ENGINEERING TEST REPORT

VHF Air Band Transceiver
Model Nos.: IC-A220
FCC ID: AFJ297420
IC: 202D-297420

Applicant:

ICOM Incorporated
1-1-32, Kamiminami, Hirano-ku
Osaka, Japan, 547-0003

Tested in Accordance with

Federal Communications Commission (FCC)
47 CFR, Parts 2 and 87 (Subpart D) – Aviation Services
ISED, RSS-141, Issue 2- Aeronautical Radio communication Equipment in the Frequency Band 117.975-137 MHz

UltraTech's File No.: 19ICOM516_FCC87RSS141

This Test report is Issued under the Authority of Tri M. Luu, BASc Vice President of Engineering UltraTech Group of Labs Date: Novemeber 20, 2019	
Report Prepared by: Santhosh Fernandez Issued Date: Novemeber 20, 2019	Tested by: Nimisha Desai Test Dates: November 13-19, 2019

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UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel.: (905) 829-1570 Fax.: (905) 829-8050
Website: www.ultratech-labs.com, Email: vic@ultratech-labs.com, Email: tri@ultratech-labs.com

APEC TEL CA0001 | 1309 | CA 0001/2049 | AT-1945 | SL2-IN-E-1119R | Korea KCC-RRA CA2049

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Parts 2 and 87 ISED RSS-141, Issue 2
Title:	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 & 87 Aeronautical Radiocommunication Equipment in the Frequency Band 117.975-137 MHz
Purpose of Test:	To gain FCC Equipment Authorization Certification for Radio operating in Part 87. To gain Technical Acceptance Certificate (TAC) under RSS-141 for Category I equipment.
Test Procedures:	▪ ANSI/TIA-603-E-2016 ▪ ANSI C63.26-2015 ▪ RSS-141, Issue 2 • RSS-Gen, Issue 6

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None

1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2019	Code of Federal Regulations, Title 47 – Telecommunication
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI/TIA-603-E	2016	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
ANSI C63.26	2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
RSS-141, Issue 2	2010	Aeronautical Radiocommunication Equipment in the Frequency Band 117.975-137 MHz
RSS-Gen, Issue 5	2018	General Requirements for Compliance of Radio Apparatus
ICES-003, Issue 6	2016 Updated 2017	Information Technology Equipment (Including Digital Apparatus) — Limits and Methods of Measurement

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Icom Incorporated
Address:	1-1-32, Kamiminami Hirano-ku, Osaka Japan, 547-0003
Contact Person:	Mr. Atsushi Tomiyama Phone #: +81 6 6793 5302 Fax #: +81 6 6793 0013 Email Address: world_support@icom.co.jp

MANUFACTURER	
Name:	Icom Incorporated
Address:	1-1-32, Kamiminami Hirano-ku, Osaka Japan, 547-0003
Contact Person:	Mr. Atsushi Tomiyama Phone #: +81 6 6793 5302 Fax #: +81 6 6793 0013 Email Address: world_support@icom.co.jp

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	ICOM Incorporated
Product Name:	VHF Air Band Transceiver
Model Name or Number:	IC-A220
Serial Number:	0000003
External Power Supply:	DC 13.8V / 27.5V
Transmitting/Receiving Antenna Type:	Non-integral
Type of Equipment:	Non-broadcast Radio Communication Equipment
Primary User Functions of EUT:	VHF air band transceiver for voice communication in Occupational environment.

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile or Base
Intended Operating Environment:	Commercial, industrial or business environment
Power Supply Requirement:	DC 13.8V / 27.5V
RF Output Power Rating:	8W
Operating Frequency Range:	118.00-136.9917MHz 161-164 MHz (Rx only weather channel)
RF Output Impedance:	50 Ω
Channel Spacing:	25.0 kHz, 8.33 kHz
Emission Designation*:	6K00A3E, 5K60A3E
Antenna Connector Type:	BNC

* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

Calculation of Necessary Bandwidth for Telephony (Commercial Quality)

Telephony, double-sideband (single channel):

Bn = 2M

Where: Bn = Necessary bandwidth in hertz
M = Maximum modulation frequency in hertz

M = 3000Hz

Bn =2(3000) = 6000 Hz = 6.00 KHz

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Antenna	1	BNC-LP	Shielded
2	D-SUB 25 Pin Connector	1	DB 25	Non-shielded

2.5. ANCILLARY EQUIPMENT

The EUT was connected to a Jig for testing through the DB25 connector.

EXHIBIT 3. EUT OPERATING CONDITION AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C - 24°C
Humidity:	30% - 57%
Pressure:	102 kPa
Power input source:	27.5V DC Power Supply

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	N/A
Special Hardware Used:	Test jig was provided by the manufacturer.
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ω Load.

