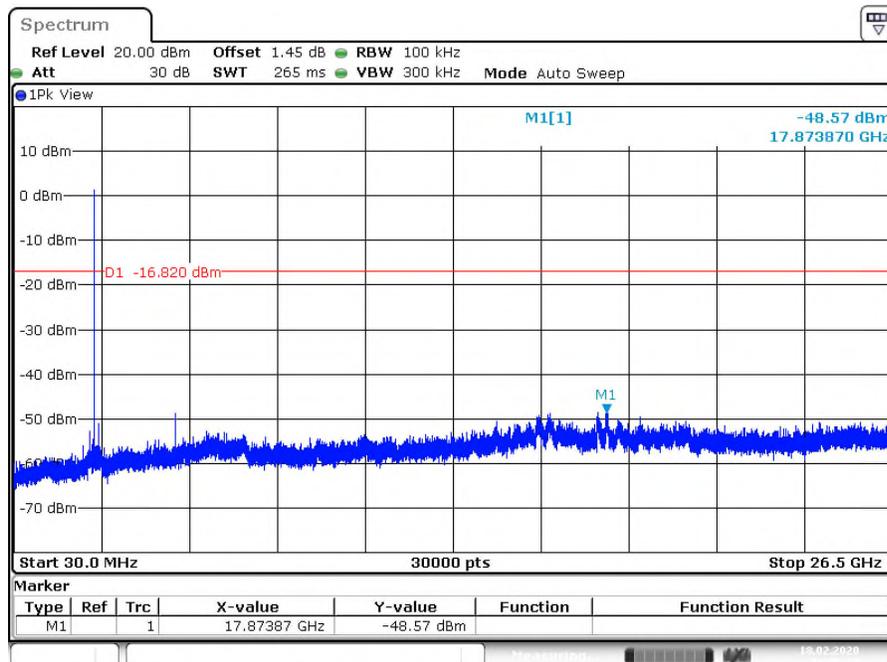
Bluetooth Low Energy 1Mbps

Low Channel

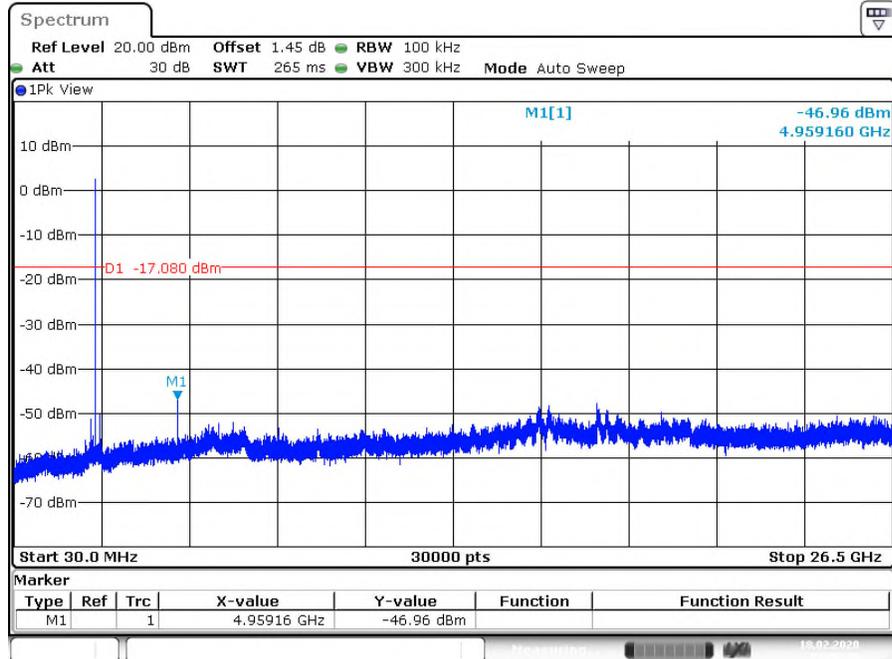


Date: 18.FEB.2020 11:03:11

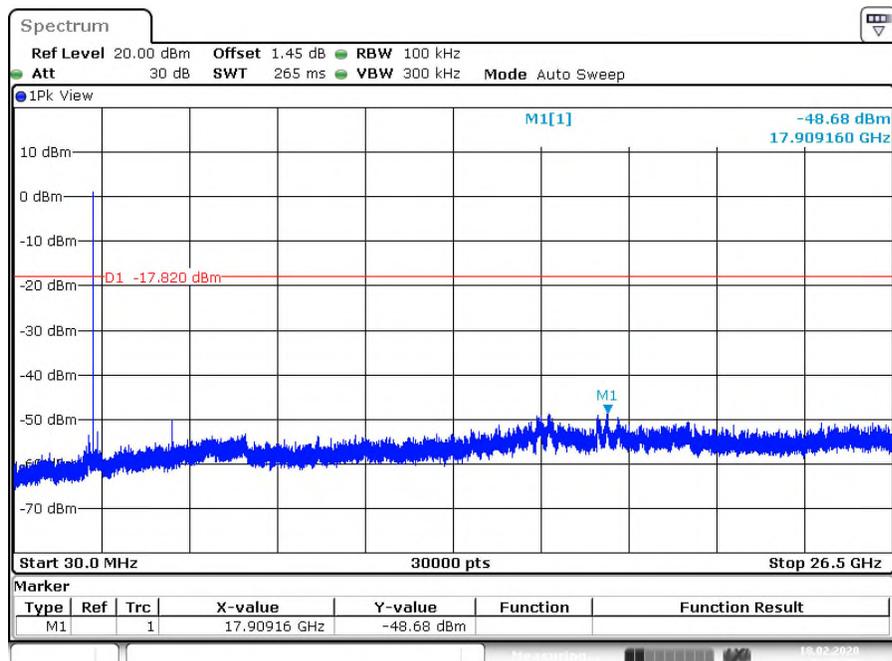
