

TEST REPORT

Part 15 Subpart C 15.231

Equipment under test Remote control

Model name FSB-REM22

FCC ID 2A66F-FSB-REM22

Applicant FESBO

Manufacturer FESBO

Date of test(s) 2022.05.31 ~ 2022.06.02

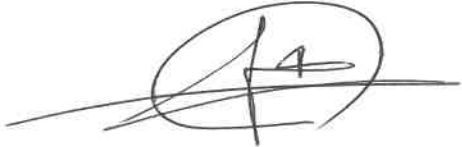
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Issued to
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This test report is not related to KS Q ISO/IEC 17025 and KOLAS.

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Test report No.:
KES-RF1-22T0073
Page (2) of (20)

Revision history

Revision	Date of issue	Test report No.	Description
-	2022.06.27	KES-RF1-22T0073	Initial

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TABLE OF CONTENTS

1.	General information	4
1.1.	EUT description	4
1.2.	Test configuration	4
1.3.	Device modifications	4
1.4.	Derivation model information	4
1.5.	Frequency/channel operations	5
2.	Summary of tests	6
3.	Test results	7
3.1.	Field strength of fundamental and the field strength of spurious emission	7
3.2.	Bandwidth of operation frequency	16
3.3.	Transmission time	17
3.4.	Duty cycle correction factor	18
Appendix A.	Measurement equipment	19
Appendix B.	Test setup photos	20

1. General information

Applicant: FESBO
Applicant address: 47812 FESBO, 279, Chungnyeol-daero, Dongnae-gu, Busan, Republic of Korea
Test site: KES Co., Ltd.
Test site address: ☐ 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
☒ 473-29, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
FCC rule part(s): 15.231
FCC ID: 2A66F-FSB-REM22
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test Remote control
Frequency range 447.697 MHz
Model FSB-REM22
Modulation technique FSK
Number of channels 447.697 MHz : 1ch
Antenna specification Antenna type: Helical antenna, Peak gain: -2.3 dBi
Power source DC 3.0 V (Battery)
H/W Version 0.1
S/W Version 0.1

1.2. Test configuration

The **FESBO // Remote control // FSB-REM22 // FCC ID: 2A66F-FSB-REM22** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Subpart C 15.231
KDB 558074 D01 V05r02
ANSI C63.10-2013

1.3. Device modifications

N/A

1.4. Derivation model information

N/A



1.5. Frequency/channel operations

Ch.	Frequency (MHz)
01	447.697



2. Summary of tests

Reference	Parameter	Test results
15.209(a) 15.231(b)	Radiated emission, Spurious emission and Field Strength of Fundamental	Pass
15.231(c)	Bandwidth of operation frequency	Pass
15.231(a)	Transmission time	Pass
15.207(a)	AC conducted emissions	N/A ¹⁾

Note.

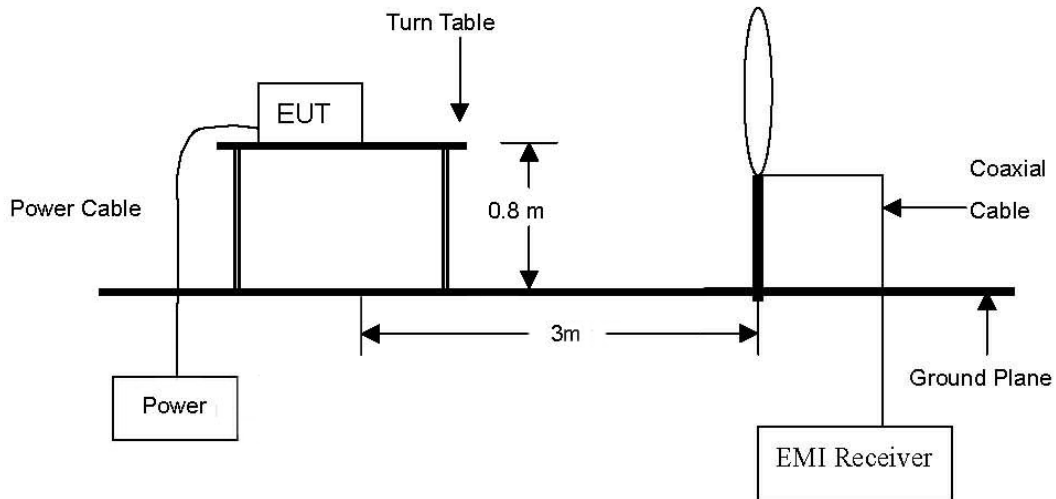
1. This product is powered by battery.

