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

Date of issue 2022.06.27

Issued to
FESBO
FESBO, 279, Chungnyeol-daero, Dongnae-gu, Busan, Republic of Korea
Tel: +82-51-555-5669 / Fax: +82-51-556-9738

Issued by
KES Co., Ltd.
C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, Korea
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Test and report completed by :	**Report approval by :**
	
Bong-Seok, Kim Test engineer	Yeong-Jun, Cho Technical manager

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

Revision history

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

TABLE OF CONTENTS

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, Yeoju-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 ㎒
Model	FSB-REM22
Modulation technique	FSK
Number of channels	447.697 ㎒ : 1ch
Antenna specification	Antenna type: Helical antenna, Peak gain: -2.3 ㏈i
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 (㎒)
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.

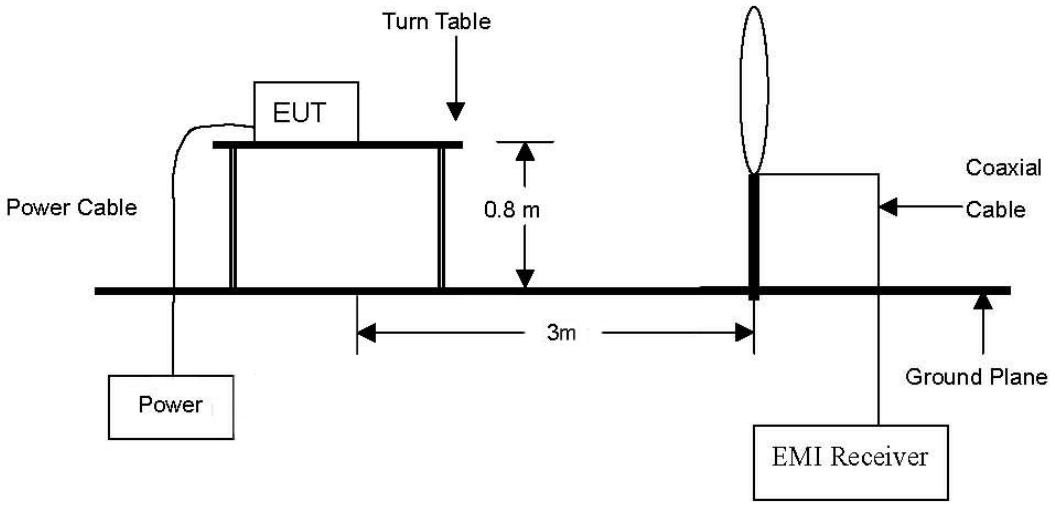
1. This product is powered by battery.

3. Test results

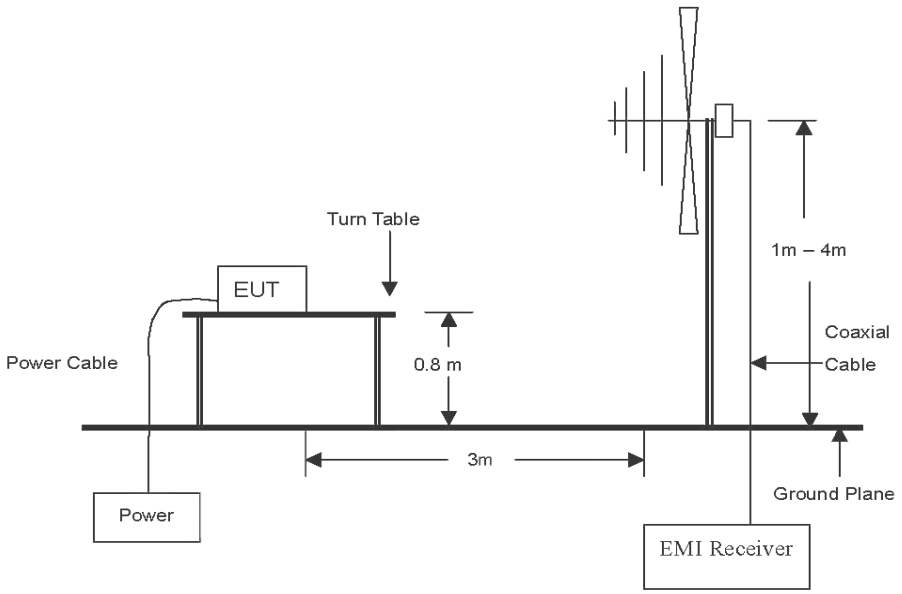
3.1. Field strength of fundamental and the field strength of spurious emission

