FCC Test Report

Report No.: AGC06326220801FE10

FCC ID	:	2ARTCAR-7
APPLICATION PURPOSE	:	Original Equipment
PRODUCT DESIGNATION	:	Two-way radio
BRAND NAME	:	Arcshell
MODEL NAME	:	AR-7
APPLICANT	:	Henan Aofeng Industrial Co., Ltd.
DATE OF ISSUE	:	Aug. 24, 2022
STANDARD(S)	:	FCC Part 90 Rules
REPORT VERSION	:	V 1.0

Attestation of Global Compliance (Shenzhen) Co., Ltd

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REPORT REVISE RECORD

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	Aug. 24, 2022	Valid	Initial Release

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1. GENERAL INFORMATION

Applicant	Henan Aofeng Industrial Co., Ltd.
Address	Zhongyuanqu Jianshexilu 92 Hao 1 Haolou 2 Danyuan 5 Ceng 44 Hao, Zhengzhou, Henan, China 450007
Manufacturer	Henan Aofeng Industrial Co., Ltd.
Address	Zhongyuanqu Jianshexilu 92 Hao 1 Haolou 2 Danyuan 5 Ceng 44 Hao, Zhengzhou, Henan, China 450007
Factory	Henan Aofeng Industrial Co., Ltd.
Address	Zhongyuanqu Jianshexilu 92 Hao 1 Haolou 2 Danyuan 5 Ceng 44 Hao, Zhengzhou, Henan, China 450007
Product Designation	Two-way radio
Brand Name	Arcshell
Test Model	AR-7
Deviation from Standard	None
Date of Receipt	Aug. 11, 2022
Date of Test	Aug. 11, 2022~Aug. 24, 2022
Test Result	Pass

WE HEREBY CERTIFY THAT:
The above equipment was tested by Attestation of Global Compliance (Shenzhen) Co., Ltd. The data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI/TIA-603-E-2016. The sample tested as described in this report is in compliance with the FCC Rules Part 90. The test results of this report relate only to the tested sample identified in this report.

Prepared By

Bibo Zhang
(Project Engineer)
Aug. 24, 2022

Reviewed By

Calvin Liu
(Reviewer)
Aug. 24, 2022

Approved By

Max Zhang
Authorized Officer
Aug. 24, 2022

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2. PRODUCT INFORMATION

2.1 PRODUCT TECHNICAL DESCRIPTION

Hardware Version	VER04	
Software Version	V1.00	
Power Supply	DC 3.7V,1500mAh by battery, charging for DC4.2V	
Adapter Information	Input: AC 100-240V, 50/60Hz, 0.15A Output: DC 4.2V 500mA	
Communication Type	Voice / Data &Voice / Tone only	
Operation Frequency Range	From 400MHz to 470MHz	
Modulation Type	Analog Voice:	FM
Channel Separation	Analog Voice:	12.5 kHz
Emission Designator	Analog Voice:	11K0F3E
Rated Output Power	2W(It was fixed by the manufacturer, any individual can’t arbitrarily change it.)	
Maximum Transmitter Power	32.41dBm(2W-12.5kHz)	
Antenna Designation	Detachable	
Antenna Gain	1.5dBi	
Frequency Tolerance	1.073ppm	

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2.2 TEST FREQUENCY LIST

Operation mode	Channel Separation	Operation Frequency Range	Test channel	Test Frequency
Analog	12.5 kHz	400-470MHz	Bottom	406.125 MHz
	12.5 kHz	400-470MHz	Middle	453.2125 MHz
	12.5 kHz	400-470MHz	Middle	458.2125 MHz
	12.5 kHz	400-470MHz	Top	469.975 MHz

Note:
In section KDB 634817 D01 Sections II) (f) (1) and (2):
Test at least one frequency in each band for each rule part applied under and ensure the device is capable of operating on the frequency under each rule part. This requirement may result in testing on multiple frequencies. Testing on one frequency may be acceptable if multiple listed bands for a rule part with a continuous frequency range are split to remove a conflict with other rules and the technical requirements in the split bands are the same. Additional requirements for RF exposure may apply.

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2.3 RELATED SUBMITTAL(S) / GRANT (S)

This submittal(s) (test report) is intended for FCC ID: **2ARTCAR-7,** filing to comply with Part 2, Part 90 of the Federal Communication Commission rules.

2.4 TEST METHODOLOGY

The tests were performed according to following standards:

No.	Identity	Document Title
1	FCC 47 CFR Part 90	Private Land Mobile Radio Services
2	FCC 47 CFR Part 2	Frequency allocations and radio treaty matters; general rules and regulations
3	ANSI/TIA-603-E	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
4	ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
5	KDB 971168 D01	KDB 971168 D01 Power Meas License Digital Systems v03r01
6	KDB 579009 D03	KDB 579009 D03 Applications Part 90 Refarming Bands v01
7	KDB 634817 D01	KDB 634817 D01 Freq Range Listing for Grants v04r01

2.5 CALCULATION OF EMISSION INDICATORS

FCC Rules and Regulations Part 2.202: Necessary Bandwidth and Emission Bandwidth

For FM Mode (ChannelSpacing: 12.5kHz)
Emission Designator 11K0F3E
In this case, the maximum modulating frequency is 3.0 kHz with a 2.5 kHz deviation.
BW = 2(M+D) = 2*(3.0 kHz + 2.5 kHz) = 11 kHz = 11K0
F3E portion of the designator represents an FM voice transmission.
Therefore, the entire designator for 12.5 kHz channel spacing FM mode is 11K0F3E.

For FM Mode (Channel Spacing: 25kHz)
Emission Designator 16K0F3E
In this case, the maximum modulating frequency is 3.0 kHz with a 5.0 kHz deviation.
BW = 2(M+D) = 2*(3.0 kHz + 5.0 kHz) = 16 kHz = 16K0
F3E portion of the designator represents an FM voice transmission.
Therefore, the entire designator for 25 kHz channel spacing FM mode is 16K0F3E.

2.6 SPECIAL ACCESSORIES

Not available for this EUT intended for grant.

2.7 EQUIPMENT MODIFICATIONS

Not available for this EUT intended for grant.

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3. TEST ENVIRONMENT

3.1 ADDRESS OF THE TEST LABORATORY

Laboratory: Attestation of Global Compliance (Shenzhen) Co., Ltd.

Address: 1-2/F, Building 19, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

3.2 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L5488

Attestation of Global Compliance (Shenzhen) Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC17025: 2017 General Requirements) for the Competence of Testing and Calibration Laboratories.

A2LA-Lab Cert. No.: 5054.02

Attestation of Global Compliance (Shenzhen) Co., Ltd. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

FCC-Registration No.: 975832

Attestation of Global Compliance (Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files with Registration 975832.

IC-Registration No.: 24842

Attestation of Global Compliance (Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the Certification and Engineering Bureau of Industry Canada. The acceptance letter from the IC is maintained in our files with Registration 24842.

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3.3 ENVIRONMENTAL CONDITIONS

	NORMAL CONDITIONS	EXTREME CONDITIONS
Temperature range (℃)	15 - 35	-20 - 50
Relative humidity range	20 % - 75 %	20 % - 75 %
Pressure range (kPa)	86 - 106	86 - 106
Power supply	DC 3.70V	LV:DC 3.15V/HV: DC 4.20V
Note: The Extreme Temperature and Extreme Voltages declared by the manufacturer.		

3.4 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement y ±U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Test Items	Measurement Uncertainty
Frequency stability	±0.5%
Transmitter power conducted	±0.8dB
Transmitter power Radiated	±1.3dB
Conducted spurious emission 9kHz-40 GHz	±2.7dB
Conducted Emission	±3.2 dB
Radiated Emission below 1GHz	±3.9 dB
Radiated Emission above 1GHz	±4.8 dB
Occupied Channel Bandwidth	±2 %
FM deviation	±2 %
Audio level	±0.98dB
Low Pass Filter Response	±0.65dB
Modulation Limiting	0.42 %
Transient Frequency Behavior	6.8 %

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3.5 LIST OF EQUIPMENTS USED

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Due
TEST RECEIVER	R&S	ESCI	10096	Mar. 28, 2022	Mar. 27, 2023
EXA Signal Analyzer	Aglient	N9020A	W1312-60196	Aug. 18, 2021	Aug. 17, 2022
EXA Signal Analyzer	Aglient	N9020A	MY52090123	Sep. 06, 2021	Sep. 05, 2022
Horn antenna	SCHWARZBECK	BBHA 9170	#768	Oct. 31, 2021	Oct. 30, 2023
preamplifier	ChengYi	EMC184045SE	980508	Oct. 29, 2021	Oct. 28, 2023
Double-Ridged Waveguide Horn	ETS LINDGREN	3117	00034609	Apr. 23, 2021	Apr. 22, 2023
Broadband Preamplifier	SCHWARZBECK	BBV 9718	9718-205	Jun. 05, 2022	Jun. 04, 2023
HORN ANTENNA	EM	EM-AH-10180	/	Feb.24, 2022	Feb.23, 2023
SIGNAL GENERATOR	AGILENT	E4421B	MY43351603	Mar. 04, 2022	Mar. 03, 2023
SIGNAL GENERATOR	R&S	SMT03	A0304261	Jun. 05, 2022	Jun. 04, 2023
ANTENNA	SCHWARZBECK	VULB9168	VULB9168-494	Jan. 08, 2021	Jan. 07, 2023
ANTENNA	SCHWARZBECK	VULB9168	D69250	Apr. 28, 2021	Apr. 27, 2023
Active loop antenna (9K-30MHz)	ZHINAN	ZN30900C	18051	Mar. 12, 2022	Mar. 11, 2023
Modulation Domain Analyzer	HP	53310A	3121A02467	Jun. 08, 2022	Jun. 07, 2024
Small environmental tester	ESPEC	SH-242	--	Sep. 03, 2020	Sep. 02, 2022
RF Communication Test Set	HP	8920B	US35010161	Sep. 06, 2020	Sep. 05, 2022
Attenuator	Weinachel Corp	58-30-33	ML030	Oct. 24, 2021	Oct. 23, 2022
RF Cable	R&S	1#	--	Each time	N/A
RF Cable	R&S	2#	--	Each time	N/A
Fliter-UHF	Microwave	N25155M2	498705	May 07, 2022	May 06, 2023

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4.SYSTEM TEST CONFIGURATION

4.1 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commission's requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

4.2 EUT EXERCISE

The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

4.3 CONFIGURATION OF TESTED SYSTEM

Fig. 2-1 Configuration of Tested System

Table 2-1 Equipment Used in Tested System

4.4 EQUIPMENT USED IN TESTED SYSTEM

The Following Peripheral Devices And Interface Cables Were Connected During The Measurement:
☐ Test Accessories Come From The Laboratory
☒ Test Accessories Come From The Manufacturer

Item	Equipment	Model No.	Identifier	Note
1	Two-way radio	AR-7	FCC ID: 2ARTCAR-7	EUT
2	Battery	AR-7	DC 3.7V 1500mAh	Accessories
3	Back clip	N/A	N/A	Accessories
4	Charger	N/A	DC 4.2V 0.5A	Accessories

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4.5 SUMMARY OF TEST RESULTS

Item	FCC Rules	Description Of Test	Result
1	FCC PART 90	Antenna Equipment	Pass
2	§90.205& 2.1046	Maximum Transmitter Power	Pass
3	§90.207& 2.1047	Modulation Characteristic	Pass
4	§2.1047	Audio Low Pass Filter Response	Pass
5	§90.209& 2.1049	Occupied Bandwidth	Pass
6	§90.210& 2.1049	Emission Mask	Pass
7	§90.213& 2.1055	Frequency Tolerance	Pass
8	§90.214	Transmitter Frequency Behavior	Pass
9	§90.210& 2.1051	Spurious Emission on Antenna Port	Pass
10	§90.210& 2.1053	Spurious Ratiated Emission	Pass

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5.DESCRIPTION OF TEST MODES

The EUT (**Two-way radio**) has been tested under normal operating condition. (The top channel, the middle channel and the bottom channel) are chosen for testing at each channel separation.

NO.	TEST MODE DESCRIPTION	CHANNEL SEPARATION
1	TX Bottom channel-UHF	12.5 kHz
2	TX Middle channel-UHF	12.5 kHz
3	TX Middle channel-UHF	12.5 kHz
4	TX Top channel-UHF	12.5 kHz

Note:

1. Only the result of the worst case was recorded in the report, if no other cases.
2. The battery is full-charged during the test.
3. For Radiated Emission, 3axis were chosen for testing for each applicable mode.
4. For Conducted Test method, a temporary antenna connector is provided by the manufacture.
5. Manufacturers use computer PC programming software to switch and operate frequency points, refer to the instructions for details

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6.FREQUENCY TOLERANCE

6.1 PROVISIONS APPLICABLE

a). According to FCC §2.1055,§90.213, the frequency stability shall be measured with variation of ambient temperature from –30℃ to +50℃ centigrade.

b). According to FCC Part 2 Section 2.1055(d)(2), for battery powered equipment, the frequency stability shall be measured with reducing primary supply voltage to the battery operating end point, which is specified by the manufacturer.

c). According to FCC Part 90 Section 90.213, the frequency tolerance must be maintained within 0.00025% for 12.5 kHz channel separation and 0.0001% for 6.25 kHz channel separation.

