RF TEST REPORT

Report No.: DDT-B24011002-2E01

Applicant	:	Sensata Technologies (Changzhou) Co., Ltd.
Applicant Address	:	No. 18, Chuangxin Road, Xinbei District, Changzhou City, Jiangsu, China, 213031
Equipment Under Test	:	TPMS Sensor
Model No.	:	AG5PF4
Series Model No.	:	N/A
Trade Mark	:	Sensata Technologies
FCC ID	:	2BAW4-AG5PF4
IC	:	N/A
Manufacturer	:	Sensata Technologies (Changzhou) Co., Ltd.
Manufacturer Address	:	No. 18, Chuangxin Road, Xinbei District, Changzhou City, Jiangsu, China, 213031

Issued By: Tianjin Dongdian Testing Service Co., Ltd.

Address: Building D-1, No. 19, West Road, Microelectronics Industrial Park, Development Area, Tianjin, China.

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REPORT

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Test Report Declare

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Address	:	No. 18, Chuangxin Road, Xinbei District, Changzhou City, Jiangsu, China, 213031

Test Standard Used:
FCC 47 CFR Part 15C;
Test Procedure Used:
ANSI C63.4-2014; ANSI C63.10-2020

We Declare:

The equipment described above is tested by Tianjin Dongdian Testing Service Co., Ltd and in the configuration tested the equipment complied with the standards specified above. The test results are contained in this test report and Tianjin Dongdian Testing Service Co., Ltd is assumed of full responsibility for the accuracy and completeness of these tests.

After test and evaluation, our opinion is that the equipment provided for test compliance with the requirement of the above standards.

Report No:	DDT-B24011002-2E01		
Date of Receipt:	Jan. 12, 2024	**Date of Test:**	Jan. 15, 2024 ~ Jan. 20, 2024

Prepared By: ***Approved By:***

Novak Wei

Aaron Zhang

Novak Wei/Engineer ***Aaron Zhang/Manager***

Note: This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Tianjin Dongdian Testing Service Co., Ltd.

The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Revision History

Rev.	Revisions	Issue Date	Revised By
---	Initial issue	Jan. 24, 2024	

1. Summary of Test Results

1.1. Summary of test result

Test Item	Standard	Result
Antenna requirement	§15.203	Pass
Restricted bands of operation	§15.205	Pass
Radiated emission limits, general requirements	§15.209 §15.231(e)	Pass
Periodic operation characteristics	§15.231(e)	Pass
Fundamental frequencies /Field strength limits	§15.231(e)	Pass
Bandwidth (20dB & 99%)	§15.231(c)	Pass

2. General Test Information

2.1. Description of EUT

EUT Description	:	TPMS Sensor
Model Number	:	AG5PF4
Series Model Number	:	N/A
Models difference	:	There are a total of 4 versions using the same model number. There are two storage methods for the main chip, one is the flash type and the other is the nvram type. In appearance, the sample has a metal mouth and a rubber mouth distinction, the rest of the hardware and software versions are exactly the same. This test used the metal mouth with flash type, and added the Radiated Emissions and Field strength test use metal mouth with nvram type.
Trade Mark	:	Sensata Technologies
Serial Number	:	N/A
Sample Type	:	Vehicle Device
Frequency Band	:	433.92 MHz
Number of Channel	:	1 Channel
Modulation	:	FSK
Antenna Type	:	Internal PCB loop antenna
Antenna Gain	:	MAX peak gain -24.5dbi
Power Supply	:	Internal 3V DC Lithium battery power supply

Note:

1. EUT is the abbreviation of equipment under test.
2. This EUT only support transmit function

2.2. Accessories of EUT

Description of Accessories	Manufacturer	Model number	Description	Remark
N/A	N/A	N/A	N/A	N/A

2.3. Assistant equipment used for test

Assistant equipment	Manufacturer	Model number	EMC Compliance	SN
TPMS Tool	BARTEC	N/A	N/A	3030020177

2.4. Block diagram of EUT configuration for test

2.5. Test environment conditions

During the measurement the environmental conditions were within the listed ranges:

Condition	Normal Condition	Extreme Condition
Pressure range	86-106KPa	N/A
Relative Humidity	30-75%	N/A
Temperature(℃)	NT: 25℃	LT: -40℃； HT: 125℃
Voltage(V)	NV: 3V	LV: 2.6V; HV:3.6V
Note: N/A: Not Applicable NV: Normal Voltage LV: Low Extreme Test Voltage HV: High Extreme Test Voltage		NT: Normal Temperature LT: Low Extreme Test Temperature HT: High Extreme Test Temperature

2.6. Test laboratory

Tianjin Dongdian Testing Service Co., Ltd.

Address: Building D-1, No. 19, Weisi Road, Microelectronics Industrial Park Development Area, Tianjin, China., 300385

Tel: +86-22-58038033, http://www.ddttest.com, Email: ddt@dgddt.com

NVLAP (National Voluntary Laboratory Accreditation Program) CODE: 500036-0

CNAS (China National Accreditation Service for Conformity Assessment) CODE: L13402

FCC Designation Number: CN5004; FCC Test Firm Registration Number: 368676

ISED (Innovation, Science and Economic Development Canada) Company Number: 27768

Conformity Assessment Body Identifier: CN0125

VCCI Facility Registration Number: C-20089, T-20093, R-20125, G-20122

3. Test Configuration

3.1. Test Mode

During testing, the interface cables and equipment positions were arranged according to standard ANSI C63.4 and ANSI C63.10.

All modes were tested in the laboratory, only worst cases shown in below table and recorded in this report.

Mode	Channel	Frequency	Condition
1	N/A	433.92 MHz	TX mode

4. Equipment Used During Test

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
RF Connected Test (MWRFtest system)					
Microwave Signal Generator	R&S	SMF100A	101396	2023/05/29	1 Year
MXG Vector Signal Generator	Keysight	N5182A	MY50143288	2023/03/07	1 Year
EMI Test Receiver	R&S	ESU26	100243	2023/03/03	1 Year
Wideband Radio Communication Tester	R&S	CMW500	158800	2023/06/20	1 Year
Power Sensor	KEYSIGHT	U2021XA	MY59150007	2023/03/22	1 Year
DC Power Supply	inSTEK	PSP-2010	EN122317	2023/02/12	1 Year
Test Software	MWRFtest	MTS8310	V03	N/A	N/A
Radiated Emission -10m EMI Chamber					
Broadband Horn Antenna	TESEQ	BHA 9118	31754	2023/10/11	1 Year
Broad Band Horn Antenna	Schwarzbeck	BBHA 9170	790	2023/05/06	1 Year
Low noise amplifier	MITEQ	TPA0118-36	0914	2023/02/16	1 Year
EMI Test Receiver	R&S	ESCI	101024	2023/02/15	1 Year
EMI Test Receiver	R&S	ESCI	101030	2023/02/15	1 Year
EMI Test Receiver	R&S	ESU26	100244	2023/03/03	1 Year
Bilog Antenna	TESEQ	CBL6112D	29068	2022/10/10	2 Year
Bilog Antenna	TESEQ	CBL6112D	29069	2022/10/10	2 Year
Amplifier	Sonoma	310N	300913	2023/02/15	1 Year
Amplifier	Sonoma	310N	300914	2023/02/15	1 Year
Ant Mast	Innco	MA4000	N/A	N/A	N/A
Ant Mast	Innco	MA4000	N/A	N/A	N/A
Mast Controller	Innco	CO2000	N/A	N/A	N/A
Mast Controller	Innco	CO2000	N/A	N/A	N/A
RF Selector 4CH	TOYO	NS4904N	Selector1	N/A	N/A
RF Selector 4CH	TOYO	NS4904N	Selector2	N/A	N/A
Test software	TOYO	EP5/RSE	Ver 1.9.1	N/A	N/A
Test software	Audix	E3	V 6.11111b	N/A	N/A

5. Measurement uncertainty

No.	Test Item	Uncertainty
1	RF frequency	3×10^{-8}
2	Radiated RF power	±3.57dB
3	Peak Output Power(Conducted)(Spectrum analyzer)	0.86dB(10 MHz ≤ f < 3.6GHz);
		1.38dB(3.6GHz≤ f < 8GHz)
4	Peak Output Power(Conducted)(Power Sensor)	0.74dB
5	Bandwidth	0.14%
6	Radiated Emissions	±3.57dB (f<26GHz)
7	Temperature	±0.4℃
8	Humidity	±2%
Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

6. Antenna requirement

6.1. Regulation

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§ 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

6.2. Result

Test Item	Verdict
The equipment meets the requirements	Yes

7. Restricted bands of Operation

7.1. Regulation

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495 - 0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	
13.36–13.41			

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.

(d) The following devices are exempt from the requirements of this section:

(1) Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph (a) of this section, the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a) of this

section, and the fundamental emission is outside of the bands listed in paragraph (a) of this section more than 99% of the time the device is actively transmitting, without compensation for duty cycle.

(2) Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.

(3) Cable locating equipment operated pursuant to § 15.213.

(4) Any equipment operated under the provisions of §§ 15.255 and 15.256 in the frequency band 75–85 GHz, § 15.257 in the 92–95 GHz band or § 15.258.

(5) Biomedical telemetry devices operating under the provisions of § 15.242 of this part are not subject to the restricted band 608–614 MHz but are subject to compliance within the other restricted bands.

(6) Transmitters operating under the provisions of subparts D or F of this part.

(7) Devices operated pursuant to § 15.225 are exempt from complying with this section for the 13.36–13.41 MHz band only.

(8) Devices operated in the 24.075–24.175 GHz band under § 15.245 are exempt from complying with the requirements of this section for the 48.15–48.35 GHz and 72.225–72.525 GHz bands only, and shall not exceed the limits specified in § 15.245(b).

(9) Devices operated in the 24.0–24.25 GHz band under § 15.249 are exempt from complying with the requirements of this section for the 48.0–48.5 GHz and 72.0–72.75 GHz bands only, and shall not exceed the limits specified in § 15.249(a).

(10) White space devices operating under subpart H of this part are exempt from complying with the requirements of this section for the 608–614 MHz band.

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of § 15.245 shall not exceed the limits specified in § 15.245(b).

7.2. Result

Test Item	Verdict
The equipment meets the requirements	Yes

8. Radiated Spurious Emission

8.1. Regulation limit

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100	3
88–216	150	3
216–960	200	3
Above 960	500	3

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

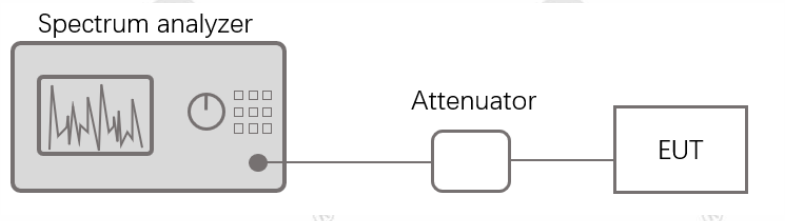
(f) In accordance with § 15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in § 15.109 and as based on the frequency of

the emission being measured, or, except for emissions contained in the restricted frequency bands shown in § 15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in § 15.109 that are applicable to the incorporated digital device.

