RADIO PERFORMANCE TEST REPORT

Test Report No.	**: OT-211-RWD-018**
Reception No.	**: 2010003880**
Applicant	**: Life & Science Co., Ltd**
Address	**: 53, Maecheon-ro 17-gil, Buk-gu, Deagu, South Korea**
Manufacturer	**: Life & Science Co., Ltd**
Address	**: 53, Maecheon-ro 17-gil, Buk-gu, Deagu, South Korea**
Type of Equipment	**: Educational toys**
FCC ID.	**: 2AYLR-ROBOTORI-LNS**
Model Name	**: Robotori coding plus**
Multiple Model Name	**: Refer to the section 3.2**
Serial number	**: N/A**
Total page of Report	**: 53 pages (including this page)**
Date of Incoming	**: December 02, 2020**
Date of issue	**: January 14, 2021**

SUMMARY

The equipment complies with the regulation; ***FCC PART 15 SUBPART C Section 15.247***

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Tested by	Reviewed by	Approved by
/ Su-Min Yoo / Assistant Manager	/ Ha-Ram Lee / Manager	/ Ki-Hong, Nam / General Manager
ONETECH Corp.	ONETECH Corp.	ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-211-RWD-018	January 14, 2021	Initial Release	All

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1. VERIFICATION OF COMPLIANCE

Applicant : Life & Science Co., Ltd

Address : 53, Maecheon-ro 17-gil, Buk-gu, Deagu, South Korea

Contact Person : DongGeun Song / Project Engineer

Telephone No. : +82-53-312-1075

FCC ID : 2AYLR-ROBOTORI-LNS

Model Name : Robotori coding plus

Brand Name : N/A

Serial Number : N/A

Date : January 14, 2021

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Educational toys
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

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2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-20122/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

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3. GENERAL INFORMATION

3.1 Product Description

The Life & Science Co., Ltd, Model Robotori coding plus (referred to as the EUT in this report) is a Educational toys. The product specification described herein was obtained from product data sheet or user's manual.

Device Type	Educational toys	
Operating Frequency	2 402 MHz ~ 2 480 MHz	
RF Output Power	Nordic Module	-20.39 dBm
	TORIANO Module	-21.80 dBm
Number of Channel	40 Channels	
Modulation Type	GFSK	
Antenna Type	Nordic Module	PCB Antenna
	TORIANO Module	
Antenna Gain	Nordic Module	0.61 dBi
	TORIANO Module	-6.77 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	32 MHz	
Rated Supply Voltage	DC 6.0 V	

Note. : Bluetooth LE of Nordic module & TORIANO Module is operate simultaneously.

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3.2 Alternative type(s)/model(s); also covered by this test report.

-. The following lists consist of the added model and their differences.

Model Name	Differences	Tested
Robotori coding plus	Basic Model	☑
TORI-MINI Animal series (puppy)	This Model is identical to basic model except for the number of block & sensor depending on each product's concept.	☐
TORI-MINI Animal series (snake)		
TORI-MINI Animal series (chameleon)		
TORI-MINI Animal Series (Turtle)		
Tori dinosaur T-REX		
Tori dinosaur Parasaurolophus		
Tori dinosaur Stegosaurus		
Tori Loo Blue		
Tori Loo Yellow		
Tori Chameleon		
TORI-MINI BOOK Dinosaur series T-REX		
TORI-MINI BOOK Dinosaur series Parasaurolophus		
TORI-MINI BOOK Dinosaur series Stegosaurus		
Tori Puppy		
Tori Ele		
Tori Mouse		
Tori Seal		
TORI-Gun		
Truck Set		
Game Tori		
TORI - Science Kit		
TORI BLOCK - Think TORI 1		
TORI BLOCK - Think TORI 2		
TORI SPACE FIGHTER		
ANITORI		

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Model Name	Differences	Tested
TORI MEGA TRUCK	This Model is identical to basic model except for the number of block & sensor depending on each product's concept.	☐
Tori land series 1		
Tori land series 2		
Tori land series 3		
TORI BLOCK - Flying TORI		
Chicken Roulette Game		
Roke		
Shoot TORI One-Player		
Shoot TORI Two-Player		
TORI BLOCK - Mega TORI		
creative kit		
Robotori Junior		
Jodie		
All my Animals TORI PUPPY		
All my Animals TORI TURTLE		
All my Animals TORI DINOSAUR		
All my Animals TORI BIRD		
All my Animals SET		
CAR RACER JODIE		
JODIE'S DRIVING PLAY SET		
TORI SCRATCH		
Tori Scratch Jr.		
Chacha		
Celly		
Robotori Coding Class		
Rokids Plus(Build a City)		
ROCOMI SERIES 01		
Robot Creation Class STEP 1		
Robot Creation Class STEP 2		
Robot Creation Class STEP 3		
Robot Creation Class STEP 4		

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Model Name	Differences	Tested
Robot Creation Class STEP 5	This Model is identical to basic model except for the number of block & sensor depending on each product's concept.	☐
Logic Boost CODING CLASS 1 (Scratch Coding Kit)		
Logic Boost CODING CLASS 2 (Scratch Coding Kit)		
Logic Boost CODING CLASS 3 (Scratch Coding Kit)		
Logic Boost CODING CLASS 4 (Scratch Coding Kit)		
Logic Boost CODING CLASS 1(Rocomi Coding Kit)		
Logic Boost CODING CLASS 2(Rocomi Coding Kit)		
Logic Boost CODING CLASS 3(Rocomi Coding Kit)		
Robot Creation Class RS1		
Robot Creation Class RS2		
Robot Creation Class RS3		
Robot Creation Class RS4		
robothink full kit		
robothink half kit		
robothink S1		
robothink S2		
robothink S3		
robothink S4		

Note: 1. Applicant consigns only basic model to test. Therefore this test report just guarantees the units, which have been tested.

2. The Applicant/manufacturer is responsible for the compliance of all variants.

4. EUT MODIFICATIONS

-. None

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5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
SB1_Servo Motor Board	Life & Science Co., Ltd	N/A	N/A
E1_Slide_SW Module Board	Life & Science Co., Ltd	N/A	N/A
E5_Main_Booster Board	Life & Science Co., Ltd	N/A	N/A
SE9_RCU Sensor Board	Life & Science Co., Ltd	N/A	N/A
SE10_DL Driver Board	Life & Science Co., Ltd	N/A	N/A
E4-2_Remocon Control Board	Life & Science Co., Ltd	N/A	N/A
SE8_IR Sensor Board	Life & Science Co., Ltd	N/A	N/A
SE7_TACT SW(Chicken Dart) Board	Life & Science Co., Ltd	N/A	N/A
SE4_MIC Sensor Board	Life & Science Co., Ltd	N/A	N/A
SE3_LED Sensor Board	Life & Science Co., Ltd	N/A	N/A
E5-1_Atmega128 Main Board	Life & Science Co., Ltd	N/A	N/A
SE7-1_Button Sensor Board	Life & Science Co., Ltd	N/A	N/A
SE12_CDS Sensor Board	Life & Science Co., Ltd	N/A	N/A
SE13_Porentiometer(RV) Sensor Board	Life & Science Co., Ltd	N/A	N/A
SE14_Tilt Sensor Board	Life & Science Co., Ltd	N/A	N/A
E3-2_Remocon_4SW Board	Life & Science Co., Ltd	N/A	N/A
SE6_Melody Sensor Board	Life & Science Co., Ltd	N/A	N/A
SB1_Servo Motor_REV02 Board	Life & Science Co., Ltd	N/A	N/A
E-10 Toriano Board	Life & Science Co., Ltd	N/A	N/A
Ultra Sonic Board	Life & Science Co., Ltd	N/A	N/A
Nordic module Board	Life & Science Co., Ltd	N/A	N/A

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
Robotori coding plus	Life & Science Co., Ltd	Educational toys (EUT)	
HP Probook	HP	Notebook PC	EUT
PPP009L-E	LIE-ON TECHNOLOGY (CHANGZHOU)CO.,LTD.	AC Adapter	Notebook PC

5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 402 MHz, 2 440 MHz, and 2 480 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this report.

-. Frequency / Channel Operations

Channel	Frequency
0	2 402
19	2 440
39	2 480

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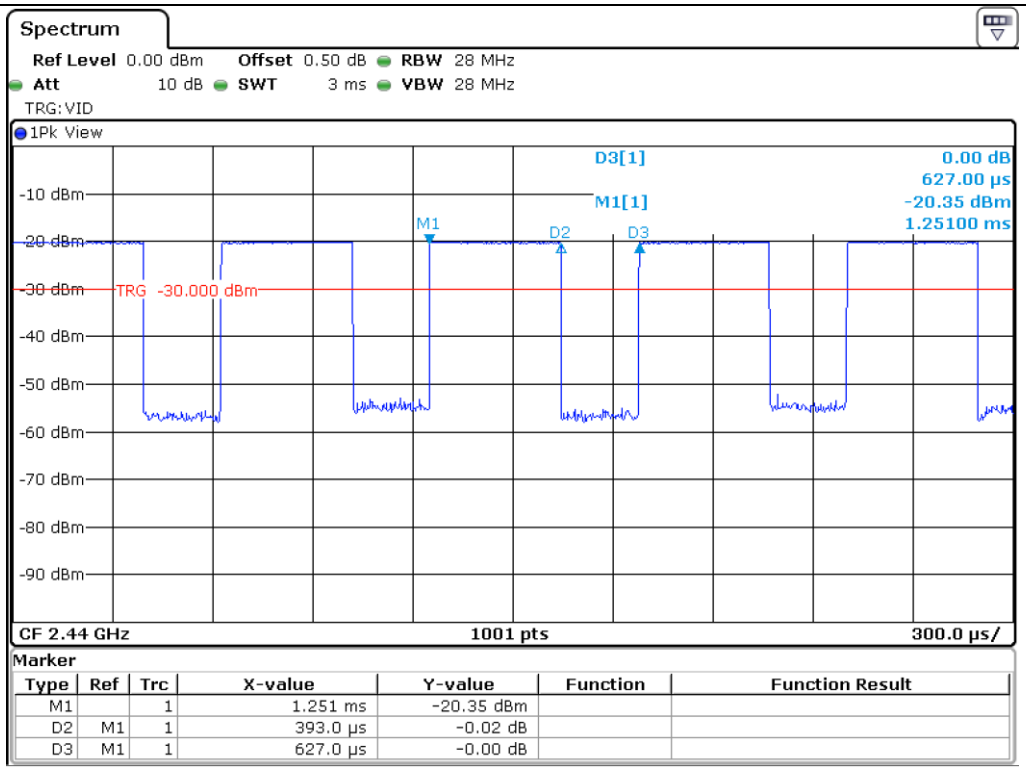
-. Duty Cycle (Nordic Module)

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth LE	0.393	0.234	62.68	2.03

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot



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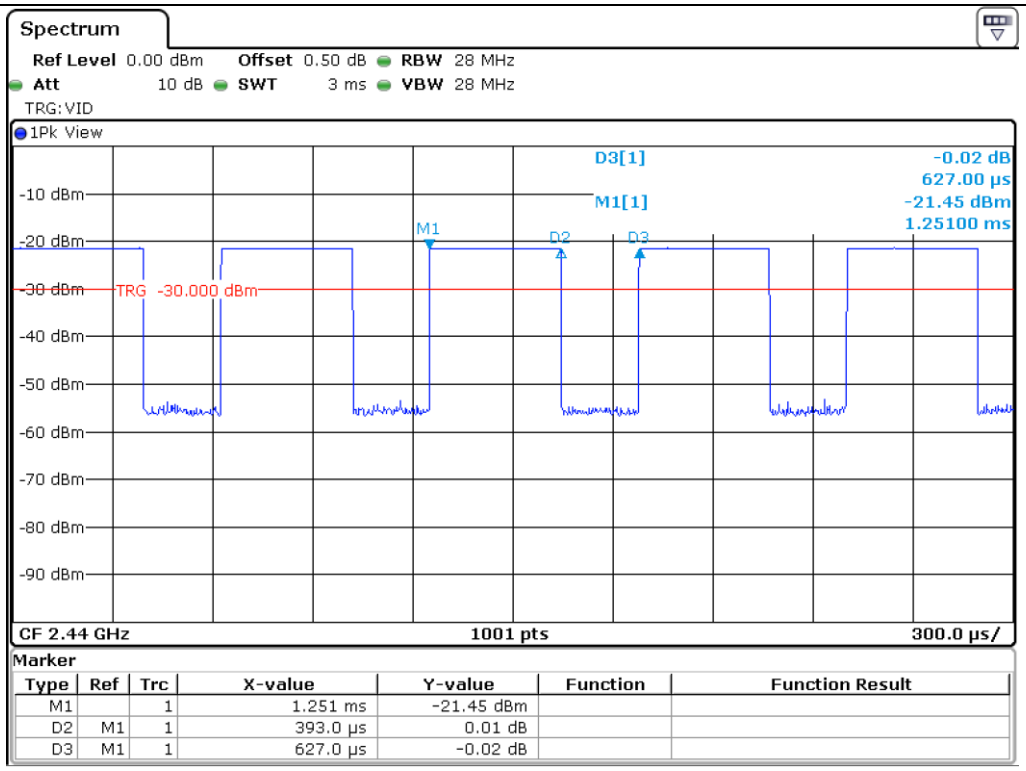
-. Duty Cycle (TORIANO Module)

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth LE	0.393	0.234	62.68	2.03

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot



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5.4 Configuration of Test System

Line Conducted Test: As the EUT is operated by DC battery, this test item is not requirement to be performed.

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The antenna of the EUT is a PCB Antenna on the main boards of 2 modules in the EUT, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

As the EUT is operated by DC battery, this test item is not requirement to be performed.

