

Test Report

Report No.: MTi220223005-01E1

Date of issue: 2022-05-05

Applicant: Shenzhen ShunSiHang Keji YouxianGongSi

Product: Remote Controller for BlueFire LED Pool Lights

Model(s): HW018-BF-US, HW017-BF-US, HW019 HW020,
HW021, AML035, AML036

FCC ID: 2A4SJ-HW018-BF-US

Shenzhen Microtest Co., Ltd.

<http://www.mtitest.com>

Instructions

1. This test report shall not be partially reproduced without the written consent of the laboratory.
2. The test results in this test report are only responsible for the samples submitted
3. This test report is invalid without the seal and signature of the laboratory.
4. This test report is invalid if transferred, altered, or tampered with in any form without authorization.
5. Any objection to this test report shall be submitted to the laboratory within 15 days from the date of receipt of the report.

Table of Contents

1 General Description.....	5
1.1 Description of the EUT.....	5
1.2 Description of support units	5
1.3 Environmental conditions.....	5
1.4 Measurement uncertainty	6
2 Summary of Test Result.....	7
3 Test Facilities and accreditations.....	8
3.1 Test laboratory	8
4 List of test equipment.....	9
5 Test Results	10
5.1 Antenna requirements.....	10
5.2 AC power line conducted emissions.....	11
1.1.1 Test Result.....	11
5.3 Transmitter timeout.....	12
5.4 Radiated emissions.....	13
5.5 20dB occupied bandwidth.....	21
5.6 Duty cycle.....	23
Photographs of the test setup.....	25
Photographs of the EUT.....	25

Test Result Certification

Applicant:	Shenzhen ShunSiHang Keji YouxianGongSi
Address:	LongChengHuaFu YongHuaFu 16D RuYi Road, LongGang Distrct, ShenZhen, GuangDong
Manufacturer:	Shenzhen ShunSiHang Keji YouxianGongSi
Address:	LongChengHuaFu YongHuaFu 16D RuYi Road, LongGang Distrct, ShenZhen, GuangDong

Product description

Product name:	Remote Controller for BlueFire LED Pool Lights
Trademark:	BlueFire
Model name:	HW018-BF-US
Serial Model:	HW017-BF-US, HW019 HW020, HW021, AML035, AML036
Standards:	FCC 47 CFR Part 15 Subpart C
Test method:	ANSI C63.10-2013

Date of Test

Date of test:	2022-02-23 ~ 2022-05-05
Test result:	Pass

Test Engineer :


(Cindy Qin)

Reviewed By:


(Leon Chen)

Approved By:


(Tom Xue)

1 General Description

1.1 Description of the EUT

Product name:	Remote Controller for BlueFire LED Pool Lights
Model name:	HW018-BF-US
Series Model:	HW017-BF-US, HW019 HW020, HW021, AML035, AML036
Model difference:	All the models have the same Circuit diagram, PCB layout and all electrical construction. The difference lies only on the model's name.
Electrical rating:	Powered by battery: DC 3V
Accessories:	N/A
Hardware version:	V4.0
Software version:	For-001
EUT serial number:	MTi220223005-01S1001

RF specification:

Operation frequency Range:	433.80MHz-433.90MHz
Modulation type:	FSK
Antenna type:	PCB antenna, antenna gain: 1.5dBi

1.2 Description of support units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Support equipment list			
Description	Model	Serial No.	Manufacturer
/	/	/	/
Support cable list			
Description	Length (m)	From	To
/	/	/	/

1.3 Environmental conditions

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

Temperature:	15°C~35°C
Humidity:	20 % RH ~ 75 % RH
Atmospheric pressure:	98 kPa~101 kPa

1.4 Measurement uncertainty

Measurement	Uncertainty
Conducted emission (9 kHz~30 MHz)	± 2.5 dB
Radiated emission (9 kHz ~ 30 MHz)	± 4.0 dB
Radiated emission (30 MHz~1 GHz)	± 4.2 dB
Radiated emission (above 1 GHz)	± 4.3 dB
Occupied bandwidth	± 3 %
Temperature	±1 degree
Humidity	± 5 %

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

2 Summary of Test Result

No.	FCC reference	Description of test	Result
1	FCC Part 15.203	Antenna requirement	Pass
2	FCC Part 15.207	AC power line Conducted emissions	N/A
3	FCC Part 15.231(a)	Transmitter timeout	Pass
4	FCC Part 15.231(b) FCC Part 15.205 & 15.209	Radiated emissions	Pass
5	FCC Part 15.231(c)	20dB occupied bandwidth	Pass

Note: N/A means not applicable.

3 Test Facilities and accreditations

3.1 Test laboratory

Test laboratory:	Shenzhen Microtest Co., Ltd.
Test site location:	101, No. 7, Zone 2, Xinxing Industrial Park, Fuhai Avenue, Xinhe Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China
Telephone:	(86-755)88850135
Fax:	(86-755)88850136
CNAS Registration No.:	CNAS L5868
FCC Registration No.:	448573

4 List of test equipment

No.	Equipment	Manufacturer	Model	Serial No.	Cal. date	Cal. Due
MTI-E043	EMI test receiver	R&S	ESCI7	101166	2021/06/02	2022/06/01
MTI-E044	Broadband antenna	Schwarzbeck	VULB9163	9163-1338	2021/05/30	2023/05/29
MTI-E045	Horn antenna	Schwarzbeck	BBHA9120D	9120D-2278	2021/05/30	2023/05/29
MTI-E046	Active Loop Antenna	Schwarzbeck	FMZB 1519 B	00066	2021/05/30	2023/05/29
MTI-E047	Pre-amplifier	Hewlett-Packard	8447F	3113A06184	2021/06/02	2022/06/01
MTI-E048	Pre-amplifier	Agilent	8449B	3008A01120	2021/06/02	2022/06/01
MTI-E122	MXA signal analyzer	Agilent	N9020A	MY54440859	2021/05/06	2022/05/05
MTI-E002	EMI Test Receiver	R&S	ESCI3	101368	2021/06/02	2022/06/01
MTI-E023	Artificial power network	Schwarzbeck	NSLK8127	#841	2021/06/02	2022/06/01
MTI-E025	Artificial power network	Schwarzbeck	NSLK8127	8127183	2021/06/02	2022/06/01

5 Test Results

5.1 Antenna requirements

15.203 requirement

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.

