TEST REPORT

Report Number	:	64.790.19.30903.01	Date of Issue:	April 10, 2020

Model	:	EOX Remote 500, EOX Remote 500(40104)
Product Type	:	E-bike Remote
Applicant	:	ZEITBIKE LLC
Manufacturer	:	SIGMA-ELEKTRO GmbH
Address of applicant	:	298 Dalton Street, Ventura, California, United States , 93003 1539

Test Result	:	■ **Positive** ☐ **Negative**
Total pages including Appendices	:	37

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2 Details about the Test Laboratory

Details about the Test Laboratory
Test Site 1

Company name:	TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch Building 12&13, Zhiheng Wisdomland Business Park, Nantou Checkpoint Road 2, Nanshan District, Shenzhen City, 518052, P. R. China
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3 Description of the Equipment under Test

Product: E-bike Remote

Model no.: EOX Remote 500, EOX Remote 500(40104)

FCC ID:M5LR500

Battery type: 12VDC

Operating Frequency Range: 2402~2480MHz

No. of Operated Channel:40

Modulation: GFSK

Antenna Type: Ceramic Antenna

Antenna Gain: 5.54 dBi

Description of the EUT: EUT is an E-bike remote controller, Bluetooth 4.0 BLE technology was used for communicating.

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4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2019 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

All the test methods were according to KDB558074 D01 v05r02 and ANSI C63.10 (2013).

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5 Summary of Test Results

Technical Requirements				
FCC Part 15 Subpart C				
Test Condition		Pages	Test Result	Test Site
§15.207	Conducted emission AC power port	N/A	--	--
15.247(b)(1)	Conducted peak output power	11-12	Pass	Site 1
§15.247(a)(2)	6dB bandwidth and 99% occupied bandwidth	13-16	Pass	Site 1
§15.247(e)	Power spectral density	17-18	Pass	Site 1
§15.247(d)	Spurious RF conducted emissions	19-23	Pass	Site 1
§15.247(d	Band edge	24-25	Pass	Site 1
§15.247(d) & §15.209	Spurious radiated emissions for transmitter and receiver	26-35	Pass	Site 1
§15.203	Antenna requirement	See note 1	Pass	--

Note 1: The EUT uses a ceramic Antenna, which gain is 5.54dBi. According to §15.203, it is considered sufficiently to comply with the provisions of this section.
N/A means Not Applicable.

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6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID:M5LR500 complies with Section 15.207, 15.247 of the FCC Part 15, Subpart C.
EOX Remote 500 and EOX Remote 500(40104) are identical in critical components, only different in algorithm of communication data packet, which will not affect RF performance.
Tests have been applied on EOX Remote 500 only.
This report is for the BLE part.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

☐ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

☐ - **Does not** fulfill the general approval requirements.

Sample Received Date: March 10, 2020

Testing Start Date: March 16, 2020

Testing End Date: March 26, 2020

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Reviewed by:	Prepared by:	Test by:
Tony Liu	Samuel Zhang	Louise Liu
Project Reviewer	Project Handler	Test Engineer

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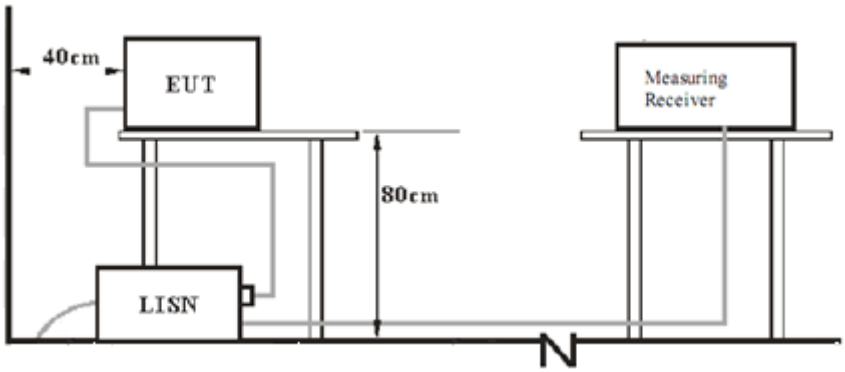
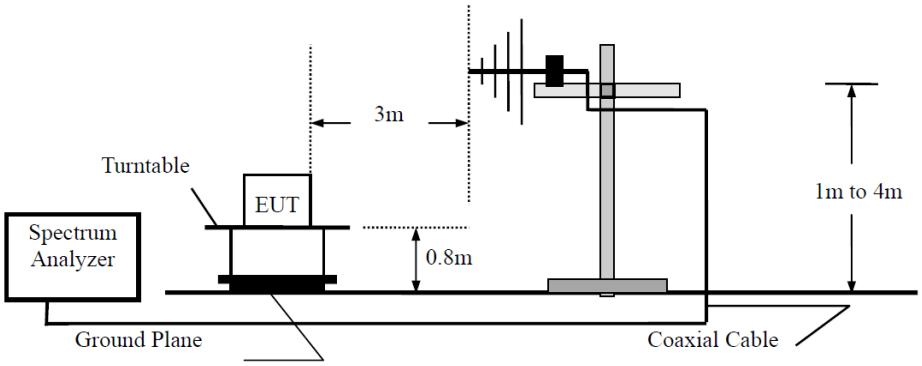
7 Test Setups

7.1 AC Power Line Conducted Emission test setups

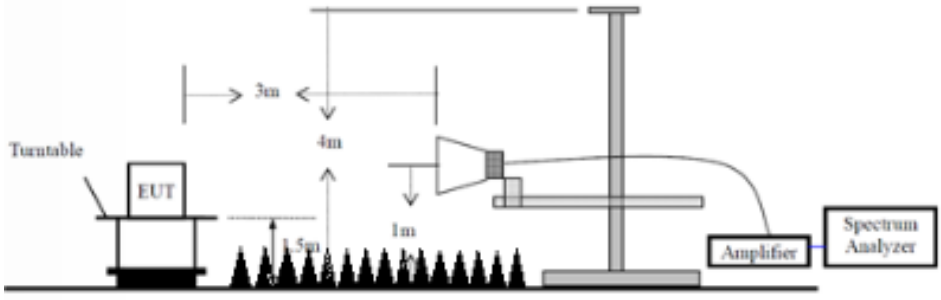


7.2 Radiated test setups

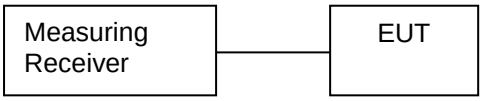
Below 1GHz



Above 1GHz



7.3 Conducted RF test setups



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8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Mobile Phone	SAMSUNG	SAMSUNG Note2	---
Laptop	Lenovo	X240	L34015282
Stopwatch	Giant	Neostrack	---

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9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

Limit

Frequency MHz	QP Limit dBµV	AV Limit dBµV
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

* Decreasing linear

Test result: Not Applicable, because the EUT is powered by DC.

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9.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
   RBW > the 6 dB bandwidth of the emission being measured, VBW≥3RBW, Span≥3RBW
   Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power.