Transmitter Test Signals	
Frequency Band(s):	118.00-136.9917MHz
Test Frequency(ies): (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	25 kHz Ch. Spacing: 118.025, 127.500 and 136.975 MHz 8.33 kHz Ch. Spacing: 118.005, 127.505 and 136.990 MHz
Transmitter Wanted Output Test Signals:	
▪ RF Power Output (measured maximum output power):	8 W
▪ Normal Test Modulation:	AM or 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation
▪ Modulating signal source:	External

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with ANAB File No.: AT-1945.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC/ISED RSS Section(s)	Test Requirements	Applicability (Yes/No)
2.1046 & 87.131 RSS-141, Section 5.1	RF Power Output	Yes
2.1047(a) & 87.141(f)	Modulation Characteristics - Audio Frequency Response	Yes
2.1047(b) & 87.141 RSS-141, Section 5.1	Modulation Characteristics - Modulation Limiting	Yes
2.1049, 87.135, 87.137 & 87.139 RSS-141, Sections 5.1 and 5.2.2	Occupied Bandwidth and Emission Limitations	Yes
2.1051, 2.1057 & 87.139, RSS-141, Section 5.2	Spurious Emissions at Antenna Terminals	Yes
2.1053, 2.1057 & 87.139 RSS-141, Section 5.2	Field Strength of Spurious Radiation	Yes
2.1055 & 87.133 RSS-141, Section 5.1	Frequency Stability	Yes
1.1307, 1.1310 & 2.1091 RSS-Gen, §3.4 & RSS-102	Radiofrequency Radiation Exposure Evaluation	Yes
RSS-Gen, § 6.4	External Controls	Yes
ICES-003, Issue 6	Digital Apparatus	Yes

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None

EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report.

5.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.
Refer to Exhibit 7 for Measurement Uncertainties.

5.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1-1.

5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

The essential function of the EUT is to correctly communicate to and from radios over RF link.

5.5. RF POWER OUTPUT [§§ 2.1046 & 87.131] [RSS-141 § 5.1]

5.5.1. Limits

The following table lists authorized emissions and maximum power. Power must be determined by direct measurement.

Class of station	Frequency band/ frequency	Authorized emission(s) [2]	Maximum power [1]
Aeronautical advisory	VHF	A3E	10 watts[3]
Aeronautical multicom	VHF	A3E	10 watts
Aeronautical search and rescue	VHF	A3E	10 watts
Aviation support	VHF	A3E	50 watts
Airport control tower	VHF	A3E	50 watts
Aeronautical utility mobile	VHF	A3E	10 watts
Aircraft	VHF	A3E	55 watts

Notes:

(1) The power is measured at the transmitter output terminals and the type of power is determined according to the emission designator as follows:
   (i) Mean power (pY) for amplitude modulated emissions and transmitting both sidebands using unmodulated full carrier.
   (ii) Peak envelope power (pX) for all emission designators other than those referred to in paragraph (i) of this note.

(2) Excludes automatic link establishment.

(3) Power is limited to 0.5 watt, but may not exceed 2 watts when station is used in an automatic unattended mode

.

[RSS-141 § 5.1]Transmitters shall comply with the limits and requirements as listed below.

Ground Equipment:

50 W for fixed equipment with A9W, G1D or G7D emissions
300 W for fixed equipment with A3E emissions
20 W for mobile, portable and transportable equipment with A3E emissions

Airborne Equipment:

55 W

5.5.2. Method of Measurements

TIA-603-E / ANSI C63.26

5.5.3. Test Data

Frequency MHz	25KHz/ 8.33KHz	Measured dBm	Power Rating dBm	Power Rating Watts	Actual Power Watts
118.025	25KHz	6.22	39.03	8	8.26
127.500	25KHz	6.03	39.03	8	7.91
136.975	25KHz	6.06	39.03	8	7.96
118.005	8.33KHz	6.21	39.03	8	8.24
127.505	8.33KHz	6.02	39.03	8	7.89
136.990	8.33KHz	6.06	39.03	8	7.96

Frequency MHz	25KHz/ 8.33KHz	Measured dBm	Power Rating dBm	Power Rating Watts	Actual Power Watts
118.025	25KHz	6.22	39.03	8	8.26
127.500	25KHz	6.03	39.03	8	7.91
136.975	25KHz	6.06	39.03	8	7.96
118.005	8.33KHz	6.22	39.03	8	8.26
127.505	8.33KHz	6.03	39.03	8	7.91
136.990	8.33KHz	6.06	39.03	8	7.96

5.6. OCCUPIED BANDWIDTH AND EMISSION LIMITATIONS [§§ 2.1049, 87.135 & 87.139] [RSS-141 §§ 5.1 & 5.2.2]

5.6.1. Limits

§ 87.139(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the frequency bands 1435–1535 MHz and 2310–2390 MHz or digital modulation (G7D) for differential GPS, the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(2) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least 43 + 10 $\log_{10}$ pY dB.