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

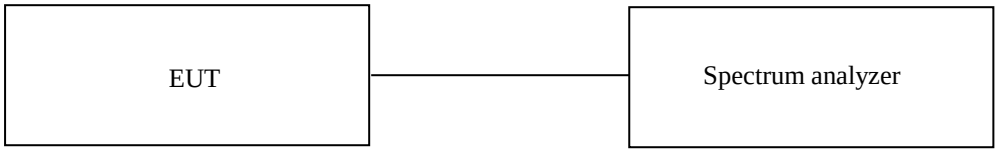
7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.3 Test Date

December 03, 2020 ~ January 05, 2021

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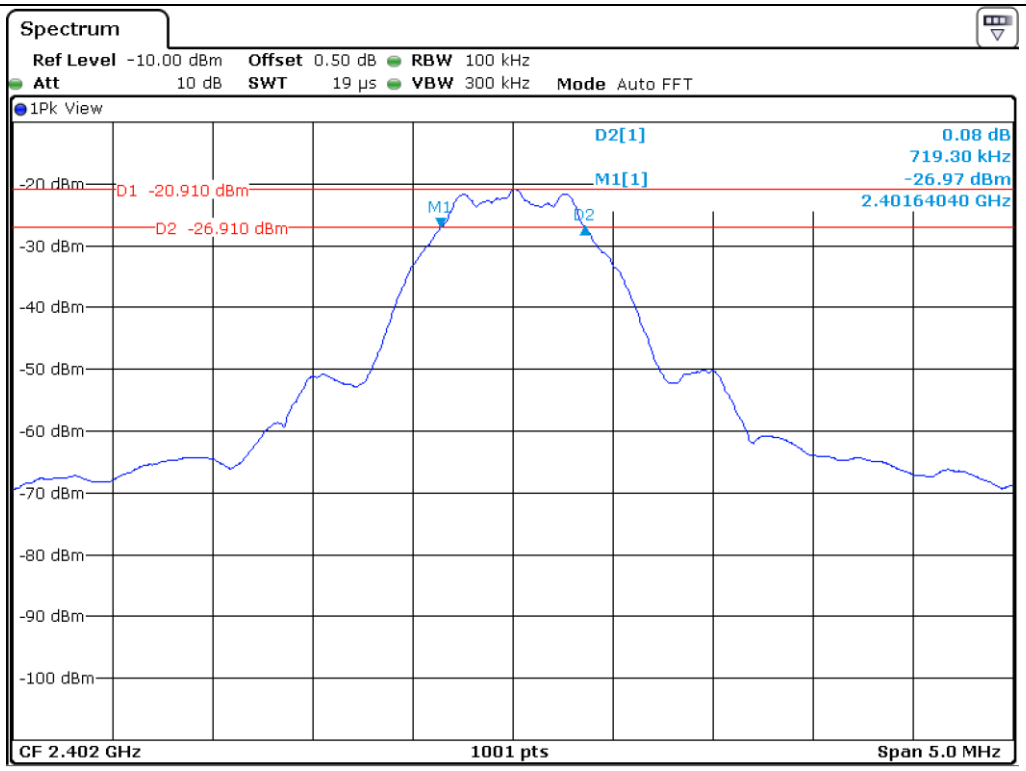
7.4 Test data for Nordic Module

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	719.30	500.00	219.30
Middle	2 440.00	709.30	500.00	209.30
High	2 480.00	704.30	500.00	204.30

Remark. Margin = Measured Value - Limit



Low Channel

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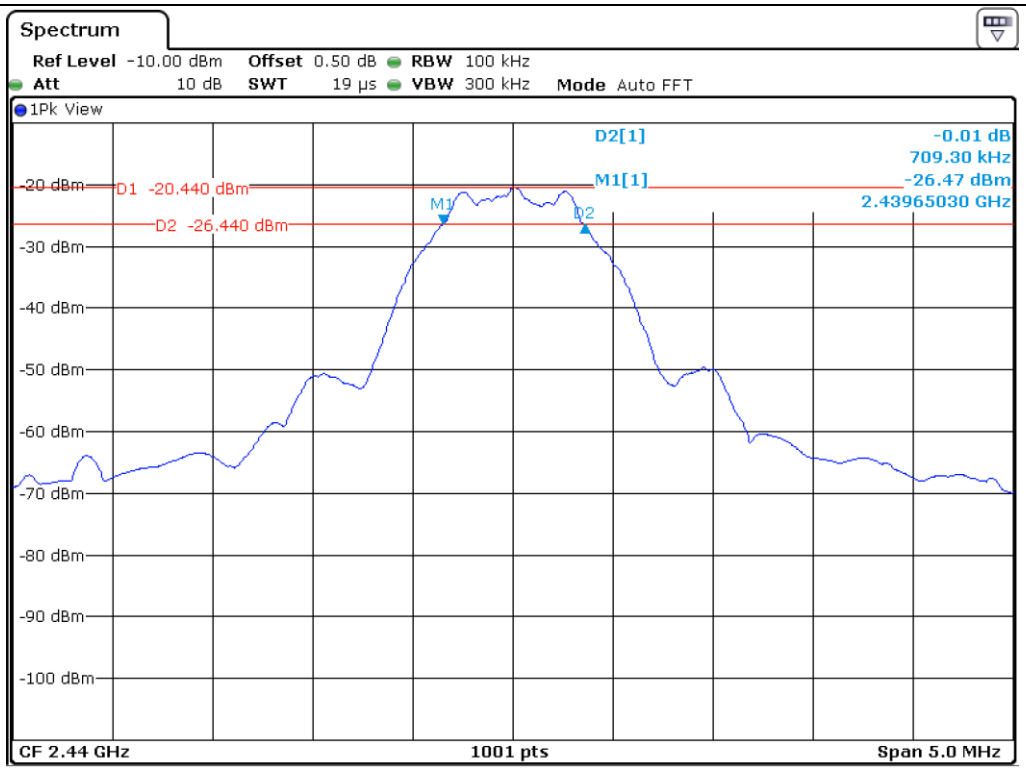
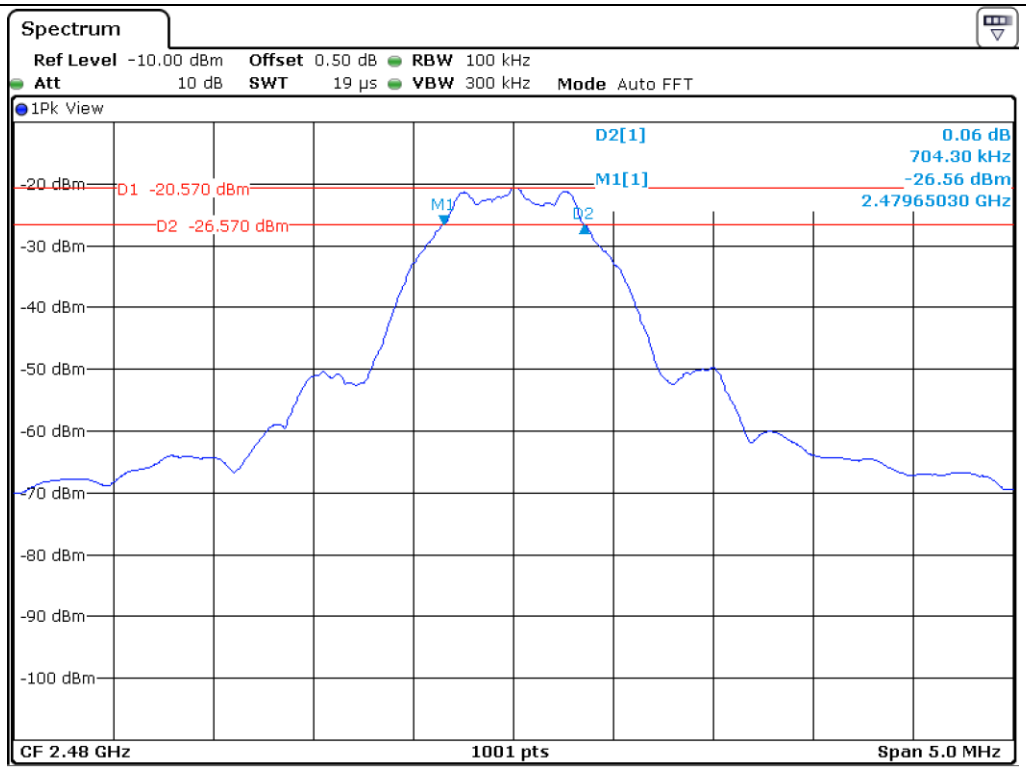


Middle Channel



High Channel

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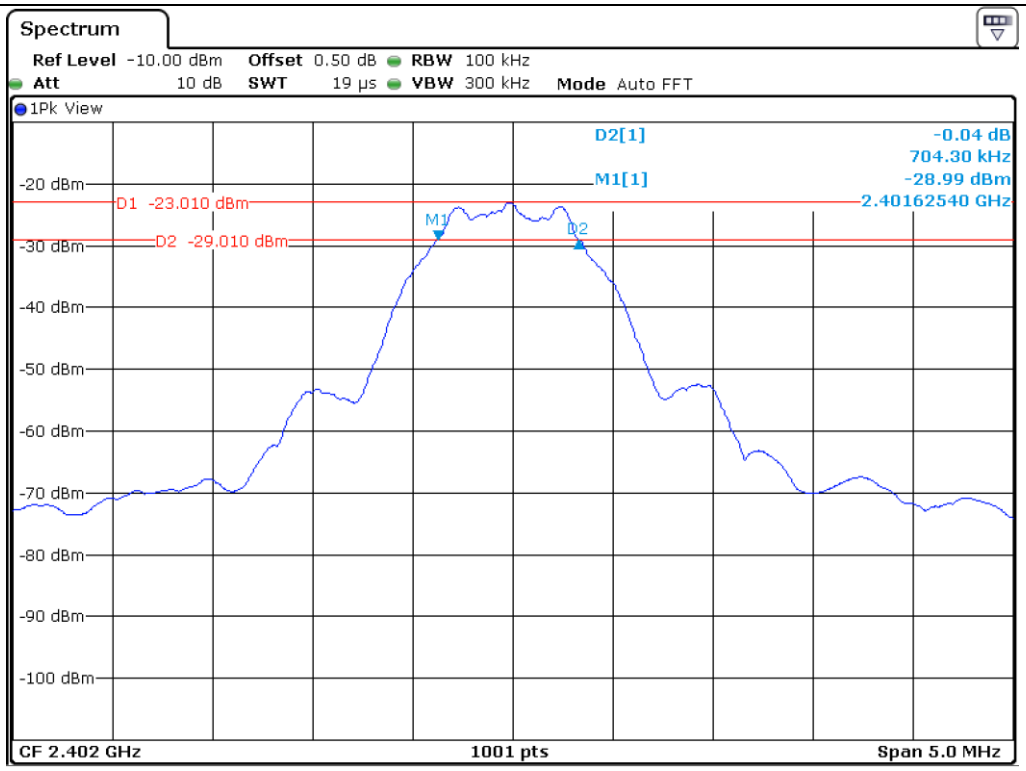
7.5 Test data for TORIANO Module

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	704.30	500.00	204.30
Middle	2 440.00	719.30	500.00	219.30
High	2 480.00	714.30	500.00	214.30

Remark. Margin = Measured Value - Limit



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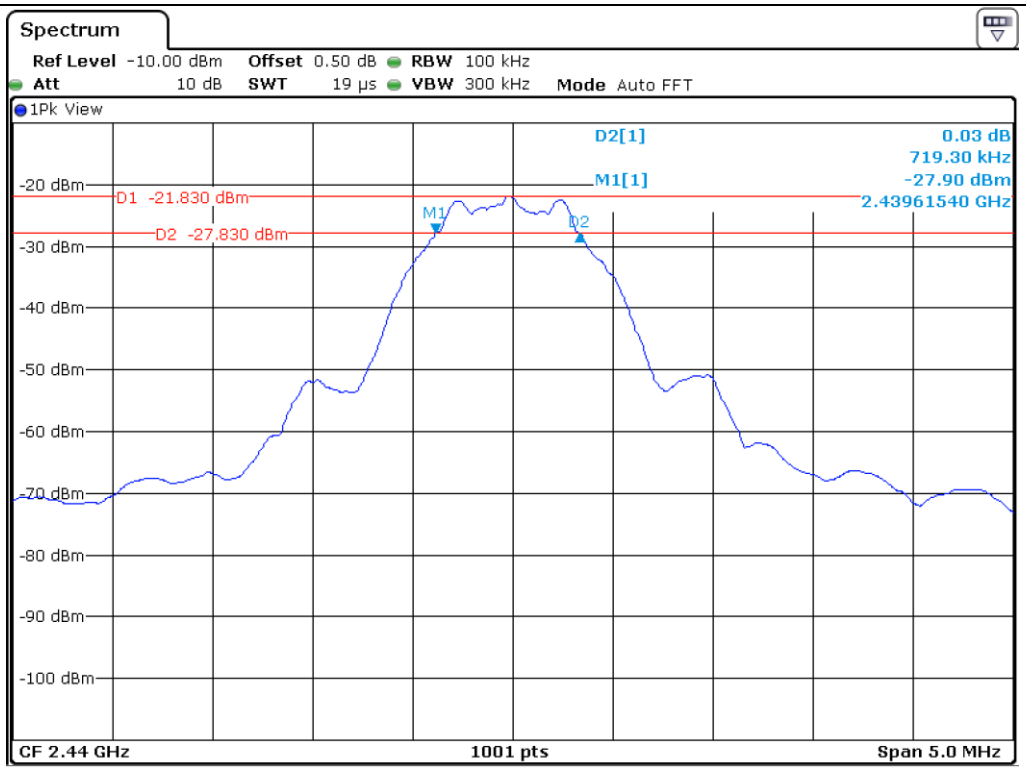
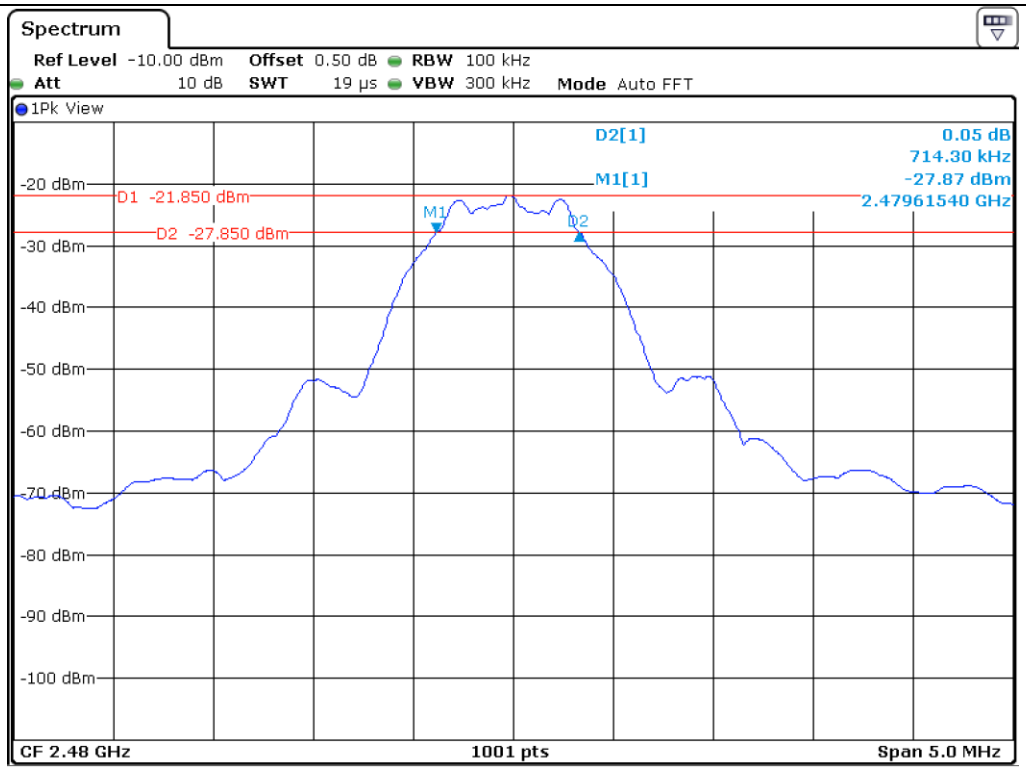


Middle Channel



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8. MAXIMUM PEAK OUTPUT POWER

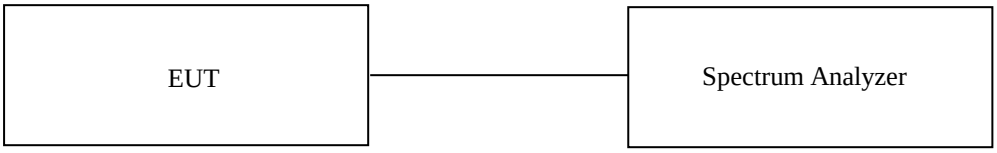
8.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to ≥ DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.



