

3M Construction & Home Improvement Markets Division

TEST REPORT

SCOPE OF WORK

FCC TESTING—PRO-COMMS 90546-SIOC

REPORT NUMBER

201218092SZN-001

ISSUE DATE

January 27, 2021

[REVISED DATE]

[-----]

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3M Construction & Home Improvement Markets Division

Application
For
Certification

FCC ID: 2AFHL-COMMS**3M Pro-Comms Wireless Gel Electronic Hearing Protector****Model: Pro-Comms 90546-SIOC****Brand Name: 3M****2.4GHz Transceiver****Report No.: 201218092SZN-001**

We hereby certify that the sample of the above item is considered to comply with the requirements of FCC Part 15, Subpart C for Intentional Radiator, mention 47 CFR [10-1-19]

Prepared and Checked by:

Approved by:

Jeff Liang
Engineer

Kidd Yang
Technical Supervisor
Date: January 27, 2021

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Intertek Testing Services Shenzhen Ltd. Longhua Branch

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MEASUREMENT/TECHNICAL REPORT

This report concerns (check one:) Original Grant X Class II Change _____

Equipment Type: DXX - Part 15 Low Power Communication Device Transmitter

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes _____ No X

If yes, defer until: _____
date

Company Name agrees to notify the Commission by: _____
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes _____ No X

If no, assumed Part 15, Subpart C for intentional radiator – the new 47 CFR [10-1-19 Edition] provision.

Report prepared by:

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Table of Contents

1.0 Summary of Test Result	4
2.0 General Description	5
2.1 Product Description	5
2.3 Test Methodology	5
2.4 Test Facility	5
3.0 System Test Configuration	6
3.1 Justification	6
3.2 EUT Exercising Software	6
3.3 Special Accessories	6
3.4 Equipment Modification	6
3.5 Measurement Uncertainty	7
3.6 Support Equipment List and Description	7
4.0 Emission Results	8
4.1 Radiated Test Results	8
4.1.1 Field Strength Calculation	8
4.1.2 Radiated Emission Configuration Photograph	9
4.1.3 Radiated Emissions	9
4.1.4 Transmitter Spurious Emissions	12
5.0 Equipment Photographs	16
6.0 Product Labelling	16
7.0 Technical Specifications	16
8.0 Instruction Manual	16
9.0 Miscellaneous Information	17
9.1 Bandedge Plot	17
9.2 20dB Bandwidth	19
9.3 Discussion of Pulse Desensitization	20
9.4 Transmitter Duty Cycle Calculation, FCC Rule 15.35(b, c)	20
9.5 Emissions Test Procedures	21
10.0 Test Equipment List	23

1.0 Summary of Test Result

Applicant: 3M Construction & Home Improvement Markets Division

Applicant Address: 3M Center, Building 251-01-E-19, St.Paul, MN 55144-1000 U.S.A

MODEL: Pro-Comms 90546-SIOC

FCC ID: 2AFHL-COMMS

Test Specification	Reference	Results
Transmitter Radiated Emission Bandedge	15.249 &15.209 &15.205	Pass
20dB Bandwidth	15.215(c)	Pass

Notes: The EUT uses an Integral Antenna which in accordance to Section 15.203 is considered sufficient to comply with the provisions of this section.

2.0 General Description

2.1 Product Description

The equipment under test (EUT) is a 3M Pro-Comms Wireless Gel Electronic Hearing Protector with Bluetooth 5.0 (dual-mode) function operating in 2402-2480MHz. The Bluetooth transmitter will be disabled while the EUT connect to the Aux in cable. The EUT is powered by DC 3V from 1.5V*2 "AA" Batteries. For more detail information pls. refer to the user manual.

Antenna Type: Integral antenna

Modulation Type: GFSK

Antenna Gain: 0dBi Max

Bluetooth Version: 5.0 BLE

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

2.2 Related Submittal(s) Grants

This is an application for certification of a 3M Pro-Comms Wireless Gel Electronic Hearing Protector with Bluetooth BLE function. For the Bluetooth EDR function was tested and demonstrated in report 201218092SZN-002. Other Digital Functions are Subject to FCC Part 15B SDOC.

