



RF TEST REPORT For FCC

RZBG(W) 20221009001-1

Applicant : UNICORN PRODUCTS LTD.

Address : South Barn, Crockham Park, Edenbridge, Kent TN8 6UP, ENGLAND

Product Name : Smartboard

Type/Model : 79700

FCC ID : 2A8Y9-79700

TEST RESULT : PASS

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 Sub-part C 15.247:Radio Frequency Device:Sub-part C;Intentional radiators.

ANSI C63.10 (2013): American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

Date of issue:Nov. 17, 22

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1. GENERAL INFORMATION of EUT

1.1 Applicant information

Applicant	UNICORN PRODUCTS LTD
Address	South Barn, Crockham Park, Edenbridge, Kent TN8 6UP, ENGLAND
Contact person	Jianbin Fu
Phone number	18158180200

1.2 Manufacture information

Manufacture	Zhejiang Zhonghe Technology Co., Ltd.
Address	Room 303, Building 4, 413Tongyun Street, Liangzhu Street, Yuhang District, Hangzhou City, Zhejiang Province.

1.3 General Description for Equipment under Test(EUT)

Eut name	Smartboard
Trade name	unicorn
Under test mode name	79700
Series model name	N/A
Description of different model name	N/A
Hardware version	V5.0-2022
Software version	V5.0-2022
Temperature range	0℃- 50℃
Network and Wireless connectivity	BLE 5.1



1.4 Technical Information of Test(EUT)

The requirement for the following technical information of the EUT was tested in this report:

Test channel	0(2402 MHz), 19 (2440MHz), 39(2480MHz)
Modulation Technology	DTS
Modulation Type	GFSK
FCC ID	2A8Y9-79700
Equipment type	<input checked="" type="checkbox"/> Mobile <input type="checkbox"/> Portable <input type="checkbox"/> Fix Location
Transfer Rate	1Mbps
Number of Channel	40 (at intervals of 2 MHz)
Antenna Type	PCB Antenna
Antenna Gain	5.3 dBi
Note: The antenna gain was declared by the Antenna report.	

The requirement for the following technical information of the EUT was tested in this report:

Support channel:

Note: the three bold fonts channels are test low, middle and high channels.

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



1.5 Additional Instructions

EUT Software Settings:

Mode	<input checked="" type="checkbox"/> Special software is used. The software provided by client to enable the EUT under transmission condition continuously at specific channel frequencies individually.
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During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Power level setup in software			
Test Software Version	JS1120-3 V2.5.44.418		
EUT Software Version	wireless_tools V4.0.0.2		
Support Units (Software installation media)	Description	Manufacturer	Model
	Notebook	Lenovo	L540
Mode	Channel	Frequency (MHz)	Soft Set
GFSK	CH0	2402	Default power
	CH19	2440	
	CH39	2480	

Sample received date : 2022.10.09

Date of test : 2022-10-10 ~ 2022.10.22



2. Description of Test Facility

<input checked="" type="checkbox"/> Company Name	Hangzhou TDT Technologies Co., Ltd.
Address	Room 101, Building 3, No. 12, Binwen Road, Xixing Street, Binjiang district, Hangzhou, Zhejiang, China
Telephone	+86571-88317620
Telefax	+86571-88316350
Test Location	Hangzhou TDT Technologies Co., Ltd.
Address	Room 101, Building 3, No. 12, Binwen Road, Xixing Street, Binjiang district, Hangzhou, Zhejiang, China
Telephone	+86571-88317620
Telefax	+86571-88316350
A2LA Certification number	4037.01
CNAS Certification number	CNAS L7728
VCCI Site registration number	C-14683, G-10832, R-14200, T-12223
FCC Site registration number	645845
Designation number	CN1197

Announce:

- 1 The test report reference to the report template version v1.0
- 2 The test report is invalid if not marked with the signatures of the persons responsible For preparing and approving the test report.
- 3 The test report is invalid if there is any evidence and/or falsification.
- 4 The result documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein
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- 7 information is provided by the customer. it shall not be reproduced except in full, without the written approval of Hangzhou TDT Technologies Co., Ltd. Any objections should be raised within thirty days from the date of issue. To validate the report, please contact us.
- 8 This is the second version of the report, which replaces the previous one. See the revision history for details



3. Summary of Test Result

3.1 Test standard

No.	Identify	Document title
1	47 CFR Part 15 Subpart C	Miscellaneous Wireless Communications Services
2	KDB Publication 558074 D01v05r02	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
5	ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

3.2 Verdict

No.	Description	FCC PART No.	Test Result	Verdict
1	Antenna Requirement	15.203; 15.247(b)	N/A	Pass ^{Note 1}
2	Output Power	15.247(b)	ANNEX A.1	Pass
3	6dB Bandwidth	15.247(a)	ANNEX A.2	Pass
4	Conducted Spurious Emission	15.247(d)	ANNEX A.3	Pass
5	Band Edge(Authorized- band band-edge)	15.209; 15.247(d)	ANNEX A.4	Pass
6	Conducted Emission	15.207	ANNEX A.5	Pass
7	Radiated Spurious Emission	15.209; 15.247(d)	ANNEX A.6	Pass
8	Band Edge(Restricted- band band-edge)	15.209; 15.247(d)	ANNEX A.7	Pass
9	Power spectral density (PSD)	15.247(e)	ANNEX A.8	Pass
10	Receiver Spurious Emissions	N/A	N/A	N/A ^{Note 2}

Note 1: Please refer to section 5.1.

Note 2: Only radio communication receivers operating in stand-alone mode within the band 30-960 MHz, as well as scanner receivers, are subject to Industry Canada requirements, so this test is not applicable.



4. GENERAL TEST CONFIGURATION

4.1 Test Enviroments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	47% - 56%	
Atmospheric Pressure	100.0 kPa – 100.1 kPa	
Temperature	NT (Normal Temperature)	20°C to 22°C
Working Voltage of the EUT	NV (Normal Voltage)	120V

4.2 Test Equipment

Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Cal. Period	Use
Spectrum Analyzer	R&S	FSV40	101015	Jun.6, 2022	1 year	✓
Integrated measuring instrument	R&S	CMW500	160809	Oct.19, 2022	1 year	×
Analog signal generator	Agilent	N5183A	MY50141794	Oct.27, 2021	1 year	×
LOOP Antenna	Com-power	1900/1/0	10160053	Jul.04,2021	2 year	✓
Automatic control unit	Tonscend	JS0806-2	T1326593	Oct.27, 2021	1 year	✓
EMI Test receiver	R&S	ESR26	101617	Oct.27, 2021	1 year	✓
PRE-AMPLIFIER (1-18GHz)	CERNEX	CBL01185030	34031	Aug.20, 2022	1 year	✓
PRE-AMPLIFIER (18-40GHz)	CERNEX	CBL18404035	24496/24495	Jun.14, 2022	1 year	✓
Bi-conical and log-periodic Antenna (30MHz-1GHz)	SCHWARZBECK	VULB 9168	796	Apr.12,2021	2year	✓
HORN Antenna (1GHz-18GHz)	SCHWARZBECK	BBHA 9120D	1935	Jan.24,2021	1 year	✓
Coaxial RF Cable	Talent Microwave	SUCOFLEX 104EA+SUCOFLEX 100	NA	Jun.14, 2022	1 year	✓
	Talent Microwave	SA360-2.92M2.92M-11M-3#	NA	Jun.14, 2022	1 year	✓
High-pass Filter	Dongsheng	ZHPF-M3-18G-SS	186101682	Jul.10, 2022	2year	✓
HORN Antenna	Com-power	AH-840	101076	Dec.05, 2021	1year	✓



4.3 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Measurement	Value
Occupied Channel Bandwidth	±2MHz
RF output power, conducted	±1.24dB
Power Spectral Density, conducted	±1.88 dB
Unwanted Emissions, conducted (30MHz-1GHz)	±0.746 dB
Unwanted Emissions, conducted (above 1GHz)	±1.328 dB
All emissions, radiated	±1.328 dB
Temperature	±1 °C
Humidity	±4 %

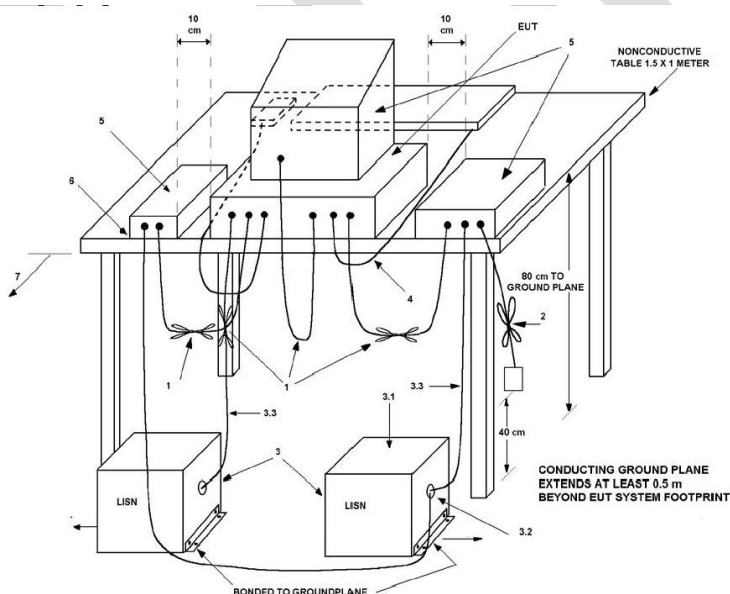
4.3 Description of Test Setup

4.4.1 For conducted Test

Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

For example: the measurement value is 10dBm and the cable 0.5dBm used, then the final result of EUT: Conducted value (dBm) = 10dBm + 0.5dB = 10.5dBm