8.3 Test Date

December 03, 2020 ~ January 05, 2021

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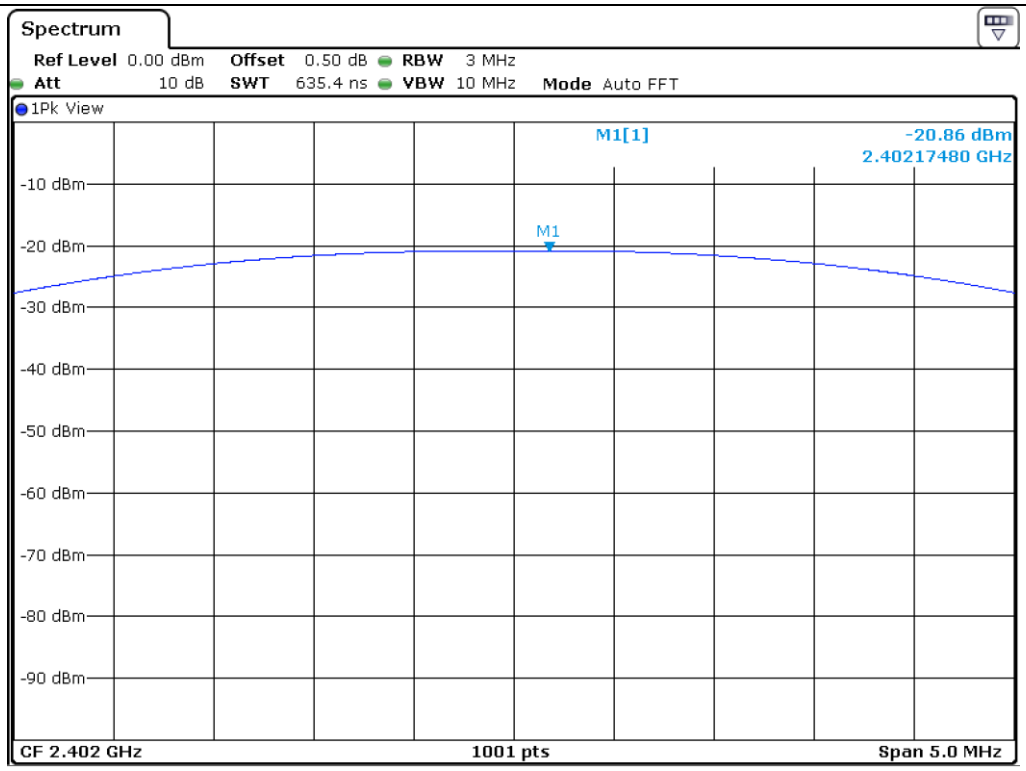
8.4 Test data for Nordic Module

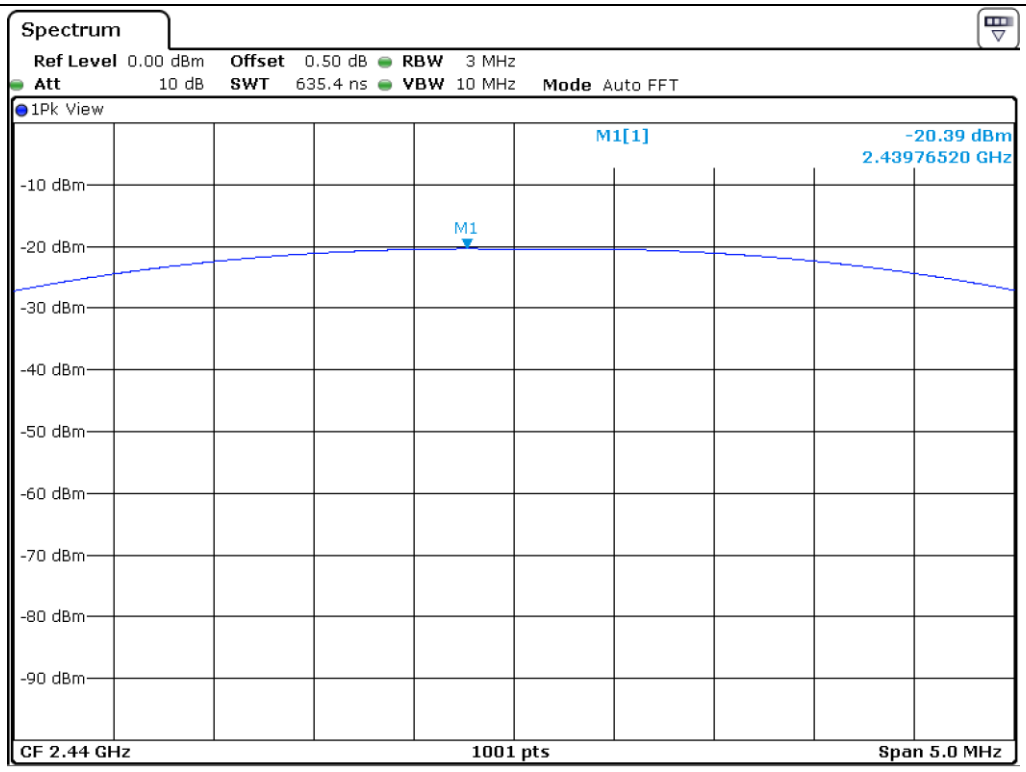
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-20.86	30.00	50.86
MIDDLE	2 440.00	-20.39	30.00	50.39
HIGH	2 480.00	-20.49	30.00	50.49

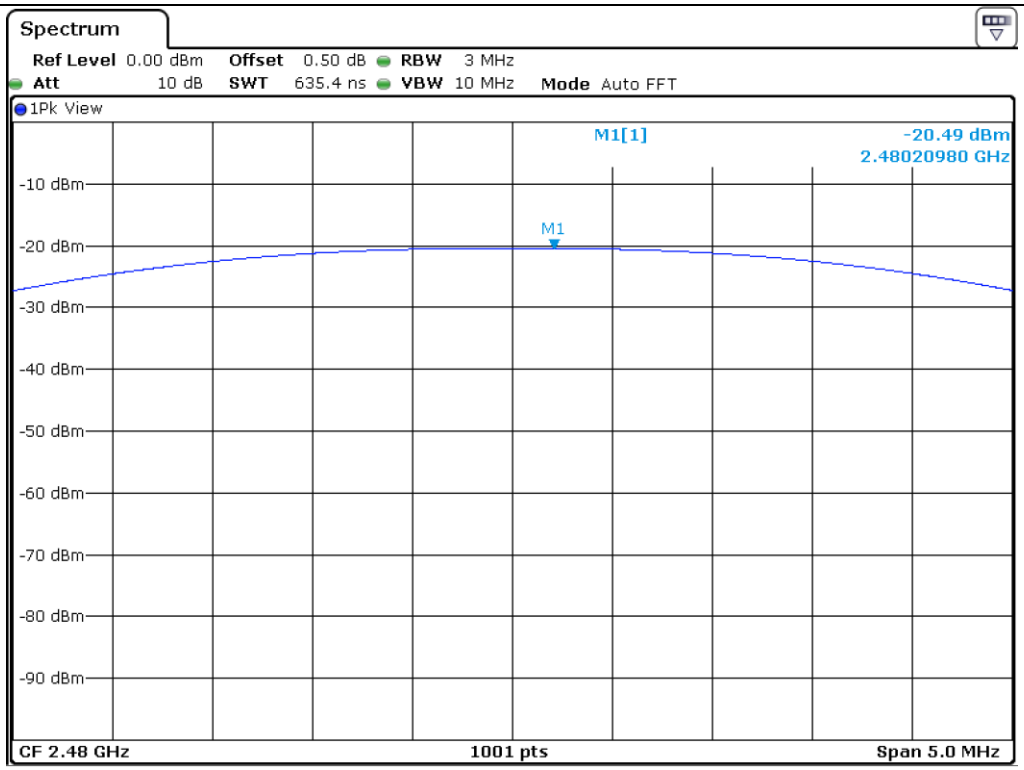
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



Low Channel



Middle Channel



High Channel

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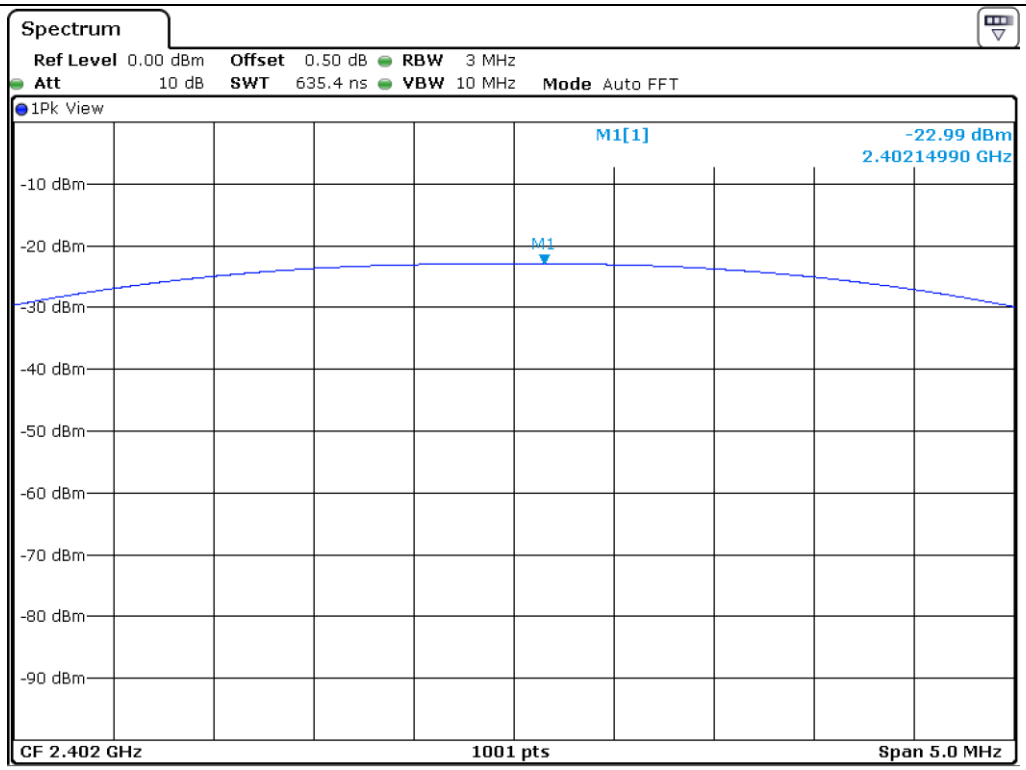
8.5 Test data for TORIANO Module

-. Test Result : Pass

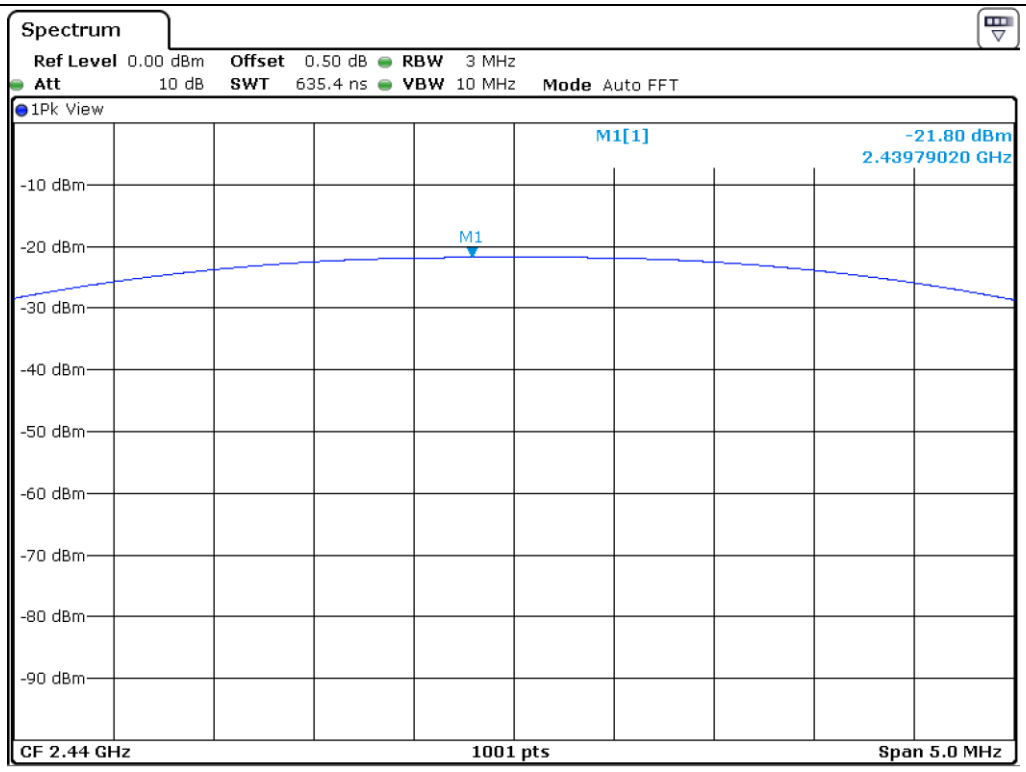
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-22.99	30.00	52.99
MIDDLE	2 440.00	-21.80	30.00	51.80
HIGH	2 480.00	-21.80	30.00	51.80

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

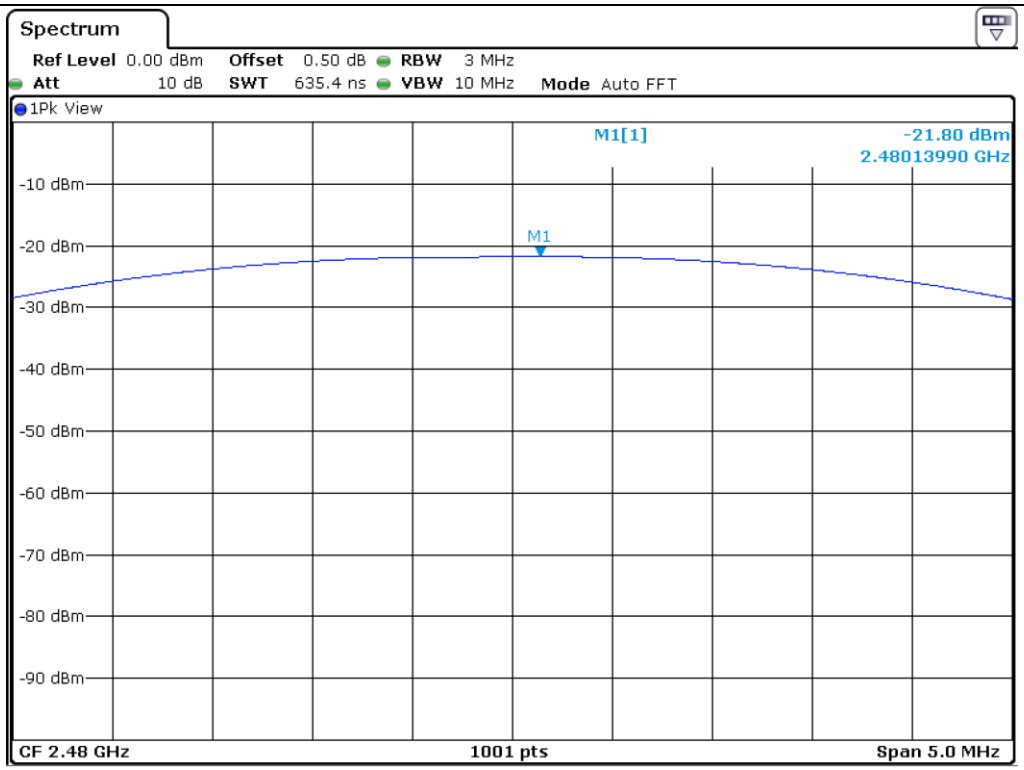


Low Channel

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)



Middle Channel



High Channel

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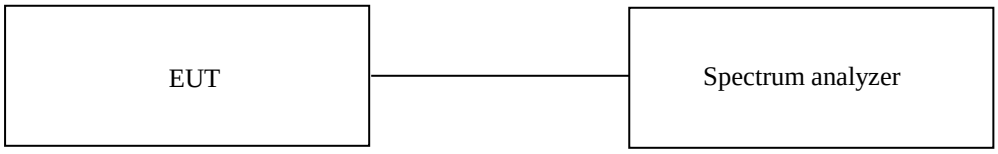
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, the video bandwidth is set to 3 times the resolution bandwidth and peak detection was used.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