Middle Channel



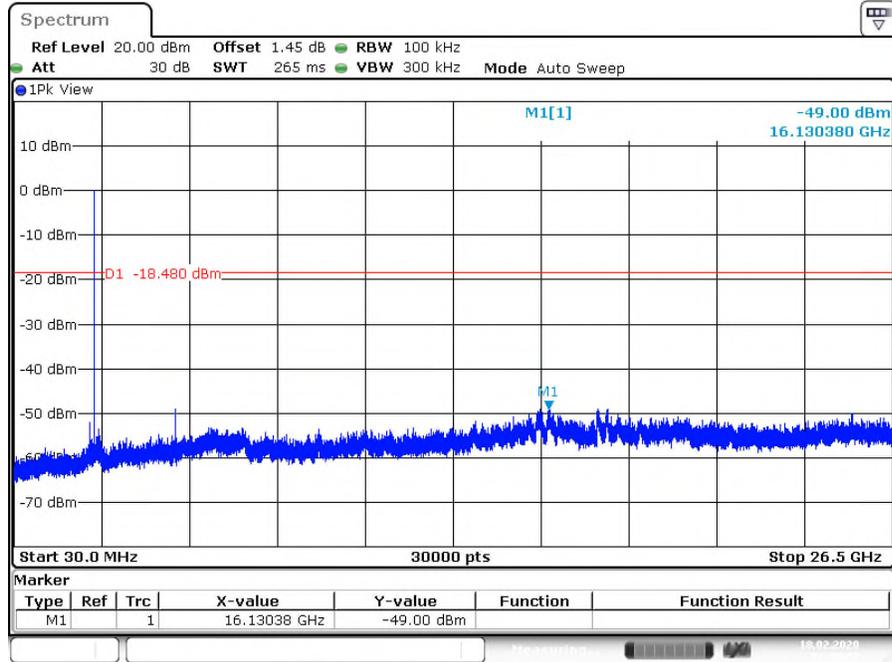
Date: 18.FEB.2020 11:05:38

High Channel


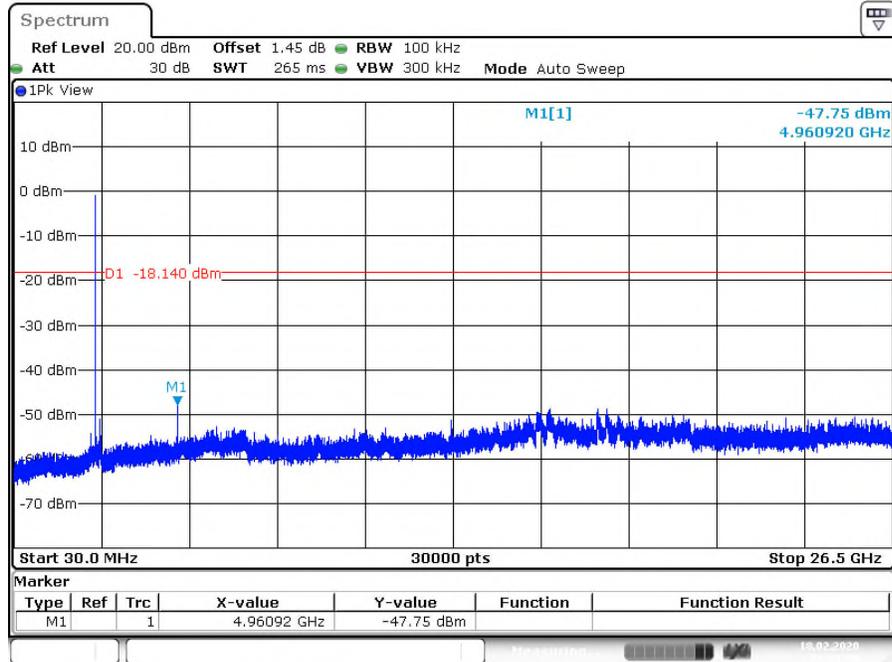
Date: 18.FEB.2020 11:09:29

