

Prüfbericht-Nr.: Test report no.:	NN204226 (P15C-BT) 001	Auftrags-Nr.: Order no.:	238490929	Seite 1 von 30 Page 1 of 30
Kunden-Referenz-Nr.: Client reference no.:	N/A	Auftragsdatum: Order date:	2020-08-20	
Auftraggeber: Client:	Zeroplus Technology Corporation 3F, No.121, Jian 8th Rd, Chung Ho District New Taipei City, 235, Taiwan			
Prüfgegenstand: Test item:	X One Adapter SE			
Bezeichnung / Typ-Nr.: Identification / Type no.:	ZPP005G			
Auftrags-Inhalt: Order content:	FCC Part 15C Test report (BT)			
Prüfgrundlage: Test specification:	FCC 47CFR Part 15: Subpart C Section 15.247			
Wareneingangsdatum: Date of sample receipt:	2020-09-21			
Prüfmuster-Nr.: Test sample no:	A002916836-006 A002916836-007			
Prüfzeitraum: Testing period:	2020-09-29 - 2020-10-05			
Ort der Prüfung: Place of testing:	EMC/RF Laboratory Taipei			
Prüflaboratorium: Testing laboratory:	Taipei Testing Laboratories			
Prüfergebnis*: Test result*:	Pass			
überprüft von: reviewed by:	genehmigt von: authorized by:			
Datum: Date:	2020-10-16	Ausstellungsdatum: Issue date:	2020-10-16	
Stellung / Position:	Jack H.C. Chang Project Manager	Stellung / Position:	Brenda S.H. Chen Project Manager	
Sonstiges / Other:				
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery:		Prüfmuster vollständig und unbeschädigt Test item complete and undamaged		
* Legende: 1 = sehr gut 2 = gut 3 = befriedigend 4 = ausreichend 5 = mangelhaft P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) N/A = nicht anwendbar N/T = nicht getestet * Legend: 1 = very good 2 = good 3 = satisfactory 4 = sufficient 5 = poor P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable N/T = not tested				
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. 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.				

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)(1)	Peak Output Power	Pass
5.1.3	15.247(a)(1)	20 dB Bandwidth	Pass
5.1.3	2.1049	99% Occupied Bandwidth	Pass
5.1.4	15.247(d)	Conducted Spurious Emission and Band Edges	Pass
5.1.5	15.247(d) & 15.205 & 15.209	Radiated Spurious Emissions and Band Edges	Pass
5.1.6	15.247(a)(1)	Hopping Channel Separation	Pass
5.1.7	15.247(a)(1) (iii)	Number of Hopping Frequency Used	Pass
5.1.8	15.247(a)(1) (iii)	Dwell Time on Each Channel	Pass
5.2.1	15.207	Mains Conducted Emission	Pass
6.1	FCC KDB 447498 D01 v06	RF Exposure Compliance	Pass

Note:

1. If the Frequency Hopping Systems operating in 2400-2483.5 MHz band and the output power less than 125 mW. The hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of hopping channel whichever is greater.
2. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

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APPENDIX A - TEST RESULT OF CONDUCTED

**APPENDIX B - TEST RESULT OF RADIATED SPURIOUS EMISSIONS & MAINS CONDUCTED
EMISSION**

APPENDIX SP - PHOTOGRAPHS TEST SETUP

APPENDIX EP - PHOTOGRAPHS OF EUT

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HISTORY OF THIS TEST REPORT

Report No.	Description	Date Issued
NN204226 (P15C-BT) 001	Original Release	2020-10-16

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

Appendix B - Test Result of Radiated Spurious Emissions & Mains Conducted Emission

Appendix SP - Photographs 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
KDB 447498 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

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)	± 1.32 dB
Radiated Emission (200 MHz ~ 1 GHz)	± 1.31 dB
Radiated Emission (1 GHz ~ 18 GHz)	± 1.53 dB
Radiated Emission (18 GHz ~ 40 GHz)	± 2.50 dB
Mains Conducted Emission	± 1.65 dB

3. General Product Information

3.1 Product Function and Intended Use

The EUT is a X One Adapter SE. 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	X One Adapter SE
Type Identification	ZPP005G
FCC ID	2ADKM005G

Technical Specification of EUT

Item	EUT information
Operating Frequency	2402 MHz ~ 2480 MHz
Channel Spacing	1 MHz
Channel number	79
Operation Voltage	5Vdc
Modulation	GFSK, $\pi/4$ -DQPSK, 8DPSK
Maximum Output Power (mW)	3.83
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

Frequency (MHz)	Power Setting		
	GFSK	$\pi/4$ -DQPSK	8DPSK
2402	Default	Default	Default
2441	Default	Default	Default
2480	Default	Default	Default

4.2 Carrier Frequency and Channel

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	HC_Data_Test.exe
---------------	------------------

The samples were used as follows:

A002916836-006

A002916836-007

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	
-	√	√	√	√	-

Note:

- For Radiated emission test, pre-tested GFSK, $\pi/4$ -DQPSK, 8DPSK modulation type and found GFSK was the worse, therefore chosen for the final test and presented in the test report.
- The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when position on **Z-plane**.
- "-" 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)	Modulation Type	Packet Type
-	2402 to 2480	2402, 2441, 2480	GFSK	1DH5
-	2402 to 2480	2402, 2441, 2480	8DPSK	3DH5

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)	Modulation Type	Packet Type
-	2402 to 2480	2402, 2441, 2480	GFSK	1DH5
-	2402 to 2480	2402, 2441, 2480	8DPSK	3DH5

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)	Modulation Type	Packet Type
-	2402 to 2480	2480	GFSK	1DH5

Mains Conducted Emission Test:

☒ 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)	Modulation Type	Packet Type
-	2402 to 2480	2480	GFSK	1DH5

Test Condition

Test Item	Ambient Temperature	Relative Humidity	Tested by
Conducted Measurement	22-26 °C	50-65 %	Stanislas Charles
Radiated Spurious Emissions above 1 GHz	22-26 °C	50-65 %	Eagle Tsai
Radiated Spurious Emissions below 1 GHz	22-26 °C	50-65 %	Eagle Tsai
Mains Conducted Emission	22-26 °C	50-65 %	Stanislas Charles

4.4 Special Accessories and Auxiliary Equipment

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

Accessory of EUT

N/A

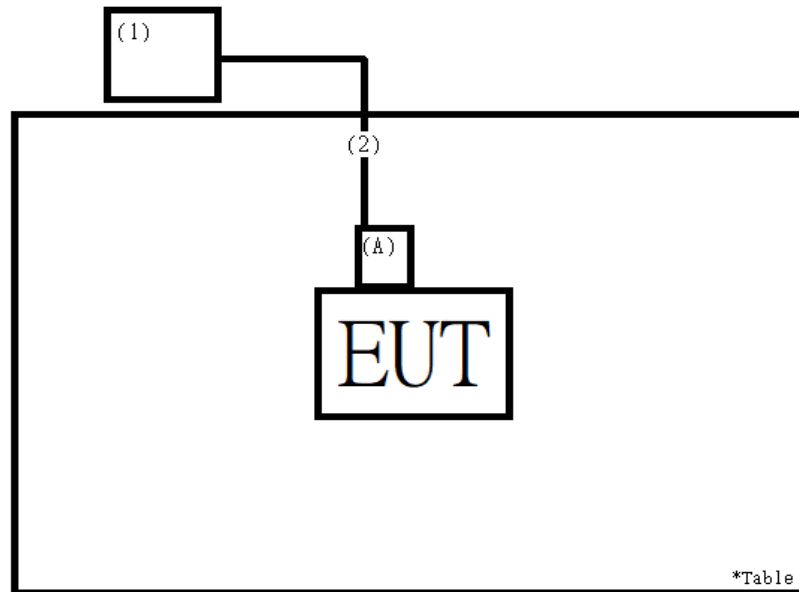
Support Unit

Support Unit					
No.	Description	Brand	Model	S/N	Remark
A	UART	N/A	N/A	N/A	--
1	Notebook	HP	15s-du0007TX	CND93662VF	--
2	Adaptor	HP	TPN-LA16	N/A	Mains Conducted
-	Wireless Tester	R&S	CBT	100866	--

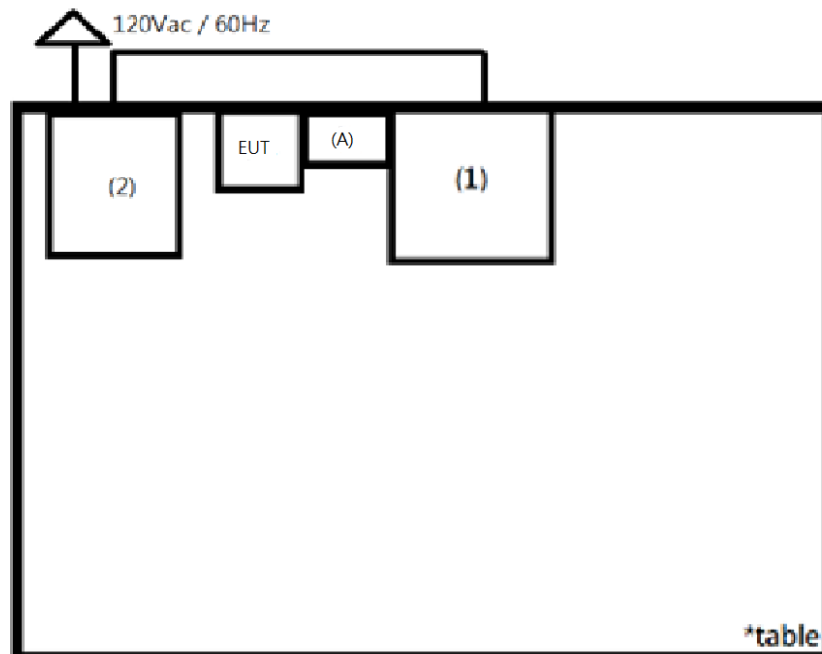
Interface Cable					
No.	Description	Shielded Type	Ferrite Core (Qty)	Length (cm)	Remark
2	USB Cable	YES	0	180	Radiated
2	Adapter Cable	YES	0	180	Mains Conducted

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 -6.72 dBi. The antenna is a printed PCB 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

Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Power Meter	Anritsu	ML2495A	1901008	2020/4/6	2021/4/5
Power Sensor	Anritsu	MA2411B	1725269	2020/4/7	2021/4/6

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
<GFSK>

Channel	Channel Frequency	Peak Output Power		Limit
	(MHz)	(dBm)	(mW)	(mW)
Low Channel	2402	5.74	3.75	125
Middle Channel	2441	5.83	3.83	125
High Channel	2480	5.55	3.59	125

<8DPSK>

Channel	Channel Frequency	Peak Output Power		Limit
	(MHz)	(dBm)	(mW)	(mW)
Low Channel	2402	5.73	3.74	125
Middle Channel	2441	5.56	3.60	125
High Channel	2480	5.53	3.57	125

Average Power
<GFSK>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	5.70	3.715
Middle Channel	2441	5.55	3.589
High Channel	2480	5.50	3.548

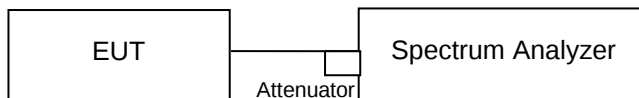
<8DPSK>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
Low Channel	2402	3.23	2.104
Middle Channel	2441	3.05	2.018
High Channel	2480	2.99	1.991

5.1.3 20 dB Bandwidth and 99% Occupied Bandwidth

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Spectrum Analyzer	R&S	FSV40	101512	2020/2/18	2021/2/17

Test Procedure

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
- Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
- Repeat above procedures until all frequencies measured were complete.
- 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.

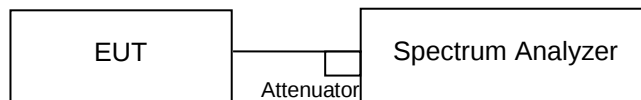
5.1.4 Conducted Spurious Emissions and Frequency Band Edges Measured in 100kHz Bandwidth

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
Spectrum Analyzer	R&S	FSV40	101512	2020/2/18	2021/2/17

Test Procedure

The transmitter output was connected to the spectrum analyzer via a low lose cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

Test Results

Please refer to Appendix A.

5.1.5 Radiated Spurious Emissions and Band Edges

Limit

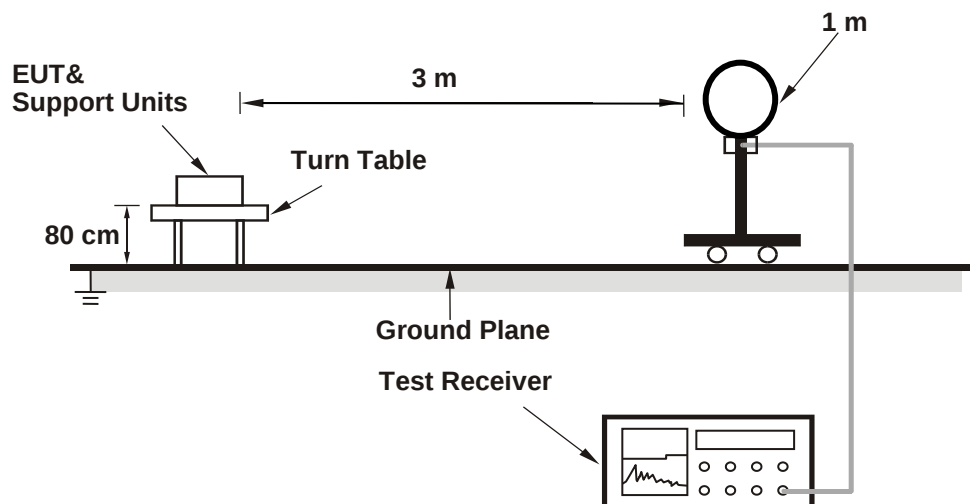
Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a).