3. Test results

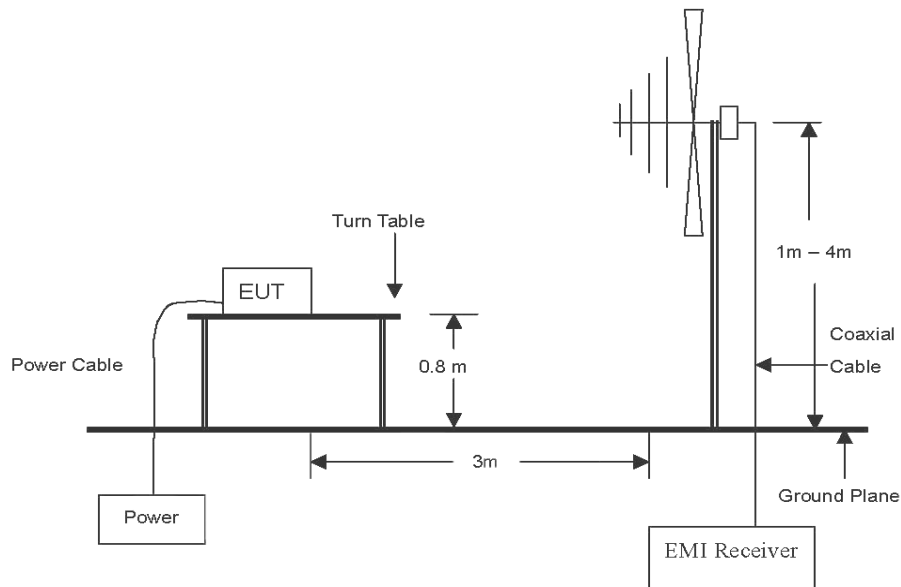
3.1. Field strength of fundamental and the field strength of spurious emission

Test setup

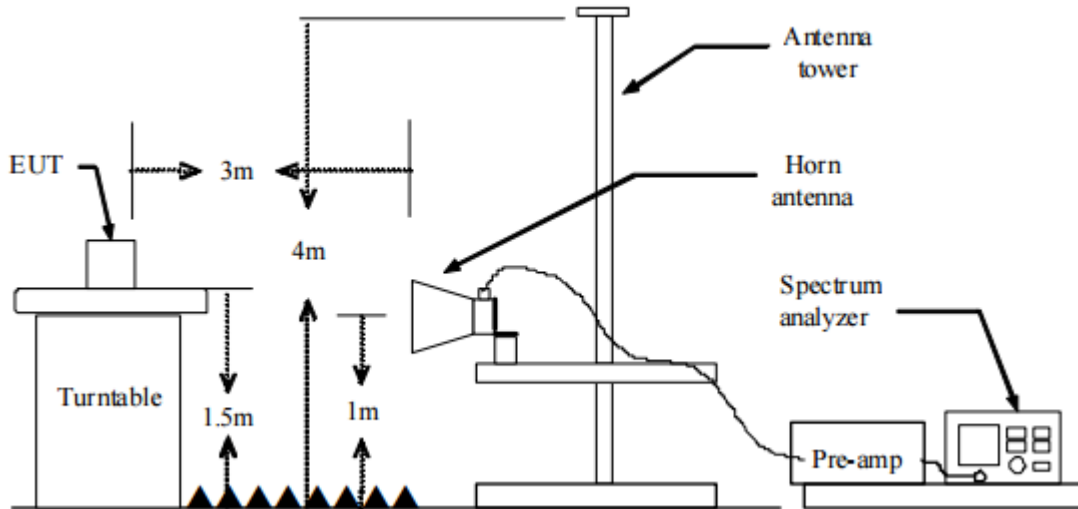
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz emissions, whichever is lower.