[RSS-141 §§ 5.1 & 5.2.2]
Transmitters shall comply with the limits and requirements as listed below.

Necessary Bandwidth:

6 kHz for A3E emissions
13 kHz for A9W emissions
14 kHz for G1D and G7D emissions

Transmitter with A3E or A9W Emissions:

For transmitters with A3E or A9W emissions, the mean power of any emissions shall be attenuated below the mean power of the transmitter, P as follows:

(a) When the frequency is removed from the equipment's channel centre frequency by more than 50% up to and including 100% of the channel bandwidth, the attenuation shall be at least 25 dB, measured with a bandwidth of 300 Hz;
(b) When the frequency is removed from the equipment's channel centre frequency by more than 100% up to and including 250% of the channel bandwidth, the attenuation shall be at least 35 dB, measured with a bandwidth of 300 Hz;
(c) When the frequency is removed from the equipment's channel centre frequency by more than 250% of the channel bandwidth, the attenuation for on-board aircraft transmitters shall be at least 40 dB; and the attenuation for ground transmitters shall be at least 43 + 10 log10 P (in watts) dB, measured with a bandwidth of 3 kHz.

5.6.2. Method of Measurements

47 CFR 2.1049, ANSI C63.26 and TIA-603-E

5.6.3. Test Data

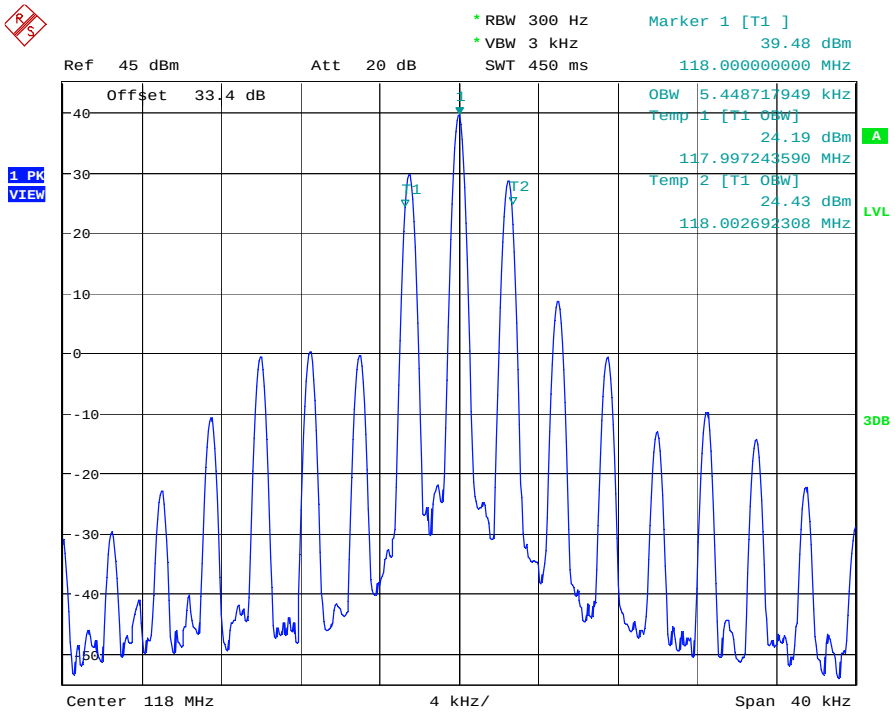
5.6.3.1. 99% Occupied Bandwidth

Frequency (MHz)	*Measured 99% OBW (kHz)	Authorized Bandwidth (kHz)
118.025	5.448	25.0
127.500	5.448	25.0
136.975	5.448	25.0
118.005	5.448	8.33
127.505	5.448	8.33
136.990	5.448	8.33

