

Prüfbericht-Nr.: <i>Test report no.:</i>	CN22D1N5 (P15C-BLE) 001	Auftrags-Nr.: <i>Order no.:</i>	238522049	Seite 1 von 30 Page 1 of 30
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	2021-11-12	
Auftraggeber: <i>Client:</i>	TAIYO YUDEN CO., LTD. 43-1, Yawatabara-machi, Takasaki-shi, Gumma, Japan			
Prüfgegenstand: <i>Test item:</i>	Bluetooth low energy/ANT/802.15.4 Module			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	EYSRSN			
Auftrags-Inhalt: <i>Order content:</i>	FCC Part 15C Test report (BLE)			
Prüfgrundlage: <i>Test specification:</i>	FCC 47CFR Part 15: Subpart C Section 15.247			
Wareneingangsdatum: <i>Date of sample receipt:</i>	2021-11-11			
Prüfmuster-Nr.: <i>Test sample no.:</i>	A003162507-001 A003162507-003			
Prüfzeitraum: <i>Testing period:</i>	2021-12-24 - 2022-02-17			
Ort der Prüfung: <i>Place of testing:</i>	EMC/RF Taipei Testing Site			
Prüflaboratorium: <i>Testing laboratory:</i>	Taipei Testing Laboratories			
Prüfergebnis*: <i>Test result*:</i>	Pass			
überprüft von: <i>compiled by:</i>	genehmigt von: <i>authorized by:</i>			
Datum: <i>Date:</i> 2022-02-22	<i>Jack Wang</i> Jack Wang	Ausstellungsdatum: <i>Issue date:</i> 2022-02-22	<i>Brenda Chen</i> Brenda Chen	
Stellung / Position:	Senior Project Engineer	Stellung / Position:	Senior Project 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

Report Section	FCC Clause	Test Item	Result
5.1.1	15.247(b) & 15.203	Antenna Requirement	Pass
5.1.2	15.247(b)(3)	Peak Output Power	Pass
5.1.3	15.247(a)(2)	6 dB Bandwidth	Pass
5.1.3	2.1049	99% Occupied Bandwidth	Pass
5.1.4	15.247(e)	Power Spectral Density	Pass
5.1.5	15.247(d)	Conducted Spurious Emissions and Band Edges	Pass
5.1.6	15.247(d) & 15.205 & 15.209	Radiated Spurious Emissions and Band Edges	Pass
5.2.1	15.207	Mains Conducted Emission	Pass

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

Contents

HISTORY OF THIS TEST REPORT	5
1. GENERAL REMARKS	6
1.1 COMPLEMENTARY MATERIALS.....	6
1.2 DECISION RULE OF CONFORMITY	6
2. TEST SITES	7
2.1 TEST LABORATORY	7
2.2 TEST FACILITY.....	7
2.3 TRACEABILITY	8
2.4 CALIBRATION	8
2.5 MEASUREMENT UNCERTAINTY	8
3. GENERAL PRODUCT INFORMATION.....	9
3.1 PRODUCT FUNCTION AND INTENDED USE	9
3.2 SYSTEM DETAILS AND RATINGS.....	9
3.3 NOISE GENERATING AND NOISE SUPPRESSING PARTS	10
3.4 SUBMITTED DOCUMENTS.....	10
4. TEST SET-UP AND OPERATION MODES.....	11
4.1 PRINCIPLE OF CONFIGURATION SELECTION	11
4.2 CARRIER FREQUENCY AND CHANNEL.....	11
4.3 TEST OPERATION AND TEST SOFTWARE.....	13
4.4 SPECIAL ACCESSORIES AND AUXILIARY EQUIPMENT	14
4.5 TEST SETUP DIAGRAM	15
5. TEST RESULTS	16
5.1 TRANSMITTER REQUIREMENT & TEST SUITES	16
5.1.1 <i>Antenna Requirement</i>	<i>16</i>
5.1.2 <i>Peak Output Power</i>	<i>17</i>
5.1.3 <i>6 dB Bandwidth and 99% Occupied Bandwidth.....</i>	<i>21</i>
5.1.4 <i>Power Spectral Density.....</i>	<i>22</i>
5.1.5 <i>Conducted Spurious Emissions and Frequency Band Edges Measured in 100kHz Bandwidth.....</i>	<i>23</i>
5.1.6 <i>Radiated Spurious Emissions and Band Edges</i>	<i>24</i>
5.2 MAINS EMISSION	29
5.2.1 <i>Mains Conducted Emission.....</i>	<i>29</i>

Prüfbericht - Nr.: CN22D1N5 (P15C-BLE) 001
Test Report No.

Seite 4 von 30
Page 4 of 30

APPENDIX A - TEST RESULT OF CONDUCTED_BLE

APPENDIX B - TEST RESULT OF CONDUCTED_ANT & NORDIC Original

APPENDIX C - TEST RESULT OF RADIATED EMISSIONS & MAINS CONDUCTED EMISSION_BLE

**APPENDIX D - TEST RESULT OF RADIATED EMISSIONS & MAINS CONDUCTED
EMISSION_ANT & NORDIC ORIGINAL**

APPENDIX SP - PHOTOGRAPHS OF TEST SETUP

APPENDIX EP - PHOTOGRAPHS OF EUT

Prüfbericht - Nr.: CN22D1N5 (P15C-BLE) 001
Test Report No.**Seite 5 von 30**
Page 5 of 30

HISTORY OF THIS TEST REPORT

Revision	Description	Date Issued
R00	Original Release	2022-01-25
R01	Update test data for ANT	2022-02-22

1. General Remarks

1.1 Complementary Materials

All attachments are integral parts of this test report. This applies especially to the following appendix:

Appendix A - Test Result of Conducted_BLE

Appendix B - Test Result of Conducted_ANT & Nordic Original

Appendix C - Test Result of Radiated Emissions & Mains Conducted Emission_BLE

Appendix D - Test Result of Radiated Emissions & Mains Conducted Emission_ANT & Nordic Original

Appendix SP - Photographs of Test Setup

Appendix EP - Photographs of EUT

Applied Standard and Test Levels

Radio
FCC 47CFR Part 15: Subpart C Section 15.247
FCC 47CFR Part 2: Subpart J Section 2.1049
ANSI C63.10:2013
KDB 558074 D01 15.247 Meas Guidance v05r02

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

Taipei Testing Laboratories

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

2.2 Test Facility

Taipei Testing Laboratories

No.458-18, Sec. 2, Fenliao Rd., Linkou Dist.,
New Taipei City 244
Taiwan (R.O.C.)
FCC Registration No.: 226631
ISED Registration No.: 25563

2.3 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.

2.4 Calibration

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

2.5 Measurement Uncertainty

All measurement uncertainty values are shown with a coverage factor of $k=2$ to indicate a 95% level of confidence.

Emission Measurement Uncertainty

Parameter	Uncertainty
Radiated Emission (9 kHz ~ 30 MHz)	± 1.15 dB
Radiated Emission (30 MHz ~ 200 MHz)	± 1.30 dB
Radiated Emission (200 MHz ~ 1 GHz)	± 1.30 dB
Radiated Emission (1 GHz ~ 18 GHz)	± 1.54 dB
Radiated Emission (18 GHz ~ 40 GHz)	± 2.52 dB
Mains Conducted Emission	± 1.65 dB

3. General Product Information

3.1 Product Function and Intended Use

The EUT is a Bluetooth low energy/ANT/802.15.4 Module. It contains a Bluetooth compatible module enabling the user to communicate data through a Wireless interface.

For details refer to the User Guide, Data Sheet and Circuit Diagram.

3.2 System Details and Ratings

Basic Information of EUT

Item	EUT information
Kind of Equipment/Test Item	Bluetooth low energy/ANT/802.15.4 Module
Type Identification	EYSRSN
FCC ID	RYYEYSRSN

Technical Specification of EUT

Item	EUT information
Operating Frequency	2402 MHz ~ 2480 MHz
Channel Number	Bluetooth Low Energy: 40 ANT: 79 Nordic Original: 79
Data Rate	Bluetooth Low Energy: 1 Mbps, 2 Mbps, 125 kbps, 500 kbps ANT: 1 Mbps Nordic Original: 2 Mbps
Operation Voltage	3 Vdc
Modulation	GFSK
Maximum Output Power (mW)	6.17
Antenna Information	Refer to 5.1.1
Accessory Device	Refer to 4.4

3.3 Noise Generating and Noise Suppressing Parts

Refer to the Circuit Diagram.

3.4 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 expected by the customer and is going to be fixed on the firmware of the final end product.

Table for Parameters of Test Software Setting

Bluetooth Low Energy		ANT		Nordic Original	
Frequency (MHz)	Power Setting	Frequency (MHz)	Power Setting	Frequency (MHz)	Power Setting
2402	8	2402	8	2402	8
2440	8	2441	8	2441	8
2480	8	2480	8	2480	8

4.2 Carrier Frequency and Channel

<Bluetooth Low Energy>

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

<ANT / Nordic Original>

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461		

4.3 Test Operation and Test Software

Setup for testing: Test samples are provided with a USB interface which makes it possible to control them through a test software installed on a notebook computer.
 This software was running on the laptop computer connected to the EUT. It was used to enable the operation modes listed as below.

Test Software	Radio Test Tool
---------------	-----------------

The samples were used as follows:

A003162507-001

A003162507-003

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

EUT Configure Mode	Applicable To				Description
	Antenna Port Conducted Measurement	Radiated Spurious Emissions above 1 GHz	Radiated Spurious Emissions below 1 GHz	Mains Conducted Emission	
Bluetooth Low Energy	√	√	√	√	-
ANT	√	√	-	-	-
Nordic Original	√	√	√	√	-

Note:

1. The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when position on **Z-plane**.
2. "-" means no effect.

Antenna Port Conducted Measurement

- Pre-Scan full test was applied on all test modes, but only worst case was shown.
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate (Mbps)
Bluetooth Low Energy (Power only)	2402 to 2480	2402, 2440, 2480	0.125 & 0.5
Bluetooth Low Energy	2402 to 2480	2402, 2440, 2480	1 & 2
ANT	2402 to 2480	2402, 2441, 2480	1
Nordic Original	2402 to 2480	2402, 2441, 2480	2

Radiated Spurious Emissions (Above 1 GHz)

- Pre-Scan full test was applied on all test modes, but only worst case was shown.
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate (Mbps)
Bluetooth Low Energy	2402 to 2480	2402, 2440, 2480	1 & 2
ANT	2402 to 2480	2402, 2441, 2480	1
Nordic Original	2402 to 2480	2402, 2441, 2480	2

Radiated Spurious Emissions (Below 1 GHz)

- Pre-Scan full test was applied on all test modes, but only worst case was shown.
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate (Mbps)
Bluetooth Low Energy	2402 to 2480	2480	1
Nordic Original	2402 to 2480	2480	2

Mains Conducted Emission

- Pre-Scan full test was applied on all test modes, but only worst case was shown.
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate (Mbps)
Bluetooth Low Energy	2402 to 2480	2440	1
		2480	2
Nordic Original	2402 to 2480	2480	2

Test Condition

Test Item	Ambient Temperature	Relative Humidity	Tested by
Conducted Measurement	21.7 °C	57 %	Stanislas Charles
Radiated Spurious Emissions above 1 GHz	24.5-26.5 °C	57-62 %	Nick Guan
Radiated Spurious Emissions below 1 GHz	24.5-26.5 °C	57-62 %	Nick Guan
Mains Conducted Emission	22.1-23.2 °C	50-55 %	Hunter Wang

4.4 Special Accessories and Auxiliary Equipment

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

Accessory of EUT

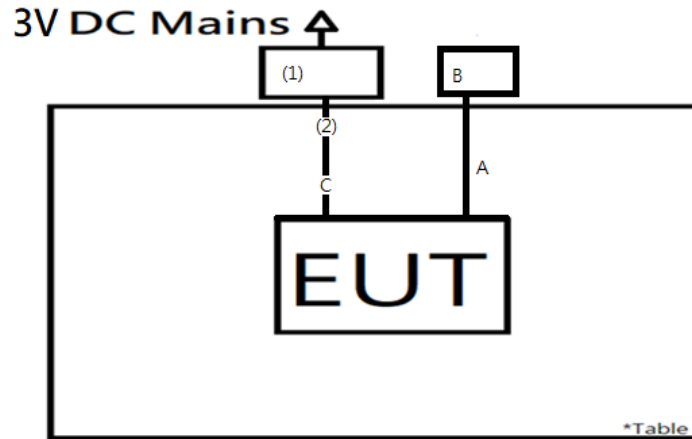
None

Support Unit

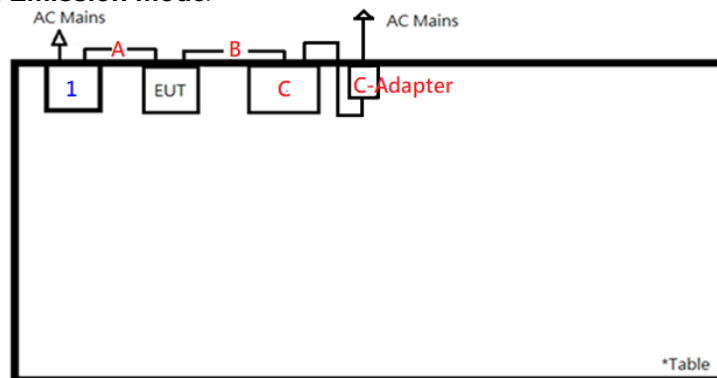
Support Unit								
No	Description	Brand	Model	S/N	Shielded	Ferrite Core (Qty)	Length (cm)	Remark
A	Mini USB Cable	TUV-JP	TUV-JP	N/A	NO	NO	180	Radiated
B	NB	TOSHIA	PORTEGE R30-A Series	N/A	-	-	-	
C	DC Cable	TUV-JP	TUV-JP	N/A	NO	NO	50	
1	DC Power Supply	GWINSTEK	GPC-3030DQ	GEN869895	-	-	-	
2	DC Cable	TUV	TUV	N/A	NO	NO	200	
A	DC Cable	TUV-JP	TUV-JP	N/A	NO	NO	50	Mains Conducted
B	Mini USB Cable	TUV-JP	TUV-JP	N/A	NO	NO	180	
C	NB	TOSHIA	PORTEGE R30-A Series	N/A	-	-	-	
1	DC Power Supply	GWINSTEK	GPC-3030DQ	GEN869895	-	-	-	