Test procedure below 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

Test procedure above 30 MHz

1. Spectrum analyzer settings for $f < 1$ GHz:
 - ① Span = wide enough to fully capture the emission being measured
 - ② RBW = 100 kHz
 - ③ VBW $\geq$ RBW
 - ④ Detector = Peak detection (PK) or Quasi-peak detection (QP)
 - ⑤ Sweep time = auto
 - ⑥ Trace = max hold
2. Spectrum analyzer settings for $f \geq 1$ GHz: Peak
 - ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
 - ② RBW = 1 MHz
 - ③ VBW $\geq$ 3 MHz
 - ④ Detector = peak
 - ⑤ Sweep time = auto
 - ⑥ Trace = max hold
 - ⑦ Trace was allowed to stabilize

Note.

1. $f < 30$ MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40\log(D_m/D_s)$
 $f \geq 30$ MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20\log(D_m/D_s)$
Where:
 F_d = Distance factor in dB
 D_m = Measurement distance in meters
 D_s = Specification distance in meters
2. CF(Correction factors(dB)) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d (dB)
3. Field strength(dB μ V/m) = Level(dB μ V) + CF (dB) + or DCF(dB)
4. Margin(dB) = Limit(dB μ V/m) - Field strength(dB μ V/m)
5. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation**.
6. The emissions are reported however whose levels were not within 20 dB of respective limits were not reported.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

Frequency (MHz)	Distance (Meters)	Radiated ($\mu\text{V}/\text{m}$)
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

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

According to 15.231(b), in addition to the provisions of section 15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts / meter)	Field strength of spurious emission (microvolts / meter)
40.66 ~ 40.70	2,250	225
70 ~ 130	1,250	125
130 ~ 174	1,250 to 3,750**	125 to 375**
174 ~ 260	3,750	375
260 ~ 470	3,750 to 12,500**	375 to 1,250**
Above 470	12,500	1,250

**Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130 ~ 174 MHz, $\mu\text{V}/\text{m}$ at 3 meters = $56.81818(F) - 6136.3636$; for the band 260 ~ 470 MHz, $\mu\text{V}/\text{m}$ at 3 meters = $41.6667(F) - 7083.333$. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.

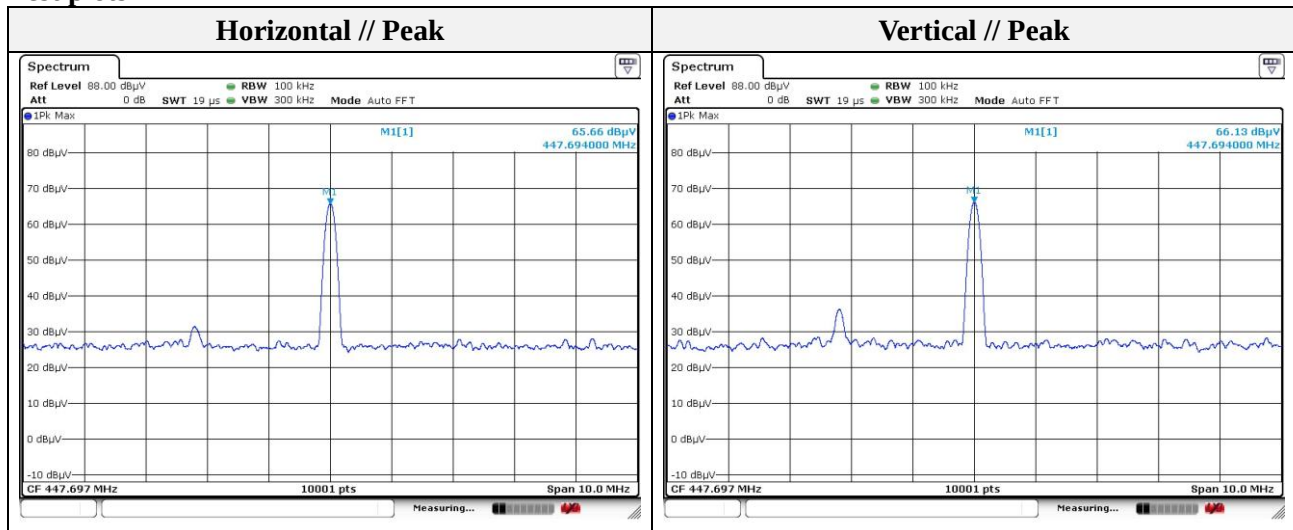
Field strength

Test results

Mode: FSK
Distance of measurement: 3 meter
Channel: 1

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
447.697	65.66	Peak	H	-15.01	-	50.65	101.27	50.62
		Average	H	-15.01	-9.65	50.65	81.27	40.26
447.697	66.13	Peak	V	-15.01	-	41.12	101.27	50.15
		Average	V	-15.01	-9.65	41.12	81.27	39.79

Test plots



Note.