6.2 MEASUREMENT PROCEDURE

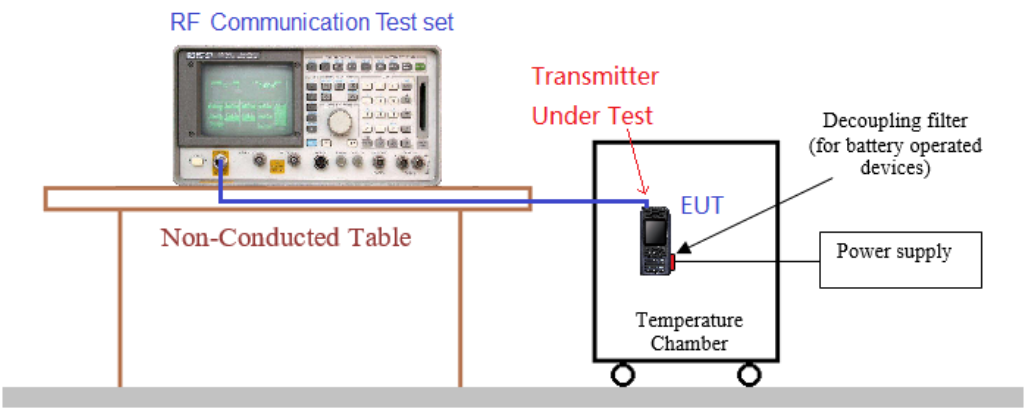
6.2.1 Frequency stability versus environmental temperature

1. Setup the configuration per figure 1 for frequencies measurement inside an environment chamber, Install new battery in the EUT.
2. Turn on EUT and set SA center frequency to the EUT radiated frequency. Set SA Resolution Bandwidth to 1kHz and Video Resolution Bandwidth to 1kHz and Frequency Span to 50kHz.Record this frequency as reference frequency.
3. Set the temperature of chamber to 50℃. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize. While maintaining a constant temperature inside the chamber, turn the EUT on and measure the EUT operating frequency.
4. Repeat step 2 with a 10℃ decreased per stage until the lowest temperature -30℃ is measured, record all measured frequencies on each temperature step.

6.2.2 Frequency stability versus input voltage

1. Setup the configuration per figure 1 for frequencies measured at temperature if it is within 15℃ to 25℃. Otherwise, an environment chamber set for a temperature of 20℃ shall be used. The EUT shall be powered by DC 3.7V.
2. Set SA center frequency to the EUT radiated frequency. Set SA Resolution Bandwidth to 1 kHz and Video Resolution Bandwidth to 1kHz. Record this frequency as reference frequency.
3. Supply the EUT primary voltage at the operating end point which is specified by manufacturer and record the frequency.

6.3 MEASUREMENT SETUP



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6.4 MEASUREMENT RESULTS

12.5 kHz Channel Separation, Analog modulation, Assigned Frequency For UHF-2W							
Test conditions		Frequency error (ppm)				Limit (ppm)	Result
Voltage (V)	Temp (℃)	Test Frequency (MHz)					
		406.125	453.2125	458.2125	469.975		
3.70	-30	1.036	0.608	0.536	0.363	2.5	Pass
	-20	0.978	0.802	0.914	0.877		
	-10	**1.073**	0.648	0.681	0.856		
	0	0.946	1.072	1.003	0.538		
	10	1.056	1.091	1.035	0.539		
	20	0.526	0.794	0.885	0.905		
	30	0.663	0.669	0.672	0.525		
	40	0.997	1.029	0.939	0.855		
	50	0.602	0.578	1.037	0.942		
4.20	20	0.703	0.643	0.581	0.444		
3.15	20	0.799	0.894	0.663	0.754		

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7. EMISSION BANDWIDTH

7.1 PROVISIONS APPLICABLE

FCC Part 90.209 & FCC Part 2.1049:
The authorized bandwidth shall be 11.25 kHz for 12.5 kHz channel separation and 6 kHz for 6.25 kHz channel separation.

7.2 MEASUREMENT PROCEDURE

1.The EUT was modulated by 2.5kHz sine wave audio signal; the level of the audio signal employed is 16dB greater than that necessary to produce 50% of rated system deviation.

Rated system deviation is 2.5 kHz for 12.5kHz channel spacing).

2.Spectrum set as follow:

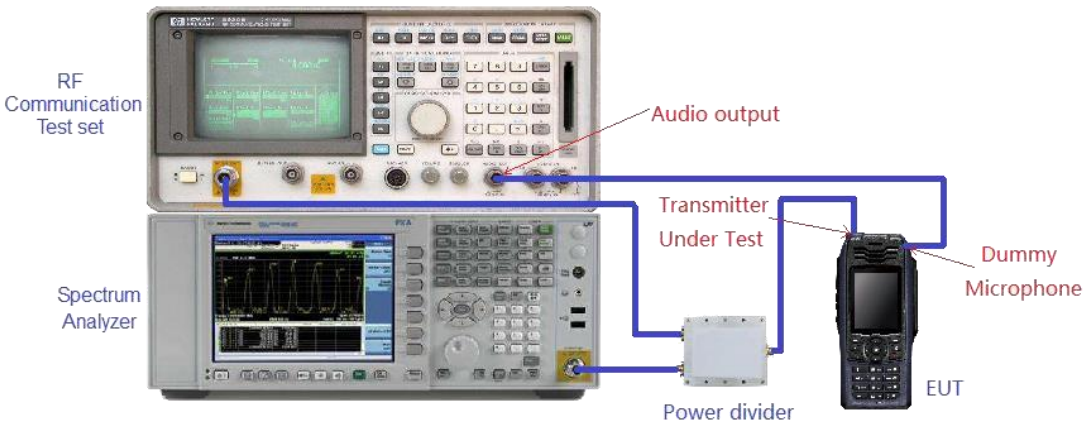
Centre frequency = fundamental frequency, span=50kHz for 12.5kHz channel spacing, RBW=100Hz, VBW=300Hz, Sweep = auto,

Detector function = peak, Trace = max hold

3.Set 99% Occupied Bandwidth and 26dB Occupied Bandwidth.

4.Measure and record the results in the test report.

7.3 MEASUREMENT SETUP



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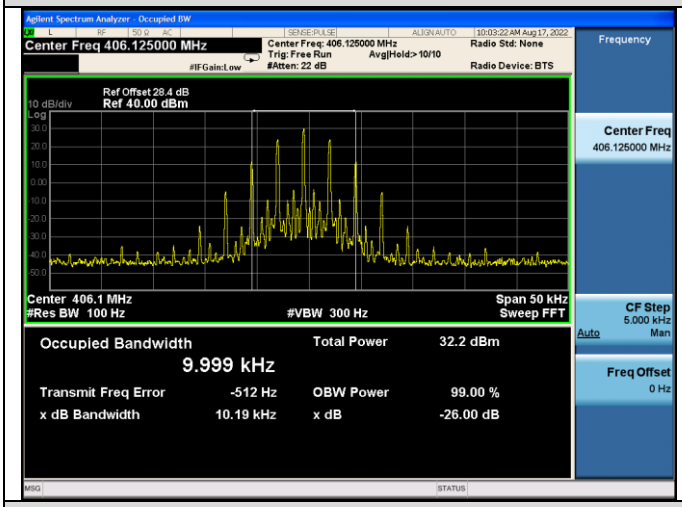
7.4 MEASUREMENT RESULTS

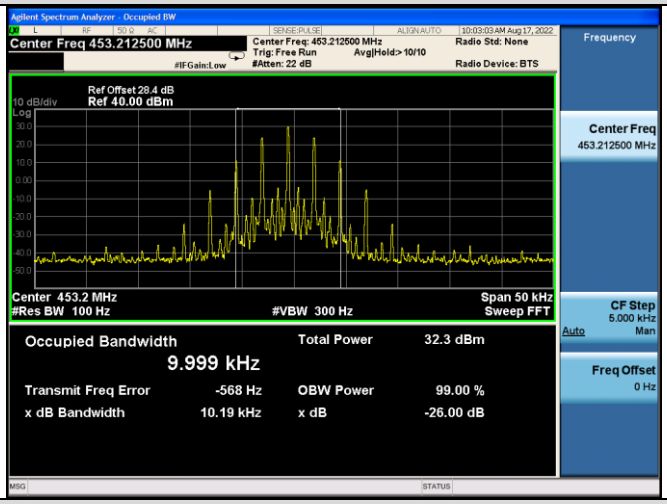
Measurement Result of UHF-Analog Modulation-2W				
Operating Frequency	12.5 kHz Channel Separation			
	Occupied Bandwidth	Emission Bandwidth	Limits	Result
406.125MHz	9.999 kHz	10.19 kHz	11.25 kHz	Pass
453.2125MHz	9.999 kHz	10.19 kHz	11.25 kHz	Pass
458.2125MHz	10.000 kHz	10.18 kHz	11.25 kHz	Pass
469.975MHz	10.000 kHz	10.21 kHz	11.25 kHz	Pass

Test plot as follows:

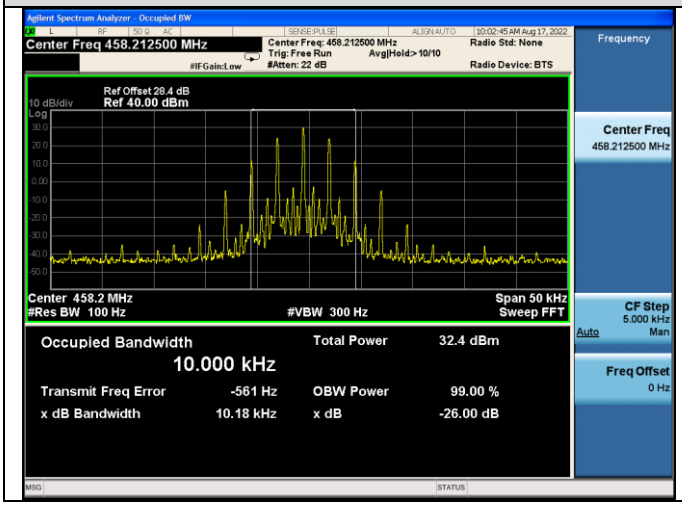
12.5kHz, FM Modulation:406.125MHz-2W



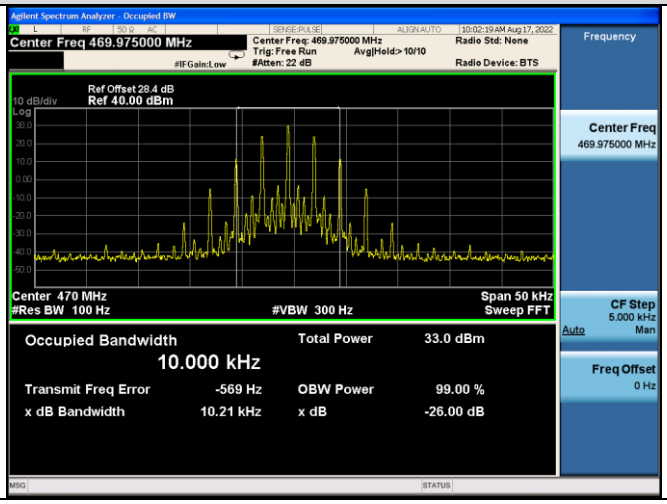
12.5kHz, FM Modulation:453.2125MHz-2W



12.5kHz, FM Modulation:458.2125MHz-2W



12.5kHz, FM Modulation:469.975MHz-2W



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8. SPURIOUS RATIATED EMISSION

8.1 PROVISIONS APPLICABLE

According to FCC §2.1053 and §90.210, the power of each unwanted emission shall be less than Transmitted Power as specified below for transmitters designed to operate with each channel separation.
Emission Mask D -for 12.5 kHz Channel Separation:

(1) On any frequency removed from the center of the authorized bandwidth fo to 5.625 kHz removed from fo: Zero dB.
(2) On any frequency removed from the center of the authorized bandwidth by a displacement Frequency (fd in kHz) fo of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd-2.88 kHz) dB
(3) On any frequency removed from the center of the authorized bandwidth by a displacement Frequency (fd in kHz)fo of more than 12.5 kHz: At least 50+10 log(P) dB or 70 dB, whichever is lesser attenuation.

8.2 MEASUREMENT PROCEDURE

(1) On a test site, the EUT shall be placed on a turntable, and in the position closest to the normal use as declared by the user.
(2) The test antenna shall be oriented initially for vertical polarization located 3m from the EUT to correspond to the transmitter.
(3) The output of the antenna shall be connected to the measuring receiver and either a peak or quasi-peak detector was used for the measurement as indicated on the report. The detector selection is based on how close the emission level was approaching the limit.
(4) The transmitter shall be switched on; if possible, without the modulation and the measurement receiver shall be tuned to the frequency of the transmitter under test.
(5) The test antenna shall be raised and lowered through the specified range of height until the measuring receiver detects a maximum signal level.
(6) The transmitter shall than be rotated through 360°in the horizontal plane, until the maximum signal level is detected by the measuring receiver.
(7) The test antenna shall be raised and lowered again through the specified range of height until the measuring receiver detects a maximum signal level.
(8) The maximum signal level detected by the measuring receiver shall be noted.
(9) The measurement shall be repeated with the test antenna set to horizontal polarization.
(10) Replace the antenna with a proper Antenna (substitution antenna).
(11) The substitution antenna shall be oriented for vertical polarization and, if necessary, the length of the substitution antenna shall be adjusted to correspond to the frequency of transmitting.
(12) The substitution antenna shall be connected to a calibrated signal generator.
(13) If necessary, the input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver.
(14) The test antenna shall be raised and lowered through the specified range of the height to ensure that the maximum signal is received.
(15) The input signal to substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver, that is equal to the level noted while the transmitter radiated power was measured, corrected for the change of input attenuation setting of the measuring receiver.
(16) The input level to the substitution antenna shall be recorded as power level in dBm, corrected for any change of input attenuator setting of the measuring receiver.
(17) The measurement shall be repeated with the test antenna and the substitution antenna oriented for horizontal polarization.

