FCC 47 CFR PART 15 SUBPART C AND ANSI C63.10: 2013

TEST REPORT

For

BX21 Wireless Relay

Model: BX21-HW

Brand: **Verkada**

Issued for

Verkada Inc

405 E. 4th Ave., San Mateo, California, United States, 94401

Issued by

Compliance Certification Services Inc.
Tainan Lab.
No.8, Jiucengling, Xinhua Dist.,
Tainan City, Taiwan
Issued Date: November 10, 2022

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REVISION HISTORY

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	November 10, 2022	Initial Issue	ALL	Gina Lin

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1. TEST REPORT CERTIFICATION

Applicant	:	**Verkada Inc** 405 E. 4th Ave., San Mateo, California, United States, 94401
Manufacturer	:	**Vision Automobile Electronics Industrial Co Ltd.** No.78, Gongye 3rd Rd., Technology Industrial Park, Tainan , Taiwan , 70955
Equipment Under Test	:	BX21 Wireless Relay
Model	:	BX21-HW
Brand	:	Verkada
Date of Test	:	October 20, 2022 ~ October 24, 2022

APPLICABLE STANDARD	
STANDARD	**TEST RESULT**
FCC Part 15 Subpart C AND ANSI C63.10: 2013	No non-compliance noted

Statements of Conformity
Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

FCC Standard Section	Report Section	Test Item	Result
15.247(a)	8.1	6dB BANDWIDTH	Pass
15.247(b)	8.2	MAXIMUM PEAK OUTPUT POWER	Pass
-	8.3	DUTY CYCLE	-
15.247(e)	8.4	POWER SPECTRAL DENSITY	Pass
15.247(d)	8.5	CONDUCTED SPURIOUS EMISSION	Pass
15.205(a)	8.6	RADIATED EMISSIONS	Pass
15.207(a)	8.7	POWERLINE CONDUCTED EMISSIONS	N/A

Approved by:

John Chen

John Chen
Supervisor

2. EUT DESCRIPTION

Product Name	BX21 Wireless Relay
Model	BX21-HW
Brand	Verkada
Received Date	October 19, 2022
Frequency Range	915.0MHz ~915.7MHz
Transmit Power	18.88 dBm (77.215mW)
Channel Spacing	0.35 MHz
Channel Number	3 Channels
Transmit Data Rate	80kbps
Type of Modulation	OQPSK
Antenna Type	Type: Helical Antenna Model: BX21 Manufacturer: N/A Gain: -0.72 dBi
Power Rating	DC 12-24V (Powered by adapter)
RF Module Brand /Model	EFR32FG23A020F512GM48/ Silicon Labs (Package Marking: FG23_A020HG_B02170_2220)
Software Version	Rev.0
Firmware Version	Rev.0
Temperature Range	-20°C ~ +60°C
Reported Date	October 31, 2022

REMARK:

1. The sample **(BX21-HW)** selected for test was engineering sample that approximated to production product and was provided by manufacturer.
2. This submittal(s) (test report) is intended for FCC ID: **2AWUU6059001,** filing to comply with Section 15.207, 15.209 and 15.247 of the FCC Part 15, Subpart C Rules.
3. For more details, please refer to the User's manual of the EUT.

3. DESCRIPTION OF TEST MODES

The EUT is a BX21 Wireless Relay .

The RF chipset is manufactured by Silicon Labs.

The antenna peak gain -0.72 dBi (highest gain) were chosen for full testing.

There are three channels have been tested as following :

Channel	Frequency (MHz)
Low	915
Middle	915.35
High	915.7

Radiated Emission Test (Below 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Tested Channel	Modulation Technology	Modulation Type
Low, Mid, High	OFDM	OQPSK

Radiated Emission Test (Above 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Tested Channel	Modulation Technology	Modulation Type
Low, Mid, High	OFDM	OQPSK

Bandedge Measurement :

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Tested Channel	Modulation Technology	Modulation Type
Low, Mid, High	OFDM	OQPSK

Antenna Port Conducted Measurement :

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Tested Channel	Modulation Technology	Modulation Type
Low, Mid, High	OFDM	OQPSK

4. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10 and FCC CFR 47 15.207, 15.209 and 15.247.

5. FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

☐ No.8, Jiucengling, Xinhua Dist., Tainan City 712, Taiwan (R.O.C.)

☒ No. 168, Ln. 523, Sec. 3, Zhongzheng Rd., Rende Dist., Tainan City 717017, Taiwan (R.O.C.)

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.10 and CISPR Publication 22.

5.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers.

Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

5.3 LABORATORY ACCREDITATIONS LISTINGS

The test facilities used to perform radiated and conducted emissions tests are accredited by Taiwan Accreditation Foundation for the specific scope of accreditation under Lab Code: 1109 to perform Electromagnetic Interference tests according to FCC PART 15 AND CISPR 22 requirements. No part of this report may be used to claim or imply product endorsement by TAF or any agency of the Government. In addition, the test facilities are listed with Federal Communications Commission (registration no: TW1109).

5.4 TABLE OF ACCREDITATIONS AND LISTINGS

Our laboratories are accredited and approved by the following accreditation body according to ISO/IEC 17025.

Taiwan	TAF

The measuring facility of laboratories has been authorized or registered by the following approval agencies.

Canada	Industry Canada (TW1109)
Germany	TUV NORD
Taiwan	BSMI
USA	FCC

5.5 MEASUREMENT EQUIPMENT USED

For §8.6

Chamber 1166 Room (Radiation Test)					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Active Loop Antenna	ETS-LINDREN	6502	8905-2356	08/29/2022	08/28/2023
Attenuator	MCL	BW-S15W5	0535	01/28/2022	01/27/2023
Band Reject Filter	MICRO-TRONICS	HPM13525	006	01/28/2022	01/27/2023
Bilog Antenna With 6dB Attenuator	SUNOL SCIENCES & EMCI	JB1 & N-6-06	A021306 & AT-N0682	10/11/2022	10/10/2023
Cable	EMCI	EM102-KMKM	CB1166-01	06/20/2022	06/19/2023
Double Ridged Guide Horn Antenna	ETS-LINDGREN	3116	00078900	03/18/2022	03/17/2023
EMI Test Receiver	R&S	ESCI 7	100856	06/21/2022	06/20/2023
EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY54430216	08/11/2022	08/10/2023
Double Ridged Guide Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-788(98006)	04/19/2022	04/18/2023
Pre-Amplifier	EMCI	EMC012645	980098	01/28/2022	01/27/2023
Pre-Amplifier	Com-Power	PAM-840A	461378	06/28/2022	06/27/2023
Software	Excel(ccs-o6-2020 v1.1)，e3(v6.101222)				

For §8.1~8.5

Chamber 1166 Room (Conducted Test)					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY54430216	08/11/2022	08/10/2023
SMA Cable+10dB Attenuator	CCS	SMA+10dB ATT	SMA/10dB	01/28/2022	01/27/2023
Software	Excel(ccs-o6-2020 v1.1)				

For §8.7

Conducted Emission room #1					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
BNC Coaxial Cable	CCS	BNC50	11	01/20/2022	01/19/2023
EMI Test Receiver	R&S	ESCI	100221	04/18/2022	04/17/2023
LISN	FCC	FCC-LISN-50-32-2	08009	07/15/2022	07/14/2023
LISN	SCHWARZBECK	NNLK8130	8130124	01/14/2022	01/13/2023
Pulse Limiter	R&S	ESH3-Z2	100116	01/20/2022	01/19/2023
Test S/W	e3(v6.101222)				

6. CALIBRATION AND UNCERTAINTY

6.1 MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

6.2 MEASUREMENT UNCERTAINTY

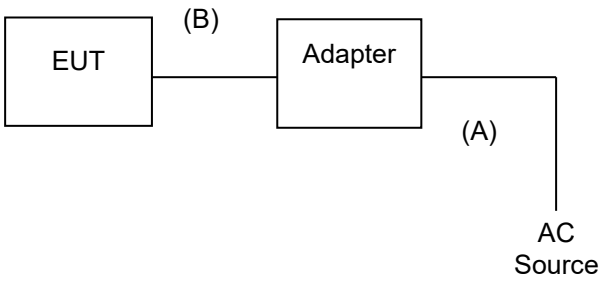
Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Radiated Emission, 9kHz~30MHz Test Site : CB1166	±2.7dB
Radiated Emission, 30 MHz ~1GHz Test Site : CB1166	±3.76dB
Radiated Emission, 1GHz ~18GHz Test Site : CB1166	±4.43dB
Radiated Emission, 18GH~26.5GHz Test Site : CB1166	±4.79dB
Radiated Emission, 26.5GH~40GHz Test Site : CB1166	±4.72dB
Power Line Conducted Emission, 9kHz~30MHz	±1.83dB
Band Width	0.025%
Peak Output Power MU	±1.9dB
Band Edge MU	±0.264dBuV
Channel Separation MU	±361.69Hz
Duty Cycle MU	±0.2%
Frequency Stability MU	±0.493Hz
Temperature	±0.5
Humidity	±3%

Uncertainty figures are valid to a confidence level of 95%, K=2

7. SETUP OF EQUIPMENT UNDER TEST

7.1 SETUP CONFIGURATION OF EUT



7.2 SUPPORT EQUIPMENT

No.	Product	Manufacturer	Model No.	Certify No.	Signal cable
1	Adapter	SINO-AMERICAN	SA145A-1240 V-6	N/A	N/A

No.	Signal cable description	
A	AC Power	Unshielded, 1.0m 1 pcs.
B	DC Power	Unshielded, 1.8m 1 pcs. with 1 core

REMARK:
1. All the above equipment/cables were placed in worse case positions to maximize emission signals during emission test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

7.3 EUT OPERATING CONDITION

RF Setup

1. Set up a whole system as the setup diagram.
2. Turn on power.

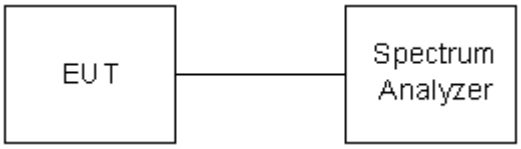
8. APPLICABLE LIMITS AND TEST RESULTS

8.1 6dB BANDWIDTH

LIMIT

§ 15.247(a) (2) For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz

TEST SETUP



TEST PROCEDURE

1. Set resolution bandwidth (RBW) = 100kHz
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

TEST RESULTS

No non-compliance noted.

Model Name	BX21-HW	Test By	Peter Chu
Temp & Humidity	21.5℃, 48%	Test Date	2022/10/20

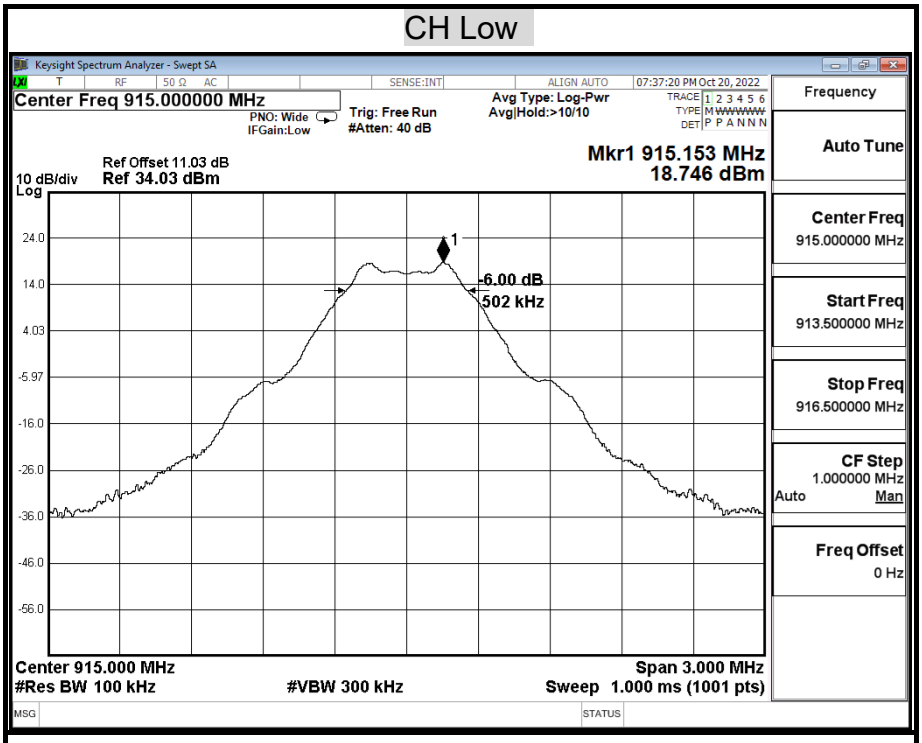
TX mode

Channel	Channel Frequency (MHz)	6dB Bandwidth (kHz)	Minimum Limit (kHz)	Pass / Fail
Low	915	502.00	500	PASS
Middle	915.35	501.00	500	PASS
High	915.7	508.00	500	PASS

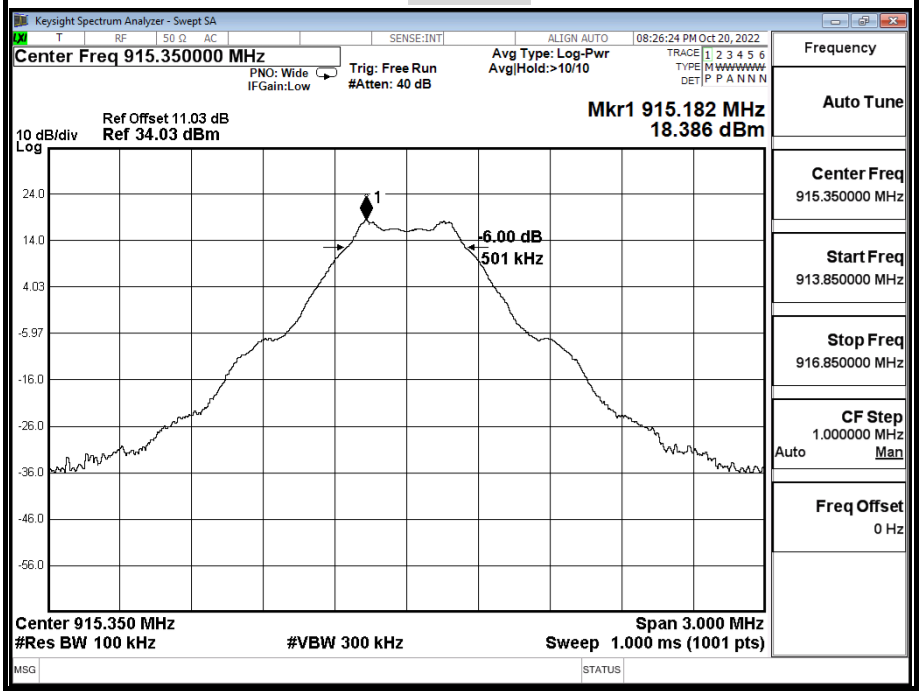
NOTE : 1. At finial test to get the worst-case emission at 80kbps long.
2. The cable assembly insertion loss of 11.45dB (including 10 dB pad and 1.45 dB cable) was entered as an offset in the spectrum analyzer to allow for direct reading of power.