- 3m Average Limit(dBμV/m) = $20\log[41.6667(F_{\text{MHz}} - 7083.3333)] = 81.27$
3m Peak Limit(dBμV/m) = Average limit + 20 = 101.27
Average Field strength = Peak Field strength + Duty Cycle Correction Factor
- Duty Cycle Correction Factor : $20\log(T_{\text{on}} / 100 \text{ ms}) = 20\log(32.94 / 100) = -9.65$
 $T_{\text{on time}} = 32.94 \text{ ms}$
 $T_{\text{on+off}} \geq 100 \text{ ms}$ (pulse train is 100 ms)



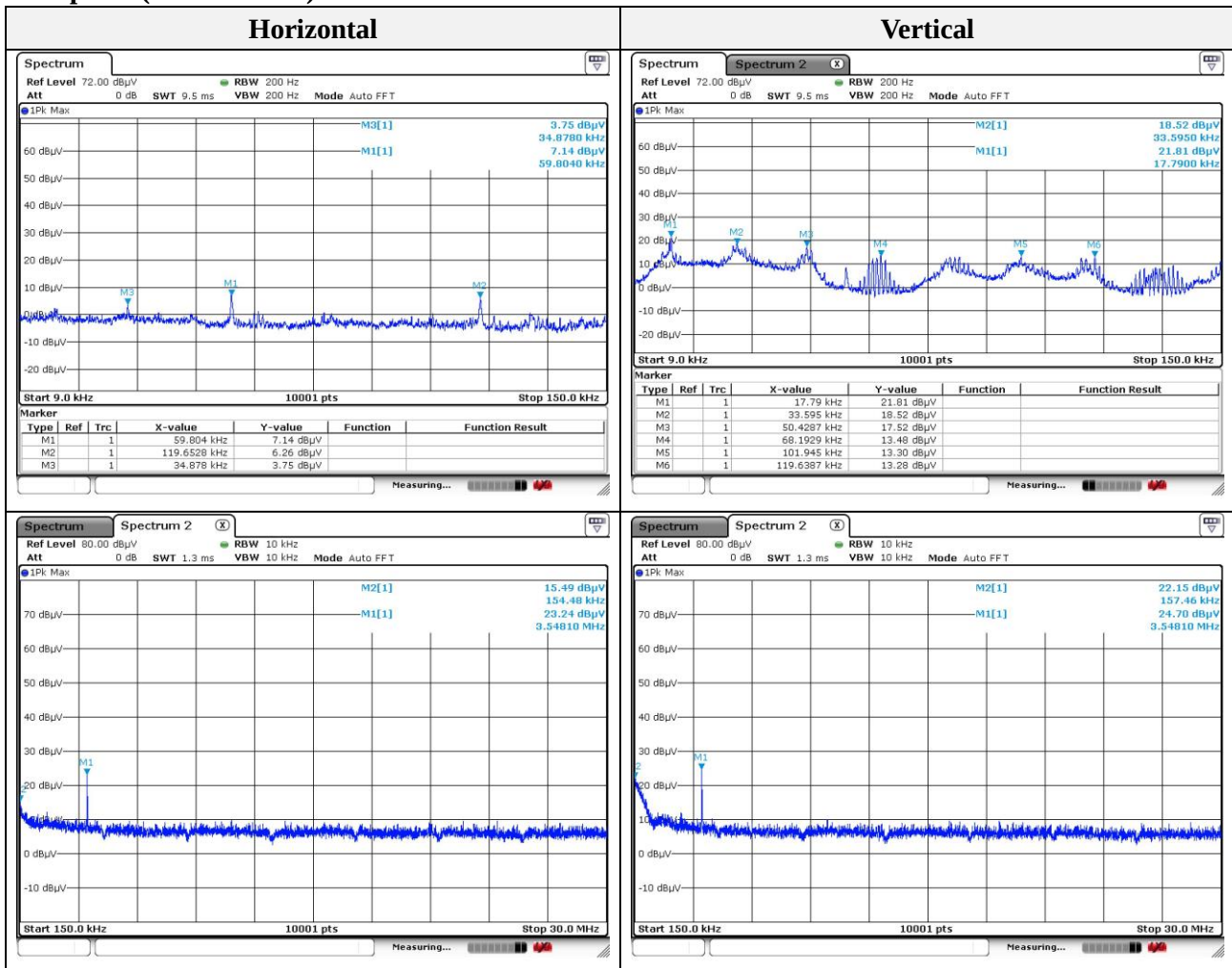
Spurious emission

Test results (Below 30 MHz)

Mode:	FSK
Distance of measurement:	3 meter
Channel:	1

Frequency (MHz)	Level (dB μ V)	Ant. Pol. (H/V)	CF (dB)	F _d (dB)	Field strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