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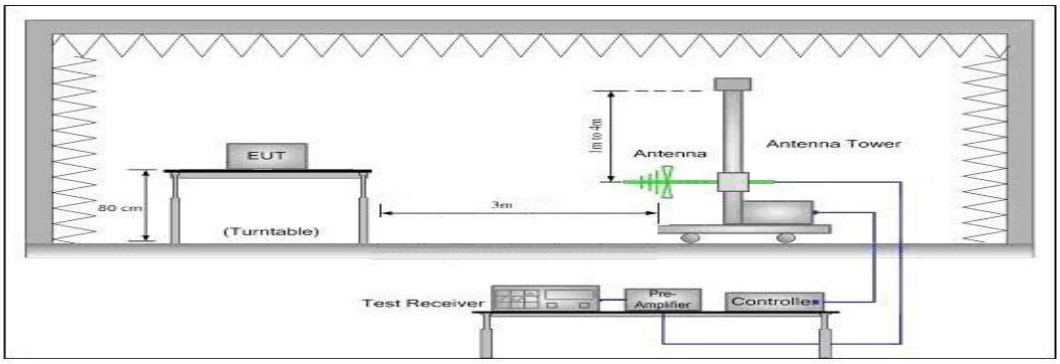
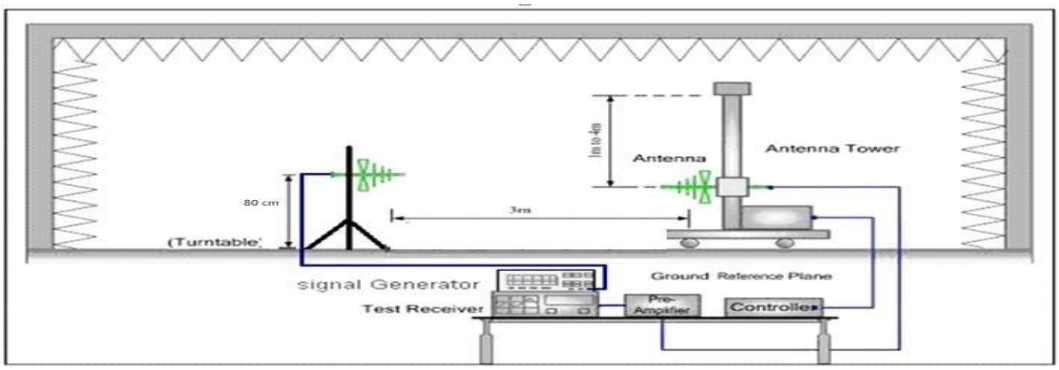
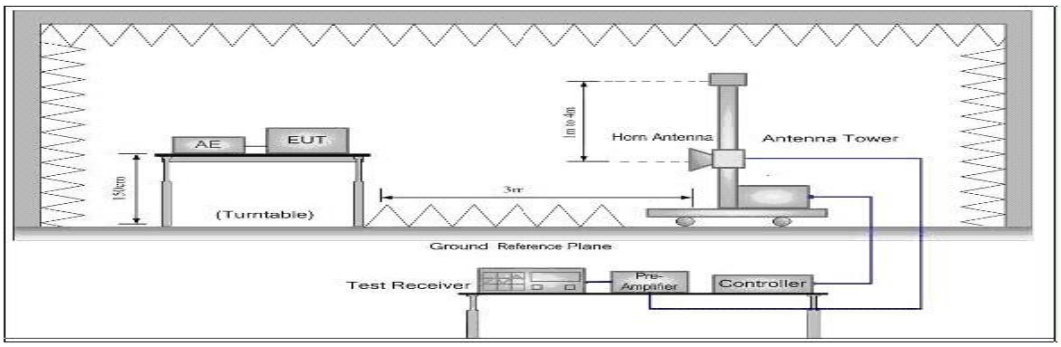
8.3 MEASUREMENT SETUP

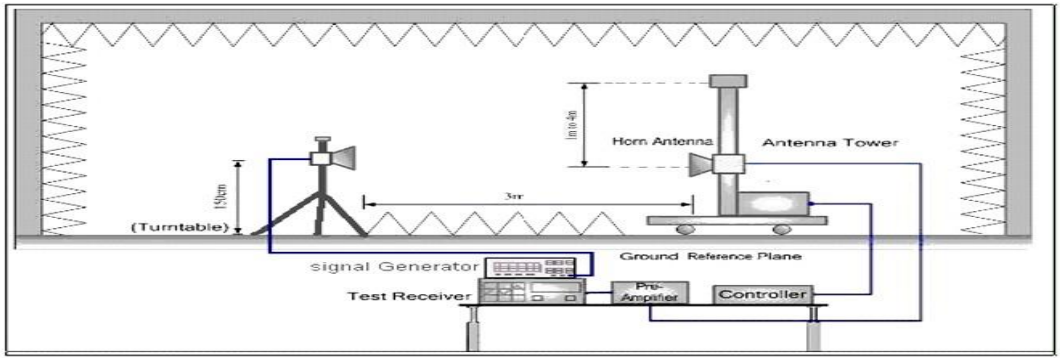
RADIATED BELOW 1GHZ





RADIATED ABOVE 1 GHZ





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8.4 MEASUREMENT RESULTS

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz for below 1GHz, and 1MHz for above 1GHz. Sufficient scans were taken to show any out of band emissions up to 10 harmonic.

In the semi-anechoic chamber, setup as illustrated above the DUT placed on the 0.8m height of Turn Table, rotated the table 45 degree each interval to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum polar radiated power for each degree interval. The “Read Value” is the spectrum reading of maximum power value.

The substitution antenna is substituted for DUT at the same position and signals generator (S.G) export the CW signal to the substitution antenna via a TX cable. The receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum radiation power. Record the power level of maximum radiation power from spectrum. So, the Measured substitution value = Ref level of S.G + TX cables loss – Substituted Antenna Gain.

EIRP = “Read Value” + Measured substitution value + 2.15.

Test limit calculation:

Preliminary calculation	Final Result
At least 50+10 log (P) =50+10log (2) =53.01 (dB)	Limit=P- Preliminary calculation=33.01-53.01=-20 dBm

Note: The report only reflects high-power test data as the worst.

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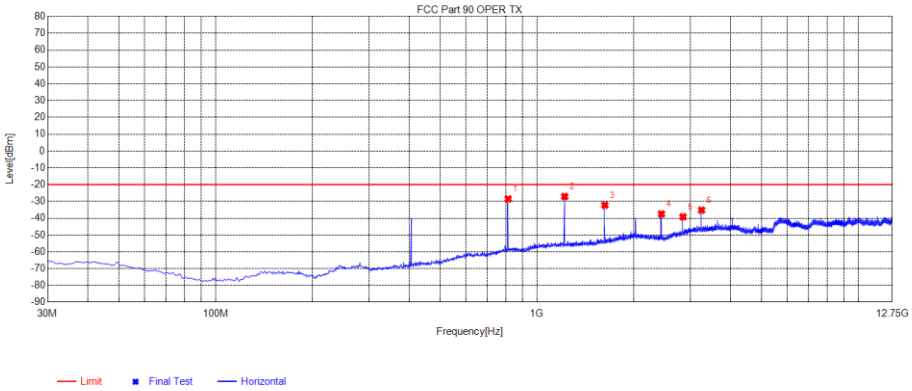
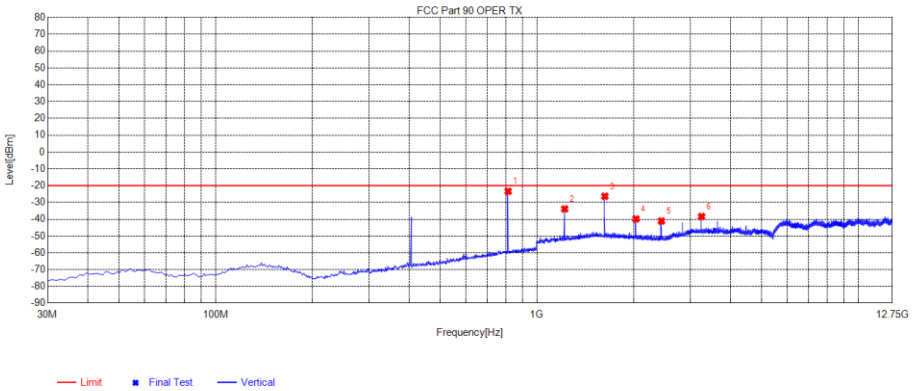
Test Mode:	TX:406.125MHz-FM 2W	Polarity:	Horizontal



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	812.79	-71.92	-28.56	-20.00	8.56	43.36	358	Horizontal
2	1218.5719	-23.28	-27.08	-20.00	7.08	-3.80	249	Horizontal
3	1625.1625	-29.96	-32.23	-20.00	12.23	-2.27	202	Horizontal
4	2437.1687	-36.26	-37.45	-20.00	17.45	-1.19	202	Horizontal
5	2843.7594	-41.00	-39.19	-20.00	19.19	1.81	9	Horizontal
6	3249.1749	-38.94	-35.21	-20.00	15.21	3.73	358	Horizontal

Test Mode:	TX:406.125MHz-FM 2W	Polarity:	Vertical



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	812.79	-65.89	-23.40	-20.00	3.40	42.49	0	Vertical
2	1218.5719	-34.17	-33.88	-20.00	13.88	0.29	51	Vertical
3	1625.1625	-28.08	-26.36	-20.00	6.36	1.72	135	Vertical
4	2030.5781	-40.19	-39.87	-20.00	19.87	0.32	173	Vertical
5	2437.1687	-40.21	-41.11	-20.00	21.11	-0.90	183	Vertical
6	3249.1749	-41.56	-38.42	-20.00	18.42	3.14	89	Vertical

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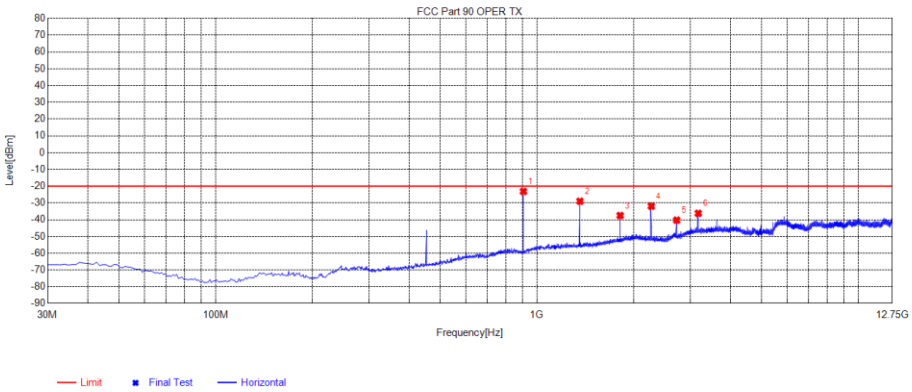
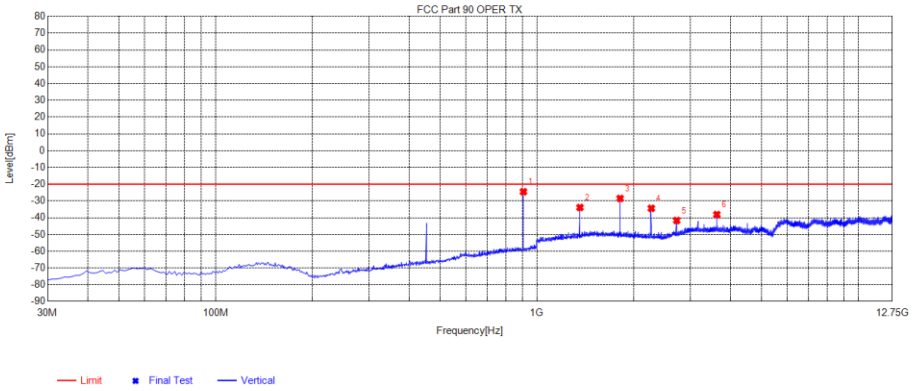
Test Mode:	TX:453.2125MHz-FM 2W	Polarity:	Horizontal



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	906.88	-66.24	-23.15	-20.00	3.15	43.09	360	Horizontal
2	1359.586	-25.50	-29.00	-20.00	9.00	-3.50	328	Horizontal
3	1813.1813	-36.64	-37.51	-20.00	17.51	-0.87	207	Horizontal
4	2266.7767	-31.44	-31.96	-20.00	11.96	-0.52	197	Horizontal
5	2719.1969	-40.91	-40.28	-20.00	20.28	0.63	328	Horizontal
6	3172.7923	-39.79	-36.19	-20.00	16.19	3.60	360	Horizontal