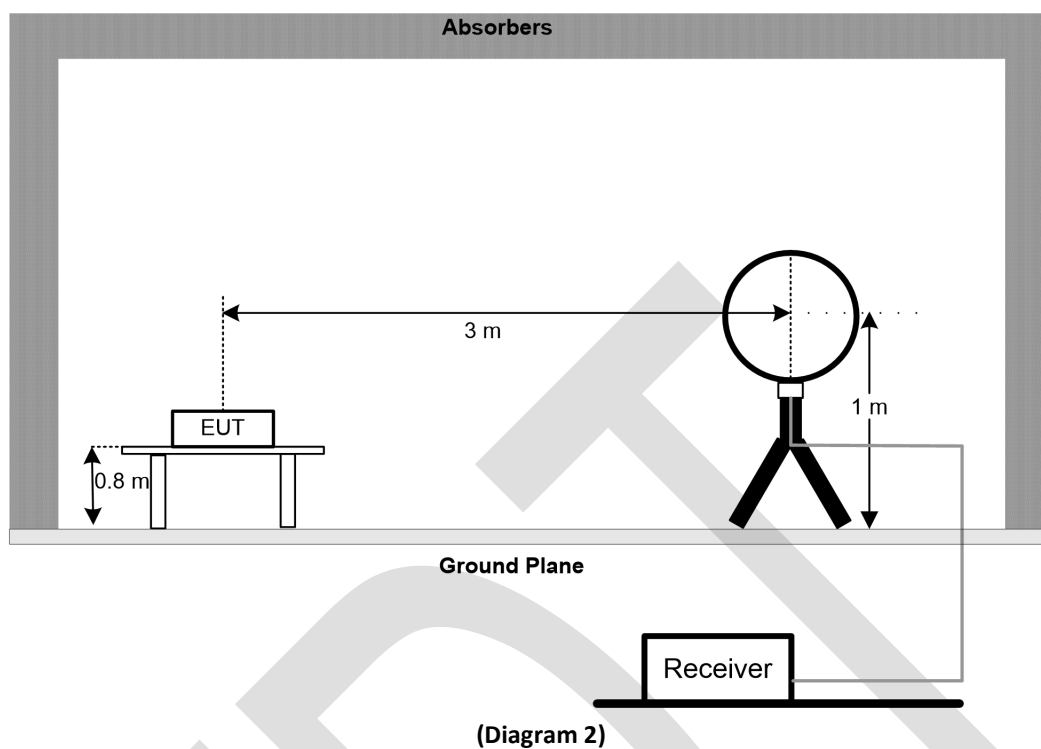
4.4.2 For AC Power Supply port Test



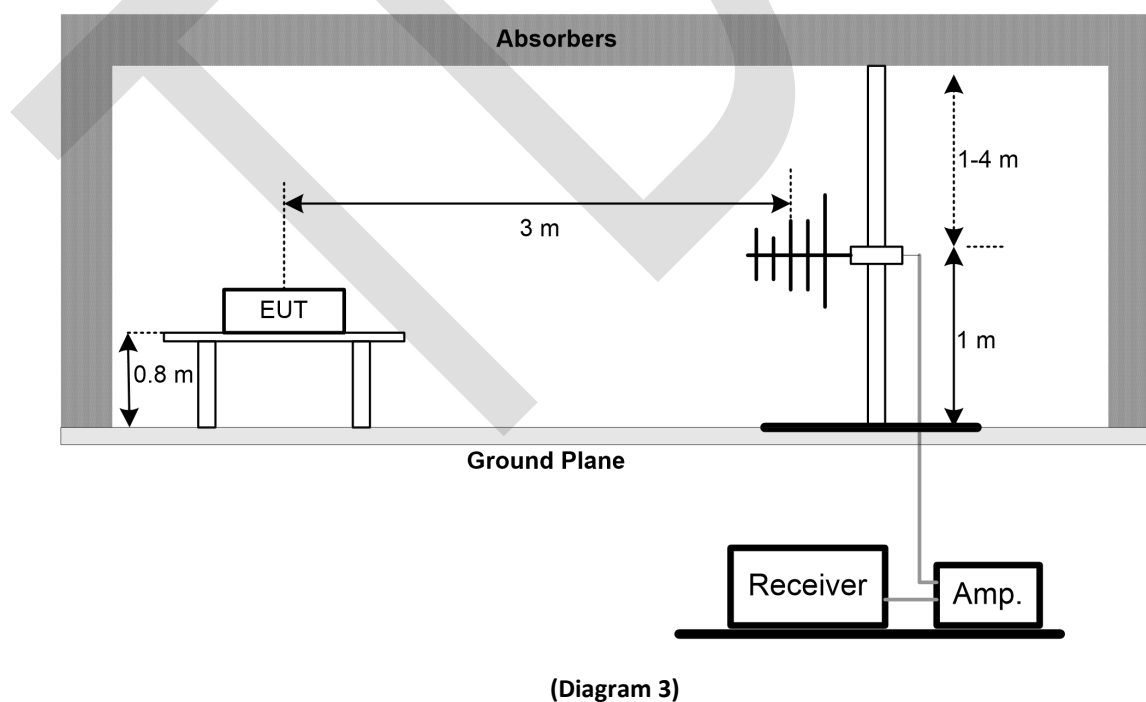
(Diagram 1)



4.4.3 For Radiated Test (Below 30 MHz)

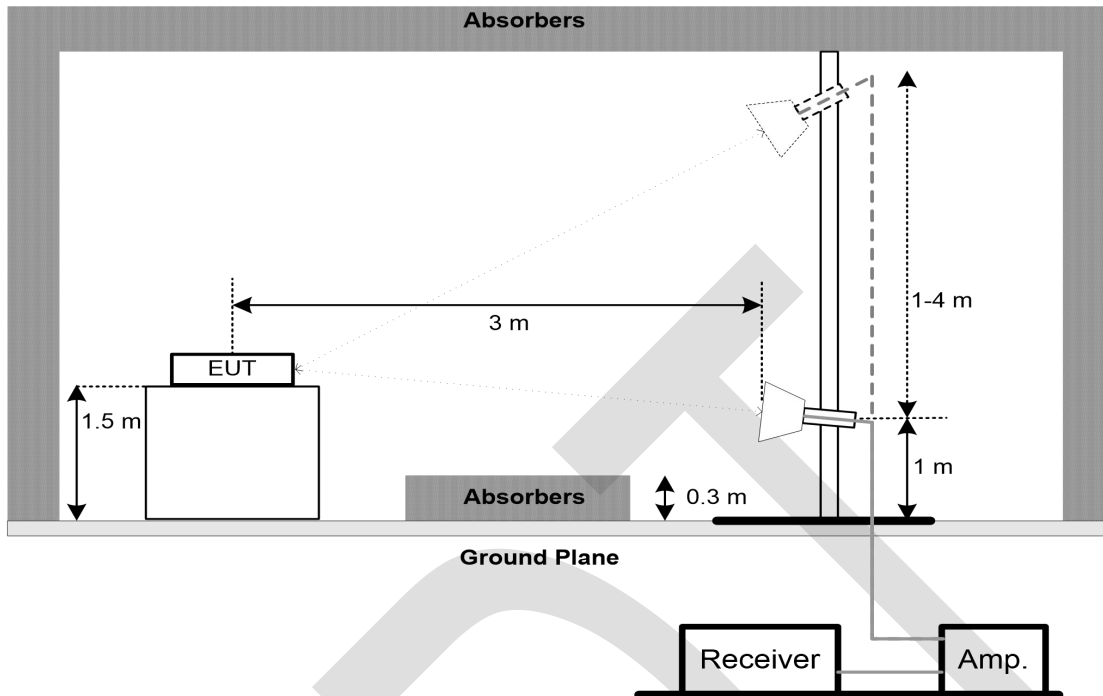


4.4.4 For Radiated Test(30MHz-1GHz)





4.4.5 For Radiated Test (Above 1 GHz)



(Diagram 4)

4.5 Measurement Results Explanation Example

4.5.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

4.5.2 For radiated band edges and spurious emission test:

$$E = \text{EIRP} - 20\log D + 104.8$$

where:

E = electric field strength in dB μ V/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

EIRP = Measure Conducted output power Value (dBm) + Maximum transmit antenna gain (dBi)
+ the appropriate maximum ground reflection factor (dB)



5. TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b); RSS-247, 5.4 (6)

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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	The antennas of the product are permanently attached. There are no provisions for connection to an external antenna.

Reference Documents	Item
Photo	Please refer to the EUT Photo documents.

Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



5.2 Output Power

Limit

FCC § 15.247(b); RSS-247, 5.4 (4)

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements.

Test Setup



Test Procedure

- a. The EUT was directly connected to the power meter and antenna output port as shown in the block diagram below.
- b. The maximum conducted output power was performed in accordance with method 11.9.1.1 (for peak power) or 11.9.2.2 (for AVG power) of ANSI C63.10-2013.