No spurious emissions were detected within 20 dB of the limit							

Test plots (Below 30 MHz)



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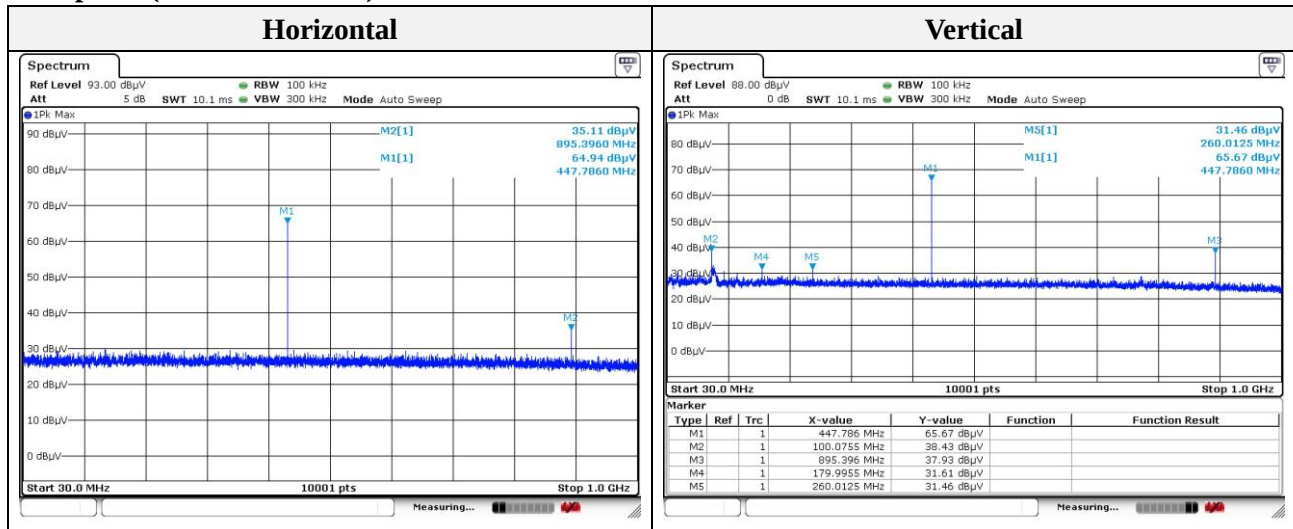


Test results (Below 1 000 MHz)

Mode: FSK
Distance of measurement: 3 meter
Channel: 1

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
100.076	38.43	Peak	V	-20.44	-	17.99	43.52	25.53
179.996	31.61	Peak	V	-22.42	-	9.19	43.52	34.33
260.013	31.46	Peak	V	-18.77	-	12.69	46.02	33.33
895.396	37.93	Peak	V	-7.32	-	30.61	46.02	15.41
895.396	35.11	Peak	H	-7.32	-	27.79	46.02	18.23

Test plots (Below 1 000 MHz)





Test results (Above 1 000 MHz)