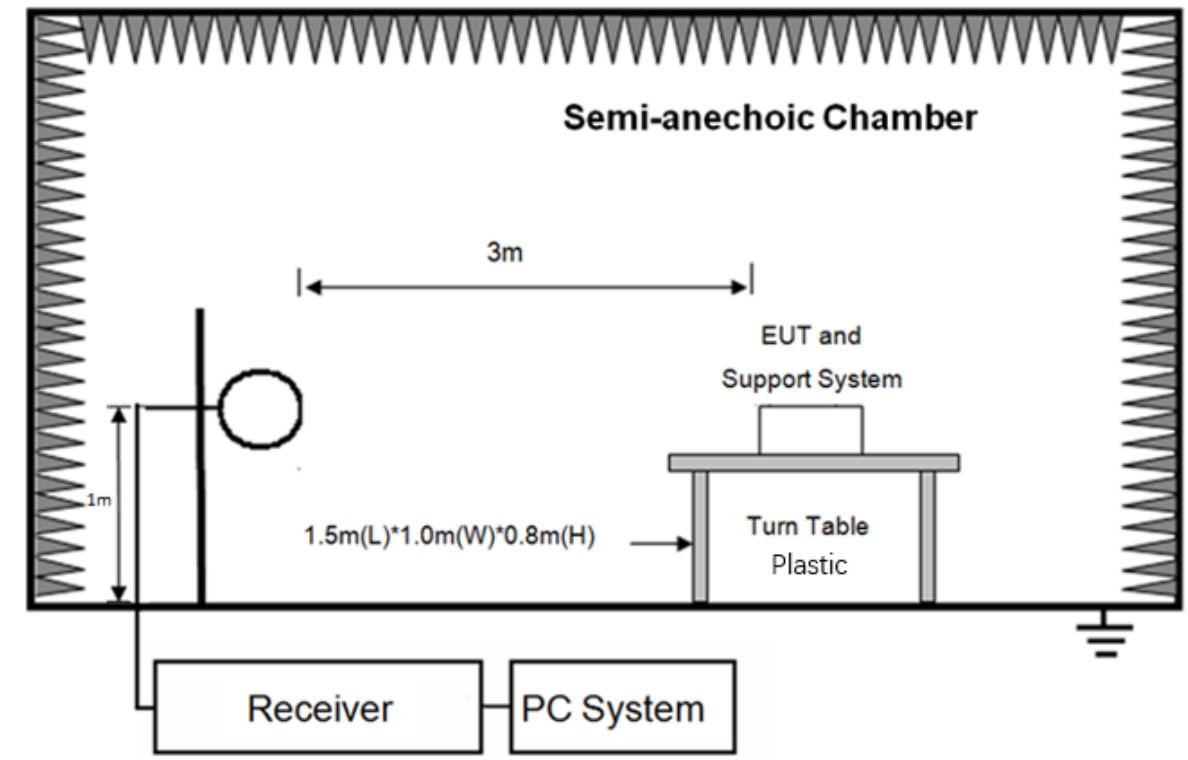
(g) Perimeter protection systems may operate in the 54–72 MHz and 76–88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

8.2. Block diagram of test setup

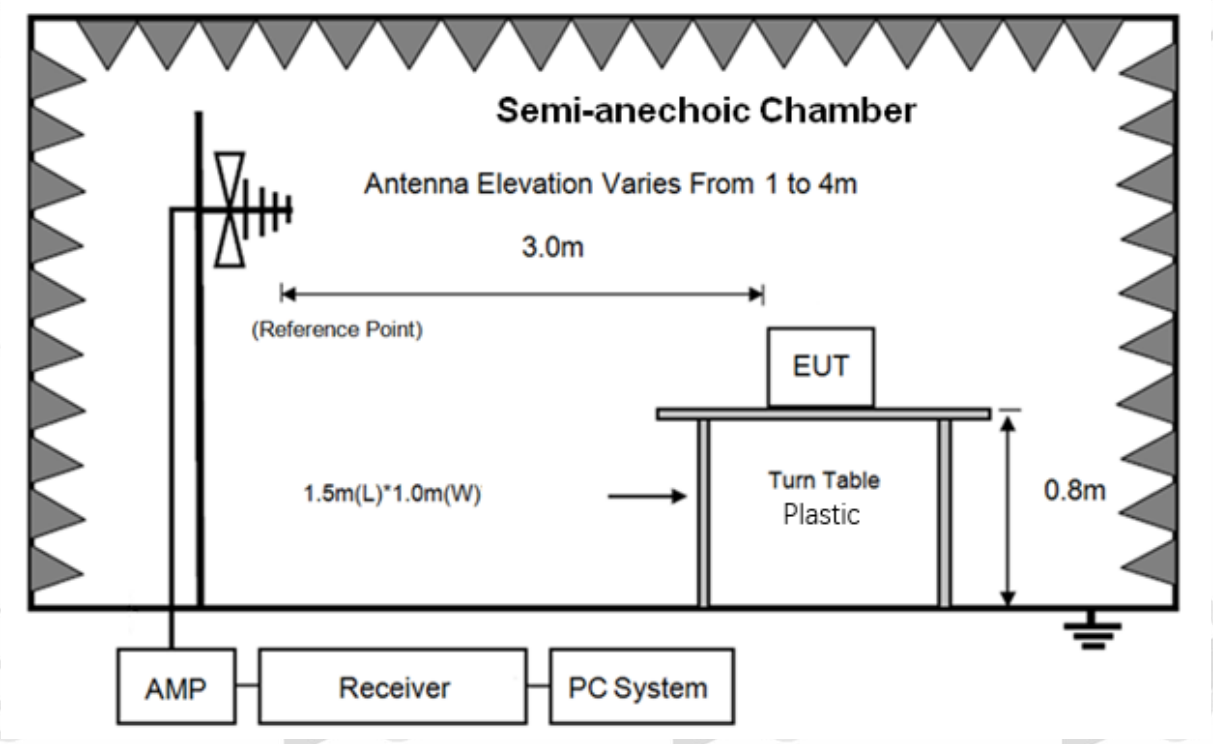
Conducted Measurement Test setup:



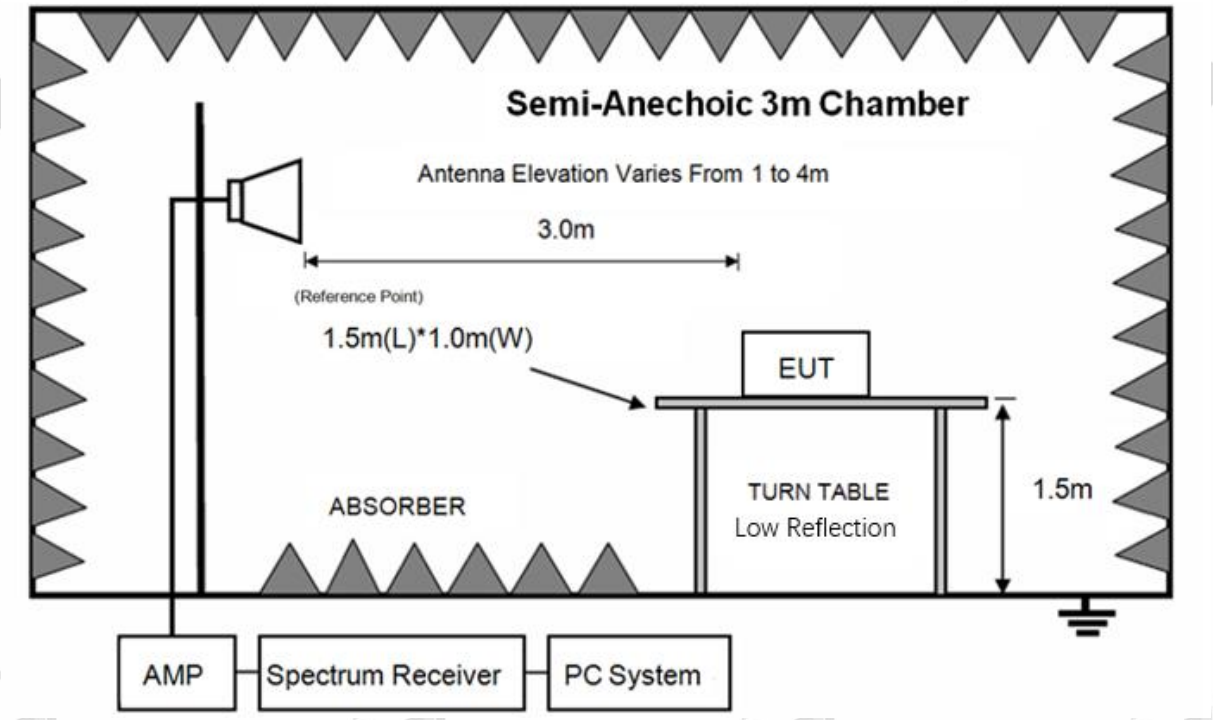
Radiated Measurement Test setup:
In 3 m Anechoic Chamber, test setup diagram for 9 kHz - 30 MHz:



In 3 m Anechoic Chamber, test setup diagram for 30 MHz – 1 GHz:



In 3 m Anechoic Chamber, test setup diagram for frequency above 1 GHz:



8.3. Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a tur table which is 0.8m above the ground. The turn table would be allowed to rotate 360 degrees to determine the position of the maximum emission level. The test distance between the EUT and

the receiving antenna are 3m. To find the maximum emission. the polarization of the receiving antenna 1s changed in horizontal and vertical polarization: the position of the EUT was changed indifferent orthogonal determinations.

In the frequency range of 9kHz to 30MHz, magnetic field measurements may be performed. This method is applicable for radiated radio noise from all units, cables, power cords, and interconnect cabling or wiring. A calibrated loop antenna shall be positioned with its plane vertical at the specified distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. For certain applications, the loop antenna may also need to be positioned horizontally at the specified distance from the EUT. The center of the loop shall be 1 m above the ground.

Measurement procedures for electric field radiated emissions above 1 GHz are covered in Clause 8 of ANSI C63.4. The ANSI C63.4 measurement procedure consists of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation. antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. The measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." We consider the "cone of radiation" to be the 3 dB beamwidth of the measurement antenna.

While the "bore-sighting" technique is not explicitly mentioned in ANSI C63.4. it is a useful technique for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including. knowledge of the beamwidth of the antenna and the result illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTS, measuring system sensitivity. Etc.