4.5 Test Setup Diagram

<Radiated Spurious Emissions mode>



<Mains Conducted Emission mode>



5. Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

Requirement Use of approved antennas only

According to the manufacturer declaration, the EUT has an antenna with a directional gain of -3.7 dBi. The antenna is PCB antenna 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

Limit 1 watt (30 dBm)

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Power Meter	Anritsu	ML2495A	1901008	2021/3/24	2022/3/23	2021/12/28	2022/02/17
Power Sensor	Anritsu	MA2411B	1725269	2021/3/24	2022/3/23	2021/12/28	2022/02/17

Test Procedures

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

Test Result
Peak Output Power
<Bluetooth Low Energy_125kbps>

Channel	Channel Frequency	Peak Output Power		Limit (dBm)
	(MHz)	(dBm)	(mW)	
Low Channel	2402	7.60	5.75	30
Middle Channel	2440	7.77	5.98	30
High Channel	2480	7.90	6.17	30

<Bluetooth Low Energy_500kbps>

Channel	Channel Frequency	Peak Output Power		Limit (dBm)
	(MHz)	(dBm)	(mW)	
Low Channel	2402	7.61	5.77	30
Middle Channel	2440	7.76	5.97	30
High Channel	2480	7.90	6.17	30

<Bluetooth Low Energy_1Mbps>

Channel	Channel Frequency	Peak Output Power		Limit (dBm)
	(MHz)	(dBm)	(mW)	
Low Channel	2402	7.61	5.77	30
Middle Channel	2440	7.77	5.98	30
High Channel	2480	7.90	6.17	30

<Bluetooth Low Energy_2Mbps>

Channel	Channel Frequency	Peak Output Power		Limit (dBm)
	(MHz)	(dBm)	(mW)	
Low Channel	2402	7.61	5.77	30
Middle Channel	2440	7.77	5.98	30
High Channel	2480	7.90	6.17	30

<ANT>

Channel	Channel Frequency	Peak Output Power		Limit (dBm)
	(MHz)	(dBm)	(mW)	
Low Channel	2402	7.62	5.78	30
Middle Channel	2441	7.41	5.51	30
High Channel	2480	7.38	5.47	30

<Nordic Original>

Channel	Channel Frequency	Peak Output Power		Limit (dBm)
	(MHz)	(dBm)	(mW)	
Low Channel	2402	7.62	5.78	30
Middle Channel	2441	7.78	6.00	30
High Channel	2480	7.90	6.17	30

Average Power
<Bluetooth Low Energy_125kbps>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	7.58	5.73
Middle Channel	2440	7.75	5.96
High Channel	2480	7.87	6.12

<Bluetooth Low Energy_500kbps>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	7.59	5.74
Middle Channel	2440	7.74	5.94
High Channel	2480	7.87	6.12

<Bluetooth Low Energy_1Mbps>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	7.59	5.74
Middle Channel	2440	7.75	5.96
High Channel	2480	7.87	6.12

<Bluetooth Low Energy_2Mbps>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	7.59	5.74
Middle Channel	2440	7.75	5.96
High Channel	2480	7.88	6.14

<ANT>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	7.60	5.75
Middle Channel	2441	7.38	5.47
High Channel	2480	7.36	5.45

<Nordic Original>

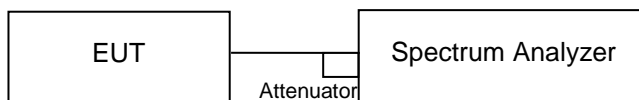
Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	7.60	5.75
Middle Channel	2441	7.75	5.96
High Channel	2480	7.88	6.14

5.1.3 6 dB Bandwidth and 99% Occupied Bandwidth

Limit The minimum 6 dB bandwidth shall be at least 500 kHz.

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	151509	2021/03/24	2022/03/23	2021/12/28	2022/2/17

Test Procedure

- a. Set resolution bandwidth (RBW) = 100 kHz
- b. Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- c. Trace mode = max hold.
- d. Sweep = auto couple.
- e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.
- f. For 99% occupied bandwidth measurement, the transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth and set the detector to PEAK. The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5% of the total mean power of a given emission.

Test Results

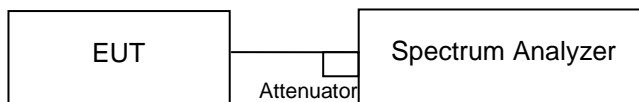
Please refer to Appendix A and B.

5.1.4 Power Spectral Density

Limit

The power spectral density shall not be greater than 8 dBm in any 3 kHz band.

Kind of Test Site Shielded room

Test Setup

Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	151509	2021/03/24	2022/03/23	2021/12/28	2022/2/17

Test Procedure

- a. Set analyzer center frequency to DTS channel center frequency.
- b. Set the span to 1.5 times the DTS bandwidth.
- c. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- d. Set the VBW $\geq 3 \times \text{RBW}$.
- e. Detector = peak.
- f. Sweep time = auto couple.
- g. Trace mode = max hold.
- h. Allow trace to fully stabilize.
- i. Use the peak marker function to determine the maximum amplitude level within the RBW.

Test Results

Please refer to Appendix A and B.

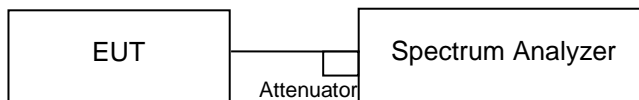
5.1.5 Conducted Spurious Emissions and Frequency Band Edges Measured in 100kHz Bandwidth

Limit

20dB (below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.)

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	151509	2021/03/24	2022/03/23	2021/12/28	2022/2/17

Test Procedure

Measurement procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement procedure OOBE

1. Set RBW = 100 kHz.
2. Set VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

Test Results

Please refer to Appendix A and B.

5.1.6 Radiated Spurious Emissions and Band Edges

Limit

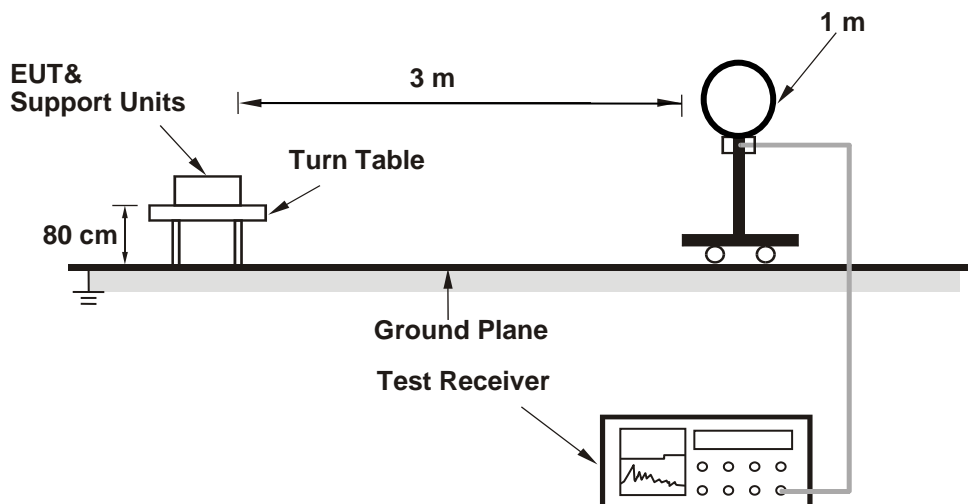
Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a).

Emissions radiated outside the restricted and authorized frequency bands must either comply with the radiated emission limits specified for the restricted bands or in §15.247(d).

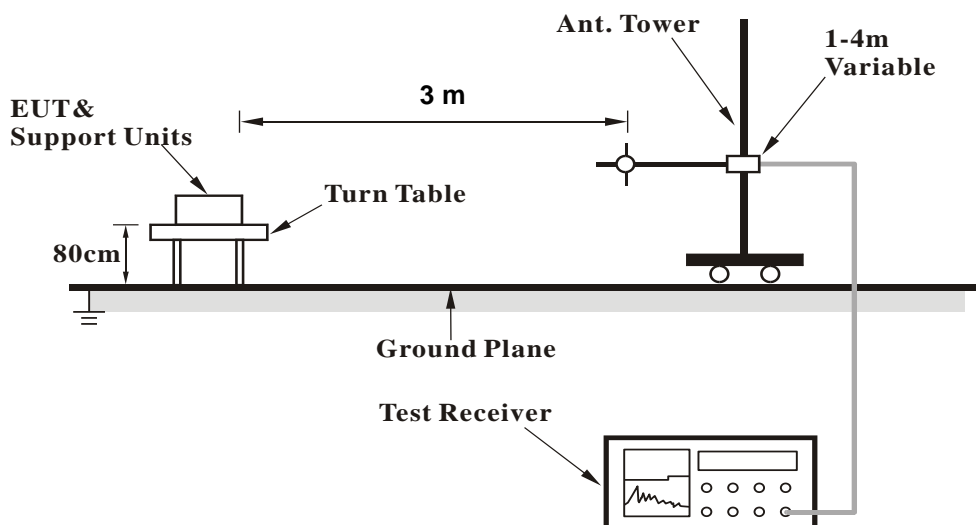
Kind of Test Site 3m Semi-Anechoic Chamber

Test Setup

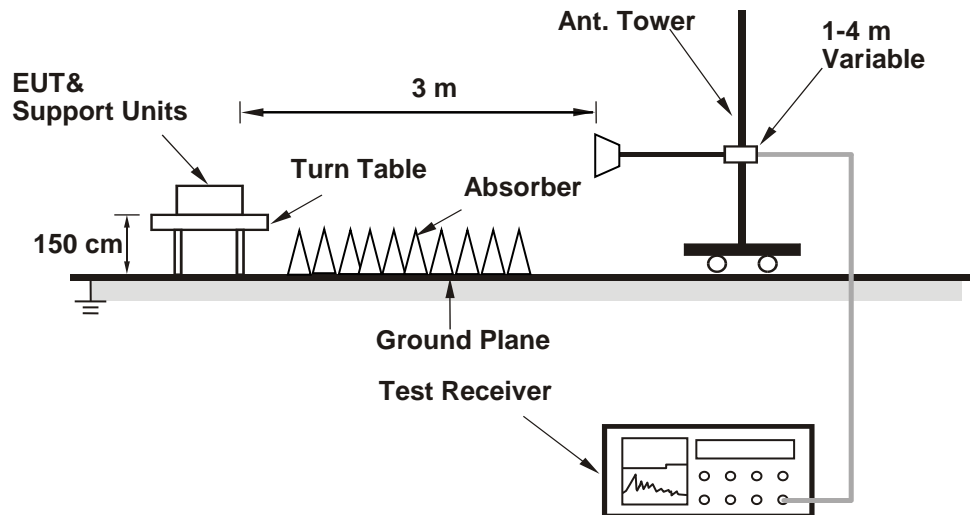
<Radiated Emissions below 30 MHz>



<Radiated Emissions 30 MHz to 1 GHz>



<Radiated Emissions above 1 GHz>



For the actual test configuration, please refer to the attached file (Test Setup Photo).

Test Instruments

Test Period: 2021-12-24 ~ 2022-02-15

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Signal Analyzer	R&S	FSV40	101508	2021/3/16	2022/3/15
Receiver	R&S	ESR7	102109	2021/3/16	2022/3/15
Bilog Antenna	SCHWARZBECK	VULB-9168	00951	2021/2/18	2022/2/17
Horn Antenna	ETS-Lindgren	3117	00218929	2021/11/25	2022/11/24
LF-AMP	Agilent	8447D	2944A10772	2021/2/18	2022/2/17
HF-AMP + AC source	EMCI	EMC051845SE	980633	2021/2/9	2022/2/8
			980635	2022/1/20	2023/1/19
HF-AMP + AC source	EMCI	EMC184045SE	980657	2021/2/1	2022/1/31
			980656	2022/1/20	2023/1/19
Horn Antenna	SCHWARZBECK	BBHA 9170	00887	2021/4/8	2022/4/7
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104EA	800056/4EA	2021/3/17	2022/3/16
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	804680/4	2021/3/17	2022/3/16
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	MY37202/4	2021/3/17	2022/3/16
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800898/2EA	2021/4/16	2022/4/15
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800901/2EA	2021/4/16	2022/4/15
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	801027/2EA	2021/4/16	2022/4/15
Loop Antenna	SCHWARZBECK	FMZB1519B	00215	2021/12/8	2022/12/7

Test Procedures**For Radiated Emissions below 30 MHz**

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel (OPEN), perpendicular (CLOSE), and ground-parallel (GROUND) orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz at frequency below 30 MHz.
2. All modes of operation were investigated and the worst-case emissions are reported.

For Radiated Emissions above 30 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30 MHz ~ 1 GHz) / 1.5 meters (for above 1 GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detected function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) or Peak detection (PK) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98 %) or 10 Hz (Duty cycle ≥ 98 %) for Average detection (AV) at frequency above 1 GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.
5. The Radiated Emissions testing was performed in the X(E1), Y(H) and Z(E2) axis orientation. The worst-case Axis orientation is recorded in this test report.