9.4 Test Date

December 03, 2020 ~ January 05, 2021

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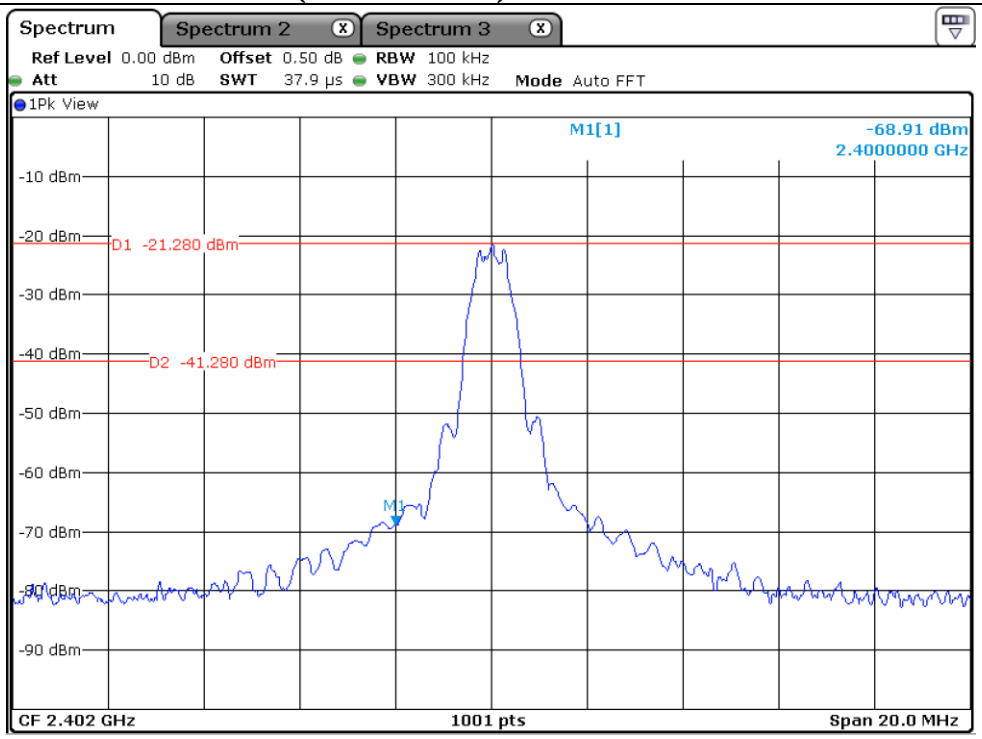
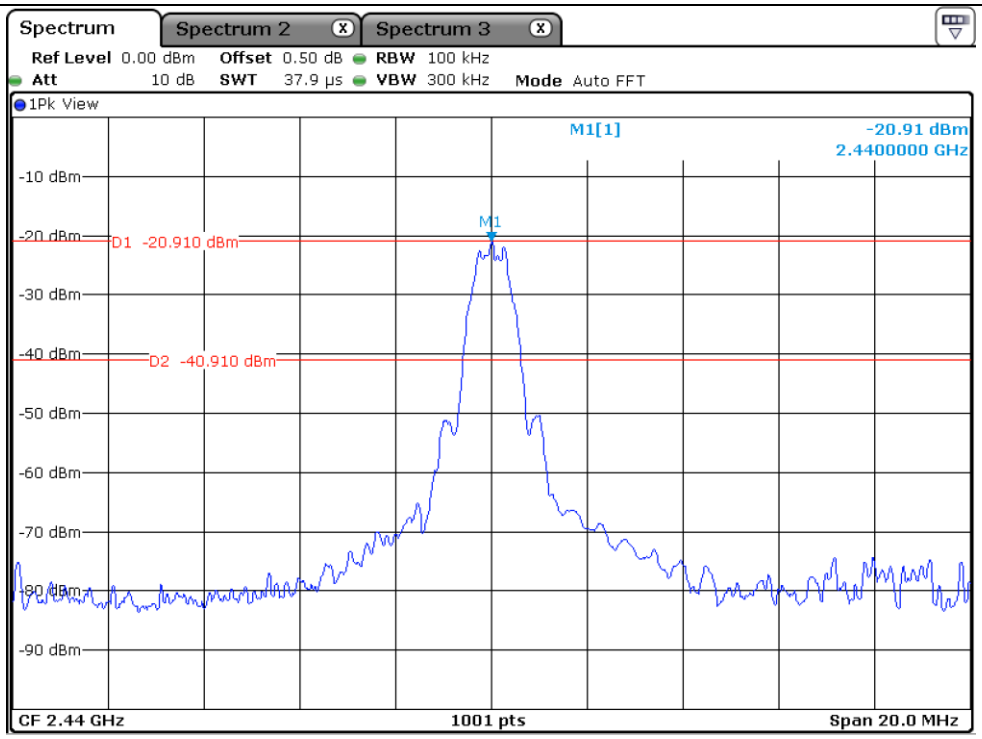
9.5 Test data for conducted emission (Nordic Module)



Low Channel



Middle Channel

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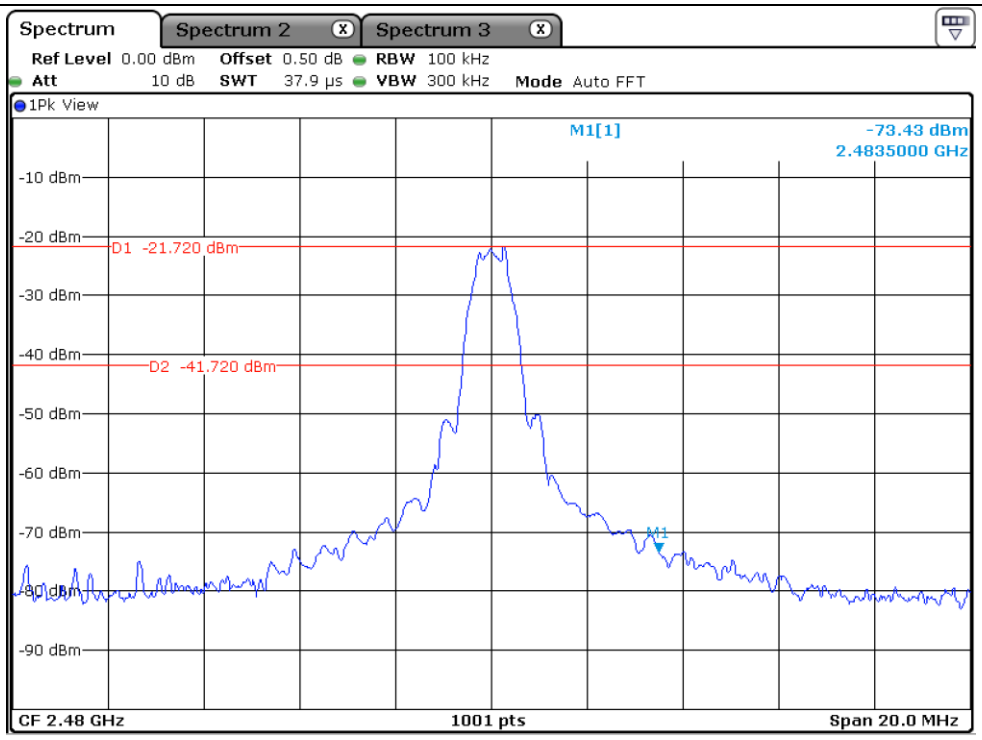

High Channel

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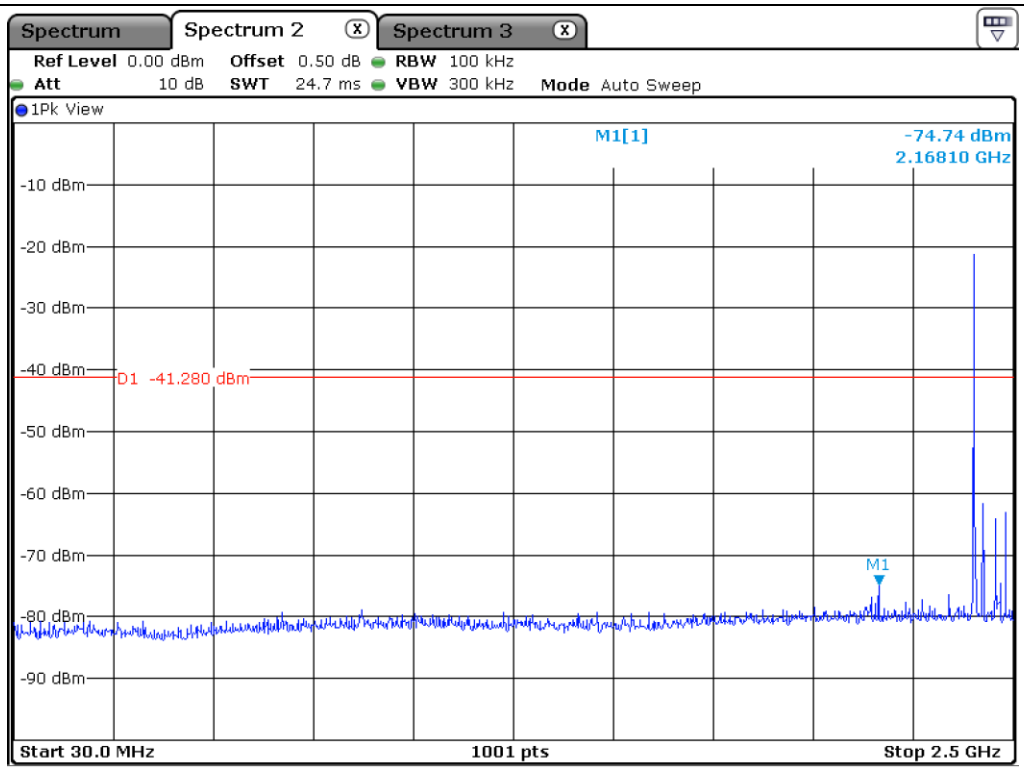
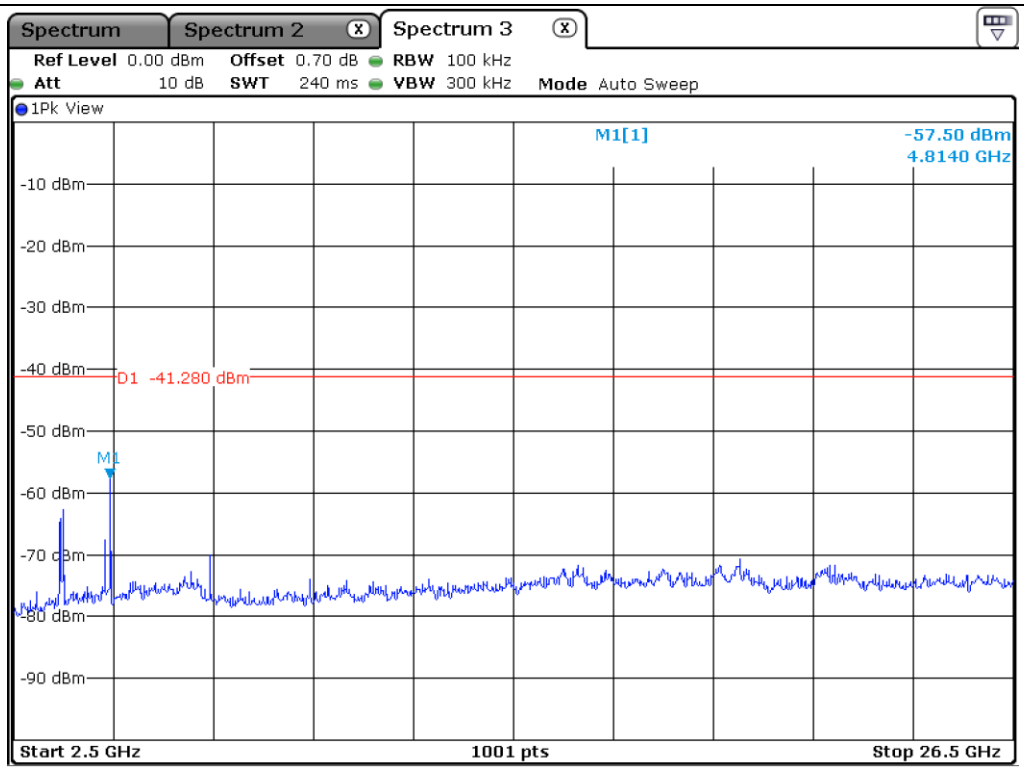