Limits

Conducted Peak Output Power Limit:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

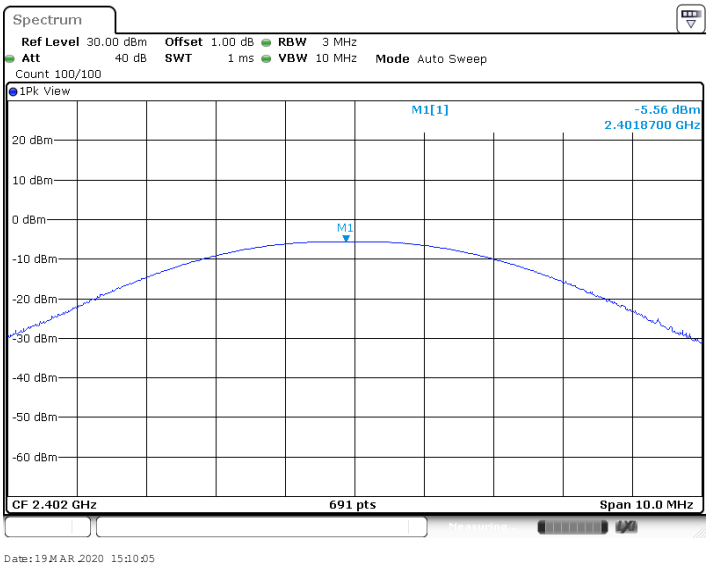
EIRP Limit :

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤4	≤36

Test result as below table

Frequency MHz	Conducted Peak Output Power dBm	E.I.R.P dBm	Result
Bottom channel 2402MHz	-5.56	-0.02	Pass
Middle channel 2440MHz	-6.05	-0.51	Pass
Top channel 2480MHz	-6.37	-0.83	Pass

2402MHz



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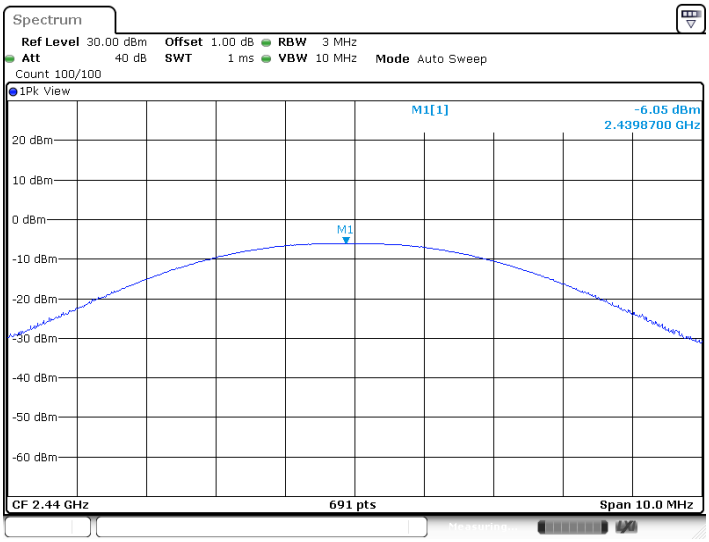
2440MHz



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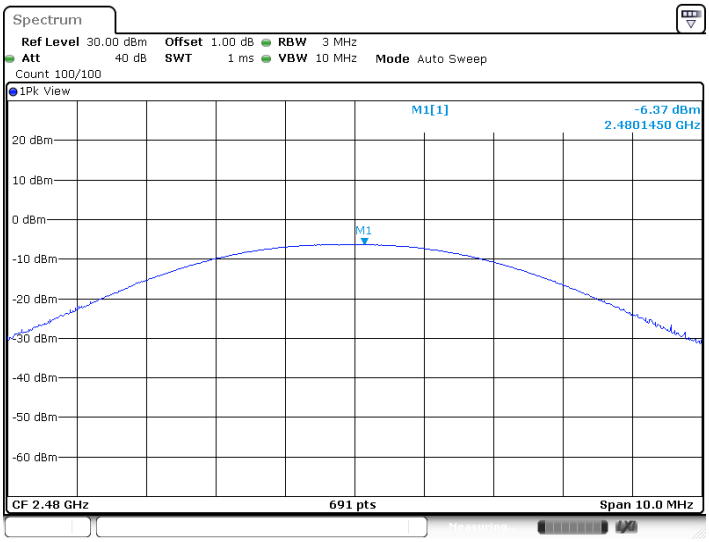
2480MHz



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9.3 6dB bandwidth and 99% Occupied Bandwidth

Test Method

1. Use the following spectrum analyzer settings:
   RBW=100K, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

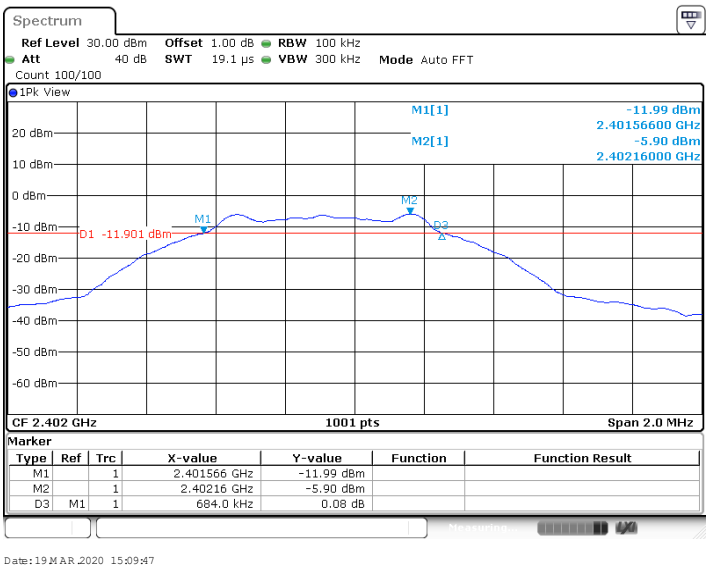
Limit

Limit [kHz]
≥500

Test result

TestMode	Channel	6dB bandwidth [MHz]	FL[MHz]	FH[MHz]	Verdict
BLE	2402	0.684	2401.566	2402.250	PASS
	2440	0.684	2439.566	2440.250	PASS
	2480	0.690	2479.560	2480.250	PASS

2402MHz



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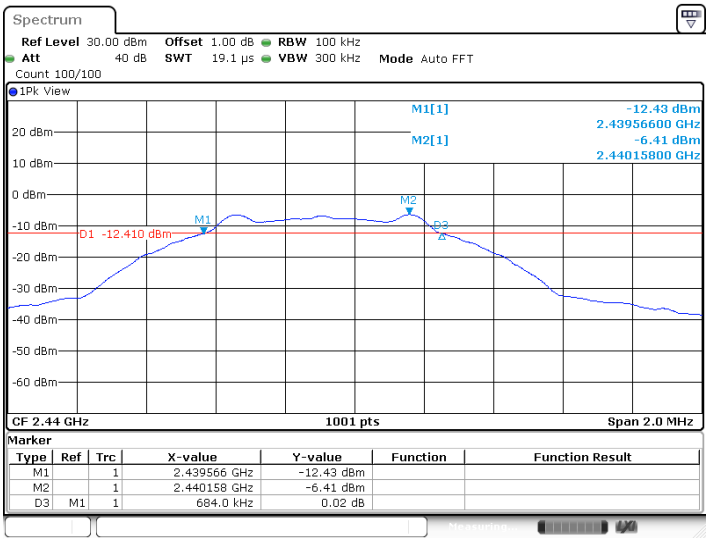
2440MHz



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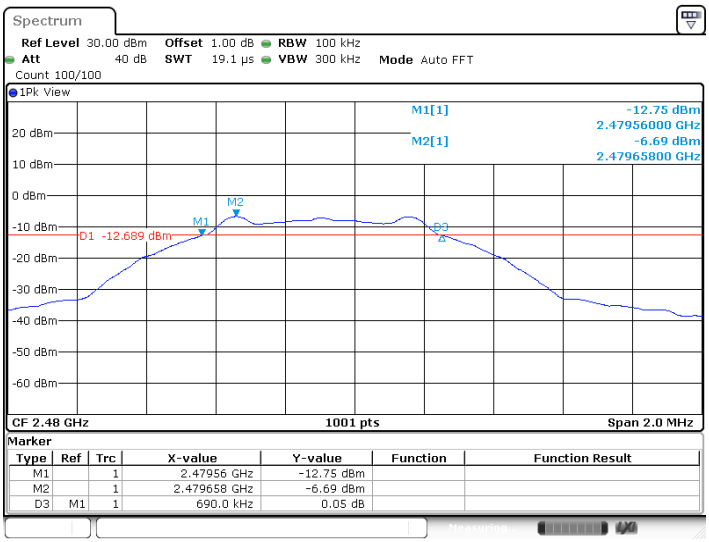
2480MHz