* See the following plots for details of measurements

5.6.3.2. Configuration: 99%OBW, 118.005MHz, 8.33 KHz channel space

OBW: 5.448 KHz

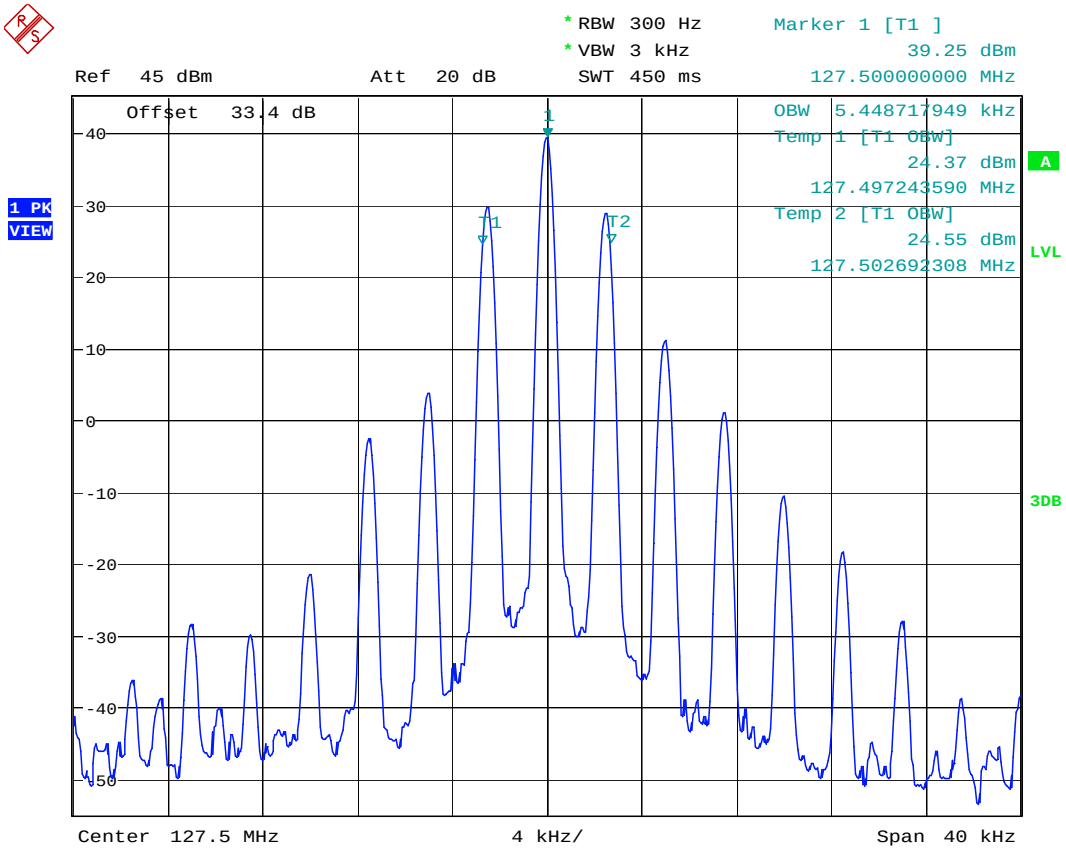


Date: 13.NOV.2019 15:53:38

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.6.3.3. Configuration: 99%OBW, 127.505MHz, 8.33 KHz channel space

OBW: 5.448 KHz



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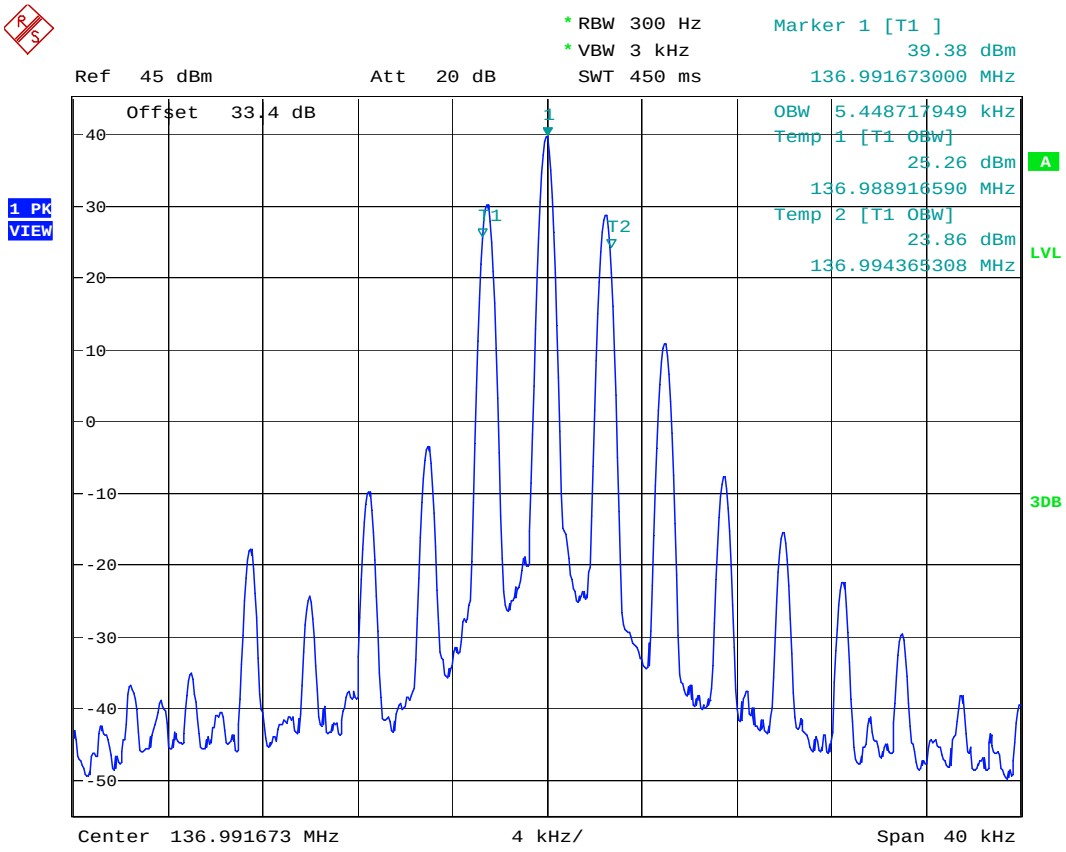
5.6.3.4. Configuration: 99%OBW, 136.990MHz, 8.33 KHz channel space