Description of the EUT antenna

The antenna of EUT is PCB antenna, the antenna gain is 1.5dBi, which is integrated on the main PCB of the EUT and no consideration of replacement.



5.2 AC power line conducted emissions

5.2.1 Limits

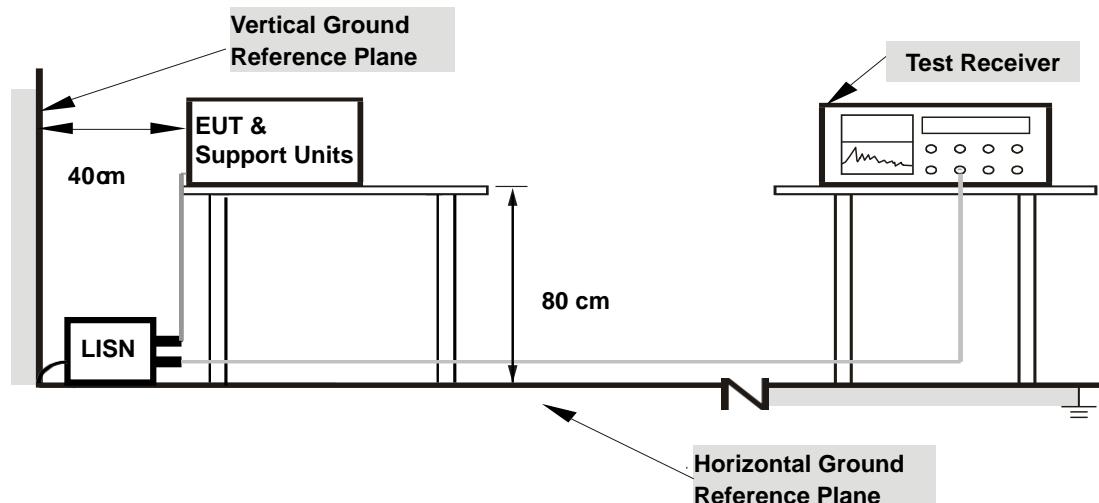
Frequency (MHz)	Detector type / Bandwidth	Limit-Quasi-peak dB μ V	Limit-Average dB μ V
0.15 -0.5	Average / 9 kHz	66 to 56	56 to 46
0.5 -5		56	46
5 -30		60	50

Note 1: the limit decreases with the logarithm of the frequency in the range of 0.15 MHz to 0.5 MHz.

5.2.2 Test Procedures

- Test method: ANSI C63.10-2013 Section 6.2.
- The EUT is connected to the main power through a line impedance stabilization network (LISN). All support equipment is powered from additional LISN(s).
- Emissions were measured on each current carrying line of the EUT using an EMI test receiver connected to the LISN powering the EUT.
- The test receiver scanned from 150 kHz to 30 MHz for emissions in each of the test modes described in Item 1.2.
- The test data of the worst-case condition(s) was recorded.

5.2.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the test setup.

1.1.1 Test Result

Note: Not applicable, the EUT only employs battery power for operation.

5.3 Transmitter timeout

5.3.1 Limits

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

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

5.3.2 Test setup



5.3.3 Test Procedures

a) The spectrum analyzer setting:

Center frequency = the EUT operating frequency

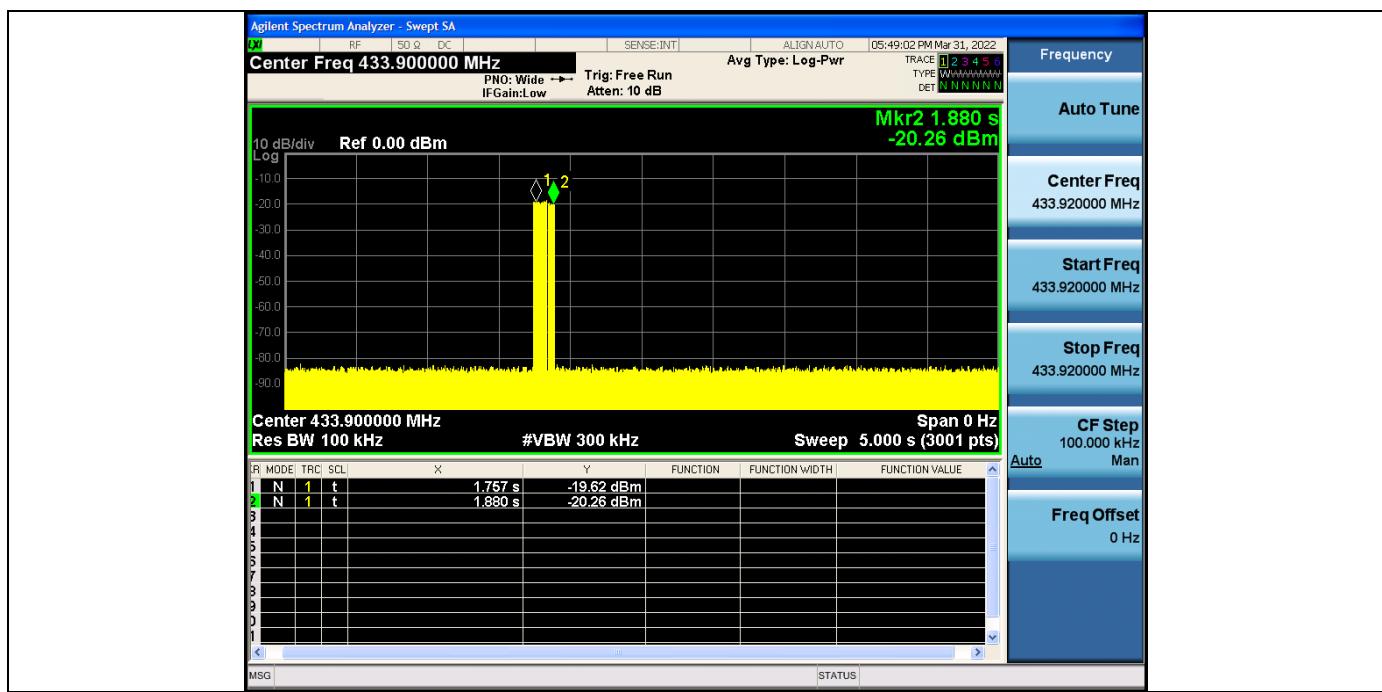
RBW = > OBW

VBW = \geq RBW

Span = zero span

b) Measure the maximum time duration of activation time.