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).

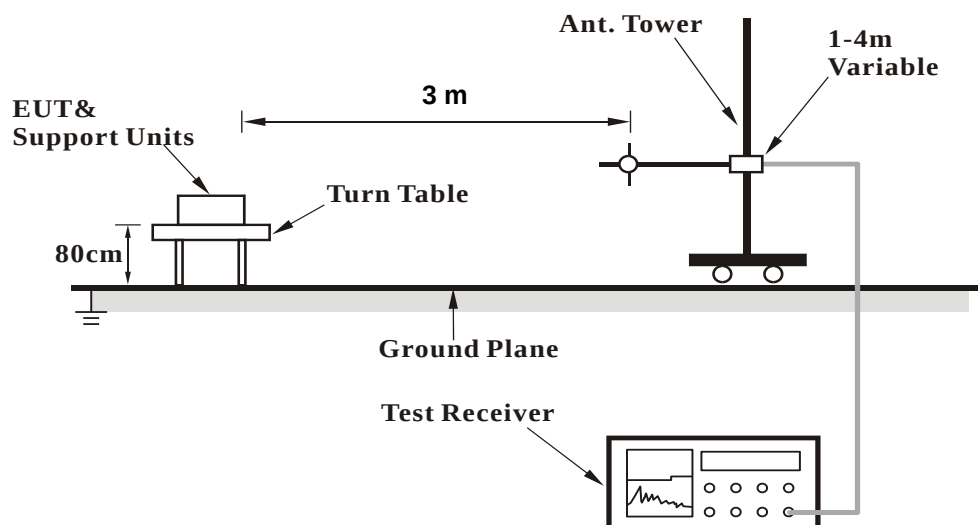
Kind of Test Site 3m Semi-Anechoic Chamber

Test Setup

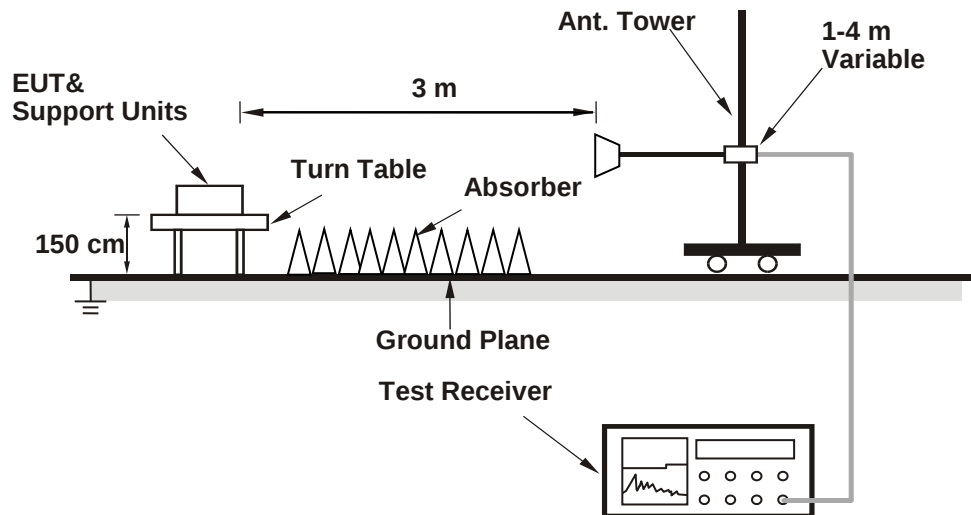
<Radiated Emissions below 30 MHz>



<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

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Signal Analyzer	R&S	FSV40	101509	2020/5/5	2021/5/4
Receiver	R&S	ESR7	102109	2020/3/30	2021/3/29
Bilog Antenna	SCHWARZBECK	VULB-9168	00950	2020/1/20	2021/1/19
Horn Antenna	ETS-Lindgren	3117	00218929	2019/11/27	2020/11/26
LF-AMP	Agilent	8447D	2727A05146	2020/2/17	2021/2/16
HF-AMP + AC source	EMCI	EMC051845SE	980635	2020/2/11	2021/2/10
HF-AMP + AC source	EMCI	EMC184045SE	980656	2020/2/11	2021/2/10
Horn Antenna	SCHWARZBECK	BBHA 9170	00890	2020/4/13	2021/4/12
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104EA	800057/4EA	2020/4/22	2021/4/21
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	802244/4	2020/4/22	2021/4/21
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	MY37203/4	2020/4/22	2021/4/21
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800897/2EA	2020/3/25	2021/3/24
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800902/2EA	2020/3/25	2021/3/24
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	801026/2EA	2020/3/25	2021/3/24
Loop Antenna	Chance Most	EMCILPA600 +calibration	287	2020/1/9	2021/1/8

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, perpendicular, and ground-parallel 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, Y and Z axis orientation. The worst-case Axis orientation is recorded in this test report.

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Test Results

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

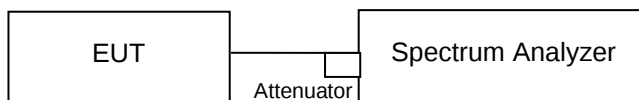
Please refer to Appendix B.

5.1.6 Hopping Channel Separation

Limit ≥ 25 kHz or 2/3 of 20 dB bandwidth, whichever is greater

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Spectrum Analyzer	R&S	FSV40	101512	2020/2/18	2021/2/17

Test Procedure

Measurement Procedure REF

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
- By using the MaxHold function record the separation of two adjacent channels.
- Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.
- Repeat above procedures until all frequencies measured were complete.

Test Results

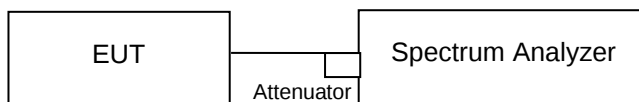
Please refer to Appendix A.

5.1.7 Number of Hopping Frequency

Limit ≥ 15 non-overlapping channels

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Spectrum Analyzer	R&S	FSV40	101512	2020/2/18	2021/2/17

Test Procedure

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
- Set the SA on View mode and then plot the result on SA screen.
- Repeat above procedures until all frequencies measured were complete.

Test Results

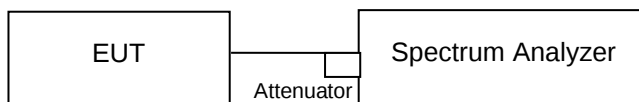
Please refer to Appendix A.

5.1.8 Dwell Time

Limit 0.4s

Kind of Test Site Shielded room

Test Setup



Test Instruments

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Spectrum Analyzer	R&S	FSV40	101512	2020/2/18	2021/2/17

Test Procedures

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
- Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
- Repeat above procedures until all different time-slot modes have been completed.

Test Results

Please refer to Appendix A.

5.2 Mains Emission

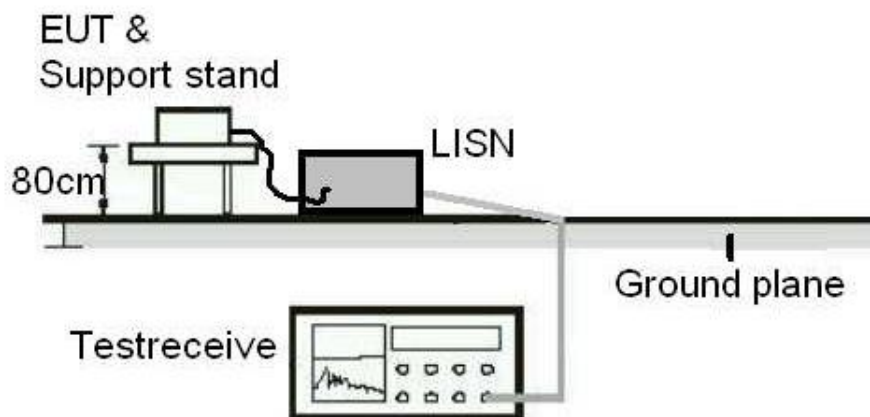
5.2.1 Mains Conducted Emission

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

<Test Date: 2020-09-30>

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
TWO-LINE V-NETWORK	SCHHWARZBECK	NSLK 8127	8127-00976	2019/10/2	2020/10/1
EMI Test Receiver	R&S	ESR7	102108	2020/4/22	2021/4/21
10dB attenuation	SCHHWARZBECK	VTSD 9561 F-N	660	2020/2/24	2021/2/23
Measurement Software	EZ	EZ EMC (Version NB-03A)	N/A	N/A	N/A

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 B.

6. Safety Human exposure

6.1 RF Exposure Compliance

6.1.1 SAR Test Exclusion Thresholds

Results

Since the maximum output power of the transmitter is 3.715 mW < 10 mW (Distance: 5 mm), hence the EUT is excluded from SAR evaluation according to FCC KDB publication 447498 D01: Mobile Portable RF Exposure.

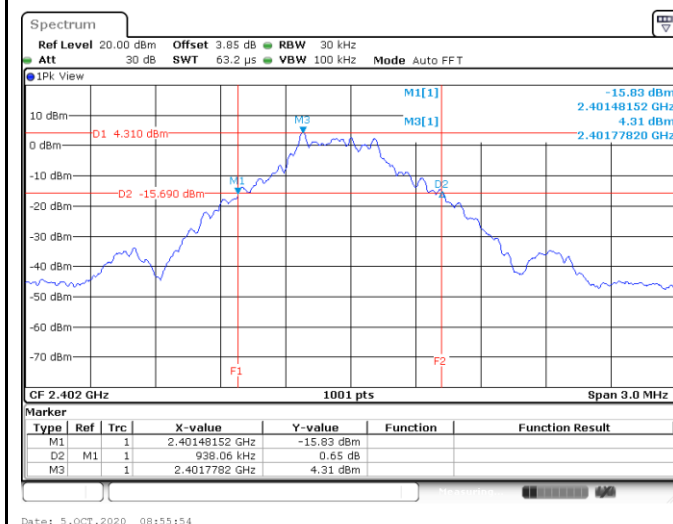
Appendix A: Test Results of Conducted Test

Test Result of 20 dB Bandwidth

GFSK

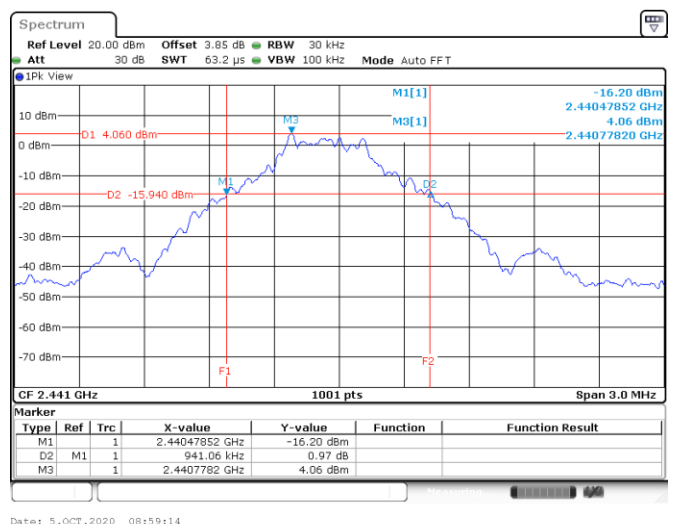
Channel	Channel Frequency (MHz)	20 dB Bandwidth (kHz)	Result
Low Channel	2402	938.06	Pass
Middle Channel	2441	941.06	Pass
High Channel	2480	941.06	Pass