Mode: FSK
Distance of measurement: 3 meter
Channel: 1

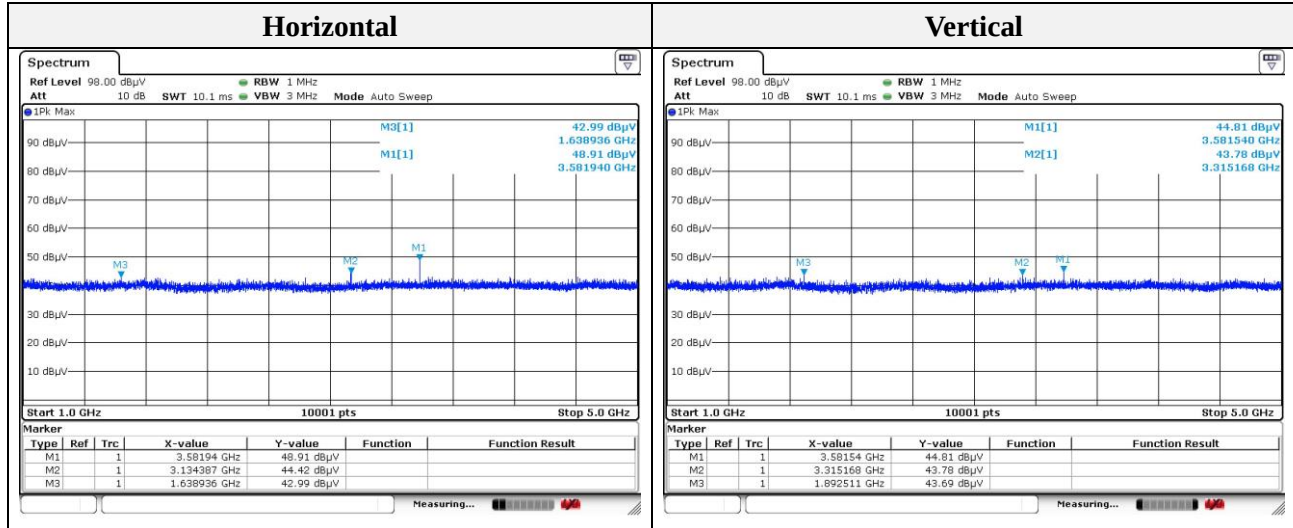
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 638.94	42.99	Peak	H	-4.28	-	38.71	81.27	42.56
1 892.51	43.69	Peak	V	0.15	-	43.84	81.27	35.43
3 134.39	44.42	Peak	H	1.42	-	45.84	81.27	31.26
3 315.17	43.78	Peak	V	1.77	-	45.55	81.27	37.43
3 581.54	44.81	Peak	V	1.10	-	45.91	81.27	35.72
3 581.94	48.91	Peak	H	1.10	-	50.01	81.27	35.36

Note.

- 3m PeakLimit(dBμV/m) = $20\log[41.6667(F_{\text{MHz}}-7083.3333)] = 81.27$
3m Average Limit(dBμV/m) = Peak limit - 20 = 61.27
Average Field strength = Peak Field strength + Duty Cycle Correction Factor
- Correction Factors = Antenna Factor + Cable Loss + Amp.Gain
- “*” means the restricted band.
- Average test would not be applied if the peak results were lower than the average limit.
- Duty Cycle Correction Factor : $20\log(T_{\text{on}} / 100 \text{ ms}) = 20\log(32.94 / 100) = -9.65$
 $T_{\text{on time}} = 32.94 \text{ ms}$
 $T_{\text{on+off}} \geq 100 \text{ ms}$ (pulse train is 100 ms)



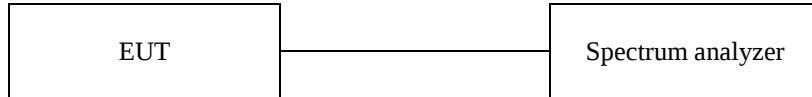
Test plots (Above 1 000 MHz)



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3.2. Bandwidth of operation frequency