6dB BANDWIDTH

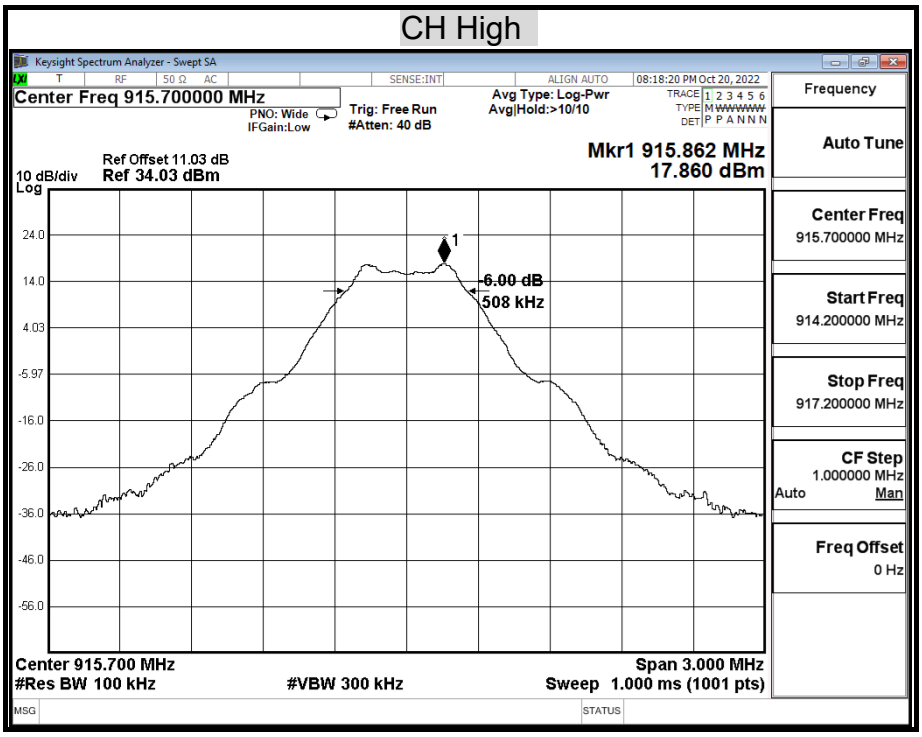
CH Low



CH Mid



CH High



8.2 MAXIMUM PEAK OUTPUT POWER

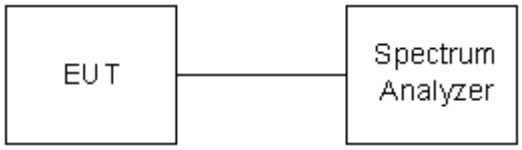
LIMIT

§ 15.247(b) The maximum peak output power of the intentional radiator shall not exceed the following :

§ 15.247(b) (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands : 1 watt.

§ 15.247(b) (4) Except as shown in paragraphs (c) of this section , if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1) or (b)(2), and (b)(3) of this section , as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST SETUP



TEST PROCEDURE

The tests were performed in accordance with KDB 558074 D01 v05r02 8.3.1.

11.9.1.1(ANSI C63.10) Measurement Procedure PK2:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Set span ≥ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

TEST RESULTS

No non-compliance noted

Model Name	BX21-HW	Test By	Peter Chu
Temp & Humidity	21.5℃, 48%	Test Date	2022/10/20

TX mode

Channel	Channel Frequency (MHz)	Peak Power (dBm)	Peak Power Limit (dBm)	Pass / Fail
Low	915	18.88	30.00	PASS
Middle	915.35	18.66	30.00	PASS
High	915.7	18.08	30.00	PASS

NOTE : 1. At finial test to get the worst-case emission at 80kbps long.
2. The cable assembly insertion loss of 11.45dB (including 10 dB pad and 1.45 dB cable) was entered as an offset in the spectrum analyzer to allow for direct reading of power.

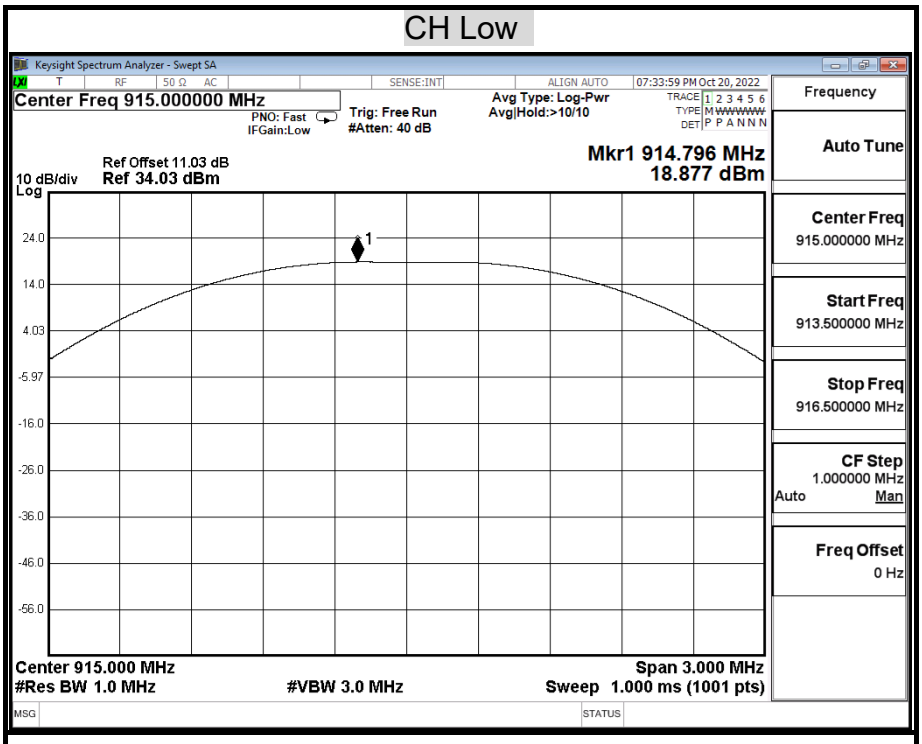
Average Power Data

TX mode

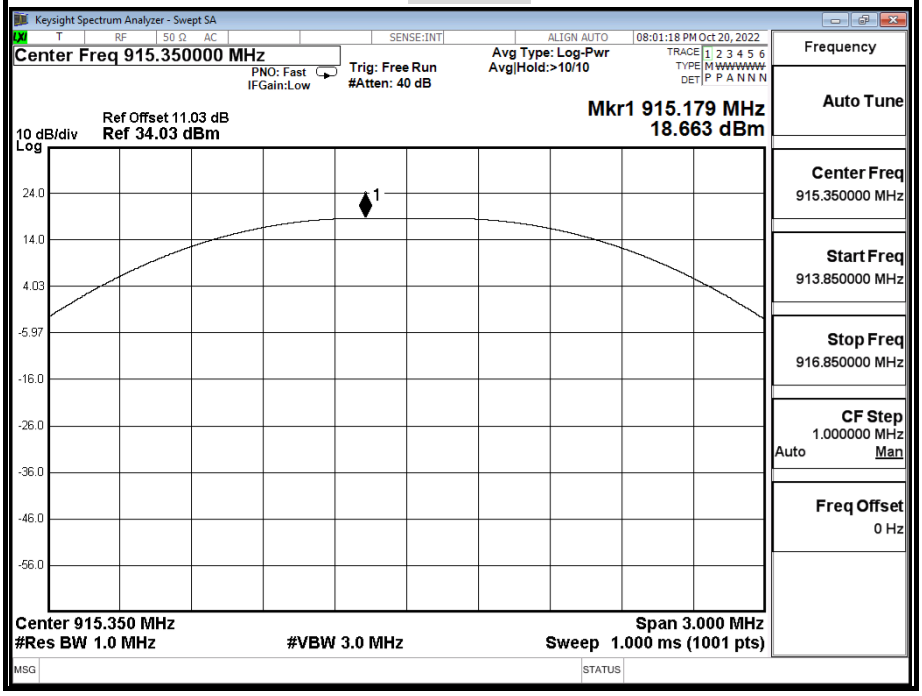
Channel	Channel Frequency (MHz)	Average Power (dBm)
Low	915	18.51
Middle	915.35	18.31
High	915.7	17.81

MAXIMUM PEAK OUTPUT POWER

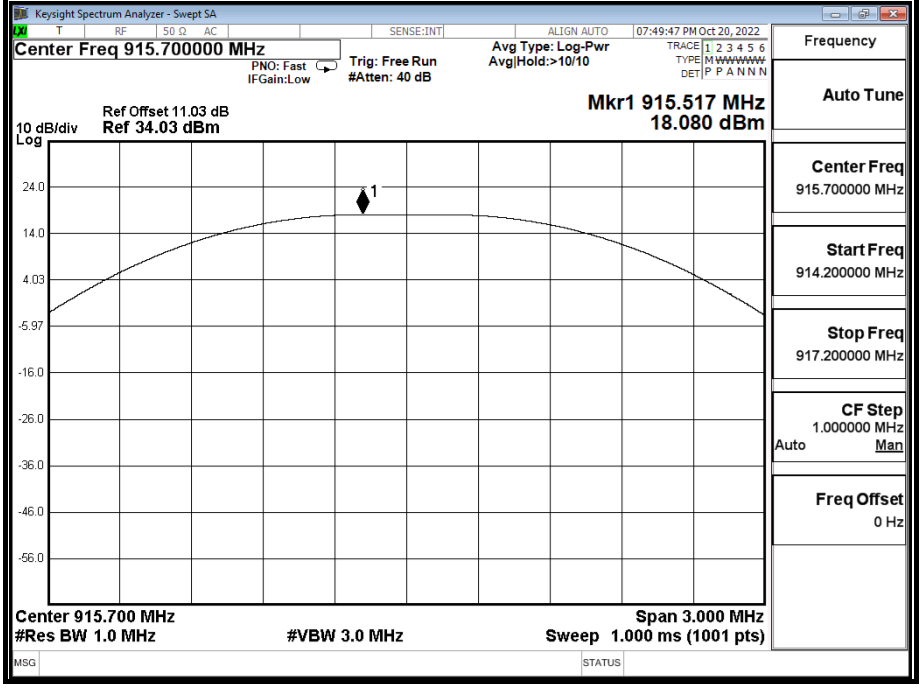
CH Low



CH Mid



CH High



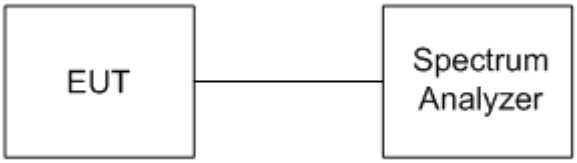
8.3 DUTY CYCLE

LIMIT

Nil (No dedicated limit specified in the Rules)

TEST EQUIPMENTS

TEST SETUP



TEST PROCEDURE

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

TEST RESULTS

No non-compliance noted.