Low Channel



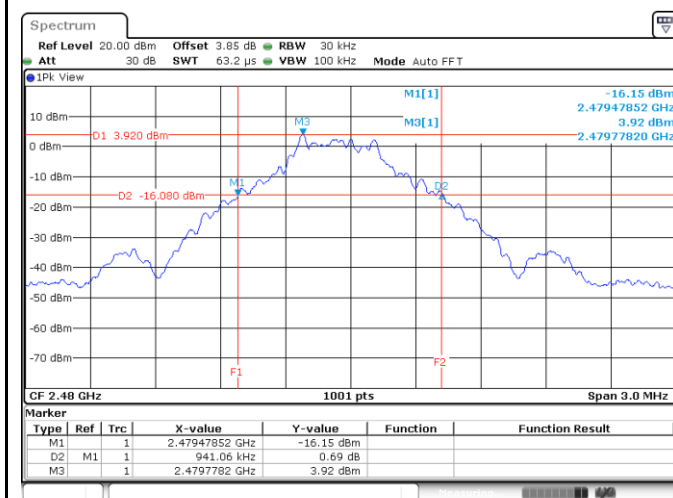
Date: 5.OCT.2020 08:55:54

Middle Channel



Date: 5.OCT.2020 08:59:14

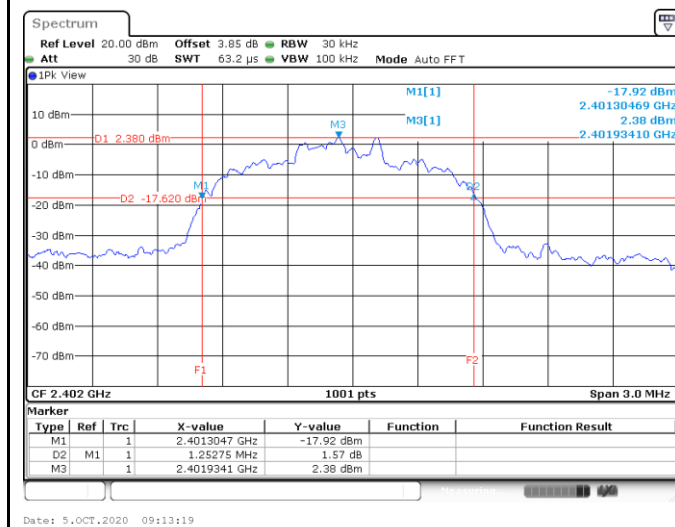
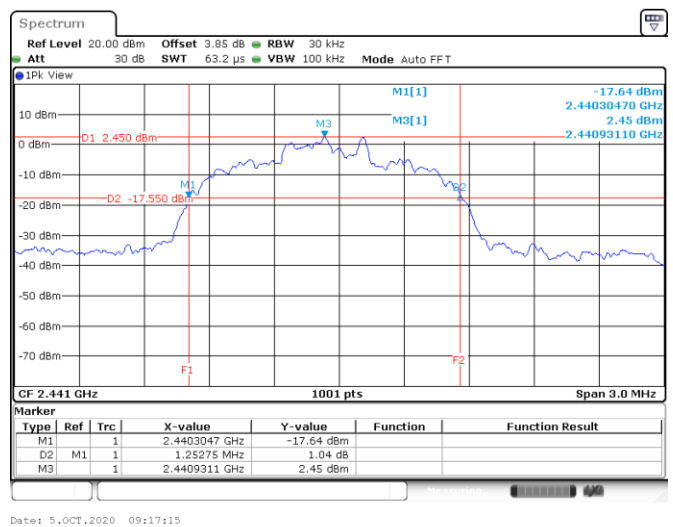
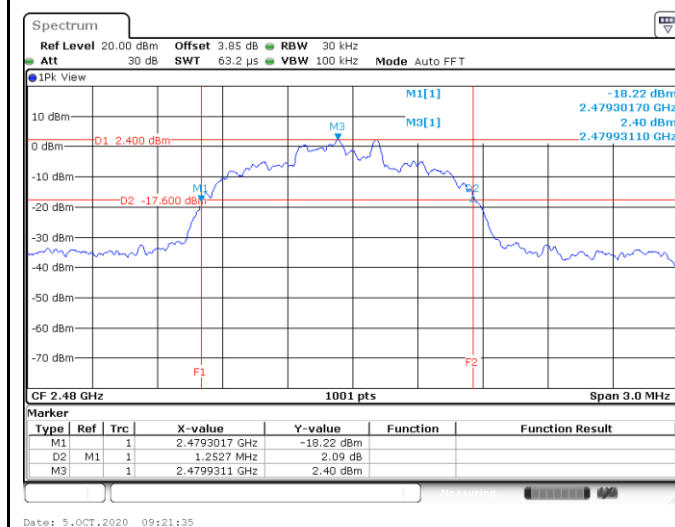
High Channel



Date: 5.OCT.2020 09:02:08

8DPSK

Channel	Channel Frequency (MHz)	20 dB Bandwidth (kHz)	Result
Low Channel	2402	1252.75	Pass
Middle Channel	2441	1252.75	Pass
High Channel	2480	1252.70	Pass

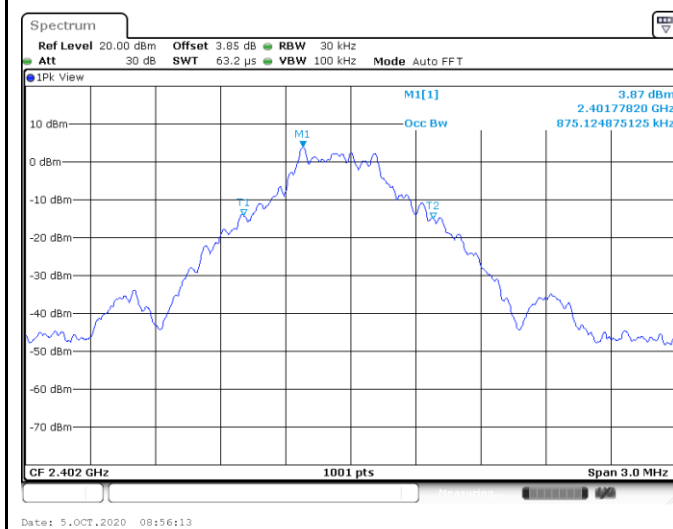
Low Channel

Middle Channel

High Channel


Test Result of 99% Occupied Bandwidth

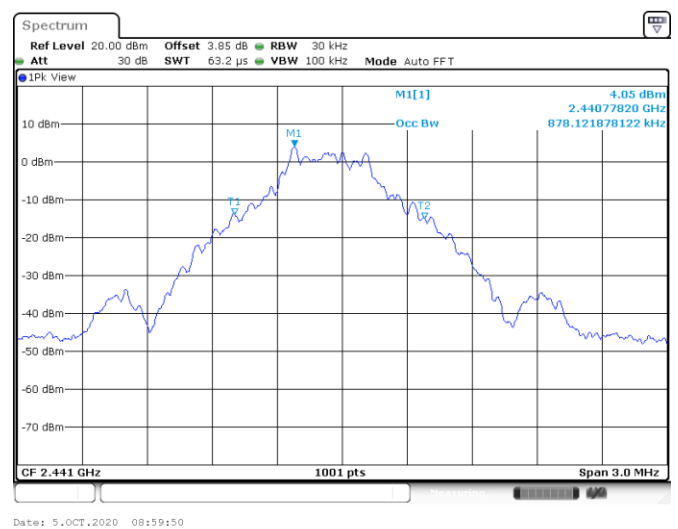
GFSK

Channel	Channel Frequency (MHz)	99% Bandwidth (kHz)
Low Channel	2402	875.12
Middle Channel	2441	878.12
High Channel	2480	878.12

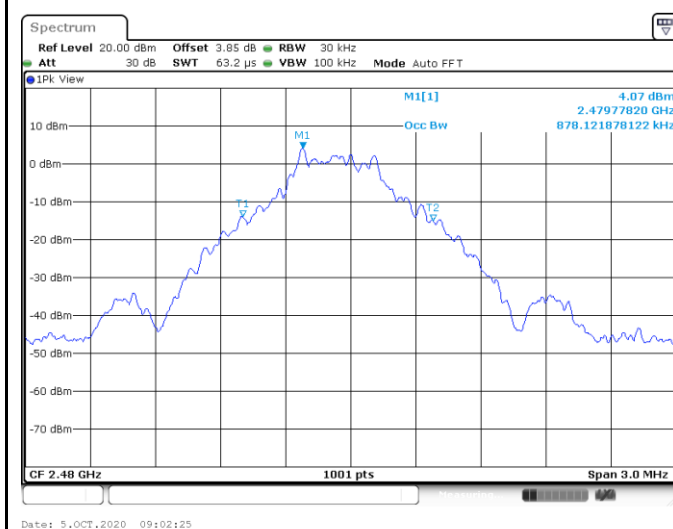
Low Channel



Middle Channel

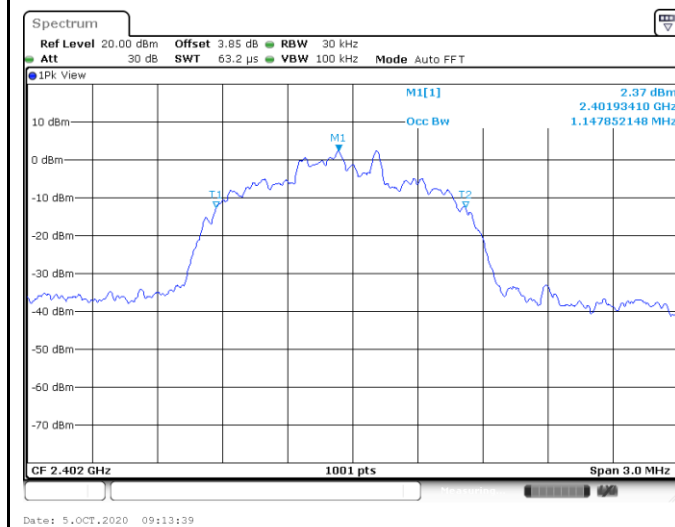
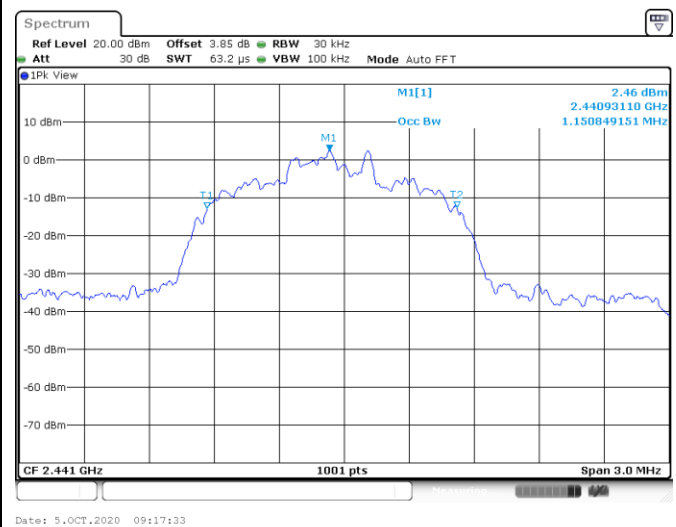
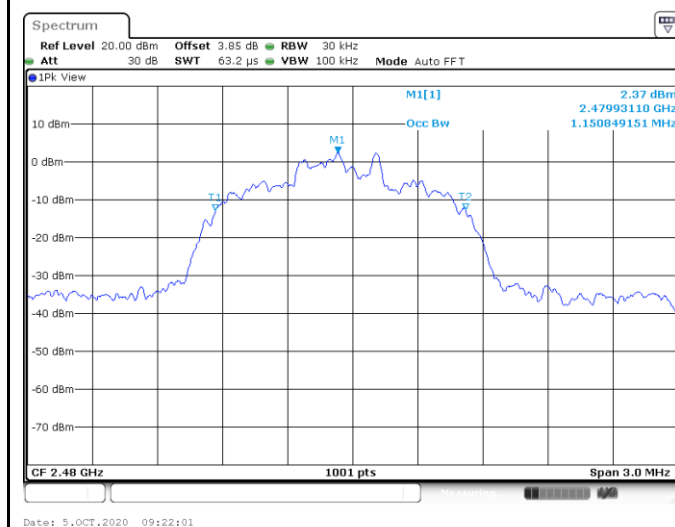


High Channel



8DPSK

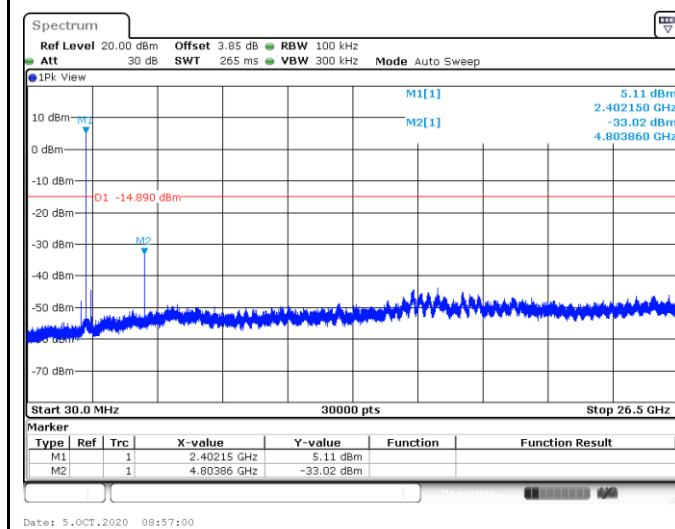
Channel	Channel Frequency (MHz)	99% Bandwidth (kHz)
Low Channel	2402	1147.85
Middle Channel	2441	1150.85
High Channel	2480	1150.85