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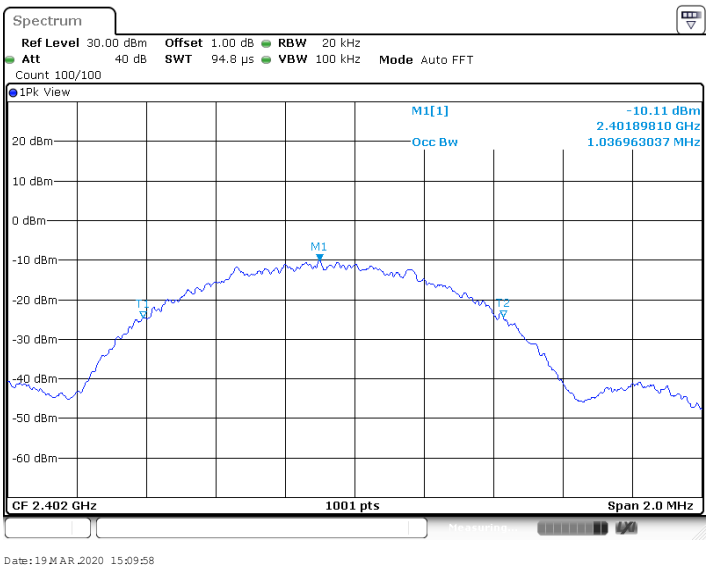
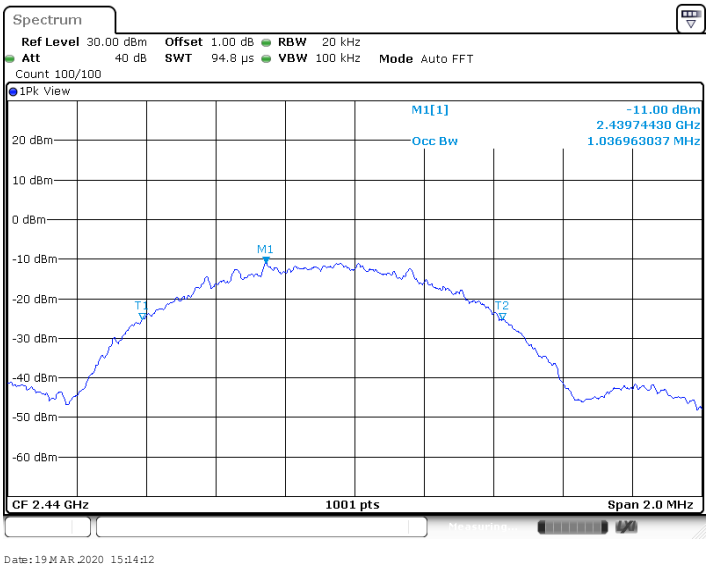
TestMode	Channel	99% OCB [MHz]	FL[MHz]	FH[MHz]	Verdict
BLE	2402	1.037	2401.391	2402.428	PASS
	2440	1.037	2439.389	2440.426	PASS
	2480	1.031	2479.393	2480.424	PASS

2402MHz



2440MHz



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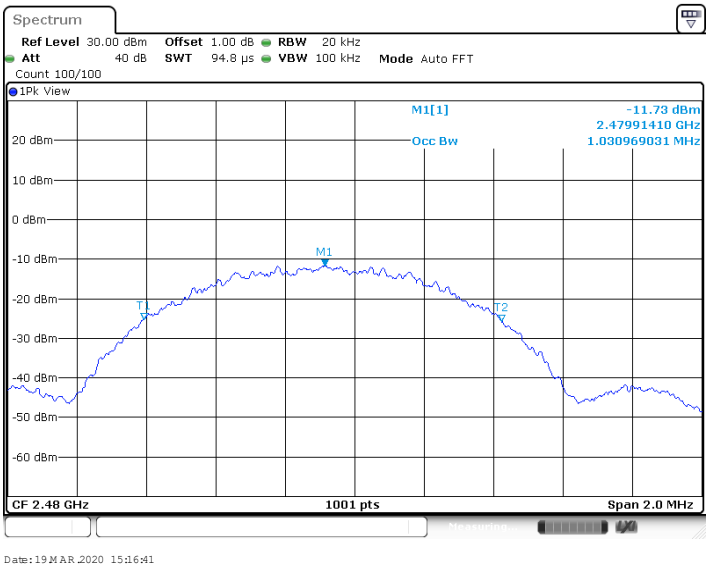
2480MHz



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9.4 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency. RBW=10kHz,VBW≥3RBW,Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

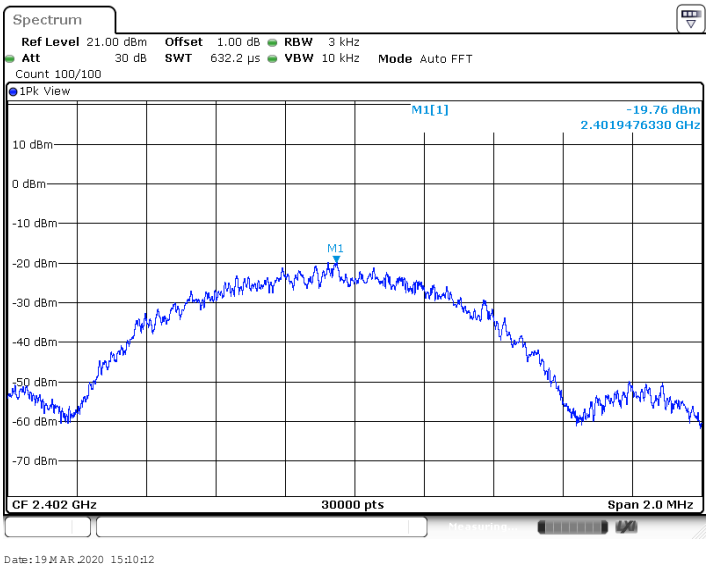
Limit

Limit [dBm/3KHz]
≤8

Test result

Frequency **MHz**	Power spectral density **dBm/3KHz**	Result
Bottom channel 2402MHz	-19.76	Pass
Middle channel 2440MHz	-20.43	Pass
Top channel 2480MHz	-20.92	Pass