TEST DATA

Model Name	BX21-HW	Test By	Peter Chu
Temp & Humidity	21.5℃, 48%	Test Date	2022/10/20

	us	Times	Ton	Total Ton time(ms)
Ton1	7700	1	7700	
Ton2		0	0	
Ton3			0	7.7
Tp				100

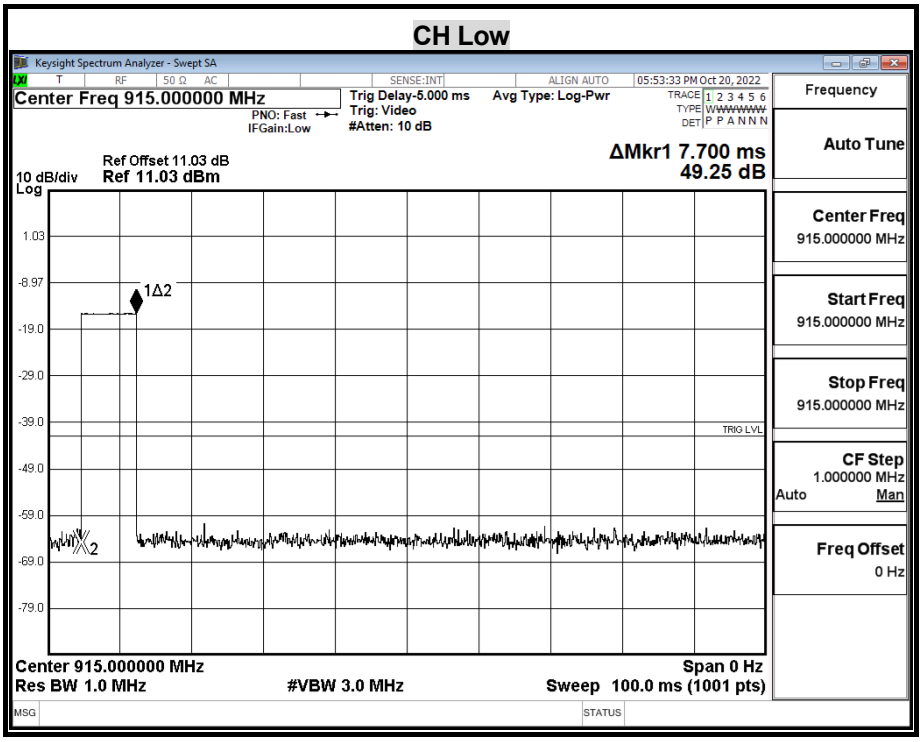
Ton	7.7
Tp(Ton+Toff)	100
Duty Cycle	0.077
Duty Factor	-22.27

Duty Factor = 20log(Duty Cycle)

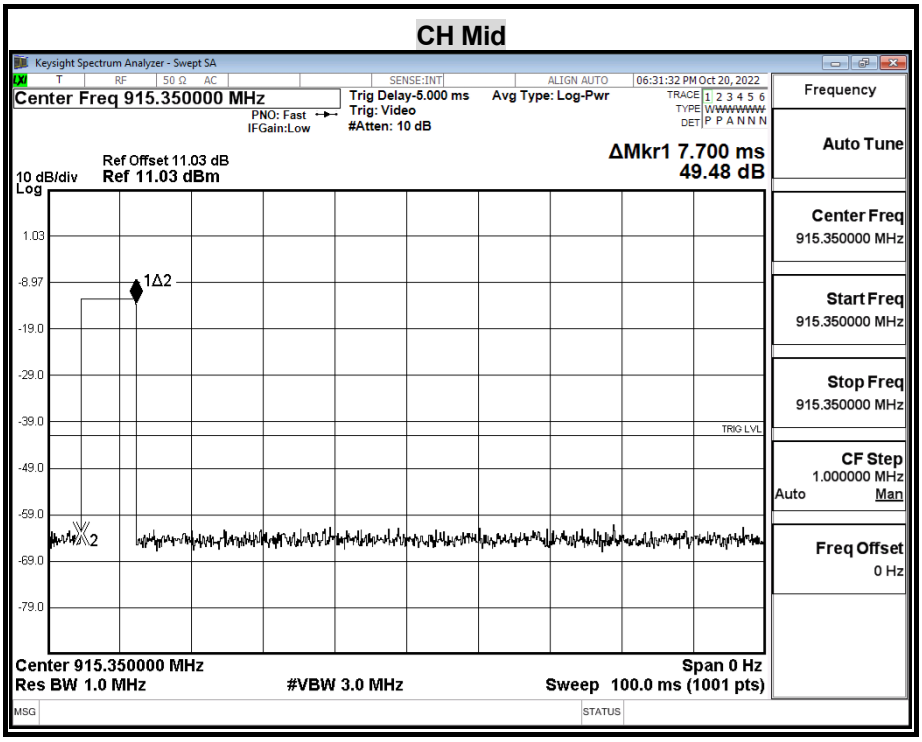
TEST PLOT

Plot

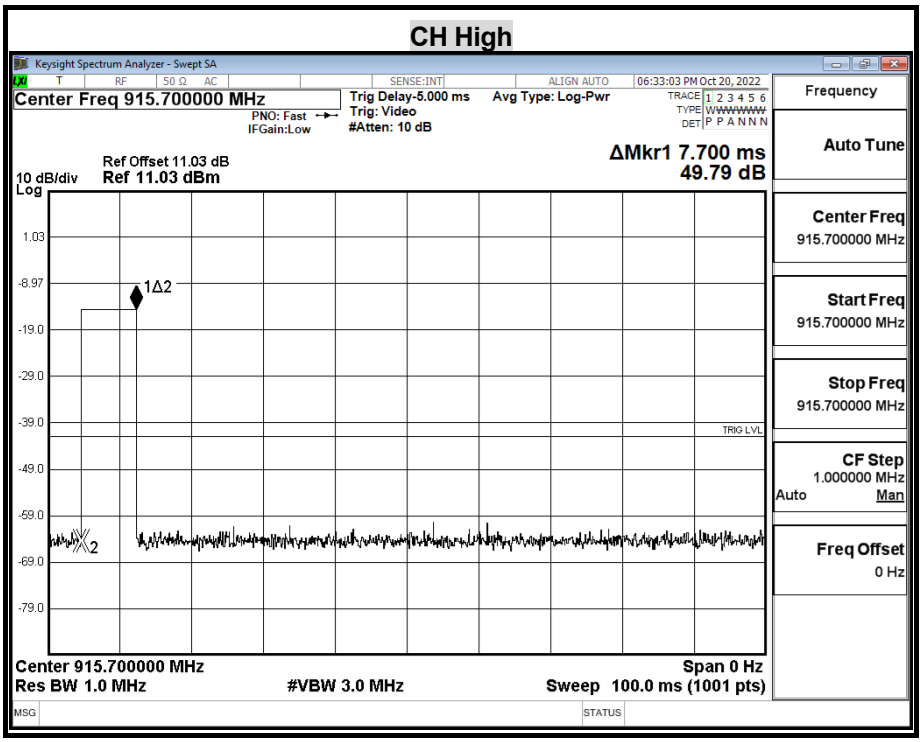
CH Low



CH Mid



CH High

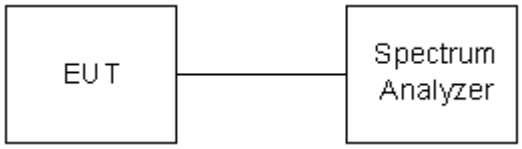


8.4 POWER SPECTRAL DENSITY

LIMIT

§ 15.247(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

TEST SETUP



TEST PROCEDURE

The tests were performed in accordance with KDB 558074 D01 v05r02 8.4.

11.10.2 (ANSI C63.10) Measurement Procedure PKPSD:

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3*RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

TEST RESULTS

Model Name	BX21-HW	Test By	Peter Chu
Temp & Humidity	21.5℃, 48%	Test Date	2022/10/20

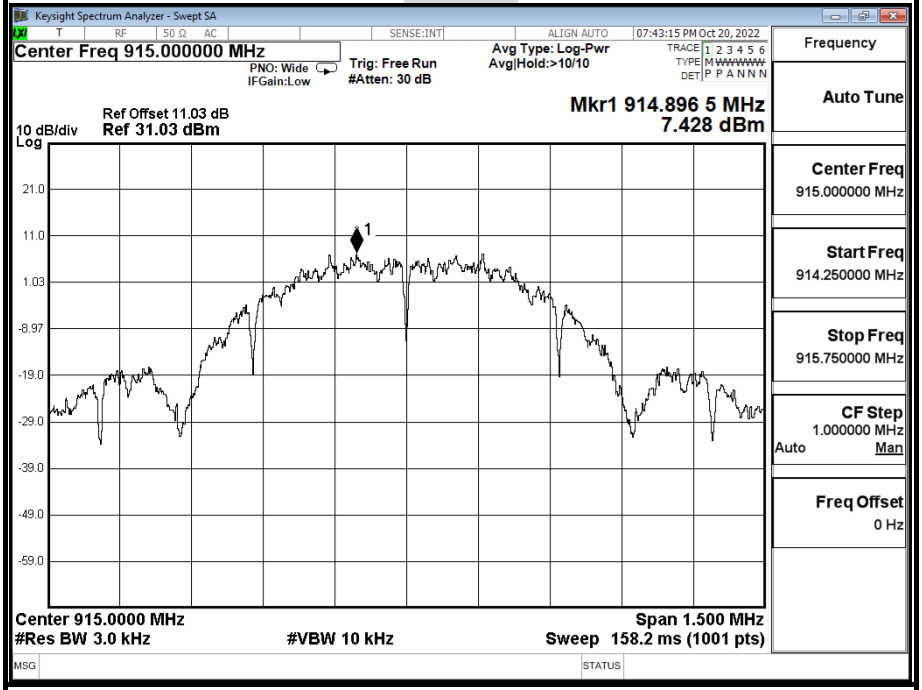
TX mode

Channel	Frequency (MHz)	PPSD/3kHz (dBm)	Limit (dBm)	Margin (dB)	Pass / Fail
Low	915	7.43	8.00	-0.57	PASS
Middle	915.35	6.86	8.00	-1.14	PASS
High	915.7	6.40	8.00	-1.60	PASS

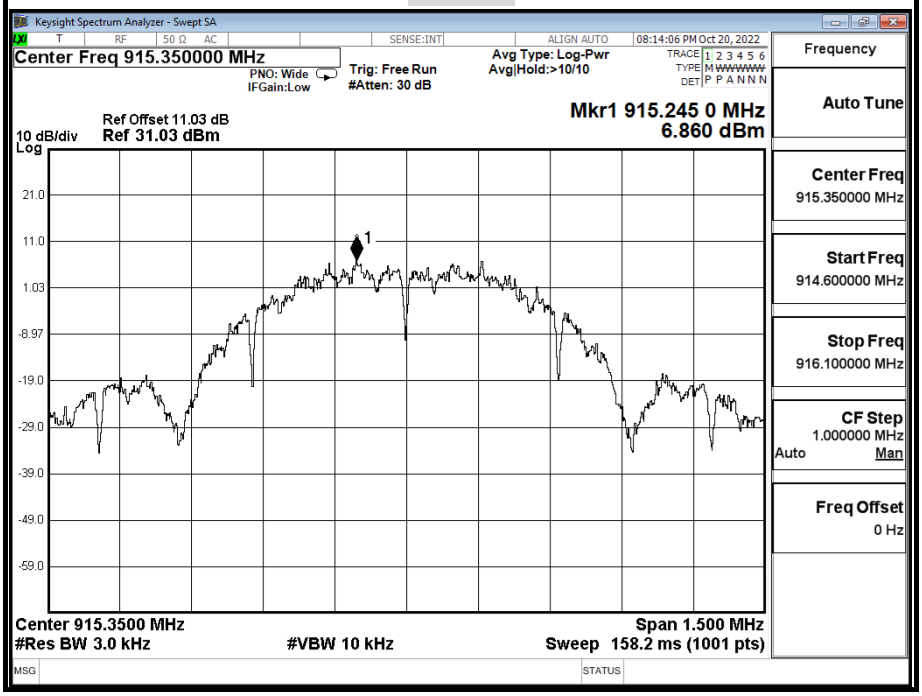
NOTE : 1. At finial test to get the worst-case emission at 80kbps long.
2. The cable assembly insertion loss of 11.45dB (including 10 dB pad and 1.45 dB cable) was Entered as an offset in the spectrum analyzer to allow for direct reading of power.

POWER SPECTRAL DENSITY (TX MODE)

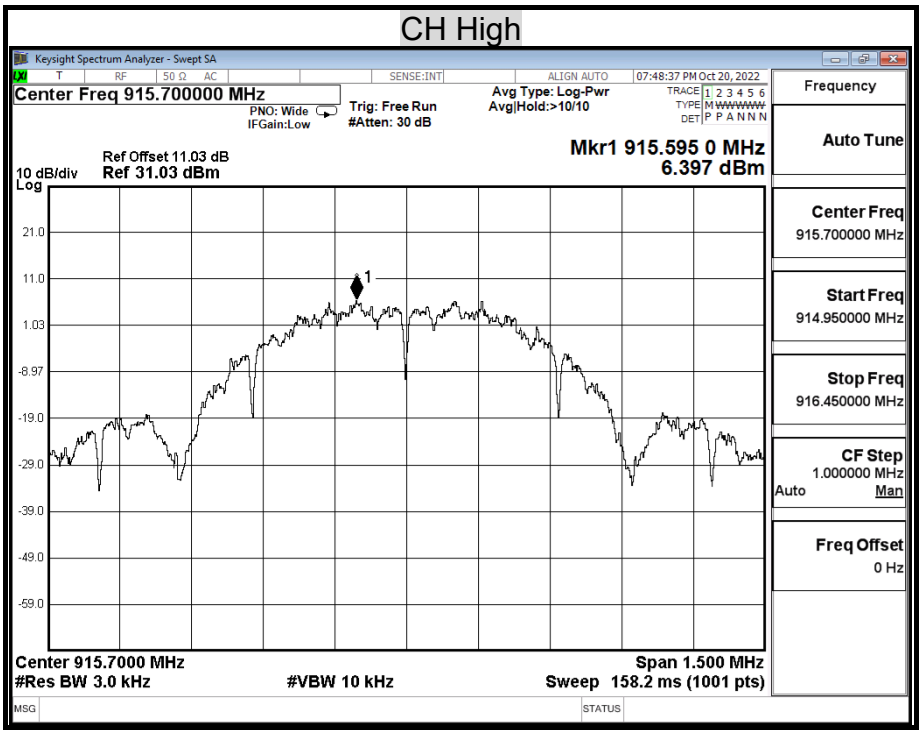
CH Low



CH Mid



CH High

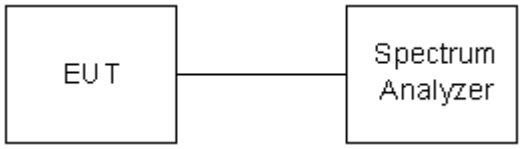


8.5 CONDUCTED SPURIOUS EMISSION

LIMITS

§ 15.247(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the and that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