2.3 Test Methodology

Radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in Semi-anechoic chamber. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the 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. All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.4 Test Facility

The Semi-Anechoic chamber used to collect the radiated data is **Intertek Testing Services Shenzhen Ltd. Longhua Branch** and located at 101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community, GuanHu Subdistrict, LongHua District, ShenZhen, P.R. China. This test facility and site measurement data have been fully placed on file with the FCC (Registration Number: CN1188).

3.0 System Test Configuration

3.1 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 EUT was powered by DC 3V from 1.5V*2 "AA" Batteries during the test, only the worst data was reported in this report.

For maximizing emissions below 30 MHz, the EUT was rotated through 360°, the centre of the loop antenna was placed 1 meter above the ground, and the antenna polarization was changed. 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 Section 4.

The unit was operated standalone and placed at the center of turntable.

The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). The EUT was placed on a turn table, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

3.2 EUT Exercising Software

The EUT exercise program (provided by client) used during testing was designed to exercise the various system components in a manner similar to a typical use.

3.3 Special Accessories

No special accessories used.

3.4 Equipment Modification

Any modifications installed previous to testing by 3M Construction & Home Improvement Markets Division will be incorporated in each production model sold / leased in the United States.

No modifications were installed by Intertek Testing Services Shenzhen Ltd. Longhua Branch.

3.5 Measurement Uncertainty

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

3.6 Support Equipment List and Description

Description	Manufacturer	Remark
Mobile Phone (Provided by Intertek)	Samsung	SM-G9300

4.0 Emission Results

Data is included worst-case configuration (the configuration which resulted in the highest emission levels).

4.1 Radiated Test Results

A sample calculation, configuration photographs and data tables of the emissions are included.

4.1.1 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

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

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
- PD = Pulse Desensitization in dB
- AV = Average Factor in -dB

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

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

Assume a receiver reading of 62.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted. The pulse desensitization factor of the spectrum analyzer was 0 dB, and the resultant average factor was -10 dB. The net field strength for comparison to the appropriate emission limit is 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$\begin{aligned} RA &= 62.0 \text{ dB}\mu\text{V} \\ AF &= 7.4 \text{ dB} \\ CF &= 1.6 \text{ dB} \\ AG &= 29.0 \text{ dB} \\ PD &= 0 \text{ dB} \\ AV &= -10 \text{ dB} \\ FS &= 62 + 7.4 + 1.6 - 29 + 0 = 42 \text{ dB}\mu\text{V/m} \end{aligned}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(42 \text{ dB}\mu\text{V/m})/20] = 125.9 \mu\text{V/m}$$

4.1.2 Radiated Emission Configuration Photograph

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

4.1.3 Radiated Emissions

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.

Worst Case Radiated Emission
at
608.023000 MHz

Judgement: Passed by 12.5 dB

TEST PERSONNEL:

