

TEST REPORT

Report No.: 22010114HKG-001

Musical Electronics Limited

Application For Certification
(Original Grant)

FCC ID: AUI-TBT02A

Transceiver

Prepared and Checked by:

Approved by:

Signed On File
Wong Cheuk Ho, Herbert
Lead Engineer

Wong Kwok Yeung, Kenneth
Assistant Supervisor
Date: January 18, 2022

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TEST REPORT

GENERAL INFORMATION

Grantee:	Musical Electronics Limited
Grantee Address:	Flat H, J, K, 12/F., World Tech Centre, 95 How Ming Street, Kwun Tong, Kowloon, Hong Kong.
Contact Person:	Richard Leung
Tel:	2372-1171
Fax:	2372-1171
e-mail:	Richardleung@musical.com.hk
Manufacturer:	Musical Electronics (Qing Yuan) Limited
Manufacturer Address:	Tai He Industrial Park, Qing Xin County, Qing Yuan City, Guangdong Province, China.
Brand Name:	circuit CUBES
Model:	21011-00000
Additional Model:	21021-00000, 21031-00000, 21041-00000, 11111-00000, 11131-00000
Type of EUT:	Transceiver
Description of EUT:	STEM Educational Toys
Serial Number:	N/A
FCC ID:	AUI-TBT02A
Date of Sample Submitted:	January 04, 2022
Date of Test:	January 04, 2022 to January 12, 2022
Report No.:	22010114HKG-001
Report Date:	January 18, 2022
Environmental Conditions:	Temperature: +10 to 40°C Humidity: 10 to 90%
Conclusion:	Test was conducted by client submitted sample. The submitted sample as received complied with the 47 CFR Part 15 Certification.

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SUMMARY OF TEST RESULT

Test Specification	Reference	Results
Radiated Emission	15.249, 15.209	Pass
Radiated Emission on the Bandedge		

The equipment under test is found to be complying with the following standards:
FCC Part 15, October 1, 2020 Edition

Note: 1. The EUT uses a permanently attached antenna which, in accordance to section 15.203, is considered sufficient to comply with the provisions of this section.
2. Pursuant to FCC part 15 Section 15.215(c), the 20 dB bandwidth of the emission was contained within the frequency band designated (mentioned as above) which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over excepted variations in temperature and supply voltage were considered.

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1.0 GENERAL DESCRIPTION

1.1 Product Description

The Equipment Under Test (EUT) is STEM Educational Toys. The EUT has Bluetooth BLE feature. It is powered by a 3.7V internal rechargeable battery.

The Models: 21021-00000, 21031-00000, 21041-00000, 11111-00000 and 11131-00000 are the same as the Model: 21011-00000 in hardware aspect as declared by client. The models are different in color, cosmetic details and model number only as declared by client.

Antenna Type: Internal, Integral

For electronic filing, the brief circuit description is saved with filename: descri.pdf.

1.2 Related Submittal(s) Grants

This is a single application for certification of a transceiver.

1.3 Test Methodology

Radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). All radiated measurements were performed in an 3m Chamber. Preliminary scans were performed in the 3m Chamber only to determine worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the **“Justification Section”** of this Application.

1.4 Test Facility

The 3m Chamber used to collect the radiated data is located at Workshop No. 3, G/F., World-Wide Industrial Centre, 43-47 Shan Mei Street, Fo Tan, Sha Tin, N.T., Hong Kong SAR, China. This test facility and site measurement data have been placed on file with the FCC.

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2.0 SYSTEM TEST CONFIGURATION

2.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.10 (2013).

The device was powered by 3.7VDC fully charged internal rechargeable battery.

For maximizing emissions, the EUT was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported in Exhibit 3.0.

The rear of unit shall be flushed with the rear of the table.

The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). The EUT was mounted to a plastic stand if necessary and placed on the wooden turntable, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

2.2 EUT Exercising Software

There was no special software to exercise the device. Once the unit is powered up, it transmits the RF signal continuously.

2.3 Special Accessories

There are no special accessories necessary for compliance of this product.