TEST SETUP



TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

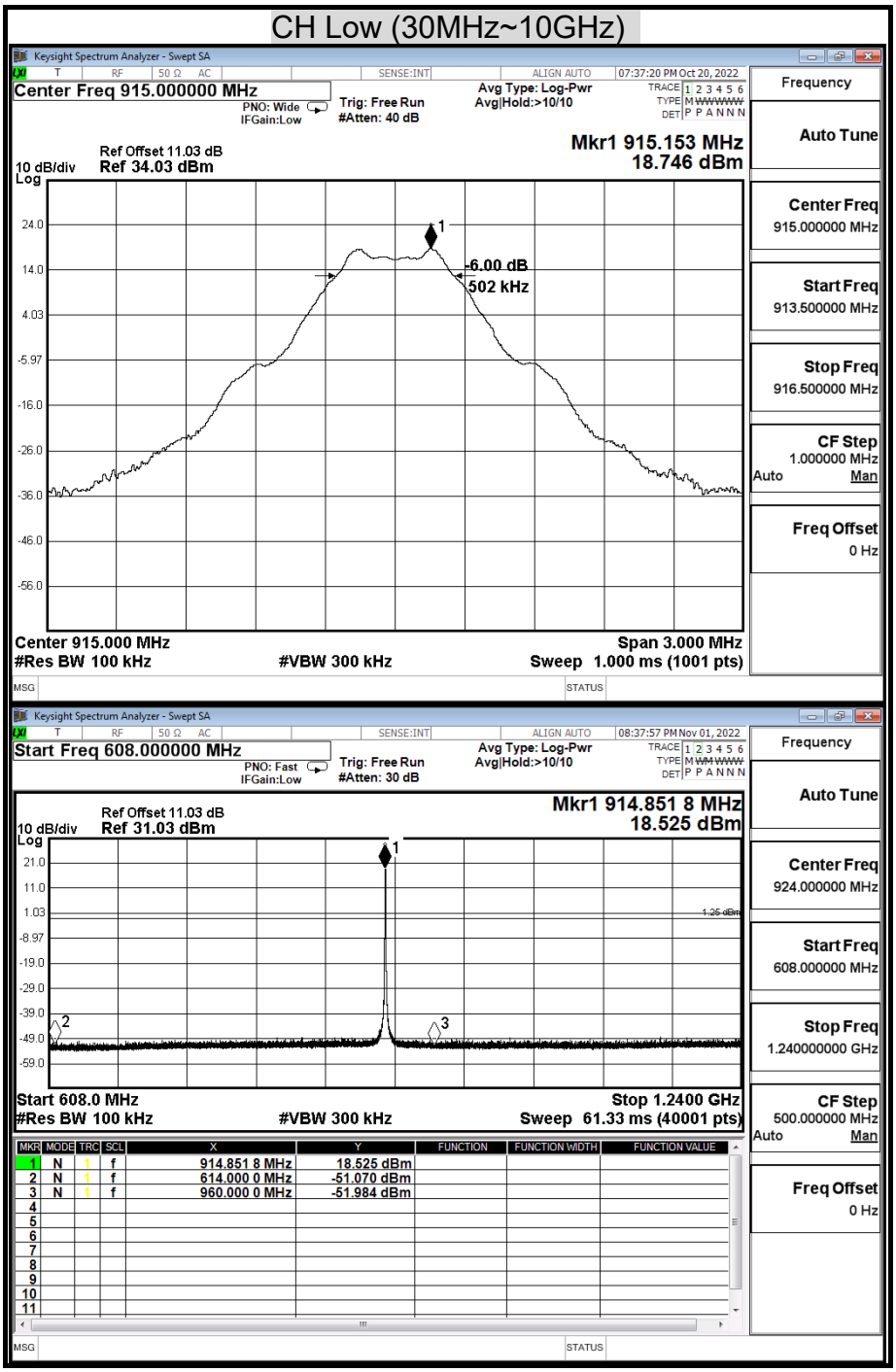
The spectrum from 30 MHz to 10 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 900MHz band.

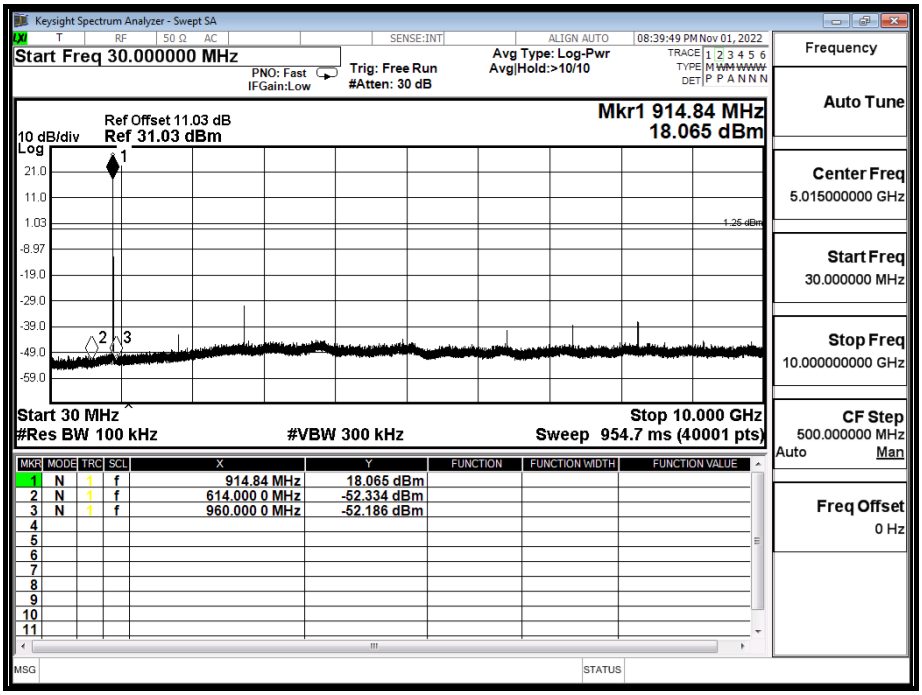
TEST RESULTS

OUT-OF-BAND SPURIOUS EMISSIONS-CONDUCTED MEASUREMENT

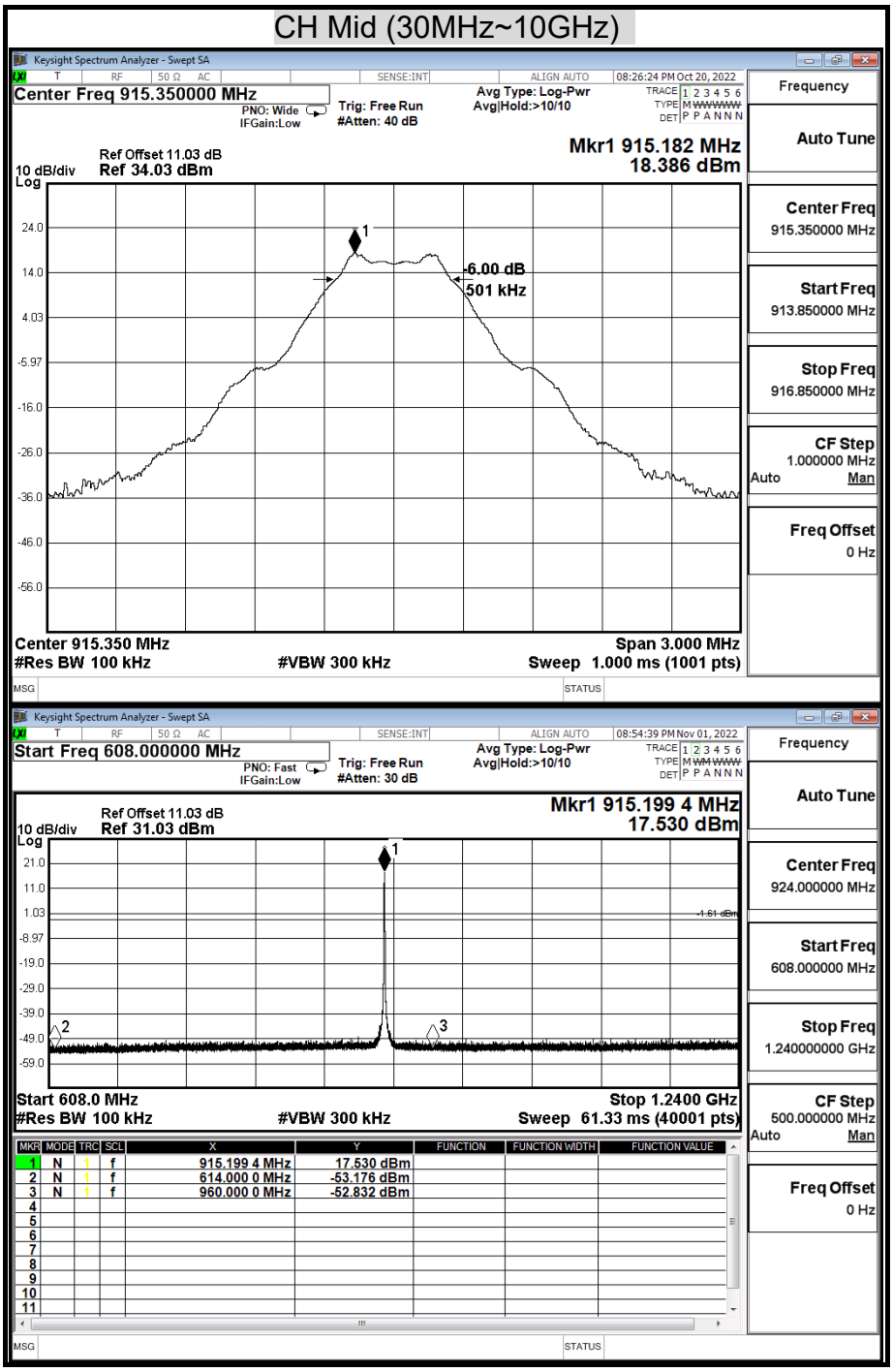
Model Name	BX21-HW	Test By	Peter Chu
Temp & Humidity	21.5℃, 48%	Test Date	2022/10/20

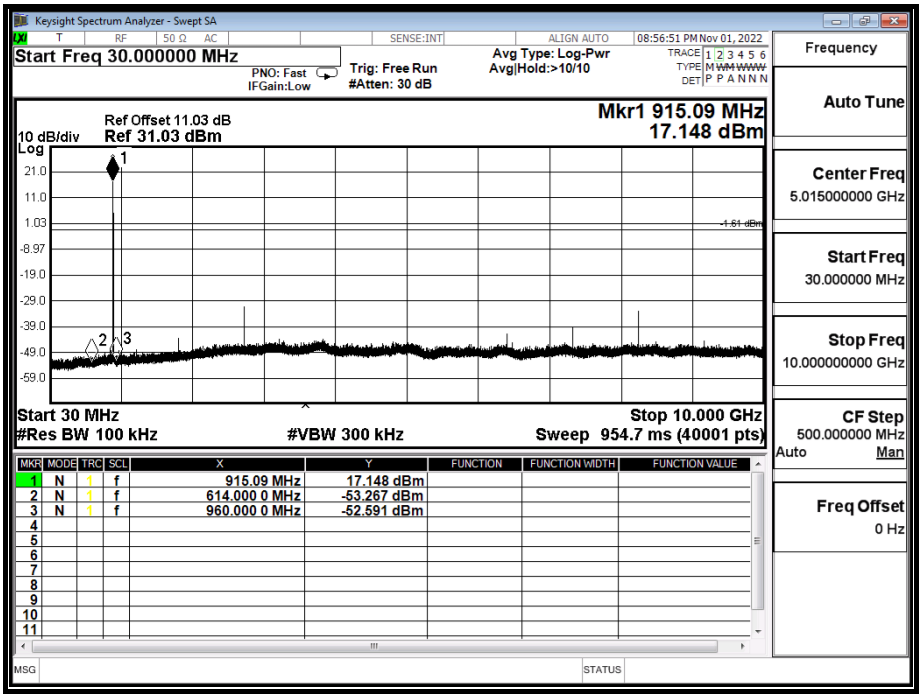
CH Low (30MHz~10GHz)