Test Result

Please refer to ANNEX A.1.



5.3 6dB Bandwidth

Limit

FCC §15.247(a); RSS-GEN, 6.6

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW. The 6 dB bandwidth must be greater than 500 kHz.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

Use the following spectrum analyzer settings:

Set RBW = 100 kHz.

Set the video bandwidth (VBW) ≥ 3 RBW.

Detector = Peak.

Trace mode = max hold.

Sweep = auto couple.

Allow the trace to stabilize.

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Test Result

Please refer to ANNEX A.2.



5.4 Conducted Spurious Emission

Limit

FCC §15.247(d); RSS-247, 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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 band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

- a) If the maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).
- b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).
- c) In either case, attenuation to levels below the 15.209 general radiated emissions limits is not required.

The following procedures shall be used to demonstrate compliance to these limits. Note that these procedures can be used in either an antenna-port conducted or radiated test set-up. Radiated tests must conform to the test site requirements and utilize maximization procedures defined herein.

Reference level measurement

Establish a reference level by using the following procedure:

Set instrument center frequency to DTS channel center frequency.



Set the span to ≥ 1.5 times the DTS bandwidth.

Set the RBW = 100 kHz.

Set the VBW $\geq 3 \times$ RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum PSD level.

Emission level measurement

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

Set the RBW = 100 kHz.

Set the VBW $\geq 3 \times$ RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

Test Result

Please refer to ANNEX A.3



5.5 Band Edge (Authorized-band band-edge)

Limit

FCC §15.247(d); RSS-GEN, 8.9, RSS-247, 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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 band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B

Test Procedure

The following procedures may be used to determine the peak or average field strength or power of an unwanted emission that is within 2 MHz of the authorized band edge. If a peak detector is utilized, use the procedure described in 13.2.1. Use the procedure described in 13.2.2 when using an average detector and the EUT can be configured to transmit continuously (i.e., duty cycle $\geq 98\%$). Use the procedure described in 13.2.3 when using an average detector and the EUT cannot be configured to transmit continuously but the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent). Use the procedure described in 13.2.4 when using an average detector for those cases where the EUT cannot be configured to transmit continuously and the duty cycle is not constant (duty cycle variations equal or exceed 2 percent).

When using a peak detector to measure unwanted emissions at or near the band edge (within 2 MHz of the authorized band), the following integration procedure can be used.

Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).

Set span to 2 MHz

RBW = 100 kHz.

VBW $\geq 3 \times$ RBW.

Detector = peak.

Sweep time = auto.



Trace mode = max hold.

Allow sweep to continue until the trace stabilizes (required measurement time may increase for low duty cycle applications)

Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency (femission) ± 0.5 MHz. If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by femission ± 0.5 MHz.

Standard method(The 99% OBW of the fundamental emission is without 2 MHz of the authorized band):

Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (\text{OBW}/\text{RBW})]$ below the reference level. Specific guidance is given in 4.1.5.2.

Attenuation: Auto (at least 10 dB preferred).

Sweep time: Coupled.

Resolution bandwidth: 100 kHz.

Video bandwidth: 300 kHz.

Detector: Peak.

Trace: Max hold.

Test Result

Please refer to ANNEX A.4.



5.6 Conducted Emission

Limit

FCC §15.207; RSS-GEN, 8.8

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 within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dB μ V)	
	Quasi-peak	Average
0.15 - 0.50	66 to 56*	56 to 46*
0.50 - 5	56	46
5 - 30	60	50

Test Setup

See section 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below. Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

Test Result

Please refer to ANNEX A.5.



5.7 Radiated Spurious Emission

Limit

FCC §15.209&15.247(c); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 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 ($\mu\text{V/m}$)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
2. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

Since the emission limits are specified in terms of radiated field strength levels, measurements performed to demonstrate compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for demonstrating compliance to the specified limits; however antenna-port conducted measurements are also now acceptable to demonstrate compliance (see below for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 shall be followed.

Antenna-port conducted measurements may also be used as an alternative to radiated



measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

General Procedure for conducted measurements in restricted bands

- a) Measure the conducted output power (in dBm) using the detector specified (see guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
- b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see guidance on determining the applicable antenna gain)
- c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies \leq 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies $>$ 1000 MHz).
- d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
- e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

$$E = \text{EIRP} - 20\log D + 104.8$$

where:

E = electric field strength in dB μ V/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

- f) Compare the resultant electric field strength level to the applicable limit.
- g) Perform radiated spurious emission test.

Quasi-Peak measurement procedure

The specifications for measurements using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

Peak power measurement procedure

Peak emission levels are measured by setting the instrument as follows:

- a) RBW = as specified in Table 1.
- b) VBW \geq 3 x RBW.
- c) Detector = Peak.



d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Table 1—RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent), then the following procedure shall be used:

a) The EUT shall be configured to operate at the maximum achievable duty cycle.

b) Measure the duty cycle, x , of the transmitter output signal as described in section 6.0.

c) RBW = 1 MHz (unless otherwise specified).

d) VBW $\geq 3 \times$ RBW.

e) Detector = RMS, if $\text{span}/(\# \text{ of points in sweep}) \leq (\text{RBW}/2)$. Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.

f) Averaging type = power (i.e., RMS).

1) As an alternative, the detector and averaging type may be set for linear voltage averaging.

2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.

g) Sweep time = auto.

h) Perform a trace average of at least 100 traces.

i) A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is $10 \log(1/x)$, where x is the duty cycle.



2) If linear voltage averaging mode was used in step f), then the applicable correction factor is $20 \log(1/x)$, where x is the duty cycle.

3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

NOTE: Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.

Determining the applicable transmit antenna gain

A conducted power measurement will determine the maximum output power associated with a restricted band emission; however, in order to determine the associated EIRP level, the gain of the transmitting antenna (in dBi) must be added to the measured output power (in dBm).

Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.

See KDB 662911 for guidance on calculating the additional array gain term when determining the effective antenna gain for a EUT with multiple outputs occupying the same or overlapping frequency ranges in the same band.

Radiated spurious emission test

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.

The measurement frequency range is from 30 MHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360° , and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.



All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Test Result

Please refer to ANNEX A.6.





5.8 Band Edge(Restricted-band band-edge)

Limit

FCC §15.209&15.247(c); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B

Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

For transmitters operating above 1 GHz repeat the measurement with an average detector..

Test Result

Please refer to ANNEX A.7.



5.9 Power Spectral density(PSD)

Limit

FCC §15.247(d); RSS-247, 5.2 (2)

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.

Set the VBW $\geq 3 \text{ RBW}$.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Test Result

Please refer to ANNEX A.8.



Annex A TEST RESULT

A.1 Maximum conducted output power

Test Result:

Duty cycle:

TestMode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
GFSK/1M	Ant1	2402	0.12	0.63	0.1905
		2440	0.11	0.62	0.1774
		2480	0.12	0.63	0.1905

Maximum conducted output power (peak)

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
GFSK/1M	Ant1	2402	0.52	<=30	PASS
		2440	0.72	<=30	PASS
		2480	0.6	<=30	PASS



A.2 DTS Bandwidth and Occupied Channel Bandwidth

Test Result:

TestMode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
GFSK/1M	Ant1	2402	0.516	0.5	PASS
		2440	0.501	0.5	PASS
		2480	0.502	0.5	PASS

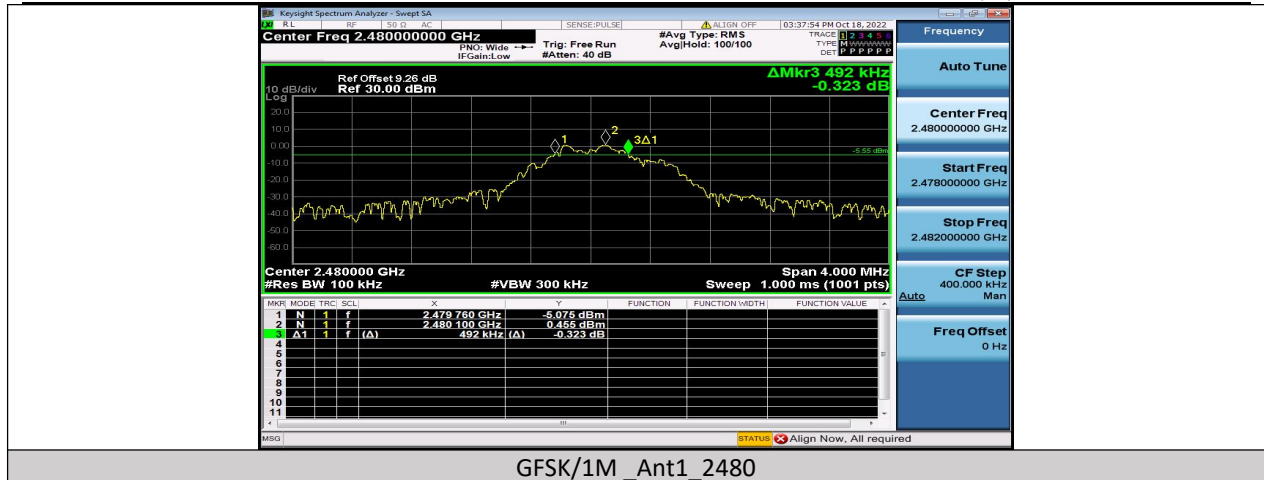
TestMode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
GFSK/1M	Ant1	2402	1.0451	---	PASS
		2440	1.0522	---	PASS
		2480	1.0516	---	PASS