Low Channel



Low Channel

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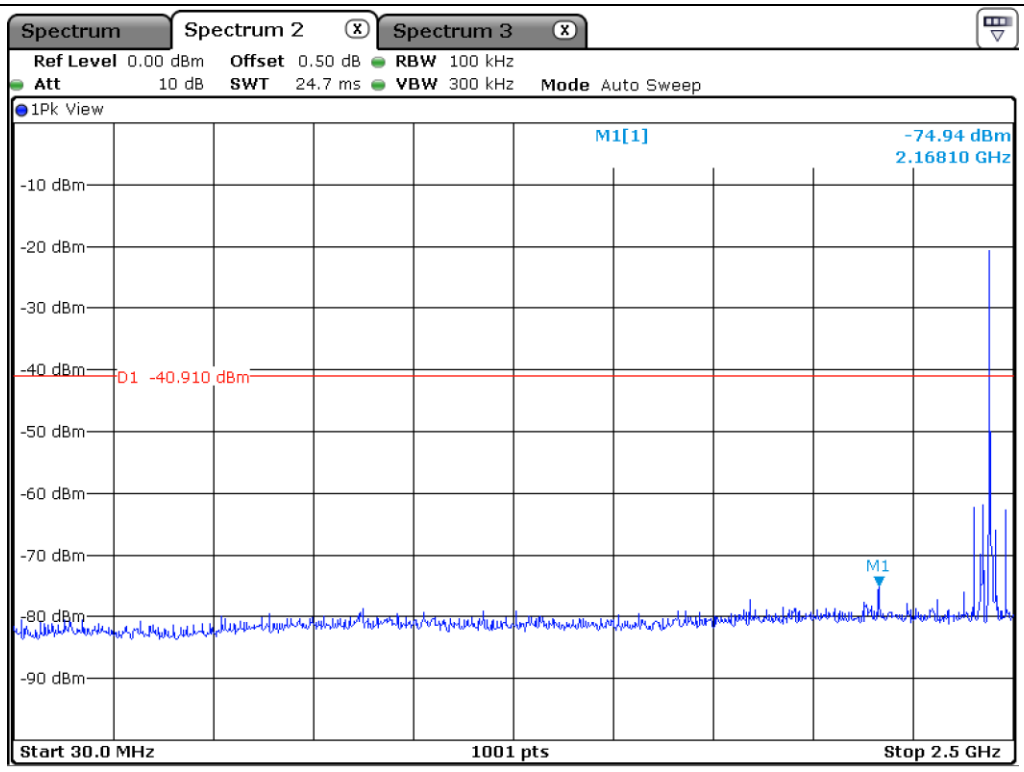
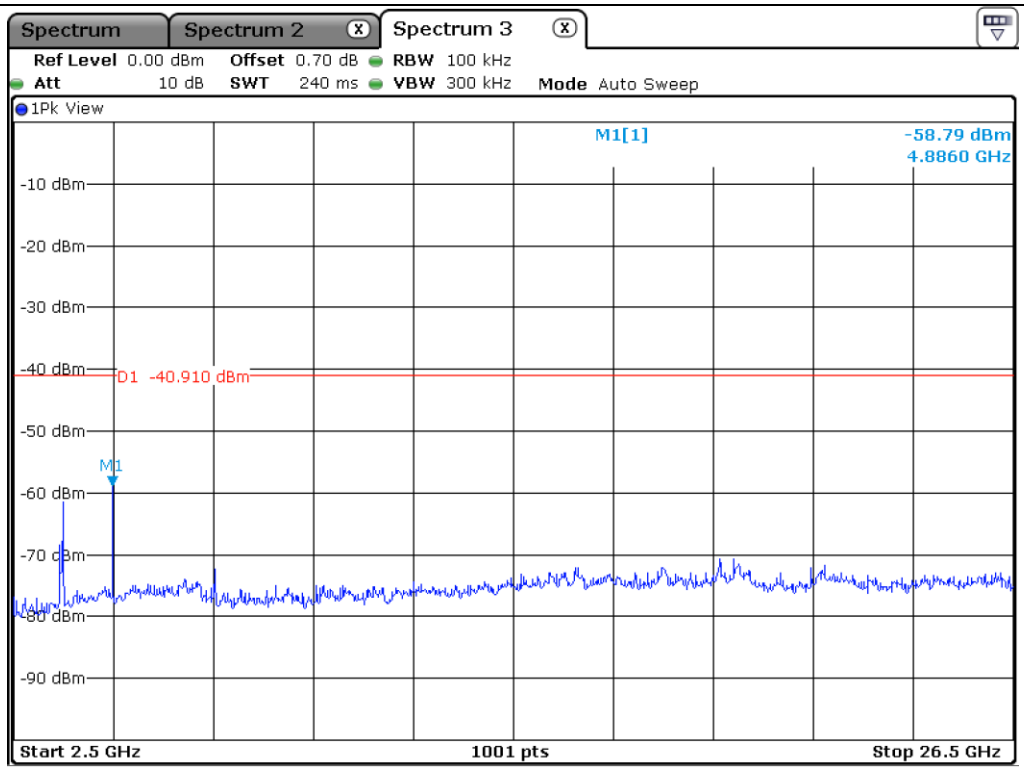
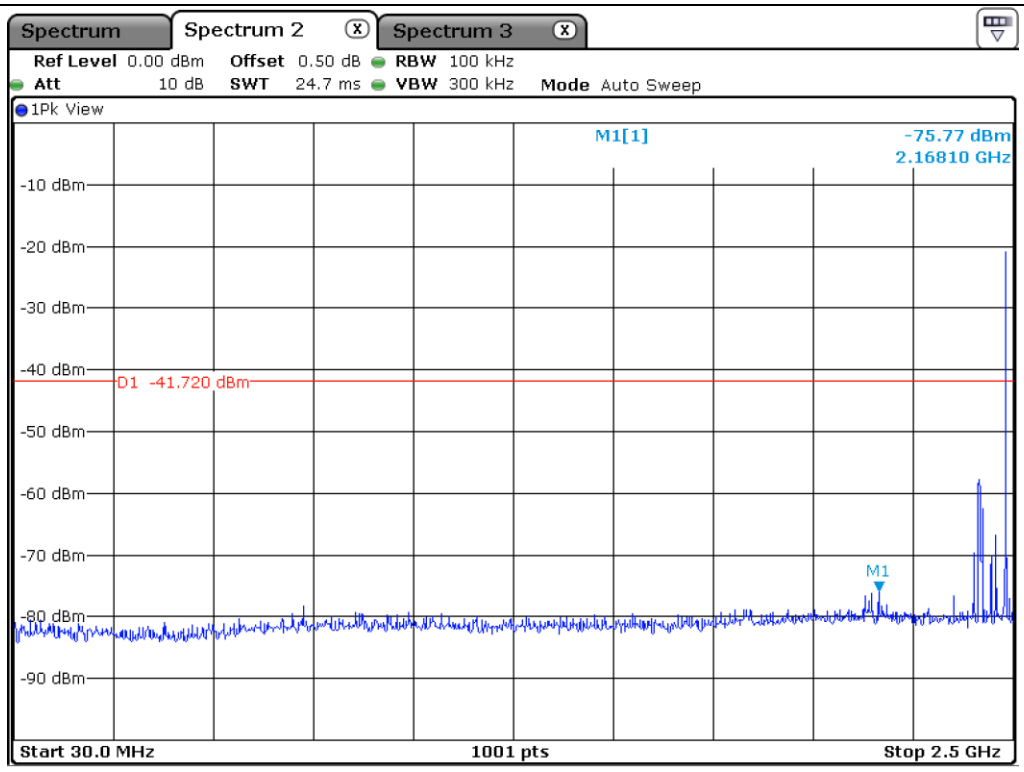


Middle Channel

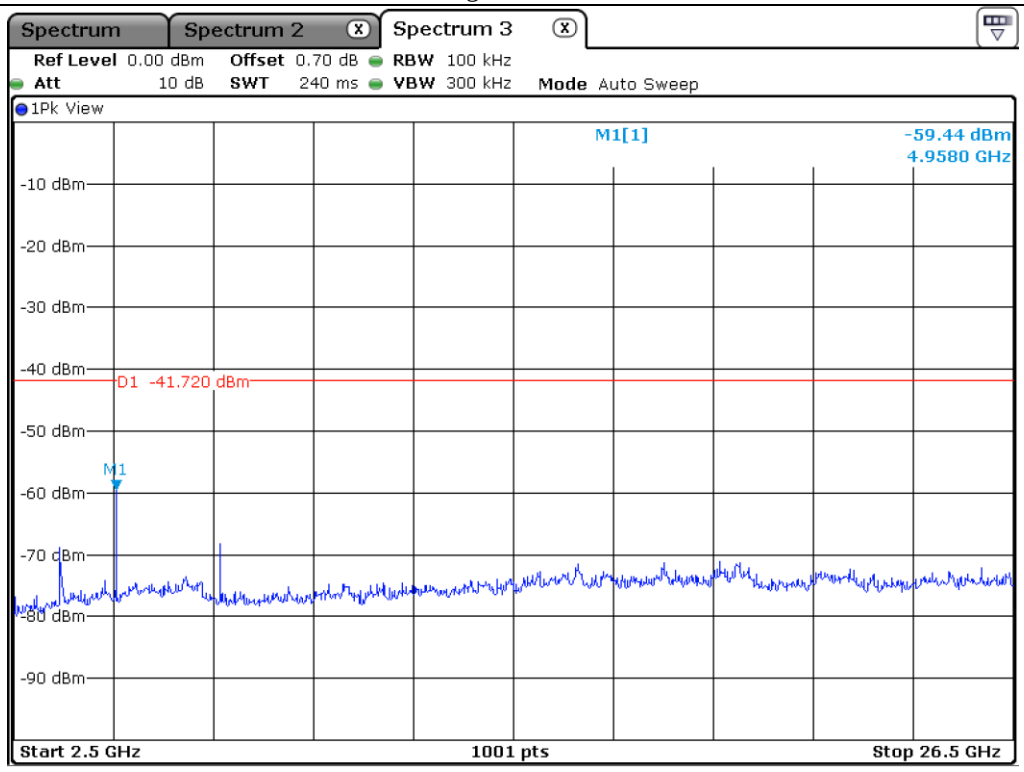


Middle Channel

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)



High Channel



High Channel

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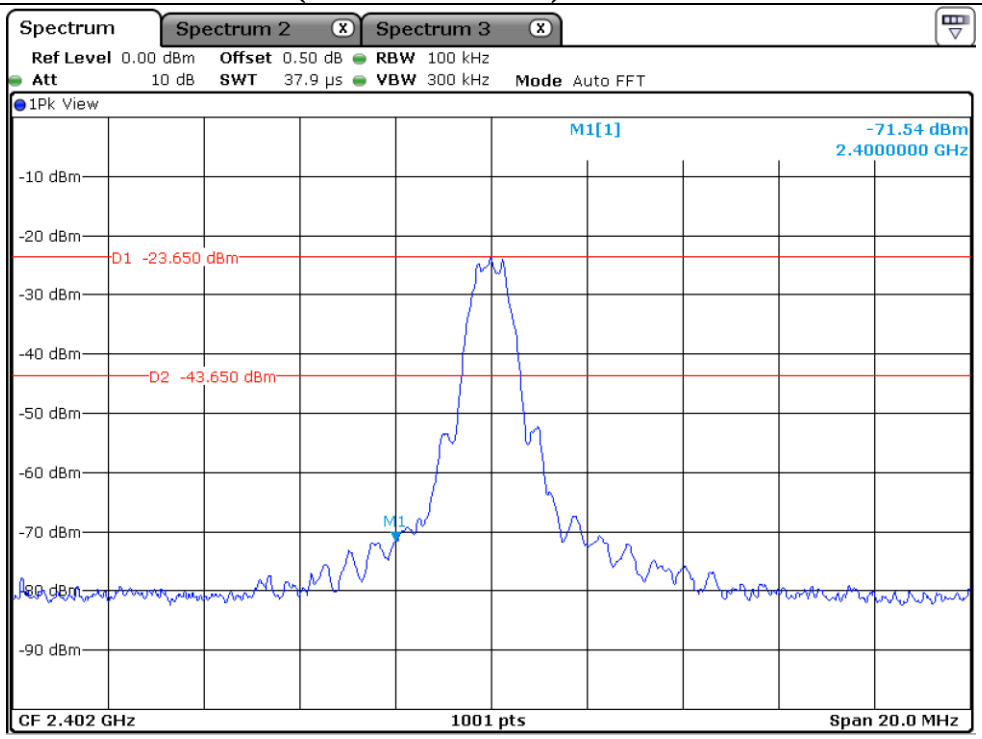
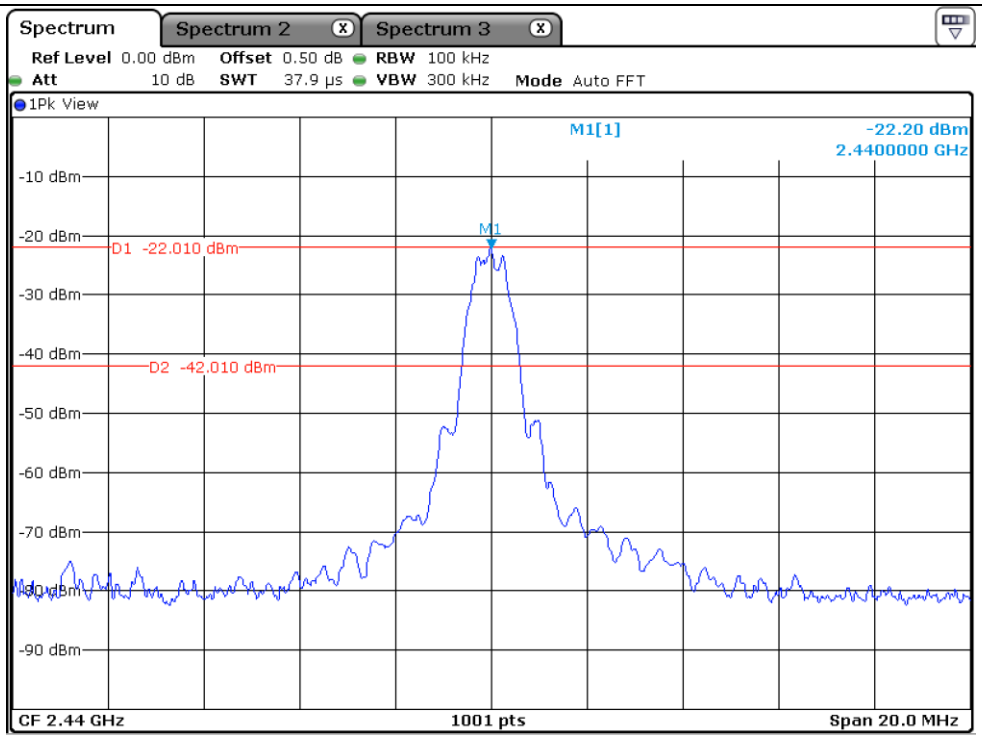
9.6 Test data for conducted emission (TORIANO Module)



Low Channel



Middle Channel

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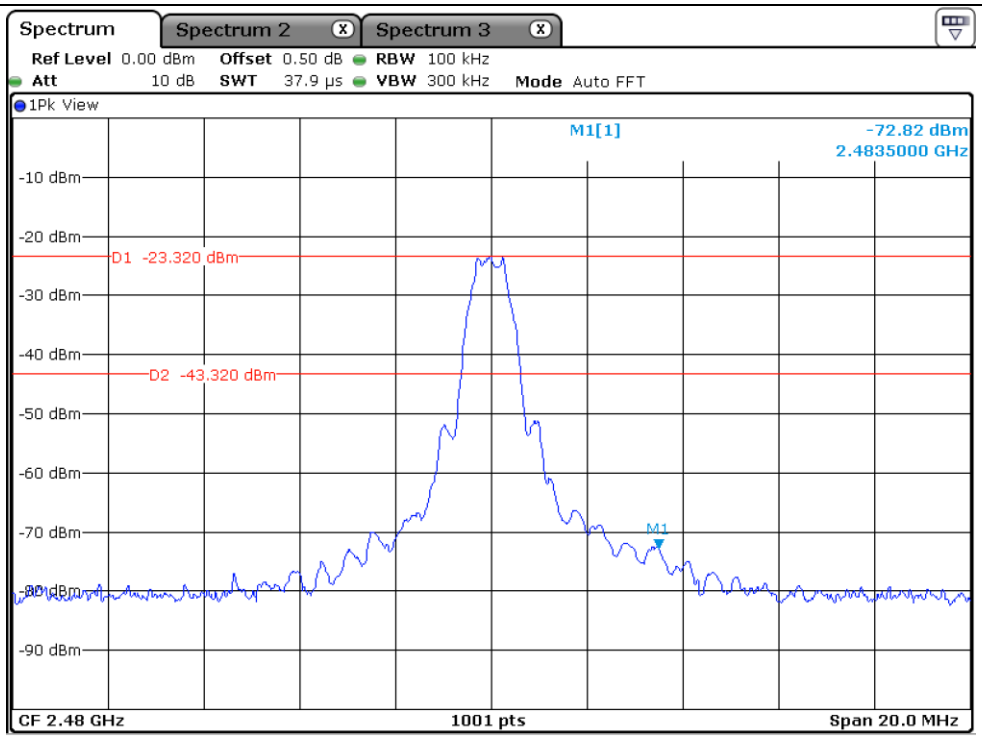