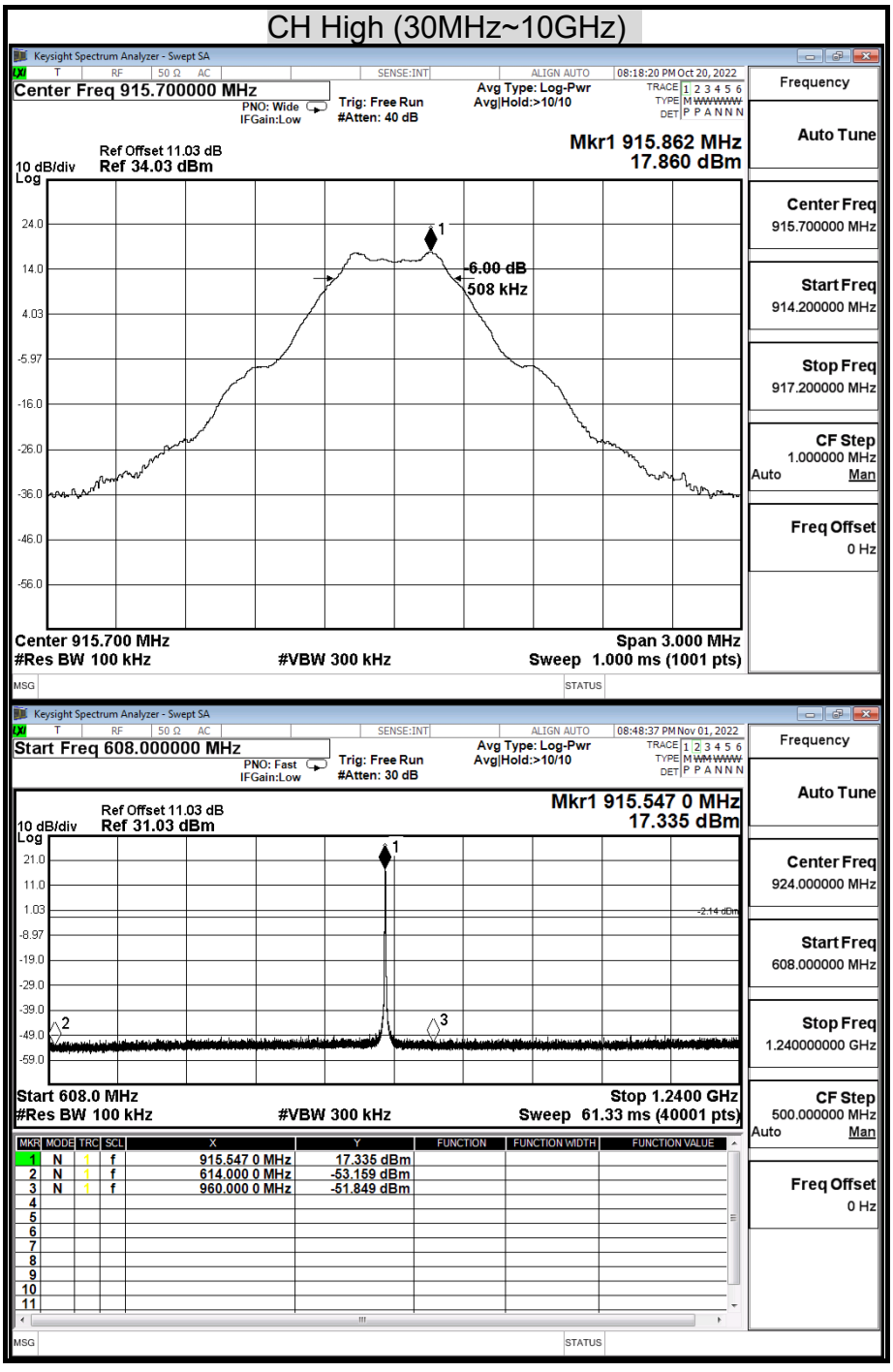


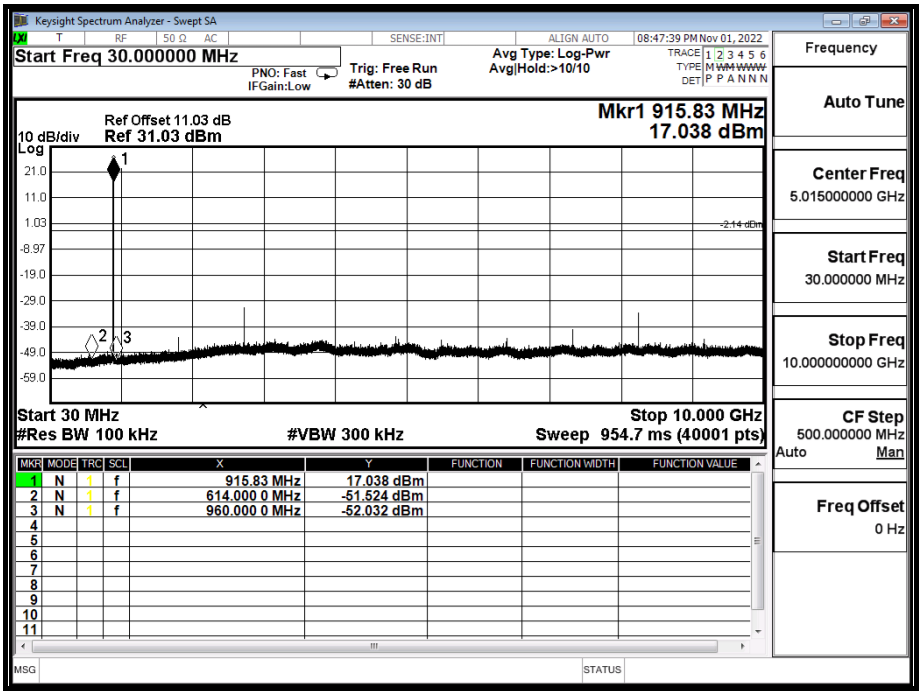
CH Mid (30MHz~10GHz)





CH High (30MHz~10GHz)





8.6 RADIATED EMISSIONS

8.6.1 TRANSMITTER RADIATED SUPURIOUS EMSSIONS

LIMITS

§ 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 -1710	10.6 -12.7
6.26775 - 6.26825	108 -121.94	1718.8 - 1722.2	13.25 -13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 – 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 -16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3338	36.43 - 36.5
12.57675 - 12.57725	322 -335.4	3600 - 4400	([2])
13.36 - 13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

[2] Above 38.6

§ 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown is Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§ 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

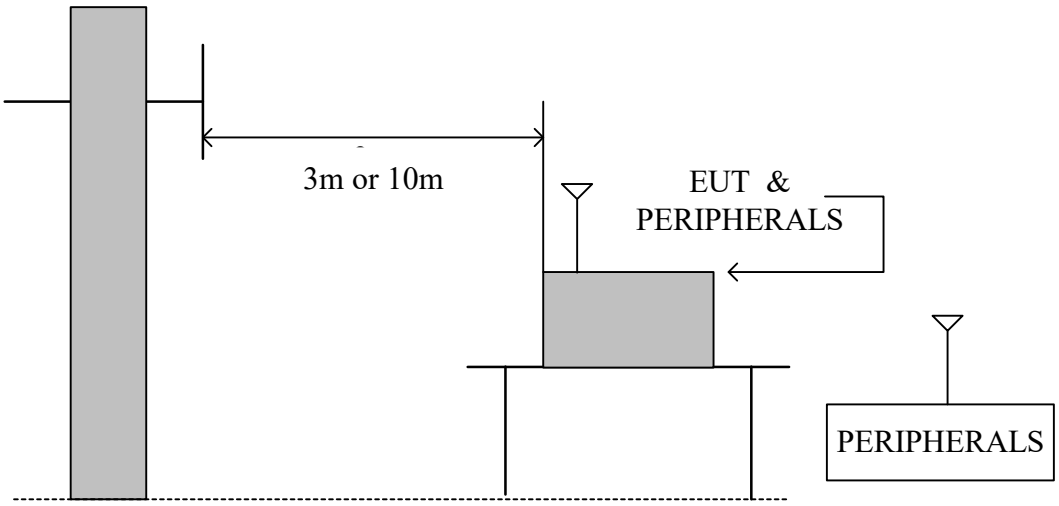
Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz, However, operation within these frequency bands is permitted under other sections of this Part, e-g, Sections 15.231 and 15.241.

§ 15.209 (b) In the emission table above, the tighter limit applies at the band edges.

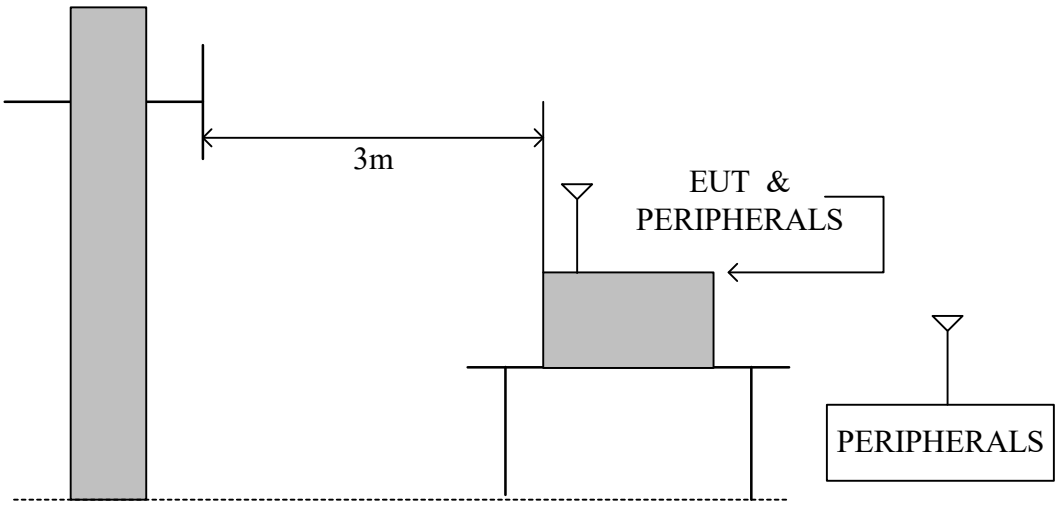
TEST SETUP

The diagram below shows the test setup that is utilized to make the measurements for emission from 30 to 1GHz.



Antenna Elevation Variable

The diagram below shows the test setup that is utilized to make the measurements for emission above 1GHz.



Antenna Elevation Variable

TEST PROCEDURE

a. The EUT was placed on the top of a rotating table 0.8/1.5 meters above the ground at a 10 meter open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.

b. White measuring the radiated emission below 1GHz, the EUT was set 3/10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. White measuring the radiated emission above 1GHz, the EUT was set 3 meters away from the interference-receiving antenna

c. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarization 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 table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The tests were performed in accordance with KDB 558074 D01 v05r02.

NOTE：

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 KHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1GHz.

2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1GHz.

3. Average value=Peak value + Duty factor.

4. No emission is found between lowest internal used/generated frequency to 30MHz (9kHz~30MHz)

TEST RESULTS

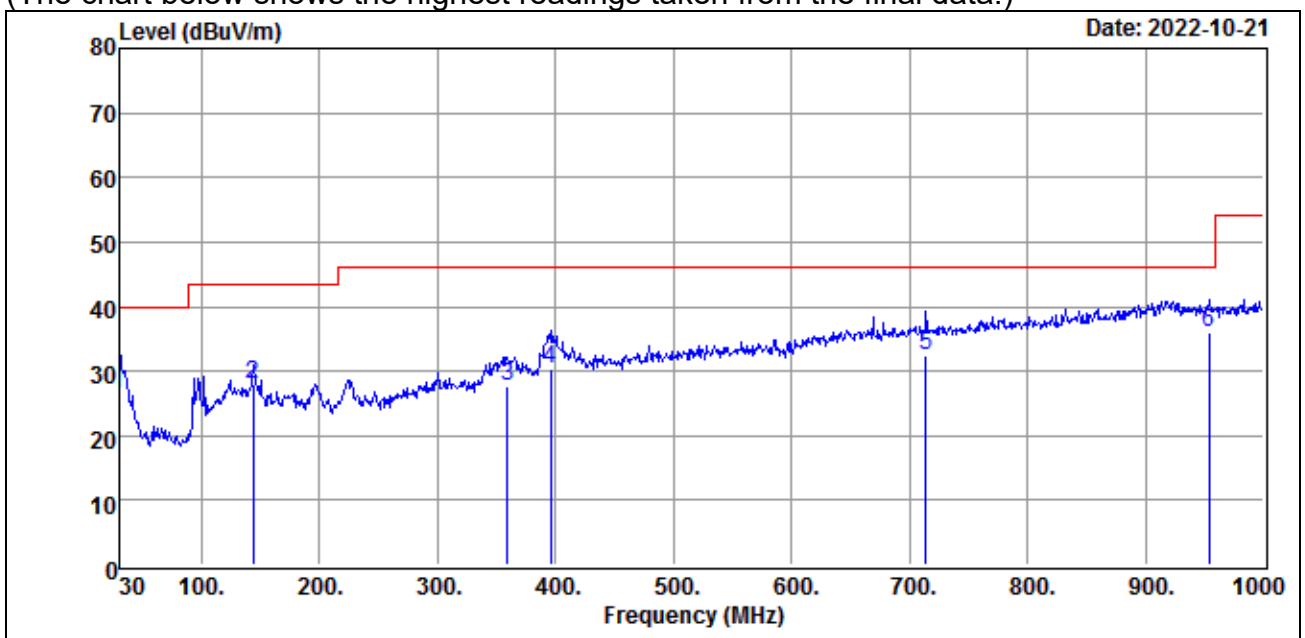
No non-compliance noted.

8.6.2 WORST-CASE RADIATED EMISSION BELOW 1 GHz

Product Name	BX21 Wireless Relay	Test Date	2022/10/21
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX	TEMP& Humidity	21.1℃/49%

Horizontal

(The chart below shows the highest readings taken from the final data.)



Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
30.00	-1.92	28.43	26.51	40.00	-13.49	QP
143.85	7.13	20.97	28.10	43.50	-15.40	QP
358.83	3.67	23.97	27.64	46.00	-18.36	QP
395.69	5.37	24.90	30.27	46.00	-15.73	QP
713.85	1.29	31.01	32.30	46.00	-13.70	QP
954.41	1.52	34.37	35.89	46.00	-10.11	QP

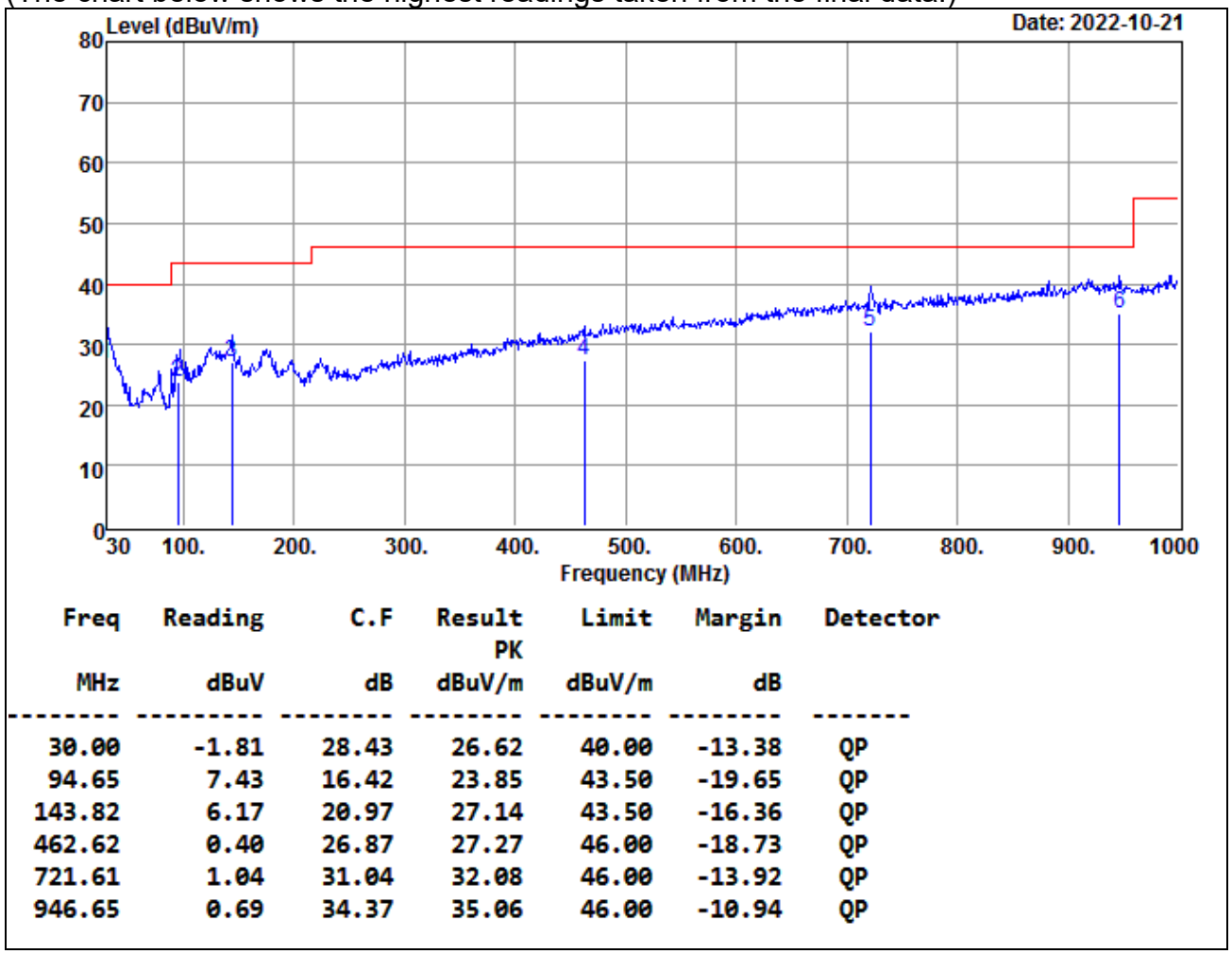
Remark:

1. No emission found between lowest internal used/generated frequency to 30MHz (9kHz~30MHz).
2. Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using peak/quasi-peak detector mode.
3. Quasi-peak test would be performed if the peak result were greater than the quasi-peak limit or as required by the applicant.
4. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>10dB from the applicable limit) and considered that's already beyond the background noise floor.
5. Emission at 3m Level=Meter Reading +Antenna Factor +Cable Loss
   Margin= Emission at 3m Level -Limits
6. That the limit for signals below 1GHz is a QP limit and peak readings are below the QP limit.
7. The fundamental signal is not shown in the test data because measurements at fundamental frequency are shown separately and were ignored during the 30 – 1000 MHz scan.

Product Name	BX21 Wireless Relay	Test Date	2022/10/21
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX	TEMP& Humidity	21.1℃/49%

Vertical

(The chart below shows the highest readings taken from the final data.)



Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
30.00	-1.81	28.43	26.62	40.00	-13.38	QP
94.65	7.43	16.42	23.85	43.50	-19.65	QP
143.82	6.17	20.97	27.14	43.50	-16.36	QP
462.62	0.40	26.87	27.27	46.00	-18.73	QP
721.61	1.04	31.04	32.08	46.00	-13.92	QP
946.65	0.69	34.37	35.06	46.00	-10.94	QP

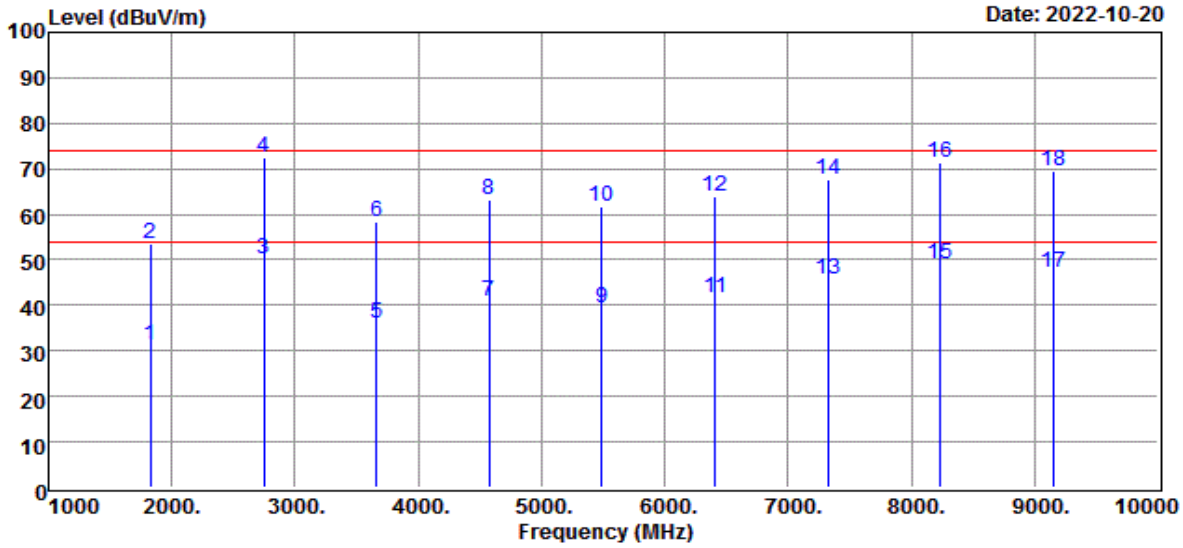
Remark:

1. No emission found between lowest internal used/generated frequency to 30MHz (9kHz~30MHz).
2. Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using peak/quasi-peak detector mode.
3. Quasi-peak test would be performed if the peak result were greater than the quasi-peak limit or as required by the applicant.
4. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>10dB from the applicable limit) and considered that's already beyond the background noise floor.
5. Emission at 3m Level=Meter Reading +Antenna Factor +Cable Loss
   Margin= Emission at 3m Level -Limits
6. That the limit for signals below 1GHz is a QP limit and peak readings are below the QP limit.
7. The fundamental signal is not shown in the test data because measurements at fundamental frequency are shown separately and were ignored during the 30 – 1000 MHz scan.

8.6.3 TRANSMITTER RADIATED EMISSION ABOVE 1 GHz

Product Name	BX21 Wireless Relay	Test Date	2022/10/20
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX (CH Low)	TEMP& Humidity	21.3℃, 51%

Horizontal



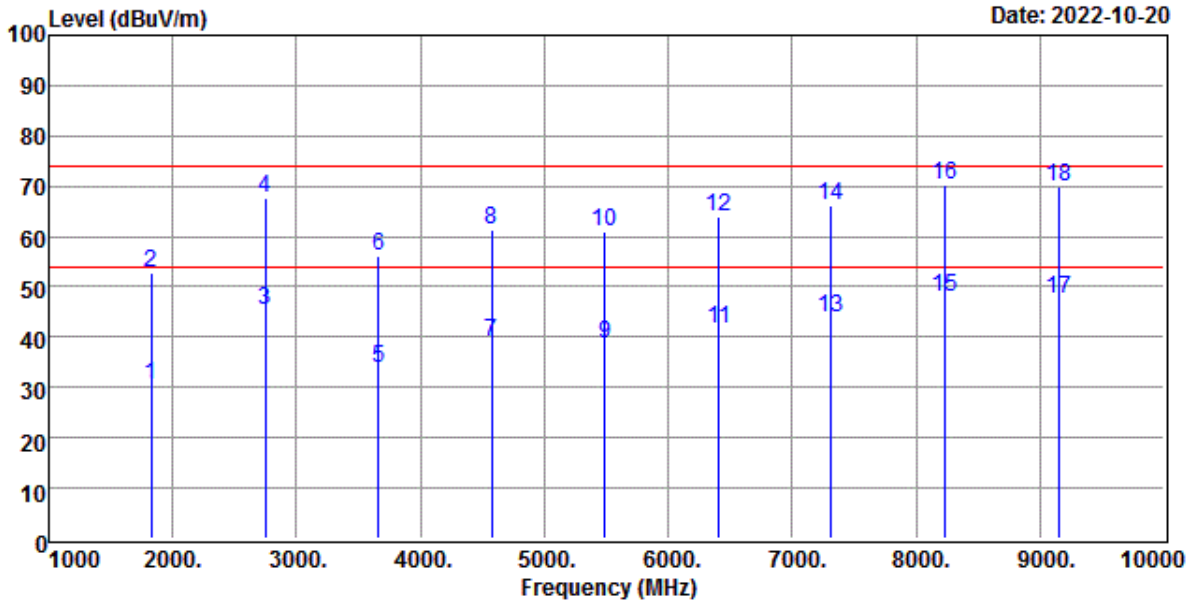
Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1827.71	—	—	31.35	54.00	-22.65	Average
1827.71	64.74	-11.11	53.63	74.00	-20.37	Peak
2745.56	—	—	50.19	54.00	-3.81	Average
2745.56	78.12	-5.66	72.46	74.00	-1.54	Peak
3660.71	—	—	35.93	54.00	-18.07	Average
3660.71	60.84	-2.64	58.20	74.00	-15.80	Peak
4574.11	—	—	40.75	54.00	-13.25	Average
4574.11	62.48	0.54	63.02	74.00	-10.98	Peak
5489.06	—	—	39.38	54.00	-14.62	Average
5489.06	58.52	3.13	61.65	74.00	-12.35	Peak
6406.25	—	—	41.80	54.00	-12.20	Average
6406.25	58.08	5.99	64.07	74.00	-9.93	Peak
7321.70	—	—	45.56	54.00	-8.44	Average
7321.70	57.61	10.22	67.83	74.00	-6.17	Peak
8233.50	—	—	49.17	54.00	-4.83	Average
8233.50	59.05	12.39	71.44	74.00	-2.56	Peak
9151.53	—	—	47.34	54.00	-6.66	Average
9151.53	54.55	15.06	69.61	74.00	-4.39	Peak

REMARK:

1. *AF: Antenna Factor, Cable: Cable Loss, Pre-Amp: Preamplifier gain, Filter: High pass-1G Filter Insertion Loss.*
2. *Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz.*
3. *Average level=Peak level + Duty factor*
4. *The result basic equation calculation is as follow:*
   Level = Reading + AF + Cable – Preamp + Filter , Margin = Level-Limit
5. *The other emission levels were 10dB below the limit*
6. *The test limit distance is 3m limit.*
7. **=Restricted bands of operation*

Product Name	BX21 Wireless Relay	Test Date	2022/10/20
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX (CH Low)	TEMP& Humidity	21.3℃, 51%

Vertical



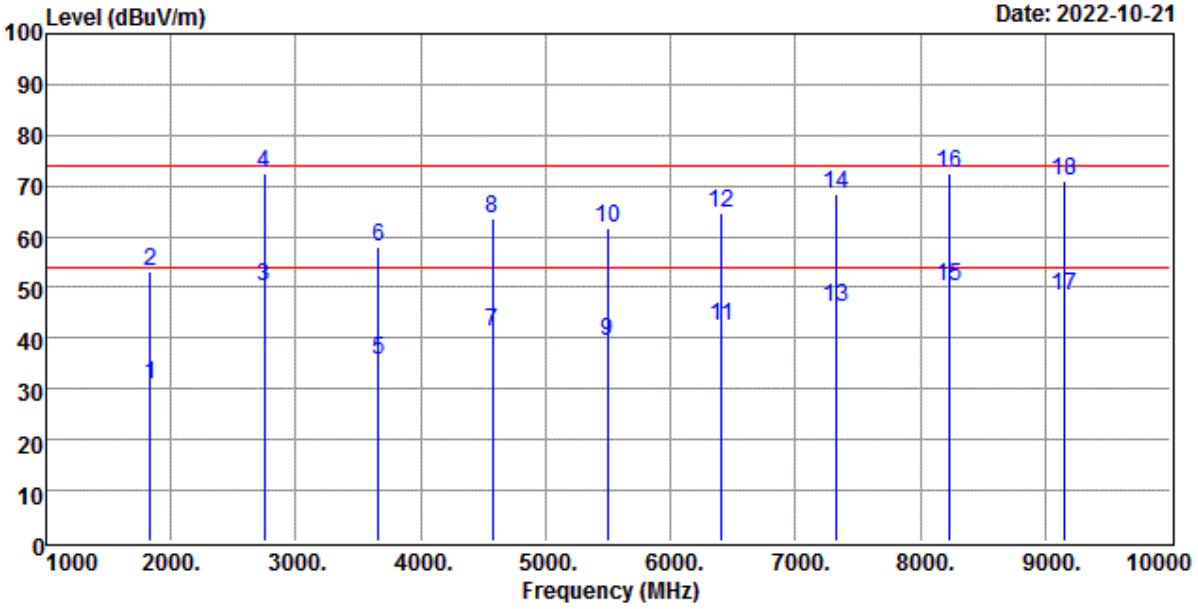
Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1829.63	—	—	30.45	54.00	-23.55	Average
1829.63	63.81	-11.09	52.72	74.00	-21.28	Peak
2744.56	—	—	45.48	54.00	-8.52	Average
2744.56	73.41	-5.66	67.75	74.00	-6.25	Peak
3660.83	—	—	33.89	54.00	-20.11	Average
3660.83	58.80	-2.64	56.16	74.00	-17.84	Peak
4575.81	—	—	39.15	54.00	-14.85	Average
4575.81	60.88	0.54	61.42	74.00	-12.58	Peak
5488.83	—	—	38.65	54.00	-15.35	Average
5488.83	57.79	3.13	60.92	74.00	-13.08	Peak
6406.24	—	—	41.77	54.00	-12.23	Average
6406.24	58.05	5.99	64.04	74.00	-9.96	Peak
7319.51	—	—	43.99	54.00	-10.01	Average
7319.51	56.04	10.22	66.26	74.00	-7.74	Peak
8233.48	—	—	47.88	54.00	-6.12	Average
8233.48	57.76	12.39	70.15	74.00	-3.85	Peak
9148.47	—	—	47.63	54.00	-6.37	Average
9148.47	54.86	15.04	69.90	74.00	-4.10	Peak