Test setup

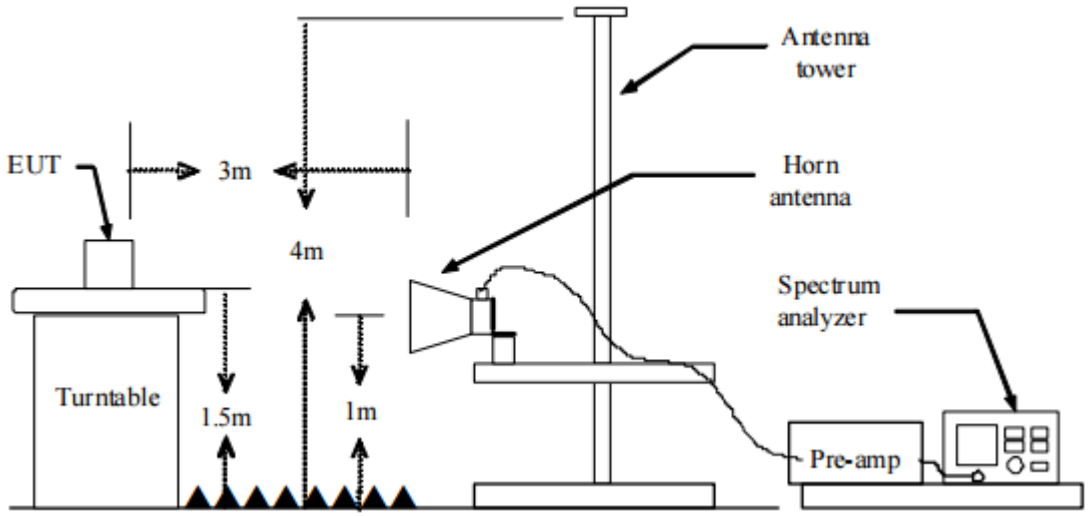
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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



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



Test procedure below 30 ㎒

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 ㎒

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

Note.

1. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥30 ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters
2. CF(Correction factors(㏈)) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or F_d(㏈)
3. Field strength(㏈㎶/m) = Level(㏈㎶) + CF (㏈) + or DCF(㏈)
4. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/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 ㏈ 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 (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2400/F(㎑)
0.490 ~ 1.705	30	24000/F(㎑)
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 ㎒, 76 ~ 88 ㎒, 174 ~ 216 ㎒ or 470 ~ 806 ㎒. 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 (㎒)	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 ㎒, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130 ~ 174 ㎒, ㎶/m at 3 meters = 56.81818(F) – 6136.3636; for the band 260 ~ 470 ㎒, ㎶/m at 3 meters = 41.6667(F) – 7083.333. The maximum permitted unwanted emission level is 20 ㏈ below the maximum permitted fundamental level.