Sign on file

Jeff Liang, Engineer
Typed/Printed Name

15 January 2021
Date

Applicant: 3M Construction & Home Improvement Markets Division

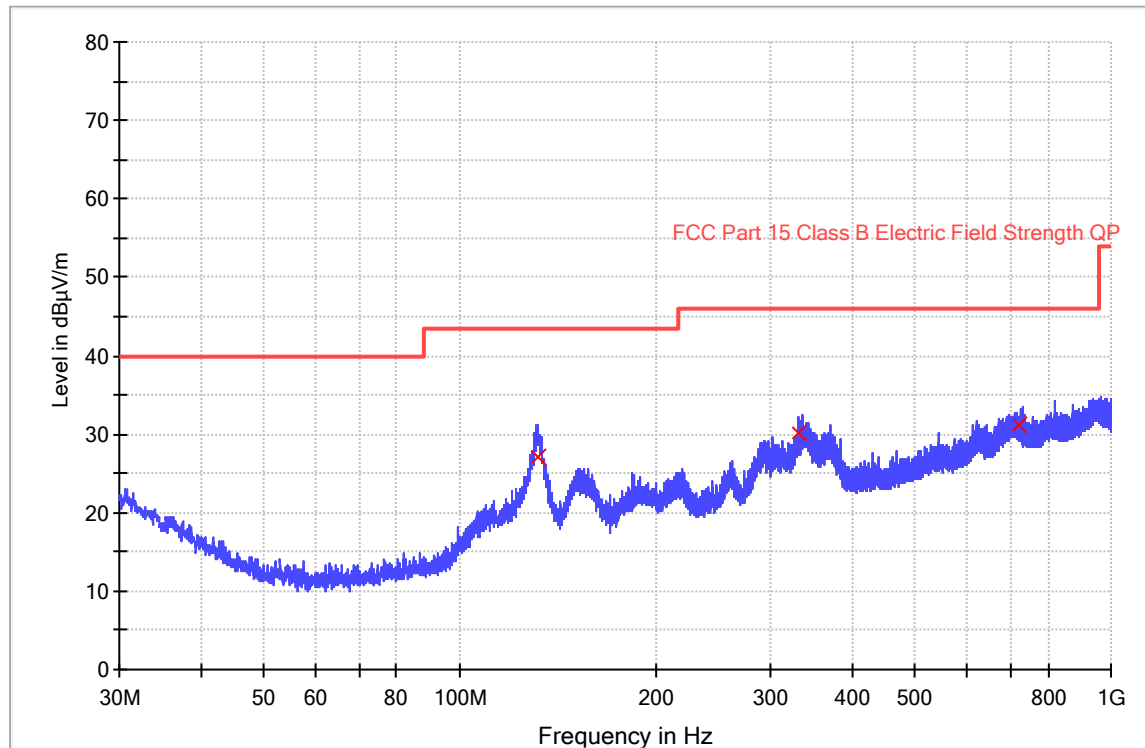
Date of Test: 15 January 2021

Model: Pro-Comms 90546-SIOC

Worst Case Operating Mode:

BT Link

ANT Polarity: Horizontal



Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV/m)
131.623667	27.1	1000.0	120.000	0.0	H	9.7	16.4	43.5
332.219667	30.2	1000.0	120.000	0.0	H	16.9	15.8	46.0
720.478333	31.1	1000.0	120.000	0.0	H	25.4	14.9	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBμV/m) = Corr. (dB/m) + Read Level (dBμV)
3. Margin (dB) = Limit Line (dBμV/m) – Level (dBμV/m)