5.3.4 Test Result



Result: Pass, the EUT had automatically deactivated transmission within 5 seconds.

5.4 Radiated emissions

5.4.1 Limits

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

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

¹ Linear interpolations.

(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

(2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in § 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of § 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

(3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in § 15.209, whichever limit permits a higher field strength.

FCC part 15.231(e): 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)	Filed strength of fundamental(microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70	1,000	100
70-130	500	50
130-174	500 to 1500 ¹	50 to 150 ¹
174-260	1,500	150
260-470	1,500 to 5,000 ¹	150 to 500 ¹
Above 470	5,000	500

¹ Linear interpolations.

§ 15.209 Radiated emission limits; general requirements.

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

Note 1: the tighter limit applies at the band edges.

Note 2: 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

§ 15.35 (b) requirements:

When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§ 15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

According to ANSI C63.10, the tests shall be performed in the frequency range shown in the following table:

Frequency range of measurements for unlicensed wireless device

Lowest frequency generated in the device	Upper frequency range of measurement
9 kHz to below 10 GHz	10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower
At or above 10 GHz to below 30 GHz	5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower
At or above 30 GHz	5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified

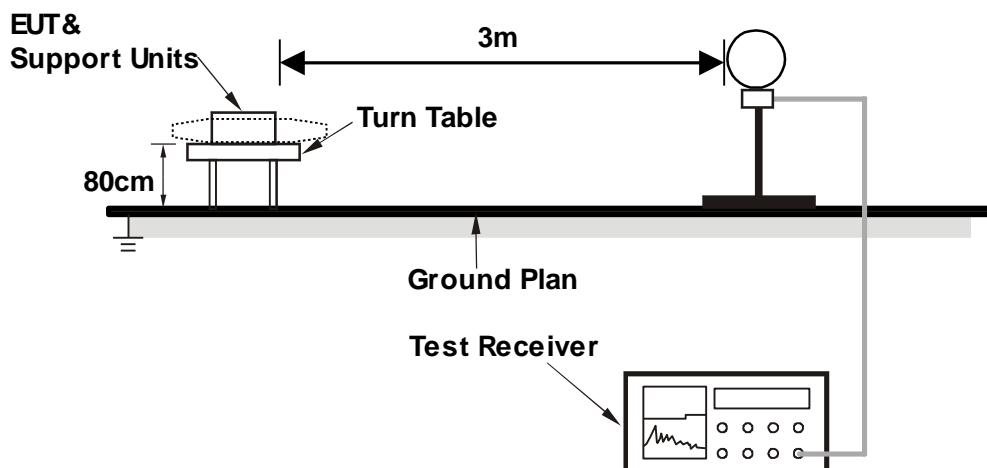
Frequency range of measurements for unlicensed wireless device with digital device

Highest frequency generated or used in the device or on which the device operates or tunes	Upper frequency range of measurement
Below 1.705 MHz	30 MHz
1.705 MHz to 108 MHz	1000 MHz
108 MHz to 500 MHz	2000 MHz
500 MHz to 1000 MHz	5000 MHz
Above 1000 MHz	5th harmonic of the highest frequency or 40 GHz, whichever is lower