Test setup



Test procedure

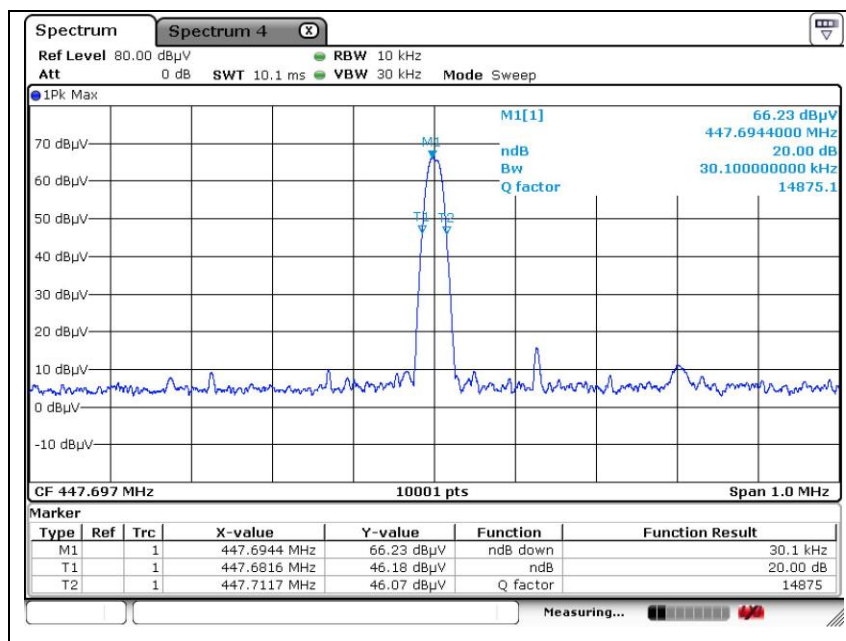
1. Use the following spectrum analyzer setting
2. RBW = 10 kHz
3. VBW = 30 kHz ($\geq$ RBW)
4. Span = 1 MHz
5. Detector function = peak
6. Trace = max hold

Limit

The bandwidth of the emissions shall be no wider than 0.25 % of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

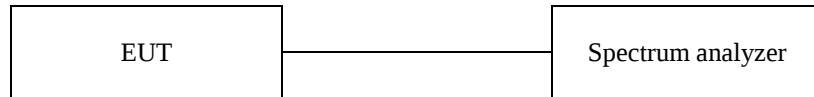
Test results

Frequency(MHz)	Bandwidth(kHz)	Limit (kHz)
447.697	30.10	11 192.425



3.3. Transmission time

Test setup



Test procedure

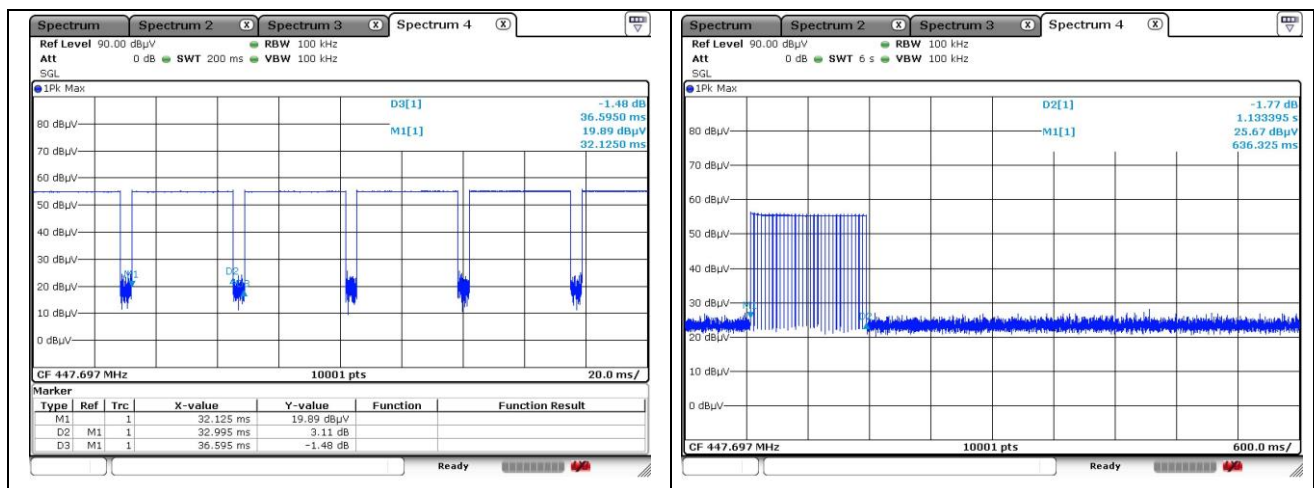
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW=100 kHz, VBW=100 kHz, Span=0 Hz.