2402MHz



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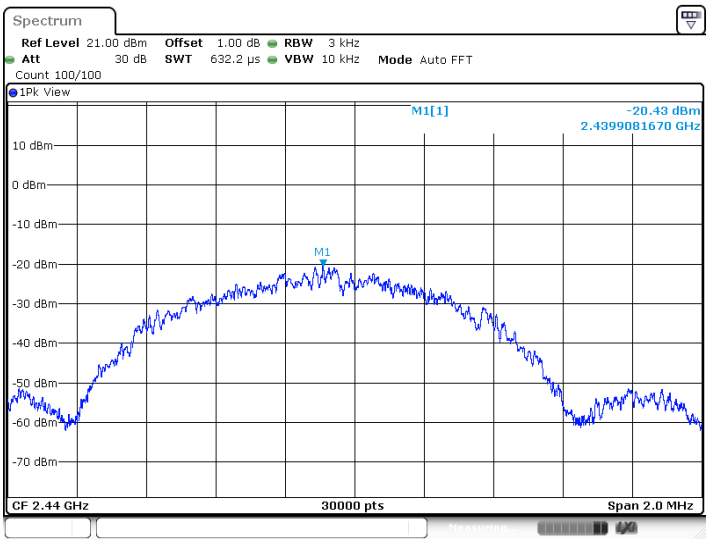
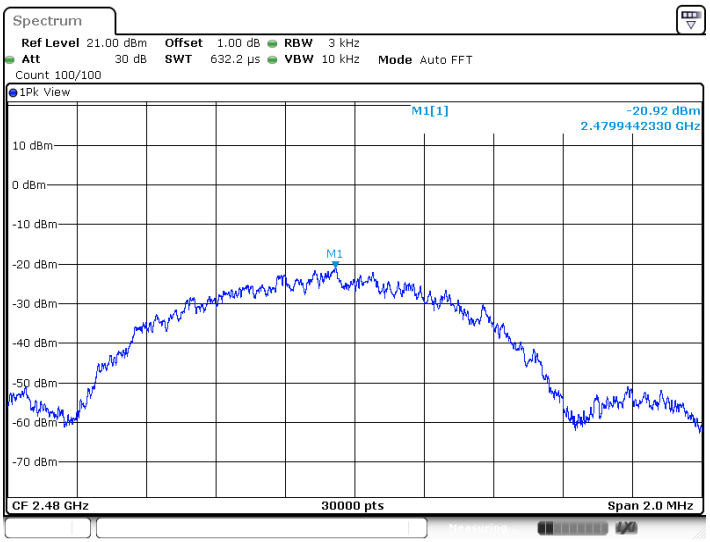
2440MHz



2480MHz



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9.5 Spurious RF conducted emissions

Test Method

1. Establish a reference level by using the following procedure:
   a. Set RBW=100 kHz. VBW≥3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
   b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
   a. Set the center frequency and span to encompass frequency range to be measured.
   b. 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, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Frequency Range MHz	Limit (dBc)
30-25000	-20

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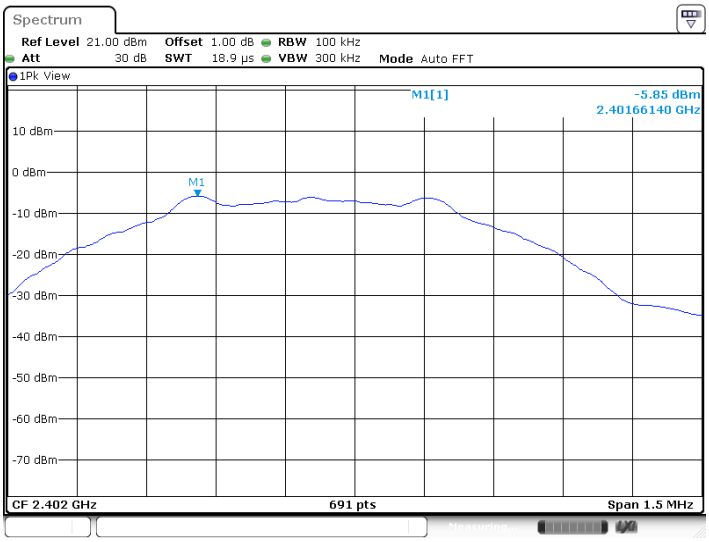
Spurious RF conducted emissions

2402MHz



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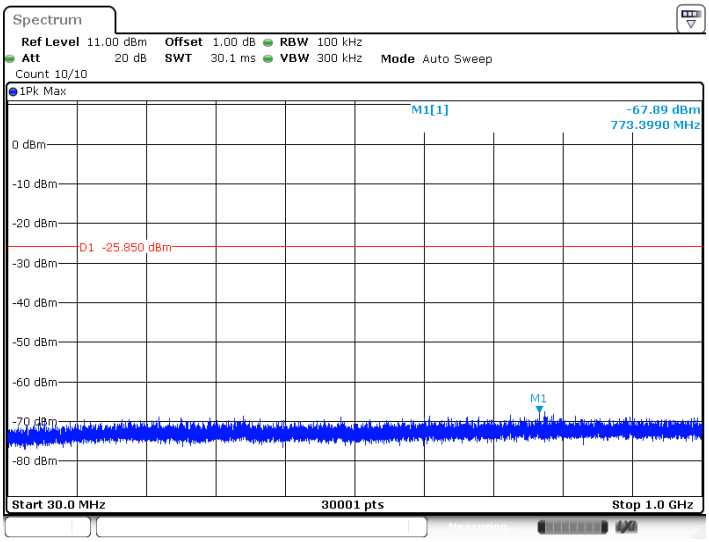

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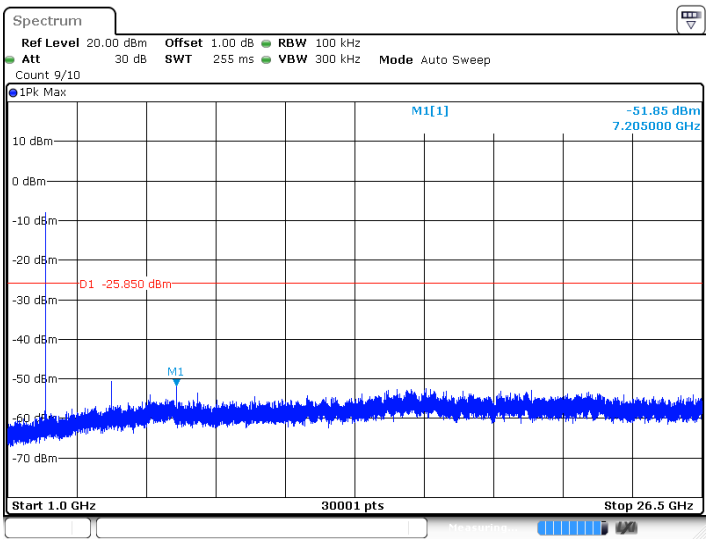
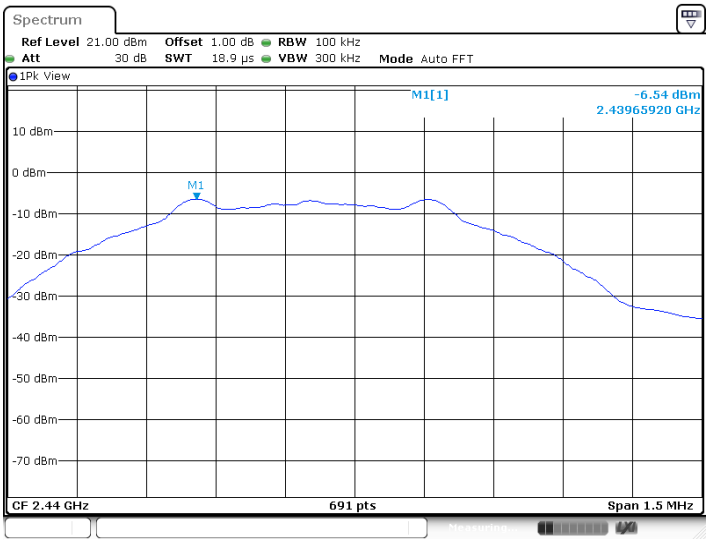
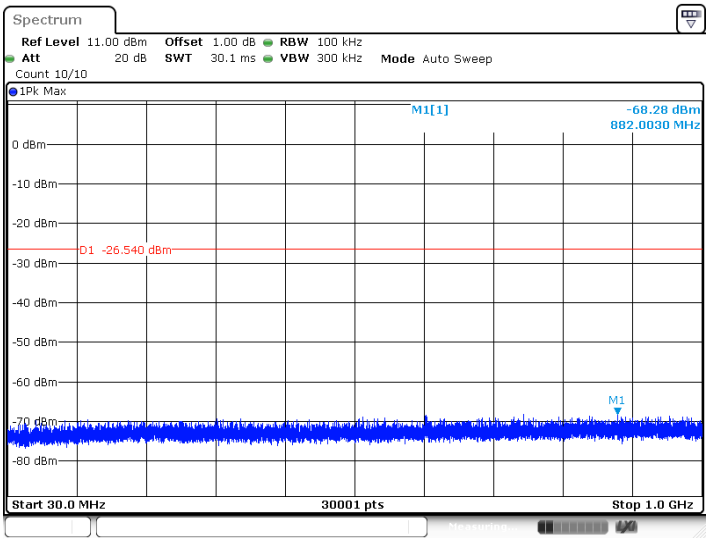