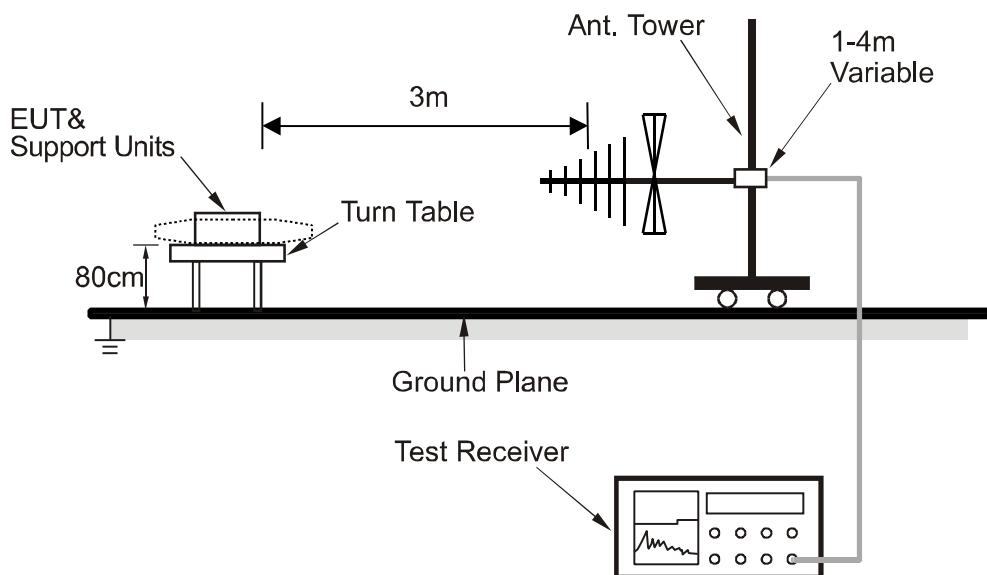


5.4.2 Test Setup

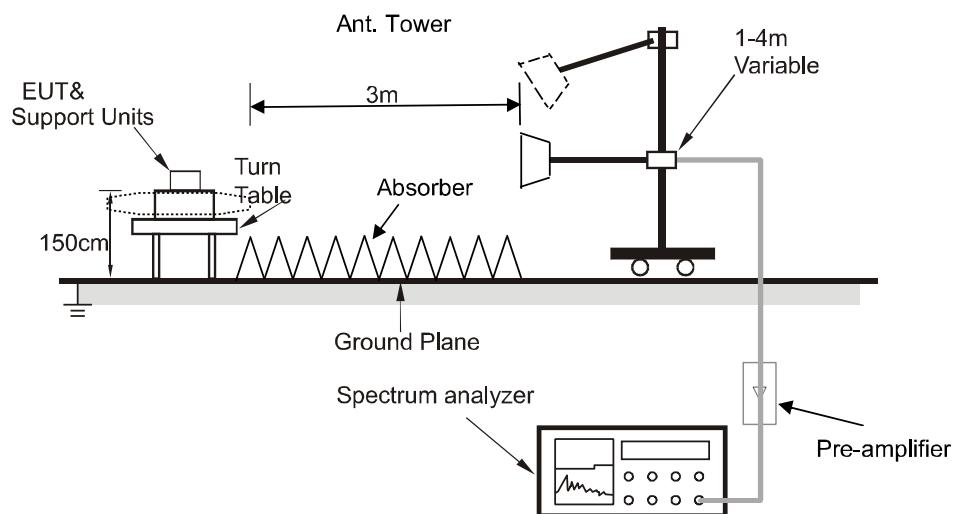
Blew 30 MHz:



Blew 1 GHz:



Above 1GHz:



For the actual test configuration, please refer to the related item – Photographs of the test setup.

5.4.3 Test Procedures

- a) Test method: ANSI C63.10-2013 Section 6.3, 6.4, 6.5, 6.6.
- b) The EUT is placed on an on-conducting table 0.8 meters above the ground plane for measurement below 1GHz, 1.5 meters above the ground plane for measurement above 1GHz.
- c) Emission below 18 GHz were measured at a 3 meters test distance, above 18 GHz were measured at 1.5-meter test distance with the application of a distance correction factor
- d) The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

Special requirements for 9 kHz to 30 MHz:

The lowest height of the magnetic antenna shall be 1 m above the ground

When the EUT contains a loop antenna that can only be placed in a vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, and then orthogonal to the axis. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable.

When the EUT contains a loop antenna that can be placed in a horizontal or vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, orthogonal to the axis, and then with the measurement antenna horizontal. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable.

Test instrument setup

Frequency	Test receiver / Spectrum analyzer setting
9 kHz ~ 150 kHz	Quasi Peak / 200 Hz
150 kHz ~ 30 MHz	Quasi Peak / 9 kHz
30 MHz ~ 1 GHz	Quasi Peak / 120 kHz
Above 1 GHz	Peak / RBW: 1 MHz, VBW: 3MHz

5.4.4 Test result

Notes:

The amplitude of spurious emissions which are attenuated more than 20 dB below the limits are not reported.

There were no emissions found below 30MHz within 20dB of the limit.

For all radiation emissions test, the EUT in each of three orthogonal axis had been tested, but only the worst case (X axis) data are reported.

Calculation formula:

Measurement (dB μ V/m) = Reading Level (dB μ V) + Correct Factor (dB/m)

Margin (dB) = Measurement (dB μ V/m) – Limit (dB μ V/m)

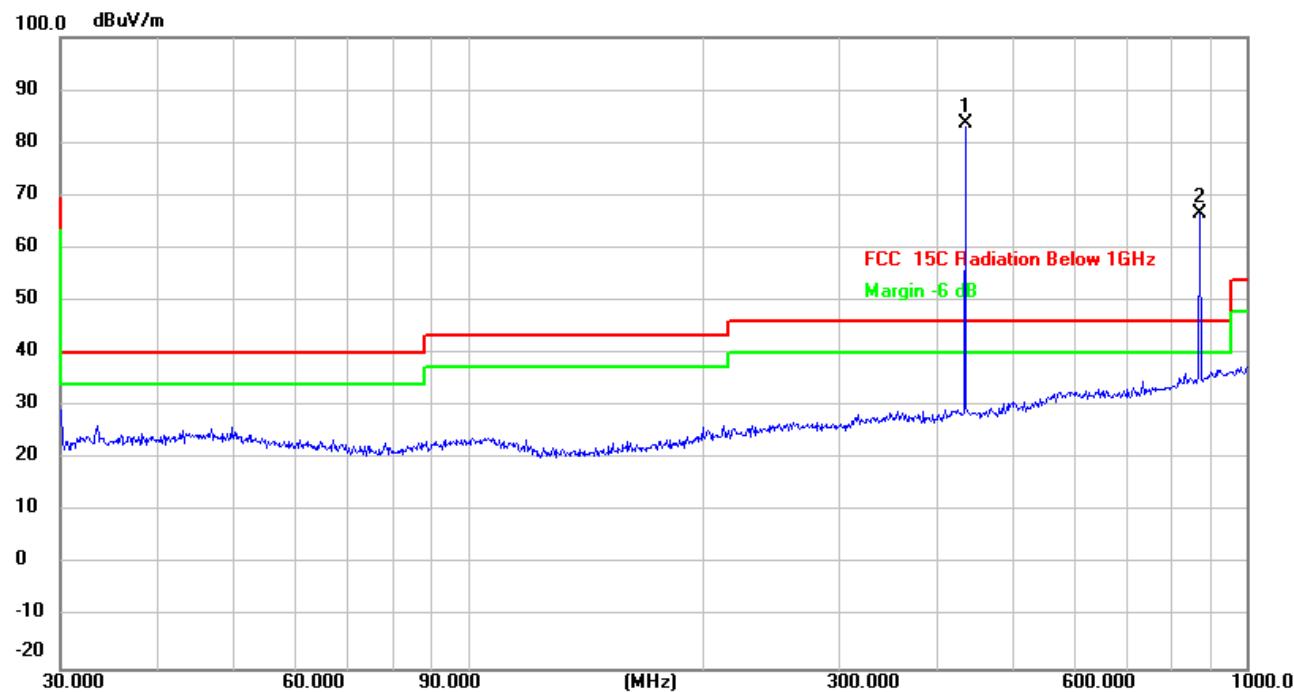
Average result = peak result + duty cycle correction factor (refer to clause 5.6)