Low Channel

Middle Channel

High Channel


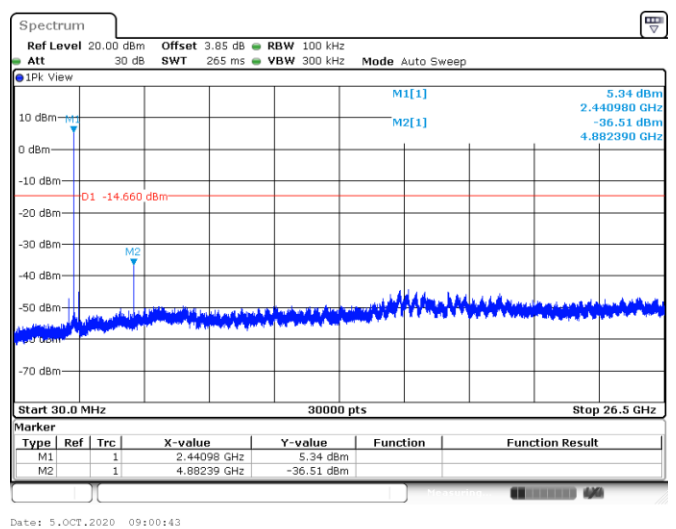
Test Result of Conducted Spurious Emissions, Tx Mode