Field strength

Test results

Mode: FSK

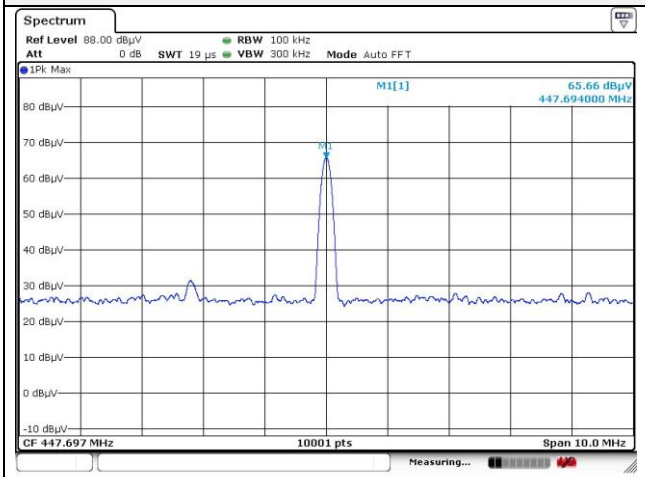
Distance of measurement: 3 meter

Channel: 1

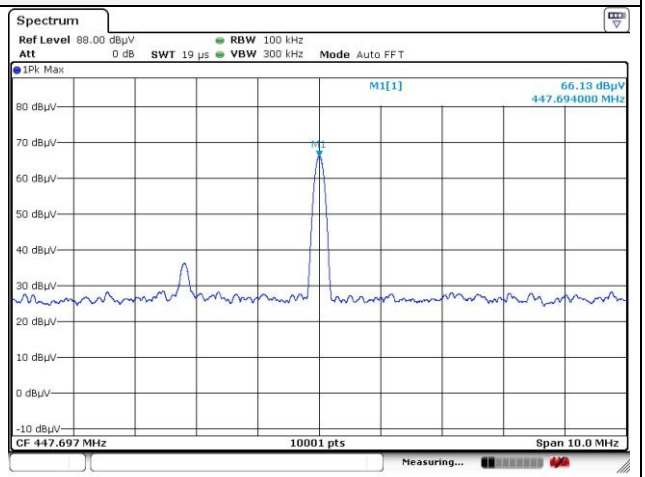
Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
447.697	65.66	Peak	H	-15.01	-	50.65	101.27	50.62
		Average	H	-15.01	-9.65	50.65	81.27	40.26
447.697	66.13	Peak	V	-15.01	-	41.12	101.27	50.15
		Average	V	-15.01	-9.65	41.12	81.27	39.79

Test plots

Horizontal // Peak



Vertical // Peak



Note.

1. 3m Average Limit(dB㎶/m) = 20log[41.6667($F_{(㎒)}$-7083.3333) = 81.27
   3m Peak Limit(dB㎶/m) = Average limit + 20 = 101.27
   Average Field strength = Peak Field strength + Duty Cycle Correction Factor
2. Duty Cycle Correction Factor : 20log(Ton / 100 ms) = 20log(32.94 / 100) = -9.65
   $Tx_{\text{on time}}$ = 32.94 ms
   $Tx_{\text{on+off}} \geq$ 100 ms (pulse train is 100 ms)

Spurious emission

Test results (Below 30 ㎒)