2.4 Measurement Uncertainty

Decision Rule for compliance: For FCC/IC standard, the measured value must be within the limits of applicable standard without accounting for the measurement uncertainty. For EN/IEC/HKTA/HKTC standard, conformity rules will be used as per standard directly excepted EN/IEC 61000-3-2, EN/IEC 61000-3-3, HKTA1004, HKCA1008, HKTA1019, HKTA1020, HKTA1041 and HKTA1044. For these excepted or not mentioned standards, Cl 4.2.2 of ILAC-G8:09/2019 decision rules will be reference and guard band will be equal to our measurement uncertainty with 95% confidence level ($k=2$). In case, the measured value is within guard band region, undetermined decision will be used.

Uncertainty and Compliance - Unless the standard specifically states that measured values are to be extended by the measurement uncertainty in determining compliance, all compliance determinations are based on the actual measured value.

2.5 Support Equipment List and Description

1. 3 x motor module
(Provided by Applicant)

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3.0 EMISSION RESULTS

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

3.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any), Average Factor (optional) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG - AV$$

where FS = Field Strength in dB μ V/m

RA = Receiver Amplitude (including preamplifier) in dB μ V

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

AV = Average Factor in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

$$FS = RR + LF$$

where FS = Field Strength in dB μ V/m

RR = RA - AG - AV in dB μ V

LF = CF + AF in dB

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB are added. The amplifier gain of 29 dB and average factor of 5 dB are subtracted, giving a field strength of 27 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$RA = 52.0 \text{ dB}\mu\text{V/m}$$

$$AF = 7.4 \text{ dB}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$AV = 5.0 \text{ dB}$$

$$FS = RR + LF$$

$$FS = 18 + 9 = 27 \text{ dB}\mu\text{V/m}$$

$$RR = 18.0 \text{ dB}\mu\text{V}$$

$$LF = 9.0 \text{ dB}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(27 \text{ dB}\mu\text{V/m})/20] = 22.4 \mu\text{V/m}$$

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3.2 Radiated Emission Configuration Photograph

The worst case in radiated emission was found at 7206.000 MHz

For electronic filing, the worst case radiated emission configuration photographs are saved with filename: radiated photos.pdf.

3.3 Radiated Emission Data

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Judgment: Passed by 0.4 dB

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RADIATED EMISSIONS

Model: 21011-00000

Date of Test: January 12, 2022

Worst-Case Operating Mode: Transmitting

Table 1
Pursuant to FCC Part 15 Section 15.249 Requirement

Lowest Channel

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - (Average) (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
V	2402.000	84.1	33	29.4	80.5	94.0	-13.5
V	4804.000	30.7	33	34.9	32.6	54.0	-21.4
V	7206.000	48.7	33	37.9	53.6	54.0	-0.4
H	9608.000	28.8	33	40.4	36.2	54.0	-17.8
H	12010.000	26.3	33	40.5	33.8	54.0	-20.2
V	14412.000	30.4	33	40.0	37.4	54.0	-16.6

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
V	2402.000	99.8	33	29.4	96.2	114.0	-17.8
V	4804.000	45.9	33	34.9	47.8	74.0	-26.2
V	7206.000	67.3	33	37.9	72.2	74.0	-1.8
H	9608.000	44.4	33	40.4	51.8	74.0	-22.2
H	12010.000	41.1	33	40.5	48.6	74.0	-25.4
V	14412.000	43.8	33	40.0	50.8	74.0	-23.2

- NOTES:
1. Peak Detector Data unless otherwise stated.
 2. Average detector is applied according to ANSI C63.10.
 3. All measurements were made at 3 meters.
 4. Negative sign in the column shows value below limit.
 5. Horn antenna is used for the emission over 1000MHz.
 6. Emission within the restricted band meets the requirement of FCC Part 15 Section 15.205.
 7. Measurement Uncertainty is ± 5.3 dB at a level of confidence of 95%.