Test Graphs(DTS Bandwidth)

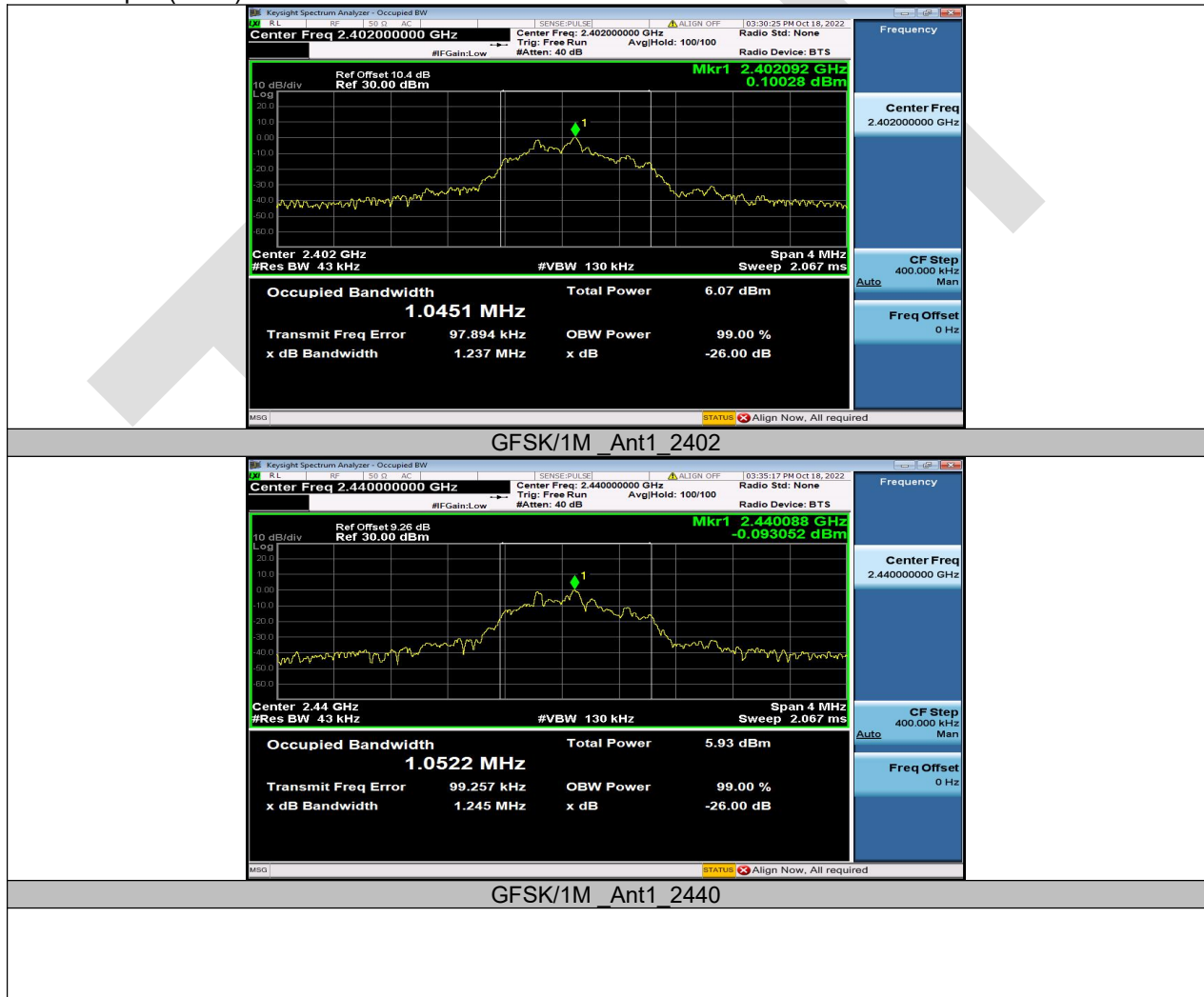




Test report No. RZBG(W)20221009001-1

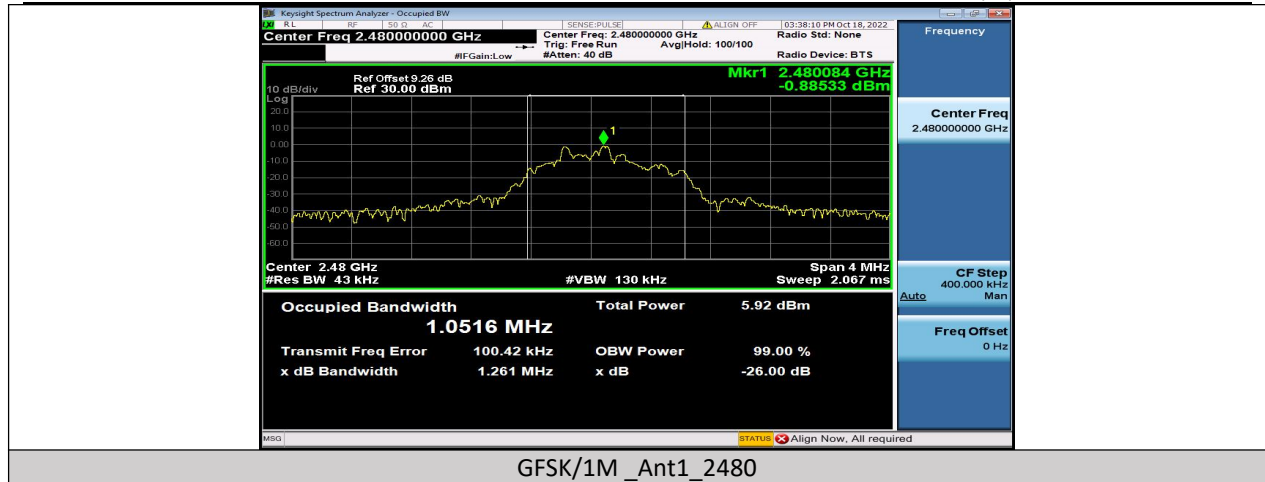


Test Graphs(OCB)





Test report No. RZBG(W)20221009001-1



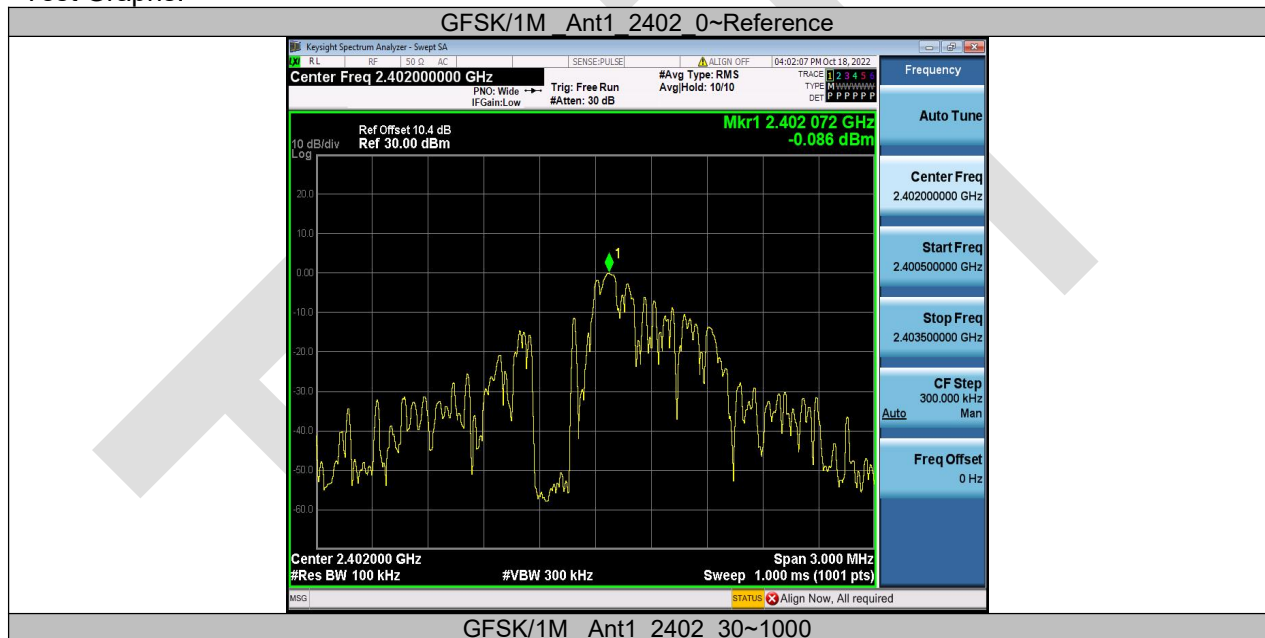


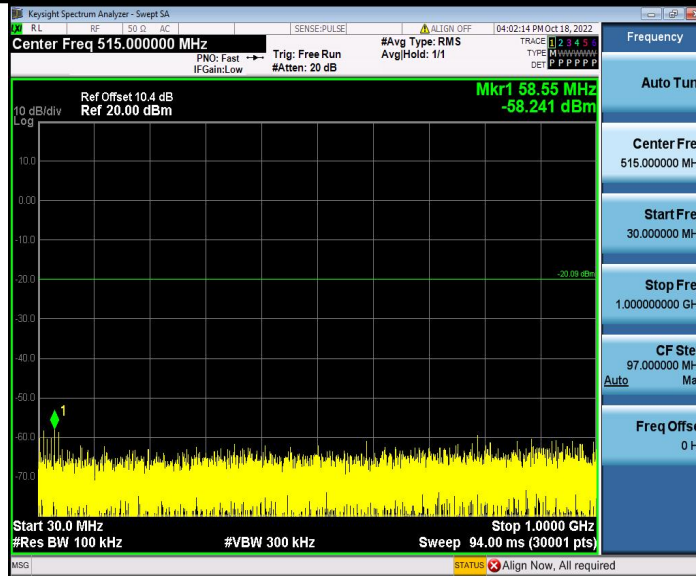
A.3 Conducted Spurious Emission

Test Result: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per was not reported.