High Channel

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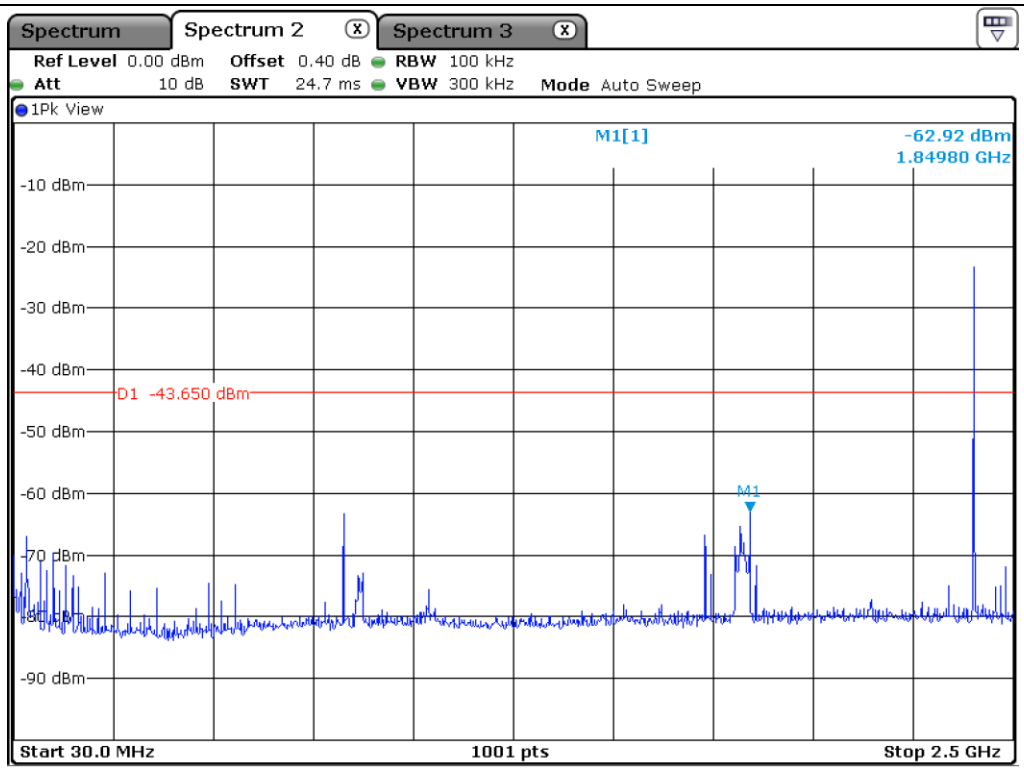
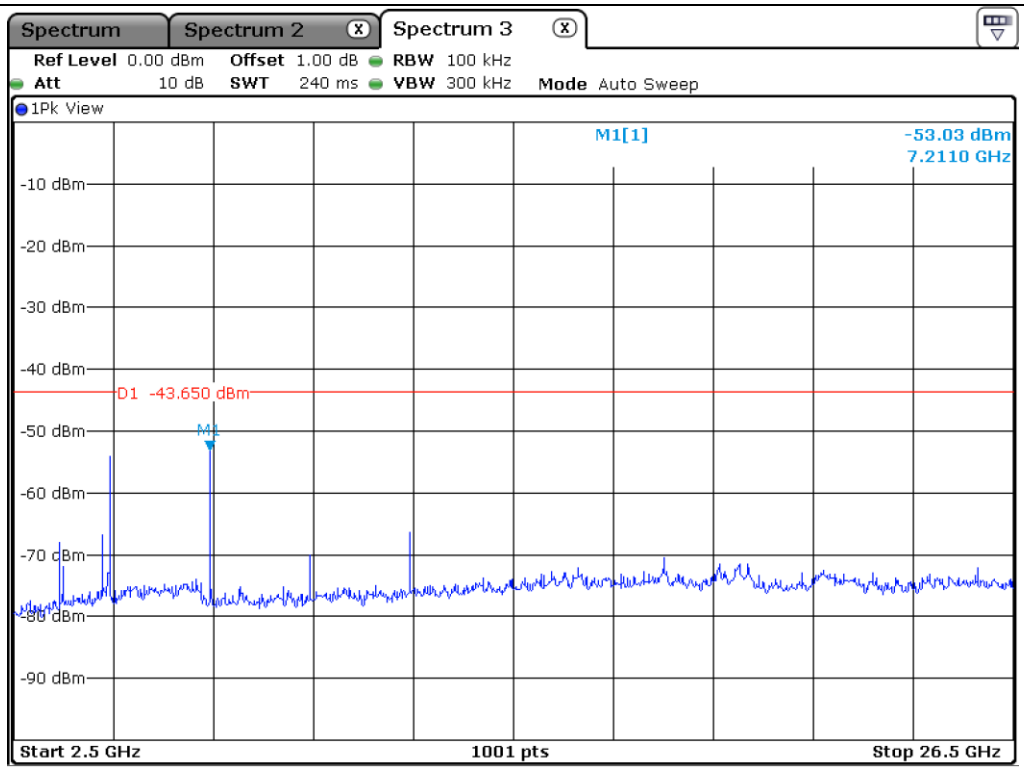


Low Channel



Low Channel

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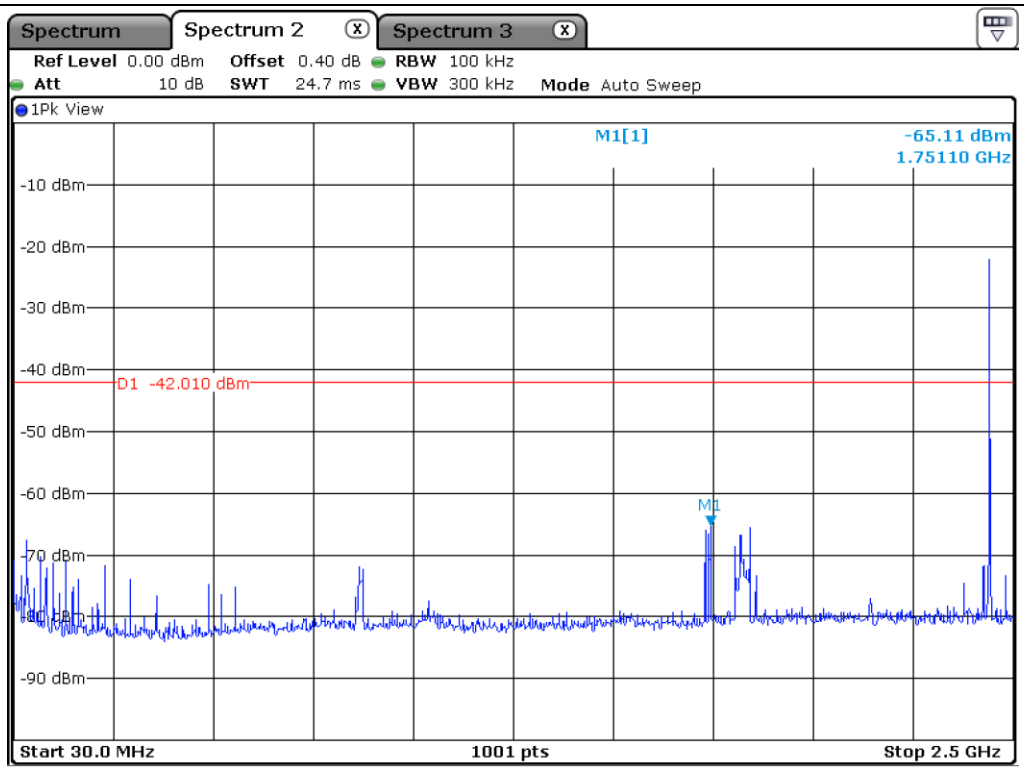
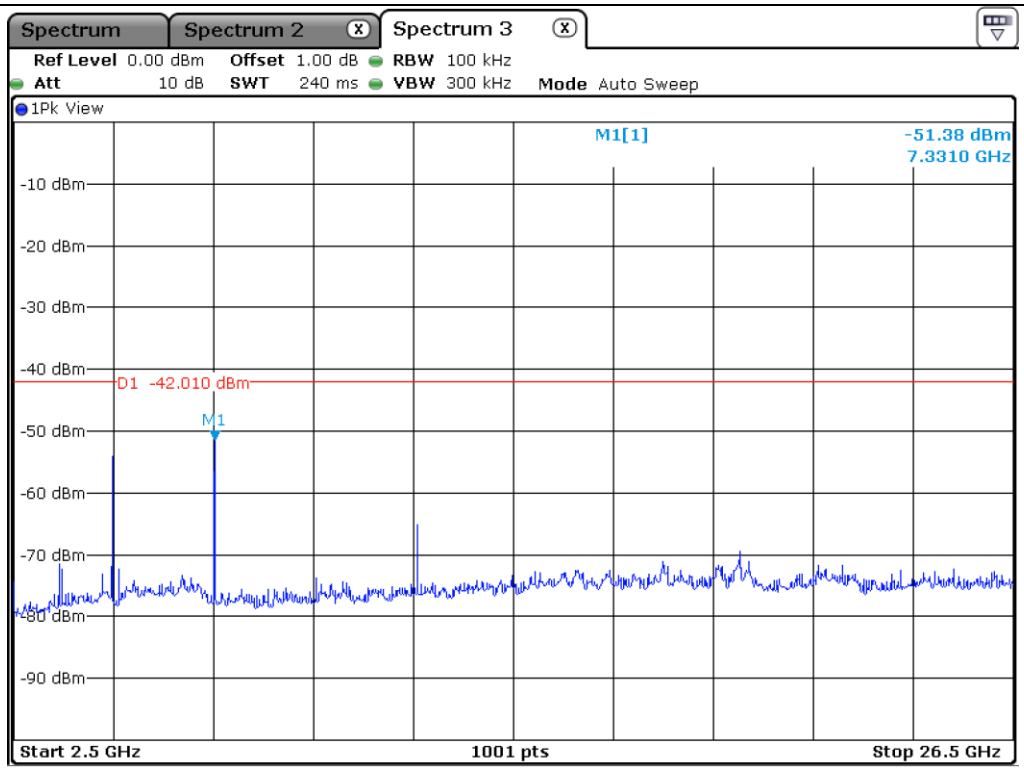


Middle Channel



Middle Channel

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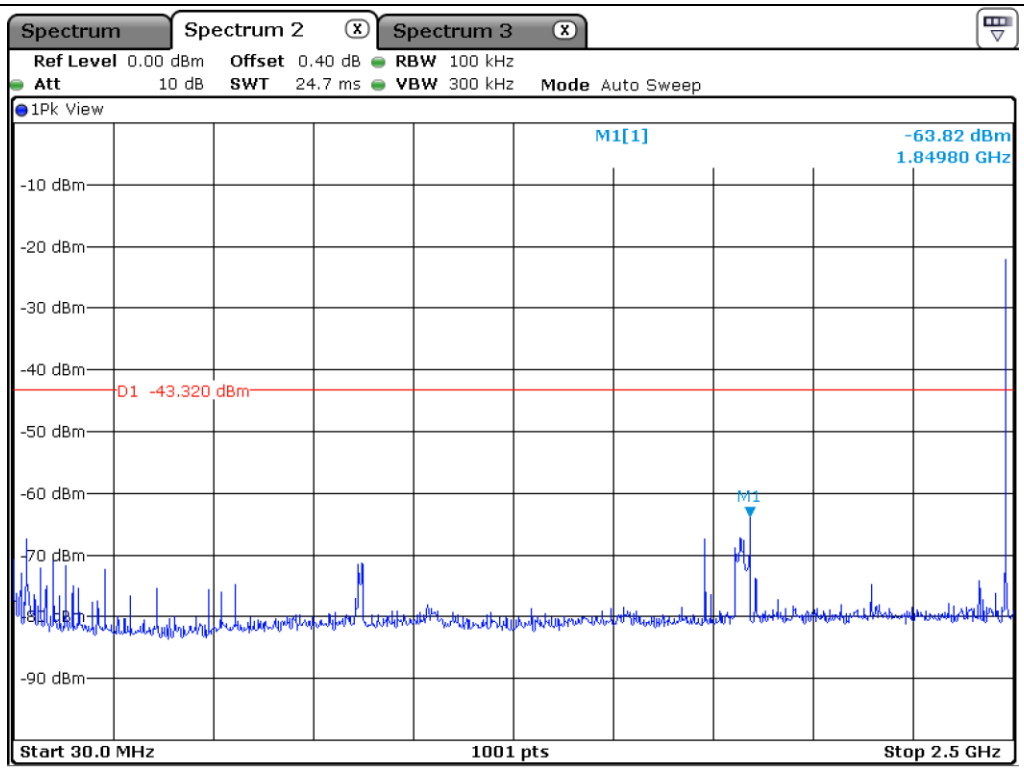
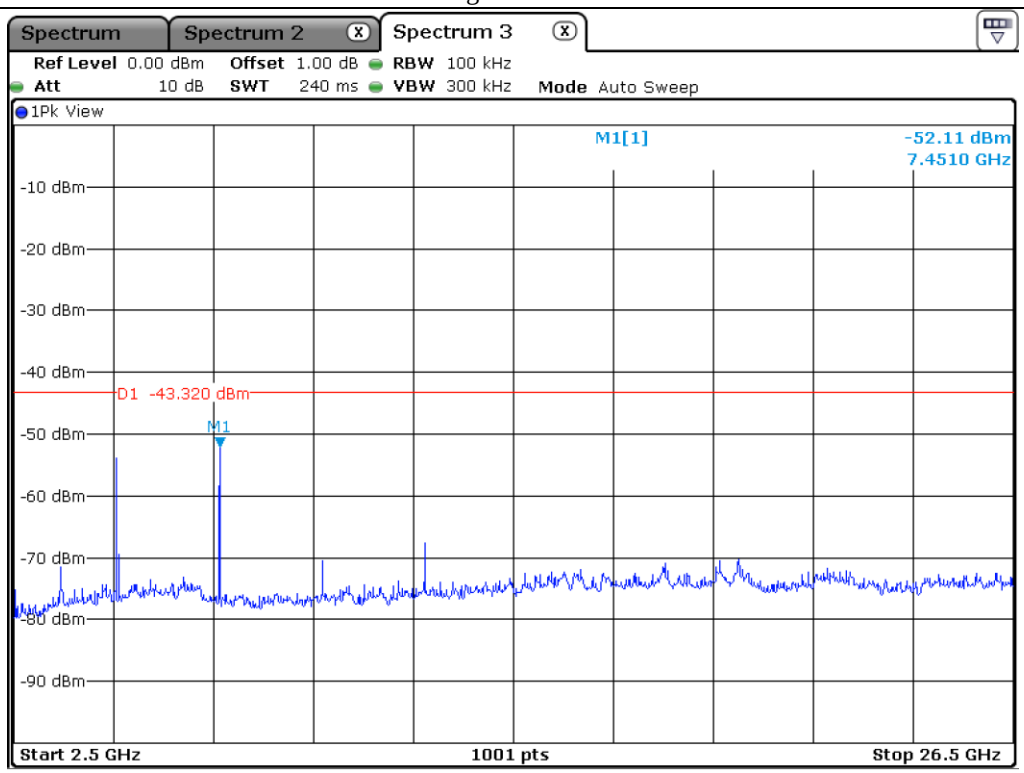


High Channel



High Channel

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9.7 Test data for radiated emission

9.7.1 Radiated Emission which fall in the Restricted Band

9.7.1.1 Test data for Nordic Module

-. Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Measurement distance : 3 m

-. Duty Cycle : 62.68 %

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
2 340.89	43.99	Peak	H	27.80	8.09	-	34.08	74.00	39.92
2 360.63	34.85	Average	H	28.30	8.09	2.03	27.47	54.00	26.53
2 363.91	43.94	Peak	V	28.30	8.09	-	34.53	74.00	39.47
2 334.74	35.06	Average	V	27.80	8.09	2.03	27.18	54.00	26.82
Test Data for High Channel									
2 485.16	44.17	Peak	H	28.80	8.30	-	35.47	74.00	38.53
2 489.57	34.86	Average	H	28.80	8.30	2.03	28.19	54.00	25.81
2 493.71	44.07	Peak	V	28.80	8.30	-	35.37	74.00	38.63
2 488.85	34.62	Average	V	28.80	8.30	2.03	27.95	54.00	26.05

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBµV/m) - Total Level (dBµV/m)

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor – Amp Gain (45.80 dB)

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9.7.1.2 Test data for TORIANO Module

-. Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Measurement distance : 3 m

-. Duty Cycle : 62.68 %

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
2 332.02	44.19	Peak	H	27.80	8.09	-	34.28	74.00	39.72
2 381.25	34.63	Average	H	28.30	8.09	2.03	27.25	54.00	26.75
2 334.26	44.00	Peak	V	27.80	8.09	-	34.09	74.00	39.91
2 330.98	34.53	Average	V	27.80	8.09	2.03	26.65	54.00	27.35
Test Data for High Channel									
2 491.32	44.36	Peak	H	28.80	8.30	-	35.66	74.00	38.34
2 487.70	34.70	Average	H	28.80	8.30	2.03	28.03	54.00	25.97
2 496.71	44.44	Peak	V	28.80	8.30	-	35.74	74.00	38.26
2 490.45	34.88	Average	V	28.80	8.30	2.03	28.21	54.00	25.79

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBµV/m) - Total Level (dBµV/m)

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor – Amp Gain (45.80 dB)

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9.7.2 Spurious & Harmonic Radiated Emission

9.7.2.1 Test data for Nordic Module

-. Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz for Peak Mode for the emissions outside restricted band