2440MHz





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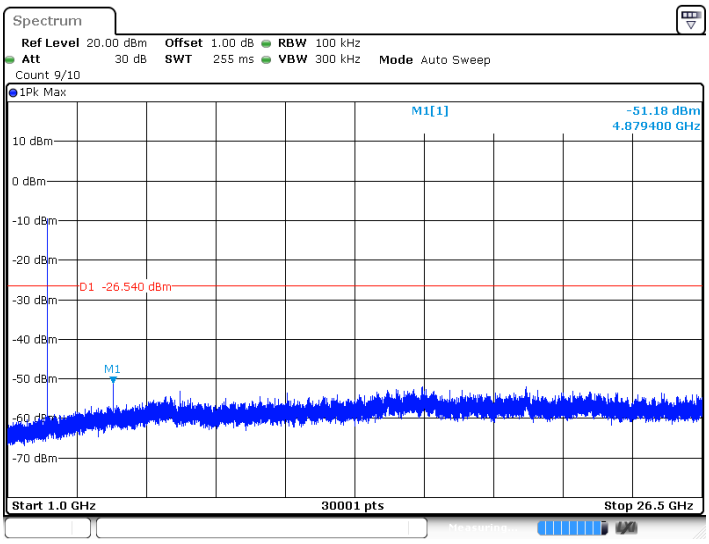

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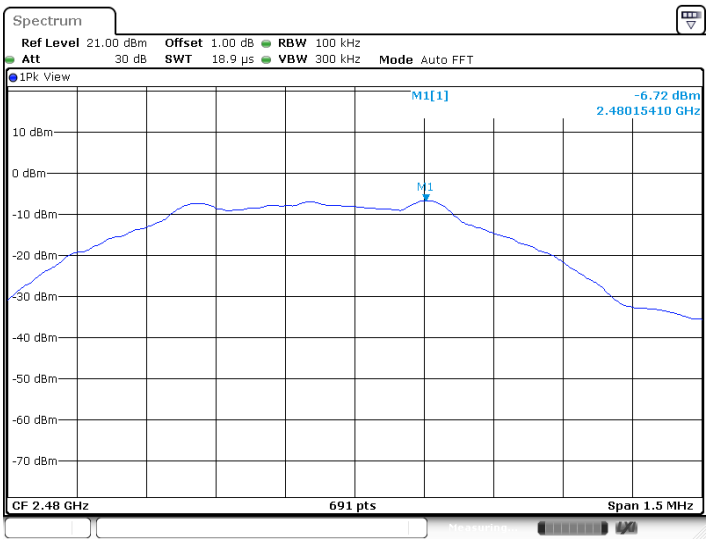

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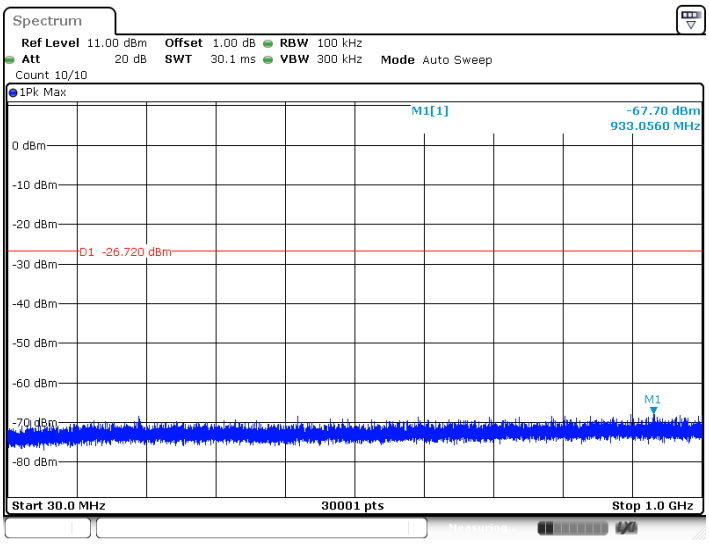
2480MHz



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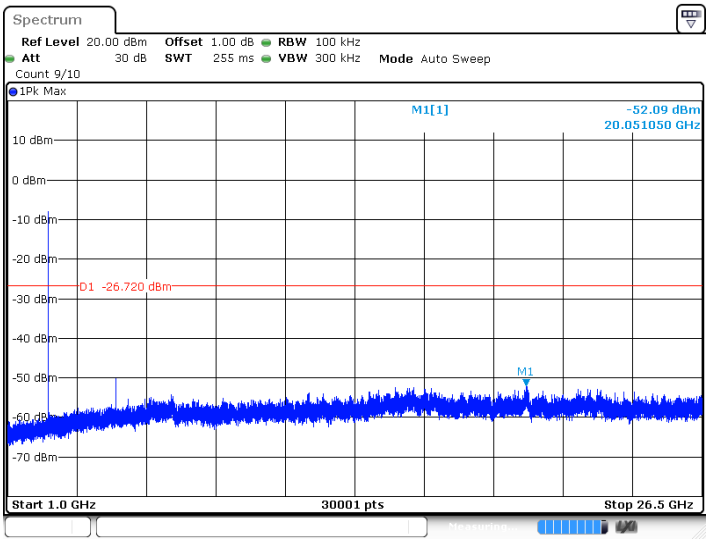

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9.6 Band edge

Test Method

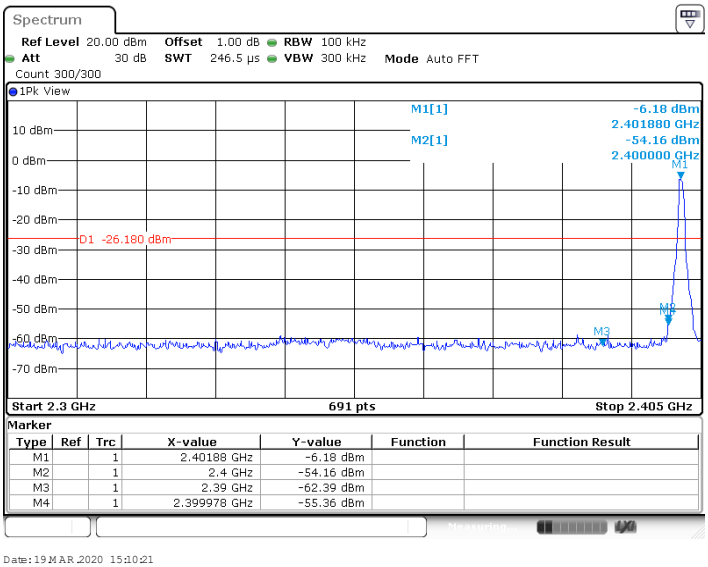
1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW≥RBW, Sweep = auto, Detector function = peak, Trace = max hold.
2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
3 The level displayed must comply with the limit specified in this Section.

Limit

In any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in 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, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).