Limit

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

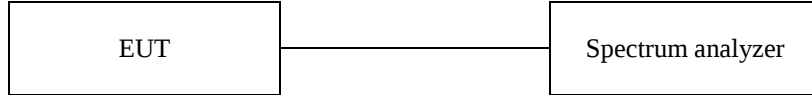
Test results

Frequency(MHz)	Transmission time (ms)	Limit (s)
447.697	1 133.395	Same or less than 5



3.4. Duty cycle correction factor

Test setup



Test procedure

1. The transmitter output is connected to the spectrum analyzer.
2. Set center frequency of spectrum analyzer = operating frequency.
3. Set the spectrum analyzer as RBW=100 kHz, VBW=100 kHz, Span=0 Hz and Sweep time =100 ms.

Limit

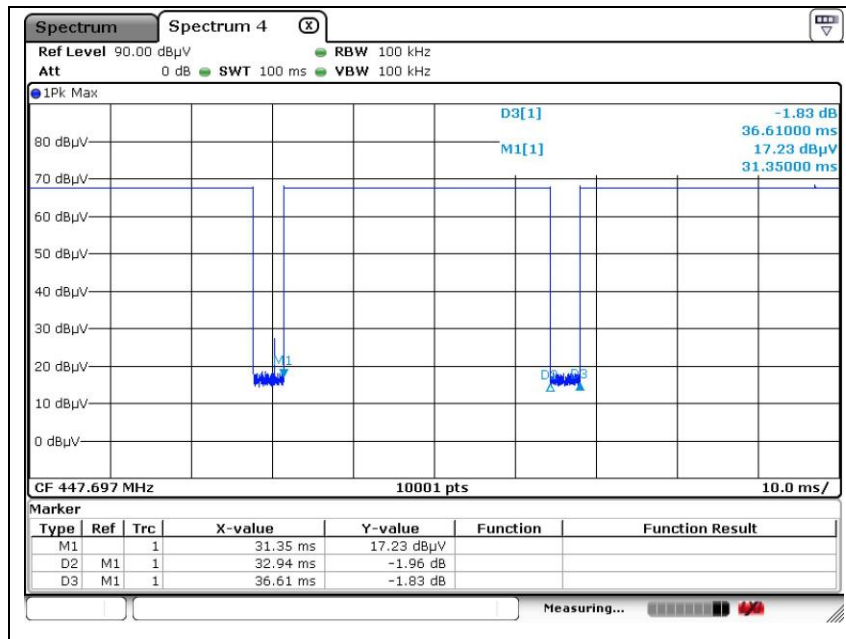
None (No dedicated Limit specified in the Rules)

Test results

Duty Cycle Correction Factor : $20\log(T_{on} / 100 \text{ ms}) = 20\log(32.94 / 100) = -9.65$

$T_{x \text{ on time}} = 32.94 \text{ ms}$

$T_{x \text{ on+off}} \geq 100 \text{ ms}$ (pulse train is 100 ms)





Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due
Spectrum Analyzer	R&S	FSV40	102194	1 year	2023.06.16
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2023.01.14
DC Power Supply	SORENSEN	DCS40-75E	1408A02745	1 year	2023.06.16
Attenuator	Mini-Circuits	BW-S10-2W263+	3	1 year	2023.01.17
Attenuator	HUBER+SUHNER	6806.17.A	-	1 year	2023.04.01
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2023.01.18
BILOG ANTENNA	Schwarzbeck	VULB 9168	9168-461	2 years	2024.04.27
Horn Antenna	A.H	SAS-571	414	1 year	2023.01.18
Amplifier	SONOMA INSTRUMENT	310N	401123	1 year	2023.06.02
PREAMPLIFIER	HP	8449B	3008A00538	1 year	2023.06.02

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
-	-	-	-