Test Mode:	TX:453.2125MHz-FM 2W	Polarity:	Vertical



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	906.88	-67.90	-24.52	-20.00	4.52	43.38	350	Vertical
2	1359.586	-35.15	-33.92	-20.00	13.92	1.23	191	Vertical
3	1813.1813	-29.59	-28.53	-20.00	8.53	1.06	135	Vertical
4	2266.7767	-34.03	-34.42	-20.00	14.42	-0.39	155	Vertical
5	2719.1969	-42.45	-41.65	-20.00	21.65	0.80	173	Vertical
6	3625.2125	-41.26	-38.14	-20.00	18.14	3.12	340	Vertical

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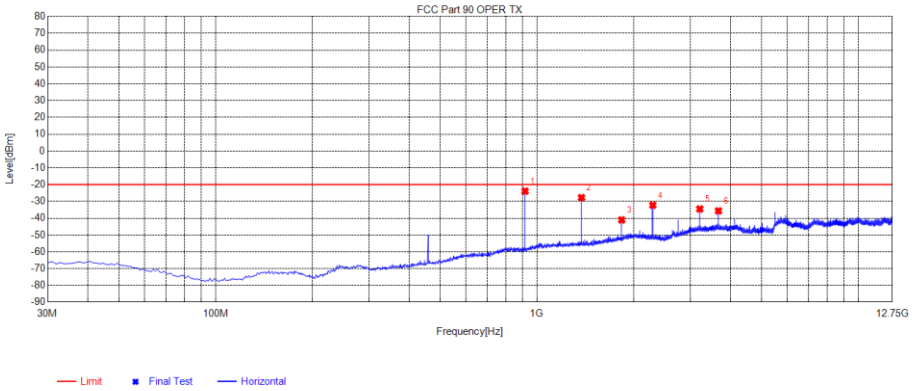
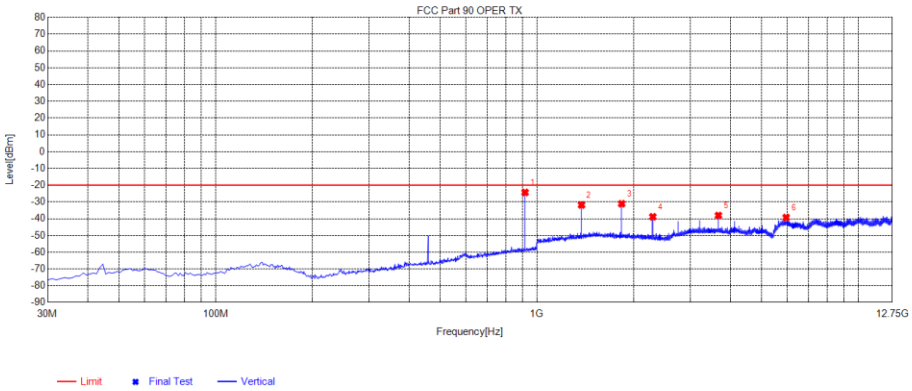
Test Mode:	TX:458.2125MHz-FM 2W	Polarity:	Horizontal



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	917.55	-67.22	-23.90	-20.00	3.90	43.32	360	Horizontal
2	1374.8625	-24.31	-27.78	-20.00	7.78	-3.47	310	Horizontal
3	1833.1583	-40.31	-41.03	-20.00	21.03	-0.72	161	Horizontal
4	2291.4541	-31.65	-32.27	-20.00	12.27	-0.62	199	Horizontal
5	3208.0458	-38.18	-34.52	-20.00	14.52	3.66	336	Horizontal
6	3666.3416	-40.02	-35.65	-20.00	15.65	4.37	352	Horizontal

Test Mode:	TX:458.2125MHz-FM 2W	Polarity:	Vertical



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	917.55	-67.83	-24.34	-20.00	4.34	43.49	350	Vertical
2	1374.8625	-33.17	-31.84	-20.00	11.84	1.33	174	Vertical
3	1833.1583	-32.08	-31.09	-20.00	11.09	0.99	136	Vertical
4	2291.4541	-38.42	-38.88	-20.00	18.88	-0.46	128	Vertical
5	3666.3416	-41.23	-38.09	-20.00	18.09	3.14	350	Vertical
6	5956.6457	-49.82	-39.31	-20.00	19.31	10.51	165	Vertical

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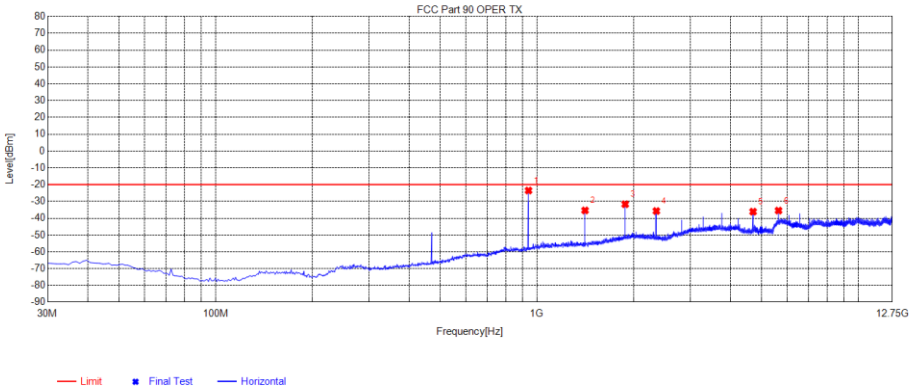
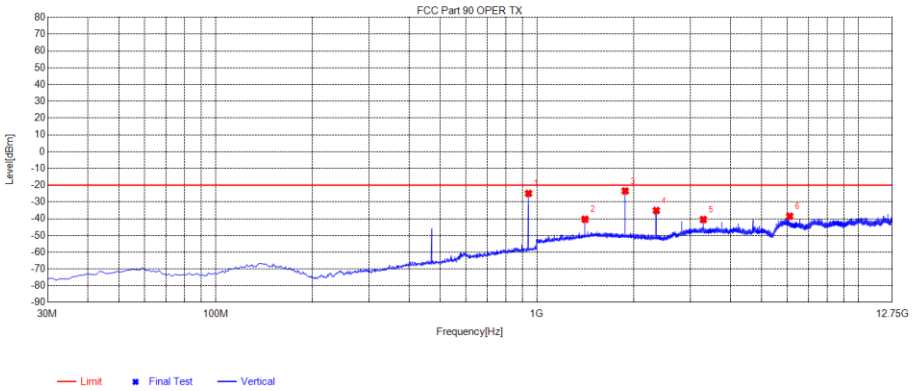
Test Mode:	TX:469.975MHz-FM 2W	Polarity:	Horizontal



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	940.83	-67.36	-23.53	-20.00	3.53	43.83	360	Horizontal
2	1410.116	-31.97	-35.37	-20.00	15.37	-3.40	233	Horizontal
3	1880.163	-31.32	-31.69	-20.00	11.69	-0.37	172	Horizontal
4	2350.21	-34.88	-35.73	-20.00	15.73	-0.85	200	Horizontal
5	4699.2699	-39.70	-36.12	-20.00	16.12	3.58	217	Horizontal
6	5639.3639	-44.90	-35.46	-20.00	15.46	9.44	217	Horizontal

Test Mode:	TX:469.975MHz-FM 2W	Polarity:	Vertical



NO.	Freq. [MHz]	Reading [dBm]	Level [dBm]	Limit [dBm]	Margin [dB]	Factor [dB]	Angle [°]	Polarity
1	940.83	-68.66	-24.93	-20.00	4.93	43.73	0	Vertical
2	1410.116	-41.92	-40.36	-20.00	20.36	1.56	0	Vertical
3	1880.163	-24.30	-23.47	-20.00	3.47	0.83	148	Vertical
4	2350.21	-34.48	-35.12	-20.00	15.12	-0.64	5	Vertical
5	3290.304	-43.64	-40.52	-20.00	20.52	3.12	50	Vertical
6	6109.4109	-49.65	-38.56	-20.00	18.56	11.09	158	Vertical

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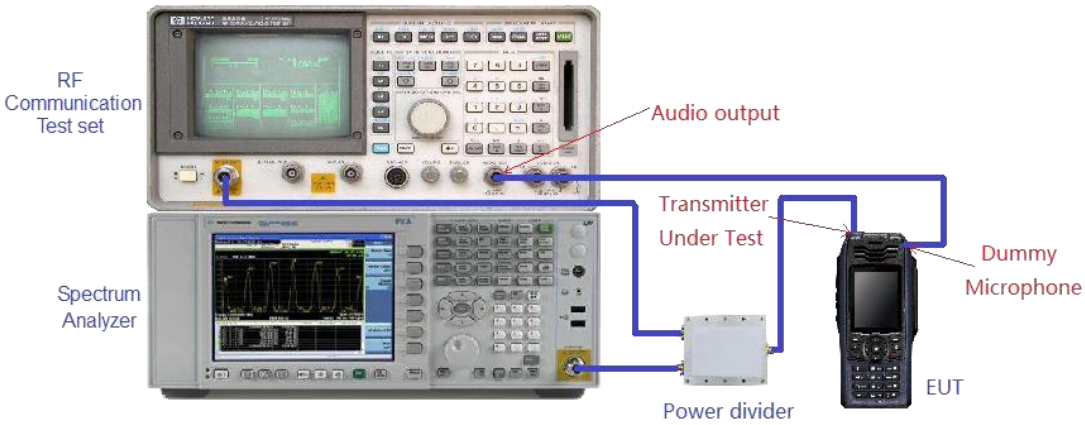
8.5 EMISSION MASK PLOT

The detailed procedure employed for Emission Mask measurements are specified as following:

-Connect the equipment as illustrated.

-Spectrum set as follow:

1. Centre frequency = fundamental frequency, Span=50kHz for 12.5kHz and 25kHz channel spacing, RBW=100Hz, VBW=300Hz for 12.5kHz, RBW=300Hz, VBW=1000Hz for 25kHz, Sweep = auto, Detector function = peak, Trace = max hold
2. Key the transmitter, and set the level of the unmodulated carrier to a fullscale reference line. This is the 0dB reference for the measurement.
3. Modulate the transmitter with a 2500 Hz sine wave at an input level 16 dB greater than that necessary to produce 50% of rated system deviation (Rated system deviation is 2.5 kHz for 12.5kHz channel spacing). The input level shall be established at the frequency of maximum response of the audio modulating circuit.
4. Transmitters employing digital modulation techniques that bypass the limiter and the audio low-pass filter shall be modulated as specified by the manufacturer.
5. Measure and record the results in the test report.



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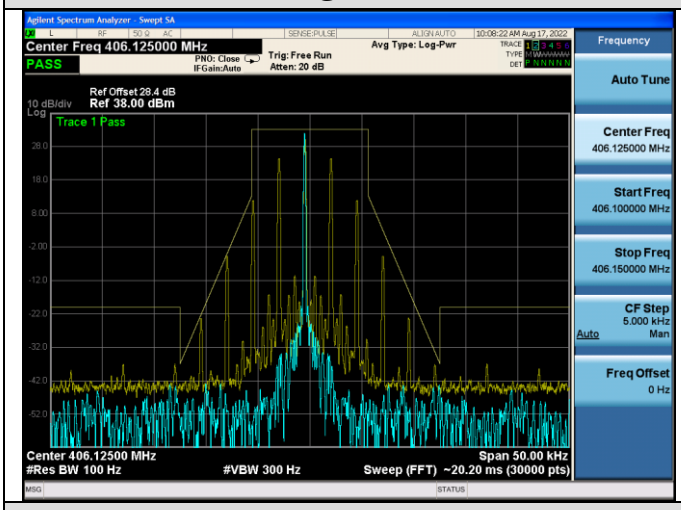
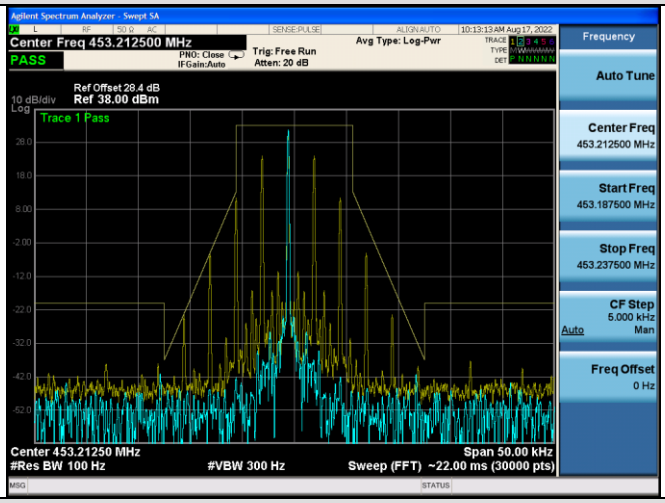
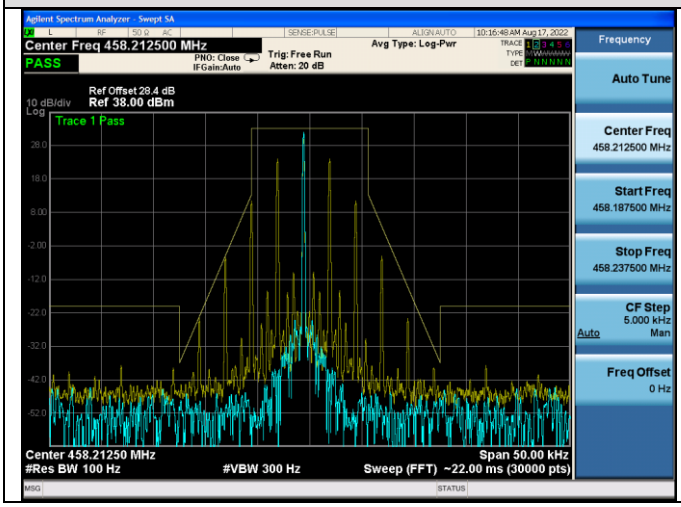
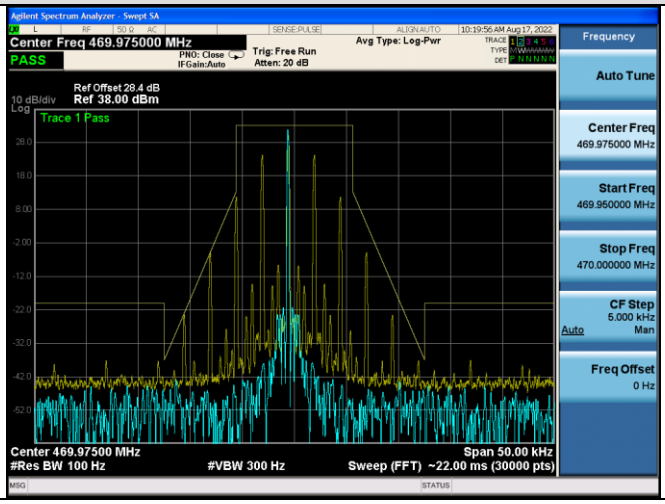
Test plot as follows:

Emission Mask D@406.125MHz-2W-FM	Emission Mask D@453.2125MHz-2W-FM
	
Emission Mask D@458.2125MHz-2W-FM	Emission Mask D@469.975MHz-2W-FM
	

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9.MODULATION CHARACTERISTICS

9.1 PROVISIONS APPLICABLE

According to FCC§2.1047 and §90.207, for Voice Modulation Communication Equipment, the frequency response of the audio modulation circuit over a range of 100 to 5000Hz shall be measured.

9.2 MEASUREMENT METHOD

9.2.1 Modulation Limit

(1). Configure the EUT as shown in figure 1, adjust the audio input for 60% of rated system deviation at 1kHz using this level as a reference (0dB) and vary the input level from –20 to +20dB. Record the frequency deviation obtained as a function of the input level.

(2). Repeat step 1 with input frequency changing to 300, 1000, 1500 and 3000Hz in sequence.

9.2.2 Audio Frequency Response

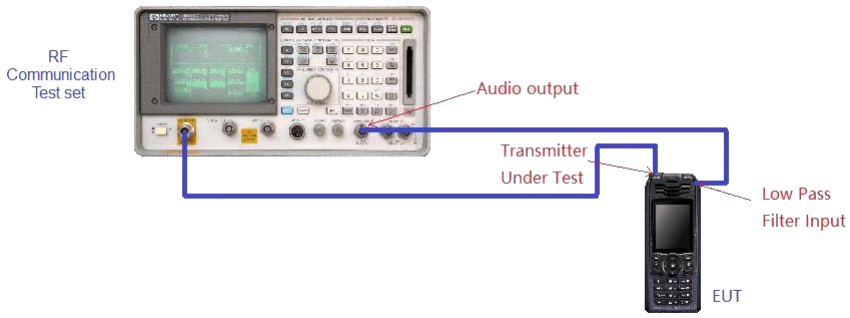
(1). Configure the EUT as shown in figure 1.

(2). Adjust the audio input for 20% of rated system deviation at 1 kHz using this level as a reference (0 dB).

(3). Vary the Audio frequency from 100 Hz to 10 kHz and record the frequency deviation.

(4). Audio Frequency Response = 20log10 (Deviation of test frequency/Deviation of 1 kHz reference).

9.3 MEASUREMENT SETUP



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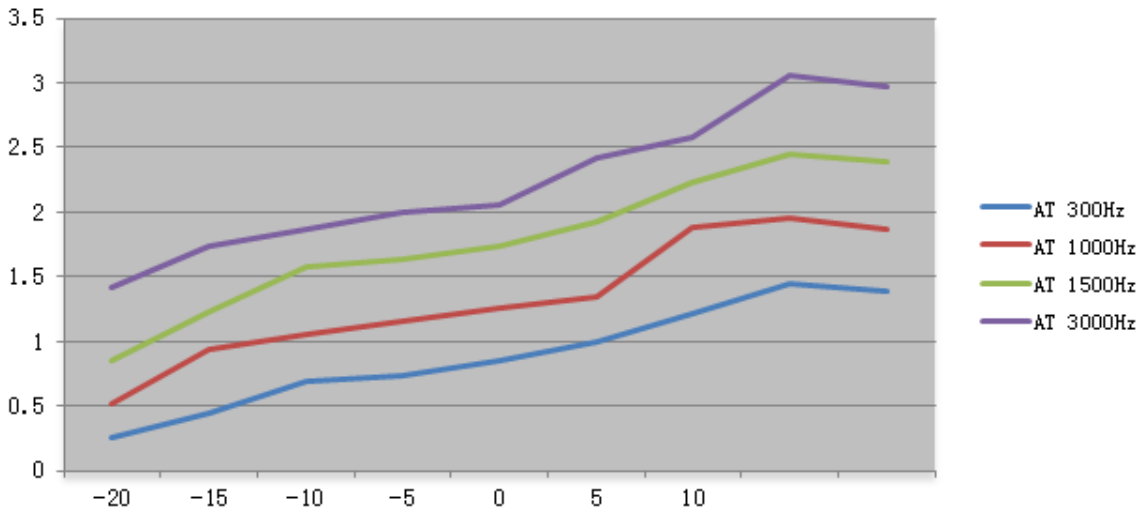
9.4 MEASUREMENT RESULTS

(A). MODULATION LIMIT:

12.5kHz, Analog modulation, Assigned Frequency:406.125MHz-2W				
Modulation Level (dB)	Peak Freq. Deviation At 300 Hz (kHz)	Peak Freq. Deviation At 1000 Hz (kHz)	Peak Freq. Deviation At 1500 Hz (kHz)	Peak Freq. Deviation At 3000 Hz (kHz)
-20	0.25	0.52	0.85	1.42
-15	0.45	0.94	1.22	1.74
-10	0.69	1.05	1.58	1.86
-5	0.74	1.16	1.63	1.99
0	0.85	1.25	1.74	2.05
+5	0.99	1.34	1.92	2.42
+10	1.21	1.88	2.23	2.58
+15	1.45	1.96	2.45	3.05
+20	1.39	1.87	2.39	2.97



Note: All the modes had been tested, but only the worst data recorded in the report.

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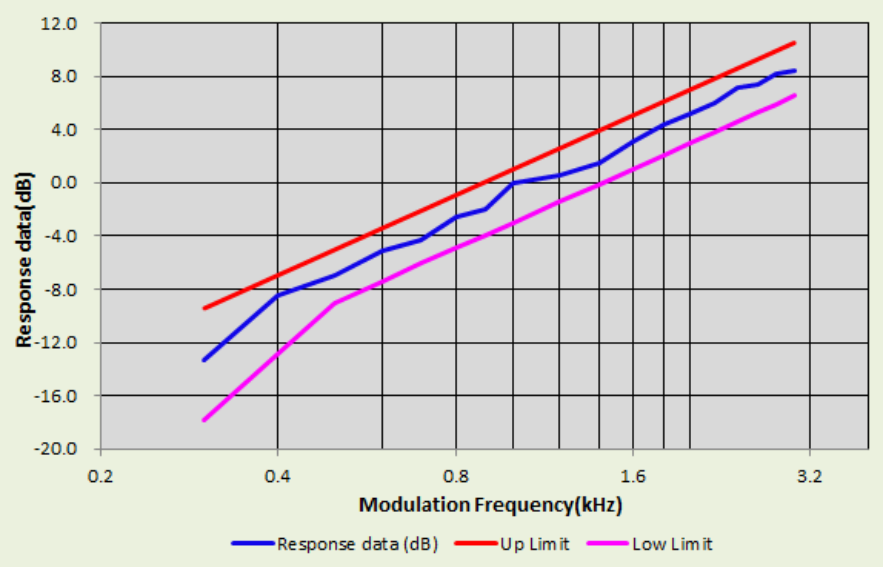
(B). AUDIO FREQUENCY RESPONSE:

12.5kHz, Analog modulation, Assigned Frequency:406.125MHz-2W		
Frequency (Hz)	Deviation (kHz)	Audio Frequency Response(dB)
100	--	--
200	--	--
300	0.16	-13.30
400	0.28	-8.44
500	0.33	-7.01
600	0.41	-5.13
700	0.45	-4.32
800	0.55	-2.58
900	0.59	-1.97
1000	**0.74**	0.00
1200	0.79	0.57
1400	0.88	1.51
1600	1.05	3.04
1800	1.23	4.41
2000	1.35	5.22
2400	1.48	6.02
2500	1.69	7.17
2800	1.74	7.43
3000	1.89	8.14



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10. MAXIMUMN TRANSMITTER POWER

10.1 PROVISIONS APPLICABLE

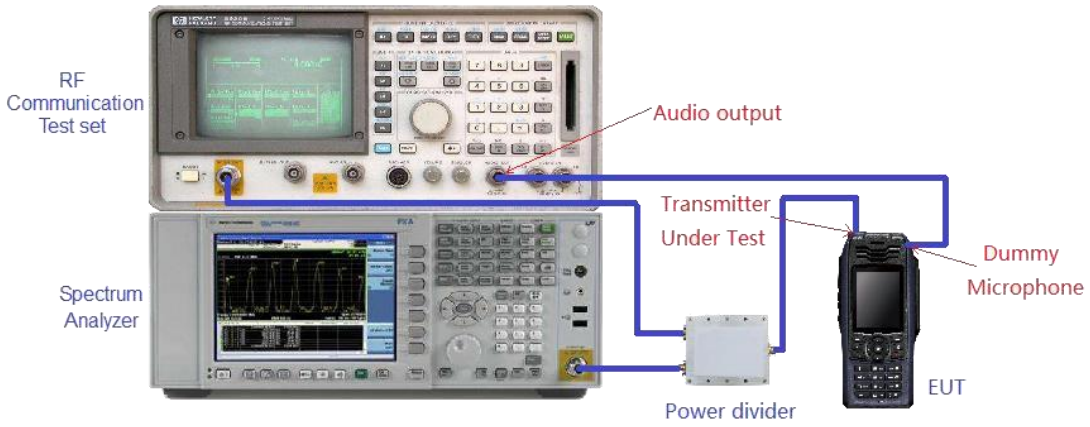
Per FCC §2.1046. § 90.205: Maximum ERP is dependent upon the station's antenna HAAT and required service area.

10.2 MEASUREMENT METHOD

The RF output of Two-way Radio was conducted to a spectrum analyzer through an appropriate attenuator.
In the semi-anechoic chamber, setup as illustrated above the DUT placed on the 0.8m height of Turn Table, rotated the table 45 degree each interval to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum polar radiated power for each degree interval. The "Read Value" is the spectrum reading of maximum power value.
The substitution antenna is substituted for DUT at the same position and signals generator (S.G) export the CW signal to the substitution antenna via a TX cable. The receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum radiation power. Record the power level of maximum radiation power from spectrum.
So, the Measured substitution value = Ref level of S.G + TX cables loss – Substituted Antenna Gain.
EIRP = "Read Value" + Measured substitution value + 2.15.