GFSK

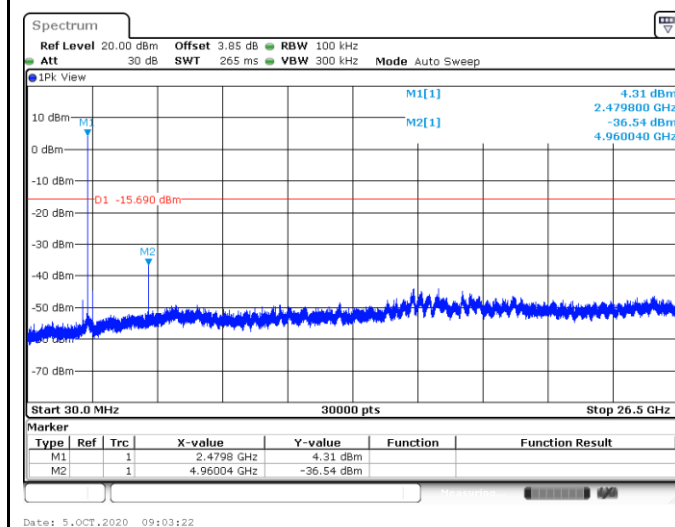
Low Channel



Middle Channel

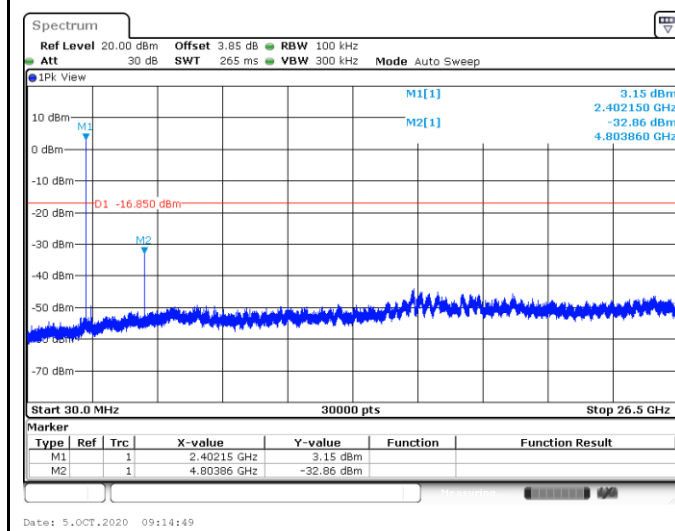


High Channel

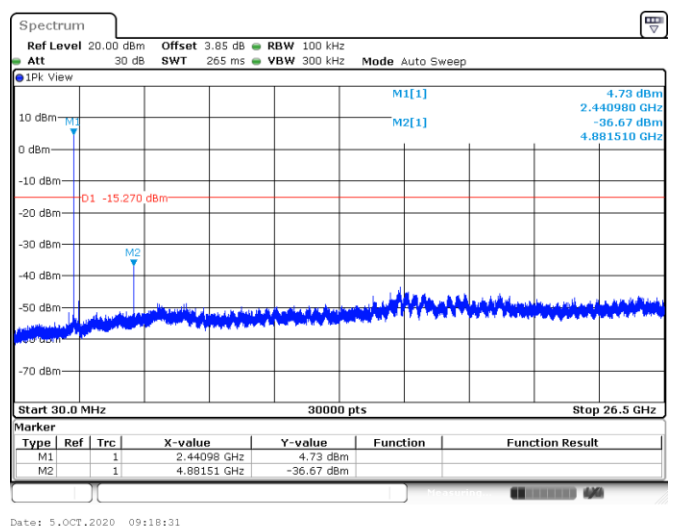


8DPSK

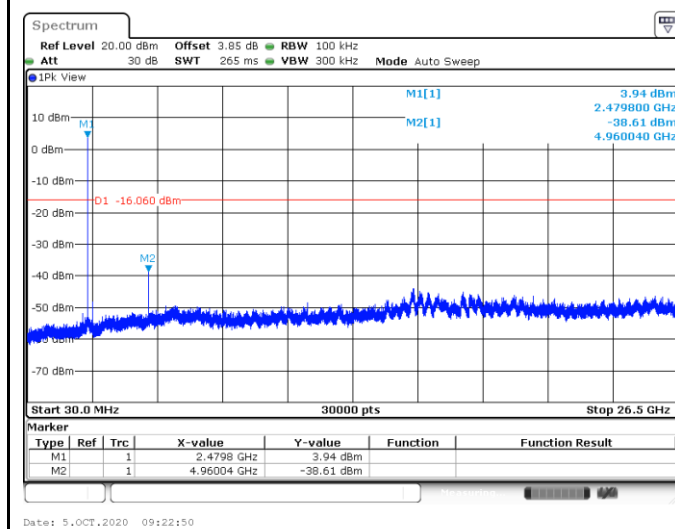
Low Channel



Middle Channel

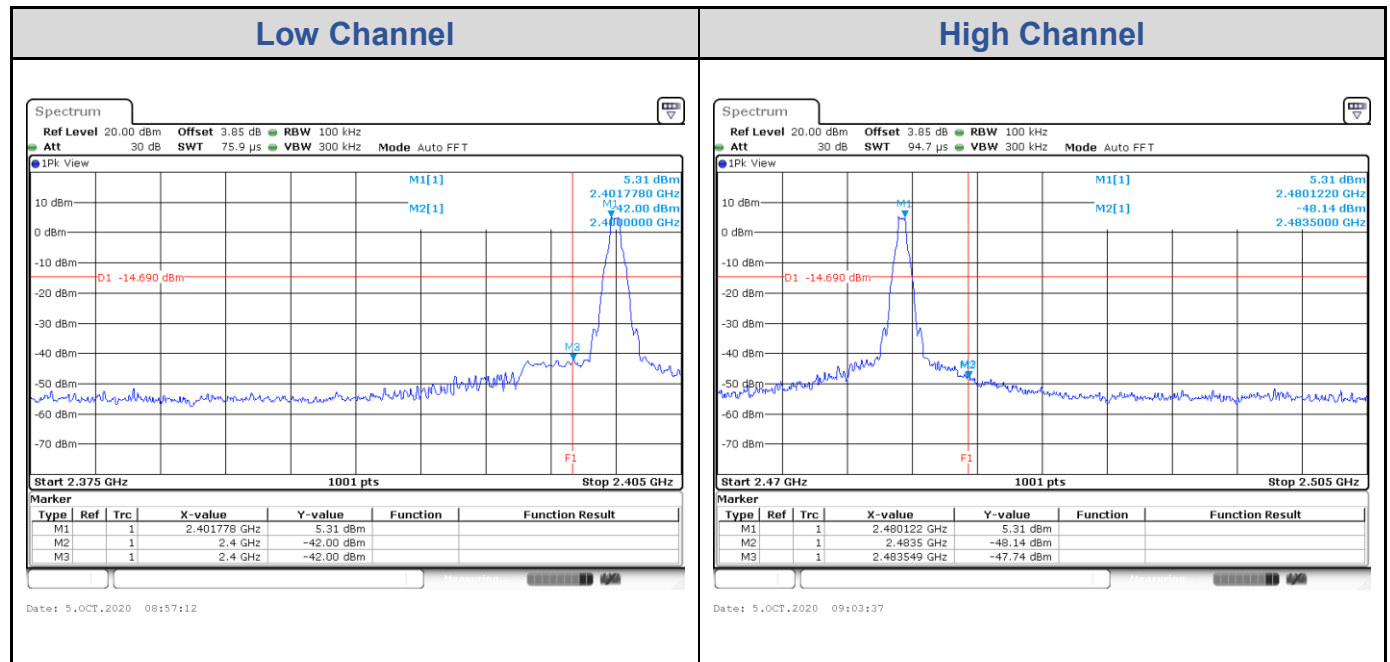


High Channel

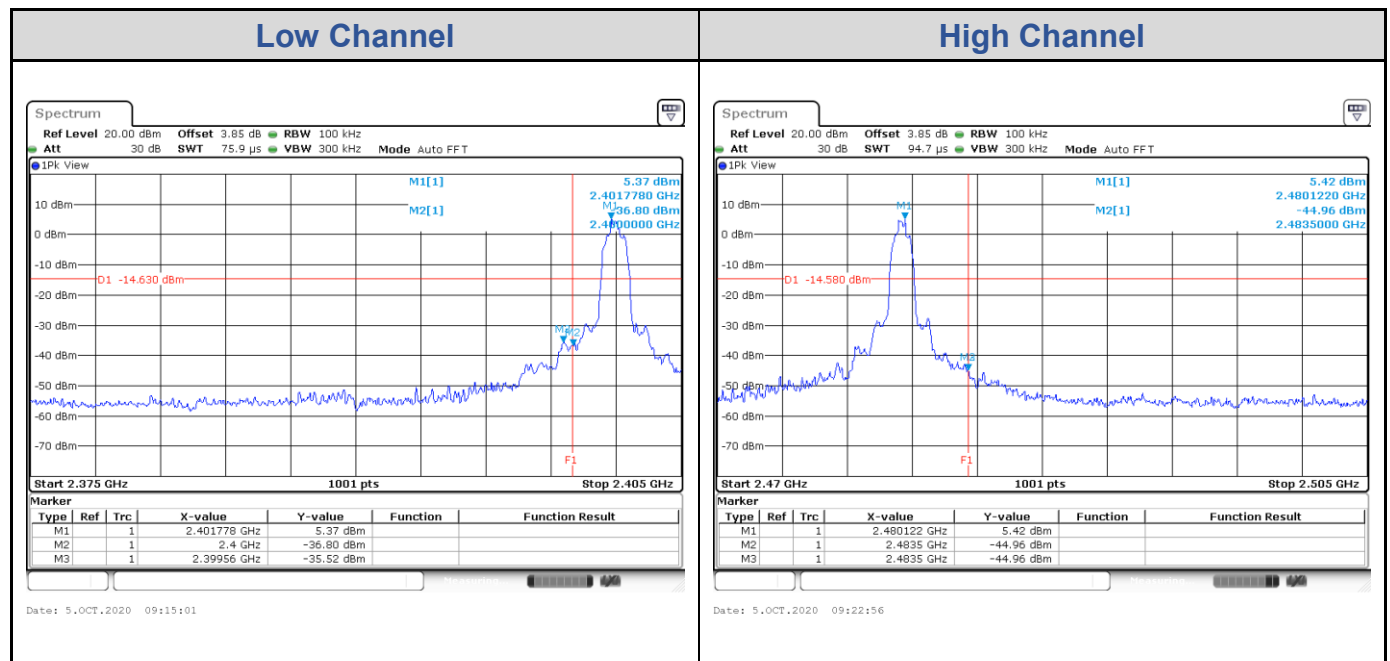


Test Result of Conducted Band Edge, Tx Mode

GFSK

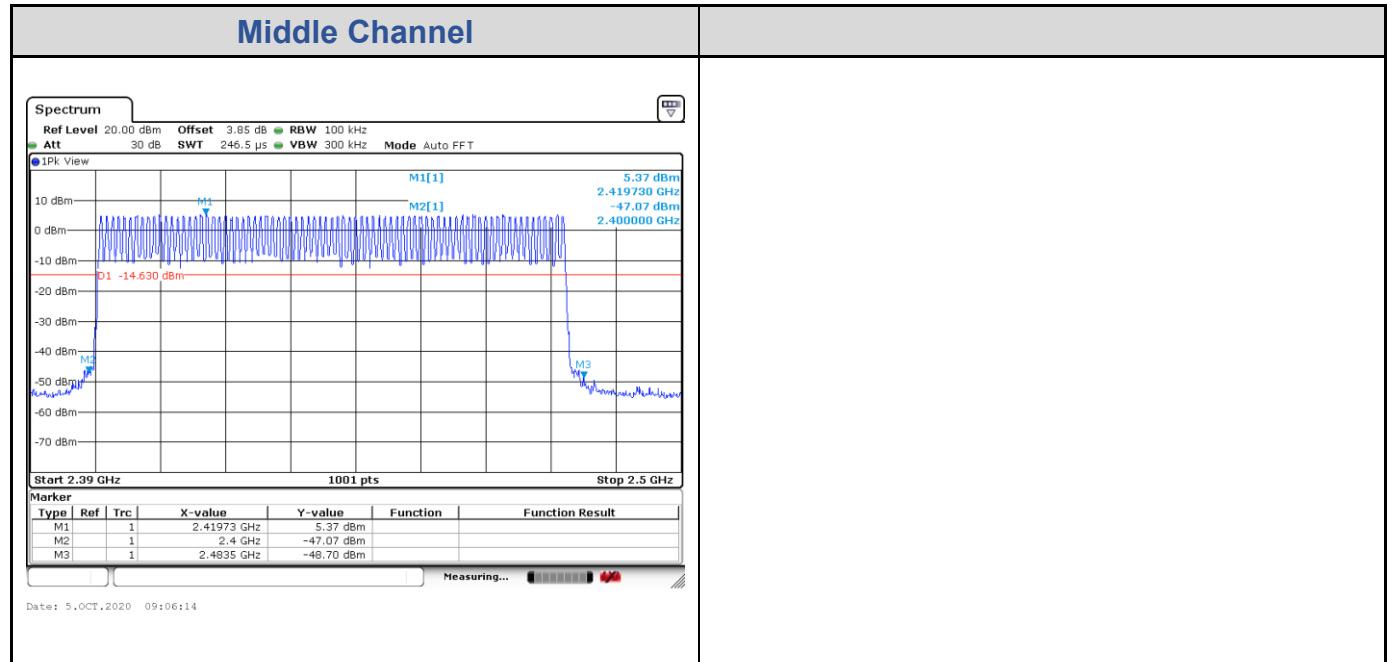


8DPSK

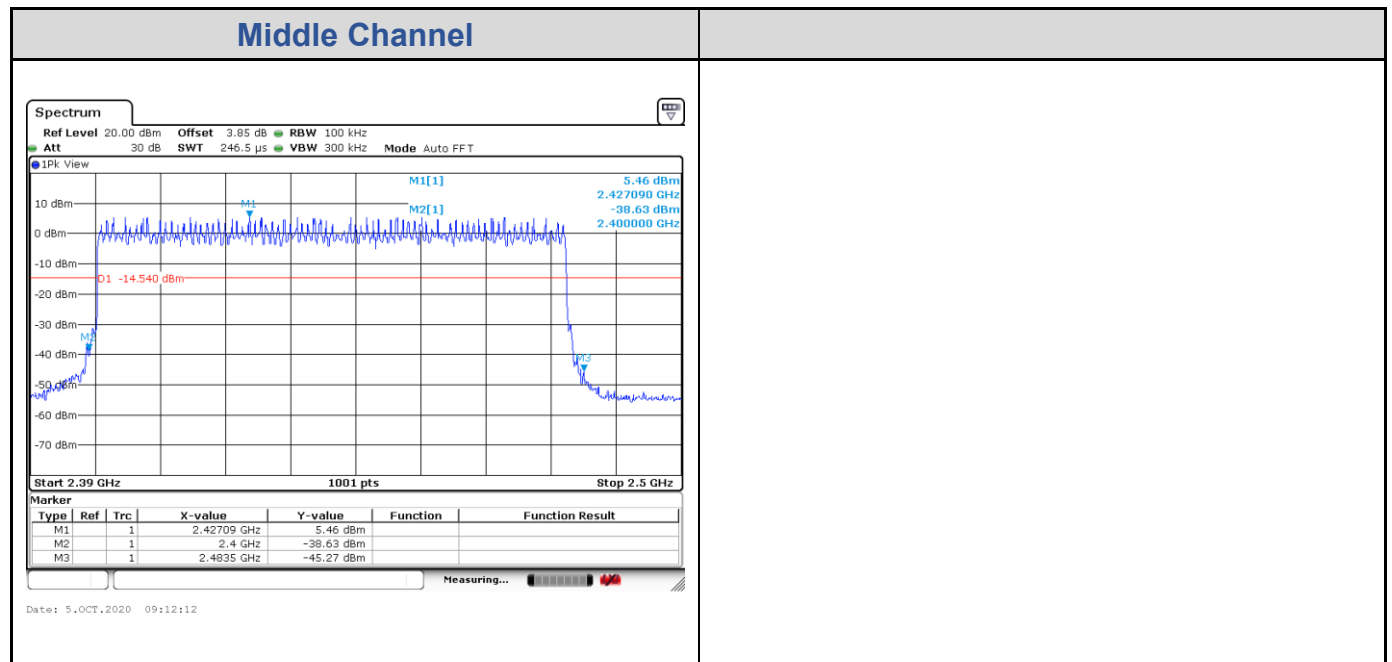


Test Result of Hopping Band Edge

GFSK



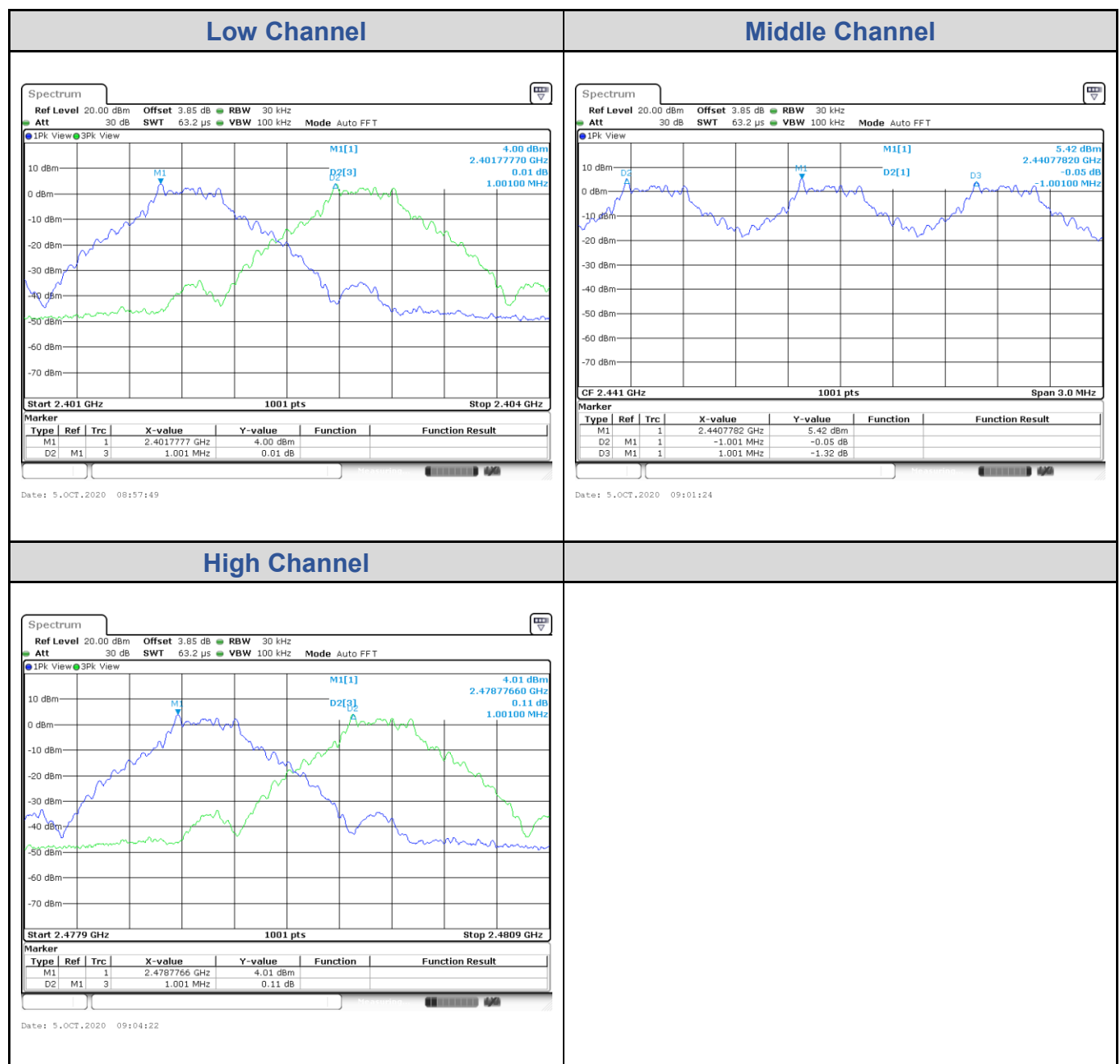
8DPSK



Test Result of Hopping Channel Separation

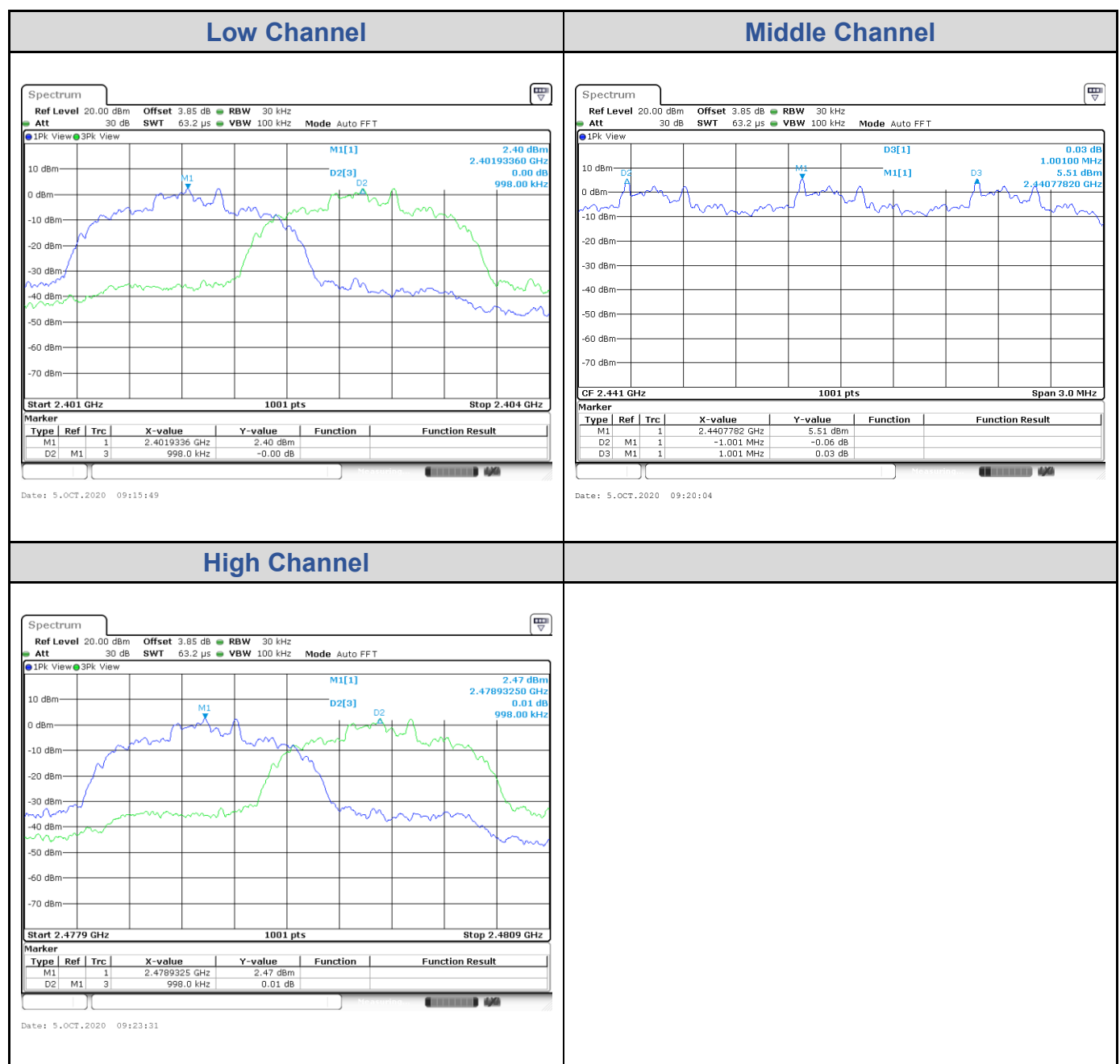
GFSK

Channel	Channel Frequency (MHz)	Adjacent Channel Separation (MHz)	20 dB Bandwidth (kHz)	Minimum Limit (MHz)	Result
0	2402	1.00	938.06	0.625	Pass
39	2441	1.00	941.06	0.627	Pass
78	2480	1.00	941.06	0.627	Pass