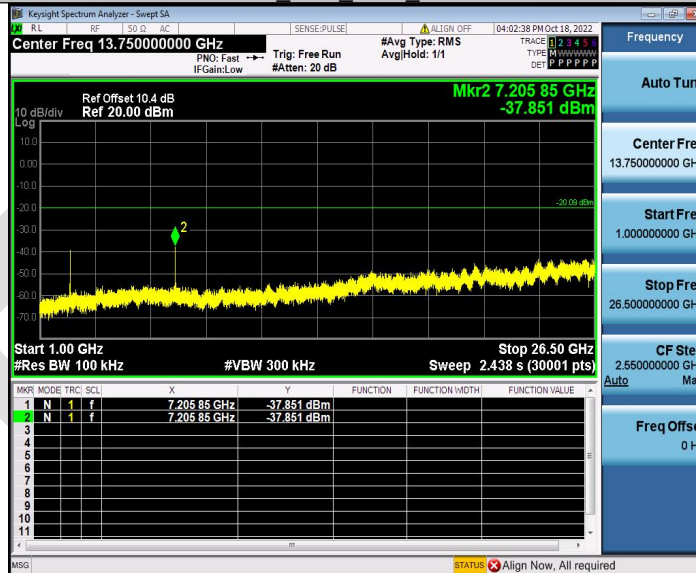
TestMode	Antenna	Channel	FreqRange [Mhz]	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
GFSK/1M	Ant1	2402	Reference	-0.09	-0.09	---	PASS
			30~1000	-0.09	-58.24	≤-20.09	PASS
			1000~26500	-0.09	-37.85	≤-20.09	PASS
		2440	Reference	-1.67	-1.67	---	PASS
			30~1000	-1.67	-58.59	≤-21.67	PASS
			1000~26500	-1.67	-43.77	≤-21.67	PASS
		2480	Reference	0.42	0.42	---	PASS
			30~1000	0.42	-59.44	≤-19.58	PASS
			1000~26500	0.42	-43.67	≤-19.58	PASS

Test Graphs:





GFSK/1M_Ant1 2402 1000~26500



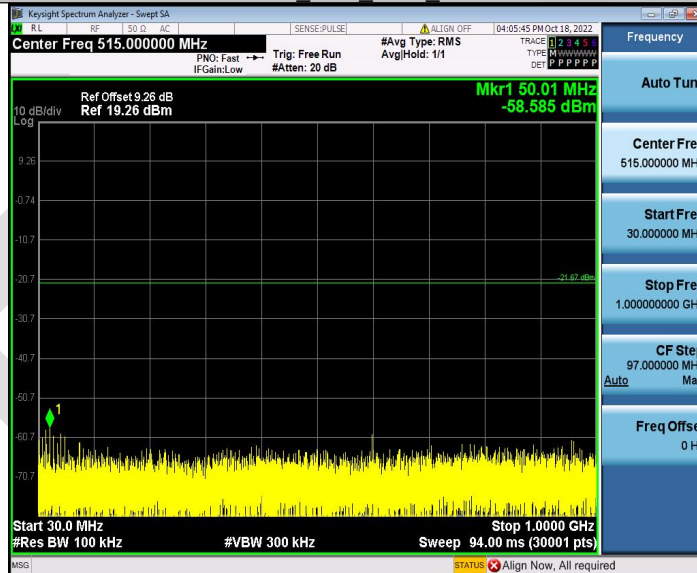
GFSK/1M_Ant1 2440 0~Reference



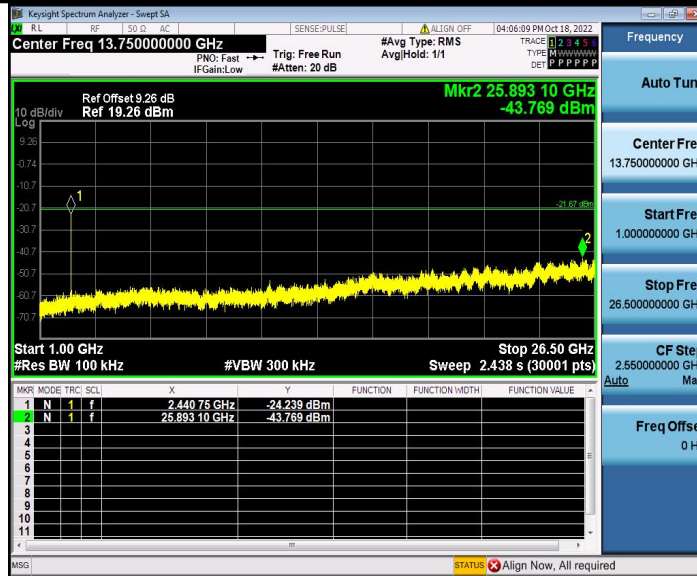
Test report No. RZBG(W)20221009001-1



GFSK/1M_Ant1_2440_30~1000



GFSK/1M_Ant1_2440_1000~26500



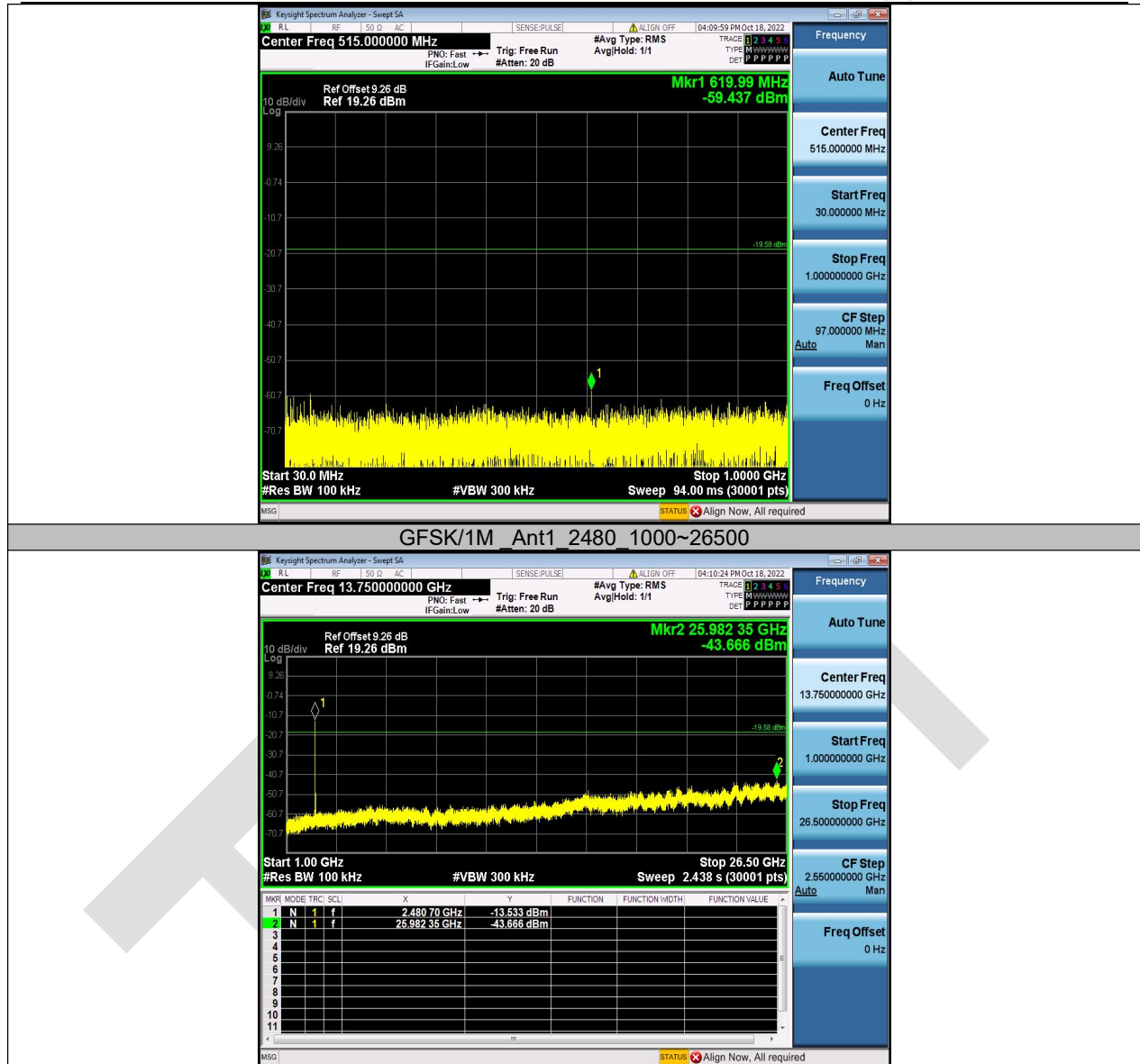
GFSK/1M_Ant1_2480_0~Reference



GFSK/1M_Ant1_2480_30~1000



Test report No. RZBG(W)20221009001-1





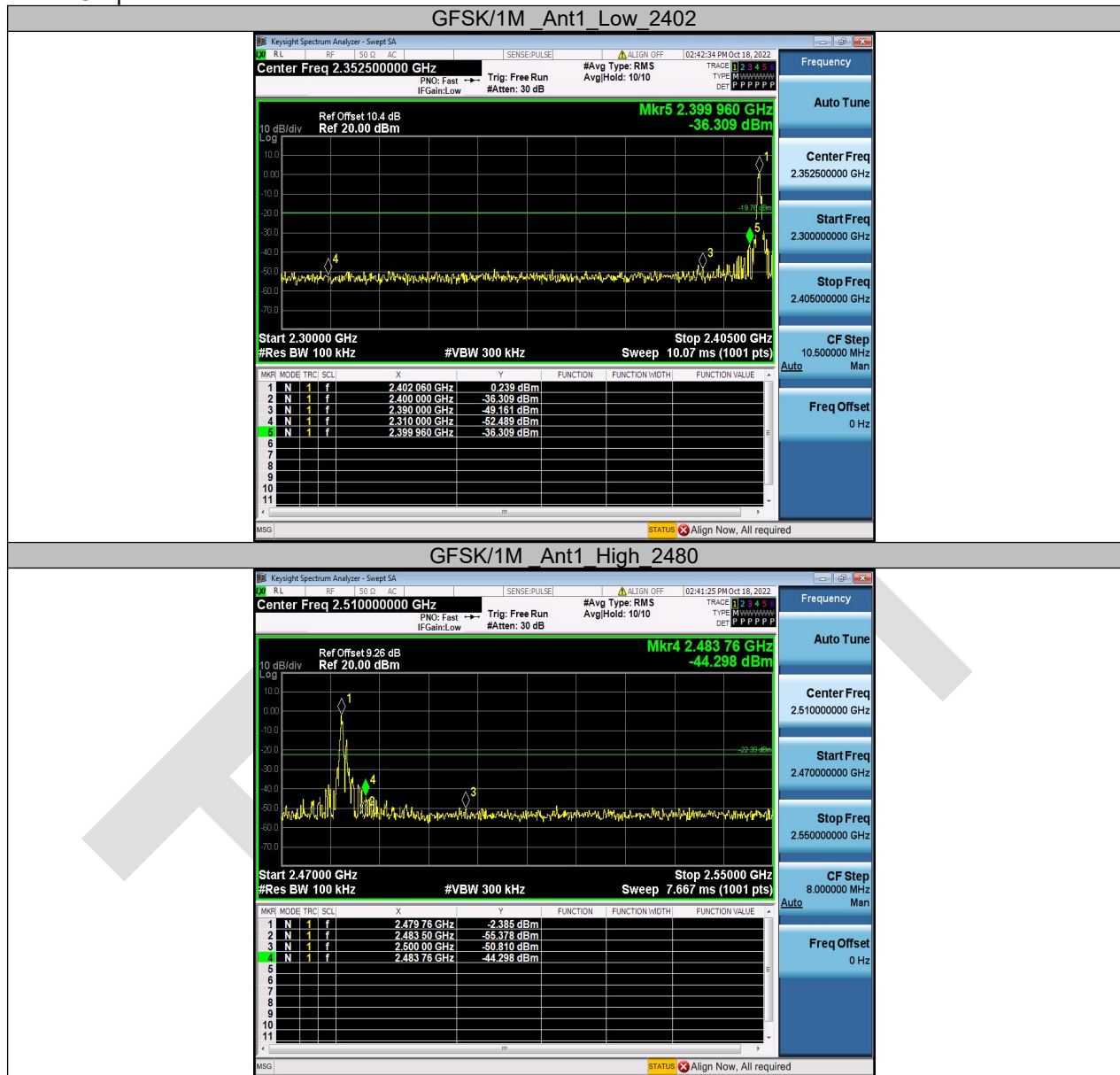
A.4 Band Edge (Authorize band-edge)

Test Result:

TestMode	Antenna	ChName	Channel	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
GFSK/1M	Ant1	Low	2402	0.24	-36.31	≤ -19.76	PASS
		High	2480	-2.39	-44.3	≤ -22.39	PASS



Test Graphs





A.5 AC Power Line Conducted Emission

Note 1: The EUT is battery powered.

Test Data and Plots: N/A





A.6 Radiated Emission

Note 1: The symbol of “--” in the table which means not application.

Note 2: For the test data above 1 GHz, According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

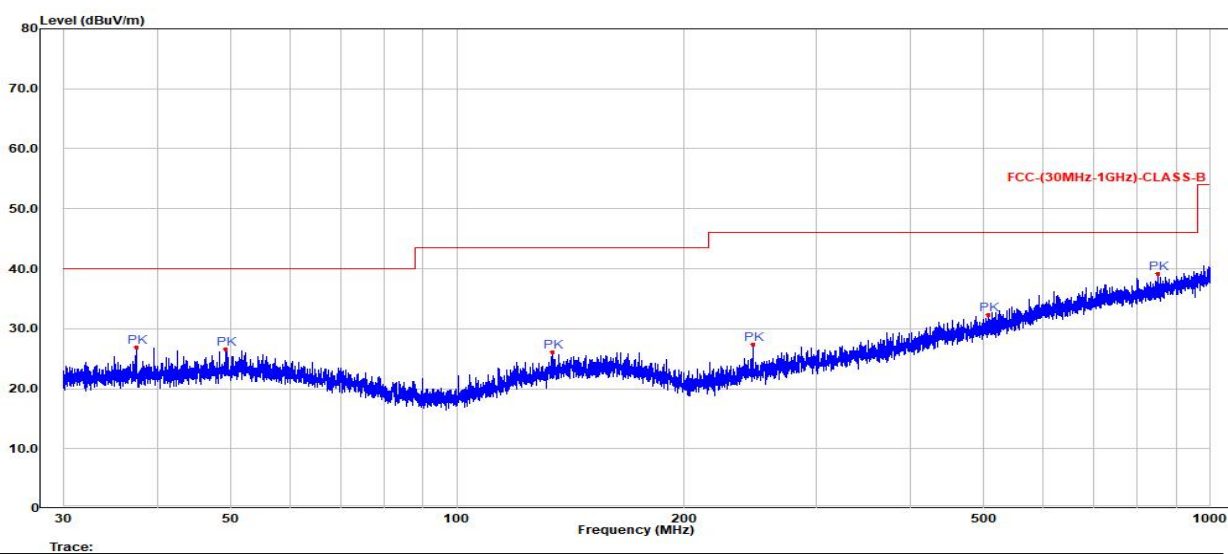
Note 3: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

Note 4: The EUT is working in the Normal link mode below 1 GHz.

Note 5: The emission in 18GHz-25GHz only show the worst test data, because of they are noisy.

Test Data and Plots:

30 MHz to 1 GHz, ANT H



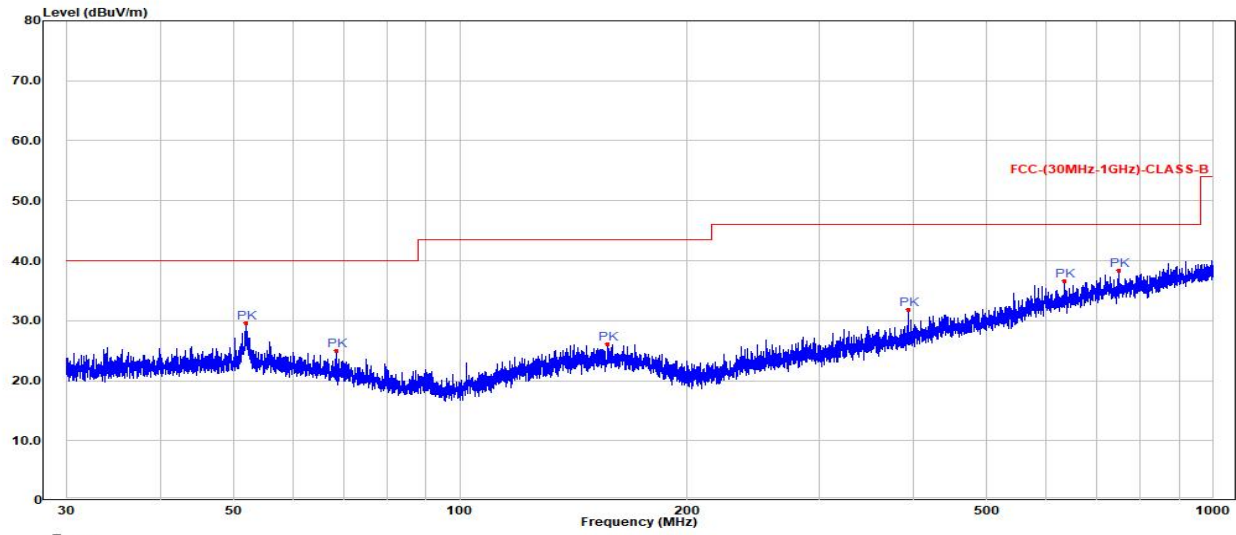
Final Data List

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarity
1	37.55	23.43	3.44	26.87	40.00	13.13	Peak	Horizontal
2	49.40	24.36	2.18	26.54	40.00	13.46	Peak	Horizontal
3	133.97	23.41	2.66	26.07	43.50	17.43	Peak	Horizontal
4	247.25	22.81	4.53	27.34	46.00	18.66	Peak	Horizontal
5	506.70	29.53	2.87	32.40	46.00	13.60	Peak	Horizontal
6	850.66	35.12	4.03	39.14	46.00	6.86	Peak	Horizontal