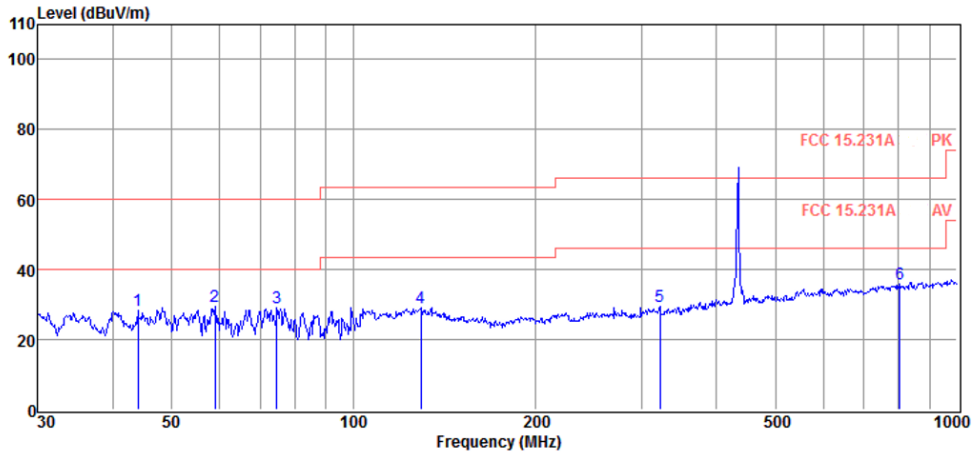
ANSI C63.4 requires that the measurement antenna 1s kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the EUT results in a maximum emission at an upwards angle from the EUT. when a directional antenna is used to make the measurements it will be necessary for it to be pointed towards the source of the

emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission, or by rotating the EUT, in both height and polarization, to maximize the measured emission. The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission f om the EUT is measured

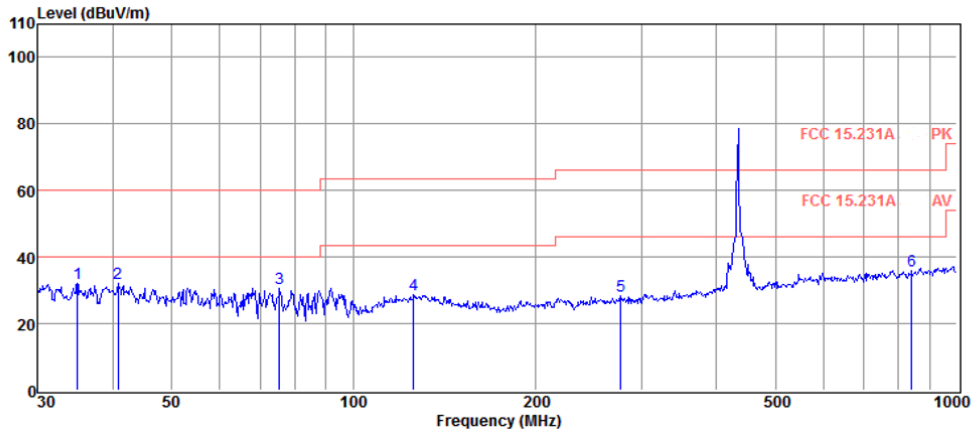
Radiated emissions test characteristics	
Frequency range	30 MHz-4000 MHz
Test distance	3m
Test instrumentation resolution bandwidth	120 KHz (30 MHz-1000 MHz)
	1 MHz (1000 MHz-4000 MHz)
Receive antenna scan height	1m-4m
Receive antenna polarization	Vertical / Horizontal

8.4. Flash Test result

Below 1G

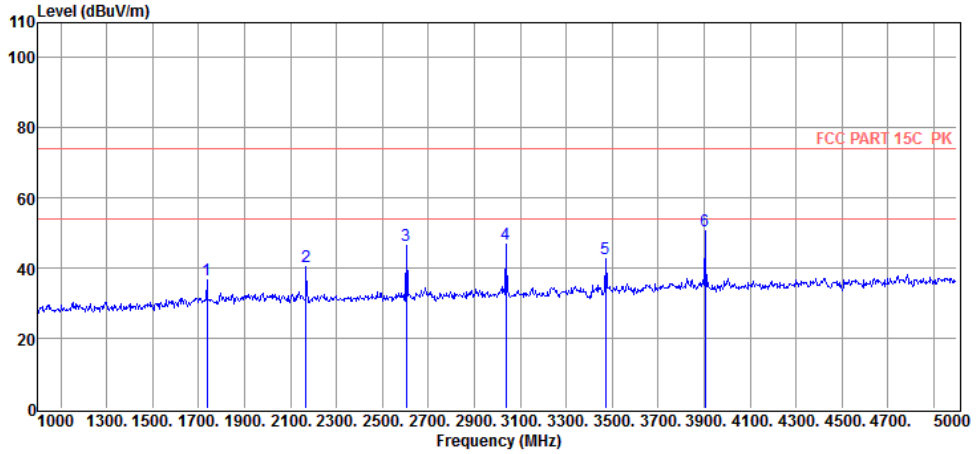


Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	43.97	42.64	21.82	-36.20	28.26	40.00	-11.74	Peak	1.3	HORIZONTAL
2	59.03	48.62	16.69	-36.01	29.30	40.00	-10.70	Peak	1.4	HORIZONTAL
3	74.66	50.97	14.10	-36.06	29.01	40.00	-10.99	Peak	1.4	HORIZONTAL
4	129.47	46.22	18.90	-35.99	29.13	43.50	-14.37	Peak	1.5	HORIZONTAL
5	322.19	45.19	19.66	-35.38	29.47	46.00	-16.53	Peak	1.5	HORIZONTAL
6	804.60	45.10	25.59	-34.71	35.98	46.00	-10.02	Peak	1.5	HORIZONTAL

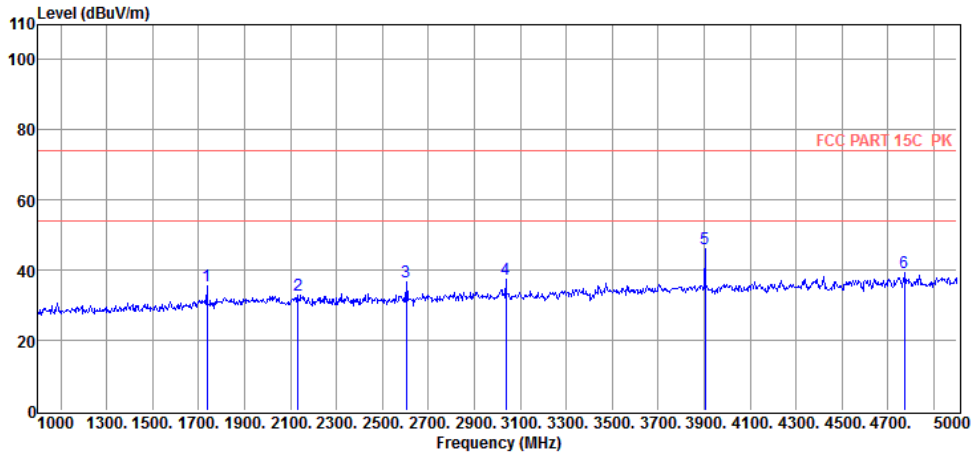


Item (Mark)	Freq. (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBμV/m)	Limit Line (dBμV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	34.88	42.06	26.35	-36.27	32.14	40.00	-7.86	Peak	1.1	VERTICAL
2	40.70	45.09	23.24	-36.25	32.08	40.00	-7.92	Peak	1.3	VERTICAL
3	75.45	52.76	14.06	-36.06	30.76	40.00	-9.24	Peak	1.3	VERTICAL
4	125.89	45.57	18.98	-36.01	28.54	43.50	-14.96	Peak	1.4	VERTICAL
5	277.09	45.29	18.66	-35.55	28.40	46.00	-17.60	Peak	1.4	VERTICAL
6	842.13	44.97	25.74	-34.62	36.09	46.00	-9.91	Peak	1.5	VERTICAL

Above 1G



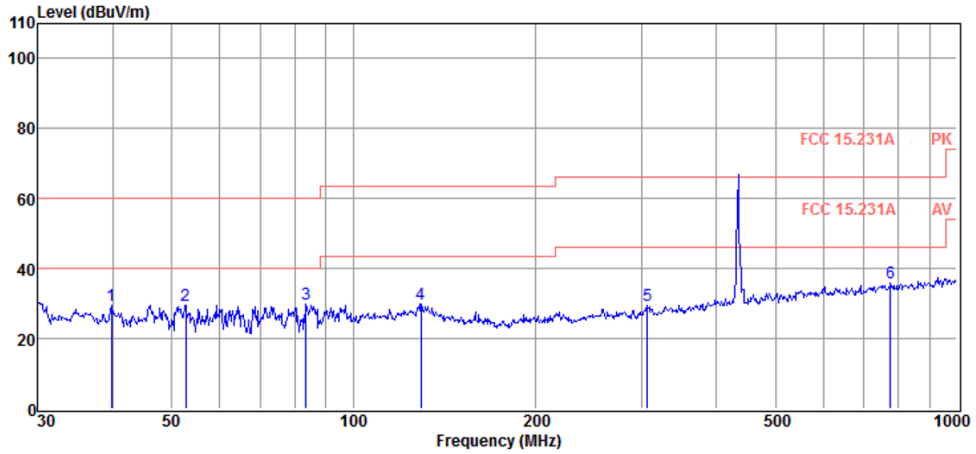
Item (Mark)	Freq. (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBμV/m)	Limit Line (dBμV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	1736.00	44.20	26.96	-34.48	36.68	54.00	-17.32	Peak	1.5	HORIZONTAL
2	2168.00	46.18	28.36	-34.26	40.28	54.00	-13.72	Peak	1.5	HORIZONTAL
3	2604.00	51.81	28.17	-33.51	46.47	54.00	-7.53	Peak	1.6	HORIZONTAL
4	3036.00	51.06	29.29	-33.43	46.92	54.00	-7.08	Peak	1.6	HORIZONTAL
5	3472.00	45.62	30.33	-33.09	42.86	54.00	-11.14	Peak	1.6	HORIZONTAL
6	3904.00	52.18	31.37	-33.01	50.54	54.00	-3.46	Peak	1.6	HORIZONTAL



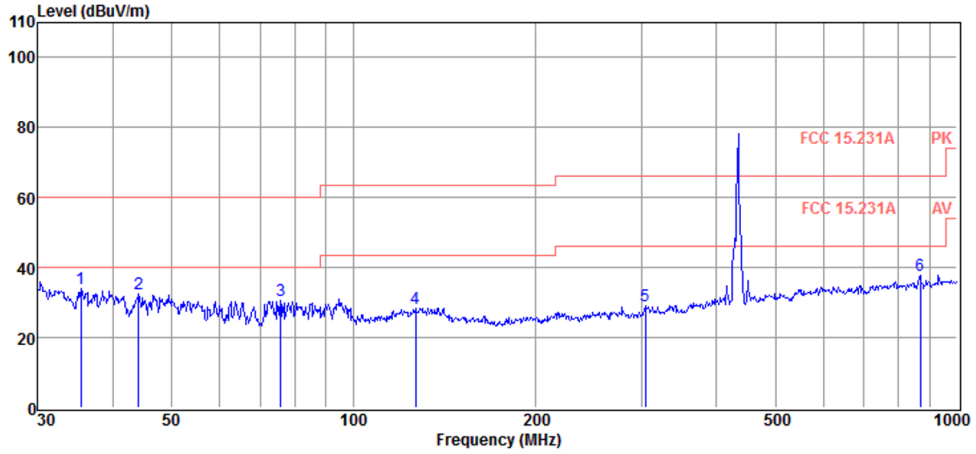
Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	1736.00	42.97	26.96	-34.48	35.45	54.00	-18.55	Peak	1.5	VERTICAL
2	2132.00	38.87	28.42	-34.29	33.00	54.00	-21.00	Peak	1.5	VERTICAL
3	2604.00	42.17	28.17	-33.51	36.83	54.00	-17.17	Peak	1.5	VERTICAL
4	3036.00	41.53	29.29	-33.43	37.39	54.00	-16.61	Peak	1.5	VERTICAL
5	3904.00	47.69	31.37	-33.01	46.05	54.00	-7.95	Peak	1.6	VERTICAL
6	4772.00	39.10	32.44	-32.15	39.39	54.00	-14.61	Peak	1.6	VERTICAL