Prüfbericht - Nr.: **CN22D1N5 (P15C-BLE) 001**
Test Report No.

Seite 28 von 30
Page 28 of 30

Test Results

Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB)
Level (dBuV/m) = Reading (dBuV) + Factor (dB/m)

Please refer to Appendix C and D.

5.2 Mains Emission

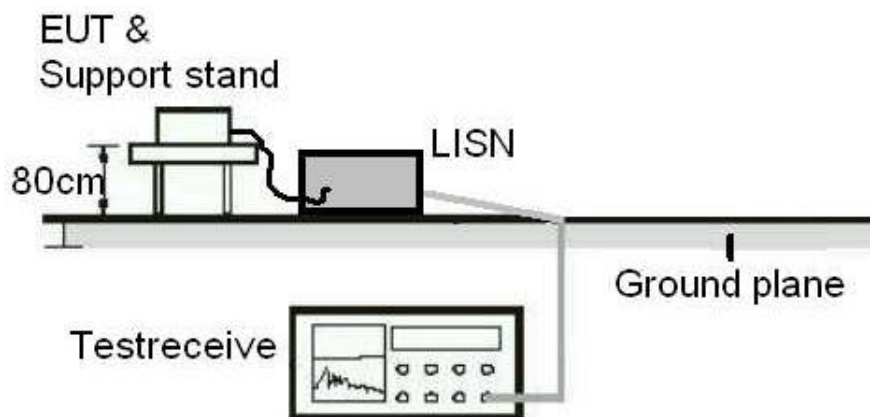
5.2.1 Mains Conducted Emission

Limit

Mains Conducted Emission as defined in §15.207 must comply with the mains conducted emission limits.

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
RF Cable	N/A	N/A	EMC-003	2021/3/16	2022/3/15
Two-Line V-Network	Rohde & Schwarz	ENV216	101938	2021/9/23	2022/9/22
EMI Test Receiver	R&S	ESCI	1816063	2021/11/15	2022/11/14

Test Procedures

- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/50 uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels under (Limit – 20 dB) was not recorded.

Note: The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15 MHz – 30 MHz.

Test Results

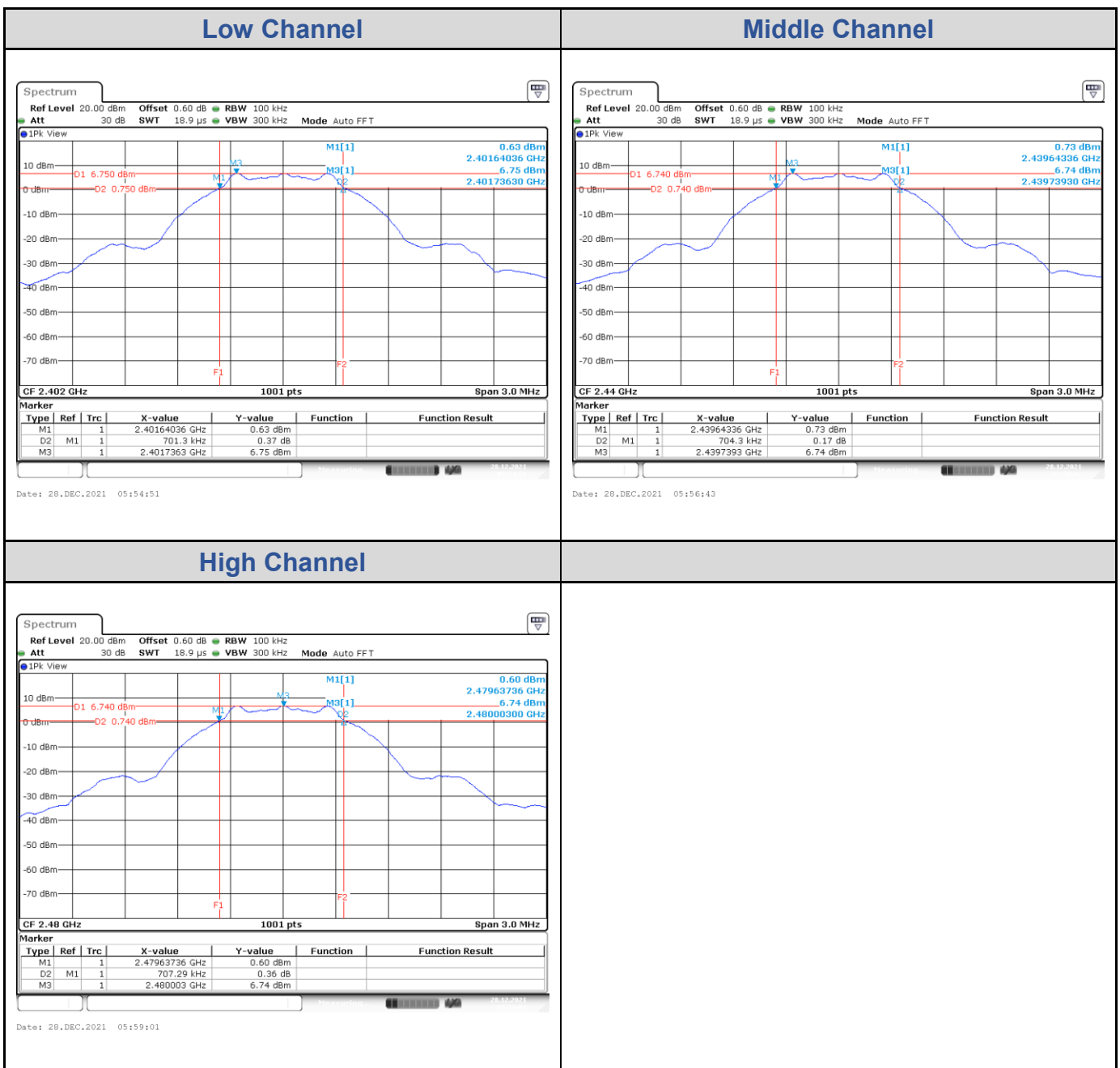
Please refer to Appendix C and D.

Appendix A: Test Results of Conducted Test_BLE

Test Result of 6 dB Bandwidth

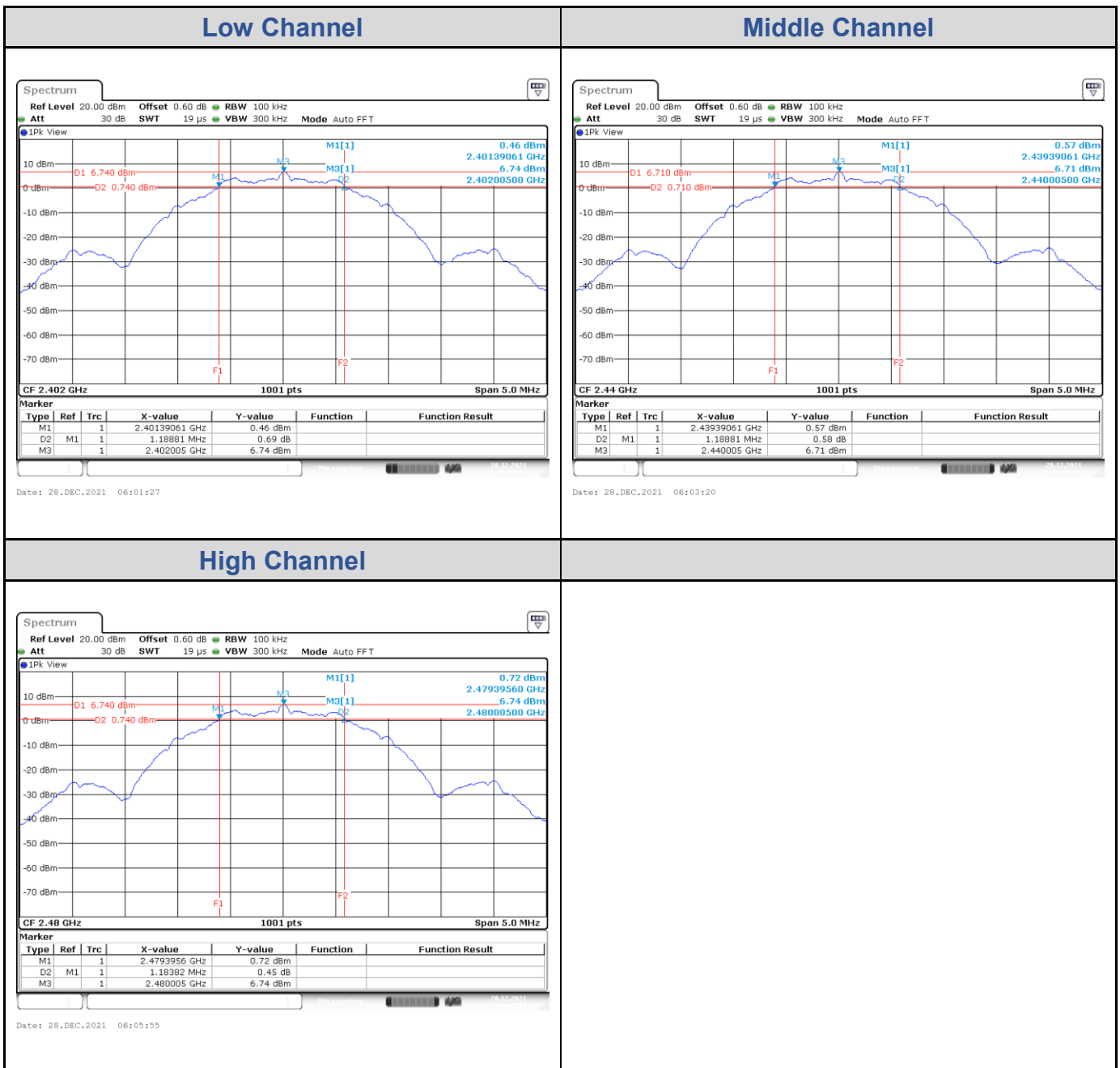
BLE_1M

Channel	Channel Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	701.30	> 500	Pass
Middle Channel	2440	704.30	> 500	Pass
High Channel	2480	707.29	> 500	Pass



BLE_2M

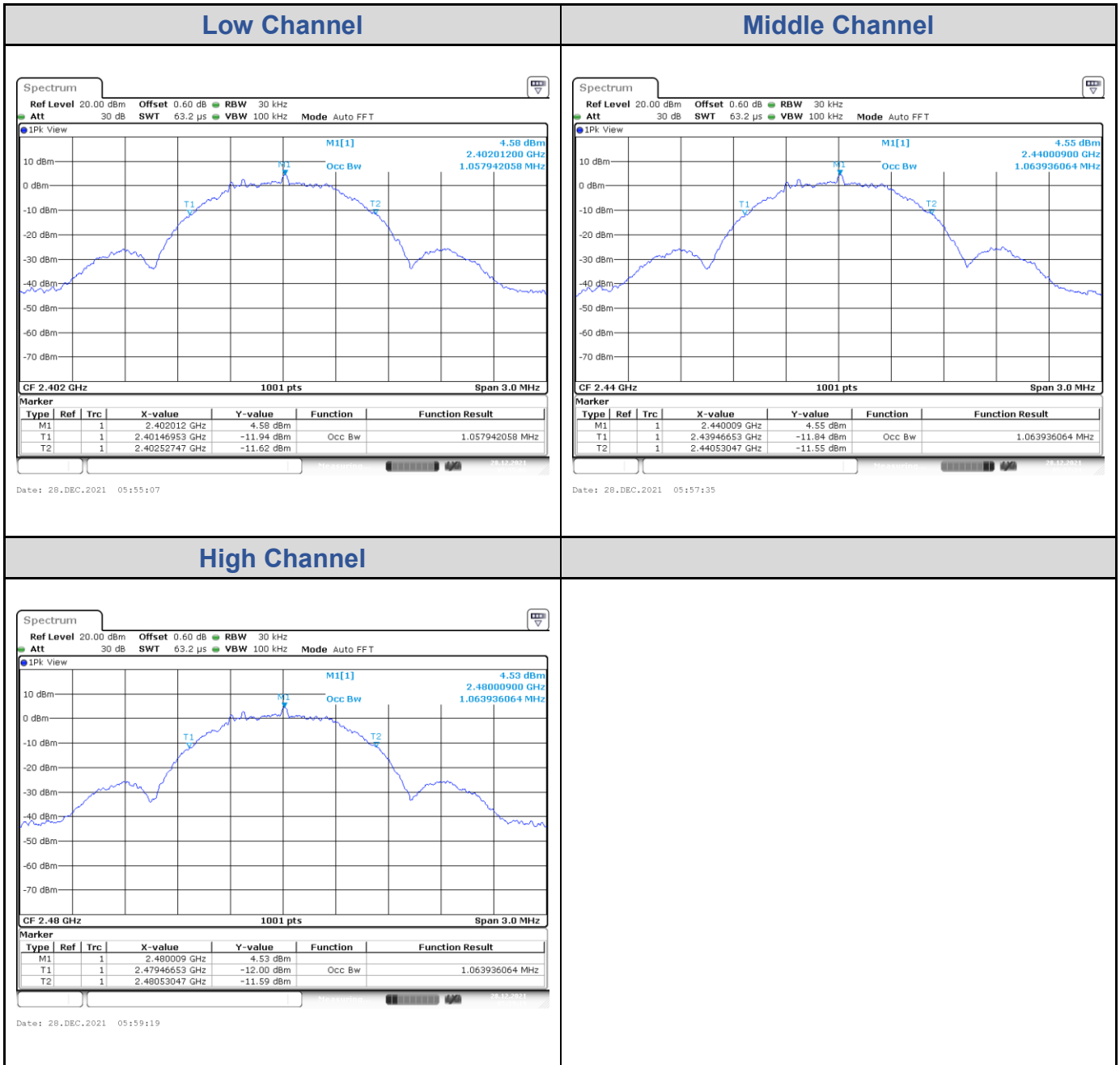
Channel	Channel Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	1188.81	> 500	Pass
Middle Channel	2440	1188.81	> 500	Pass
High Channel	2480	1183.82	> 500	Pass