Test report No. RZBG(W)20221009001-1

30 MHz to 1 GHz, ANT V



Final Data List

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarity
1	52.09	24.23	5.48	29.70	40.00	10.30	Peak	Vertical
2	68.57	22.47	2.53	25.00	40.00	15.00	Peak	Vertical
3	157.21	24.38	1.80	26.18	43.50	17.32	Peak	Vertical
4	392.96	27.18	4.68	31.86	46.00	14.14	Peak	Vertical
5	634.74	32.47	4.13	36.60	46.00	9.40	Peak	Vertical
6	747.48	34.28	4.09	38.37	46.00	7.63	Peak	Vertical



above 1GHz(1GHz-18GHz):

1M,CH0,2402MHz, ANT H

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	7206.56	4.26	52.81	57.07	74.00	16.93	Peak
2	7206.56	4.26	48.88	53.14	54.00	0.86	Average
3	9610.65	8.38	43.31	51.69	74.00	22.31	Peak

1M,CH0,2402MHz, ANT V

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	4804.11	-4.19	47.01	42.82	74.00	31.18	Peak
2	7206.56	4.26	52.25	56.50	74.00	17.50	Peak
3	7206.56	4.26	48.68	52.94	54.00	1.06	Average

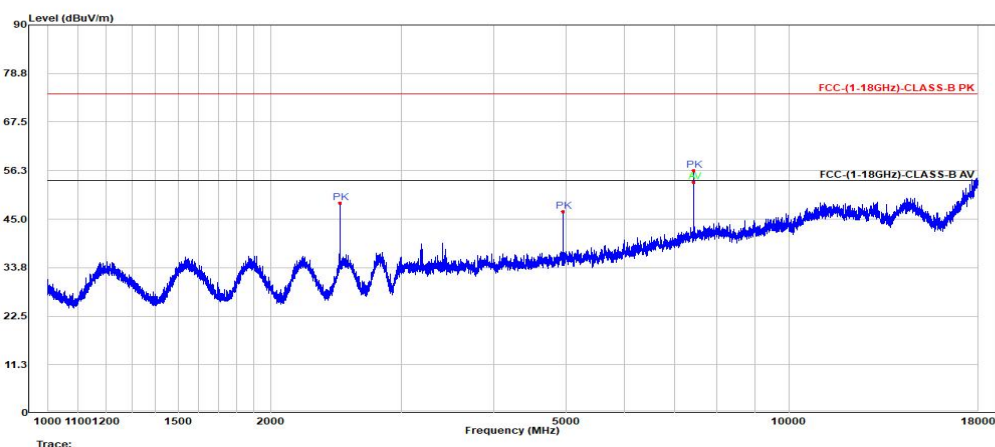
1M,CH39,2480MHz, ANT H

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	4959.31	-3.18	49.41	46.23	74.00	27.77	Peak
2	7439.36	5.31	51.90	57.21	74.00	16.79	Peak
3	7439.36	5.31	47.12	52.43	54.00	1.57	Average

1M,CH39,2480MHz, ANT V

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	4960.74	-3.17	49.97	46.80	74.00	27.20	Peak
2	7441.51	5.31	51.06	56.37	74.00	17.63	Peak
3	7441.51	5.31	48.24	53.55	54.00	0.45	Average

worst test data (CH39,2480MHz)





1M ,CH39,2480MHz, ANT H(18GHz-25GHz)

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	21850.290	-18.33	59.34	41.01	74.00	32.99	Peak
2	22956.970	-19.34	59.66	40.32	74.00	33.68	Peak

1M ,CH39,2480MHz, ANT V(18GHz-25GHz)

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	21826.234	-18.52	60.36	41.84	74.00	32.16	Peak
2	23485.332	-16.88	59.85	42.97	74.00	31.03	Peak



A.7 Band Edge (Restricted band-edge)

Test Result:

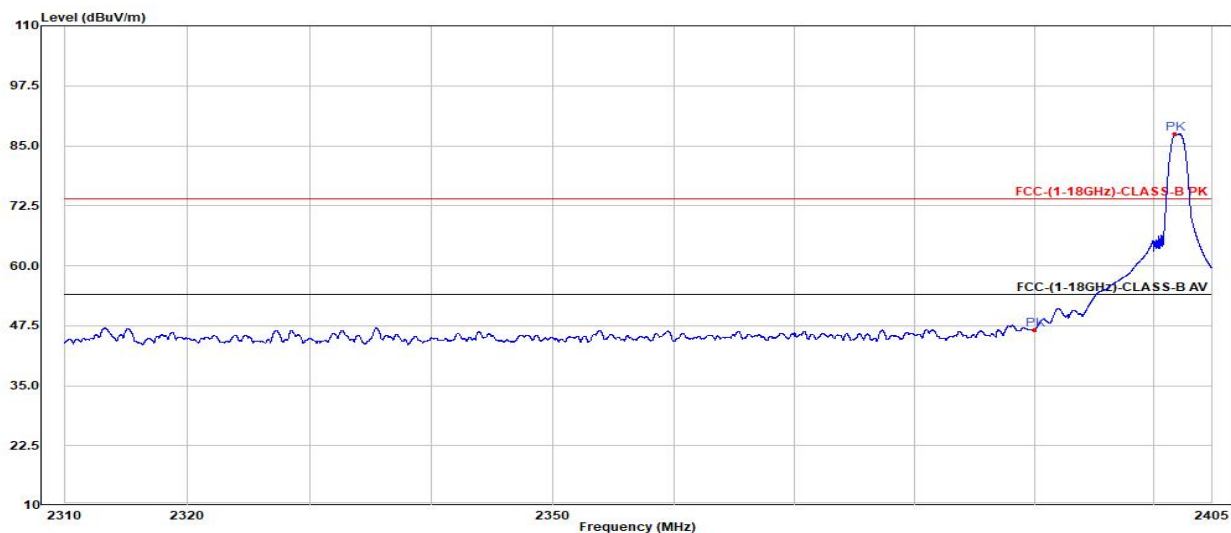
Note:

1. The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.
2. The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.
3. According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement



Test Graphs

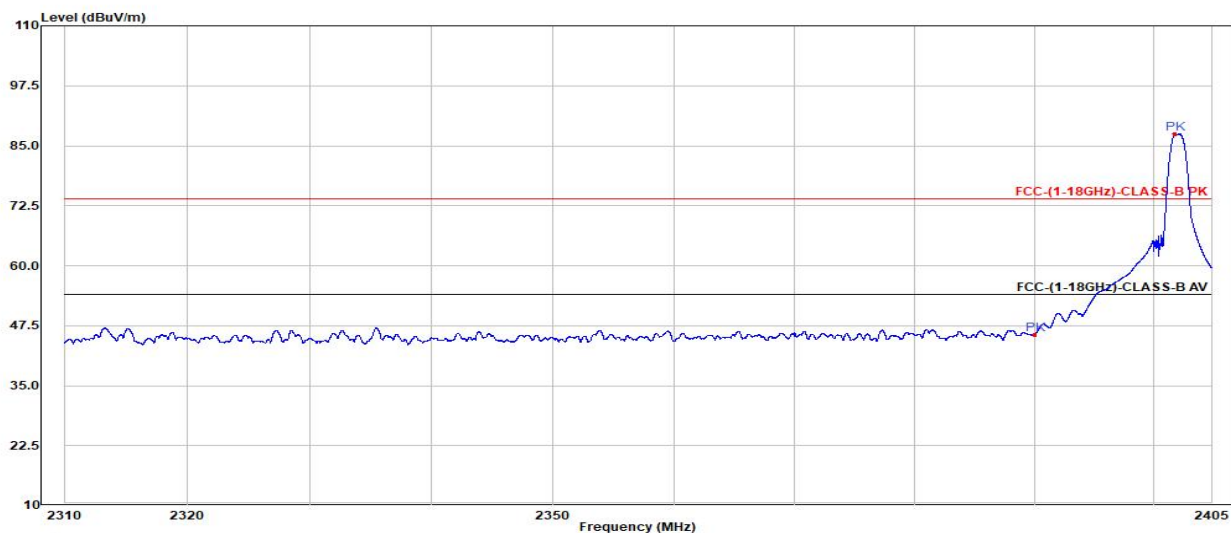
GFSK/1M_Ant1_Low_2402_H



Trace:

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	33.98	12.70	46.69	74.00	27.31	Peak
2	2401.85	34.00	53.50	87.50	74.00	N/A	Peak