OBW: 5.448 KHz



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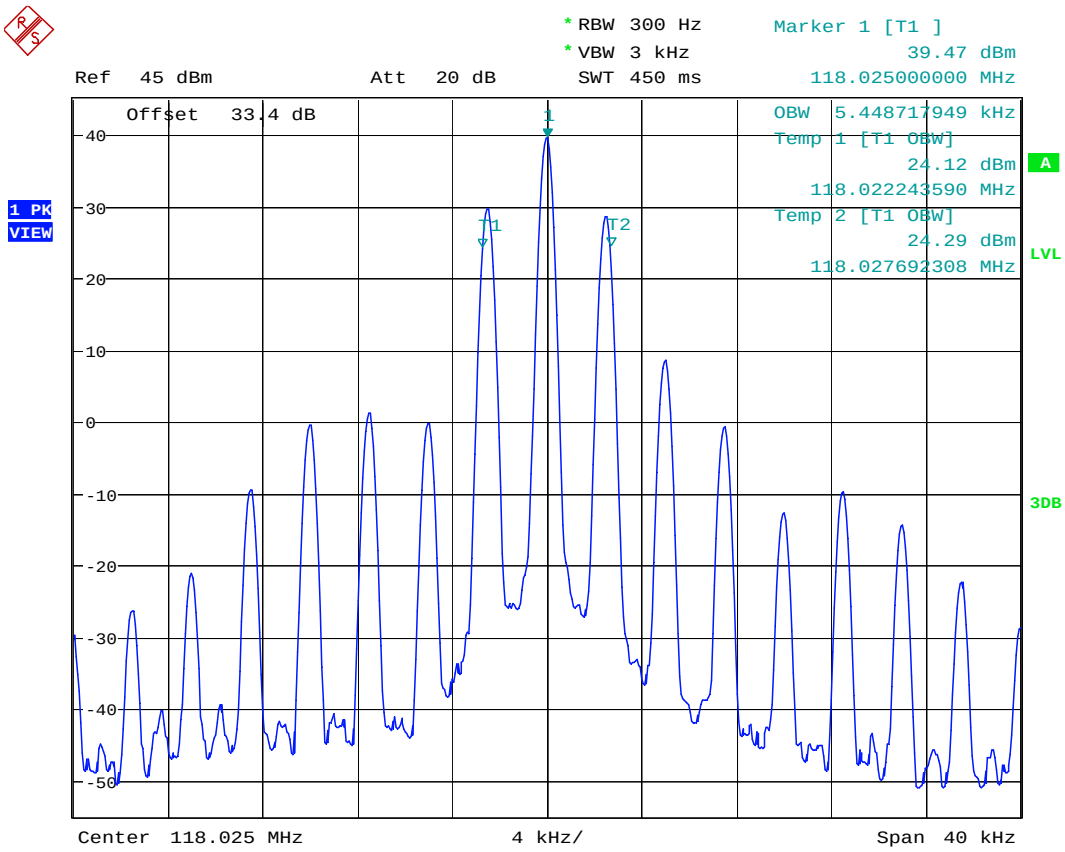
5.6.3.5. Configuration: 99%OBW, 118.025MHz, 25KHz channel space