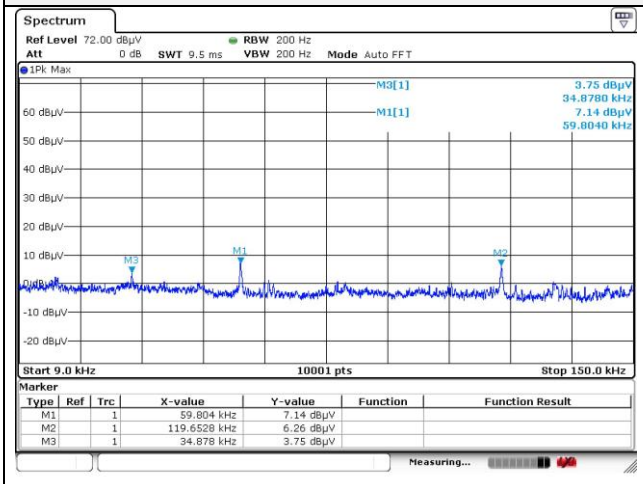
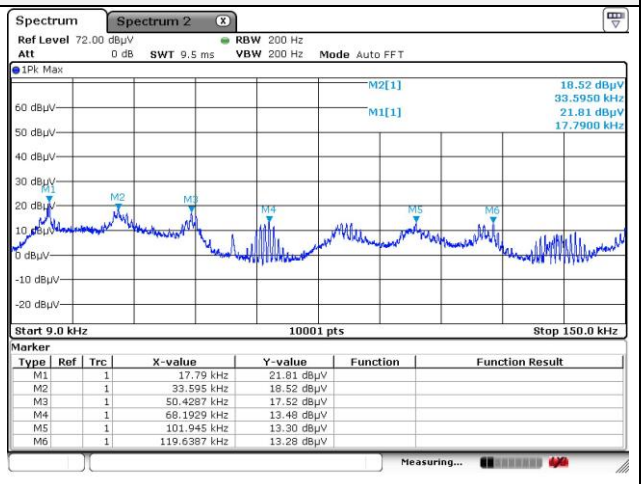
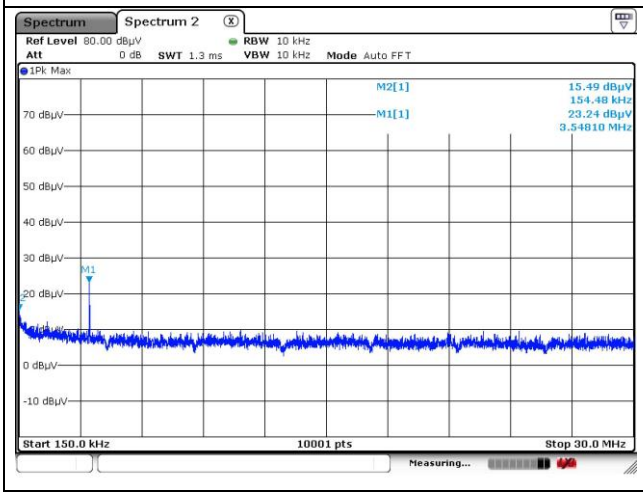
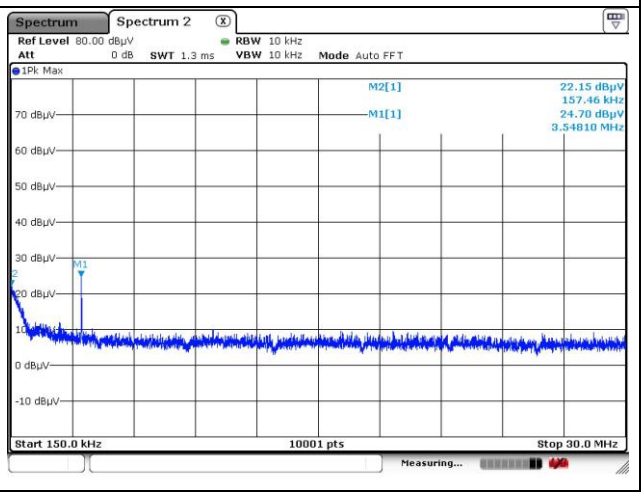
Mode: FSK

Distance of measurement: 3 meter

Channel: 1

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

Test plots (Below 30 ㎒)

Horizontal	Vertical
	
	

Test results (Below 1 000 ㎒)