10.3 MEASUREMENT METHOD

CONDUCTED OUTPUT POWER:



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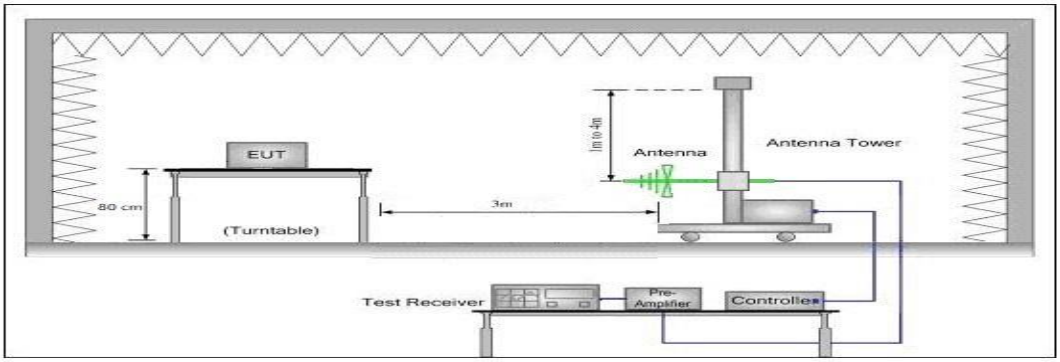
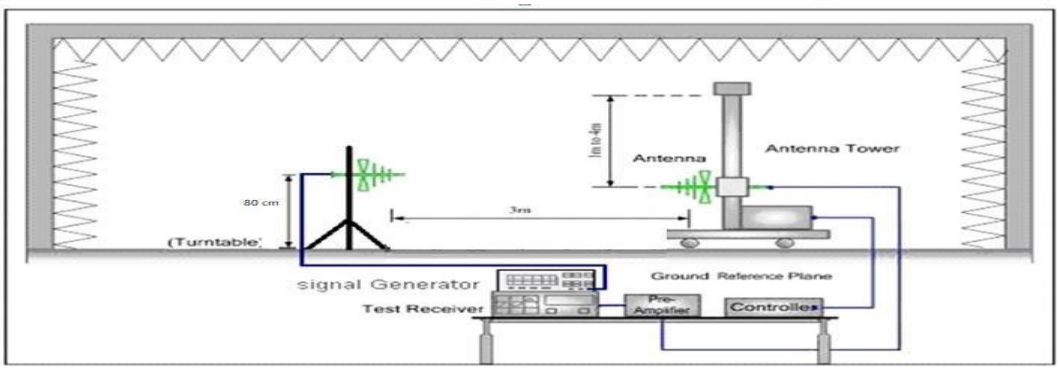
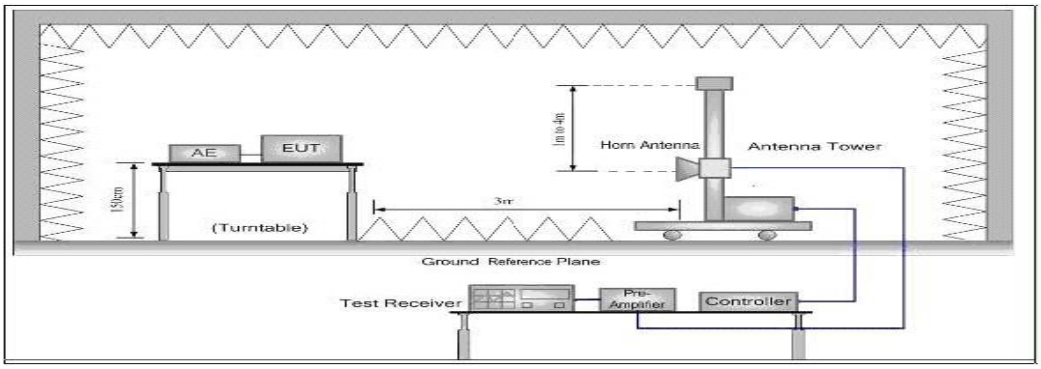
EFFECTIVE RADIATED POWER:

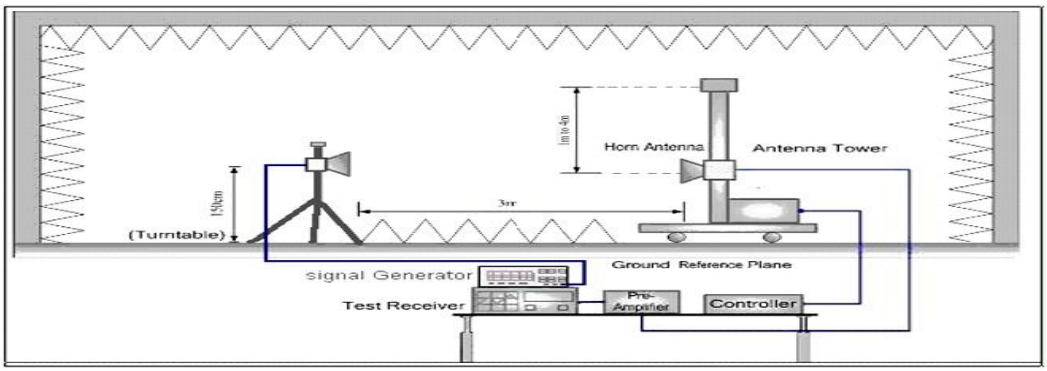
Radiated Below1GHz





Radiated Above 1 GHz





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10.4 MEASUREMENT RESULTS

Conducted Power Measurement Results			
Mode	**Channel Separation**	**Test Channel**	**Measurement Result (dBm)**
			For 33.01dBm(2W)
Analog +Vioce	12.5 kHz	Bottom(406.125MHz)	32.13
		Middle(453.2125MHz)	32.38
		Middle(458.2125MHz)	**32.41**
		Top (469.975MHz)	32.18

Radiated Power Measurement Results								
Test Mode	Frequency (MHz)	Reading Level (dBuv/m)	Antenna Polarization	S.G. (dBm)	Cable Loss (dB)	Ant.Gain (dBi)	ERP Results (dBm)	Limit (dBm)
Analog +Vioce	406.1250	101.26	V	26.03	0.85	6.9	32.08	33.01
	406.1250	101.10	H	25.87	0.85	6.9	31.92	33.01
	453.2125	101.30	V	26.07	0.85	6.9	32.12	33.01
	453.2125	101.28	H	26.05	0.85	6.9	32.10	33.01
	458.2125	101.43	V	26.20	0.85	6.9	32.25	33.01
	458.2125	101.32	H	26.09	0.85	6.9	32.14	33.01
	469.9750	101.28	V	26.05	0.85	6.9	32.10	33.01
	469.9750	101.23	H	26.00	0.85	6.9	32.05	33.01

Note: Calculation Formula: CP = R + A + L
(1) CP: The final Conducted Power
(2) R: The reading value from spectrum analyzer
(3) A: The attenuation value of the used attenuator
(4) L: The loss of all connection cables
(5) Measurement Result=Peak Power (Max)

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11. SPURIOUS EMISSION ON ANTENNA PORT

11.1 PROVISIONS APPLICABLE

Please refer to FCC 47 CFR 2.1051, 2.1057 & 90.210 for specification details.
Emissions shall be attenuated below the mean output power of the transmitter as follows:

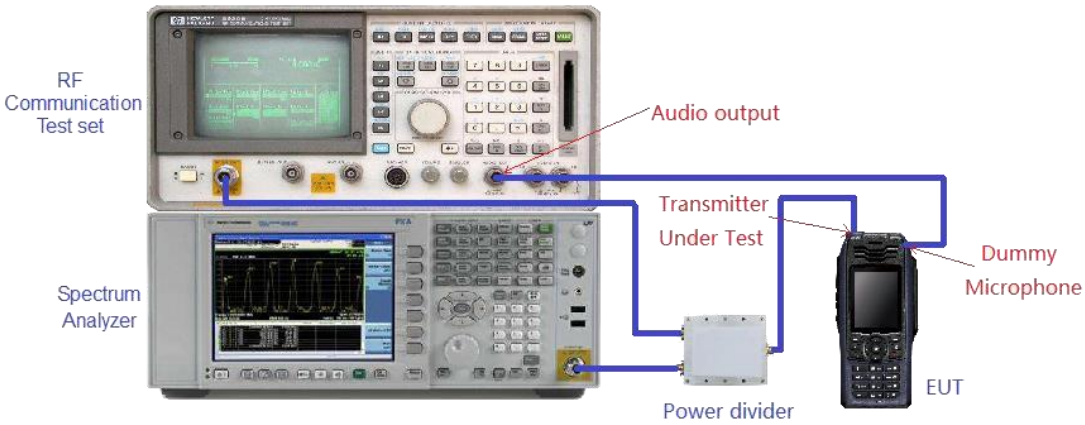
FCC Rules	Attenuation Limit (dBc)
§ 90.210	At least 50 + 10 log (P) dB

50 +10 log (Pwatts)
Note: In general, the worse case attenuation requirement shown above was applied.
Calculation: Limit (dBm) =EL-50-10log10 (TP)
EL is the emission level of the Output Power expressed in dBm,
In this application, the EL is P(dBm)
Limit (dBm) = P(dBm)-50-10 log (Pwatts) = -20dBm

11.2 MEASUREMENT METHOD

1. The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation.
2. The resolution bandwidth of the spectrum analyzer was set to 100 kHz. Sufficient scans were taken to show any out of band emission up to 10th . Harmonic for the lower and the highest frequency range.
3. Set RBW 100 kHz, VBW 300 kHz in the frequency band 30MHz to 1GHz,while set RBW=1MHz.VBW=3MHz from the 1GHz to 10th Harmonic.
4. The audio input was set the unmodulated carrier, the resulting picture is print out for each channel separation.

11.3 MEASUREMENT SETUP



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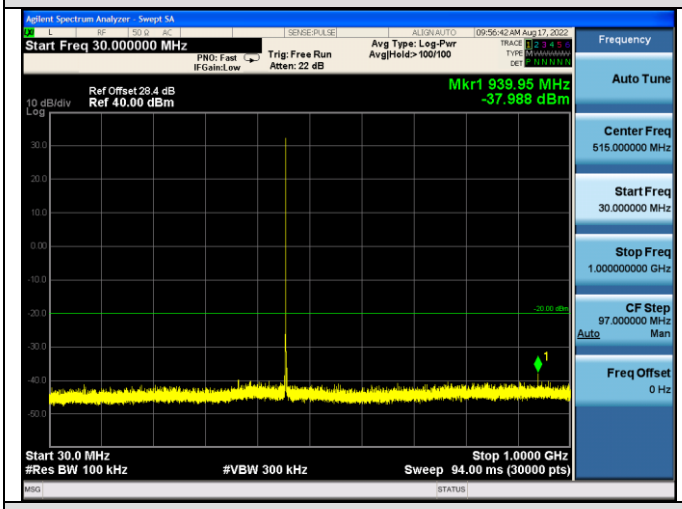
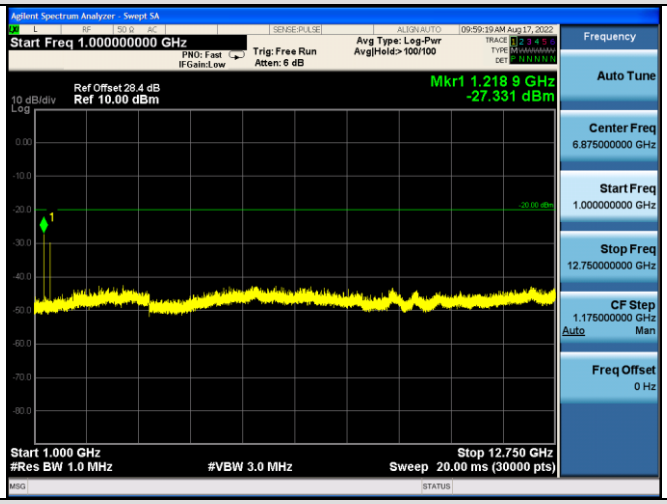
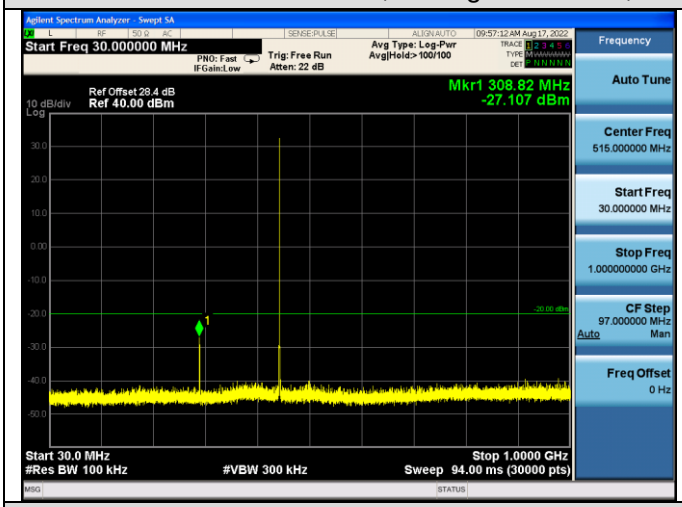
11.4 MEASUREMENT RESULTS

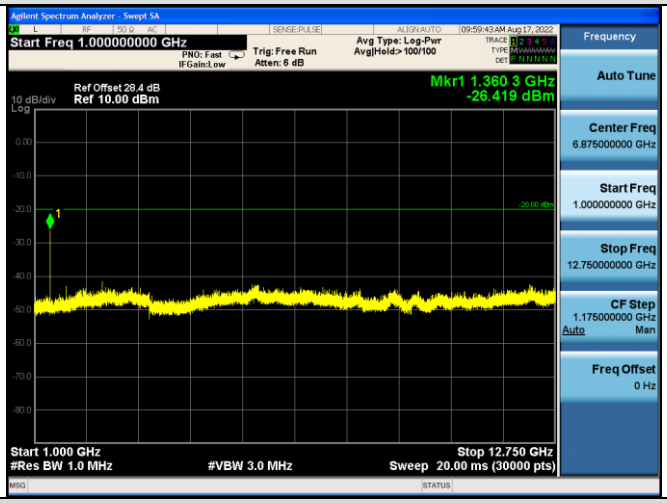
12.5kHz, Analog modulation, Assigned Frequency:406.125MHz, 2W