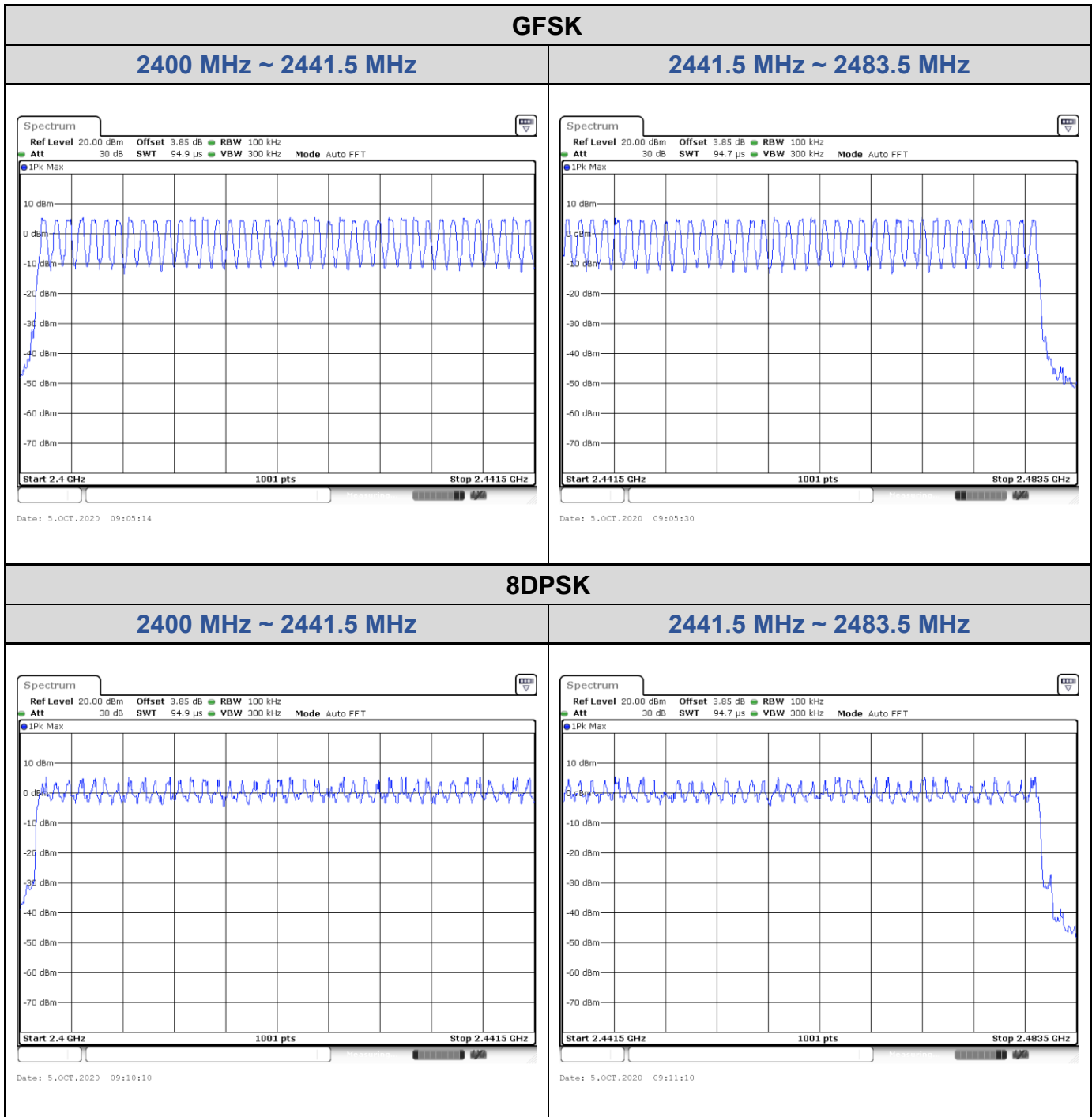
8DPSK

Channel	Channel Frequency (MHz)	Adjacent Channel Separation (MHz)	20 dB Bandwidth (kHz)	Minimum Limit (MHz)	Result
0	2402	1.00	1252.75	0.835	Pass
39	2441	1.00	1252.75	0.835	Pass
78	2480	1.00	1252.70	0.835	Pass



Test Result of Number of Hopping Frequency

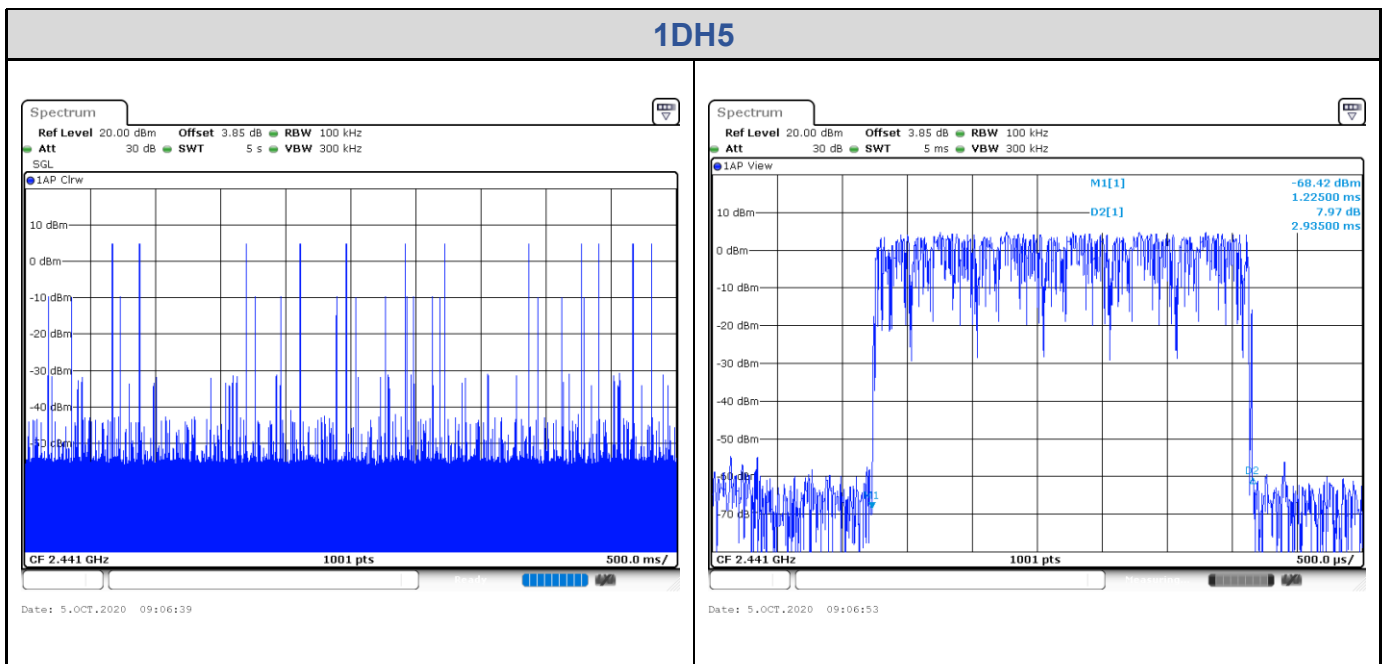
Frequency Range	Measured Quantity of Hopping Channel	Limit	Result
2400 to 2483.5 MHz	79	≥15	Pass



Test Result of Dwell Time

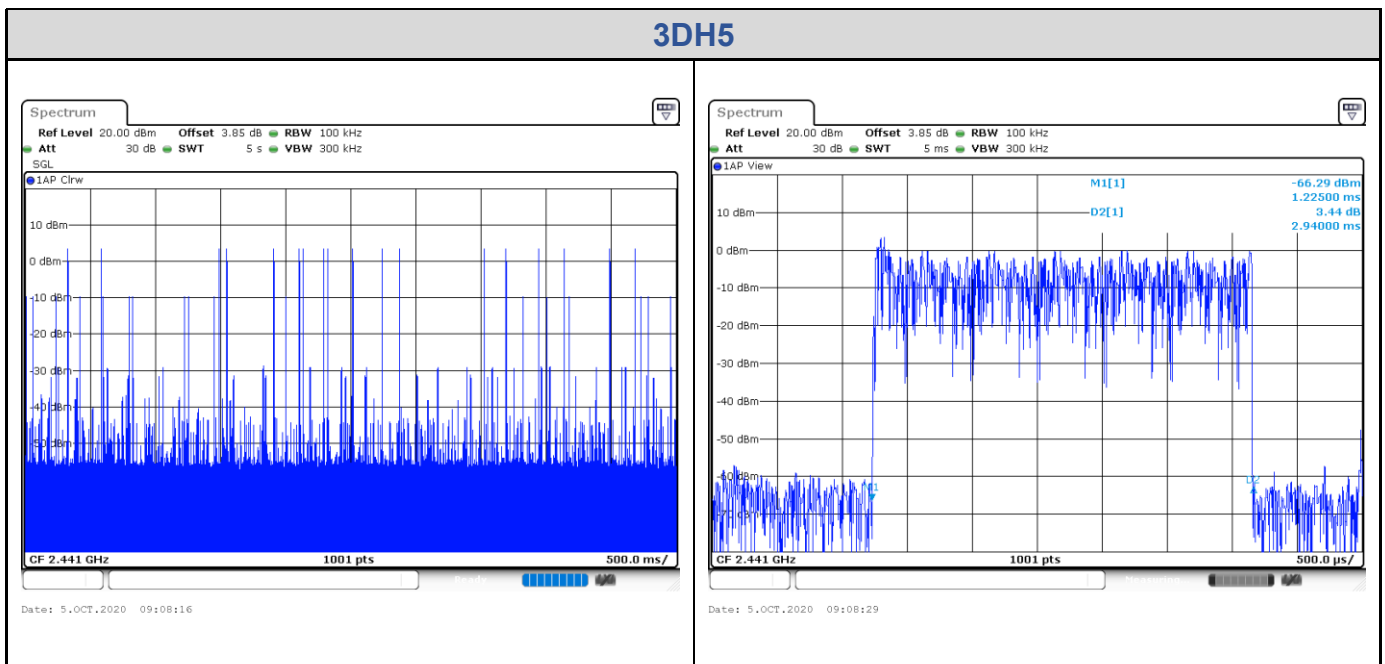
GFSK

Data Mode	Number of transfer in a 31.6 (79Hopping*0.4s)	Package transfer time (msec)	Dwell time (s)	Limit (s)	Result
1DH5	12 (times / 5 sec) * 6.32 = 75.84 times	2.94	0.22	0.4	Pass



8DPSK

Data Mode	Number of transfer in a 31.6 (79Hopping*0.4s)	Package transfer time (msec)	Dwell time (s)	Limit (s)	Result
3DH5	18 (times / 5 sec) * 6.32 = 113.76 times	2.94	0.33	0.4	Pass



Appendix B: Test Results of Radiated Spurious Emissions & Mains

Conducted Emission Test

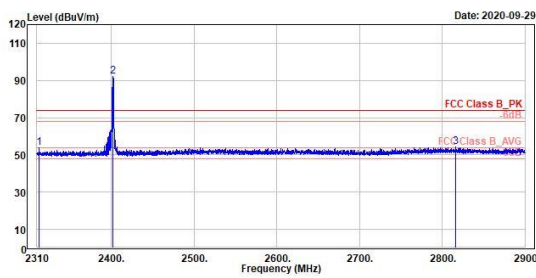
Band Edges, 2.31GHz ~ 2.9GHz

GFSK

Low Channel (Horizontal) Peak



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 Tel: +886-2172-1000 Fax: +886-2172-1322

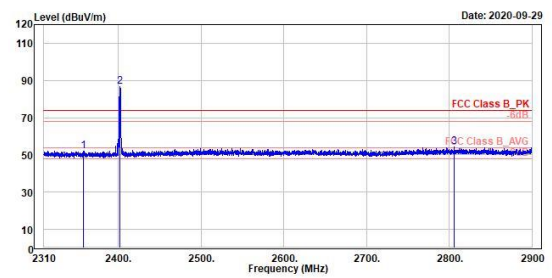


	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2312.71	53.78	16.65	37.13	74.00	-20.22	353	230	Peak	Horizontal		
2 *	2402.00	92.18	55.03	37.15	74.00	18.18	353	230	Peak	Horizontal		
3	2816.81	54.25	16.13	38.12	74.00	-19.75	353	230	Peak	Horizontal		

Low Channel (Vertical) Peak



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 Tel: +886-2172-1000 Fax: +886-2172-1322



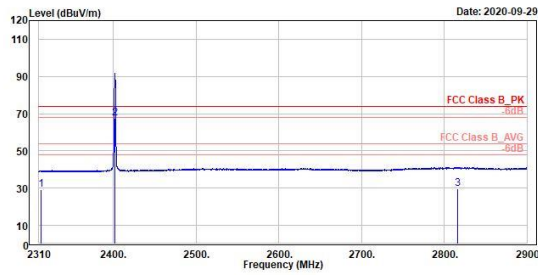
	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2358.03	52.18	15.02	37.16	74.00	-21.82	375	0	Peak	Vertical		
2 *	2402.00	86.07	49.72	37.15	74.00	12.07	375	0	Peak	Vertical		
3	2806.31	54.50	16.38	38.12	74.00	-19.50	375	0	Peak	Vertical		

GFSK

Low Channel (Horizontal) Average



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Tel: +886-2172-1000 Fax: +886-2172-1322

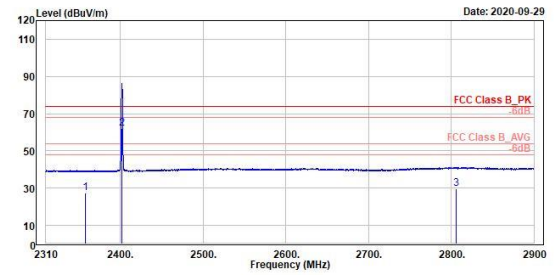


	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2312.71	29.08	-8.05	37.13	54.00	-24.92	353	230	Average	Horizontal	DF	
2 *	2402.00	67.48	30.33	37.15	54.00	13.48	353	230	Average	Horizontal	DF	
3	2816.81	29.55	-8.57	38.12	54.00	-24.45	353	230	Average	Horizontal	DF	