Mode: FSK

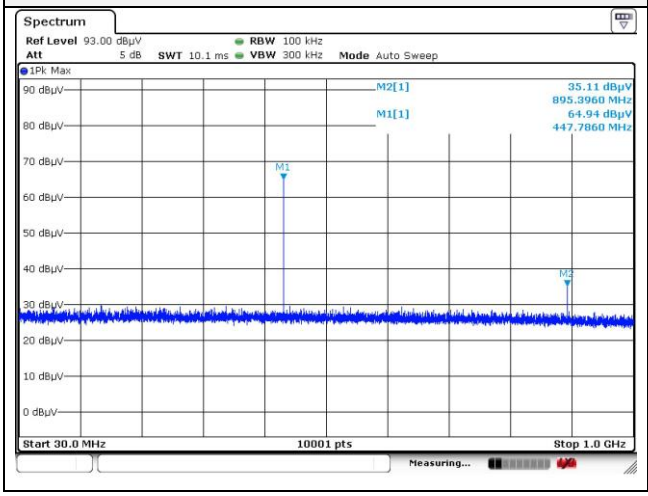
Distance of measurement: 3 meter

Channel: 1

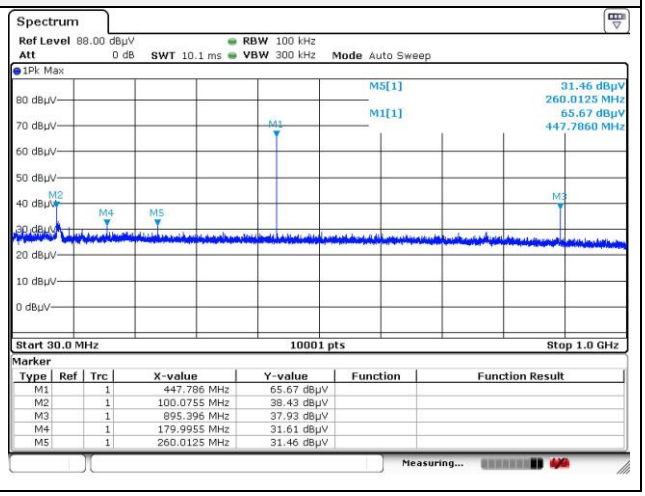
Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
100.076	38.43	Peak	V	-20.44	-	17.99	43.52	25.53
179.996	31.61	Peak	V	-22.42	-	9.19	43.52	34.33
260.013	31.46	Peak	V	-18.77	-	12.69	46.02	33.33
895.396	37.93	Peak	V	-7.32	-	30.61	46.02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

Test plots (Below 1 000 ㎒)

Horizontal



Vertical



Test results (Above 1 000 ㎒)

Mode: FSK

Distance of measurement: 3 meter

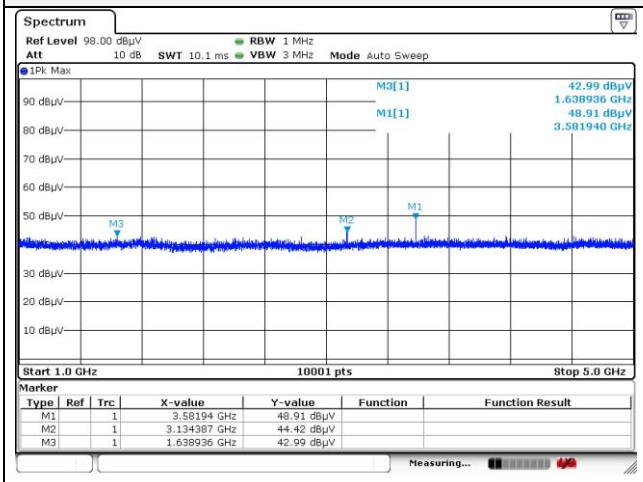
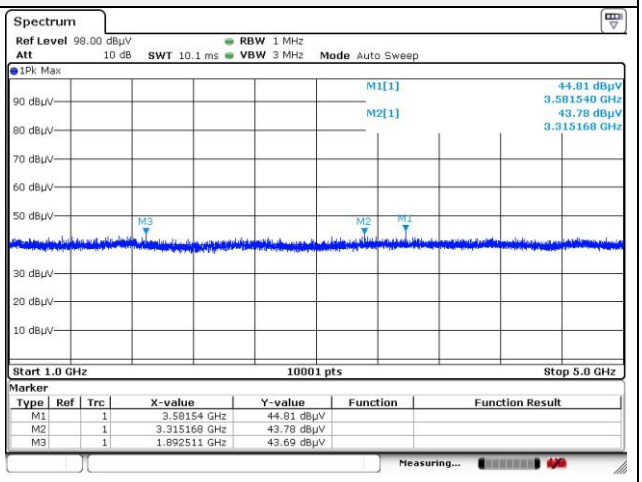
Channel: 1

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/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.