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Model: 21011-00000

Date of Test: January 12, 2022

Worst-Case Operating Mode: Transmitting

Table 2
Pursuant to FCC Part 15 Section 15.249 Requirement

Middle Channel

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - (Average) (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
H	2440.000	84.0	33	29.4	80.4	94.0	-13.6
H	4880.000	28.9	33	34.9	30.8	54.0	-23.2
H	7320.000	45.9	33	37.9	50.8	54.0	-3.2
H	9760.000	29.2	33	40.4	36.6	54.0	-17.4
H	12200.000	26.9	33	40.5	34.4	54.0	-19.6
H	14640.000	32.4	33	38.4	37.8	54.0	-16.2

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
V	2440.000	99.4	33	29.4	95.8	114.0	-18.2
V	4880.000	43.7	33	34.9	45.6	74.0	-28.4
V	7320.000	63.9	33	37.9	68.8	74.0	-5.2
H	9760.000	44.4	33	40.4	51.8	74.0	-22.2
H	12200.000	40.1	33	40.5	47.6	74.0	-26.4
V	14640.000	46.4	33	38.4	51.8	74.0	-22.2

- NOTES:
1. Peak Detector Data unless otherwise stated.
 2. Average detector is applied according to ANSI C63.10.
 3. All measurements were made at 3 meters.
 4. Negative sign in the column shows value below limit.
 5. Horn antenna is used for the emission over 1000MHz.
 6. Emission within the restricted band meets the requirement of FCC Part 15 Section 15.205.
 7. Measurement Uncertainty is ± 5.3 dB at a level of confidence of 95%.

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Model: 21011-00000

Date of Test: January 12, 2022

Worst-Case Operating Mode: Transmitting

Table 3
Pursuant to FCC Part 15 Section 15.249 Requirement

Highest Channel

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - (Average) (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
V	2480.000	83.2	33	29.4	79.6	94.0	-14.4
V	4960.000	29.6	33	34.9	31.5	54.0	-22.5
V	7440.000	48.3	33	37.9	53.2	54.0	-0.8
H	9920.000	29.4	33	40.4	36.8	54.0	-17.2
H	12400.000	28.3	33	40.5	35.8	54.0	-18.2
V	14880.000	31.8	33	38.4	37.2	54.0	-16.8

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
V	2480.000	99.2	33	29.4	95.6	114.0	-18.4
V	4960.000	44.9	33	34.9	46.8	74.0	-27.2
V	7440.000	65.6	33	37.9	70.5	74.0	-3.5
H	9920.000	44.4	33	40.4	51.8	74.0	-22.2
H	12400.000	42.7	33	40.5	50.2	74.0	-23.8
V	14880.000	45.1	33	38.4	50.5	74.0	-23.5

- NOTES:
1. Peak Detector Data unless otherwise stated.
 2. Average detector is applied according to ANSI C63.10.
 3. All measurements were made at 3 meters.
 4. Negative sign in the column shows value below limit.
 5. Horn antenna is used for the emission over 1000MHz.
 6. Emission within the restricted band meets the requirement of FCC Part 15 Section 15.205.
 7. Measurement Uncertainty is ± 5.3 dB at a level of confidence of 95%.

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Model: 21011-00000

Date of Test: January 12, 2022

Worst-Case Operating Mode: Bluetooth Searching

Table 4
Pursuant to FCC Part 15 Section 15.209 Requirement

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-amp (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Limit at 3m (dBμV/m)	Margin (dB)
V	31.108	35.8	16	10.0	29.8	40.0	-10.2
V	112.752	21.8	16	14.0	19.8	43.5	-23.7
V	118.844	20.8	16	14.0	18.8	43.5	-24.7
V	131.032	37.5	16	14.0	35.5	43.5	-8.0
V	143.462	18.6	16	14.0	16.6	43.5	-26.9
V	150.288	20.2	16	14.0	18.2	43.5	-25.3
H	419.022	17.2	16	25.0	26.2	46.0	-19.8

- NOTES:
1. Quasi-Peak Detector Data unless otherwise stated.
 2. All measurements were made at 3 meters.
 3. Negative sign in the column shows value below limit.
 4. Horn antenna is used for the emission over 1000MHz.
 5. Emission within the restricted band meets the requirement of FCC Part 15 Section 15.205.
 6. Measurement Uncertainty is ± 5.3 dB at a level of confidence of 95%.

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4.0 EQUIPMENT PHOTOGRAPHS

For electronic filing, the photographs are saved with filename: external photos.pdf and internal photos.pdf.