Applicant: 3M Construction & Home Improvement Markets Division

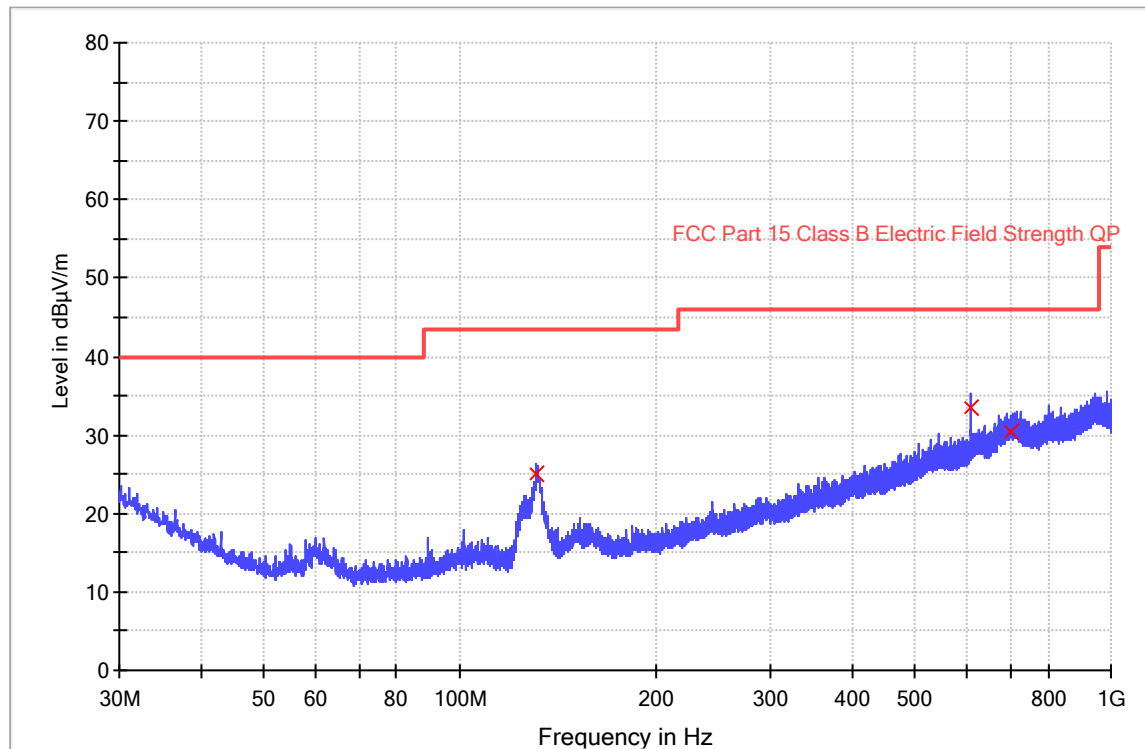
Date of Test: 15 January 2021

Model: Pro-Comms 90546-SIOC

Worst Case Operating Mode:

BT Link

ANT Polarity: Vertical



Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV/m)
131.365000	25.1	1000.0	120.000	0.0	V	9.7	18.4	43.5
608.023000	33.5	1000.0	120.000	0.0	V	23.4	12.5	46.0
702.695000	30.5	1000.0	120.000	0.0	V	25.9	15.5	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBμV/m) = Corr. (dB/m) + Read Level (dBμV)
3. Margin (dB) = Limit Line (dBμV/m) – Level (dBμV/m)

4.1.4 Transmitter Spurious Emissions (Radiated)

Worst Case Radiated Emission
at
2480.000 MHz

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

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.

Judgement: Passed by 6.9 dB

TEST PERSONNEL:

Sign on file

Jeff Liang, Engineer
Typed/Printed Name

15 January 2021
Date

Applicant: 3M Construction & Home Improvement Markets Division

Date of Test: 15 January 2021

Model: Pro-Comms 90546-SIOC

Worst Case Operating Mode:

Transmitting

Table 1

Radiated Emissions

(2402MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2402.000	108.3	36.7	28.1	99.7	114.0	-14.3
Horizontal	4804.000	43.9	36.7	35.5	42.7	74.0	-31.3
Horizontal	7206.000	45.8	36.1	36.5	46.2	74.0	-27.8

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2402.000	89.7	36.7	28.1	81.1	94.0	-12.9
Horizontal	4804.000	34.3	36.7	35.5	33.1	54.0	-20.9
Horizontal	7206.000	41.0	36.1	36.5	41.4	54.0	-12.6

Notes: 1. Peak detector is used for the emission measurement (RBW=1MHz / VBW=3MHz for Peak value, and RBW=1MHz / VBW=10Hz for Average value; RBW=3MHz is used for fundamental emission measurement).

2. All measurements were made at 3 meters. Harmonic emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other harmonic emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna is used for the emission over 1000MHz.

Test Engineer: Jeff Liang

Applicant: 3M Construction & Home Improvement Markets Division

Date of Test: 15 January 2021

Model: Pro-Comms 90546-SIOC

Worst Case Operating Mode:

Transmitting

Table 2

Radiated Emissions

(2440MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2440.000	107.1	36.7	28.1	98.5	114.0	-15.5
Horizontal	4880.000	44.6	36.7	35.5	43.4	74.0	-30.6
Horizontal	7320.000	46.4	36.1	37.2	47.5	74.0	-26.5

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2440.000	91.4	36.7	28.1	82.8	94.0	-11.2
Horizontal	4880.000	36.0	36.7	35.5	34.8	54.0	-19.2
Horizontal	7320.000	41.6	36.1	37.2	42.7	54.0	-11.3

Notes: 1. Peak detector is used for the emission measurement (RBW=1MHz / VBW=3MHz for Peak value, and RBW=1MHz / VBW=10Hz for Average value; RBW=3MHz is used for fundamental emission measurement).