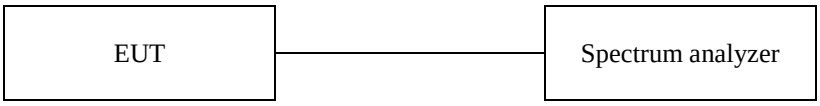
1. 3m PeakLimit(dB㎶/m) = 20log[41.6667($F_{(㎒)}$-7083.3333) = 81.27
   3m Average Limit(dB㎶/m) = Peak limit - 20 = 61.27
   Average Field strength = Peak Field strength + Duty Cycle Correction Factor
2. Correction Factors = Antenna Factor + Cable Loss + Amp.Gain
3. "*"means the restricted band.
4. Average test would not be applied if the peak results were lower than the average limit.
5. Duty Cycle Correction Factor : 20log(Ton / 100 ms) = 20log(32.94 / 100) = -9.65
   $Tx_{\text{on time}}$ = 32.94 ms
   $Tx_{\text{on+off}} \geq$ 100 ms (pulse train is 100 ms)

Test plots (Above 1 000 ㎒)

Horizontal	Vertical
	

3.2. Bandwidth of operation frequency

Test setup



Test procedure

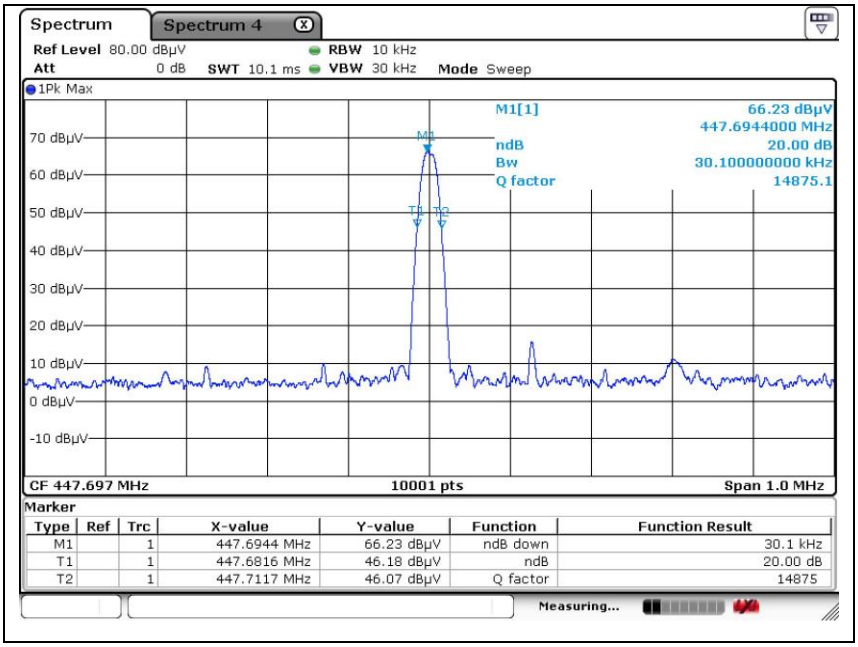
1. Use the following spectrum analyzer setting
2. RBW = 10 ㎑
3. VBW = 30 ㎑ (≥ RBW)
4. Span = 1 ㎒
5. Detector function = peak
6. Trace = max hold