If the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement



Radiated emissions: 30MHz – 1GHz

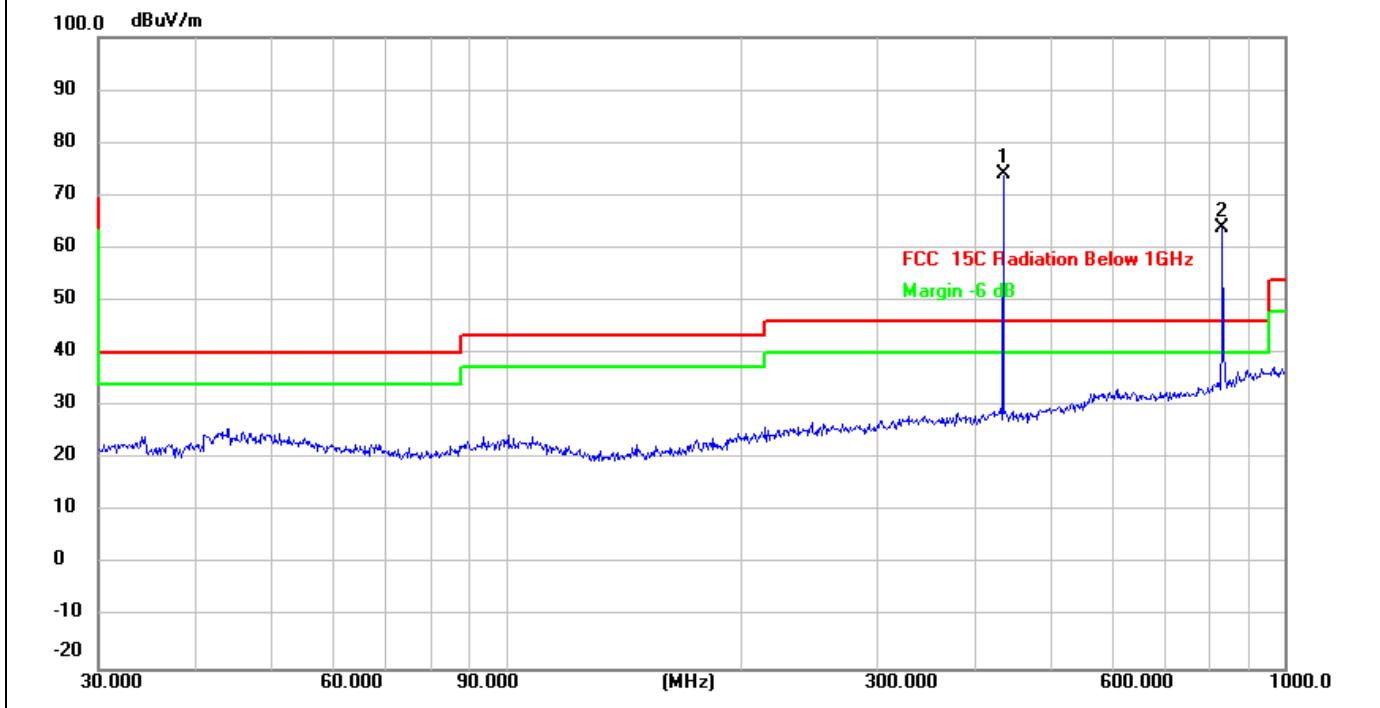
Test mode:	Transmitting-433.90 MHz	Polarization:	Horizontal
Power supply:	DC 3V	Test site:	RE chamber 1



No.	Frequency (MHz)	Reading Level (dB μ V)	Correct Factor dB/m	Measure- ment (dB μ V/m)	Limit (dB μ V/m)	Margin dB	Detector
1(Fundamental)	433.90	86.64	-3.29	83.35	100.8	-17.45	Peak
	/	/	/	76.81	80.8	-3.99	AVG
2(Harmonic)	867.8000	63.11	3.01	66.12	80.8	-14.68	Peak
	/	/	/	59.54	60.8	-1.26	AVG

Radiated emissions: 30MHz – 1GHz

Test mode:	Transmitting-433.90 MHz	Polarization:	Vertical
Power supply:	DC 3V	Test site:	RE chamber 1