OBW: 5.448 KHz



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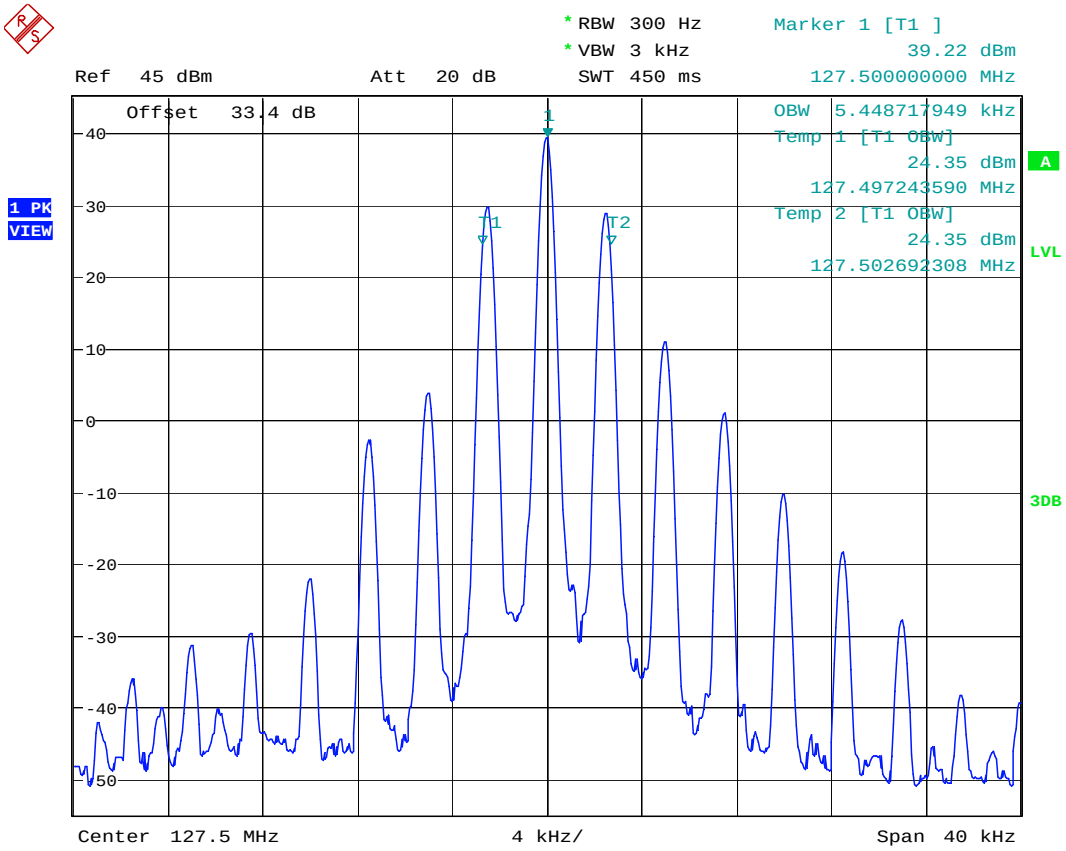
5.6.3.6. Configuration: 99%OBW, 127.500MHz, 25KHz channel space

OBW: 5.448 KHz



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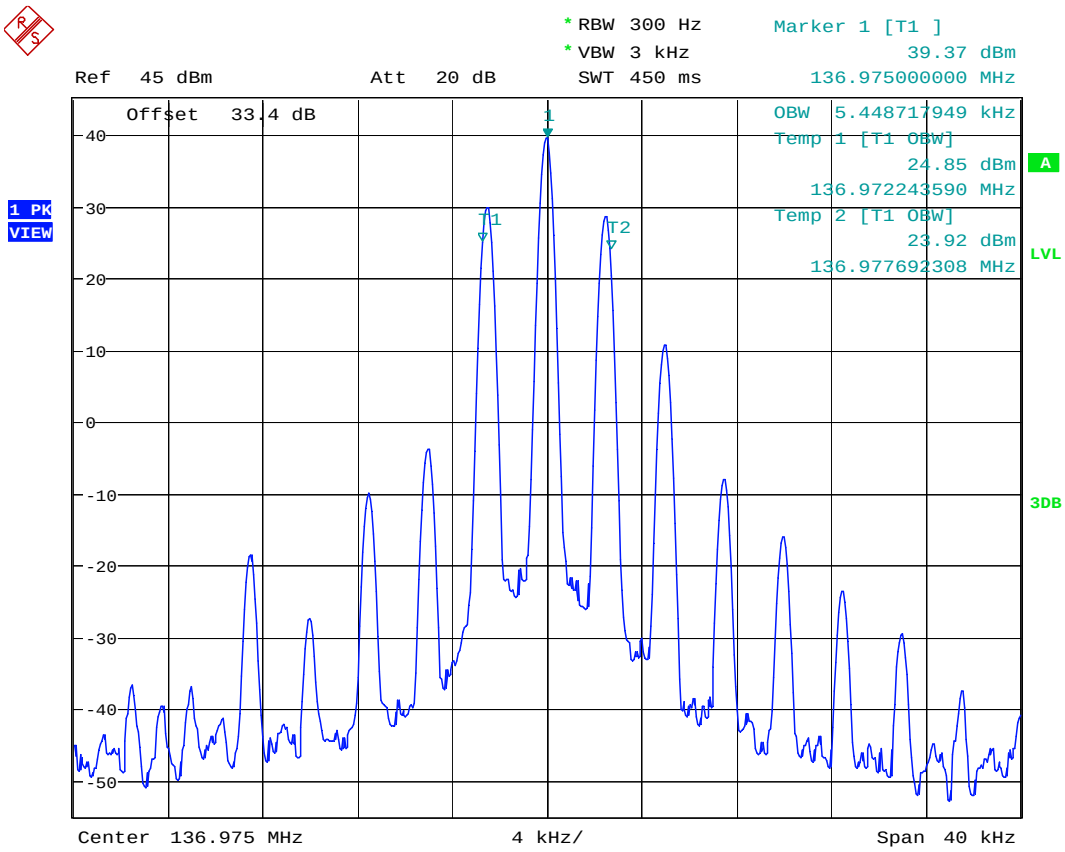
5.6.3.7. Configuration: 99%OBW, 136.975MHz, 25KHz channel space