Low Channel (Vertical) Average



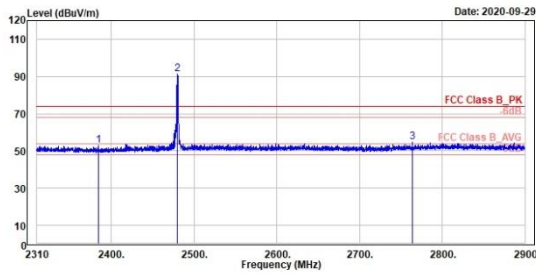
TÜV Rheinland Taiwan Ltd.
No. 458-18, Sec. 2, Fenliao, Linkou Dist., New Taipei City 244, Taiwan(R.O.C.)
Tel: +886-2172-1000 Fax: +886-2172-1322



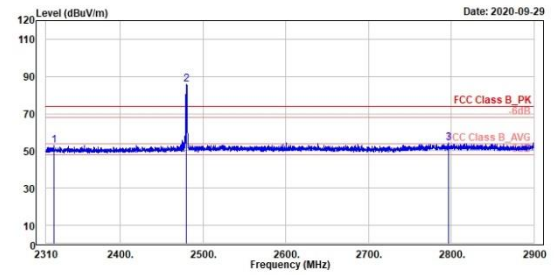
	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2358.03	27.48	-9.68	37.16	54.00	-26.52	375	0	Average	Vertical	DF	
2 *	2402.00	62.17	25.02	37.15	54.00	8.17	375	0	Average	Vertical	DF	
3	2806.31	29.80	-8.32	38.12	54.00	-24.20	375	0	Average	Vertical	DF	

GFSK

High Channel (Horizontal) Peak



Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2384.10	52.91	15.76	37.15	74.00	-21.09	301	221	Peak	Horizontal	
2 *	2488.00	91.08	53.52	37.56	74.00	17.08	301	221	Peak	Horizontal	
3	2764.42	54.85	16.77	38.08	74.00	-19.15	301	221	Peak	Horizontal	



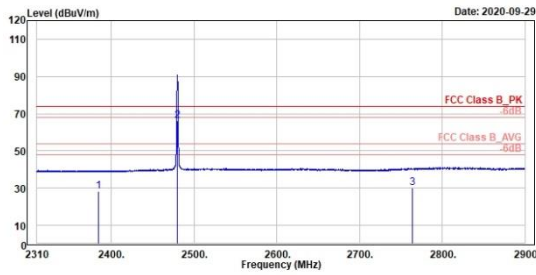
Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2319.79	52.84	15.70	37.14	74.00	-21.16	100	157	Peak	Vertical	
2 *	2488.00	91.08	53.52	37.56	74.00	17.08	100	157	Peak	Vertical	
3	2796.51	54.15	16.03	38.12	74.00	-19.85	100	157	Peak	Vertical	

GFSK

High Channel (Horizontal) Average



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Tel: +886-2172-1000 Fax: +886-2172-1322

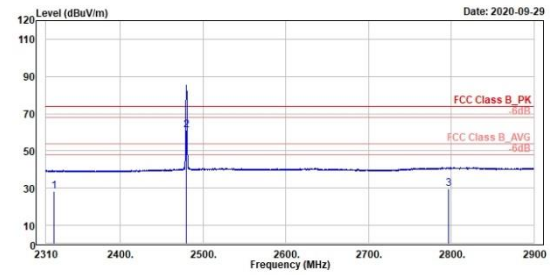


Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2384.10	28.21	-8.94	37.15	54.00	-25.79	301	221	Average	Horizontal	DF
2 *	2488.00	66.38	28.82	37.56	54.00	12.38	301	221	Average	Horizontal	DF
3	2764.42	30.14	-7.94	38.08	54.00	-23.86	301	221	Average	Horizontal	DF

High Channel (Vertical) Average



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Tel: +886-2172-1000 Fax: +886-2172-1322



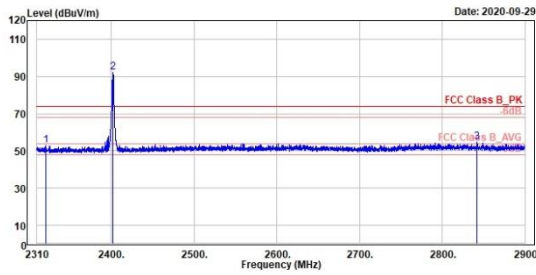
Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2319.79	28.14	-9.00	37.14	54.00	-25.86	100	157	Average	Vertical	DF
2 *	2488.00	61.26	23.78	37.56	54.00	7.26	100	157	Average	Vertical	DF
3	2796.51	29.45	-8.67	38.12	54.00	-24.55	100	157	Average	Vertical	DF

8DPSK

Low Channel (Horizontal) Peak



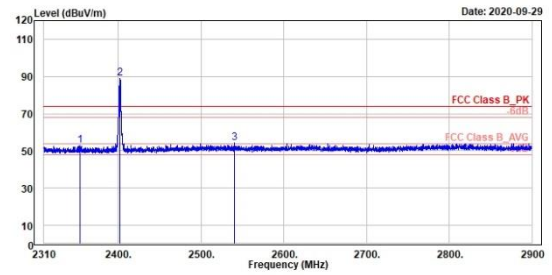
TÜV Rheinland Taiwan Ltd.
No. 458-18, Sec. 2, Fenhiao, Linkou Dist., New Taipei City 244, Taiwan(R.O.C.)
Tel: +886-2172-1000 Fax: +886-2172-1322



Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2320.62	52.89	15.75	37.14	74.00	-21.11	184	228	Peak	Horizontal	
2 *	2402.00	92.04	54.69	37.35	74.00	18.04	184	228	Peak	Horizontal	
3	2842.53	54.54	16.45	38.09	74.00	-19.46	184	228	Peak	Horizontal	



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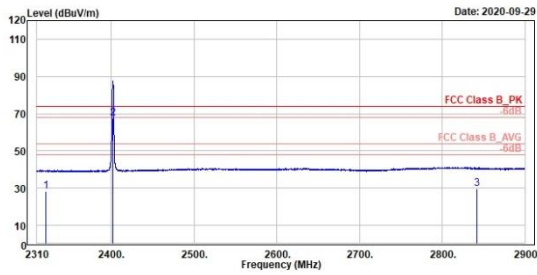
Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2353.19	52.87	15.70	37.17	74.00	-21.13	350	286	Peak	Vertical	
2 *	2402.00	89.07	51.92	37.15	74.00	15.07	350	286	Peak	Vertical	
3	2540.69	54.10	16.23	37.87	74.00	-19.90	350	286	Peak	Vertical	

8DPSK

Low Channel (Horizontal) Average



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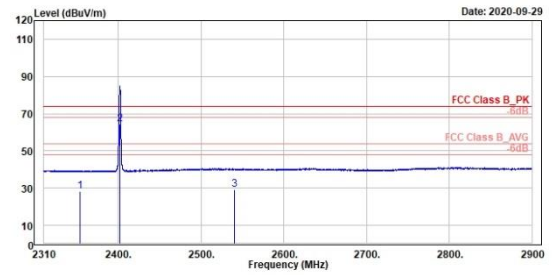


Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2320.62	28.19	-8.95	37.14	54.00	-25.81	184	228	Average	Horizontal	DF
2 *	2402.00	67.34	30.19	37.15	54.00	13.34	184	228	Average	Horizontal	DF
3	2842.53	29.84	-8.25	38.09	54.00	-24.16	184	228	Average	Horizontal	DF

Low Channel (Vertical) Average



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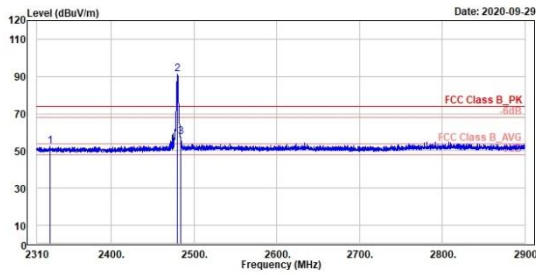
Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	2353.19	28.17	-9.00	37.17	54.00	-25.83	350	286	Average	Vertical	DF
2 *	2402.00	64.37	27.22	37.15	54.00	10.37	350	286	Average	Vertical	DF
3	2540.69	29.40	-8.47	37.87	54.00	-24.60	350	286	Average	Vertical	DF

8DPSK

High Channel (Horizontal) Peak



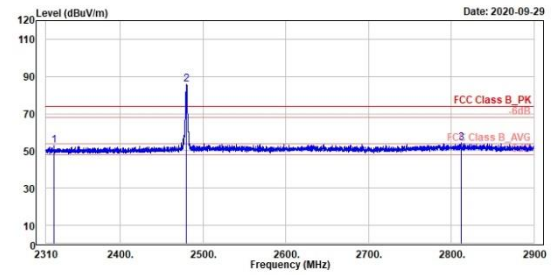
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Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	cm	deg			
1	2325.81	52.38	15.24	37.14	74.00	-21.62	300	222	Peak	Horizontal	
2 *	2480.00	91.06	53.50	37.56	74.00	17.06	300	222	Peak	Horizontal	
3	2483.70	57.42	19.85	37.57	74.00	-16.58	300	222	Peak	Horizontal	



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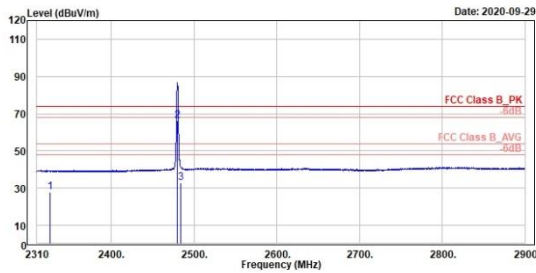
Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	cm	deg			
1	2319.68	52.87	15.73	37.14	74.00	-21.13	100	158	Peak	Vertical	
2 *	2480.00	85.92	48.36	37.56	74.00	11.92	100	158	Peak	Vertical	
3	2812.56	54.40	16.29	38.11	74.00	-19.60	100	158	Peak	Vertical	

8DPSK

High Channel (Horizontal) Average



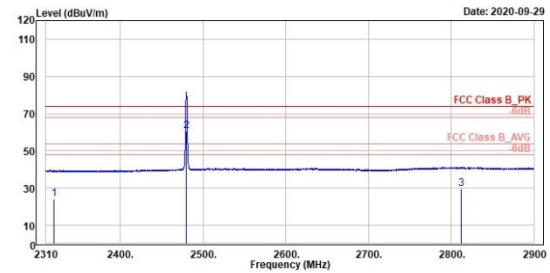
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Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	cm	deg			
1	2325.81	27.68	-9.46	37.14	54.00	-26.32	300	222	Average	Horizontal	DF
2 *	2480.00	66.36	28.80	37.56	54.00	12.36	300	222	Average	Horizontal	DF
3	2483.70	32.72	-4.85	37.57	54.00	-21.28	300	222	Average	Horizontal	DF



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Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	cm	deg			
1	2319.68	24.08	-13.06	37.14	54.00	-29.92	100	158	Average	Vertical	DF
2 *	2480.00	60.59	23.03	37.56	54.00	6.59	100	158	Average	Vertical	DF
3	2812.56	29.70	-8.41	38.11	54.00	-24.30	100	158	Average	Vertical	DF

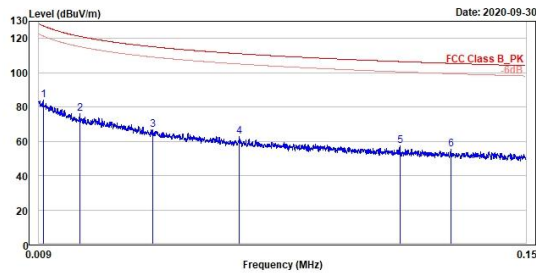
Spurious Emissions, Tx Mode, 9kHz ~ 30MHz

GFSK

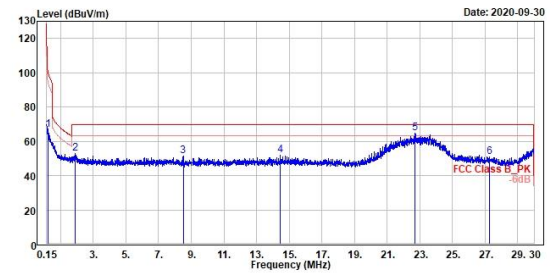
High Channel(Open) 9kHz~150kHz



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Tel: +886-2172-1000 Fax: +886-2172-1322



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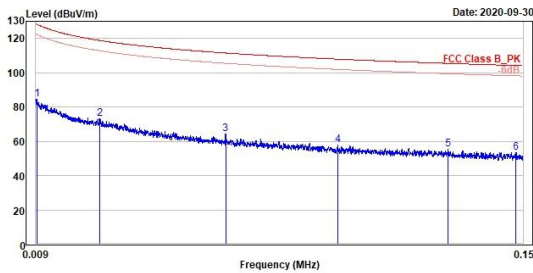