Test Result of 99% Occupied Bandwidth

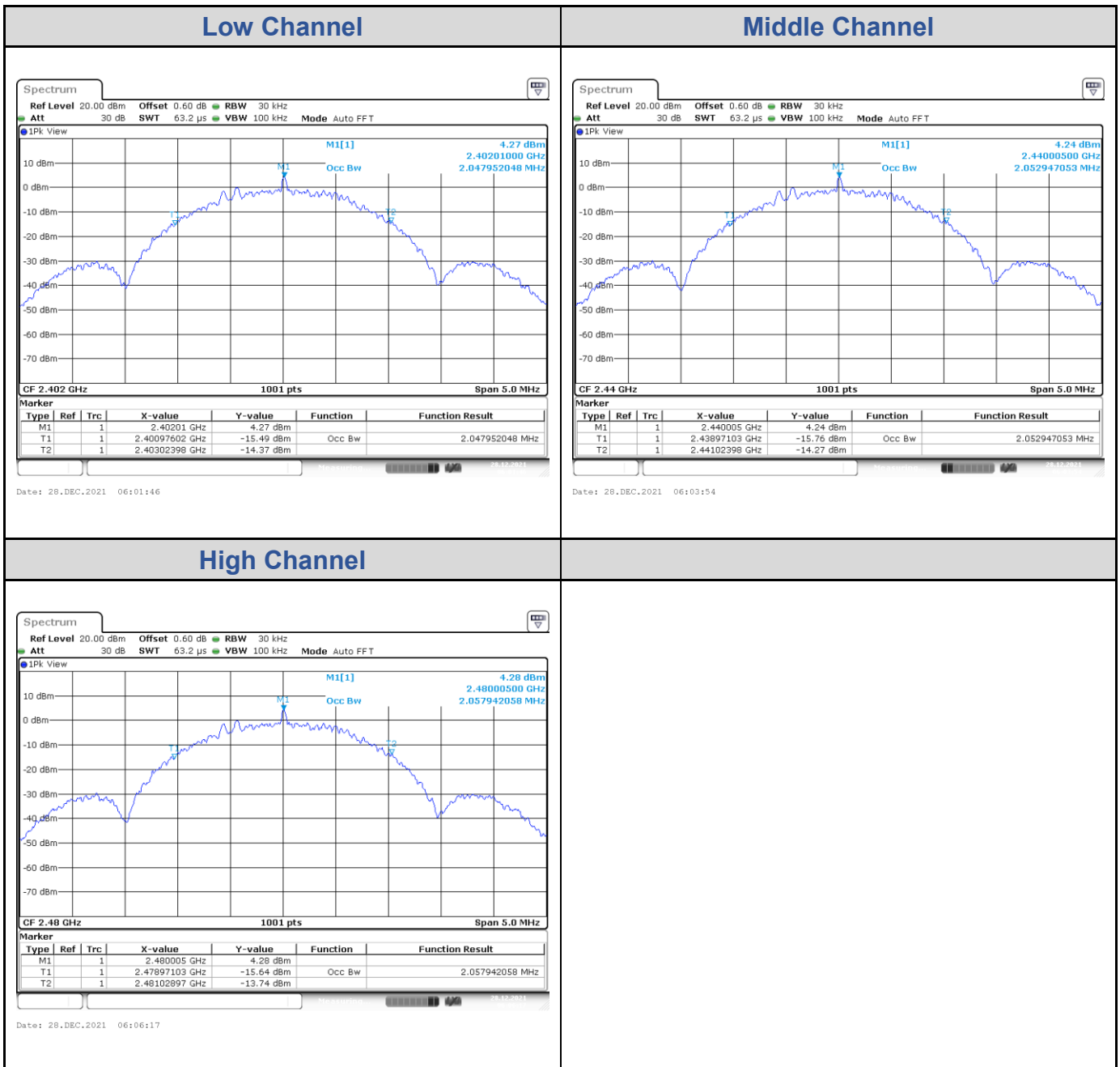
BLE_1M

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2402	1.058
Middle Channel	2440	1.064
High Channel	2480	1.064



BLE_2M

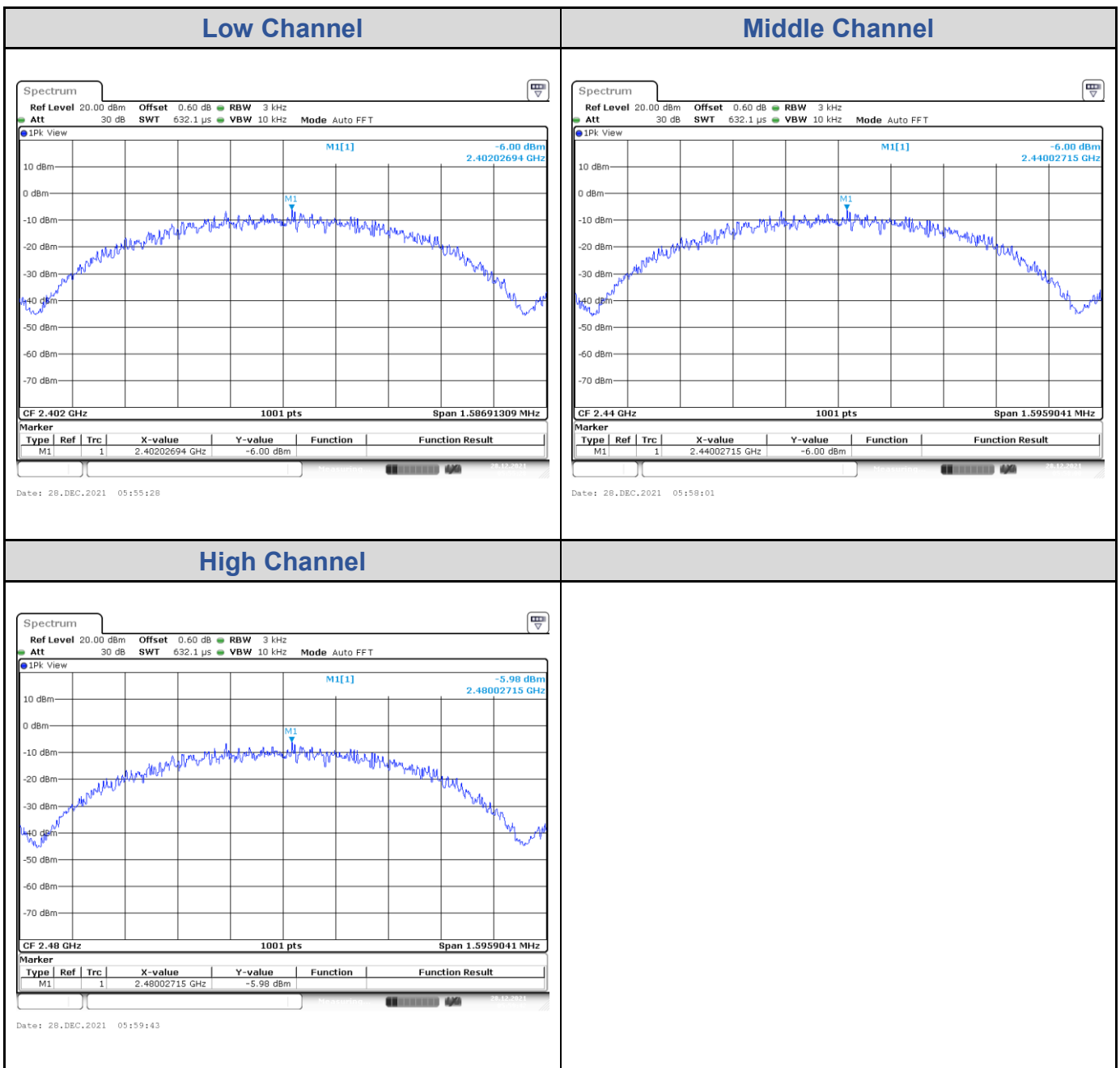
Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2402	2.048
Middle Channel	2440	2.053
High Channel	2480	2.058



Test Result of Power Spectral Density

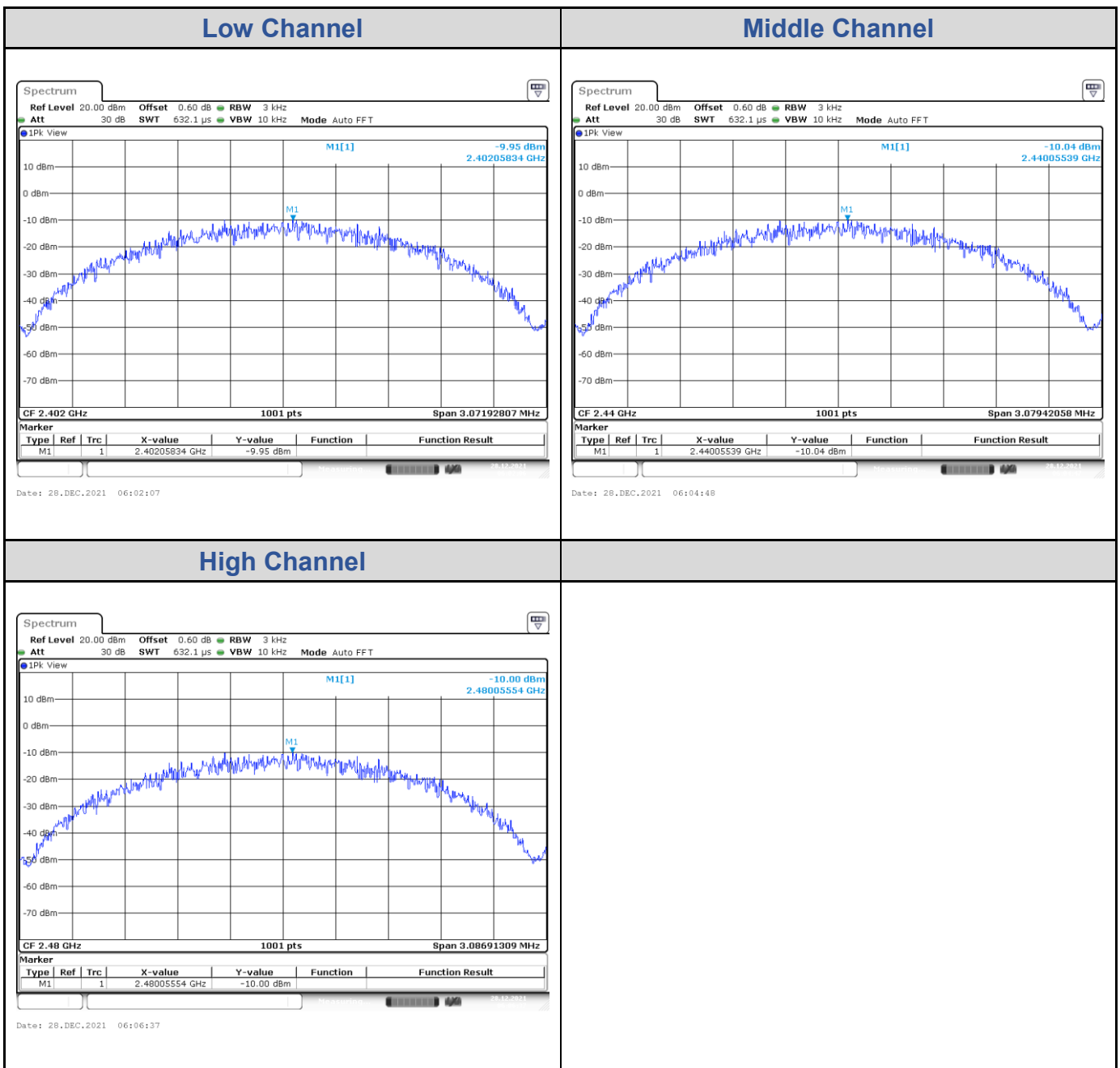
BLE_1M

Channel	Channel Frequency (MHz)	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
Low Channel	2402	-6.00	8	Pass
Middle Channel	2440	-6.00	8	Pass
High Channel	2480	-5.98	8	Pass