8.5. Nvram Test result

Below 1G

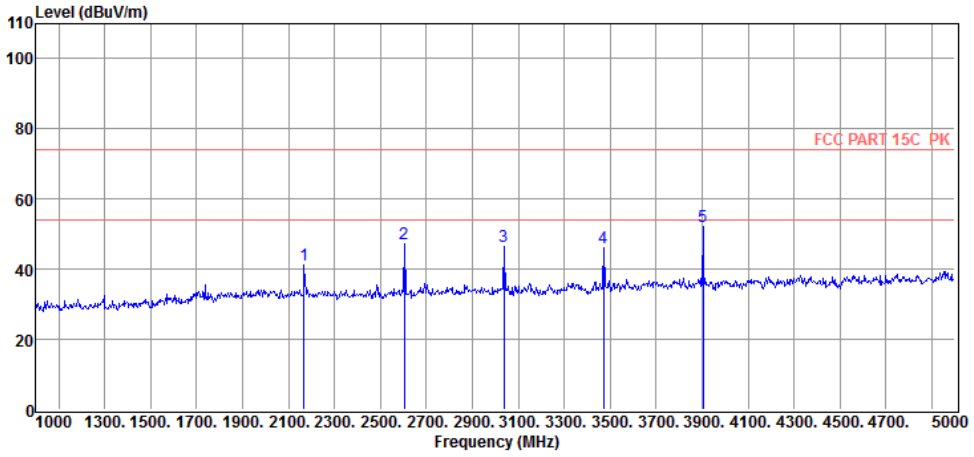


Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	39.72	41.92	23.91	-36.26	29.57	40.00	-10.43	Peak	1.3	HORIZONTAL
2	52.76	47.33	18.27	-36.07	29.53	40.00	-10.47	Peak	1.4	HORIZONTAL
3	83.52	52.91	13.05	-36.08	29.88	40.00	-10.12	Peak	1.4	HORIZONTAL
4	129.47	47.11	18.90	-35.99	30.02	43.50	-13.48	Peak	1.5	HORIZONTAL
5	306.75	45.17	19.67	-35.46	29.38	46.00	-16.62	Peak	1.5	HORIZONTAL
6	776.88	45.11	25.41	-34.78	35.74	46.00	-10.26	Peak	1.5	HORIZONTAL

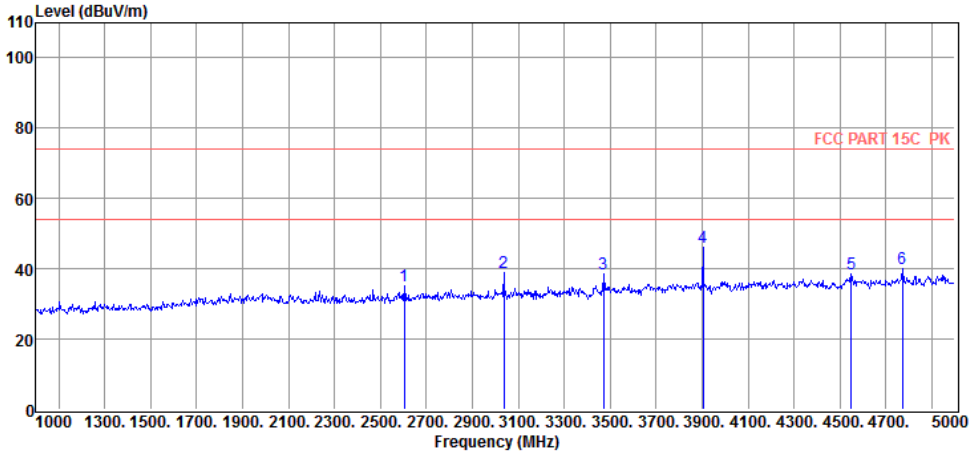


Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	35.38	44.04	26.15	-36.26	33.93	40.00	-6.07	Peak	1.3	HORIZONTAL
2	44.12	46.91	21.72	-36.19	32.44	40.00	-7.56	Peak	1.4	HORIZONTAL
3	75.71	52.60	14.03	-36.07	30.56	40.00	-9.44	Peak	1.4	HORIZONTAL
4	126.77	45.63	18.92	-36.01	28.54	43.50	-14.96	Peak	1.5	HORIZONTAL
5	304.61	44.94	19.56	-35.45	29.05	46.00	-16.95	Peak	1.5	HORIZONTAL
6	869.13	46.24	26.07	-34.67	37.64	46.00	-8.36	Peak	1.5	HORIZONTAL

Above 1G



Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	1264.00	39.07	24.56	-34.91	28.72	54.00	-25.28	Peak	1.5	HORIZONTAL
2	1996.00	37.80	28.58	-34.39	31.99	54.00	-22.01	Peak	1.5	HORIZONTAL
3	2482.00	37.67	27.93	-33.82	31.78	54.00	-22.22	Peak	1.6	HORIZONTAL
4	3037.00	46.42	29.29	-33.43	42.28	54.00	-11.72	Peak	1.6	HORIZONTAL
5	3472.00	49.53	30.33	-33.09	46.77	54.00	-7.23	Peak	1.6	HORIZONTAL
6	3907.00	48.88	31.38	-33.00	47.26	54.00	-6.74	Peak	1.6	HORIZONTAL



Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Antenna Height (m)	Polarization
1	1258.00	38.59	24.53	-34.92	28.20	54.00	-25.80	Peak	1.5	VERTICAL
2	1999.00	37.78	28.59	-34.43	31.94	54.00	-22.06	Peak	1.5	VERTICAL
3	2653.00	36.27	28.30	-33.25	31.32	54.00	-22.68	Peak	1.5	VERTICAL
4	3124.00	37.56	29.50	-33.29	33.77	54.00	-20.23	Peak	1.5	VERTICAL
5	3472.00	45.48	30.33	-33.09	42.72	54.00	-11.28	Peak	1.6	VERTICAL
6	3904.00	44.89	31.37	-33.01	43.25	54.00	-10.75	Peak	1.6	VERTICAL

9. Periodic operation characteristics

9.1. Regulation

Devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

9.2. Result

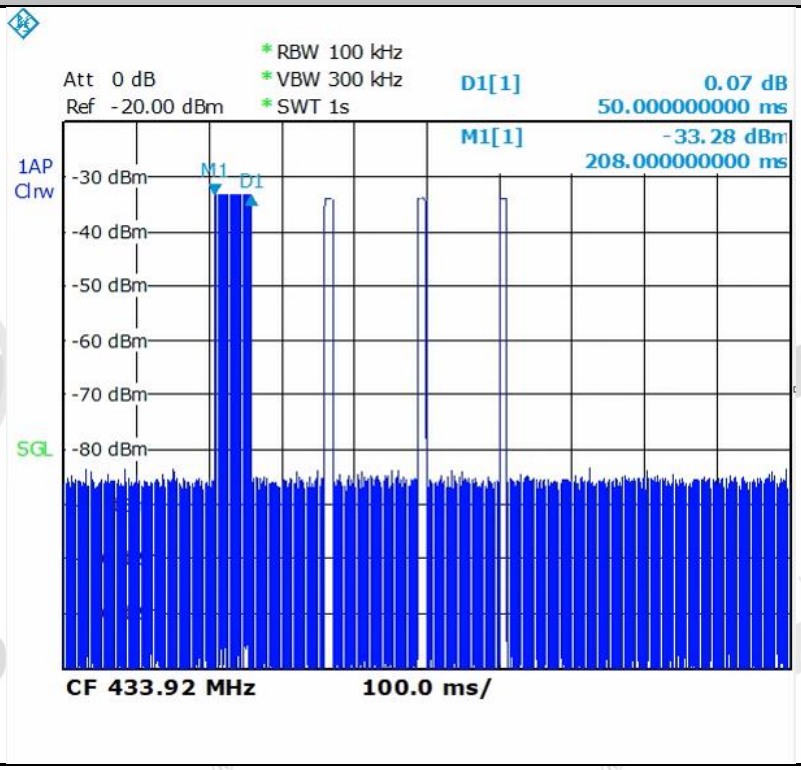
The intentional radiator complies with the provisions of paragraph (e) of FCC CFR § 15.231.

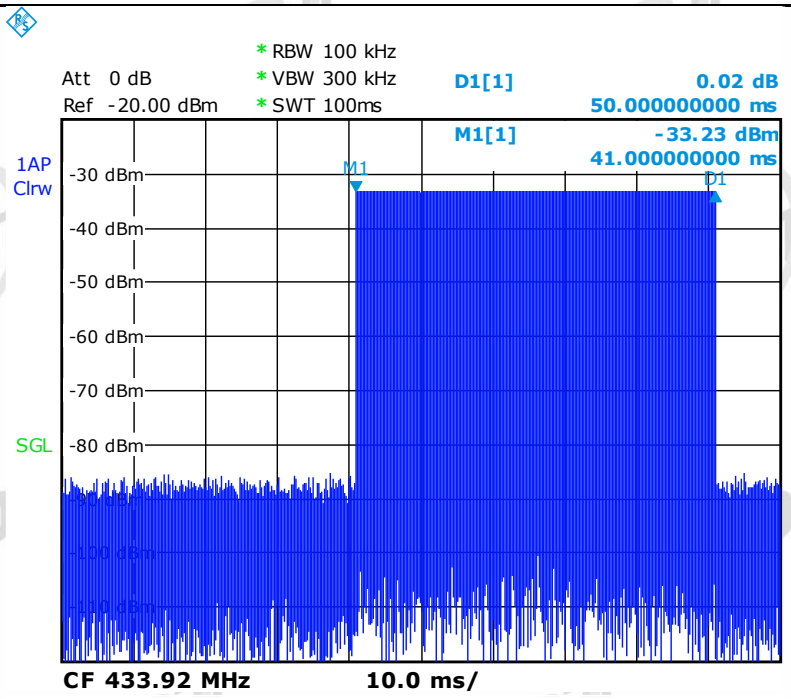
Modulation	Transmission Time Result (s)	Silent period Result (s)	Transmission Time Limit (s)	Silent period Limit (s)	Result
FSK	0.055	61.6	1	10	Pass

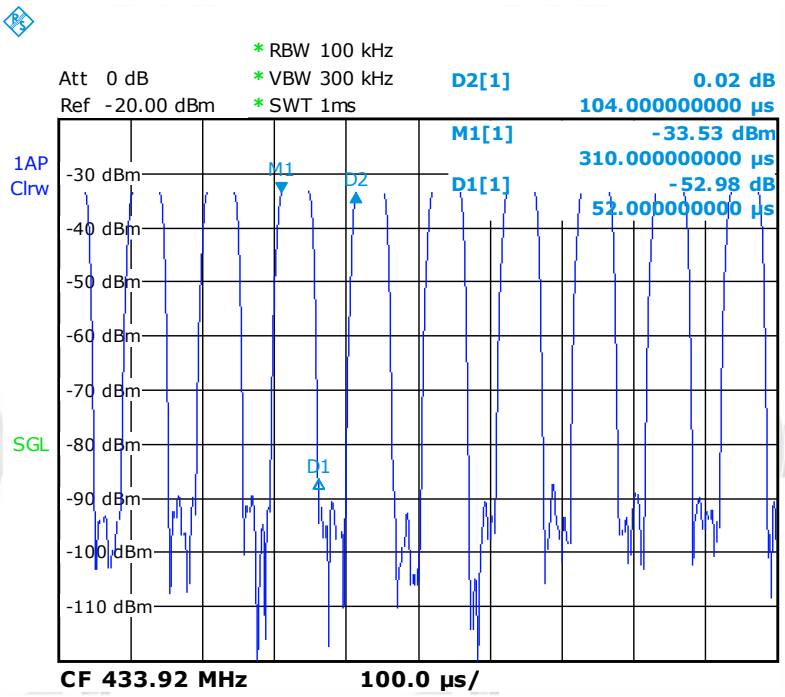
Note:

1.Transmission time=T1+3*T2=25ms+3*10ms=55ms

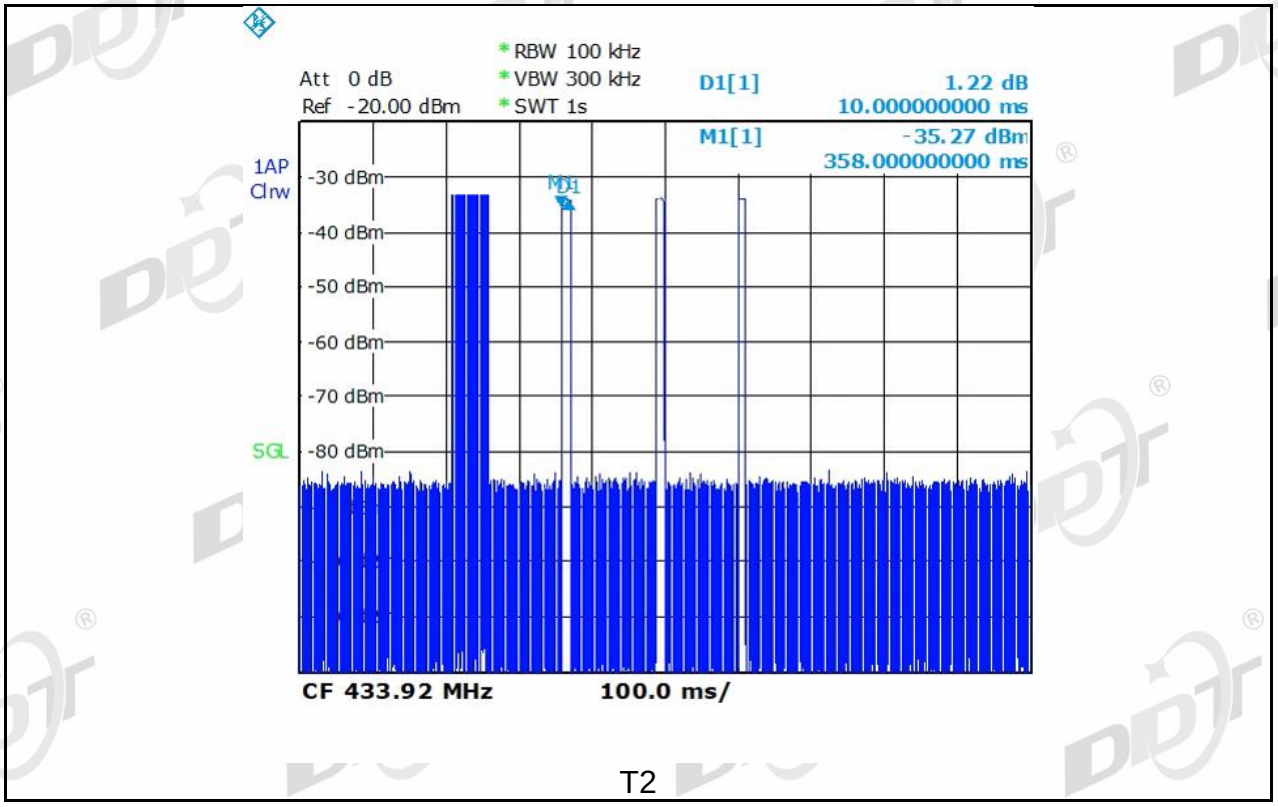
2. T1 = Ton1N1,+ Ton2N2,+ ... + TOnnNn.= 50ms x (52us/104us)=25ms

Transmission time



* RBW 100 kHz
Att 0 dB
* VBW 300 kHz
Ref -20.00 dBm
* SWT 100ms
D1[1]
0.02 dB
50.000000000 ms
M1[1]
-33.23 dBm
41.000000000 ms
1AP
Clrw
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
SGL
-80 dBm
M1
D1
CF 433.92 MHz
10.0 ms/

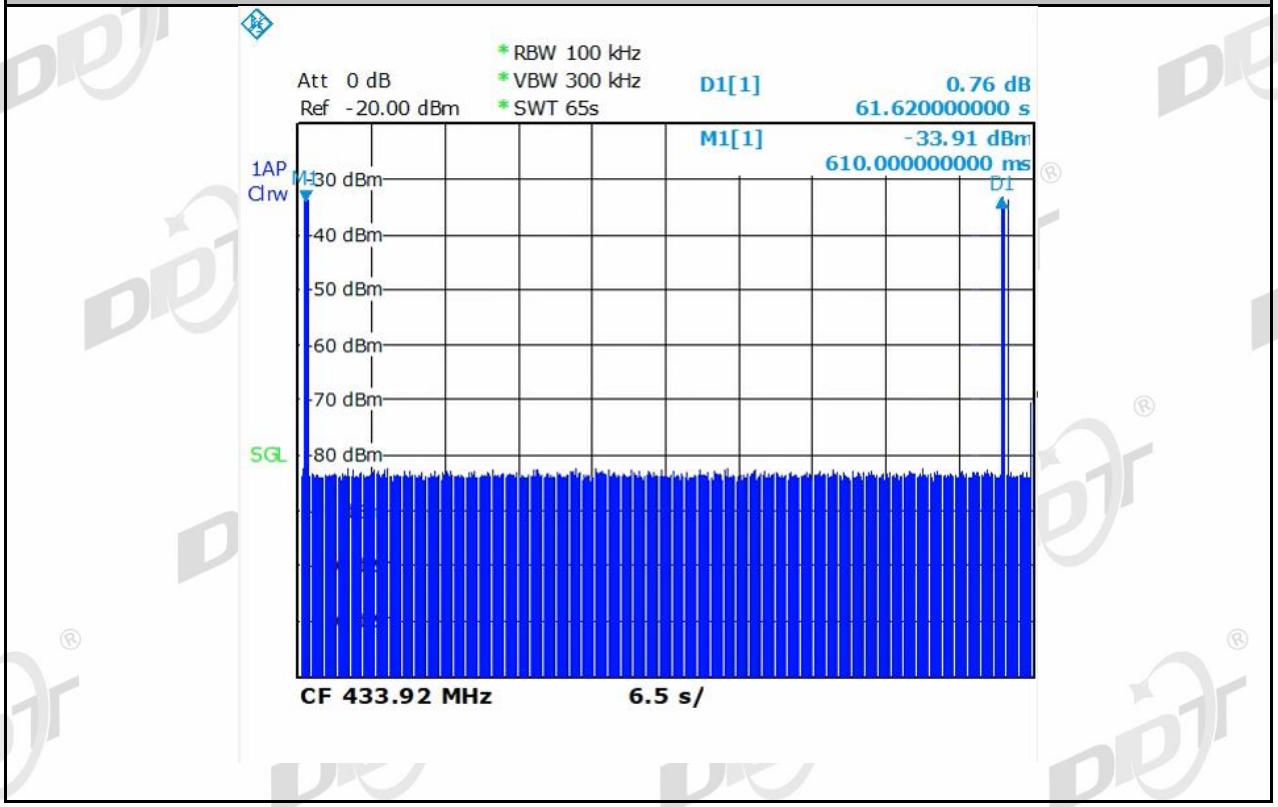

* RBW 100 kHz
Att 0 dB
* VBW 300 kHz
Ref -20.00 dBm
* SWT 1ms
D2[1]
0.02 dB
104.000000000 µs
M1[1]
-33.53 dBm
310.000000000 µs
D1[1]
-52.98 dB
52.000000000 µs
1AP
Clrw
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
SGL
-80 dBm
-90 dBm
-100 dBm
-110 dBm
M1
D2
D1
CF 433.92 MHz
100.0 µs/

T1



T2

Silent period



10. Fundamental frequencies/Field strength

10.1. Regulation limit

Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) of this section and may be employed for any type of operation, including operation prohibited in paragraph (a) of this section, provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this section, except the field strength table in paragraph (b) of this section is replaced by the following:

Fundamental Frequency (MHz)	Field strength of Fundamental (microvolts/meter)	Field strength of spurious emission (microvolts/meter)
40.66-40.70	1000	100
70-130	500	50
130-174	500 to 1500	50 to 150
174-260	1500	150
260-470	1500 to 5000	150 to 500
Above 470	5000	500

#Linear interpolation with frequency, f, in MHz:

For 130-174 MHz: Field Strength (uV/m) = (22.73 x f)-2454.55
For 260-470 MHz: Field Strength (uV/m) = (16.67 x f)-2833.33

10.2. Block diagram of test setup

Refer to 8.2.

10.3. Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a tum table which is 0.8m above the ground. The turn table would be allowed to rotate 360 degrees to determine the position of the maximum emission level. The test distance between the EUT and the receiving antenna are 3m. To find the maximum emission, the polarization of the receiving antenna are changed in horizontal and vertical polarization. the position of the EUT was changed indifferent orthogonal determinations.

Measurement procedures for electric field radiated emissions above 30MHz below 1 GHz are covered in ANSI C63 4. The ANSI C63.4 measurement procedure consists of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation. antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest

amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it 1s necessary to maximize the measured radiated emission. ANSI C63.4 states that the measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." We consider the “*cone of radiation” to be the 3 dB beamwidth of the measurement antenna.

While the "bore-sighting" technique is not explicitly mentioned in ANSI C63.4, it is a useful technique for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed. including: knowledge of the beamwidth of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTS, measuring system sensitivity. etc.

ANSI C63.4 requires that the measurement antenna is kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the EUT results in a maximum emission at an upwards angle from the EUT, when a directional antenna 1s used to make the measurement it will be necessary for it to be pointed towards the source of the emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission. or by rotating the EUT. in both height and polarization. to maximize the measured emission The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured

when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 s (100 ms). In cases where the pulse train exceeds 0.1 s, the measured field strength shall be determined during a 0.1 s interval. The following procedure is an example of how the average value may be determined. The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown in Equation:

$$\delta(\mathrm{dB}) = 20\log(\Delta)$$

where

δ is the duty cycle correction factor (dB)
Δ is the duty cycle (dimensionless)

This correction factor may then be subtracted from the peak pulse amplitude (in dB) to find the

average emission. This correction may be applied to all emissions that demonstrate the same pulse timing characteristics as the fundamental emission (e.g., the fundamental and harmonic emissions). In cases where the pulse train is truly random or pseudo random, some regulatory agencies might accept a declaration by the manufacturer of the worst-case value of t_{ON}. The duty cycle correction is determined as follows:

a) Adjust and configure any EUT switches, controls, or input data streams to ensure that the EUT is transmitting or encoded to obtain the “worst-case” pulse ON time.

b) Couple the final radio frequency output signal to the input of a spectrum analyzer. This may be performed by a radiated, direct connection (i.e., conducted) or by a “near-field” coupling method. The signal received shall be of sufficient level to trigger adequately the spectrum analyzer sweep display.

NOTE—If the bandwidth of the pulse is greater than the RBW of the spectrum analyzer, then a similar measurement may be performed using a wideband digital storage oscilloscope (DSO).

c) Adjust the center frequency of the spectrum analyzer to the center of the RF signal.

d) Set the spectrum analyzer for ZERO SPAN.

e) Adjust the SWEEP TIME to obtain at least a 100 ms period of time on the horizontal display axis of the spectrum analyzer.

f) If the pulse train is periodic (i.e., consists of a series of pulses that repeat in a characteristic pattern over a constant time period), and the period (T) is less than or equal to 100 ms, then:

1) Set the TRIGGER on the spectrum analyzer to capture at least one period of the pulse train, including any blanking intervals.

2) Determine the total maximum pulse “ON time” (t_{ON}) over one period of the pulse train. If the pulse train contains pulses of different widths, then t_{ON} is determined by summing the duration of all of the pulses within the pulse train [i.e., $t_{ON} = \Sigma(t1 + t2 + \ldots tn)$].