5.0 PRODUCT LABELLING

For electronics filing, the FCC ID label artwork and the label location are saved with filename: label.pdf.

6.0 TECHNICAL SPECIFICATIONS

For electronic filing, the block diagram and schematic of the tested EUT are saved with filename: block.pdf and circuit.pdf respectively.

7.0 INSTRUCTION MANUAL

For electronic filing, a preliminary copy of the Instruction Manual is saved with filename: manual.pdf.

This manual will be provided to the end-user with each unit sold/leased in the United States.

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8.0 MISCELLANEOUS INFORMATION

The miscellaneous information includes details of the test procedure and measured.

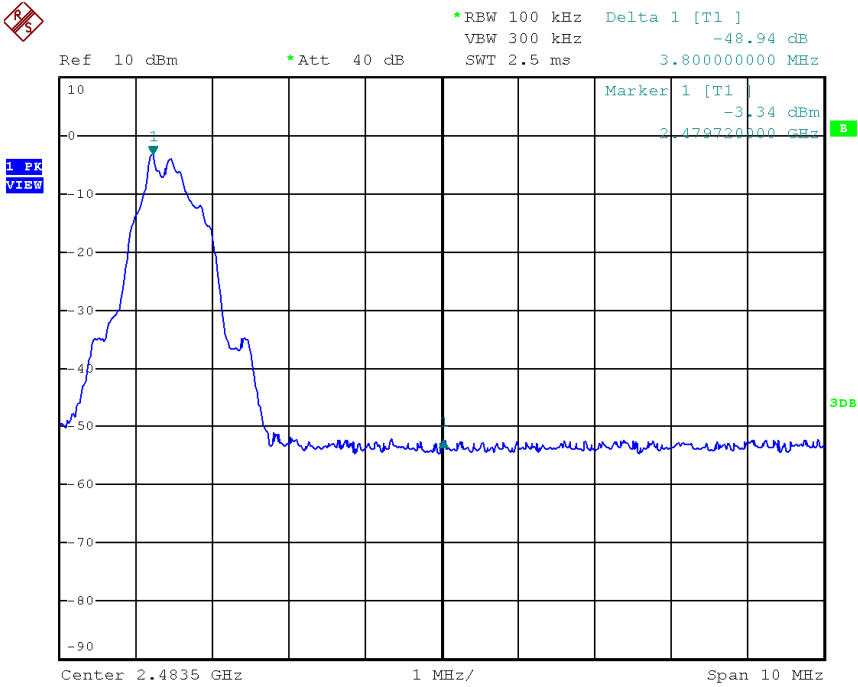
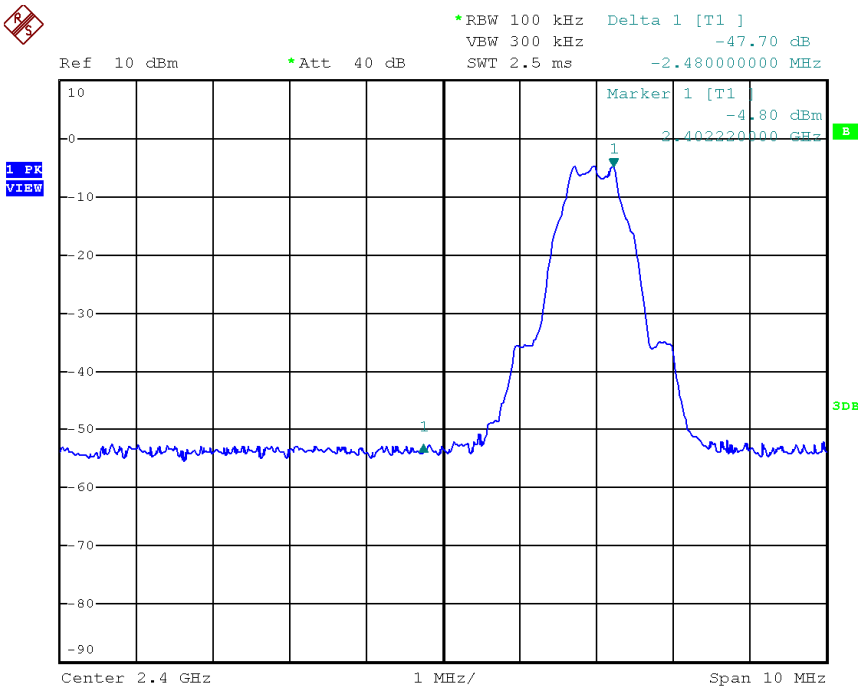
8.1 Radiated Emission on the Bandedge