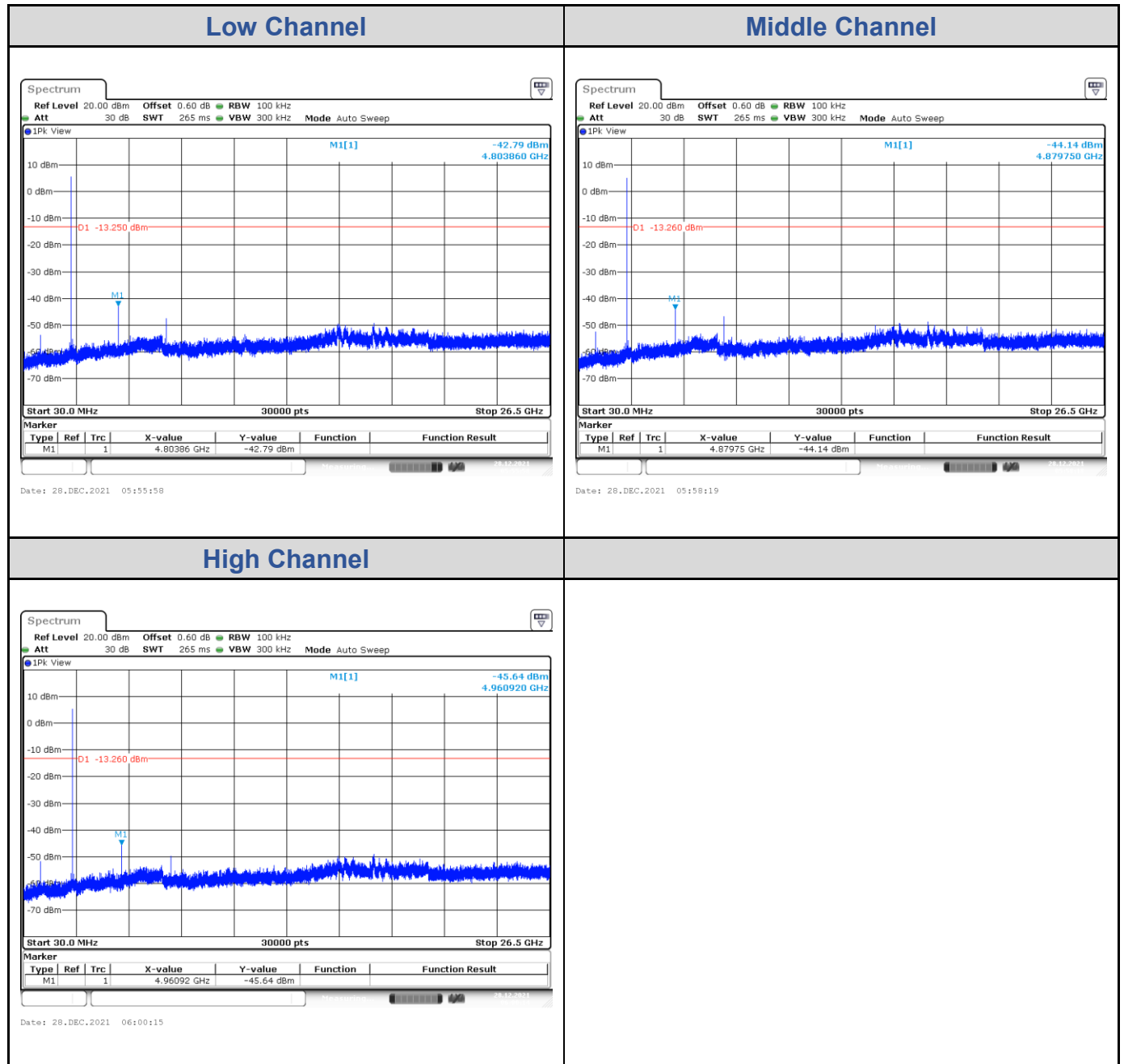
BLE_2M

Channel	Channel Frequency (MHz)	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
Low Channel	2402	-9.95	8	Pass
Middle Channel	2440	-10.04	8	Pass
High Channel	2480	-10.00	8	Pass