Bluetooth Low Energy 2Mbps
Low Channel


Date: 18.FEB.2020 11:35:09

Middle Channel


Date: 18.FEB.2020 11:28:58

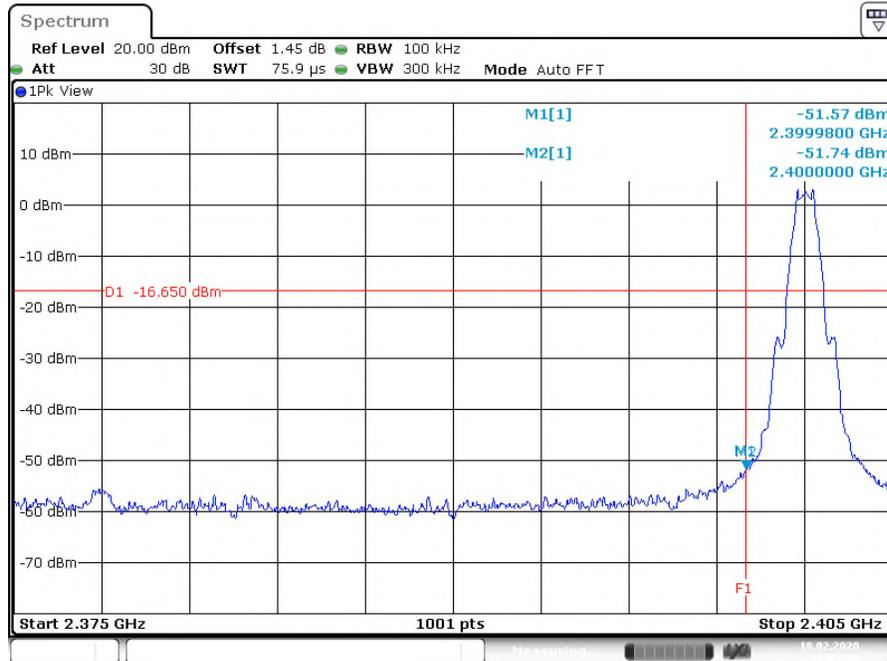
High Channel


Date: 18.FEB.2020 11:31:46