OBW: 5.448 KHz



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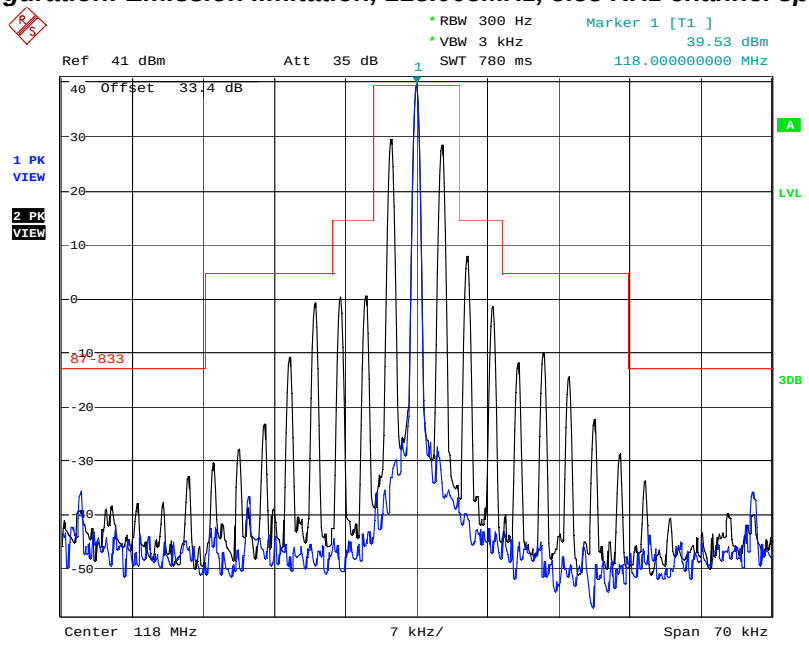
5.6.3.8. Configuration: Emission limitation, 118.005MHz, 8.33 KHz channel space



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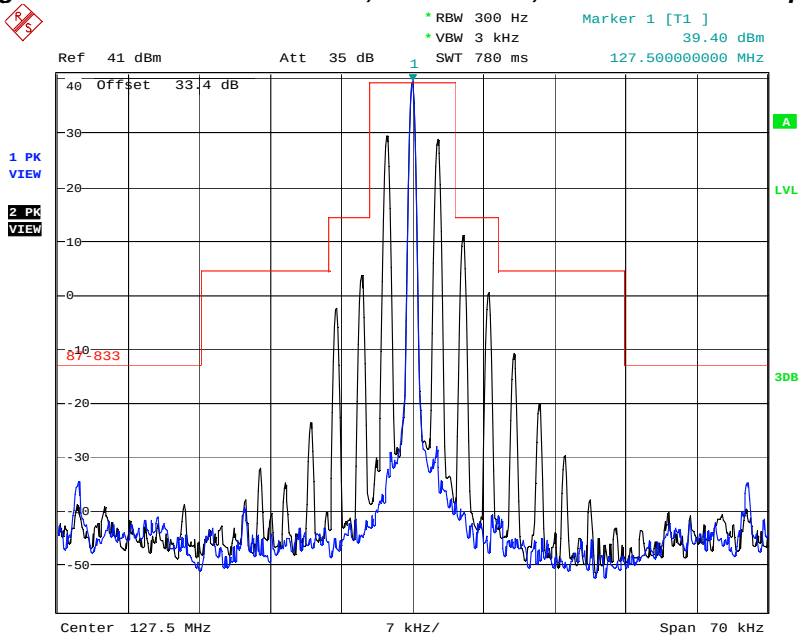
5.6.3.9. Configuration: Emission limitation, 127.505MHz, 8.33 KHz channel space