2. All measurements were made at 3 meters. Harmonic emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other harmonic emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna is used for the emission over 1000MHz.

Test Engineer: Jeff Liang

Applicant: 3M Construction & Home Improvement Markets Division

Date of Test: 15 January 2021

Model: Pro-Comms 90546-SIOC

Worst Case Operating Mode:

Transmitting

Table 3

Radiated Emissions

(2480MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2480.000	107.6	36.7	28.1	99.0	114.0	-15.0
Horizontal	4960.000	44.0	36.7	35.5	42.8	74.0	-31.2
Horizontal	7440.000	45.5	36.1	37.2	46.6	74.0	-27.4

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2480.000	95.7	36.7	28.1	87.1	94.0	-6.9
Horizontal	4960.000	35.5	36.7	35.5	34.3	54.0	-19.7
Horizontal	7440.000	40.4	36.1	37.2	41.5	54.0	-12.5

Notes: 1. Peak detector is used for the emission measurement (RBW=1MHz / VBW=3MHz for Peak value, and RBW=1MHz / VBW=10Hz for Average value; RBW=3MHz is used for fundamental emission measurement).

2. All measurements were made at 3 meters. Harmonic emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other harmonic emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna is used for the emission over 1000MHz.

Test Engineer: Jeff Liang

5.0 Equipment Photographs

For electronic filing, the photographs of the tested EUT are saved with filename: external photos.pdf & internal photos.pdf.

6.0 Product Labelling

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

7.0 Technical Specifications

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

8.0 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.

9.0 Miscellaneous Information

This miscellaneous information includes details of the measured bandedge, 20dB Bandwidth, the test procedure and calculation of factor such as pulse desensitization.

9.1 Bandedge Plot

The test plots are attached as below. From the below plots, the field strength of any emissions outside of the specified frequency band are attenuated to the general radiated emission limits in section 15.209. It fulfils the requirement of 15.249(d).

Peak Measurement

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

(i) Lowest frequency channel (2402MHz):

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

$$\begin{aligned} &= 99.7 \text{ dB}\mu\text{V/m} - 48.77 \text{ dB} \\ &= 50.93 \text{ dB}\mu\text{V/m} \end{aligned}$$

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

$$\begin{aligned} &= 81.1 \text{ dB}\mu\text{V/m} - 48.77 \text{ dB} \\ &= 32.33 \text{ dB}\mu\text{V/m} \end{aligned}$$

(ii) Highest frequency channel (2480MHz):