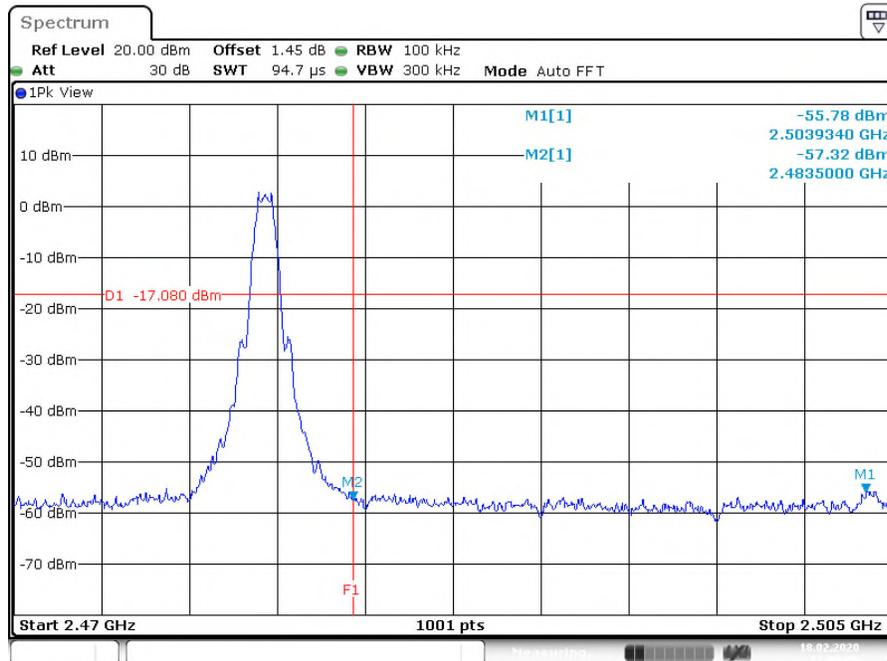
Test Plot 100kHz RBW of Band Edge

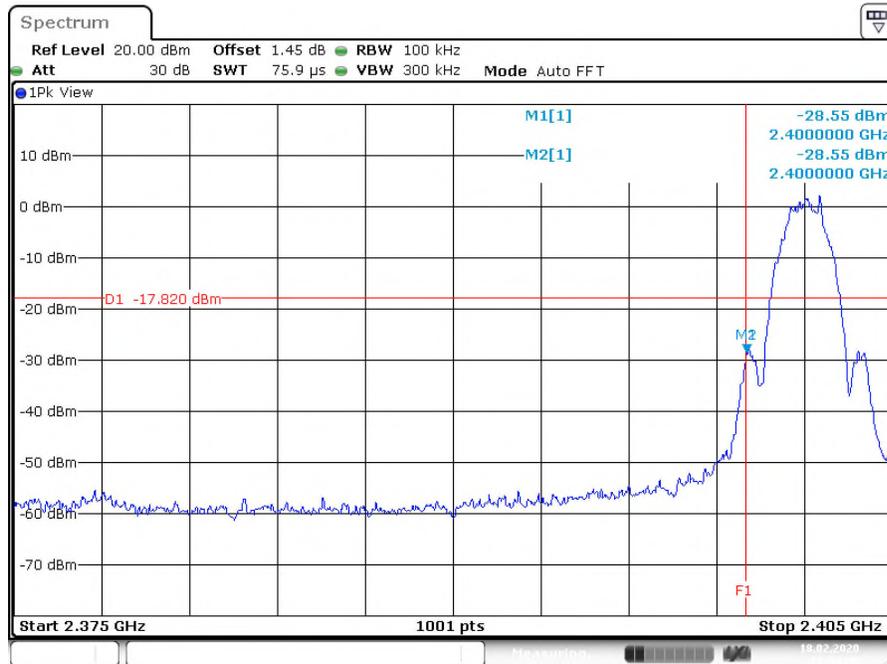
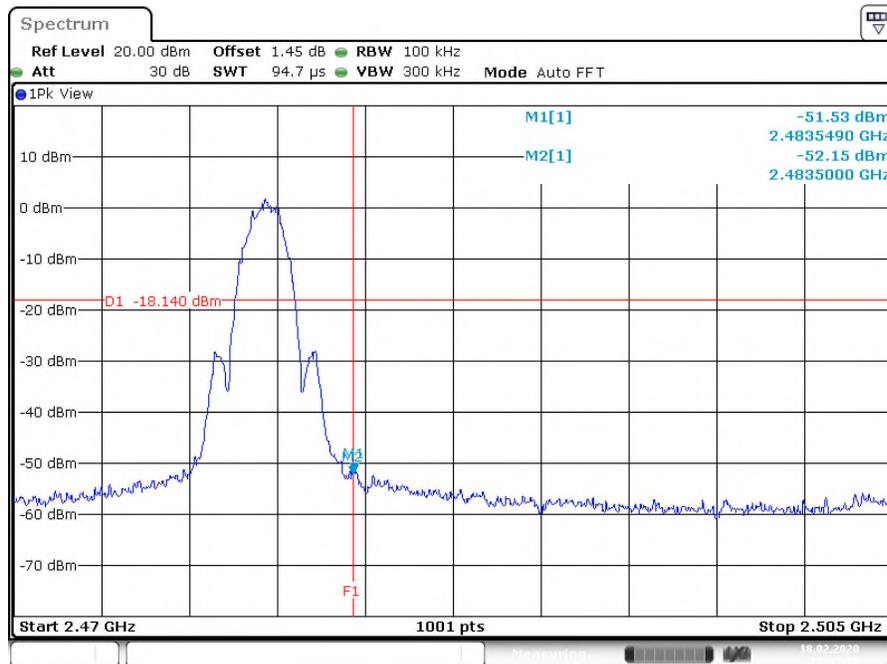
Bluetooth Low Energy 1Mbps