Test result

2402MHz



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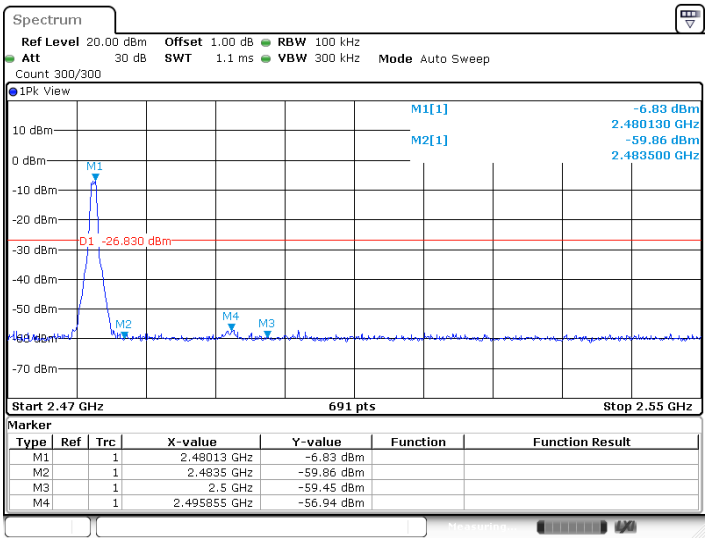
2480MHz



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9.7 Spurious radiated emissions for transmitter

Test Method

1: The EUT was place on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

2: The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.

3: The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

4: For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

5: Use the following spectrum analyzer settings According to C63.10:

For Below 1GHz

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious RBW = 100 KHz to 120KHz, VBW≥RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

For Peak unwanted emissions Above 1GHz:

Span = wide enough to capture the peak level of the in-band emission and all spurious RBW = 1MHz, VBW≥RBW for peak measurement ,Sweep = auto, Detector function = peak, Trace = max hold.

Procedures for average unwanted emissions measurements above 1000 MHz

a) RBW = 1 MHz.

b) VBW ≥[3 × RBW].

c) Detector = RMS (power averaging), if [span / (# of points in sweep)] \ RBW / 2. Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.

d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)

e) Sweep time = auto.

f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of 1 / D,where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)

g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the

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emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is [10 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.
2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is [20 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.
3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

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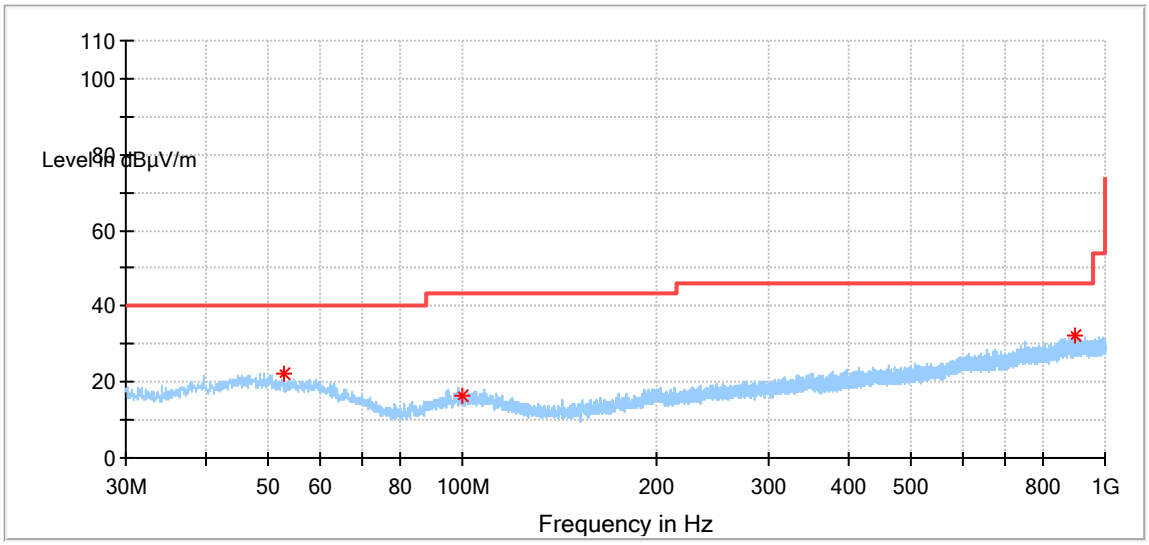
Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Transmitting spurious emission test result as below:

Transmitting spurious emission test result as below:

30MHz - 1GHz



Frequency	Emission Level	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
52.795	22.10	Horizontal	46.00	QP	Pass

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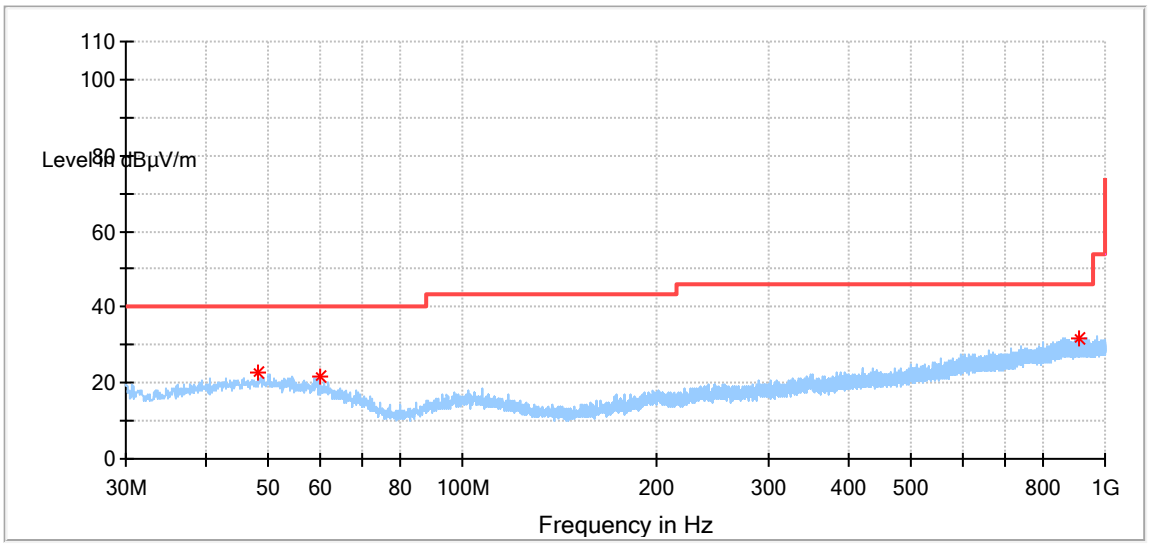

Frequency	Emission Level	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
48.0528	22.74	Vertical	46.00	QP	Pass

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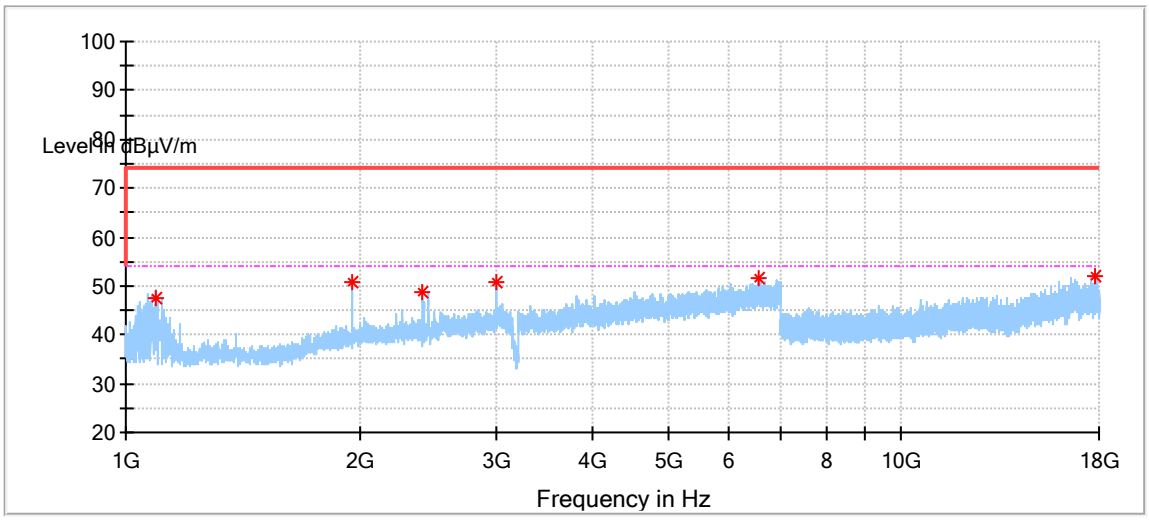
2402MHz (Above 1GHz)