Limit

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

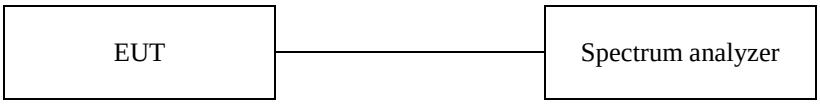
Test results

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



3.3. Transmission time

Test setup



Test procedure

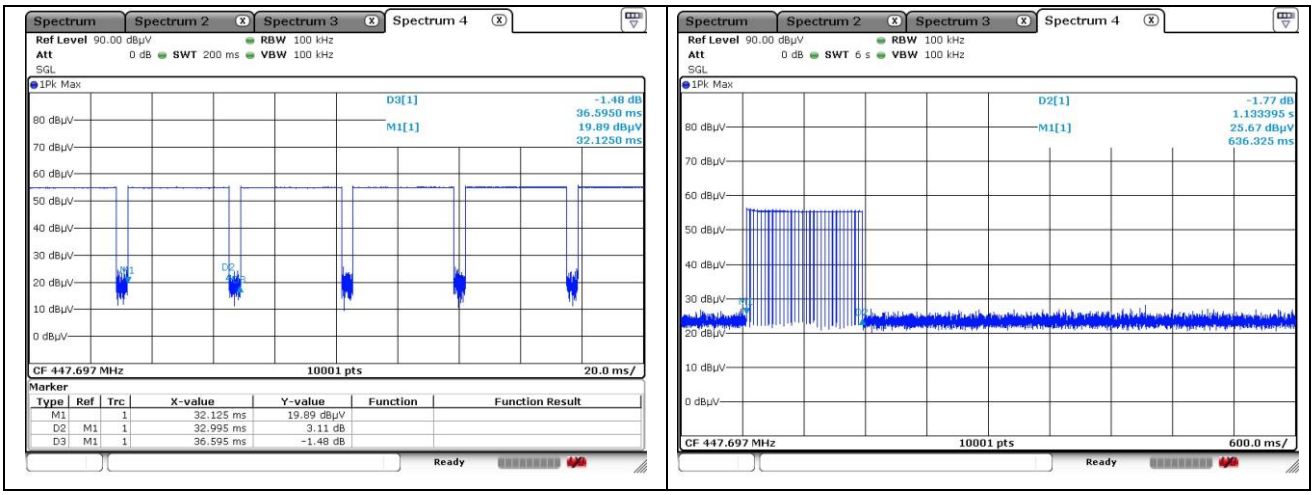
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW=100 ㎑, VBW=100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

Limit

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

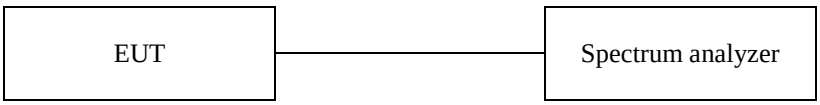
Test results

Frequency(㎒)	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 ㎑, VBW=100 ㎑, Span=0 ㎐ and Sweep time =100 ㎳.

Limit

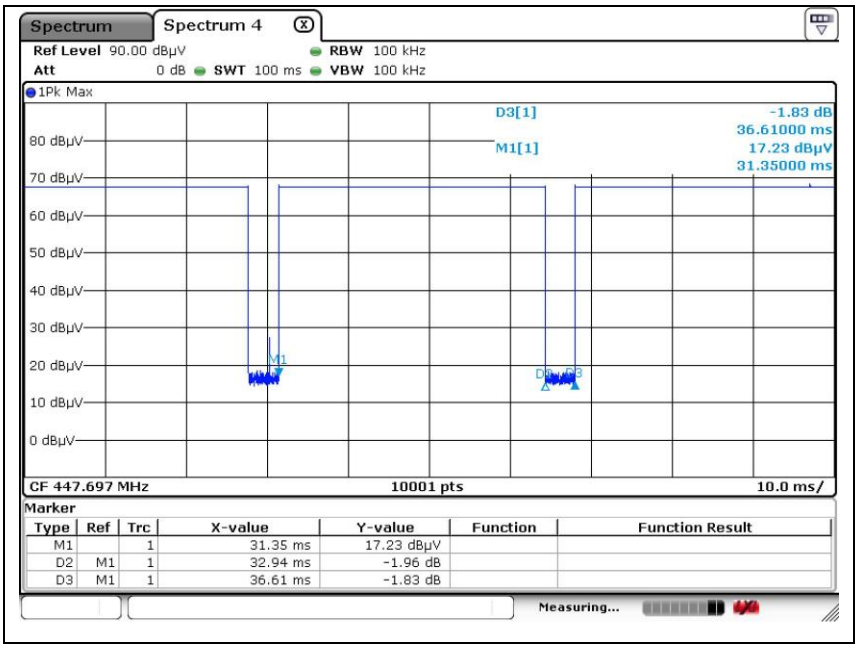
None (No dedicated Limit specified in the Rules)

Test results

Duty Cycle Correction Factor : 20log(Ton / 100 ms) = 20log(32.94 / 100) = -9.65

$Tx_{on\ time}$ = 32.94 ms

$Tx_{on+off} \geq$ 100 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.
-	-	-	-