GFSK

High Channel(Close) 9kHz~150kHz



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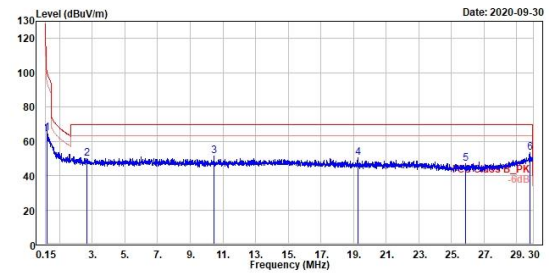


	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	0.01	84.58	5.04	79.54	128.15	-43.57	100	194	QP	Close		
2	0.03	73.16	1.99	71.17	118.78	-45.62	100	264	QP	Close		
3	0.06	64.23	1.09	63.14	111.48	-47.25	100	219	QP	Close		
4	0.10	57.79	-1.89	59.68	107.92	-50.13	100	245	QP	Close		
5	0.13	55.30	-2.31	57.61	105.43	-50.13	100	28	QP	Close		
6	0.15	53.56	-2.90	56.46	104.19	-50.63	100	84	QP	Close		

High Channel(Close) 150kHz~30MHz



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	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	0.25	65.00	12.02	52.98	99.80	-34.80	100	15	QP	Close		
2	2.67	49.86	11.48	38.38	69.50	-19.64	100	127	QP	Close		
3	10.47	51.35	13.95	37.40	69.50	-18.15	100	192	QP	Close		
4	19.27	50.33	13.93	36.40	69.50	-19.17	100	267	QP	Close		
5	25.87	47.14	12.88	34.26	69.50	-22.36	100	331	QP	Close		
6	29.80	53.17	13.88	39.29	69.50	-16.33	100	267	QP	Close		

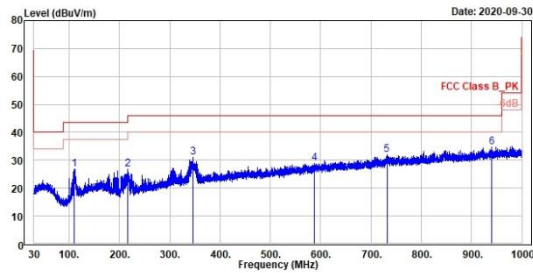
Spurious Emissions, Tx Mode, 30MHz ~ 1GHz

GFSK

High Channel (Horizontal)



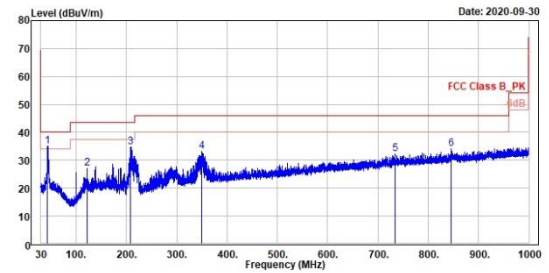
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	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	110.70	26.81	36.32	-9.51	43.50	-16.69	300	103	QP	horizontal		
2	217.11	26.79	35.18	-8.39	46.00	-19.21	100	5	QP	horizontal		
3	346.71	30.90	35.03	-4.13	46.00	-15.10	300	274	QP	horizontal		
4	586.97	28.88	29.05	-0.17	46.00	-17.12	300	359	QP	horizontal		
5	731.80	31.91	30.00	1.91	46.00	-14.09	200	250	QP	horizontal		
6	940.15	34.60	29.76	4.84	46.00	-11.40	200	211	QP	horizontal		



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	Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
	MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	deg				
1	43.48	34.92	41.23	-6.31	40.00	-5.08	200	198	QP	vertical		
2	121.76	27.22	35.88	-8.66	43.50	-16.28	200	360	QP	vertical		
3	208.48	34.67	42.96	-8.29	43.50	-8.83	100	360	QP	vertical		
4	349.13	33.23	37.33	-4.10	46.00	-12.77	120	360	QP	vertical		
5	733.64	32.12	30.17	1.95	46.00	-13.88	300	342	QP	vertical		
6	845.67	34.18	30.75	3.43	46.00	-11.82	100	168	QP	vertical		

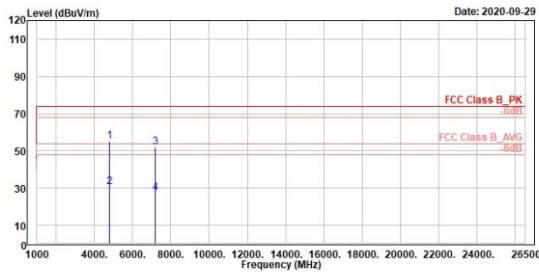
Spurious Emissions, Tx Mode, 1GHz ~ 26.5GHz

GFSK

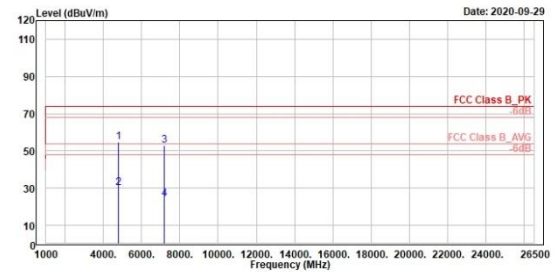
Low Channel (Horizontal)



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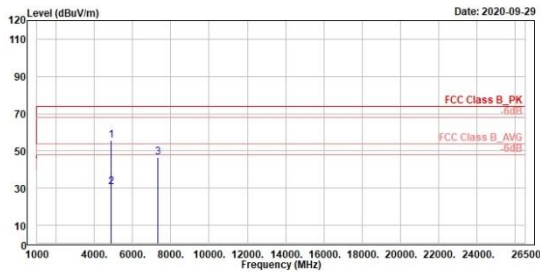


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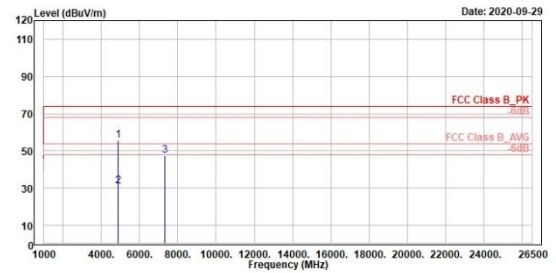
Middle Channel (Horizontal)



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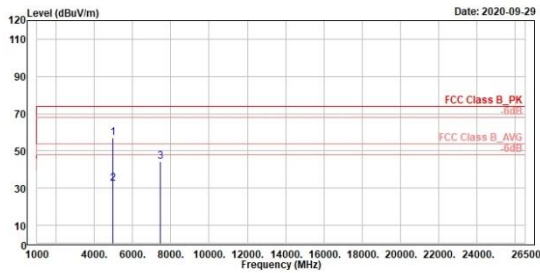


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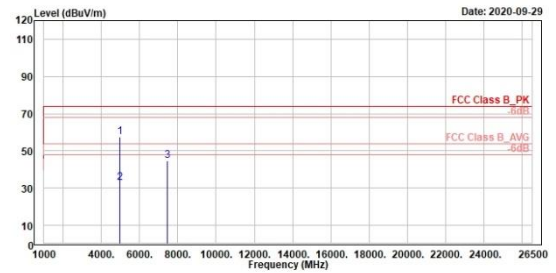
High Channel (Horizontal)



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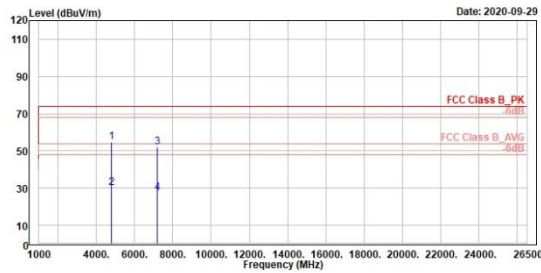


8DPSK

Low Channel (Horizontal)



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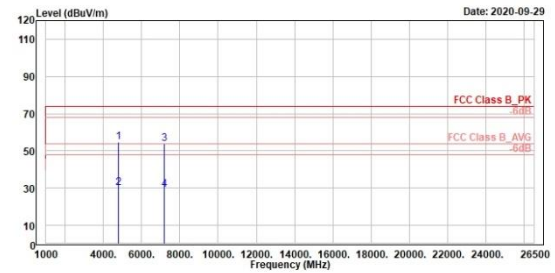


Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	cm	deg			
1	4894.00	54.92	64.36	-9.44	74.00	-19.08	116	206	Peak	horizontal	
2	4894.00	30.22	39.66	-9.44	54.00	-23.78	116	206	Average	horizontal	DF
3	7206.00	52.03	58.85	-6.82	74.00	-21.97	100	55	Peak	horizontal	
4	7206.00	27.33	34.15	-6.82	54.00	-26.67	100	55	Average	horizontal	DF

Low Channel (Vertical)



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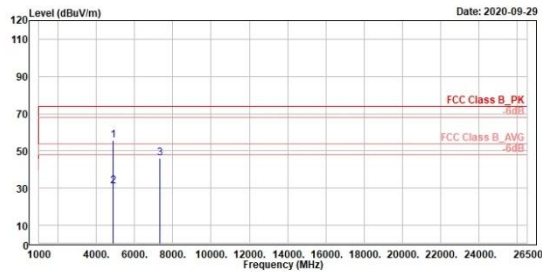
Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV	dB/m	dBuV/m	dB	cm	cm	deg			
1	4894.00	54.95	64.39	-9.44	74.00	-19.05	101	69	Peak	vertical	
2	4894.00	30.25	39.69	-9.44	54.00	-23.75	101	69	Average	vertical	DF
3	7206.00	53.68	60.50	-6.82	74.00	-20.32	395	179	Peak	vertical	
4	7206.00	28.98	35.80	-6.82	54.00	-25.02	395	179	Average	vertical	DF

8DPSK

Middle Channel (Horizontal)



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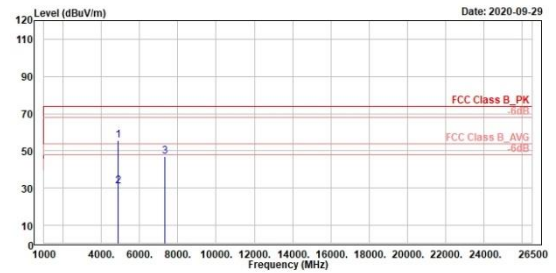


Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV/m	dBuV/m	dB	dBuV/m	dB	cm	deg			
1	4882.00	55.52	64.82	-9.30	74.00	-18.48	100	203	Peak	horizontal	
2	4882.00	30.82	40.12	-9.30	54.00	-23.18	100	203	Average	horizontal	DF
3	7323.00	45.90	52.60	-6.70	74.00	-28.10	100	265	Peak	horizontal	

Middle Channel (Vertical)



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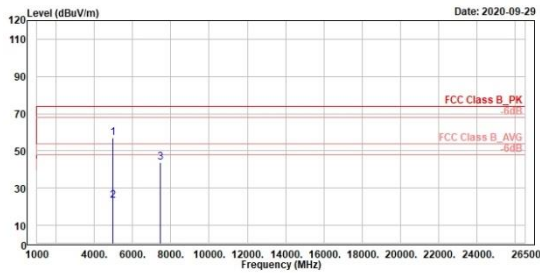
Freq	Level	Read	Level	Factor	Limit	Over	APos	TPos	Remark	Pol/Phase	Note
MHz	dBuV/m	dBuV/m	dBuV/m	dB	dBuV/m	dB	cm	deg			
1	4882.00	55.50	64.00	-9.30	74.00	-18.50	104	66	Peak	vertical	
2	4882.00	30.80	40.10	-9.30	54.00	-23.20	104	66	Average	vertical	DF
3	7323.00	47.12	53.82	-6.70	74.00	-26.88	100	241	Peak	vertical	

8DPSK

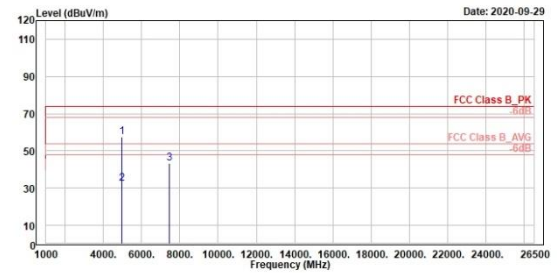
High Channel (Horizontal)



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Mains Conducted Emission, 150kHz ~ 30MHz

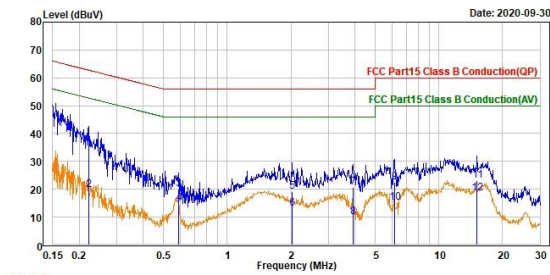
Worst Band

(Line)

(Neutral)



TUV Rheinland Taiwan Ltd(New Taipei City Branch),
No. 458-19, Sec. 2, Fenliao Rd., Linkou Dist., New Taipei City 244
Tel:+886-2172-1000 Fax:+886-2172-1322



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No. 458-19, Sec. 2, Fenliao Rd., Linkou Dist., New Taipei City 244
Tel:+886-2172-1000 Fax:+886-2172-1322