3) The duty cycle is then determined by dividing the total maximum “ON time” by the period of the pulse train (t_{ON}/T).

g) If the pulse train is nonperiodic or is periodic with a period that exceeds 100 ms, or as an alternative to step f), then:

1) Set the TRIGGER on the spectrum analyzer to capture the greatest amount of pulse “ON time” over 100 ms.

2) Find the 100 ms period that contains the maximum “on time”; this could require summing the duration of multiple pulses as described in step f2).

3) Determine the duty cycle by dividing the total maximum “ON time” by 100 ms (t_{ON}/100 ms).

10.4. Flash Test result

Item (Mark)	Freq. (MHz)	Result Level (PK) (dBμV/m)	Result Level (AV) (dBμV/m)	Limit Line (PK) (dBμV/m)	Limit Line (AV) (dBμV/m)	Over Limit (dB)	Detector	Polarization
1	433.92	66.95	54.95	92.9	72.9	-17.95	PK	H
2	433.92	74.11	62.11	92.9	72.9	-10.79	PK	V

Note:

1.Calculate Average value based on Duty Cycle correction factor:

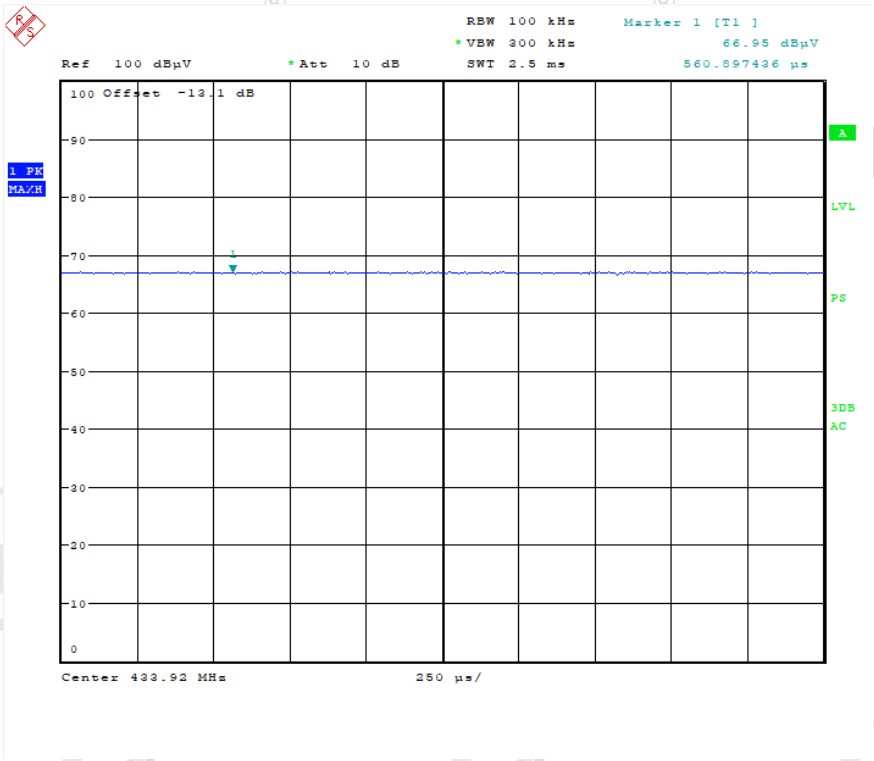
Ton = Ton_1N_1,+ Ton_2N_2,+ ... + TOn_nN_n.= 50ms x (52us/104us)=25ms

Tp=100ms

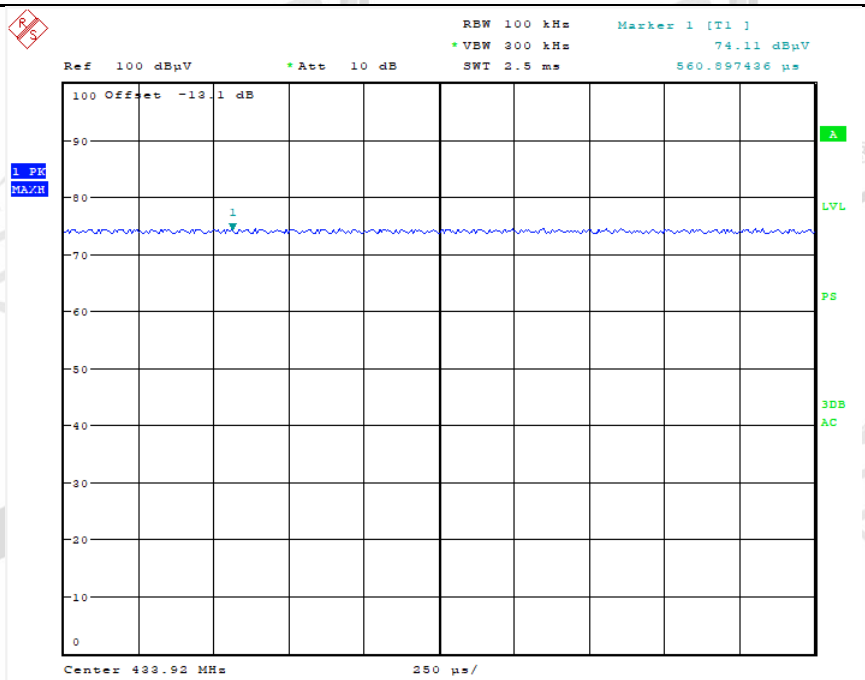
duty cycle factor=20*log(Ton/Tp)= 20*log(25ms/100ms)=-12