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

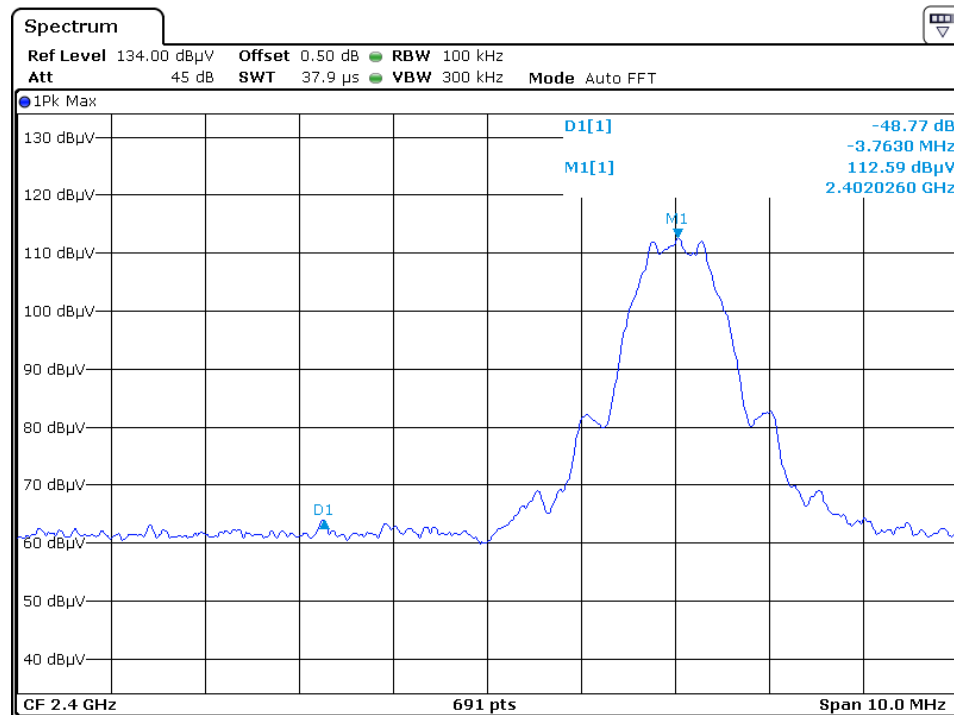
$$\begin{aligned} &= 99.0 \text{ dB}\mu\text{V/m} - 49.29 \text{ dB} \\ &= 49.71 \text{ dB}\mu\text{V/m} \end{aligned}$$

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

$$\begin{aligned} &= 87.1 \text{ dB}\mu\text{V/m} - 49.29 \text{ dB} \\ &= 37.81 \text{ dB}\mu\text{V/m} \end{aligned}$$

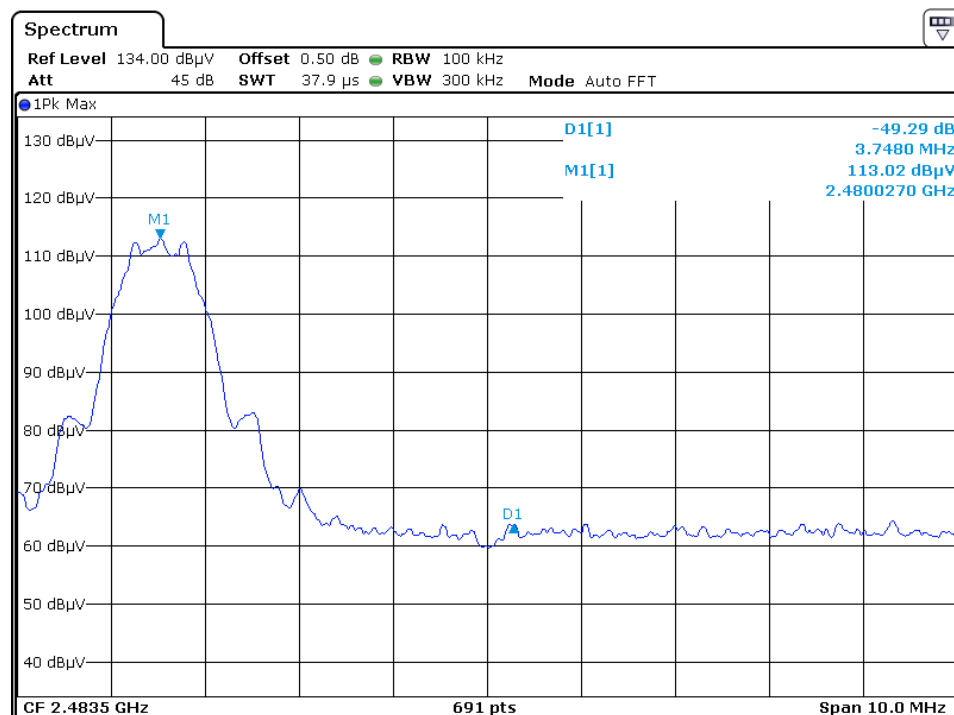
The resultant field strength meets the general radiated emission limit in section 15.209, which does not exceed 74dB μ V/m (Peak Limit) and 54dB μ V/m (Average Limit).