From the following plots, they show that the fundamental emissions are confined in the specified band (2400MHz to 2483.5MHz). In case of the fundamental emissions are within two standard bandwidths from the bandedge, the delta measurement technique is used for determining bandedge compliance. Standard bandwidth is the bandwidth specified by ANSI C63.10 (2013) for frequency being measured.

Emissions radiated outside of the specified frequency bands, except harmonics, are attenuated by 50dB below the level of the fundamental or to the general radiated emissions limits in Section 15.209, whichever is the lesser attenuation, which meet the requirement of part 15.249(d).

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PEAK MEASUREMENT



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PEAK MEASUREMENT

Bandedge compliance is determined by applying marker-delta method, i.e. (Bandedge Plot).

Lower bandedge

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the plot

=96.2 dB μ V/m - 47.7 dB

=48.5 dB μ V/m

Average Resultant field strength = Fundamental emissions (average value) – delta from the plot

=80.5 dB μ V/m - 47.7 dB

=32.8 dB μ V/m

Upper bandedge

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the plot

=95.6 dB μ V/m - 48.9 dB

=46.7 dB μ V/m

Average Resultant field strength = Fundamental emissions (average value) – delta from the plot

=79.6 dB μ V/m - 48.9 dB

=30.7 dB μ V/m

The resultant field strength meets the general radiated emission limit in Section 15.209, which does not exceed 74 dB μ V/m (Peak Limit) and 54 dB μ V/m (Average Limit).

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8.2 Discussion of Pulse Desensitization

Pulse desensitivity is not applicable for this device. The effective period (T_{eff}) is approximately $625\mu s$ for a digital "1" bit which illustrated on technical specification, with a resolution bandwidth (3dB) of 1MHz, so the pulse desensitivity factor is 0dB.

8.3 Emissions Test Procedures

The following is a description of the test procedure used by Intertek Testing Services Hong Kong Ltd. in the measurements of transmitter operating under the Part 15, Subpart C rules.

The transmitting equipment under test (EUT) is placed on a wooden turntable which is four feet in diameter and approximately 0.8m in height above the ground plane for emission measurement at or below 1GHz and 1.5m in height above the ground plane for emission measurement above 1GHz. During the radiated emissions test, the turntable is rotated and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The EUT is adjusted through all three orthogonal axis to obtain maximum emission levels. The antenna height and polarization are also varied during the testing to search for maximum signal levels. The height of the antenna is varied from one to four meters.

Detector function for radiated emissions is in peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings. A detailed description for the calculation of the average factor can be found in Exhibit 8.3.

The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.

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8.3 Emissions Test Procedures (cont'd)

The EUT is warmed up for 15 minutes prior to the test.

AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new, fully charged battery is used.

Conducted measurements were made as described in ANSI C63.10 (2013).