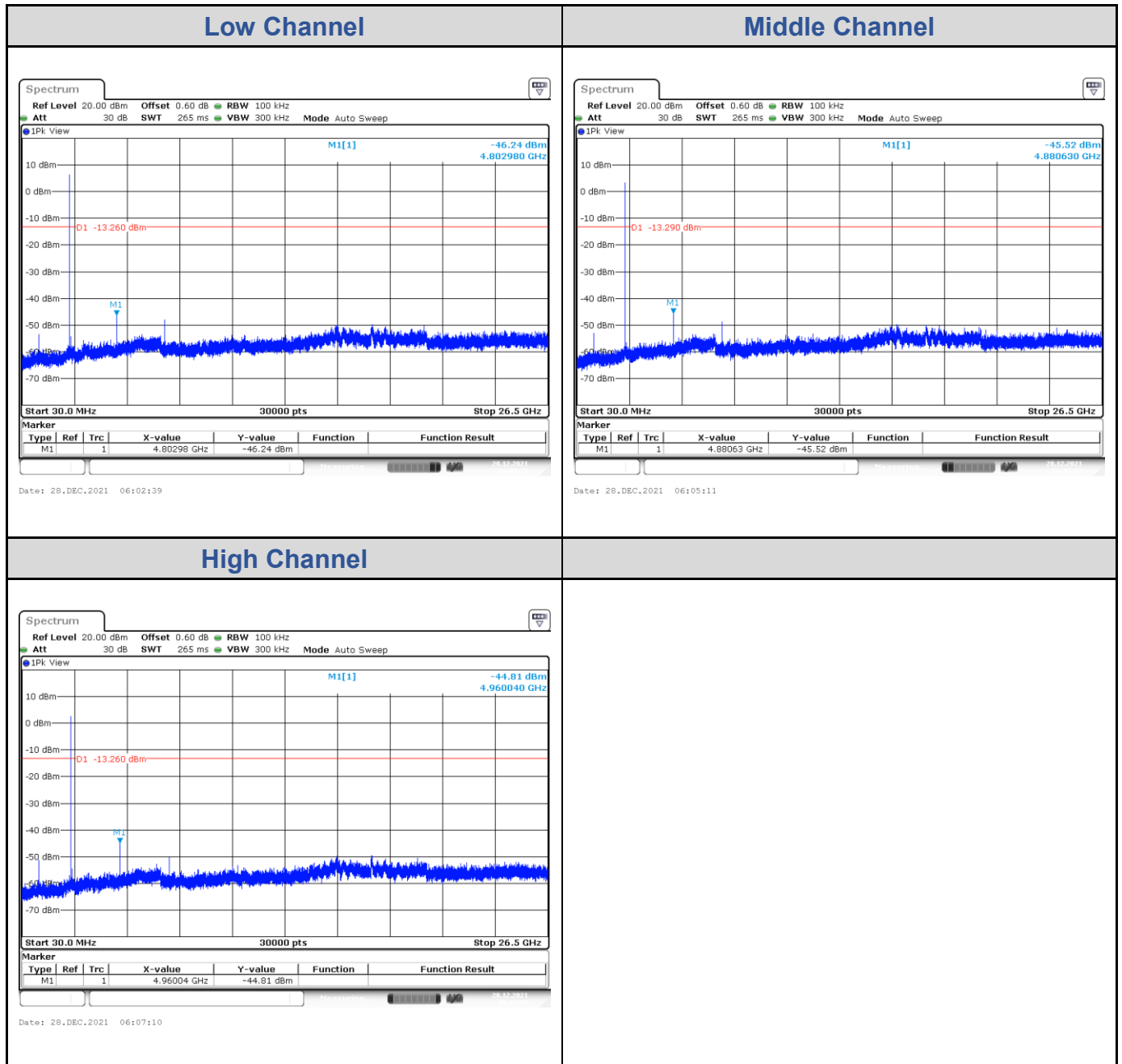


Test Result of Conducted Spurious Emissions, Tx Mode

BLE_1M

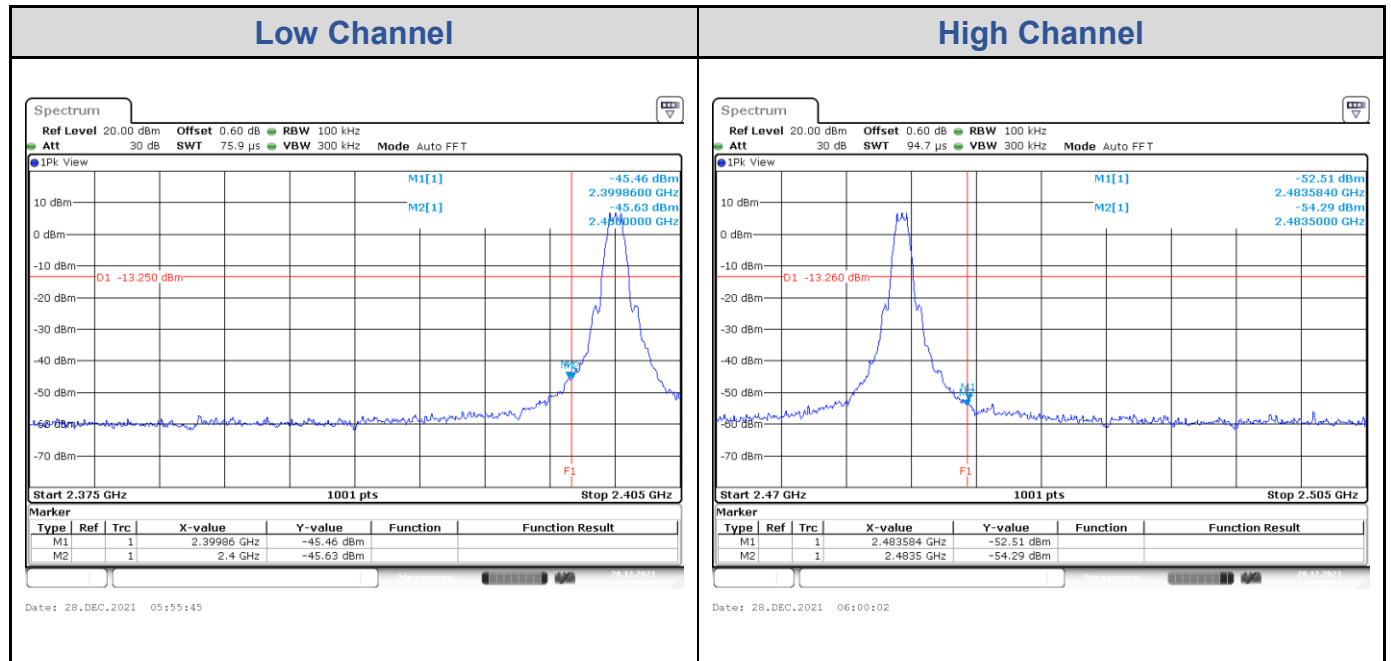


BLE_2M

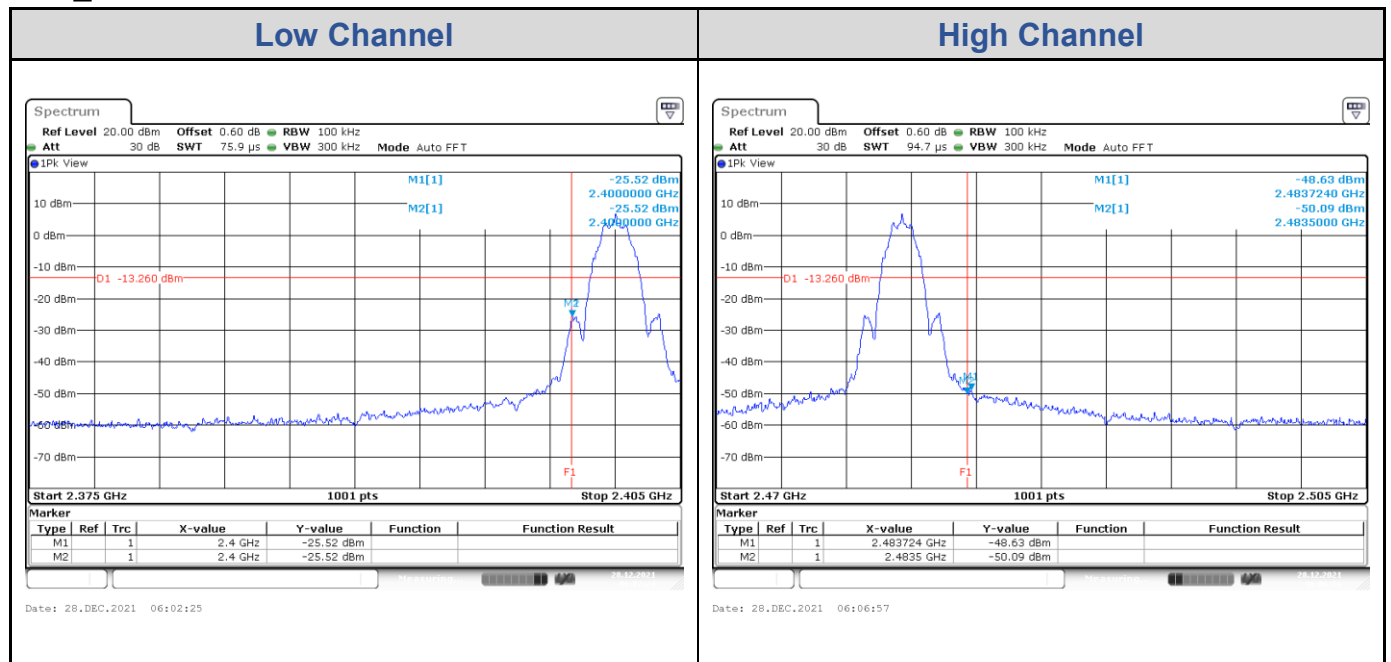


Test Result of Conducted Band Edge, Tx Mode

BLE_1M



BLE_2M



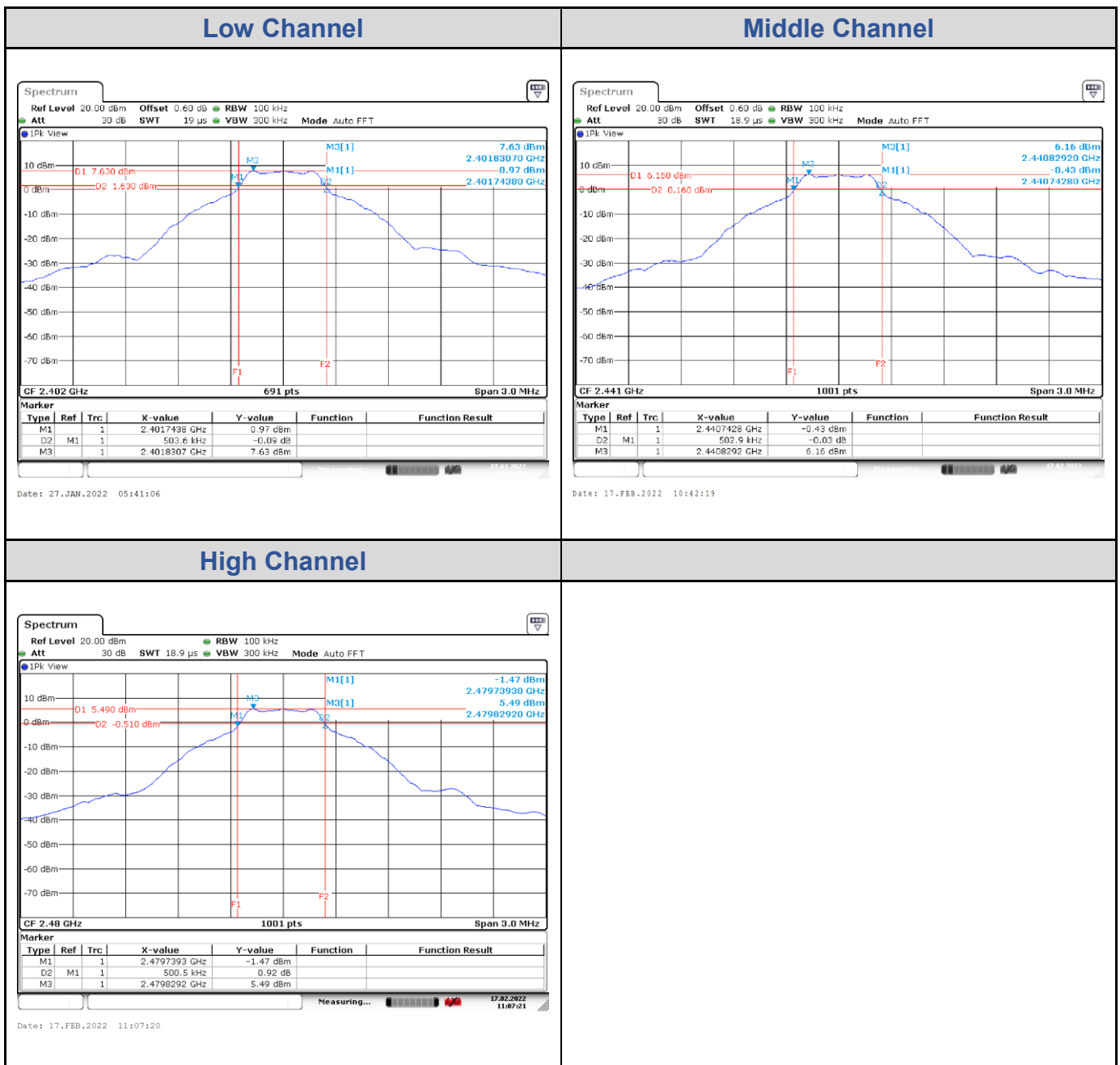
Appendix B: Test Results of Conducted Test_ANT & Nordic

Original

Test Result of 6 dB Bandwidth

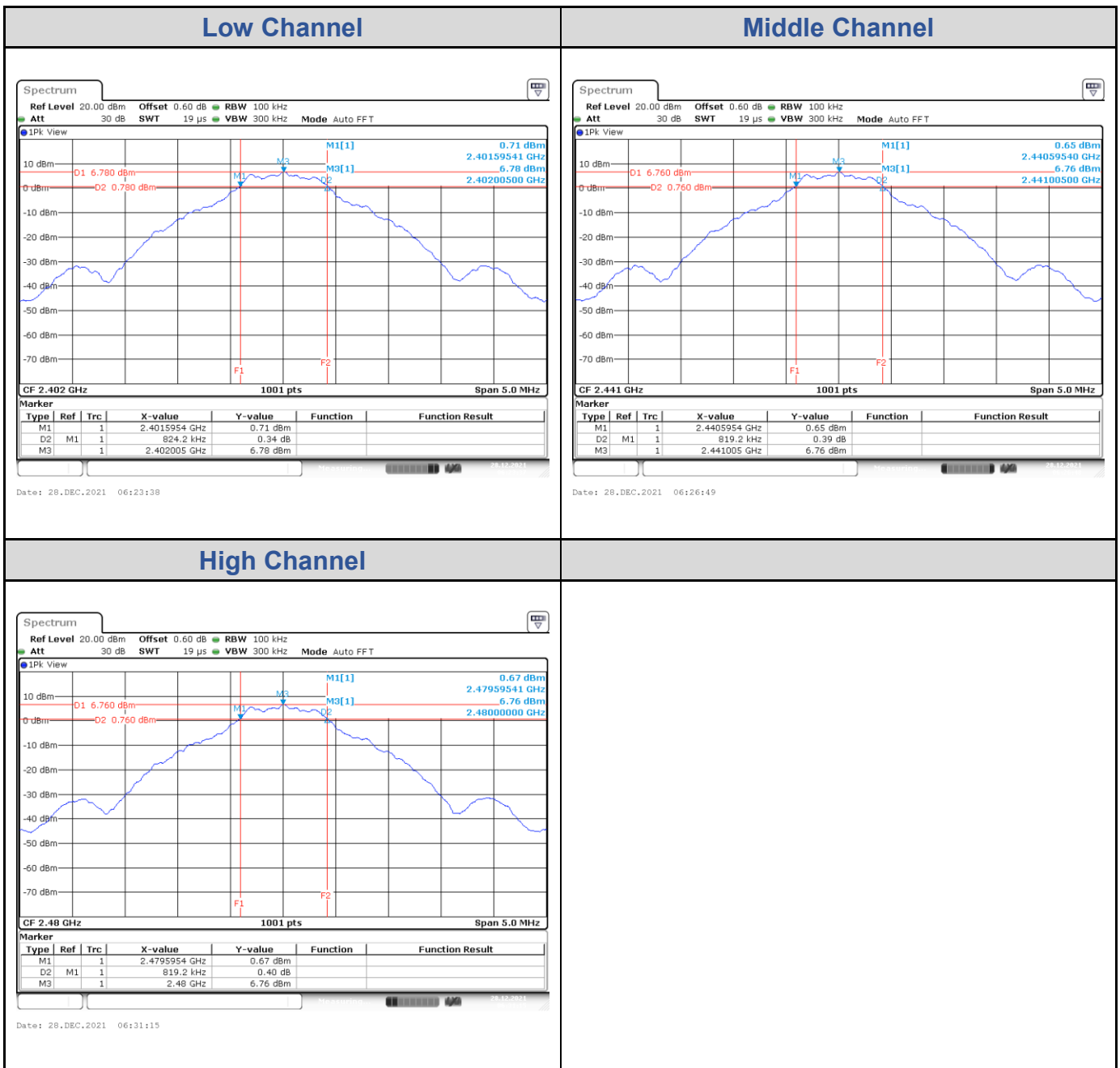
<ANT>

Channel	Channel Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	503.6	> 500	Pass
Middle Channel	2441	502.9	> 500	Pass
High Channel	2480	500.5	> 500	Pass



<Nordic Original>

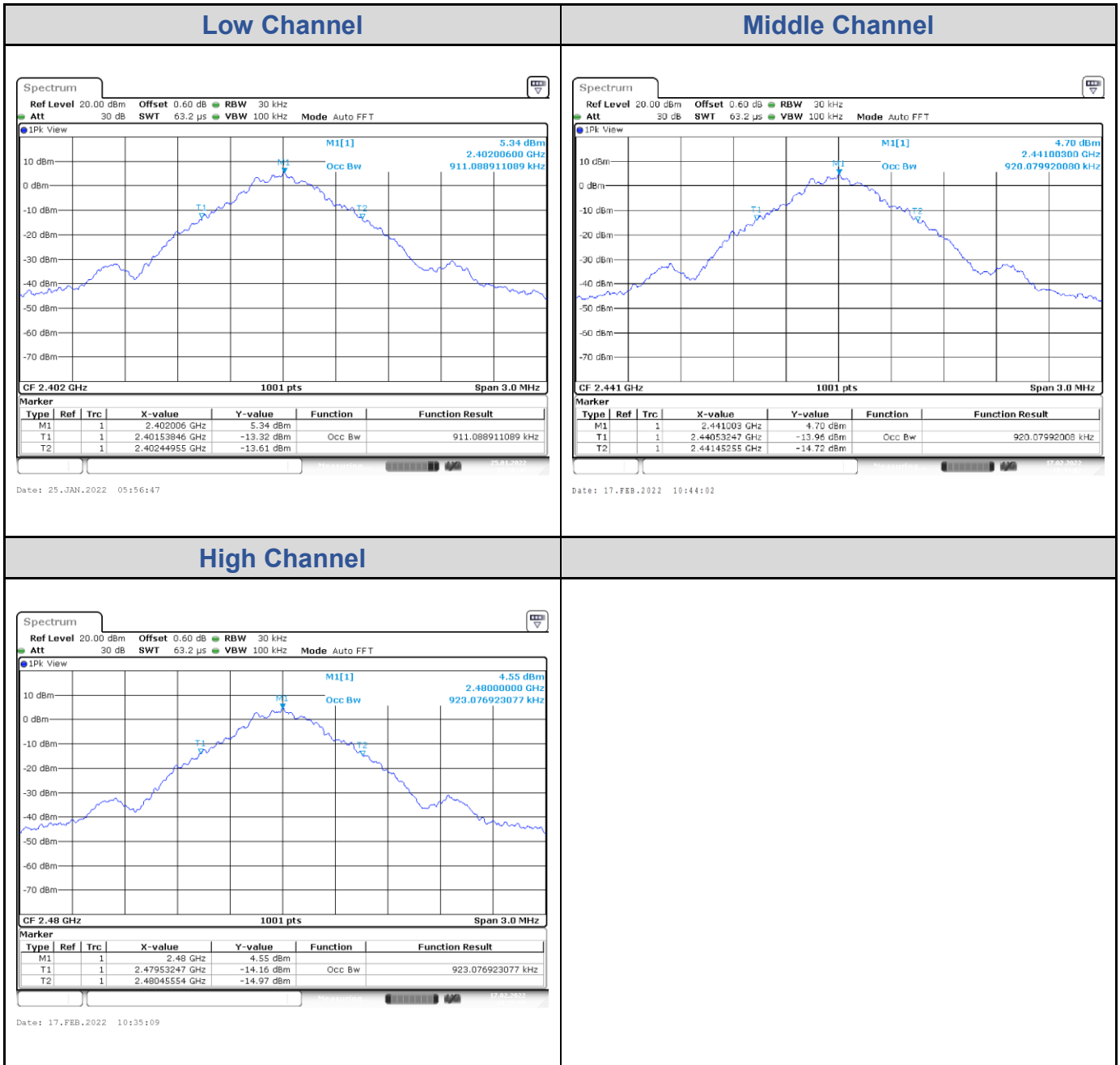
Channel	Channel Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	824.2	> 500	Pass
Middle Channel	2441	819.2	> 500	Pass
High Channel	2480	819.2	> 500	Pass



Test Result of 99% Occupied Bandwidth

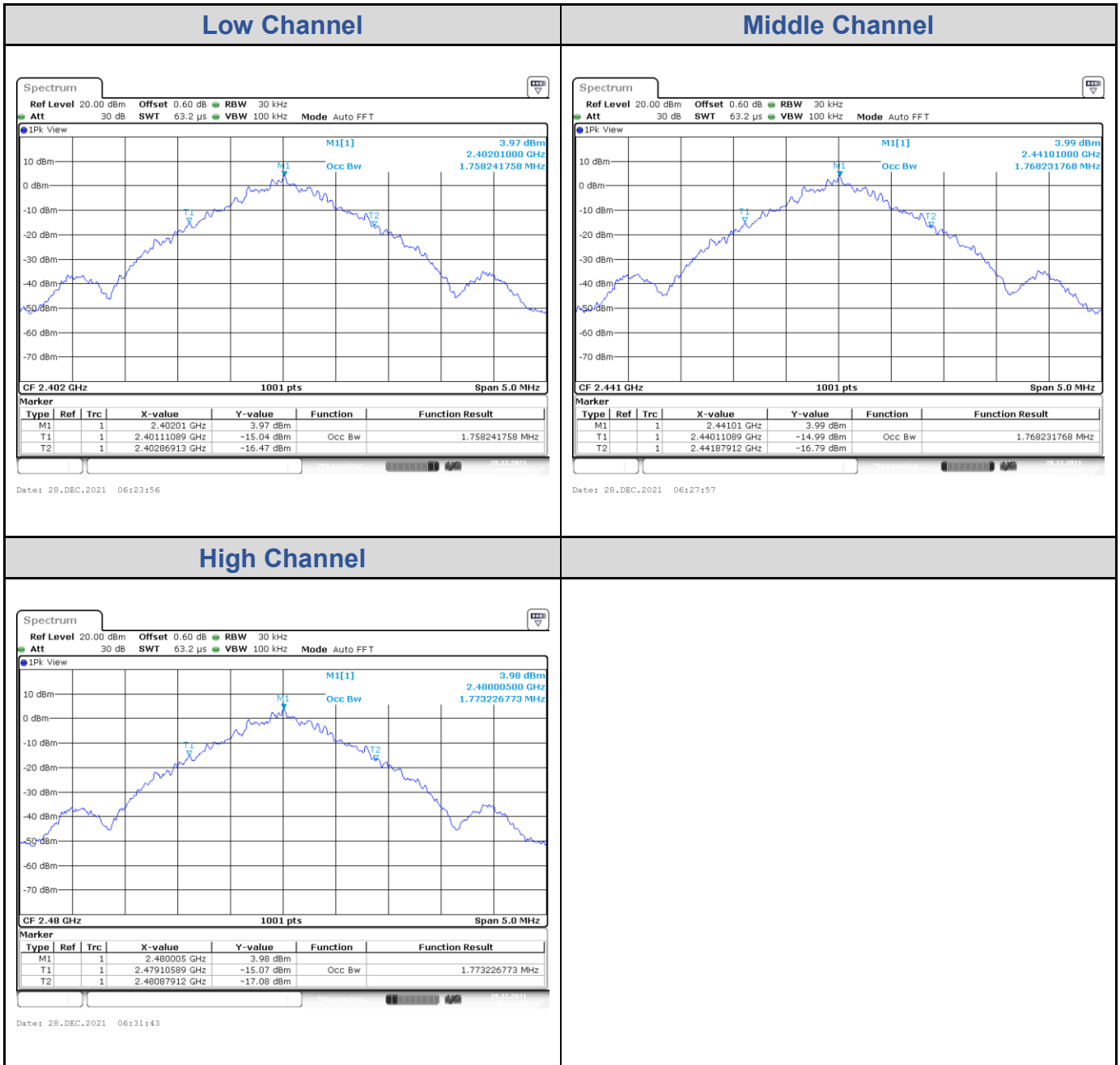
<ANT>

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2402	0.911
Middle Channel	2441	0.920
High Channel	2480	0.923