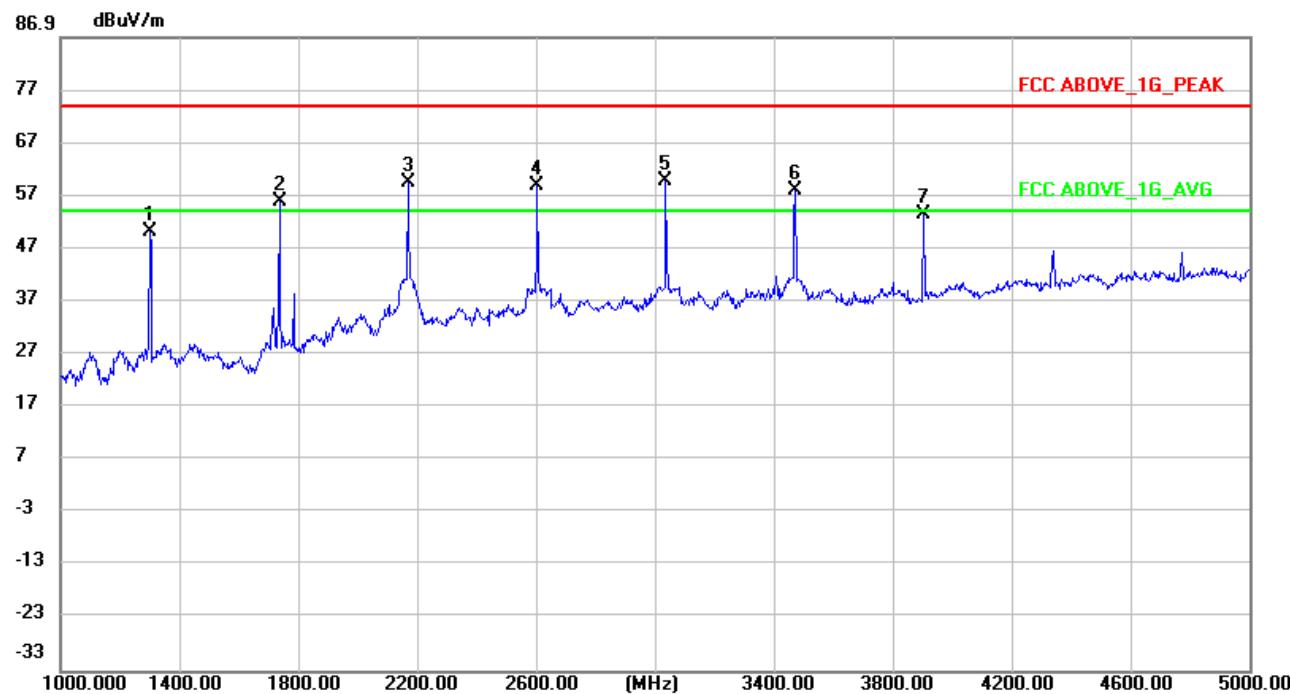


No.	Frequency (MHz)	Reading Level (dB μ V)	Correct Factor dB/m	Measure- ment (dB μ V/m)	Limit (dB μ V/m)	Margin dB	Detector
1(Fundamental)	433.90	77.33	-3.29	74.04	100.8	-26.76	Peak
	/	/	/	67.51	80.8	-13.29	AVG
2Harmonic	867.8000	61.29	2.3	63.59	80.8	-17.21	Peak
	/	/	/	57.08	60.8	-3.72	AVG



Radiated emissions: above 1GHz

Test mode:	Transmitting-433.90 MHz	Polarization:	Horizontal
Power supply:	DC 3V	Test site:	RE chamber 2

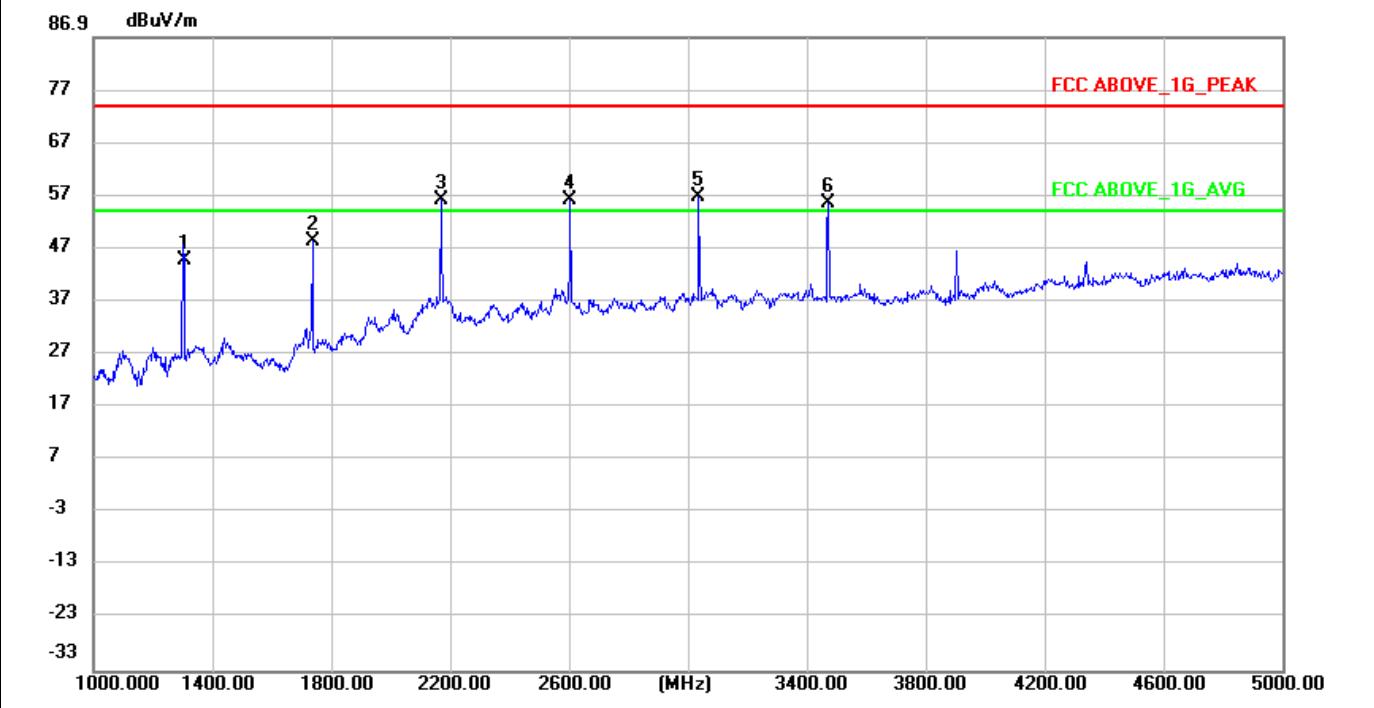


No.	Frequency (MHz)	Reading Level (dB μ V)	Correct Factor dB/m	Measure- ment (dB μ V/m)	Limit (dB μ V/m)	Margin dB	Detector
1(Harmonic)	1301.7	63.58	-13.28	50.3	74	-23.7	Peak
	/	/	/	43.76	54	-10.24	AVG
2(Harmonic)	1735.6	67.6	-11.71	55.89	80.8	-24.91	Peak
	/	/	/	49.35	60.8	-11.45	AVG
3(Harmonic)	2169.5	66.59	-7.26	59.33	80.8	-21.47	Peak
	/	/	/	52.79	60.8	-8.01	AVG
4(Harmonic)	2603.4	64.37	-5.49	58.88	80.8	-21.92	Peak
	/	/	/	52.34	60.8	-8.46	AVG
5(Harmonic)	3037.3	64.26	-4.52	59.74	80.8	-21.06	Peak
	/	/	/	53.2	60.8	-7.6	AVG
6(Harmonic)	3471.2	61.29	-3.26	58.03	80.8	-22.77	Peak
	/	/	/	51.49	60.8	-9.31	AVG
7(Harmonic)	3905.1	55.49	-1.96	53.53	74	-20.47	Peak
	/	/	/	46.99	54	-7.01	AVG