Frequency	Emission Level	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
1091.50	47.64	Horizontal	74.00	PK	Pass
1963.00	50.57	Horizontal	74.00	PK	Pass
2417.50	48.74	Horizontal	74.00	PK	Pass
3007.00	50.80	Horizontal	74.00	PK	Pass
6563.00	51.52	Horizontal	74.00	PK	Pass
17738.50	51.98	Horizontal	74.00	PK	Pass

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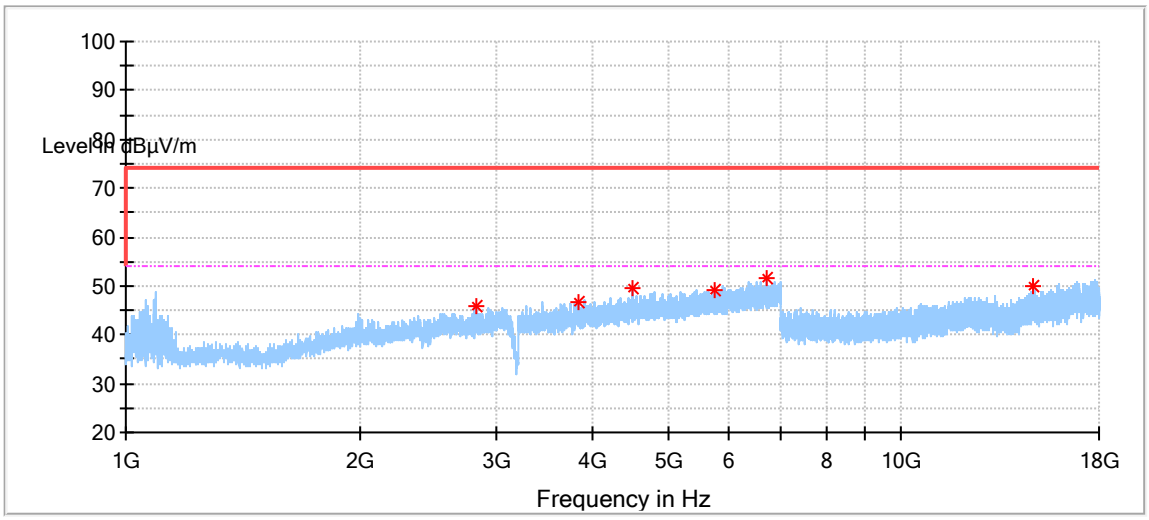

Frequency	Emission Level	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
2830.50	45.79	Vertical	74.00	PK	Pass
3835.50	46.57	Vertical	74.00	PK	Pass
4511.50	49.65	Vertical	74.00	PK	Pass
5742.50	49.21	Vertical	74.00	PK	Pass
6699.00	51.59	Vertical	74.00	PK	Pass
14804.50	49.79	Vertical	74.00	PK	Pass

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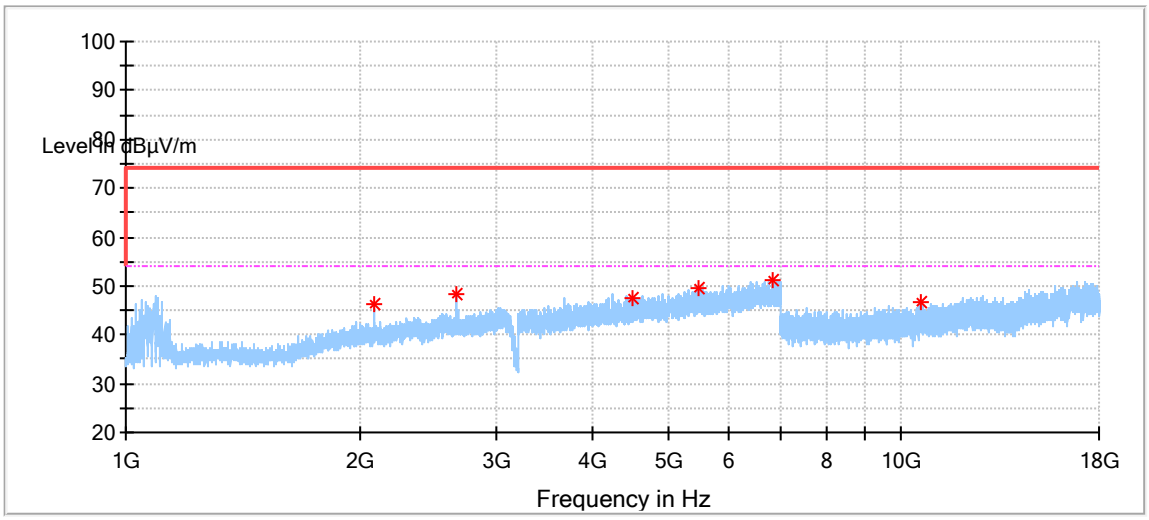
2440MHz (Above 1GHz)



Frequency	Emission Level	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
2085.00	46.44	Horizontal	74	PK	Pass
2666.00	48.44	Horizontal	74	PK	Pass
4503.00	47.65	Horizontal	74	PK	Pass
5485.50	49.37	Horizontal	74	PK	Pass
6844.50	51.11	Horizontal	74	PK	Pass
10580.00	46.58	Horizontal	74	PK	Pass

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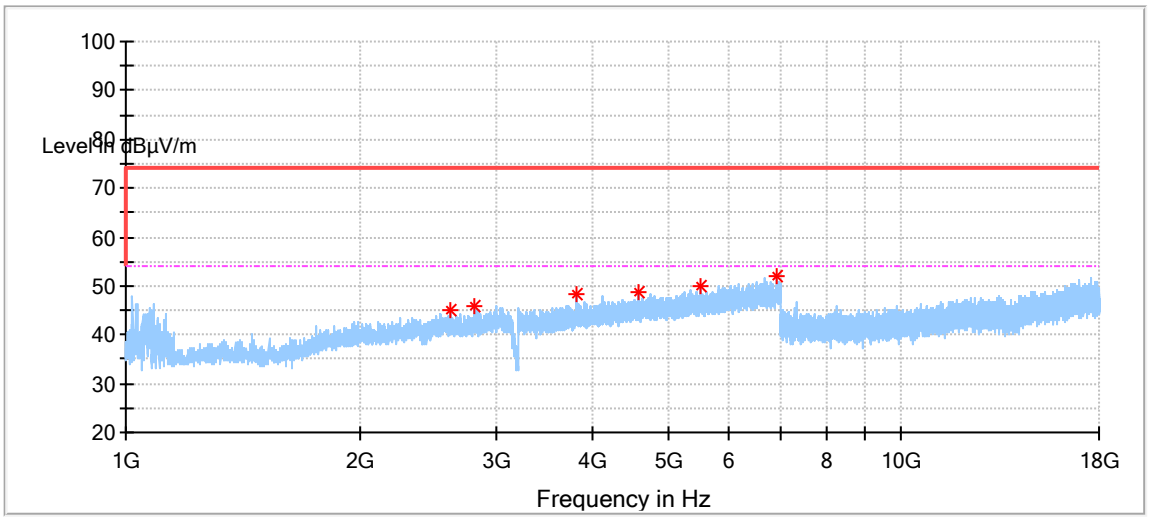