Low Channel



High Channel



Bluetooth Low Energy 2Mbps
Low Channel

High Channel


5.1.6 Spurious Emission

RESULT: **Passed**

Test standard : FCC part 15.247(d), FCC 15.205, FCC 15.209, ISED
RSS-247 5.5 and ISED RSS-Gen Issue 5 8.9

Basic standard : ANSI C63.10: 2013

Limits : Radiated emissions which fall in the restricted bands, as
defined in FCC 15.205(a) and RSS-Gen i5, 8.10 (Table 7),
must comply with the radiated emission limits specified in
FCC 15.209(a) and ISED RSS-Gen 5, 8.9 (Table 5 and 6).

Emission radiated outside the restricted and authorized
frequency bands must either comply with the radiated
emission limits specified for the restricted bands or in
FCC15.247(d) and ISED RSS-247 i2, 5.5

Kind of test site : 3m Semi-Anechoic Chamber

Test setup

Test Channel : Refer to Appendix D

Operation mode : A

Ambient temperature : 20-24 °C

Relative humidity : 50-65 %

Atmospheric pressure : 100-103 kPa

Factor (dB/m)=Antenna Factor(dB/m)+Cable loss (dB)

Level(dBuV/m)=Reading(dBuV)+ Factor(dB/m)

Testing was carried out within frequency range 9kHz to the tenth harmonic. For details refer to
Appendix D. The Radiated Emissions testing was performed in the X, Y and Z axis orientation. The
worst-case Axis orientation is recorded in this test report.

5.2 Mains Emissions

5.2.1 Mains Conducted Emissions

RESULT:**Passed**

Test standard	:	FCC Part 15.207, FCC Part 15.107, ISED RSS-Gen Issue 5: 8.8
Limits	:	Mains Conducted emissions as defined in above test standards must comply with the mains conducted emission limits specified.
Kind of test site	:	Shielded Room
Test setup		
Operation mode	:	A
Ambient temperature	:	20-24 °C
Relative humidity	:	50-65 %
Atmospheric pressure	:	100-103 kPa

Factor (dB/m)=Antenna Factor(dB/m)+Cable loss (dB)

Level(dBuV/m)=Reading(dBuV)+ Factor(dB/m)

Remark: For details refer to Appendix D.

6. Safety Human exposure

6.1 Radio Frequency Exposure Compliance

6.1.1 Electromagnetic Fields

RESULT:**Passed**

Test standard : FCC KDB Publication 447498 D01

FCC:

Since maximum peak output power of the transmitter is 2.64 mW < 10mW, hence the EUT is excluded from SAR evaluation according to FCC KDB publication 447498: Mobile Portable RF Exposure

Canada:

Maximum conducted peak power:	2.64 mW
Antenna Gain:	-1.3 dbi
Maximum EIRP available	2 mW

Since maximum output power of the transmitter is 2.64mW(maximum power)<4mW (distance ≤5mm), hence the EUT is excluded from SAR evaluation according to Table 1 in ISED RSS-102, For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 of ISED RSS-102 are multiplied by a factor of 2.5.

---End---

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