Radiated emissions: above 1GHz

Test mode:	Transmitting-433.90 MHz	Polarization:	Vertical
Power supply:	DC 3V	Test site:	RE chamber 2



No.	Frequency (MHz)	Reading Level (dB μ V)	Correct Factor dB/m	Measure- ment (dB μ V/m)	Limit (dB μ V/m)	Margin dB	Detector
1(Harmonic)	1301.7	57.98	-13.24	44.74	74	-29.26	Peak
	/	/	/	38.2	54	-15.8	AVG
2(Harmonic)	1735.600	60.14	-11.71	48.43	80.8	-32.37	Peak
	/	/	/	41.89	60.8	-18.91	AVG
3(Harmonic)	2169.500	63.53	-7.26	56.27	80.8	-24.53	Peak
	/	/	/	49.73	60.8	-11.07	AVG
4(Harmonic)	2603.400	61.51	-5.49	56.02	80.8	-24.78	Peak
	/	/	/	49.48	60.8	-11.32	AVG
5(Harmonic)	3037.300	61.26	-4.52	56.74	80.8	-24.06	Peak
	/	/	/	50.2	60.8	-10.6	AVG
6(Harmonic)	3471.200	58.76	-3.26	55.5	74	-18.5	Peak
	/	/	/	48.96	54	-5.04	AVG

5.5 20dB occupied bandwidth

5.5.1 Limits

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.

For devices operating within the frequency band 40.66-40.70 MHz, the bandwidth of the emission shall be confined within the band edges and the frequency tolerance of the carrier shall be $\pm 0.01\%$. This frequency tolerance shall be maintained for a temperature variation of -20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

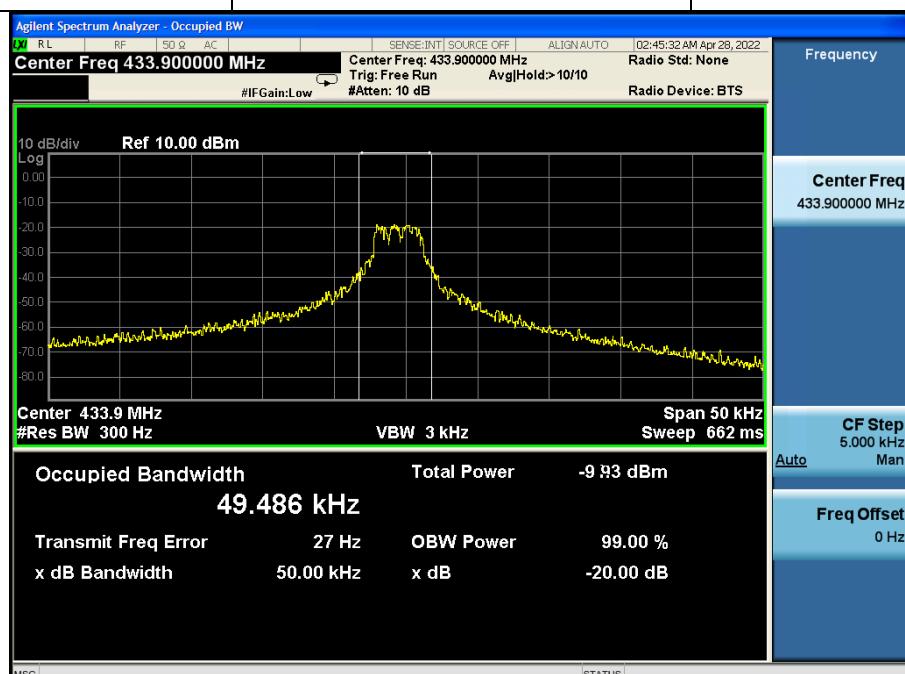
5.5.2 Test setup



5.5.3 Test Procedures

- a) Test method: ANSI C63.10-2013 Section 6.9.2.
- b) 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.
- c) 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 approximately three times RBW.
- d) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “-xx dB down” requirement
- f) Set detection mode to peak and trace mode to max hold.
- g) 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.

5.5.4 Test Result

Frequency (MHz)	20 dB occupied bandwidth (MHz)	Limit (MHz)
433.900	0.05	≤ 1.0848
 <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 433.900000 MHz</p> <p>Ref 10.00 dBm</p> <p>10 dB/div</p> <p>Log</p> <p>10.00</p> <p>-10.00</p> <p>-20.00</p> <p>-30.00</p> <p>-40.00</p> <p>-50.00</p> <p>-60.00</p> <p>-70.00</p> <p>-80.00</p> <p>Center 433.9 MHz</p> <p>#Res BW 300 Hz</p> <p>VBW 3 kHz</p> <p>Span 50 kHz</p> <p>Sweep 662 ms</p> <p>Occupied Bandwidth 49.486 kHz</p> <p>Total Power -9.93 dBm</p> <p>Transmit Freq Error 27 Hz</p> <p>OBW Power 99.00 %</p> <p>x dB Bandwidth 50.00 kHz</p> <p>x dB -20.00 dB</p> <p>CF Step 5.000 kHz</p> <p>Auto</p> <p>Freq Offset 0 Hz</p> <p>MSG STATUS</p>		

5.6 Duty cycle

5.6.1 Limits

None, for reporting purposes only.

5.6.2 Test setup



5.6.3 Test Procedures

a) Test method: ANSI C63.10-2013 Section 7.5.

b) The spectrum analyzer setting:

Center frequency = the EUT operating frequency

RBW = > OBW

VBW = \geq RBW

Span = zero span

Sweep time = at least 100ms

5.6.4 Test Result

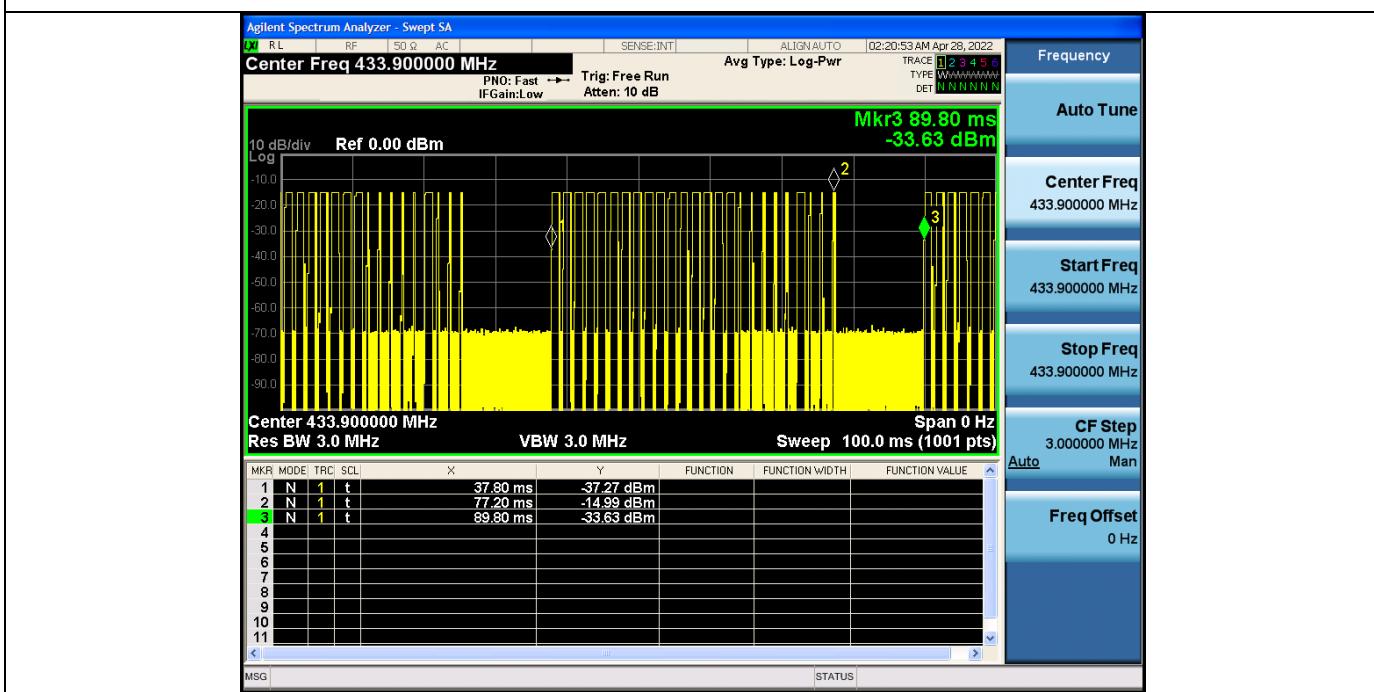
	On time (ms)	Times	T _{on} (ms)	Total T _{on} time (ms)
T _{on1}	1.3	17	22.1	24.5
T _{on2}	0.3	8	2.4	

Total T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle correction factor (dB)
24.5	52	0.4712	-6.54

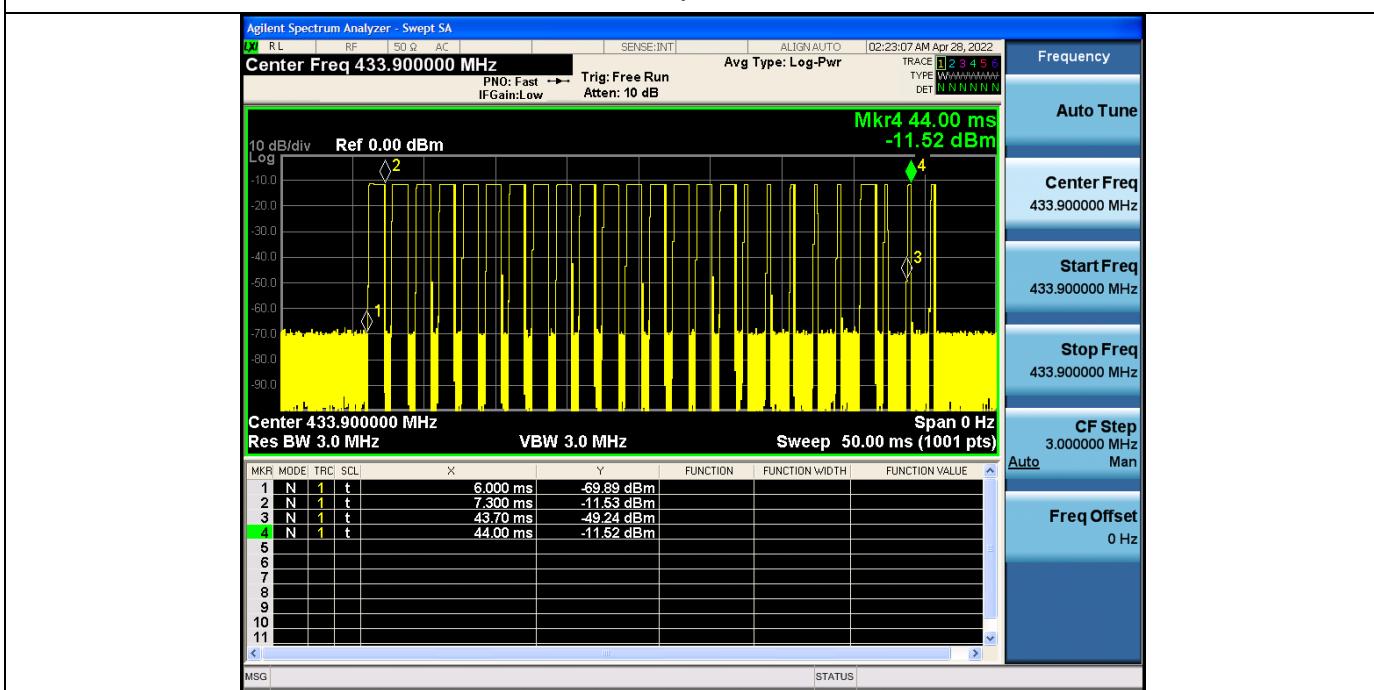
Note: Duty cycle correction factor = $20 * \log(\text{Duty cycle})$



Test plot - 1



Test plot - 2



Photographs of the test setup

See the Appendix – Test Setup Photos.

Photographs of the EUT

See the Appendix - EUT Photos.

----End of Report----