GFSK/1M_Ant1_Low_2402_V

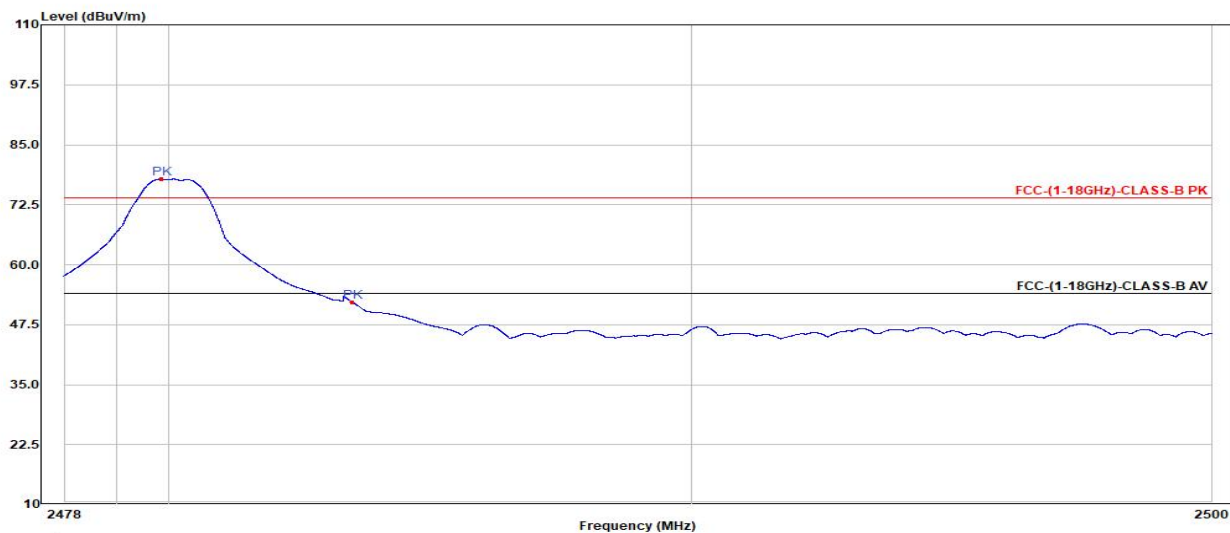


Trace:

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	33.98	11.70	45.69	74.00	28.31	Peak
2	2401.85	34.00	53.50	87.50	74.00	N/A	Peak



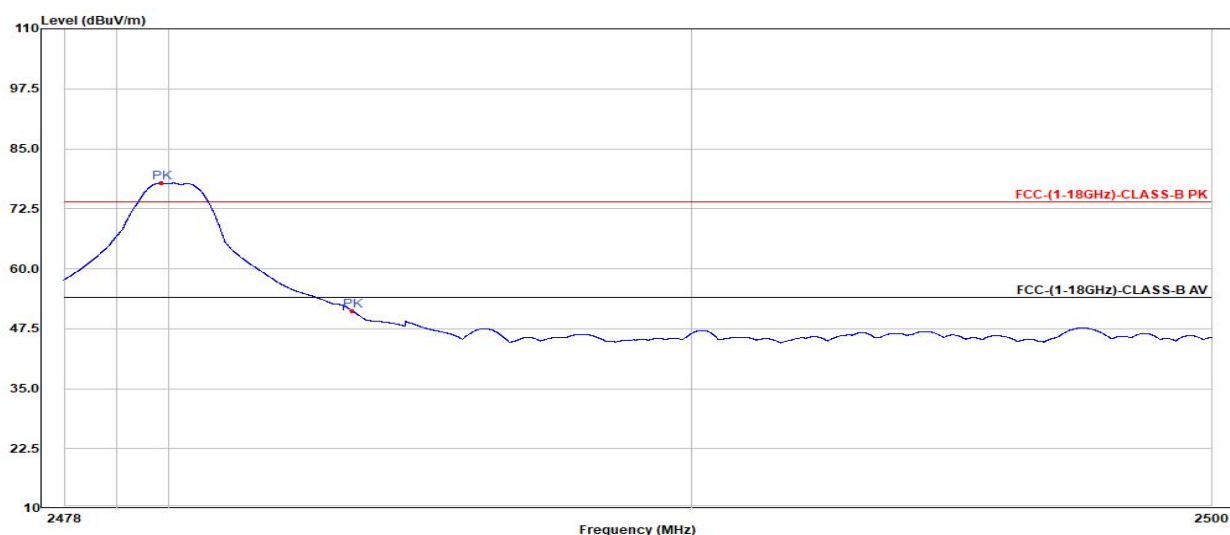
GFSK/1M_Ant1_High_2480_H



Trace:

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2479.85	34.24	43.62	77.86	74.00	N/A	Peak
2	2483.50	34.27	18.00	52.27	74.00	21.73	Peak

GFSK/1M_Ant1_High_2480_V



Trace:

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2479.85	34.24	43.62	77.86	74.00	N/A	Peak
2	2483.50	34.27	17.00	51.27	74.00	22.73	Peak



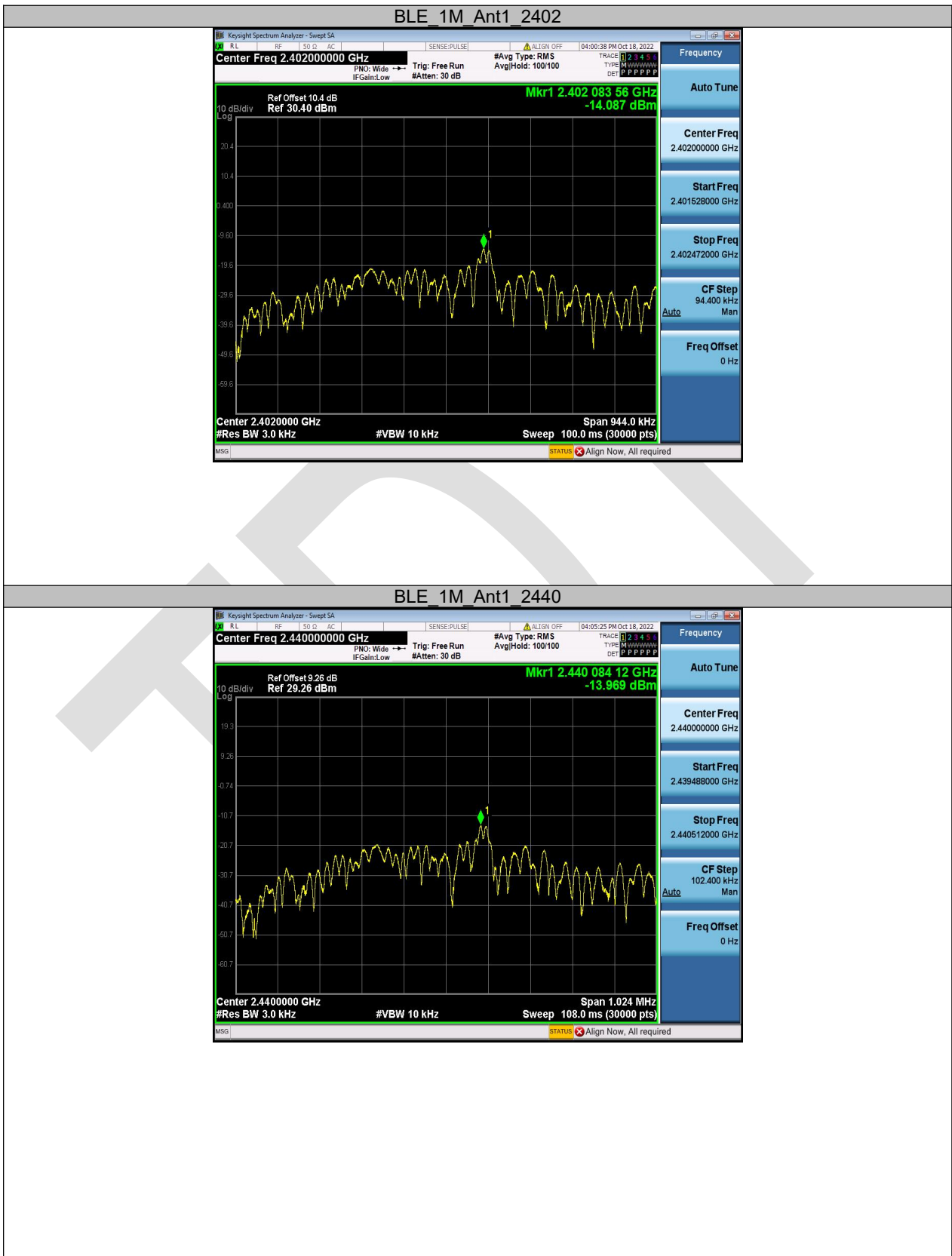
A.8 Power Spectral Density

Test Result:

TestMode	Antenna	Channel	Result[dBm/3-100kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-14.09	<=8	PASS
		2440	-13.97	<=8	PASS
		2480	-14.12	<=8	PASS



Test Graphs





Annex B Test Setup Photograph

Please refer the document “RZBG(W)20221009001-2 RF Test Setup Photos”pdf

Annex C EUT Internal Photograph

Please refer the document “RZBG(W) 20221009001-3 EUT Internal Photos”pdf

Annex D EUT External Photograph

Please refer the document “RZBG(W) 20221009001-4 EUT External Photos”pdf



Annex E Revision History

Version	Issue Date	Revisions Content
Rev.01	Oct.23.2022	Initial Issue

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