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Duty Cycle : 62.68 %

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
4 804	44.04	Peak	H	33.40	11.60	-	42.74	74.00	31.26
4 804	34.03	Average	H	33.40	11.60	2.03	34.76	54.00	19.24
4 804	44.55	Peak	V	33.40	11.60	-	43.25	74.00	30.75
4 804	35.02	Average	V	33.40	11.60	2.03	35.75	54.00	18.25
Test Data for Middle Channel									
4 880	44.08	Peak	H	33.30	11.80	-	42.88	74.00	31.12
4 880	34.94	Average	H	33.30	11.80	2.03	35.77	54.00	18.23
4 880	44.14	Peak	V	33.30	11.80	-	42.94	74.00	31.06
4 880	34.77	Average	V	33.30	11.80	2.03	35.60	54.00	18.40
Test Data for High Channel									
4 960	44.11	Peak	H	33.60	12.00	-	43.41	74.00	30.59
4 960	34.54	Average	H	33.60	12.00	2.03	35.87	54.00	18.13
4 960	43.95	Peak	V	33.60	12.00	-	43.25	74.00	30.75
4 960	33.26	Average	V	33.60	12.00	2.03	34.59	54.00	19.41

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBµV/m) - Total Level (dBµV/m)

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor - Amp Gain (46.30 dB)

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9.7.2.2 Test data for TORIANO Module

-. Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz for Peak Mode for the emissions outside restricted band

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Duty Cycle : 62.68 %

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
4 804	42.93	Peak	H	33.40	11.60	-	41.63	74.00	32.37
4 804	33.09	Average	H	33.40	11.60	2.03	33.82	54.00	20.18
4 804	43.57	Peak	V	33.40	11.60	-	42.27	74.00	31.73
4 804	33.89	Average	V	33.40	11.60	2.03	34.62	54.00	19.38
Test Data for Middle Channel									
4 880	43.45	Peak	H	33.30	11.80	-	42.25	74.00	31.75
4 880	32.96	Average	H	33.30	11.80	2.03	33.79	54.00	20.21
4 880	43.99	Peak	V	33.30	11.80	-	42.79	74.00	31.21
4 880	34.05	Average	V	33.30	11.80	2.03	34.88	54.00	19.12
Test Data for High Channel									
4 960	43.53	Peak	H	33.60	12.00	-	42.83	74.00	31.17
4 960	34.44	Average	H	33.60	12.00	2.03	35.77	54.00	18.23
4 960	43.78	Peak	V	33.60	12.00	-	43.08	74.00	30.92
4 960	33.69	Average	V	33.60	12.00	2.03	35.02	54.00	18.98

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBµV/m) - Total Level (dBµV/m)

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor - Amp Gain (46.30 dB)

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10. PEAK POWER SPECTRAL DENSITY

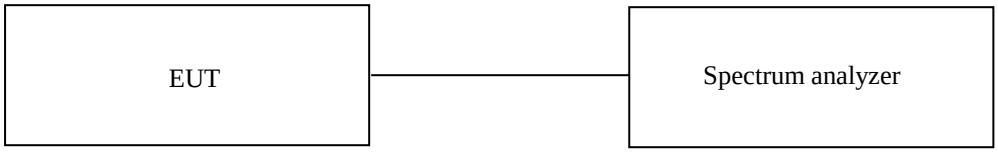
10.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to 3 kHz ≤ RBW ≤100 kHz, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Test Date

December 03, 2020 ~ January 05, 2021

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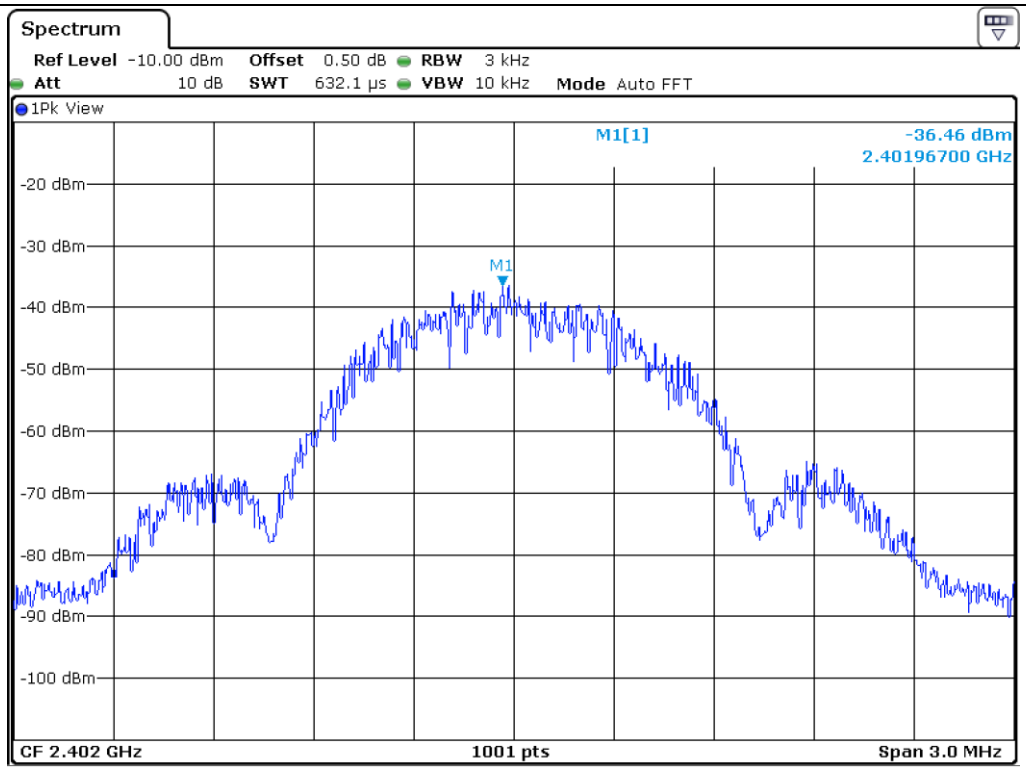
10.4 Test data for Nordic Module

-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-36.46	8.00	44.46
Middle	2 440.00	-35.93	8.00	43.93
High	2 480.00	-36.04	8.00	44.04

Remark. Margin = Limit – Measured value



Low Channel

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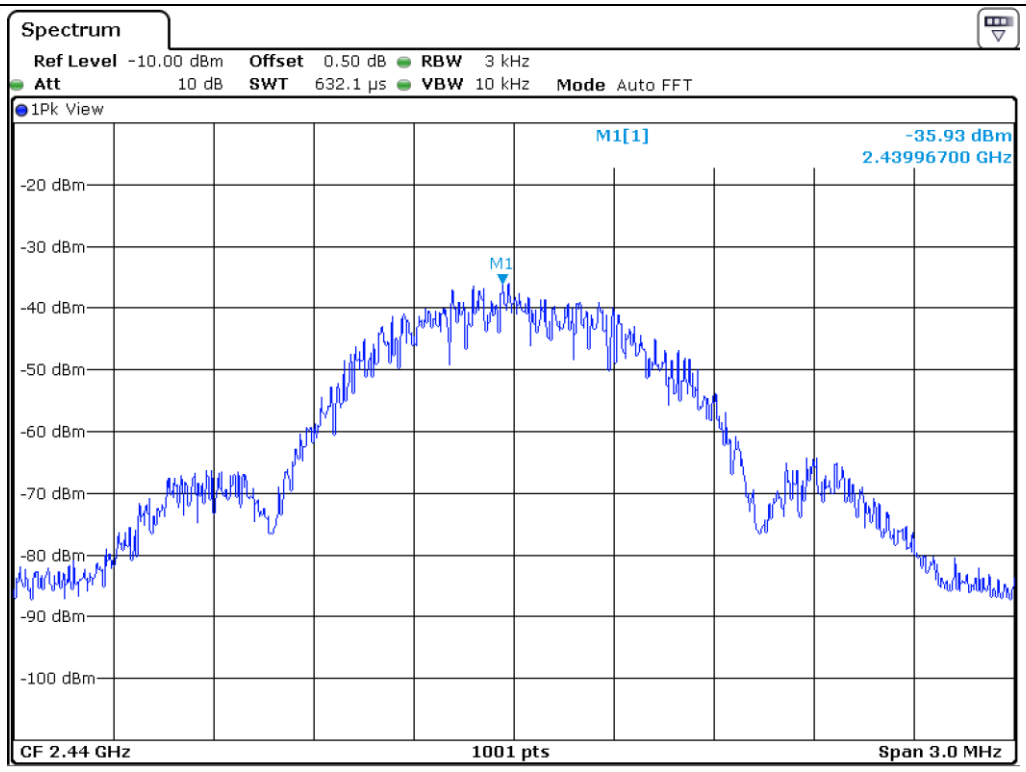
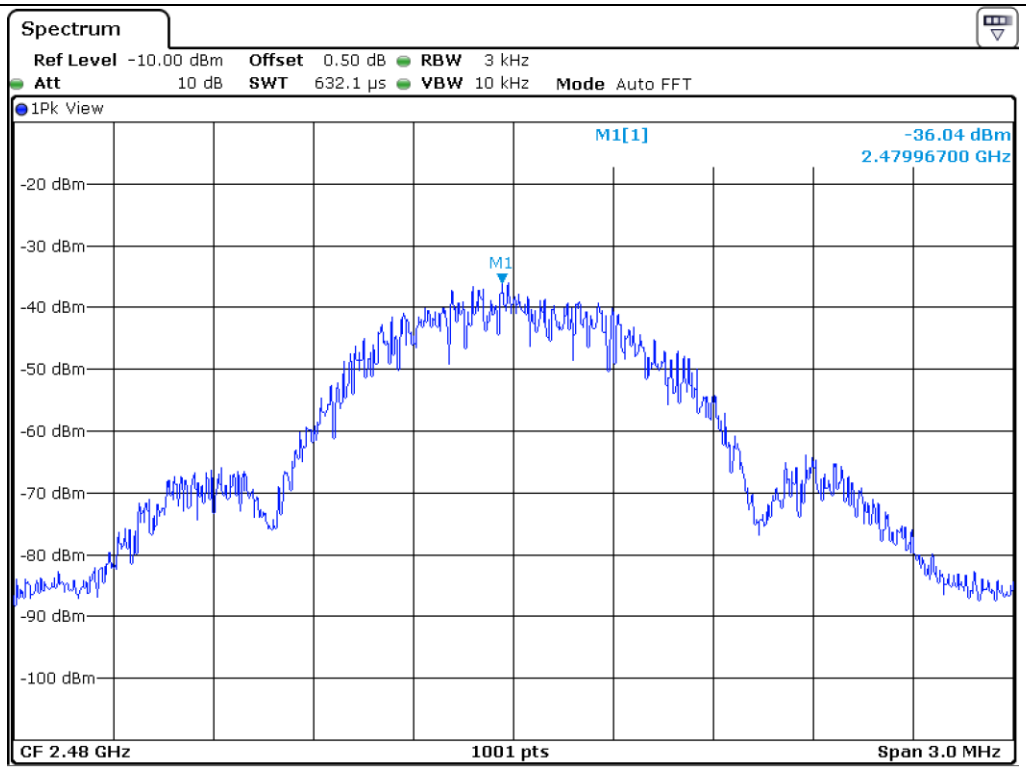


Middle Channel



High Channel

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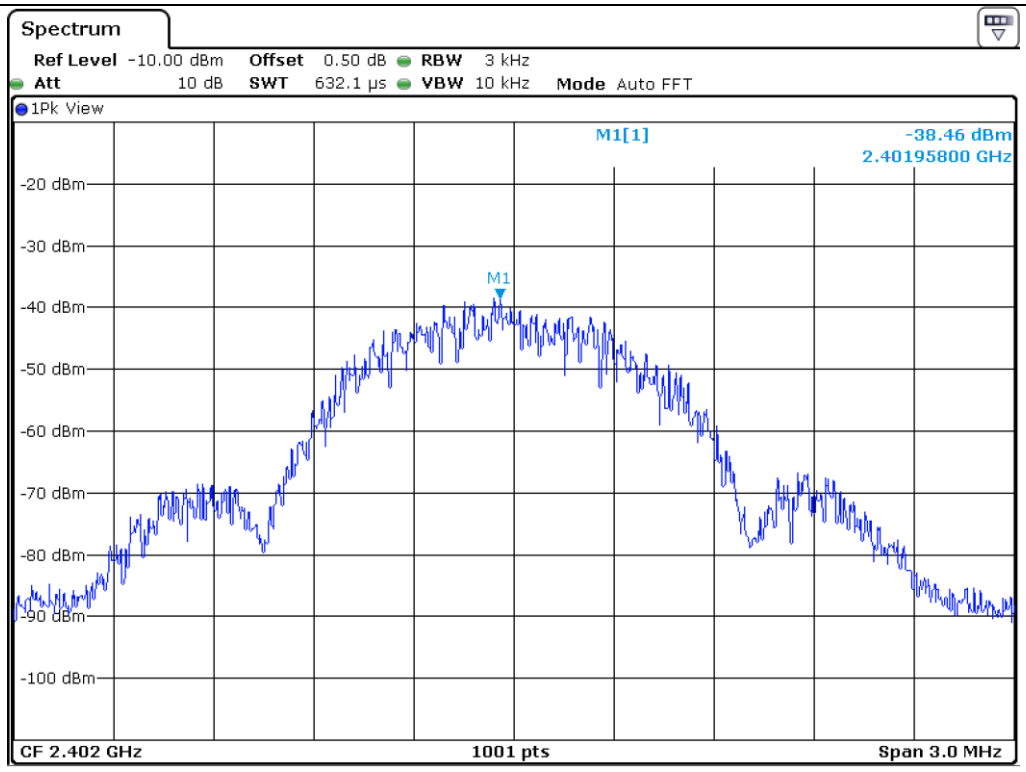
10.5 Test data for TORIANO Module

-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-38.46	8.00	46.46
Middle	2 440.00	-37.24	8.00	45.24
High	2 480.00	-37.28	8.00	45.28