Lowest frequency Channel



Date: 8 JAN 2021 09:22:00

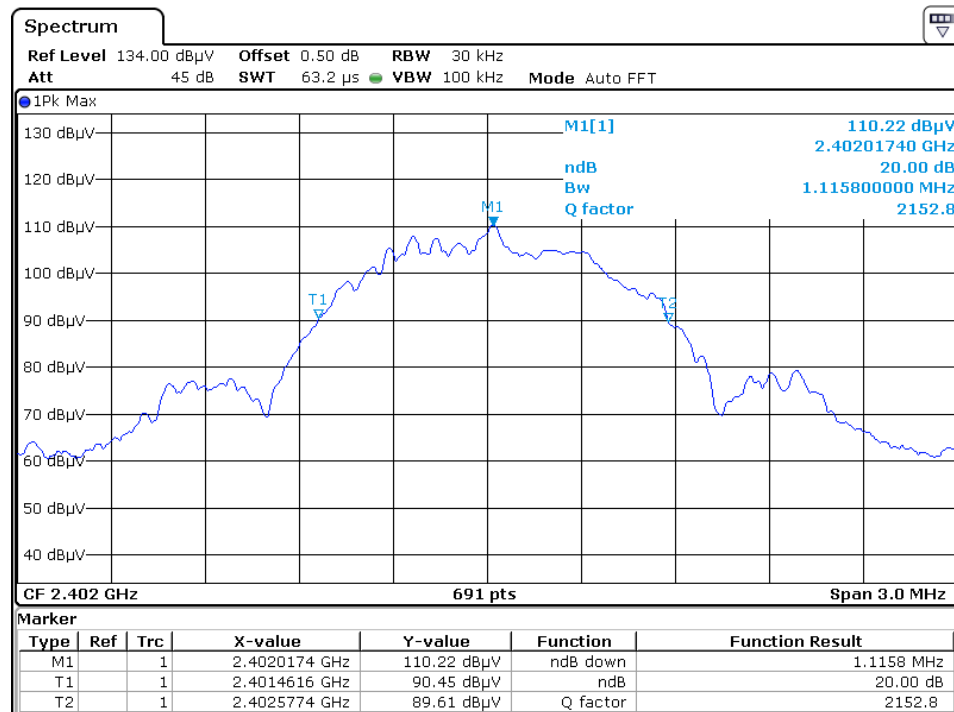
Highest frequency Channel



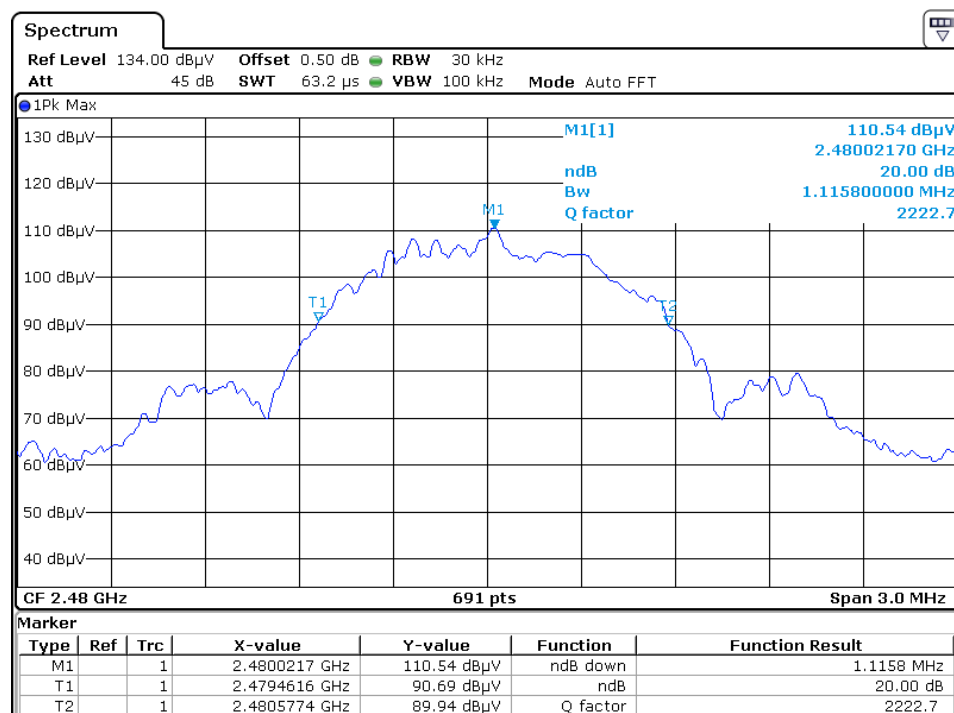
Date: 8 JAN 2021 09:23:40

9.2 20dB bandwidth

Pursuant to FCC part 15 Section 15.215(c), the 20dB 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. The test plots are reported as below.



Date: 8 JAN 2021 09:20:49



Date: 8 JAN 2021 09:24:10

9.3 Discussion of Pulse Desensitization

Pulse desensitivity is not applicable for this device since the transmitter transmits the RF signal continuously.

9.4 Transmitter Duty Cycle Calculation, FCC Rule 15.35(b, c)

The EUT antenna output port was connected to the input of the spectrum analyzer. The analyzer center frequency was set to EUT RF channel carrier. The SWEP function on the analyzer was set to ZERO SPAN. The Transmitter ON time was determined from the resultant time-amplitude display:

	See attached spectrum analyzer chart (s) for Transmitter timing
	See Transmitter timing diagram provided by manufacturer
x	Not applicable, duty cycle was not used.

9.5 Emissions Test Procedures

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

The test set-up and procedures described below are designed to meet the requirements of ANSI C63.10 - 2013.

The transmitting equipment under test (EUT) is placed on a styrene turntable which is four feet in diameter and approximately 0.8 meter up to 1GHz and 1.5 meter above 1GHz in height above the ground plane. 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 adjust through all three orthogonal axes to obtain maximum emission levels. The antenna height and polarization are varied during the testing to search for maximum signal levels.