2. EUT emission period is more than 100ms, the factor is calculated in units of 100ms.

Test Result

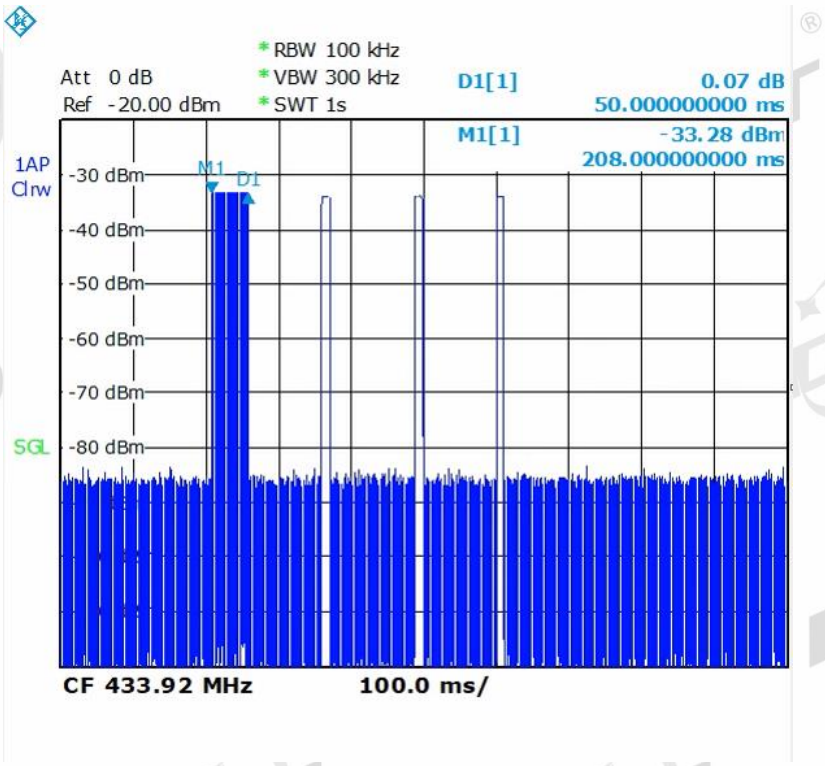


H

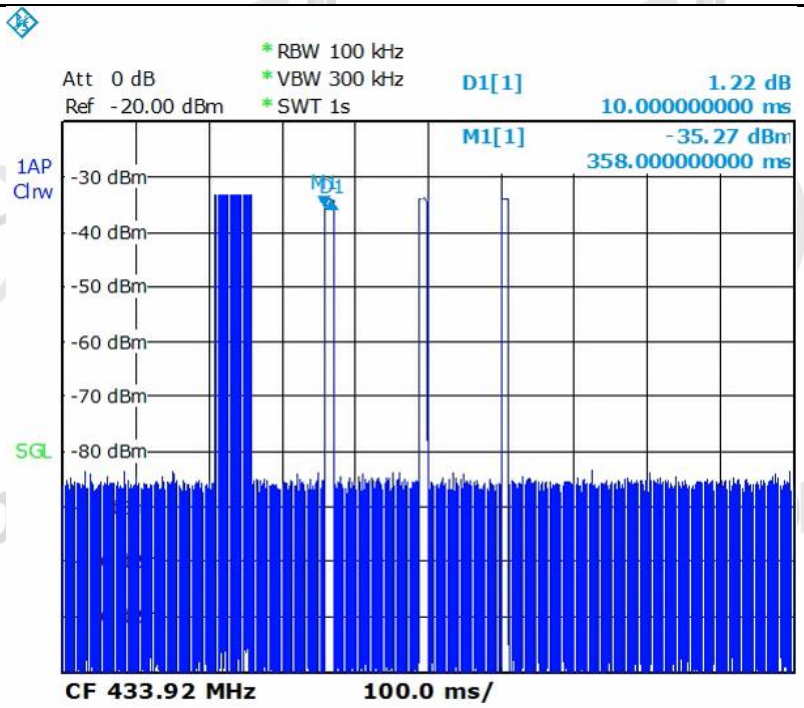


V

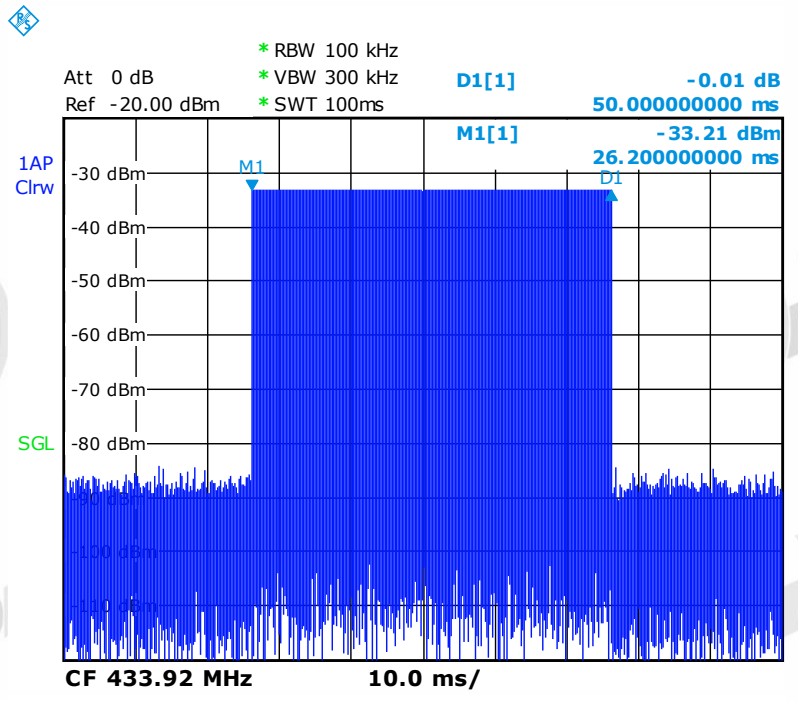
Duty Cycle



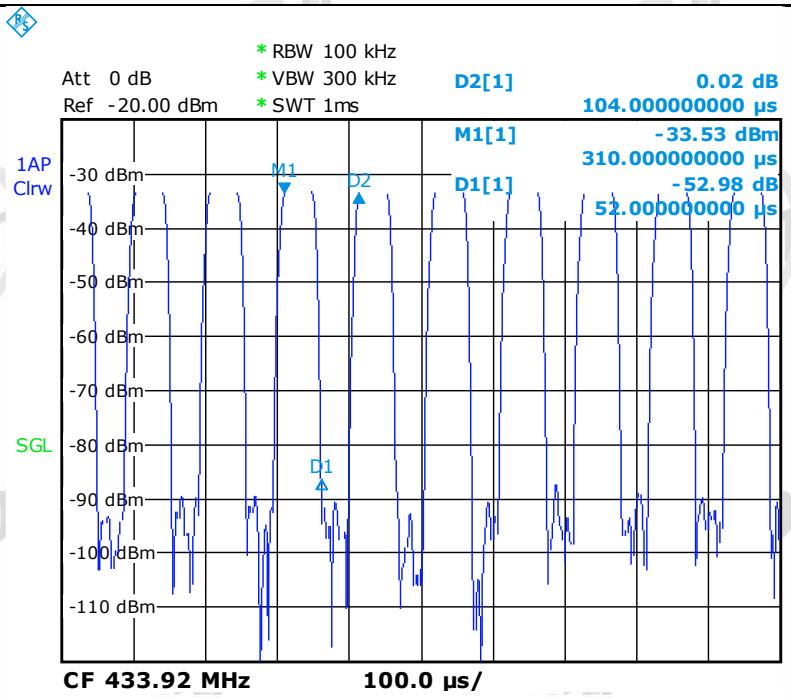
50ms


RBW 100 kHz
VBW 300 kHz
SWT 1s
Att 0 dB
Ref -20.00 dBm
D1[1]
1.22 dB
10.000000000 ms
M1[1]
-35.27 dBm
358.000000000 ms
1AP
Clrw
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
SGL
-80 dBm
CF 433.92 MHz
100.0 ms/

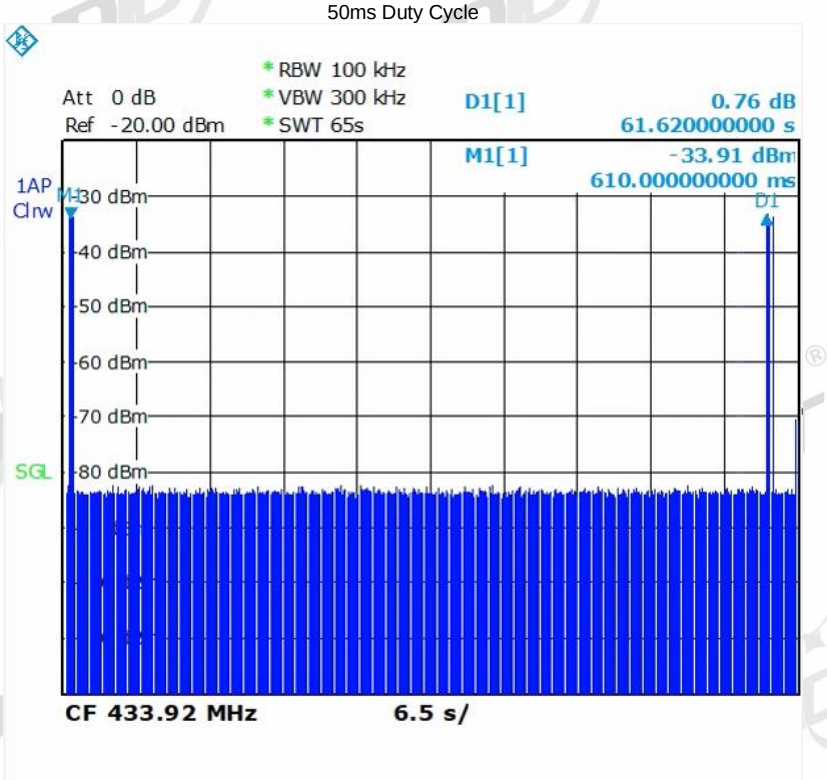
10ms


RBW 100 kHz
VBW 300 kHz
SWT 100ms
Att 0 dB
Ref -20.00 dBm
D1[1]
-0.01 dB
50.000000000 ms
M1[1]
-33.21 dBm
26.200000000 ms
1AP
Clrw
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
SGL
-80 dBm
CF 433.92 MHz
10.0 ms/

50ms



50ms Duty Cycle



transmitting period

10.5. Nvram Test result

Item (Mark)	Freq. (MHz)	Result Level (PK) (dBμV/m)	Result Level (AV) (dBμV/m)	Limit Line (PK) (dBμV/m)	Limit Line (AV) (dBμV/m)	Over Limit (dB)	Detector	Polarization
1	433.92	66.75	54.75	92.9	72.9	-18.15	PK	H
2	433.92	73.66	61.66	92.9	72.9	-11.24	PK	V

Note:

1.Calculate Average value based on Duty Cycle correction factor:

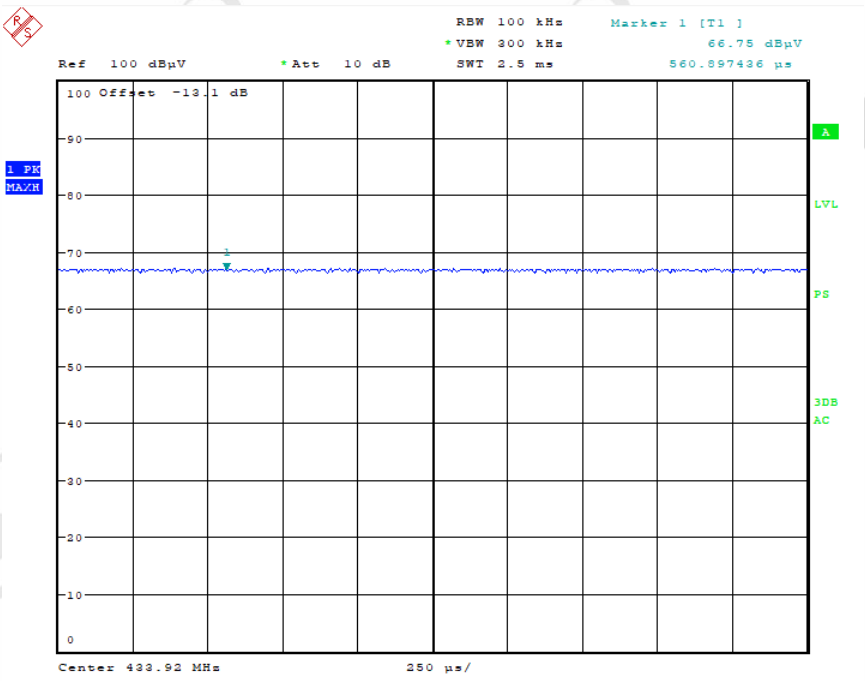
Ton = Ton_1N_1,+ Ton_2N_2,+ ... + TOn_nN_n.= 50ms x (52us/104us)=25ms

Tp=100ms

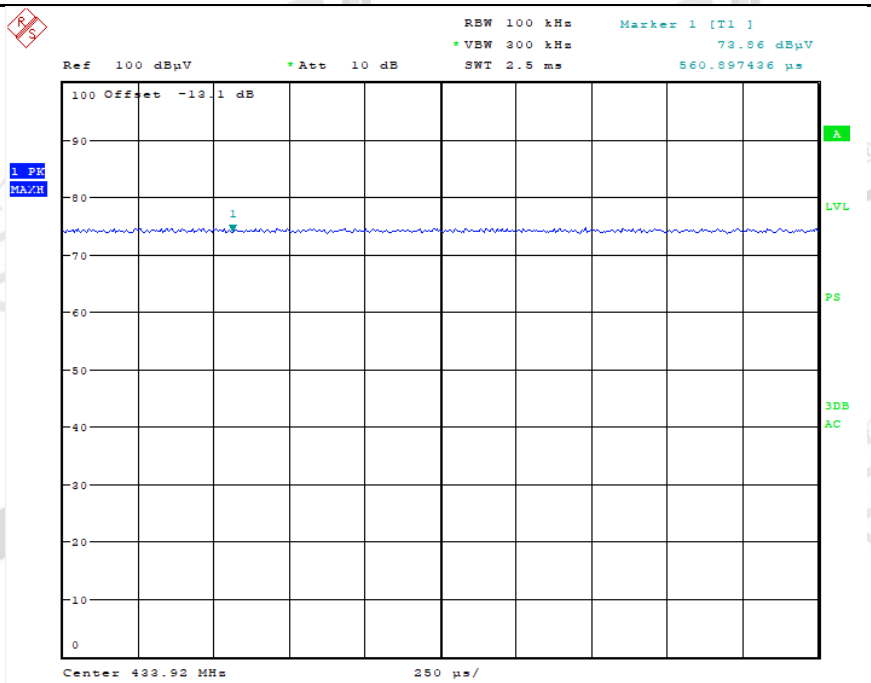
duty cycle factor=20*log(Ton/Tp)= 20*log(25ms/100ms)=-12