REMARK:

1. *AF: Antenna Factor, Cable: Cable Loss, Pre-Amp: Preamplifier gain, Filter: High pass-1G Filter Insertion Loss.*
2. *Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz.*
3. *Average level=Peak level + Duty factor*
4. *The result basic equation calculation is as follow:*
   Level = Reading + AF + Cable – Preamp + Filter , Margin = Level-Limit
5. *The other emission levels were 10dB below the limit*
6. *The test limit distance is 3m limit.*
7. **=Restricted bands of operation*

Product Name	BX21 Wireless Relay	Test Date	2022/10/21
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX (CH Middle)	TEMP& Humidity	21.1℃, 49%

Horizontal



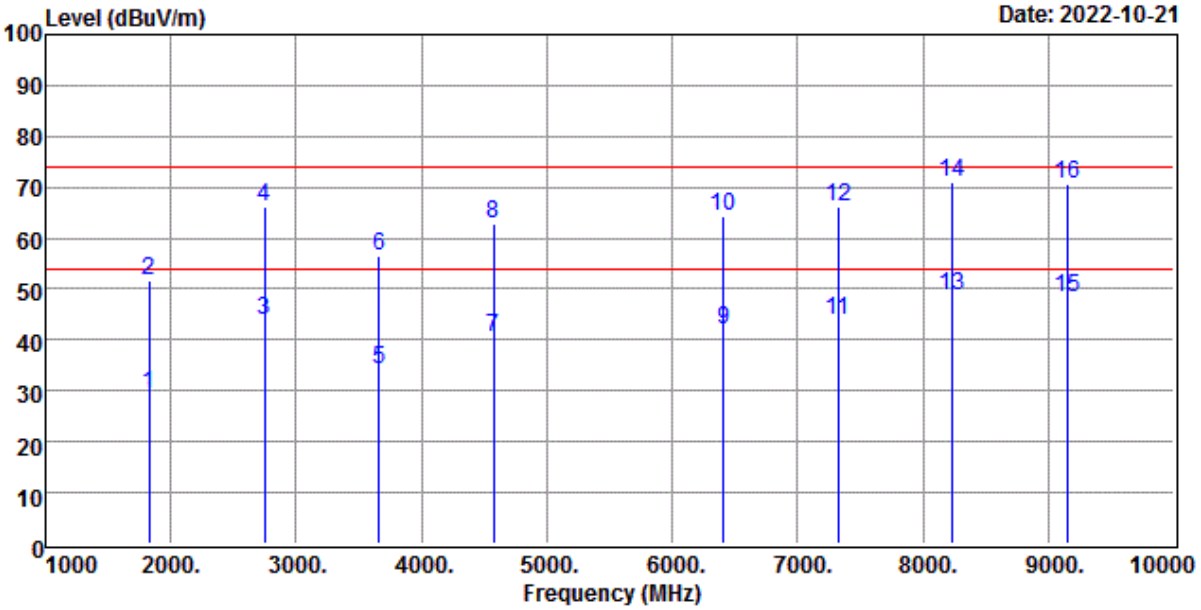
Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1830.98	—	—	30.85	54.00	-23.15	Average
1830.98	64.19	-11.07	53.12	74.00	-20.88	Peak
2745.59	—	—	50.09	54.00	-3.91	Average
2745.59	78.02	-5.66	72.36	74.00	-1.64	Peak
3660.76	—	—	35.87	54.00	-18.13	Average
3660.76	60.78	-2.64	58.14	74.00	-15.86	Peak
4575.66	—	—	41.33	54.00	-12.67	Average
4575.66	63.06	0.54	63.60	74.00	-10.40	Peak
5493.20	—	—	39.54	54.00	-14.46	Average
5493.20	58.67	3.14	61.81	74.00	-12.19	Peak
6406.57	—	—	42.44	54.00	-11.56	Average
6406.57	58.72	5.99	64.71	74.00	-9.29	Peak
7323.82	—	—	46.13	54.00	-7.87	Average
7323.82	58.15	10.25	68.40	74.00	-5.60	Peak
8236.84	—	—	50.14	54.00	-3.86	Average
8236.84	60.02	12.39	72.41	74.00	-1.59	Peak
9151.92	—	—	48.45	54.00	-5.55	Average
9151.92	55.95	15.07	71.02	74.00	-2.98	Peak

REMARK:

1. *AF: Antenna Factor, Cable: Cable Loss, Pre-Amp: Preamplifier gain, Filter: High pass-1G Filter Insertion Loss.*
2. *Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz.*
3. *Average level=Peak level + Duty factor*
4. *The result basic equation calculation is as follow:*
   Level = Reading + AF + Cable – Preamp + Filter , Margin = Level-Limit
5. *The other emission levels were 10dB below the limit*
6 *The test limit distance is 3m limit.*
7 **=Restricted bands of operation*

Product Name	BX21 Wireless Relay	Test Date	2022/10/21
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX (CH Middle)	TEMP& Humidity	21.1℃, 49%

Vertical



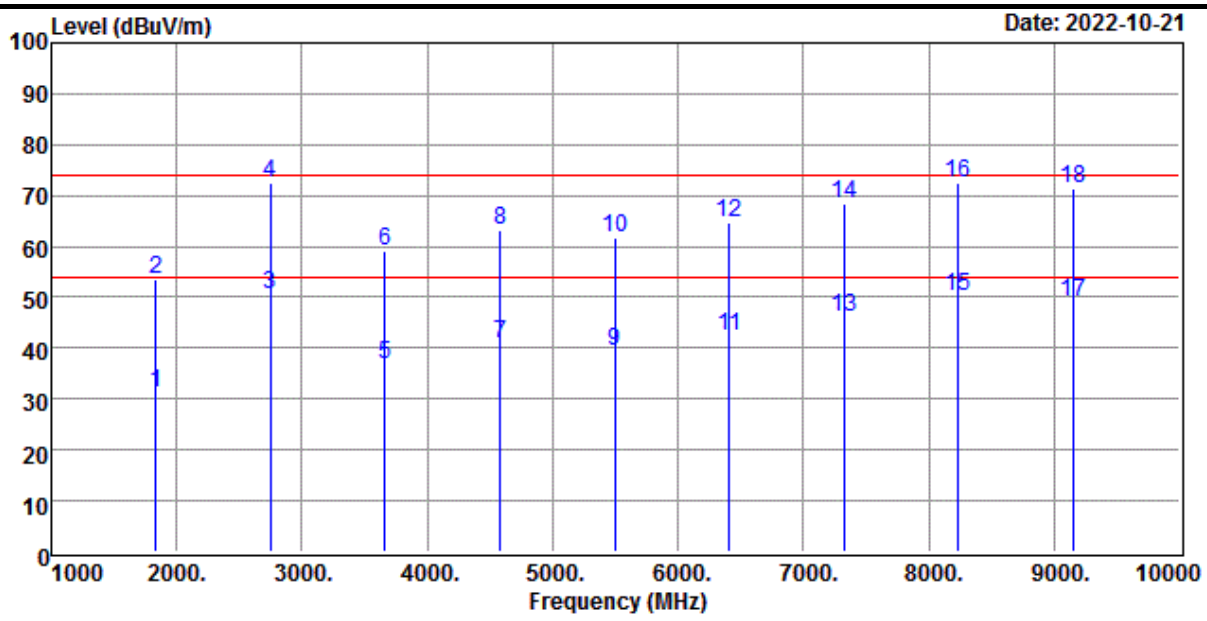
Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1830.44	—	—	29.39	54.00	-24.61	Average
1830.44	62.74	-11.08	51.66	74.00	-22.34	Peak
2745.54	—	—	44.04	54.00	-9.96	Average
2745.54	71.97	-5.66	66.31	74.00	-7.69	Peak
3662.09	—	—	34.08	54.00	-19.92	Average
3662.09	58.99	-2.64	56.35	74.00	-17.65	Peak
4577.59	—	—	40.49	54.00	-13.51	Average
4577.59	62.20	0.56	62.76	74.00	-11.24	Peak
6408.67	—	—	41.90	54.00	-12.10	Average
6408.67	58.17	6.00	64.17	74.00	-9.83	Peak
7324.22	—	—	43.85	54.00	-10.15	Average
7324.22	55.87	10.25	66.12	74.00	-7.88	Peak
8236.80	—	—	48.84	54.00	-5.16	Average
8236.80	58.72	12.39	71.11	74.00	-2.89	Peak
9151.77	—	—	48.23	54.00	-5.77	Average
9151.77	55.44	15.06	70.50	74.00	-3.50	Peak

REMARK:

1. *AF: Antenna Factor, Cable: Cable Loss, Pre-Amp: Preamplifier gain, Filter: High pass-1G Filter Insertion Loss.*
2. *Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz.*
3. *Average level=Peak level + Duty factor*
4. *The result basic equation calculation is as follow:*
   Level = Reading + AF + Cable – Preamp + Filter , Margin = Level-Limit
5. *The other emission levels were 10dB below the limit*
6. *The test limit distance is 3m limit.*
7. **=Restricted bands of operation*

Product Name	BX21 Wireless Relay	Test Date	2022/10/21
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX (CH High)	TEMP& Humidity	21.1℃, 49%

Horizontal



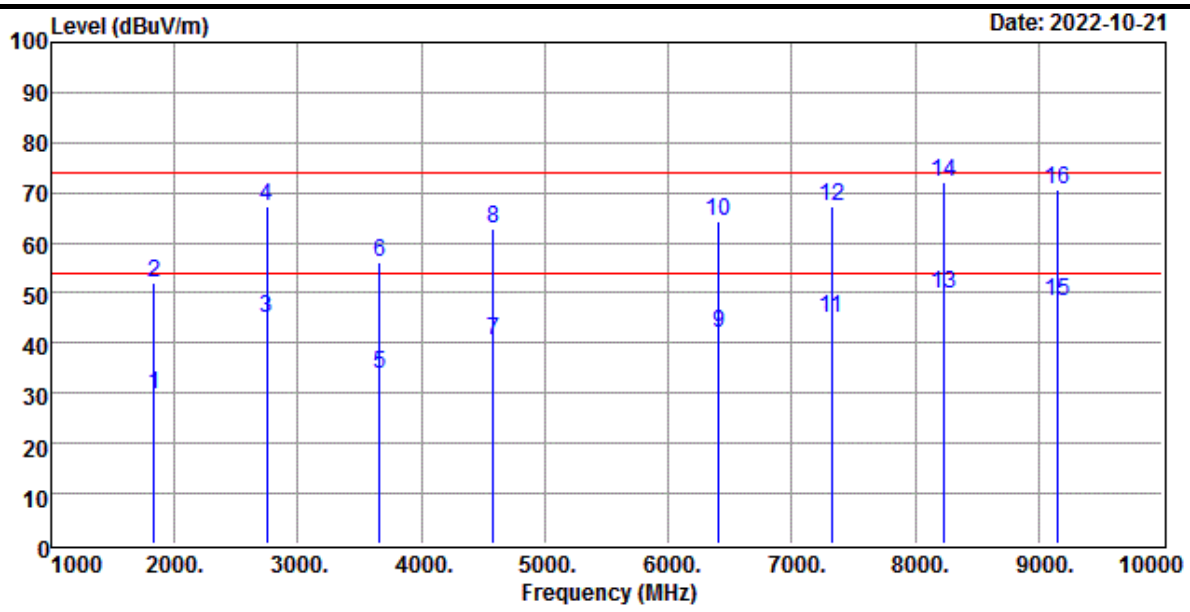
Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1830.95	—	—	31.24	54.00	-22.76	Average
1830.95	64.58	-11.07	53.51	74.00	-20.49	Peak
2746.56	—	—	50.40	54.00	-3.60	Average
2746.56	78.31	-5.64	72.67	74.00	-1.33	Peak
3662.13	—	—	36.67	54.00	-17.33	Average
3662.13	61.58	-2.64	58.94	74.00	-15.06	Peak
4579.36	—	—	40.97	54.00	-13.03	Average
4579.36	62.67	0.57	63.24	74.00	-10.76	Peak
5492.97	—	—	39.31	54.00	-14.69	Average
5492.97	58.44	3.14	61.58	74.00	-12.42	Peak
6408.92	—	—	42.53	54.00	-11.47	Average
6408.92	58.80	6.00	64.80	74.00	-9.20	Peak
7324.19	—	—	46.19	54.00	-7.81	Average
7324.19	58.21	10.25	68.46	74.00	-5.54	Peak
8239.80	—	—	50.31	54.00	-3.69	Average
8239.80	60.20	12.38	72.58	74.00	-1.42	Peak
9158.67	—	—	49.11	54.00	-4.89	Average
9158.67	56.25	15.13	71.38	74.00	-2.62	Peak