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBµV/m	Detector	Result
2628.50	44.98	Vertical	74	PK	Pass
2809.00	45.67	Vertical	74	PK	Pass
3810.50	48.49	Vertical	74	PK	Pass
4583.000000	48.62	Vertical	74	PK	Pass
5510.000000	50.05	Vertical	74	PK	Pass
6905.000000	51.95	Vertical	74	PK	Pass

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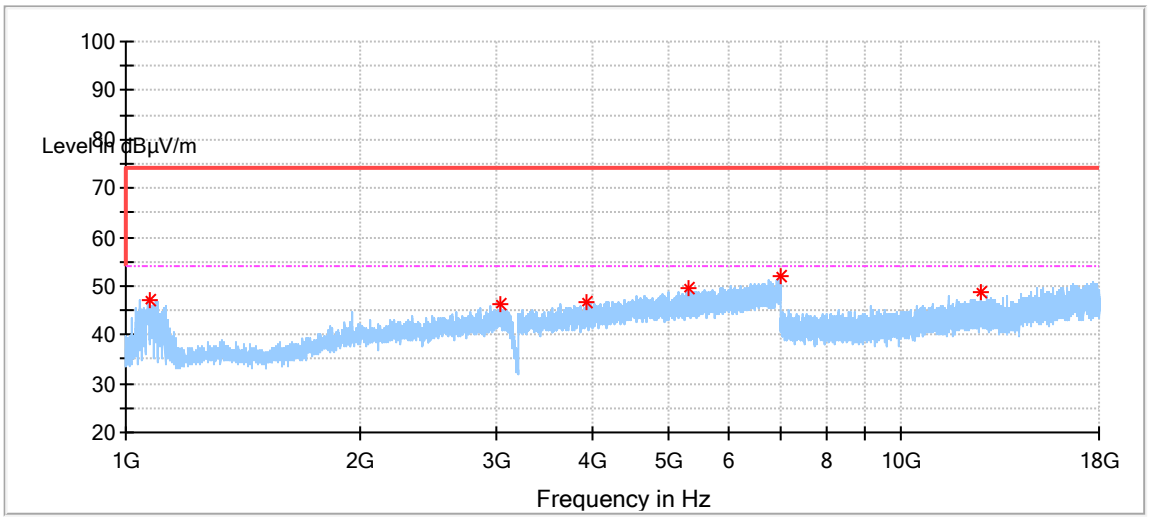
2480MHz (Above 1GHz)



Frequency	Emission Level	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
1076.50	47.15	Horizontal	74.00	PK	Pass
3039.50	46.13	Horizontal	74.00	PK	Pass
3935.00	46.79	Horizontal	74.00	PK	Pass
5303.50	49.66	Horizontal	74.00	PK	Pass
6979.00	52.14	Horizontal	74.00	PK	Pass
12641.00	48.53	Horizontal	74.00	PK	Pass

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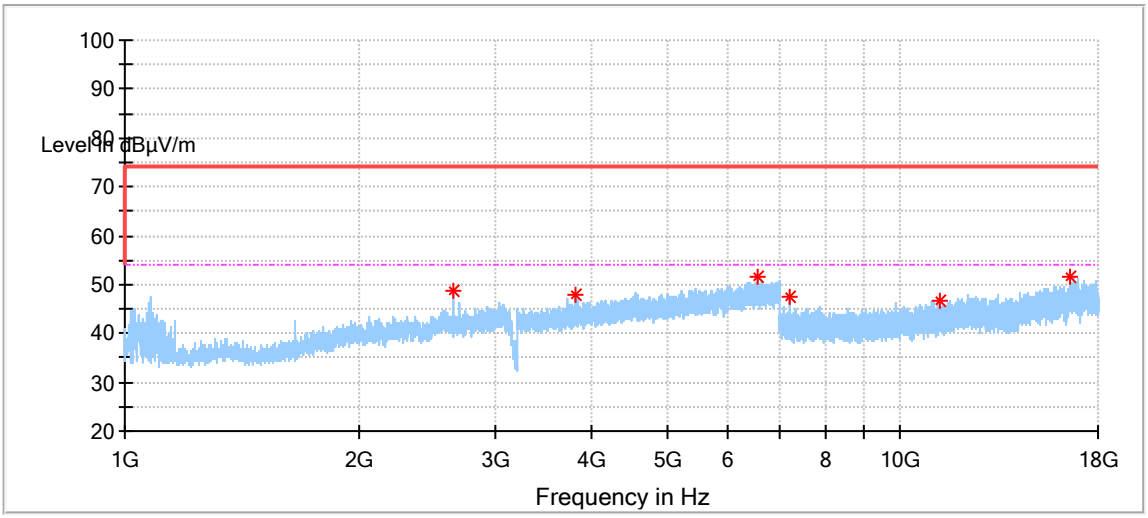

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBµV/m	Detector	Result
2655.50	48.54	Vertical	74.00	PK	Pass
3812.50	48.06	Vertical	74.00	PK	Pass
6545.50	51.54	Vertical	74.00	PK	Pass
7204.50	47.58	Vertical	74.00	PK	Pass
11233.00	46.87	Vertical	74.00	PK	Pass
16563.00	51.75	Vertical	74.00	PK	Pass

Remark:

(1) Data of Data of measurement within frequency range18-26GHz are the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report.

(2) Level =Reading Level + Correction Factor
Above 1GHz: Corrector factor = Antenna Factor + Cable Loss- Amplifier Gain
Below 1GHz: Corrector factor = Antenna Factor + Cable Loss
(The Reading level is recorded by software which is not shown in the sheet)

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10 Test Equipment List

List of Test Instruments

- Radiated Emission Test

Description	Manufacturer	Model no.	Serial no.	cal. due date
EMI Test Receiver	Rohde & Schwarz	ESR 26	101269	2020-6-28
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9163	707	2020-8-20
Horn Antenna	Rohde & Schwarz	HF907	102294	2020-6-22
Pre-amplifier	Rohde & Schwarz	SCU 18	102230	2020-7-7
Signal Generator	Rohde & Schwarz	SMY01	839369/005	2020-6-28
Attenuator	Agilent	8491A	MY39264334	2020-6-28
3m Semi-anechoic chamber	TDK	9X6X6	----	2020-6-28
Test software	Rohde & Schwarz	EMC32	Version 9.15.00	N/A

- RF conducted test

Description	Manufacturer	Model no.	Serial no.	cal. due date
Signal Analyzer	Rohde & Schwarz	FSV40	101030	2020-6-28
RF Switch Module	Rohde & Schwarz	OSP120/OSP	101226/100851	2020-6-28
Power Splitter	Weinschel	1580	SC319	2020-6-28
10dB Attenuator	Weinschel	4M-10	43152	2020-6-28
Test software	Rohde & Schwarz	EMC32	Version 10.38.00	N/A
Test software	Tonscend	System for BT/WIFI	Version 2.6	N/A

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11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

System Measurement Uncertainty	
Test Items	Extended Uncertainty
Uncertainty for Radiated Spurious Emission 25MHz-3000MHz	Horizontal: 4.80dB; Vertical: 4.87dB;
Uncertainty for Radiated Spurious Emission 3000MHz-18000MHz	Horizontal: 4.59dB; Vertical: 4.58dB;
Uncertainty for Radiated Spurious Emission 18000MHz-40000MHz	Horizontal: 5.05dB; Vertical: 5.04dB;
Uncertainty for Conducted RF test with TS 8997	Power level test involved: 1.16dB Frequency test involved: 0.6×10^{-7} or 1%

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