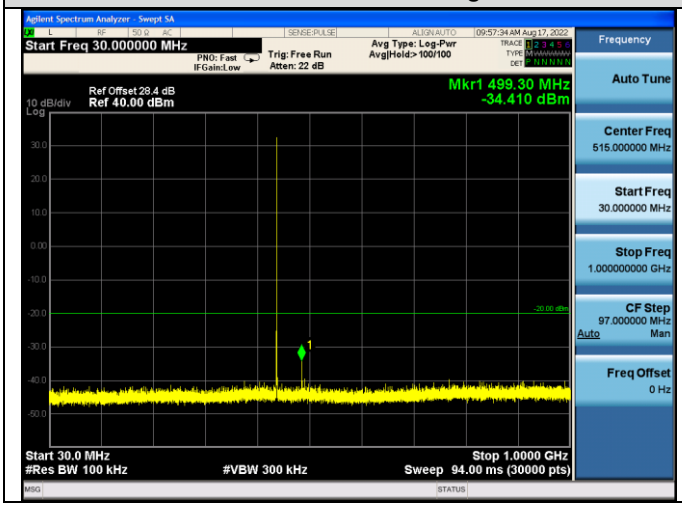


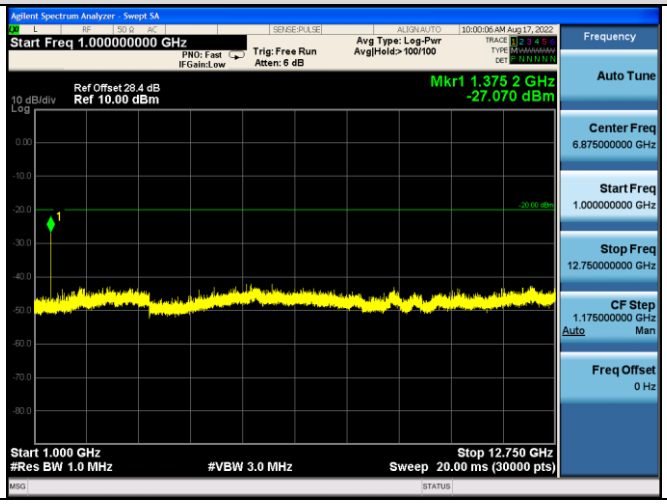
12.5kHz, Analog modulation, Assigned Frequency:453.2125MHz, 2W





12.5kHz, Analog modulation, Assigned Frequency:458.2125MHz, 2W





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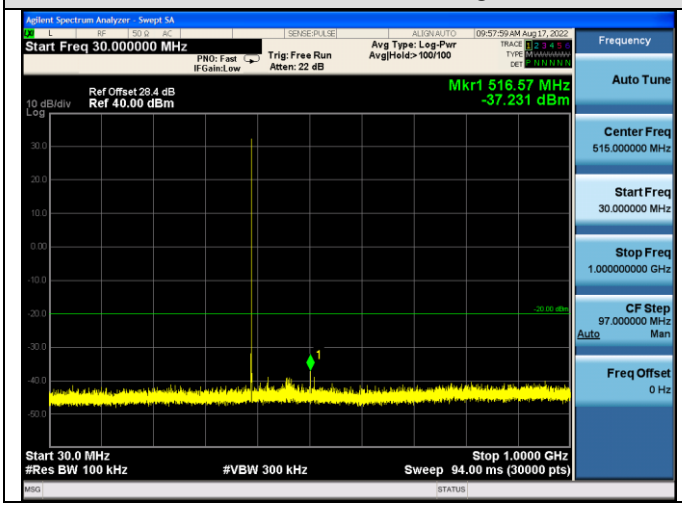
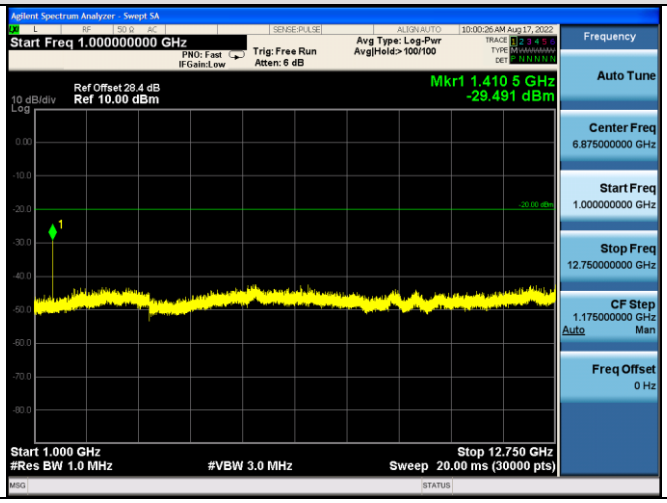
12.5kHz, Analog modulation, Assigned Frequency:469.975MHz, 2W	
	

Note: 1. All the test frequencies was tested, but only the worst data be recorded in this part.

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12.TRANSMITTER FREQUENCY BEHAVIOR

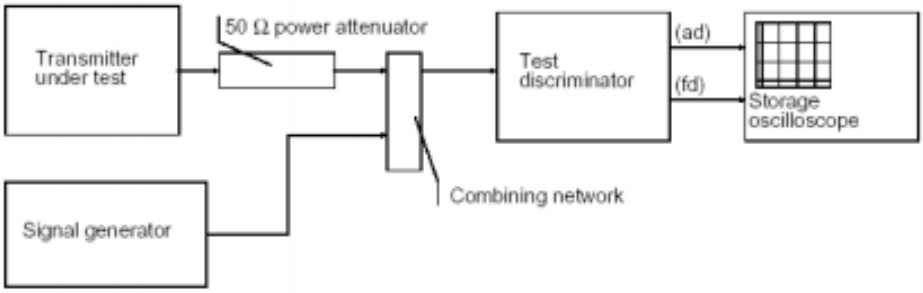
12.1 PROVISIONS APPLICABLE

FCC §90.214

Time intervals [1, 2]	Maximum frequency difference [3]	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1 [4]	± 25.0 kHz	5.0 ms	10.0 ms
t_2	± 12.5 kHz	20.0 ms	25.0 ms
t_3 [4]	± 25.0 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t_1 [4]	± 12.5 kHz	5.0 ms	10.0 ms
t_2	± 6.25 kHz	20.0 ms	25.0 ms
t_3 [4]	± 12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t_1 [4]	± 6.25 kHz	5.0 ms	10.0 ms
t_2	± 3.125 kHz	20.0 ms	25.0 ms
t_3 [4]	± 6.25 kHz	5.0 ms	10.0 ms

[1] t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.
t_1 is the time period immediately following t_{on}.
t_2 is the time period immediately following t_1.
t_3 is the time period from the instant when the transmitter is turned off until t_{off}.
t_{off} is the instant when the 1 kHz test signal starts to rise.
[2] During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in § 90.213.
[3] Difference between the actual transmitter frequency and the assigned transmitter frequency.
[4] If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

13.2 MEASUREMENT SETUP



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12.3 MEASUREMENT METHOD

According to TIA/EIA-603 2.2.19 requirement, as for the product different from PTT, we use test steps as follows:
1. Connect DUT into Test discriminator and Storage Oscilloscope and keep DUT stats ON;
2. Input 1kHz signal into DUT;
3. Set the modulation domain analyzer to trigger on the rising edge of the waveform in order to capture a single-shot turn-on of the transmitter signals;
4. Keep DUT in OFF state and Key the PTT;
5. Observe the stored oscilloscope of modulation domain analyzer. The signal trace shall be maintained within the allowable limits during the periods t1 and t2,and shall also remain within limits following t2;
6. Adjust the modulation domain analyzer to trigger on the falling edge of the transmitter waveform in order to capture a single-shot turn-off transmitter of the transmitter signal.
7. Keep the digital portable radio in ON state and unkey the PTT;
8. Observe the stored oscilloscope of modulation domain analyzer, The signal trace shall be maintained within the allowable limits during the period t3.
9. Set the signal generator to the assigned transmitter frequency and modulate it with a 1 kHz tone at ±12.5 kHz deviation and set its output level to -100dBm.
10. Turn on the transmitter.
11. Supply sufficient attenuation via the RF attenuator to provide an input level to the stored oscilloscope
12. that is 40 dB below the maximum allowed input power when the transmitter is operating at its rated power level. Note this power level on the stored oscilloscope as P0.
13. Turn off the transmitter.
14. Adjust the RF level of the signal generator to provide RF power equal to P0. This signal generator RF level shall be maintained throughout the rest of the measurement.
15. Remove the attenuation, so the input power to the stored oscilloscope is increased by 30 dB when the transmitter is turned on.
16. Adjust the vertical amplitude control of the stored oscilloscope to display the 1000 Hz at ±4 divisions vertically centered on the display. Set trigger mode of the Spectrum Analyzer to “Video”, and tune the “trigger level” on suitable level. Then set the “tiger offset” to -10ms for turn on and -15ms for turn off.
17. Turn on the transmitter and the transient wave will be captured on the screen of Spectrum Analyzer. Observe the stored display. The instant when the 1 kHz test signal is completely suppressed is considered to be ton. The trace should be maintained within the allowed divisions during the period t1 and t2.
18. Then turn off the transmitter, and another transient wave will be captured on the screen of Spectrum
19. Analyzer. The trace should be maintained within the allowed divisions during the period t3.

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DESCRIBE LIMIT LINE OF RANSMITTER FREQUENCY BEHAVIOR:

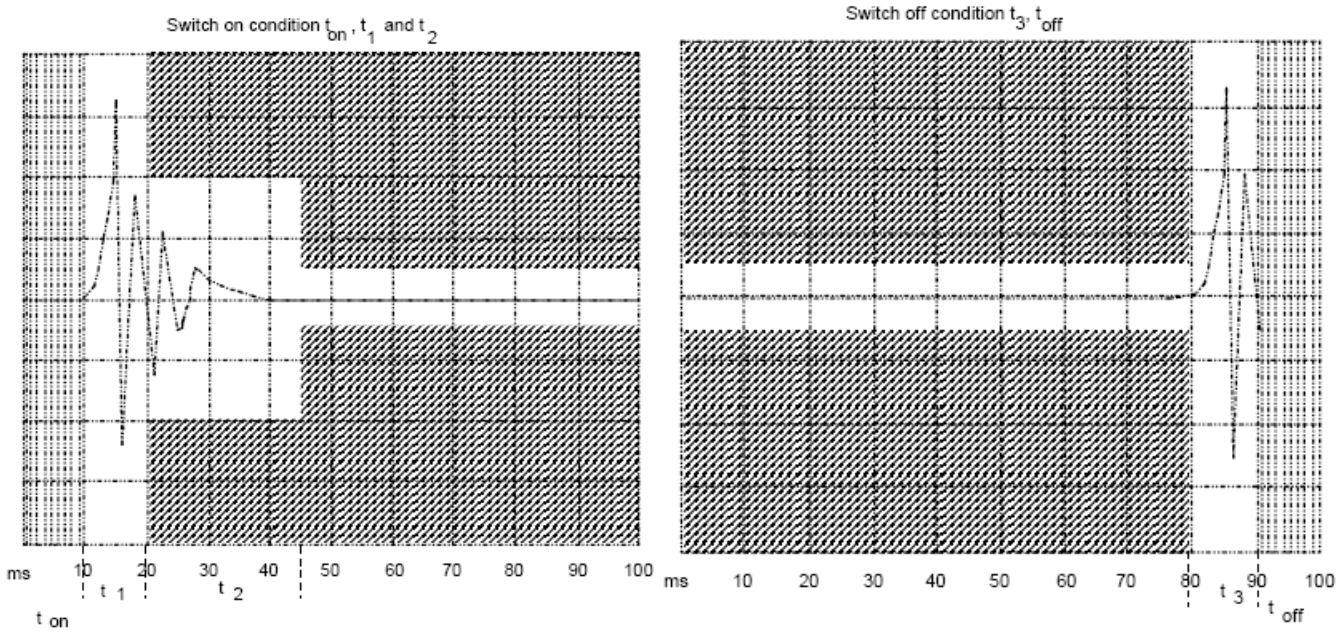
ton: The switch-on instant ton of a transmitter is defined by the condition when the output power, measured at the antenna terminal, exceeds 0,1 % of the full output power (-30 dBc).

t1: period of time starting at ton and finishing according to above 11.1

t2: period of time starting at the end of t1 and finishing according to above 11.1

toff: switch-off instant defined by the condition when the output power falls below 0,1 % of the full output power (-30 dBc).