Remark. Margin = Limit – Measured value



Low Channel

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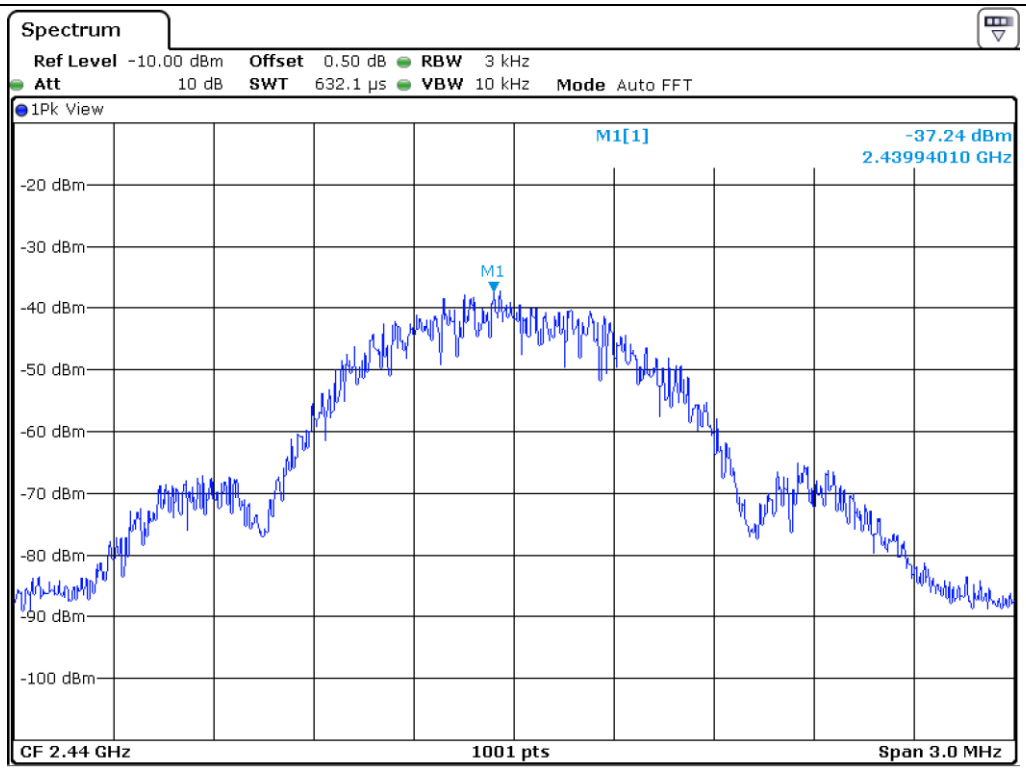
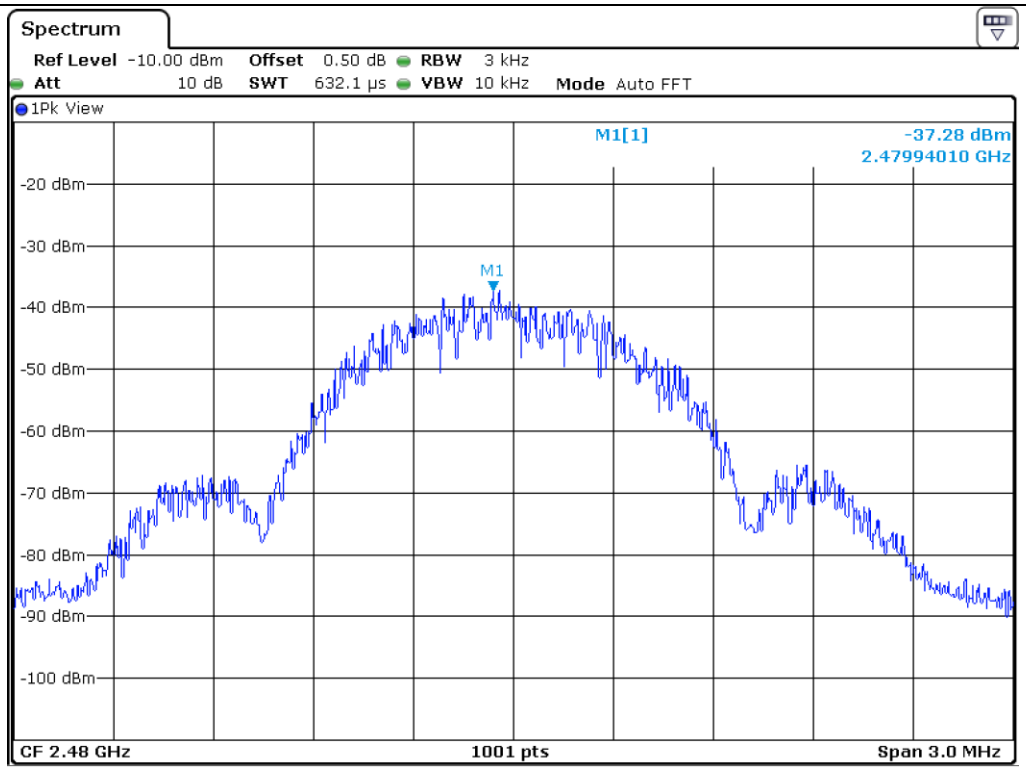


Middle Channel



High Channel

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11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % R.H.

11.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

11.3 Test Date

December 03, 2020 ~ January 05, 2021

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11.4 Test data for Nordic Module

11.4.1 Test data for 30 MHz ~ 1000 MHz

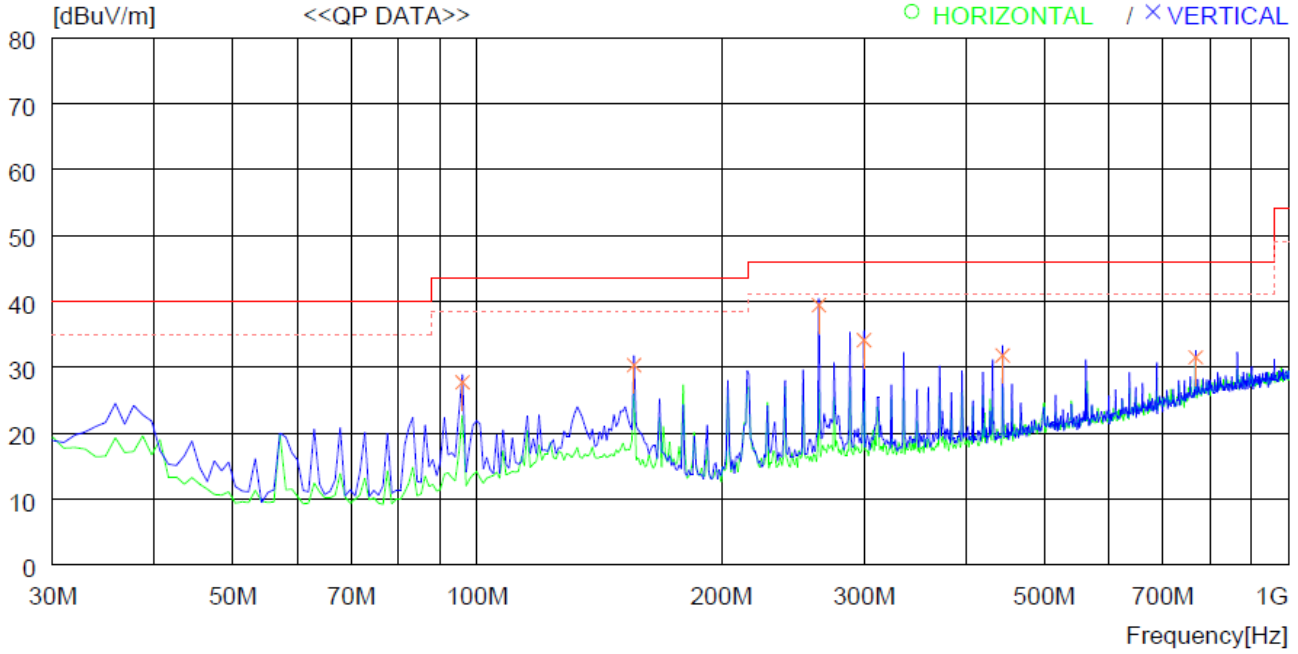
Humidity Level : 45 % R.H. Temperature: 23 °C

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Educational toys

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Vertical ------										
1	95.960	43.9	14.6	1.2	32.0	27.7	43.5	15.8	100	205
2	156.100	42.6	18.2	1.5	32.0	30.3	43.5	13.2	100	106
3	263.770	51.2	18.2	2.0	32.0	39.4	46.0	6.6	100	330
4	299.660	44.8	19.2	2.1	32.0	34.1	46.0	11.9	100	359
5	444.191	39.7	21.8	2.5	32.2	31.8	46.0	14.2	100	359
6	768.163	33.2	26.6	3.8	32.1	31.5	46.0	14.5	100	154

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11.4.2 Test data for Below 30 MHz

-. Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)

-. Frequency range : 9 kHz ~ 30 MHz

-. Measurement distance : 3 m

-.Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.4.3 Test data for above 1 GHz

-. Resolution bandwidth : 1 MHz for Peak and Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-.Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

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11.5 Test data for TORIANO Module

11.5.1 Test data for 30 MHz ~ 1000 MHz

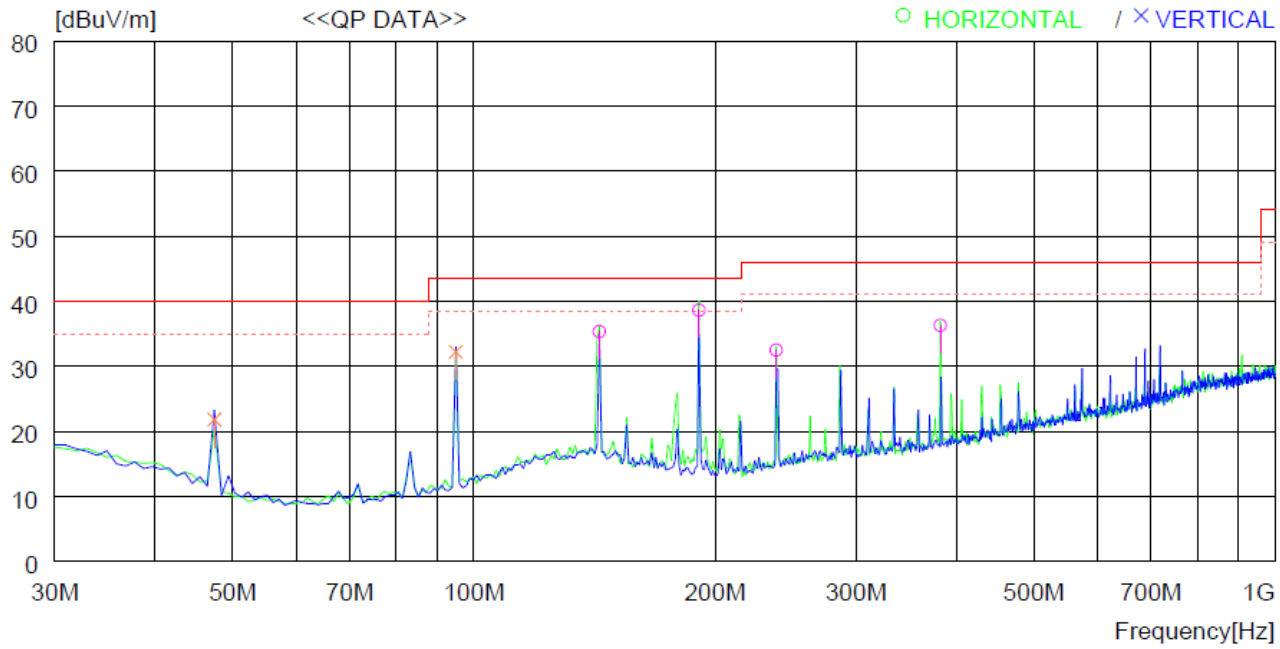
Humidity Level : 45 % R.H. Temperature: 23 °C

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Educational toys

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ [MHz]	READING QP [dBuV]	C.FACTOR [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]	COMMENT
----- Horizontal -------									
1	191.020	52.9	-14.3	38.6	43.5	4.9	200	185	
2	143.490	46.7	-11.4	35.3	43.5	8.2	200	243	
3	238.550	45.3	-12.8	32.5	46.0	13.5	100	301	
4	382.110	45.7	-9.4	36.3	46.0	9.7	100	0	
----- Vertical -------									
5	47.460	38.8	-17.0	21.8	40.0	18.2	100	359	
6	94.990	48.6	-16.4	32.2	43.5	11.3	100	359	

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11.5.2 Test data for Below 30 MHz

-. Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)

-. Frequency range : 9 kHz ~ 30 MHz

-. Measurement distance : 3 m

-.Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.5.3 Test data for above 1 GHz

-. Resolution bandwidth : 1 MHz for Peak and Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-.Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

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11.6 Test data for Intermodulation mode (Nordic Module + TORIANO Module)

11.6.1 Test data for 30 MHz ~ 1000 MHz

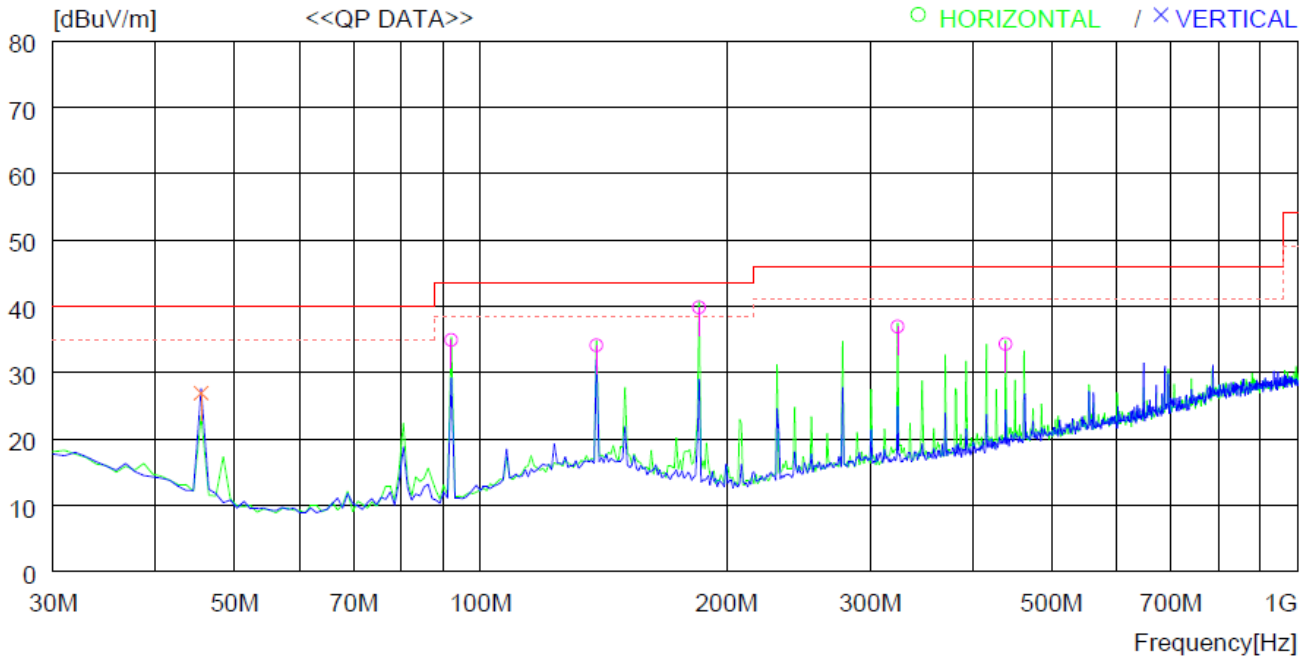
Humidity Level : 45 % R.H. Temperature: 23 °C

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Educational toys

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ [MHz]	READING QP [dBuV]	C.FACTOR [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]	COMMENT
----- Horizontal -------									
1	185.200	53.8	-14.0	39.8	43.5	3.7	200	0	
2	92.080	51.8	-16.9	34.9	43.5	8.6	300	359	
3	138.640	45.3	-11.2	34.1	43.5	9.4	200	92	
4	323.910	47.1	-10.2	36.9	46.0	9.1	100	336	
5	439.341	42.4	-8.1	34.3	46.0	11.7	100	359	
----- Vertical -------									
6	45.520	43.1	-16.2	26.9	40.0	13.1	100	0	

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11.6.2 Test data for Below 30 MHz

-. Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)

-. Frequency range : 9 kHz ~ 30 MHz

-. Measurement distance : 3 m

-.Operating mode : Intermodulation mode

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.6.3 Test data for above 1 GHz

-. Resolution bandwidth : 1 MHz for Peak and Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-.Operating mode : Intermodulation mode

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

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12. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV40-N	Rohde & Schwarz	Signal Analyzer	101457	Apr. 20, 2020 (1Y)
ESW	Rohde & Schwarz	EMI Test Receiver	101851	Mar. 27, 2020 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 16, 2020 (1Y)
BBV 9718 B	Schwarzbeck	Broadband Preamplifier	00009	Mar. 16, 2020 (1Y)
PAM-840A	Com-Power	Pre-Amplifer	461339	Oct. 16, 2020 (1Y)
PAM-118A	Com-Power	Pre-Amplifer	18040081	Oct. 12, 2020 (1Y)
DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
HLP-2008	TDK RF Solutions	Hybrid Antenna	131316	Feb. 27, 2020 (1Y)
AH-118	Com-Power	Horn Antenna	10050061	Oct. 15, 2020 (1Y)
VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 08, 2020 (2Y)
BBHA 9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jul. 23, 2020 (1Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 07, 2021(1Y)
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2020(2Y)
HPF 3GHz	Rohde & Schwarz	High Pass Filter	N/A	Feb. 19, 2020 (1Y)

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