REMARK:

1. *AF: Antenna Factor, Cable: Cable Loss, Pre-Amp: Preamplifier gain, Filter: High pass-1G Filter Insertion Loss.*
2. *Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz.*
3. *Average level=Peak level + Duty factor*
4. *The result basic equation calculation is as follow:*
   Level = Reading + AF + Cable – Preamp + Filter , Margin = Level-Limit
5. *The other emission levels were 10dB below the limit*
6. *The test limit distance is 3m limit.*
7. **=Restricted bands of operation*

Product Name	BX21 Wireless Relay	Test Date	2022/10/21
Model	BX21-HW	Test By	Peter Chu
Test Mode	TX (CH High)	TEMP& Humidity	21.1℃, 49%

Vertical



Freq	Reading	C.F	Result PK	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1831.03	—	—	29.85	54.00	-24.15	Average
1831.03	63.19	-11.07	52.12	74.00	-21.88	Peak
2747.61	—	—	45.14	54.00	-8.86	Average
2747.61	73.03	-5.62	67.41	74.00	-6.59	Peak
3662.17	—	—	33.80	54.00	-20.20	Average
3662.17	58.71	-2.64	56.07	74.00	-17.93	Peak
4579.19	—	—	40.57	54.00	-13.43	Average
4579.19	62.27	0.57	62.84	74.00	-11.16	Peak
6408.43	—	—	42.12	54.00	-11.88	Average
6408.43	58.39	6.00	64.39	74.00	-9.61	Peak
7324.04	—	—	45.14	54.00	-8.86	Average
7324.04	57.16	10.25	67.41	74.00	-6.59	Peak
8239.74	—	—	49.98	54.00	-4.02	Average
8239.74	59.87	12.38	72.25	74.00	-1.75	Peak
9158.30	—	—	48.41	54.00	-5.59	Average
9158.30	55.55	15.13	70.68	74.00	-3.32	Peak

REMARK:

1. *AF: Antenna Factor, Cable: Cable Loss, Pre-Amp: Preamplifier gain, Filter: High pass-1G Filter Insertion Loss.*
2. *Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz.*
3. *Average level=Peak level + Duty factor*
4. *The result basic equation calculation is as follow:*
   Level = Reading + AF + Cable – Preamp + Filter , Margin = Level-Limit
5. *The other emission levels were 10dB below the limit*
6. *The test limit distance is 3m limit.*
7. **=Restricted bands of operation*

8.7 POWERLINE CONDUCTED EMISSIONS

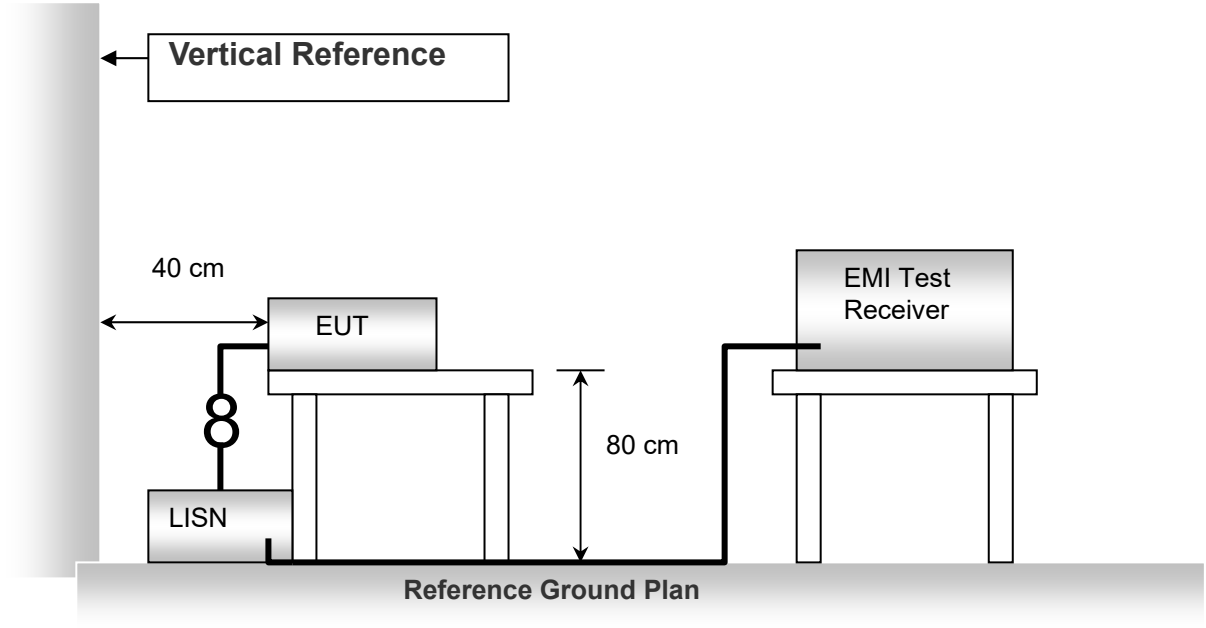
LIMITS

§ 15.207 (a) Except as shown in paragraph (b) and (c) this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted limit (dBμv)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56	56 to 46
0.5 - 5	56	46
5 - 30	60	50

TEST SETUP



TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80cm above the horizontal ground plane. The EUT IS CONFIGURED IN ACCORDANCE WITH ANSI C63.10.

The resolution bandwidth is set to 9 kHz for both quasi-peak detection and average detection measurements.

Line conducted data is recorded for both NEUTRAL and LINE.

TEST RESULTS

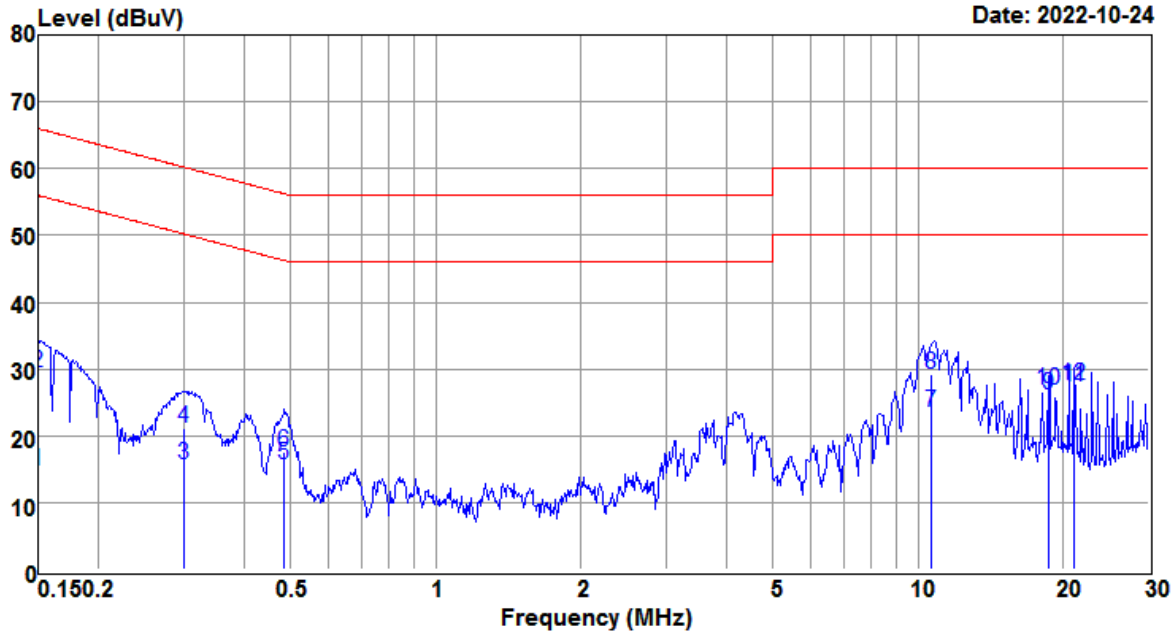
No non-compliance noted.

Test Voltage: AC 120V, 60Hz

Model No.	BX21-HW	**Test Mode**	Normal Operation
Environmental Conditions	24.2℃, 51% RH	**Resolution Bandwidth**	9 kHz
Tested by	Peter Chu		

Line

(The chart below shows the highest readings taken from the final data.)

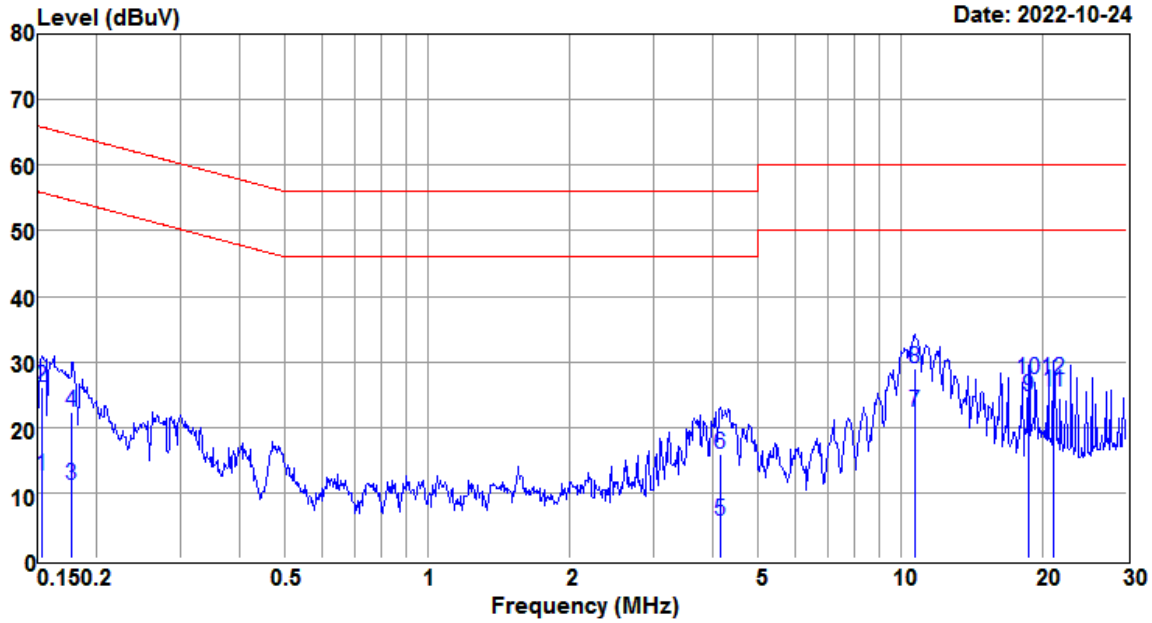


Freq	Reading Level	C.F	Result	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV	dBuV	dB	
0.150	4.50	10.22	14.72	56.00	-41.28	Average
0.150	19.24	10.22	29.46	66.00	-36.54	QP
0.302	5.42	10.22	15.64	50.19	-34.55	Average
0.302	10.84	10.22	21.06	60.19	-39.13	QP
0.486	5.54	10.23	15.77	46.23	-30.46	Average
0.486	7.36	10.23	17.59	56.23	-38.64	QP
10.669	11.30	12.10	23.40	50.00	-26.60	Average
10.669	17.02	12.10	29.12	60.00	-30.88	QP
18.622	12.08	14.14	26.22	50.00	-23.78	Average
18.622	12.74	14.14	26.88	60.00	-33.12	QP
21.021	12.44	14.75	27.19	50.00	-22.81	Average
21.021	12.86	14.75	27.61	60.00	-32.39	QP

Model No.	BX21-HW	Test Mode	Normal Operation
Environmental Conditions	24.2℃, 51% RH	Resolution Bandwidth	9 kHz
Tested by	Peter Chu		

Neutral

(The chart below shows the highest readings taken from the final data.)



Freq	Reading Level	C.F	Result	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV	dBuV	dB	
0.153	2.47	10.22	12.69	55.82	-43.13	Average
0.153	15.97	10.22	26.19	65.82	-39.63	QP
0.178	0.93	10.22	11.15	54.59	-43.44	Average
0.178	12.16	10.22	22.38	64.59	-42.21	QP
4.158	-4.92	10.71	5.79	46.00	-40.21	Average
4.158	5.20	10.71	15.91	56.00	-40.09	QP
10.676	9.89	12.33	22.22	50.00	-27.78	Average
10.676	16.53	12.33	28.86	60.00	-31.14	QP
18.623	10.26	14.40	24.66	50.00	-25.34	Average
18.623	12.90	14.40	27.30	60.00	-32.70	QP
21.019	10.38	14.97	25.35	50.00	-24.65	Average
21.019	12.40	14.97	27.37	60.00	-32.63	QP

9. ANTENNA REQUIREMENT

9.1 STANDARD APPLICABLE

For intentional device, according to FCC 47 CFR 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.

And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

9.2 ANTENNA CONNECTED CONSTRUCTION

Type: Helical Antenna
Model: BX21
Manufacturer: N/A
Gain: -0.72 dBi

=== END of Report ===