t3: period of time that finishing at toff and starting according to above 11.1



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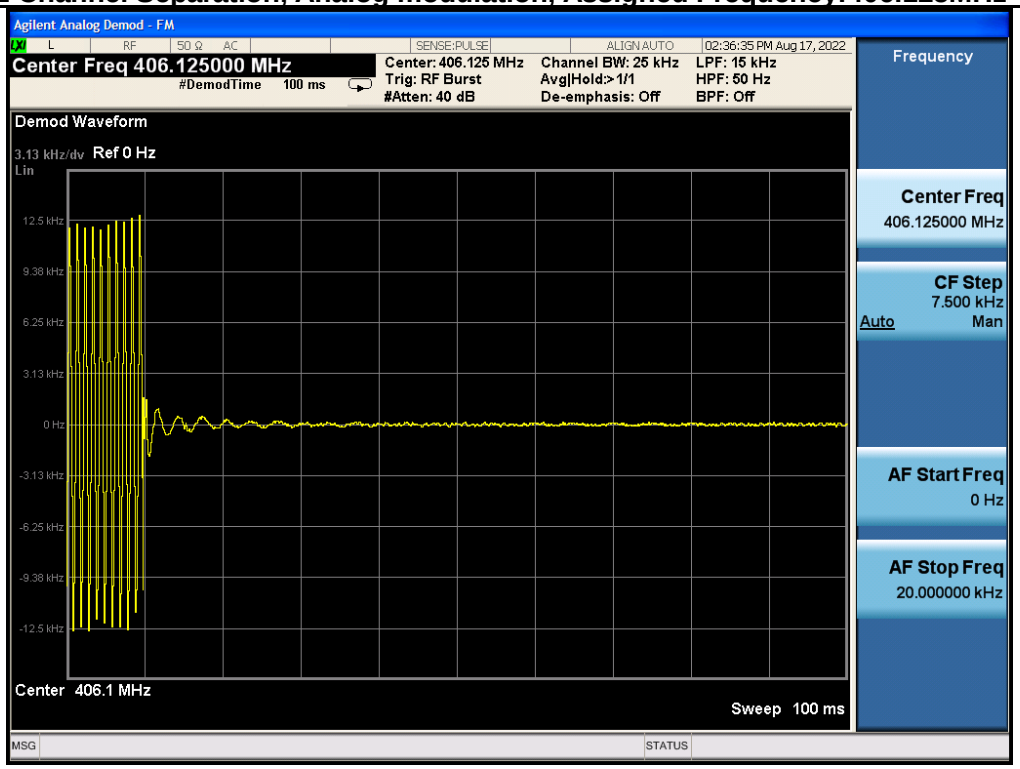
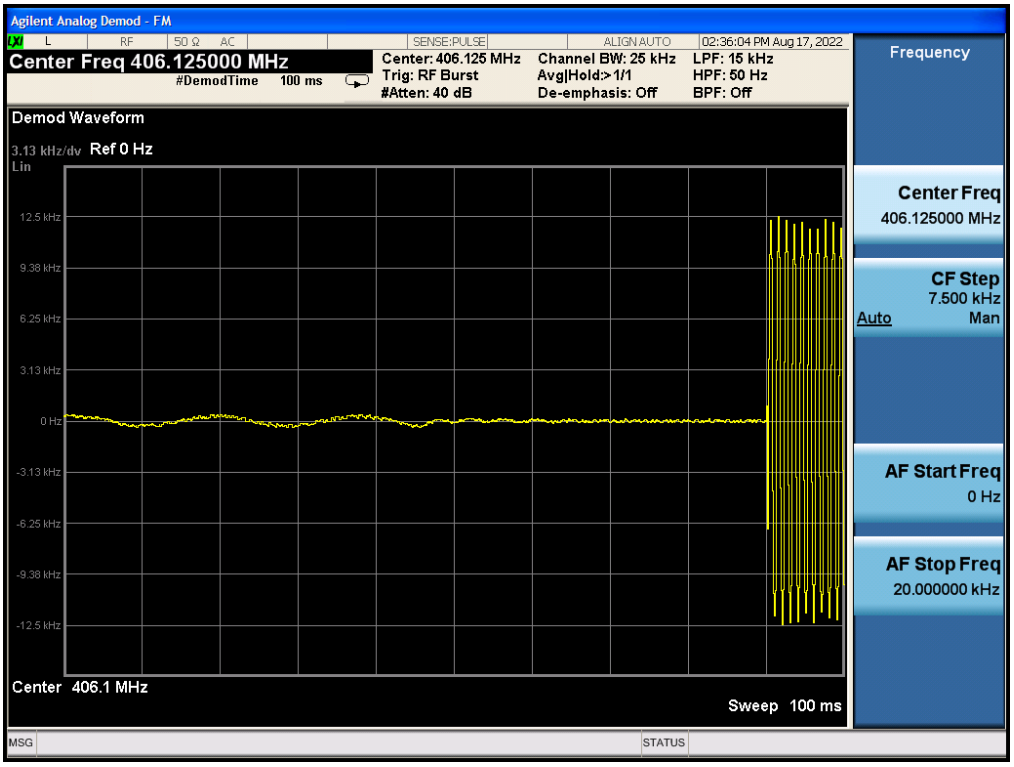
12.4 MEASURET RESULTS

12.5 kHz Channel Separation, Analog modulation, Assigned Frequency:406.125MHz-Turn On



12.5 kHz Channel Separation, Analog modulation, Assigned Frequency:406.125MHz-Turn Off



Note: All the test frequencies was tested, but only the worst data be recorded in this part.

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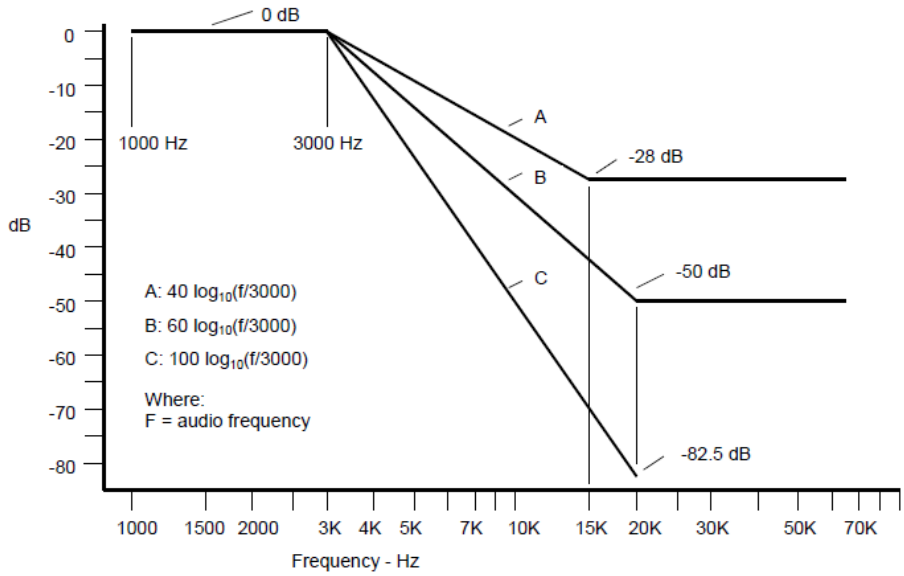
13. AUDIO LOW PASS FILTER RESPONSE

13.1 PROVISIONS APPLICABLE

2.1047(a): Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

ANSI TIA/EIA 603-E:2016 3.2.15: Recommended audio filter attenuation characteristics are given below:



For audio frequencies above 3000 Hz, the audio response of the post limiter low-pass filter shall meet or exceed the following requirements:

a) For equipment operating on 20, 25 or 30 kHz channel bandwidth in the 25 MHz to 174 MHz range:

At frequencies from 3000 Hz through 15,000 Hz the attenuation shall be greater than the attenuation at 1000 Hz by at least: 40 log10 (f / 3000) dB where: f is the audio frequency in Hz.

At frequencies above 15,000 Hz, the attenuation shall be greater than the attenuation at 1000 Hz, by at least: 28 dB.

b) For equipment operating with 25 kHz bandwidth channels between 406 and 512 MHz through 896 MHz, and between 929 MHz through 930 MHz: At frequencies from 3000 Hz through 20,000 Hz, the attenuation shall be greater

than the attenuation at 1000 Hz by at least: 60 log10 (f / 3000) dB where: f is the audio frequency in Hz.

At frequencies above 20,000 Hz the attenuation shall be greater than the attenuation at 1000 Hz by at least: 50 dB.

c) For equipment operating on channels between 896 MHz through 901 MHz,between 935 MHz through 940 MHz, and 12.5 or 15 kHz spaced channels in the frequency range 138-174 MHz and 406-512 MHz.

At frequencies from 3000 Hz through 20,000 Hz the attenuation shall be greater than the attenuation at 1000 Hz by at least: 100 log10 (f / 3000) dB where: f is the audio frequency in Hz.

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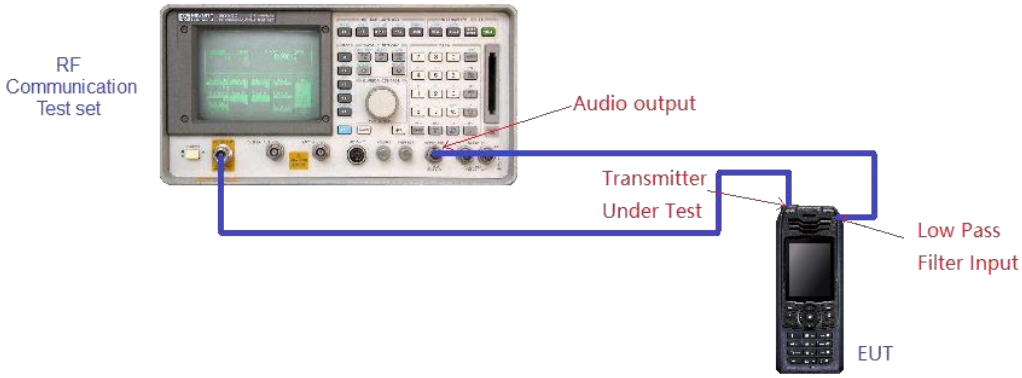
13.2 MEASUREMENT METHOD

The rated audio input signal was applied to the input of the audio low-pass filter (or of all modulation stages) using an audio oscillator, this input signal level and its corresponding output signal were then measured and recorded using the FFT Digital Spectrum Analyzer. Tests were repeated at different audio signal frequencies from 0 to 50 kHz.

13.3 MEASUREMENT SETUP



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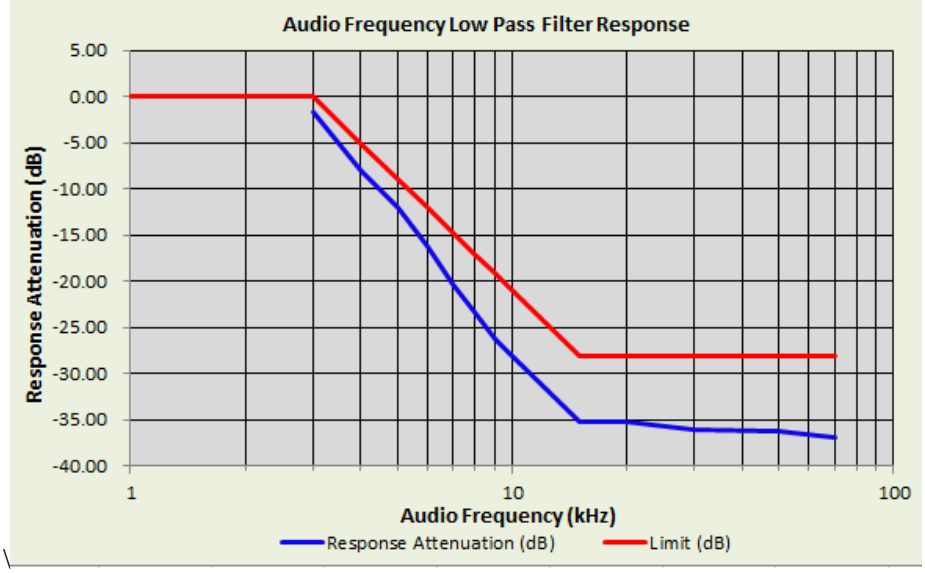
13.4 MEASURET RESULTS

12.5kHz, Analog modulation, Assigned Frequency: 406.125MHz-2W		
Audio Frequency (kHz)	Response Attenuation (dB)	Limit (dB)
1	0	/
3	-1.59	0.00
4	-7.85	-5.00
5	-11.99	-8.87
6	-16.30	-12.04
7	-20.35	-14.72
8	-23.28	-17.04
9	-26.20	-19.08
10	-28.14	-20.92
15	-35.14	-28.00
20	-35.22	-28.00
30	-36.03	-28.00
50	-36.24	-28.00
70	-36.88	-28.00



Note: All the test frequencies was tested, but only the worst data be recorded in this part.

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APPENDIX I: PHOTOGRAPHS OF TEST SETUP

Refer to the Report No.: AGC06326220801AP01

APPENDIX II: PHOTOGRAPHS OF TEST EUT

Refer to the Report No.: AGC06326220801AP02

-----END OF REPORT-----

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3.The Company shall not be called or be liable to be called to give evidence or testimony on the Report in a court of law without its prior written consent, unless required by the relevant governmental authorities, laws or court orders.
4. In the event of the improper use of the report as determined by the Company, the Company reserves the right to withdraw it, and to adopt any other additional remedies which may be appropriate.
5. Samples submitted for testing are accepted on the understanding that the Report issued cannot form the basis of, or be the instrument for, any legal action against the Company.
6. The Company will not be liable for or accept responsibility for any loss or damage however arising from the use of information contained in any of its Reports or in any communication whatsoever about its said tests or investigations.
7.Clients wishing to use the Report in court proceedings or arbitration shall inform the Company to that effect prior to submitting the sample for testing.
8. The Company is not responsible for recalling the electronic version of the original report when any revision is made to them. The Client assumes the responsibility to providing the revised version to any interested party who uses them.
9. Subject to the variable length of retention time for test data and report stored hereinto as otherwise specifically required by individual accreditation authorities, the Company will only keep the supporting test data and information of the test report for a period of six years. The data and information will be disposed of after the aforementioned retention period has elapsed. Under no circumstances shall we provide any data and information which has been disposed of after retention period. Under no circumstances shall we be liable for damage of any kind, including (but not limited to) compensatory damages, lost profits, lost data, or any form of special, incidental, indirect, consequential or punitive damages of any kind, whether based on breach of contract of warranty, tort (including negligence), product liability or otherwise, even if we are informed in advance of the possibility of such damages.

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