<Nordic Original>

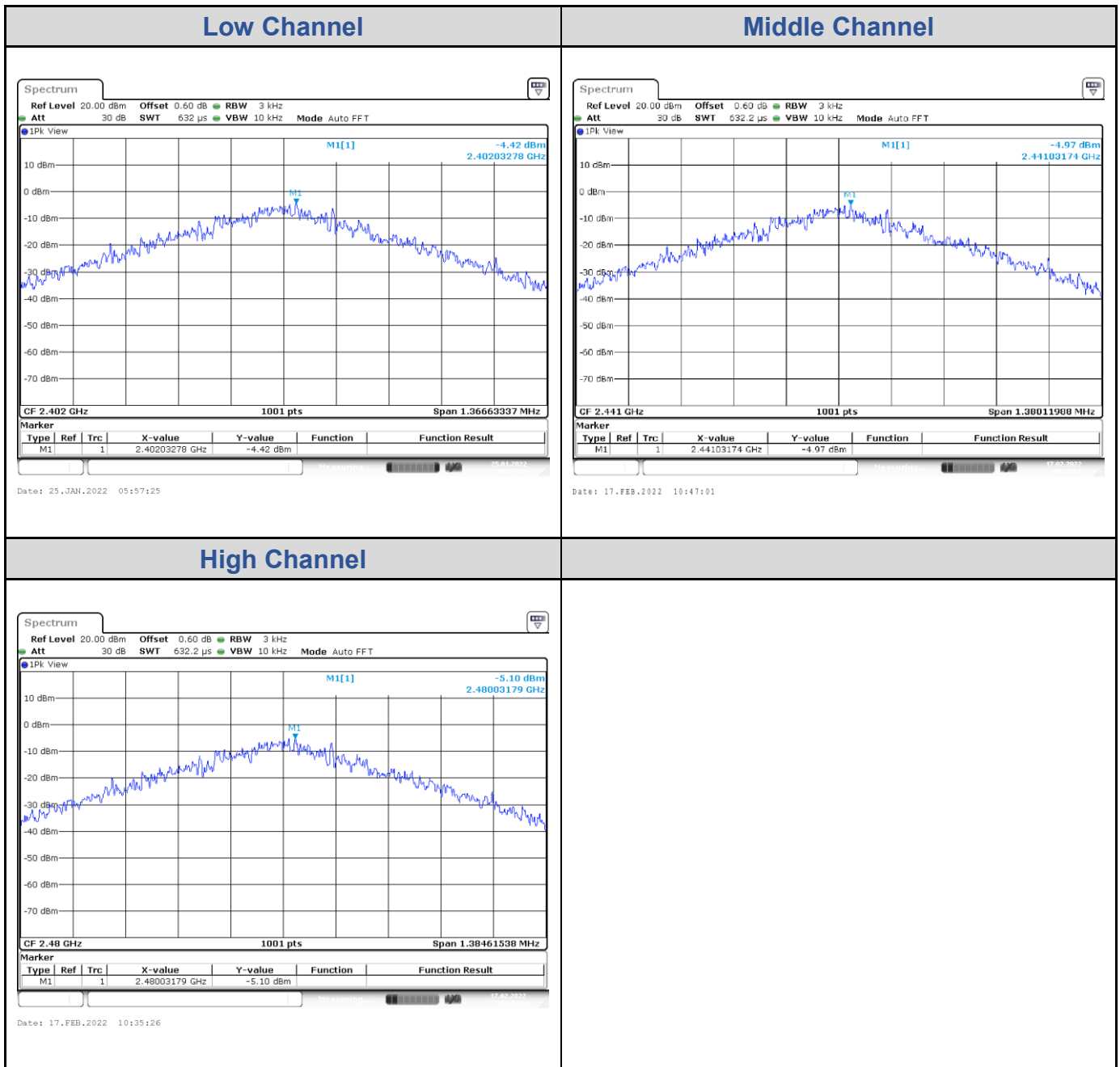
Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2402	1.758
Middle Channel	2441	1.768
High Channel	2480	1.773



Test Result of Power Spectral Density

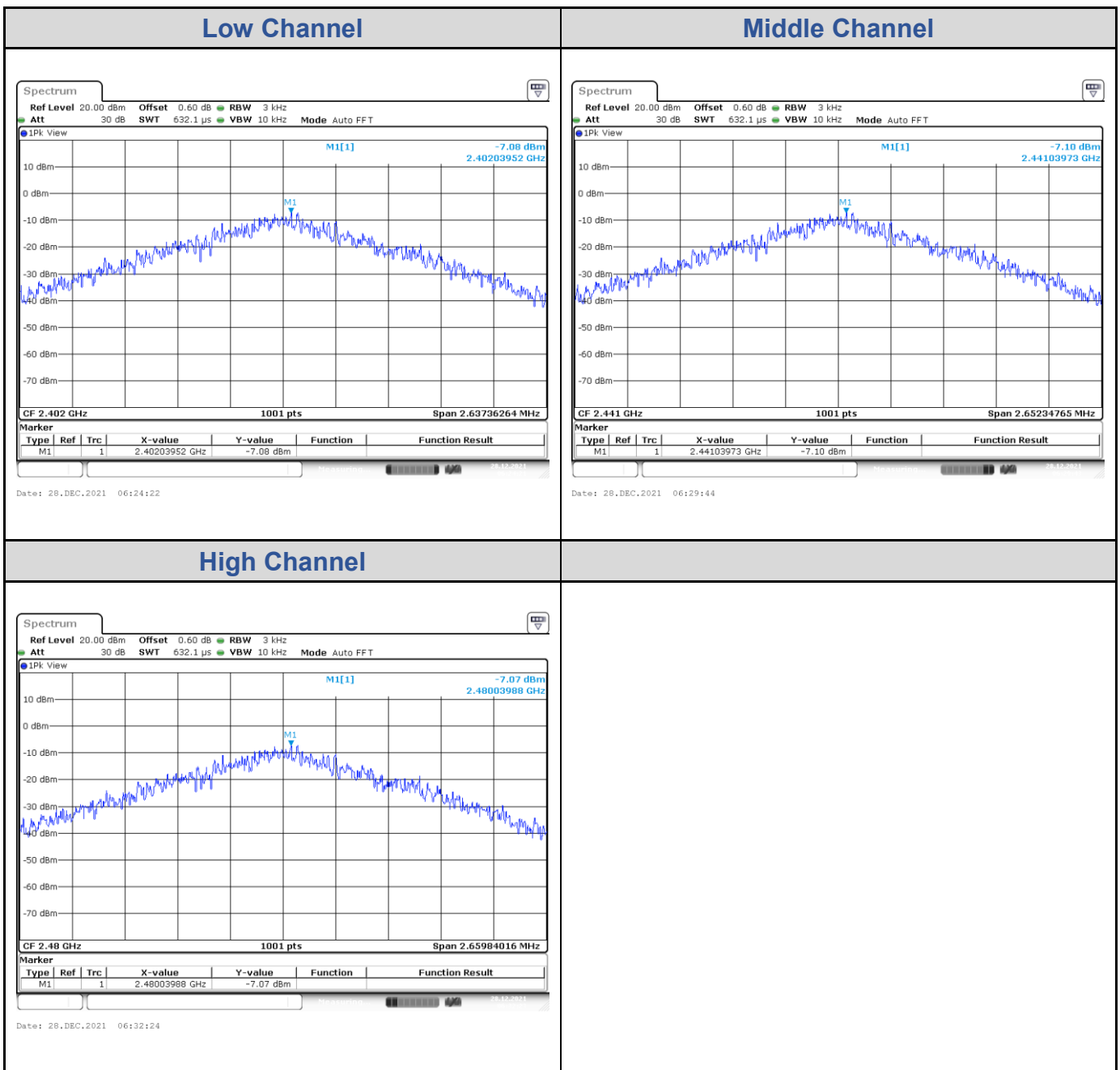
<ANT>

Channel	Channel Frequency (MHz)	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
Low Channel	2402	-4.42	8	Pass
Middle Channel	2441	-4.97	8	Pass
High Channel	2480	-5.10	8	Pass



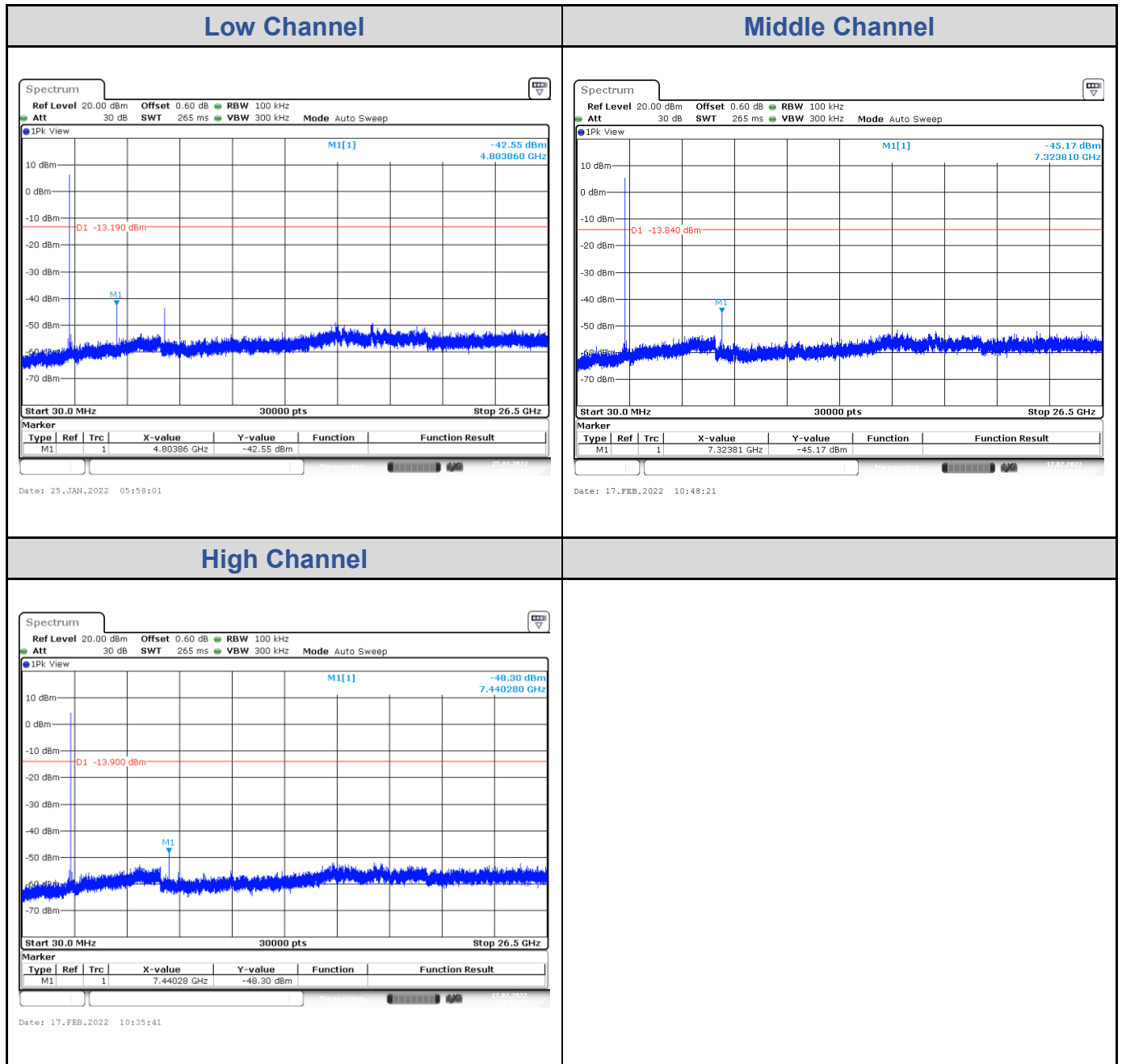
<Nordic Original>

Channel	Channel Frequency (MHz)	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
Low Channel	2402	-7.08	8	Pass
Middle Channel	2441	-7.10	8	Pass
High Channel	2480	-7.07	8	Pass