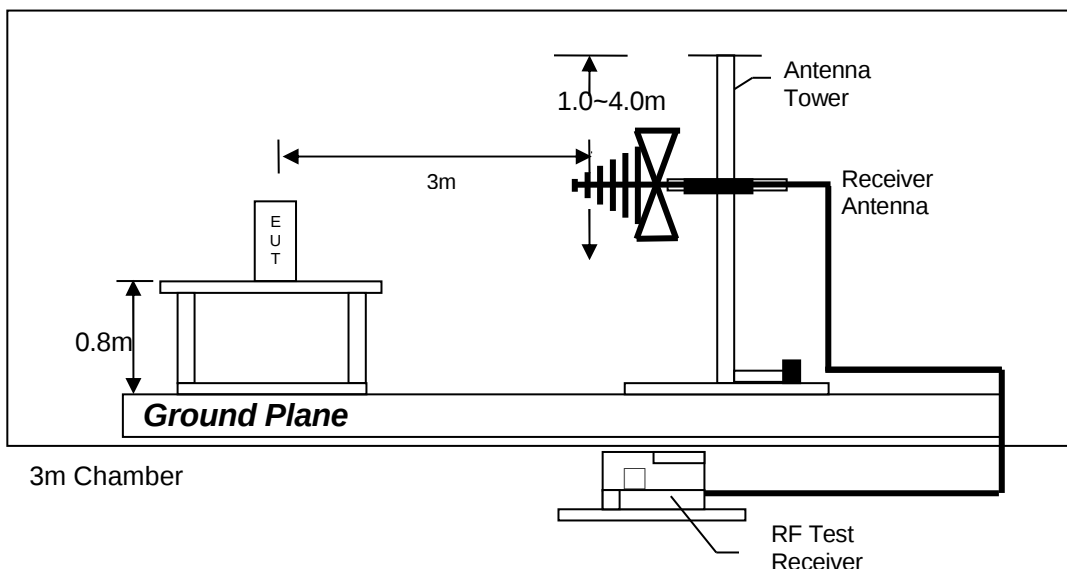
The IF bandwidth used for measurement of radiated signal strength was 100 kHz or greater when frequency is below 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application Note 150-2. A discussion of whether pulse desensitivity is applicable to this unit is included in this report (See Exhibit 8.1). Above 1000 MHz, a resolution bandwidth of 3 MHz is used.

Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the forbidden bands and above 1 GHz, signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, unless otherwise reported. Measurements taken at a closer distance are so marked.

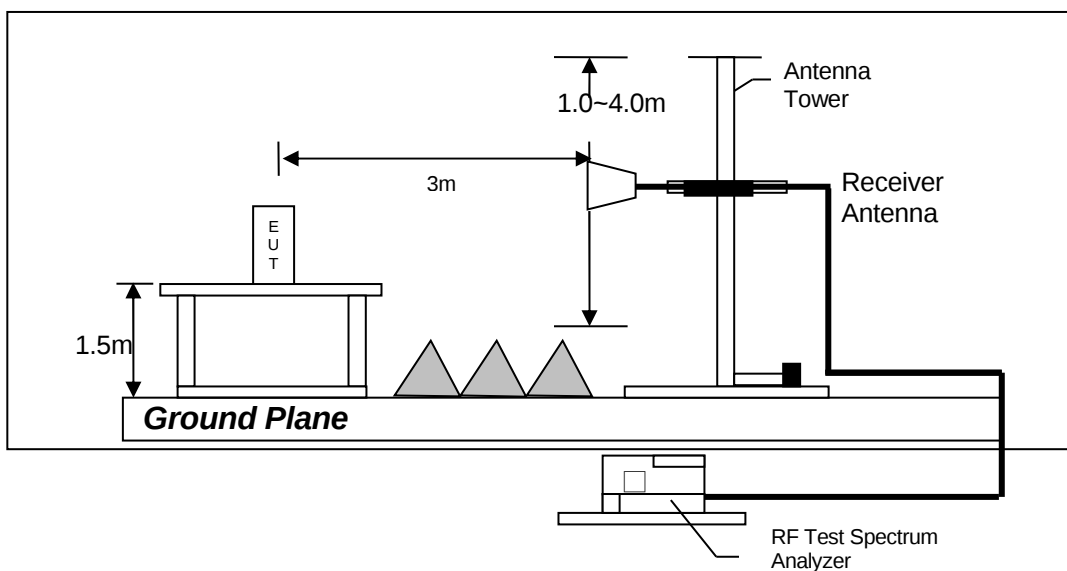
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8.3.1 Radiated Emission Test Setup

The figure below shows the test setup, which is utilized to make these measurements.