2. EUT emission period is more than 100ms, the factor is calculated in units of 100ms.

Test Result

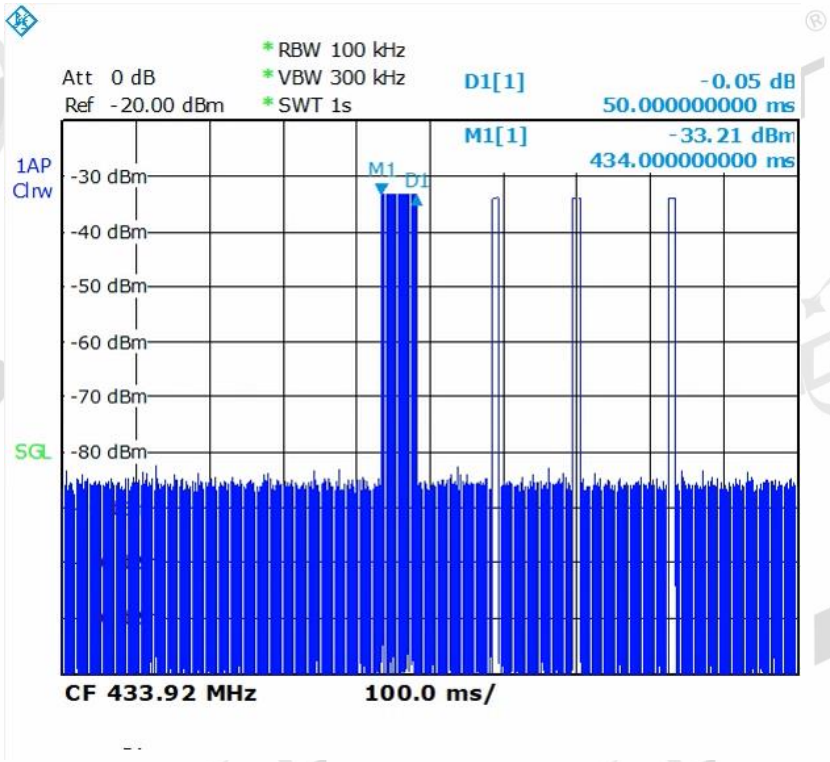


H

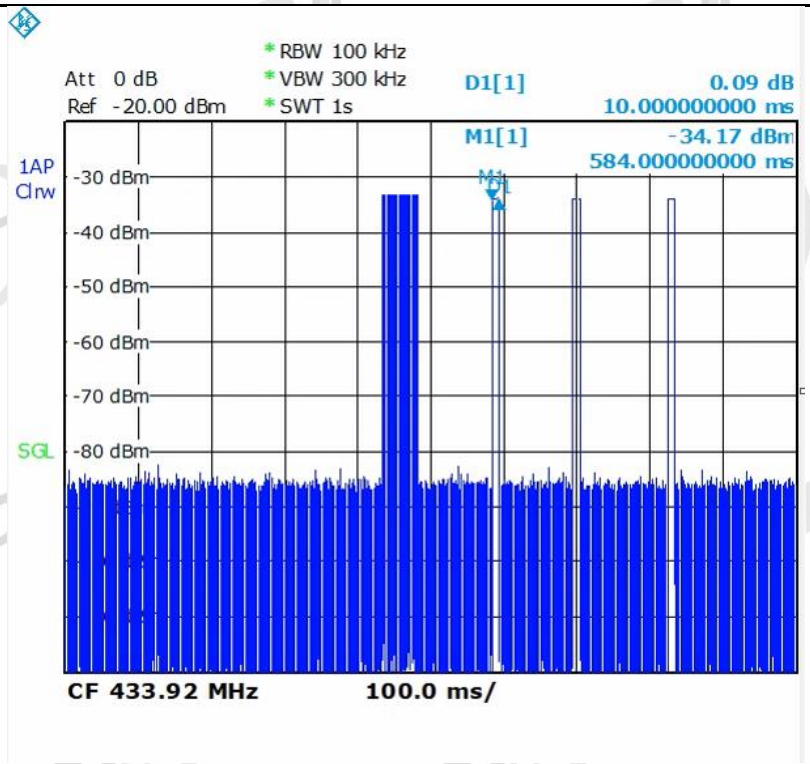


V

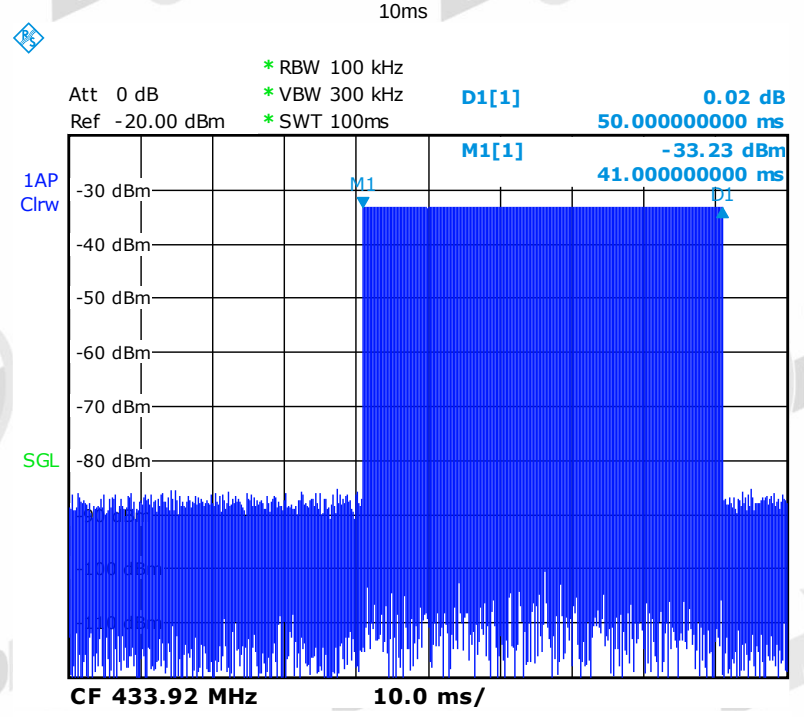
Duty Cycle



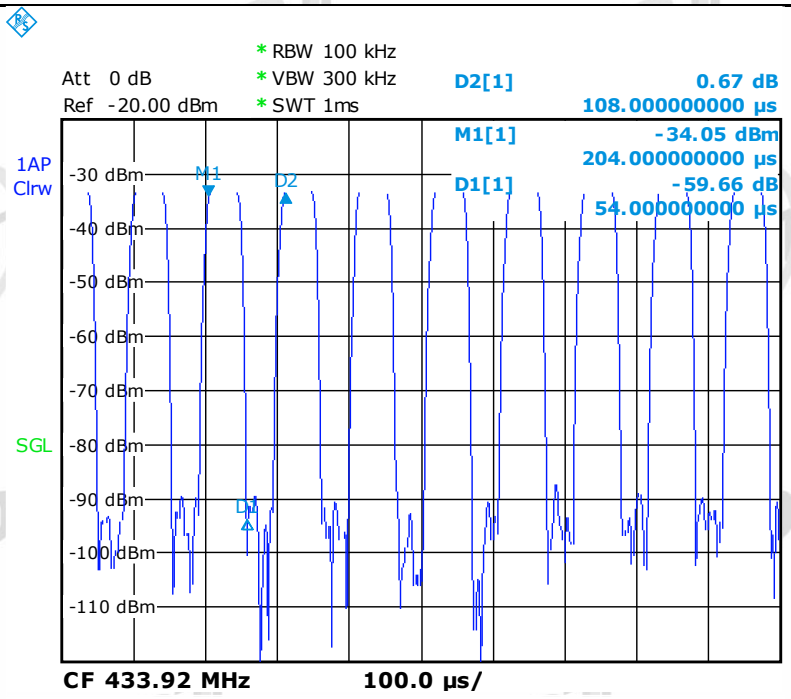
50ms


RBW 100 kHz
VBW 300 kHz
SWT 1s
Att 0 dB
Ref -20.00 dBm
D1[1]
0.09 dB
10.000000000 ms
M1[1]
-34.17 dBm
584.000000000 ms
1AP
Clrw
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
SGL
-80 dBm
CF 433.92 MHz
100.0 ms/

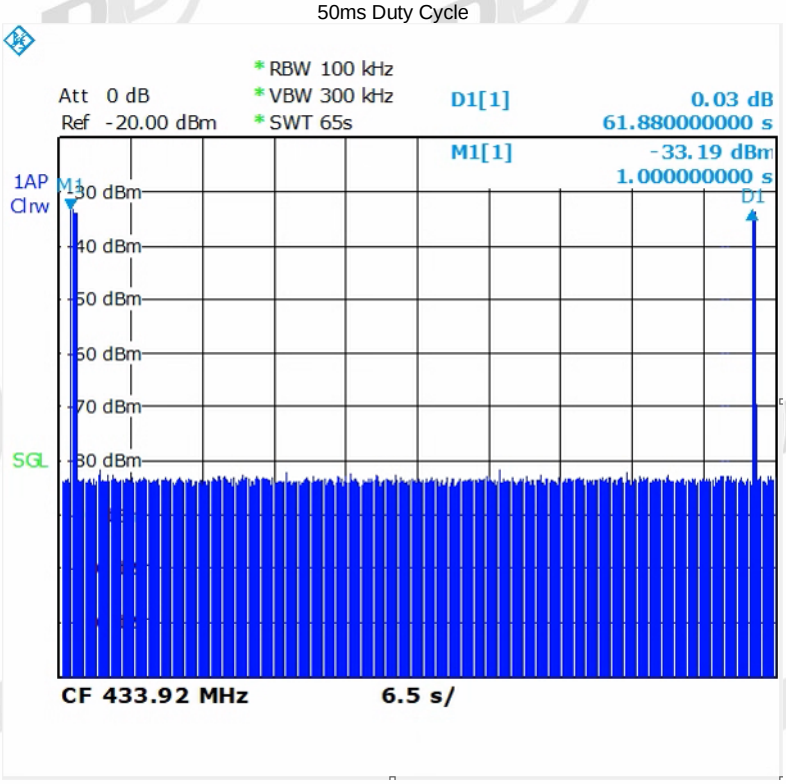
10ms


RBW 100 kHz
VBW 300 kHz
SWT 100ms
Att 0 dB
Ref -20.00 dBm
D1[1]
0.02 dB
50.000000000 ms
M1[1]
-33.23 dBm
41.000000000 ms
1AP
Clrw
M1
D1
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
SGL
-80 dBm
CF 433.92 MHz
10.0 ms/

50ms



50ms Duty Cycle



transmitting period

11. Bandwidth(20dB)

11.1. Regulation

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz, For devices operating above 900 MHz. the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

11.2. Calculation of the 20dB bandwidth limit

The 20 dB bandwidth limit = 0.0025 * 433.92 MHz = 1.0848 MHz = 1084.8 kHz

11.3. Test Procedure

A dBc bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are −6 dB, −20 dB, and −26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by “−xx dB.” The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the “−xx dB” bandwidth; other requirements might specify that the “−xx dB” bandwidth be entirely contained within the authorized or designated frequency band

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be at least three times RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.

d) Steps a) through c) might require iteration to adjust within the specified tolerances.

e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “−xx dB down” requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.

f) Set detection mode to peak and trace mode to max-hold.

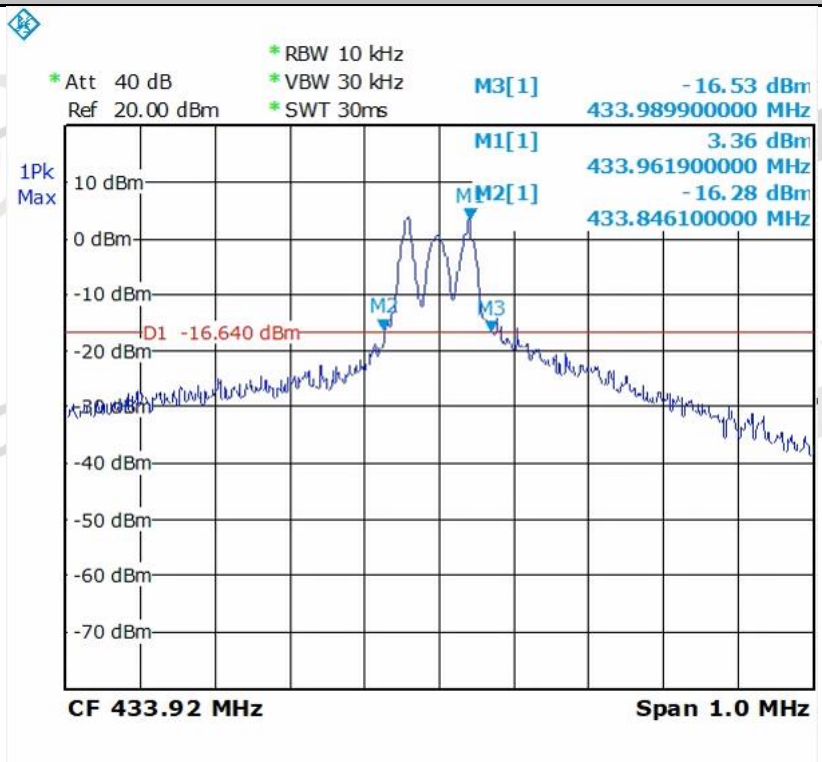
g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

h) Determine the “−xx dB down amplitude” using [(reference value) - xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “−xx dB down amplitude” determined in step h). If a marker is below this “−xx dB down amplitude” value, then it shall be as close as possible to this value. The dBc bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “−xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.
k) The dBc bandwidth shall be reported by providing spectral plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

11.4. Test result

Modulation	F_L Result (MHz)	F_H Result (MHz)	Limit Low (MHz)	Limit high (MHz)	Bandwidth Result (kHz)	Bandwidth Limit (kHz)	Result
FSK	433.846	433.990	432.8352	435.0048	144	1084.8	Pass

Note: The EUT is not capable of producing an unmodulated carrier.

20dB Bandwidth


END REPORT