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 section 9.4.

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.

9.5 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.

The IF bandwidth used for measurement of radiated signal strength was 10 kHz for emission below 30 MHz and 120 kHz for emission from 30 MHz to 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. Above 1000 MHz, a resolution bandwidth of 1 MHz is used (RBW 3MHz used for fundamental emission).

Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the restricted 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, but those measurements taken at a closer distance are so marked.

10.0 Test Equipment List

Equipment No.	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
SZ061-03	Biconilog Antenna	ETS	3142C	00078828	24-May-2019	24-May-2021
SZ185-01	EMI Receiver	R&S	ESCI	100547	22-Dec-2020	22-Dec-2021
SZ061-08	Horn Antenna	ETS	3115	00092346	07-Sep-2019	07-Sep-2021
SZ061-06	Active Loop Antenna	Electro-Metrics	EM-6876	217	24-May-2019	24-May-2021
SZ056-03	Spectrum Analyzer	R&S	FSP 30	101148	27-May-2020	27-May-2021
SZ056-06	Signal Analyzer	R&S	FSV 40	101101	27-May-2020	27-May-2021
SZ181-04	Preamplifier	Agilent	8449B	3008A02474	27-May-2020	27-May-2021
SZ188-01	Anechoic Chamber	ETS	RFD-F/A-100	4102	15-Dec-2018	15-Dec-2021
SZ062-02	RF Cable	RADIAL	RG 213U	--	12-Dec-2020	12-Jun-2021
SZ062-05	RF Cable	RADIAL	0.04-26.5GHz	--	24-Aug-2020	24-Feb-2021
SZ062-12	RF Cable	RADIAL	0.04-26.5GHz	--	24-Aug-2020	24-Feb-2021
SZ067-04	Notch Filter	Micro-Tronics	BRM5070 2-02	--	27-May-2020	27-May-2021

***** End of Report*****