Test setup of radiated emissions up to 1GHz



Test setup of radiated emissions above 1GHz

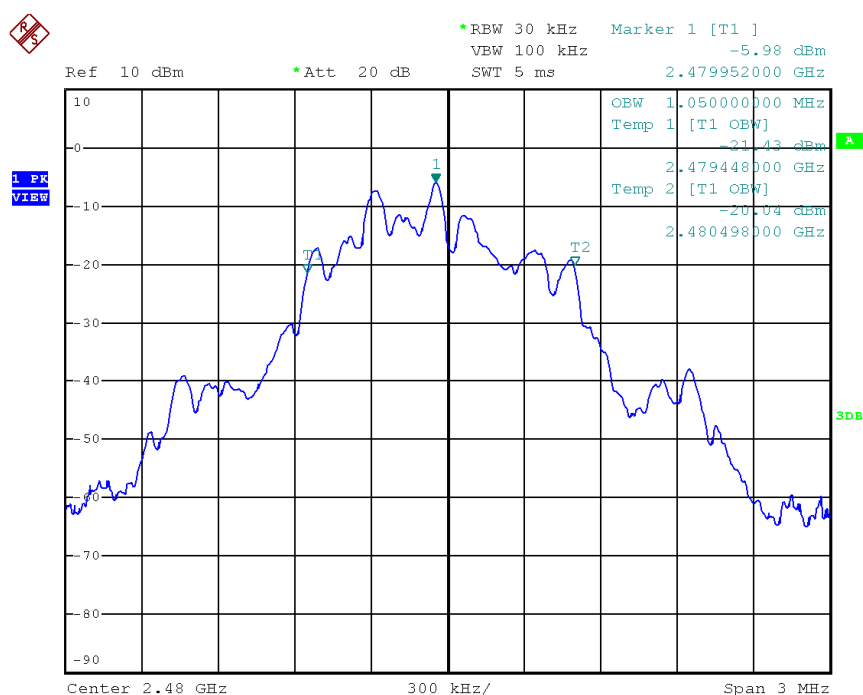
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8.4 Occupied Bandwidth

Occupied Bandwidth Results:

Occupied Bandwidth (kHz)	
Low Channel: 2402	1050
Middle Channel: 2440	1050
High Channel: 2480	1050

The worst case is shown as below



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9.0 EQUIPMENT LIST

1) Radiated Emissions Test

Equipment	EMI Test Receiver (9kHz to 26.5GHz)	Spectrum Analyzer	Biconical Antenna (20MHz to 200MHz)
Registration No.	EW-3156	EW-2466	EW-3061
Manufacturer	ROHDESCHWARZ	ROHDESCHWARZ	EMCO
Model No.	ESR26	FSP30	3142E
Calibration Date	January 25, 2021	November 18, 2019	February 02, 2021
Calibration Due Date	January 25, 2022	August 18, 2022	August 02, 2022

Equipment	Log Periodic Antenna	Double Ridged Guide Antenna	Active Loop H-field (9kHz to 30MHz)
Registration No.	EW-3243	EW-1133	EW-3302
Manufacturer	EMCO	EMCO	EMCO
Model No.	3148B	3115	6502
Calibration Date	June 30, 2021	June 03, 2021	December 13, 2021
Calibration Due Date	December 30, 2022	June 03, 2022	June 13, 2023

Equipment	RF Preamplifier (9kHz to 6000MHz)	2.4GHz Notch Filter	14m Double Shield RF Cable (20MHz to 6GHz)
Registration No.	EW-3006b	EW-3435	EW-2074
Manufacturer	SCHWARZBECK	MICROWAVE	RADIAL
Model No.	BBV9718	N0324413	N(m)-RG142-BNC(m) L=14M
Calibration Date	November 25, 2019	November 16, 2019	November 14, 2019
Calibration Due Date	June 25, 2022	June 16, 2022	August 14, 2022

Equipment	Pyramidal Horn Antenna
Registration No.	EW-0905
Manufacturer	EMCO
Model No.	3160-09
Calibration Date	July 23, 2019
Calibration Due Date	June 23, 2022

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2) Bandedge Measurement

Equipment	Spectrum Analyzer	5m RF Cable (40GHz)
Registration No.	EW-2466	EW-2701
Manufacturer	ROHDESCHWARZ	RADIALL
Model No.	FSP30	Sma m-m 5m 40G
Calibration Date	November 18, 2019	November 24, 2020
Calibration Due Date	August 18, 2022	February 24, 2022

END OF TEST REPORT