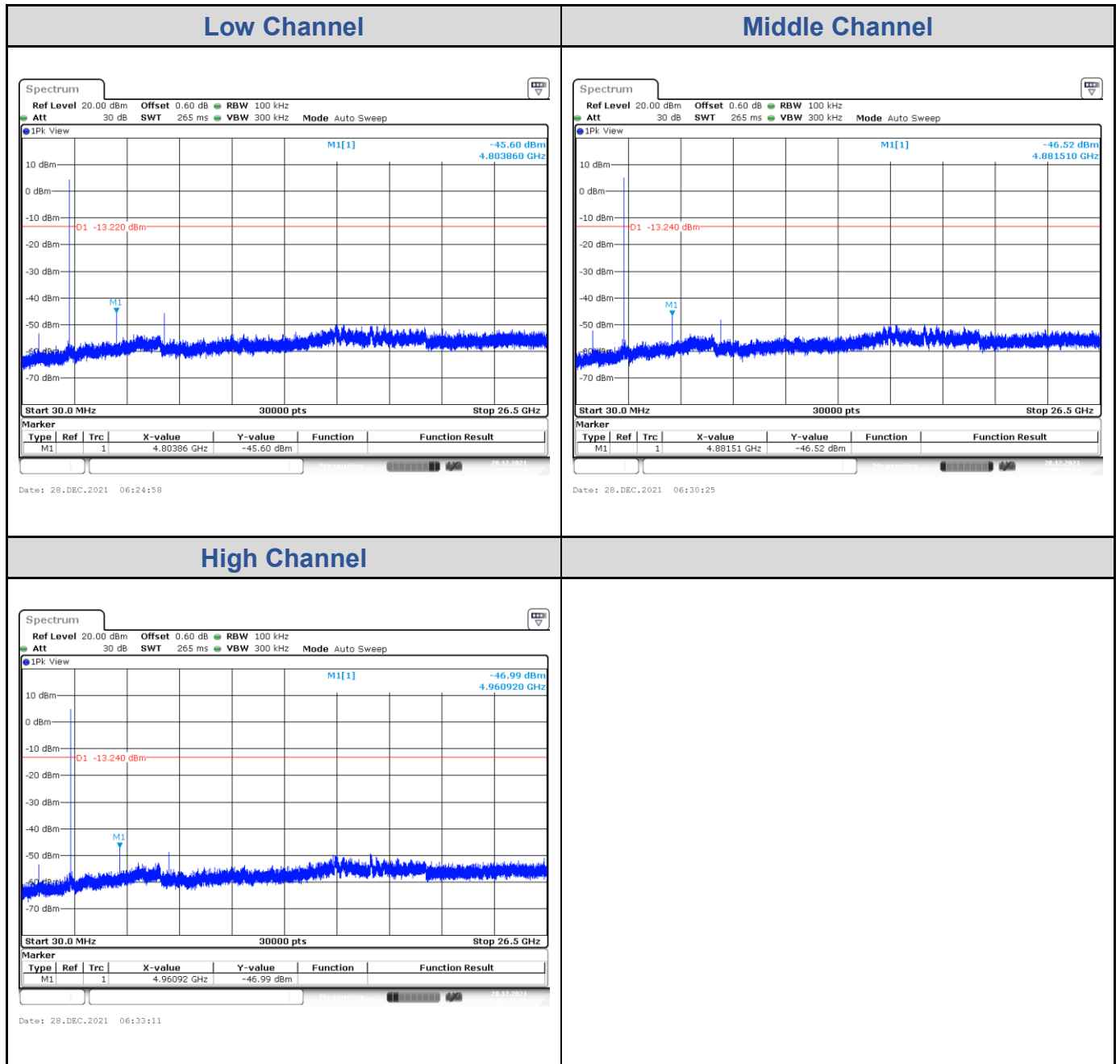


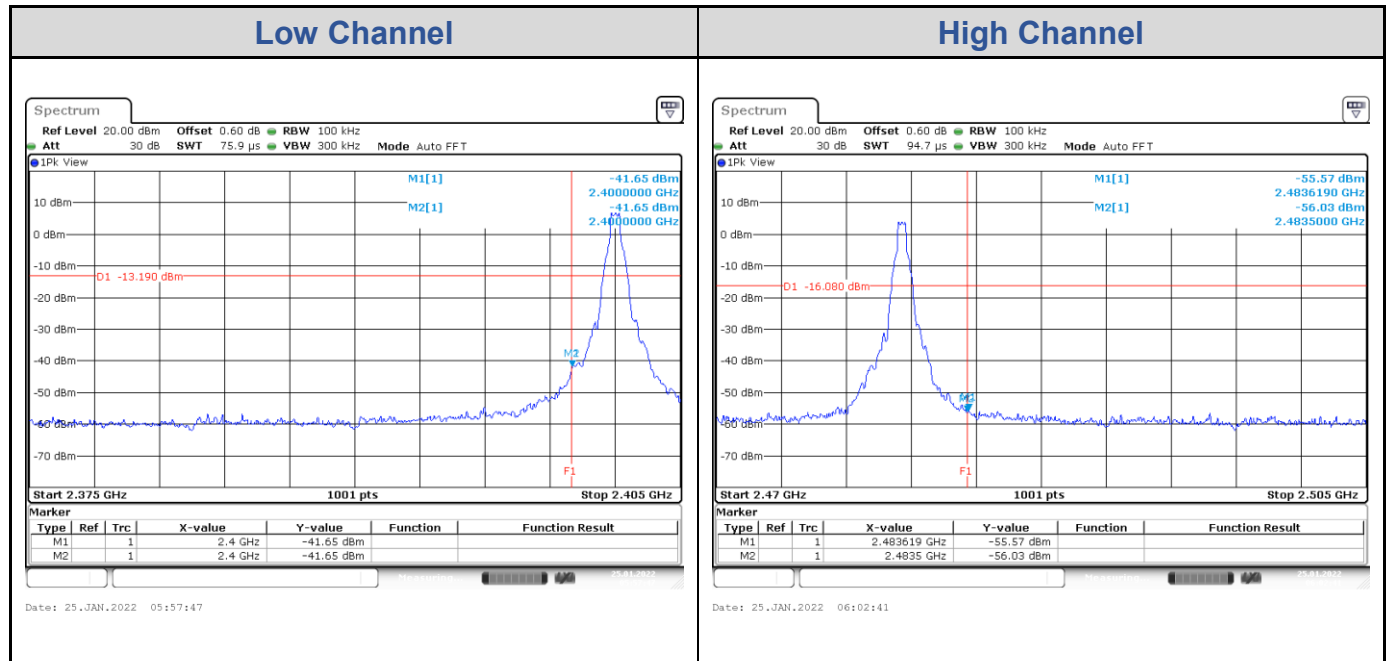
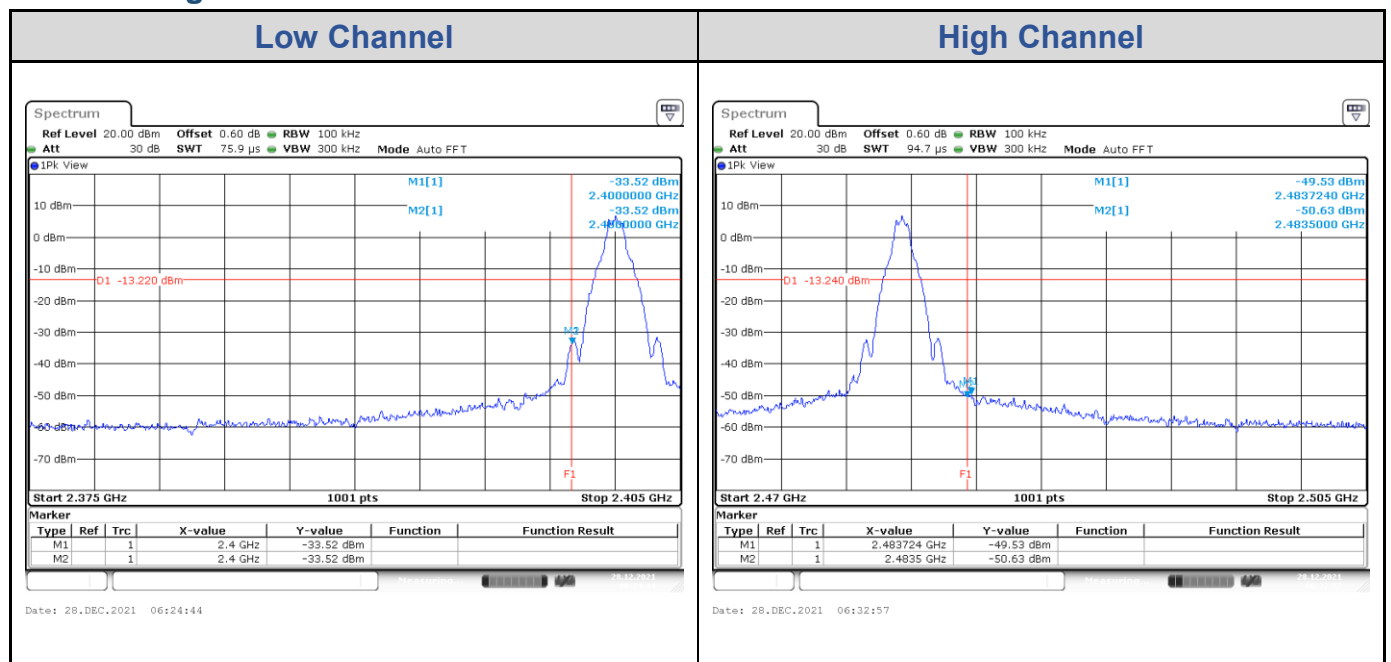
Test Result of Conducted Spurious Emissions, Tx Mode

<ANT>



<Nordic Original>



Test Result of Conducted Band Edge, Tx Mode
<ANT>

<Nordic Original>


Appendix C: Test Results of Radiated Spurious Emissions & Mains

Conducted Emission Test_BLE

Band Edges, 2.31GHz ~ 2.9GHz

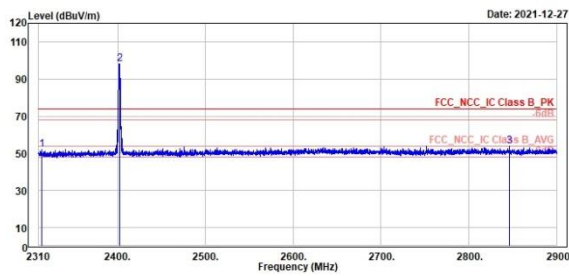
BLE_1M

Low Channel (Horizontal) Peak

Low Channel (Vertical) Peak



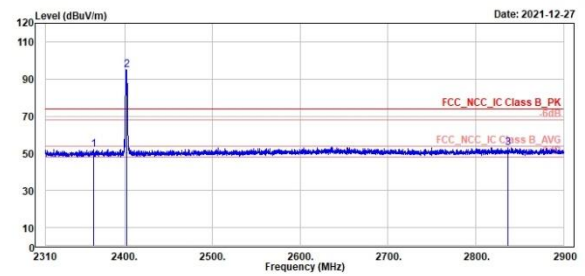
TÜV Rheinland Taiwan Ltd.
 No. 458-18, Sec 2, Fenliao, Linkou Dist., New Taipei City 244, Taiwan(R.O.C.)
 Tel: +886-2172-1000 Fax: +886-2172-1322



Peak	Freq	Level	Read	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg		
1	2313.42	51.88	14.52	37.36	74.00	-22.12	137	114 Peak	Horizontal	
2 *	2402.00	97.94	60.31	37.63	74.00	23.94	137	114 Peak	Horizontal	
3	2845.96	53.92	15.85	38.07	74.00	-20.08	137	114 Peak	Horizontal	



TÜV Rheinland Taiwan Ltd.
 No. 458-18, Sec 2, Fenliao, Linkou Dist., New Taipei City 244, Taiwan(R.O.C.)
 Tel: +886-2172-1000 Fax: +886-2172-1322



Peak	Freq	Level	Read	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg		
1	2364.75	51.92	14.40	37.52	74.00	-22.08	106	189 Peak	Vertical	
2 *	2402.00	94.95	57.32	37.63	74.00	20.95	106	189 Peak	Vertical	
3	2836.75	52.99	14.91	38.08	74.00	-21.01	106	189 Peak	Vertical	

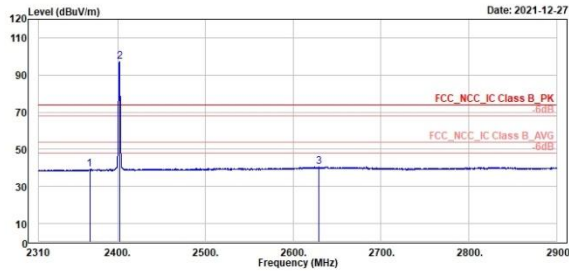
BLE_1M

Low Channel (Horizontal) Average

Low Channel (Vertical) Average



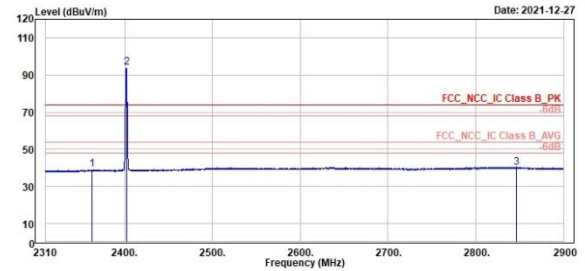
TUV Rheinland Taiwan Ltd.
No. 458-18, Sec 2, Fenliao, Linkou Dist., New Taipei City 244, Taiwan(R.O.C.)
Tel: +886-2172-1000 Fax: +886-2172-1322



Freq	Level	Read	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg		
1	2368.17	39.34	1.81	37.53	54.00	-14.66	137	114 Average	Horizontal
2 *	2402.00	96.98	59.35	37.63	54.00	42.98	137	114 Average	Horizontal
3	2629.07	40.55	2.35	38.20	54.00	-13.45	137	114 Average	Horizontal



TUV Rheinland Taiwan Ltd.
No. 458-18, Sec 2, Fenliao, Linkou Dist., New Taipei City 244, Taiwan(R.O.C.)
Tel: +886-2172-1000 Fax: +886-2172-1322



Freq	Level	Read	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg		
1	2363.10	39.12	1.60	37.52	54.00	-14.88	186	189 Average	Vertical
2 *	2402.00	93.97	56.34	37.63	54.00	39.97	186	189 Average	Vertical
3	2846.66	40.24	2.17	38.07	54.00	-13.76	186	189 Average	Vertical