Date: 14.NOV.2019 09:53:40

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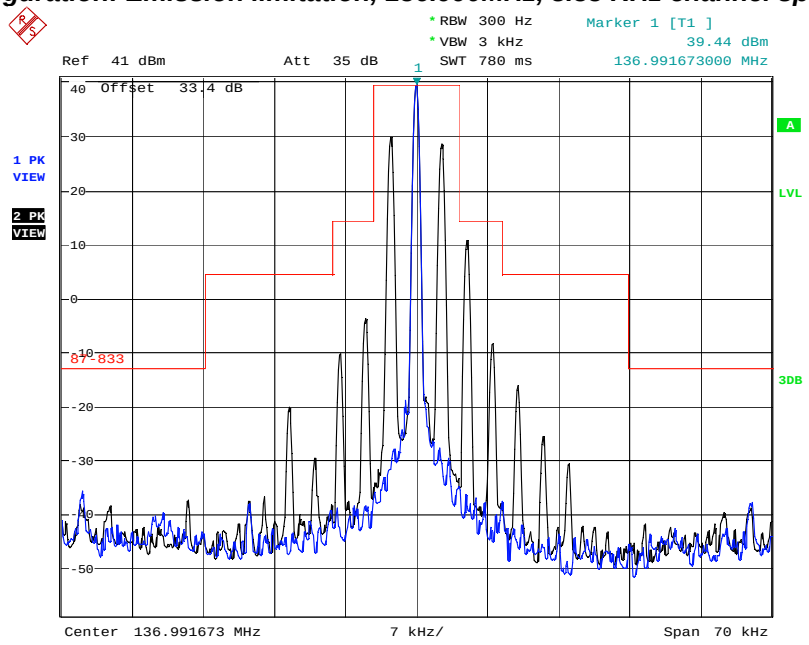
5.6.3.10. Configuration: Emission limitation, 136.990MHz, 8.33 KHz channel space



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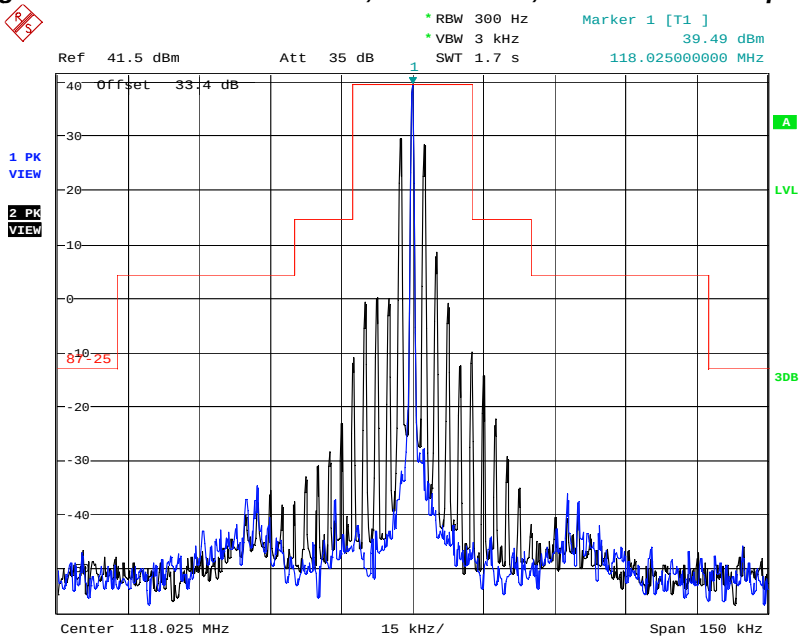
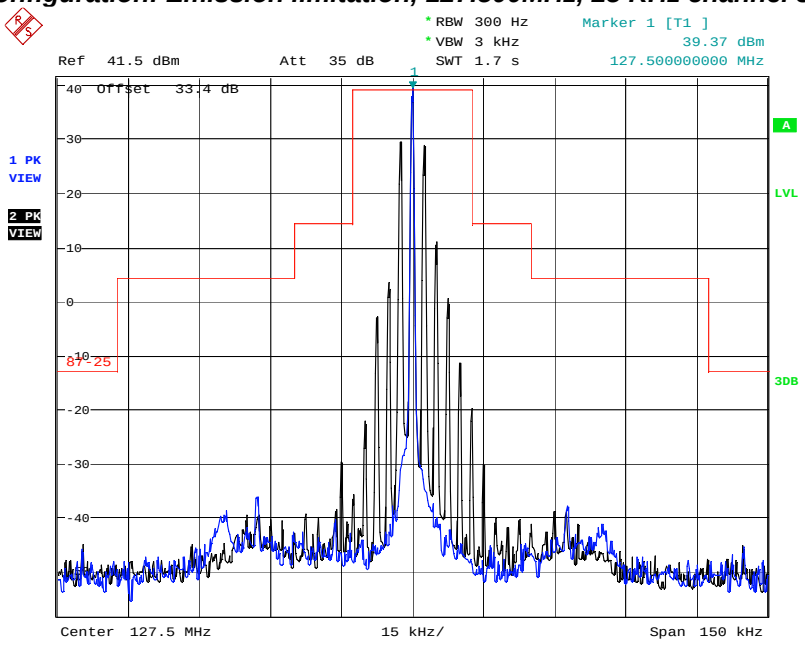
5.6.3.11. Configuration: Emission limitation, 118.025MHz, 25 KHz channel space



Date: 14.NOV.2019 10:01:25

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.6.3.12. Configuration: Emission limitation, 127.500MHz, 25 KHz channel space



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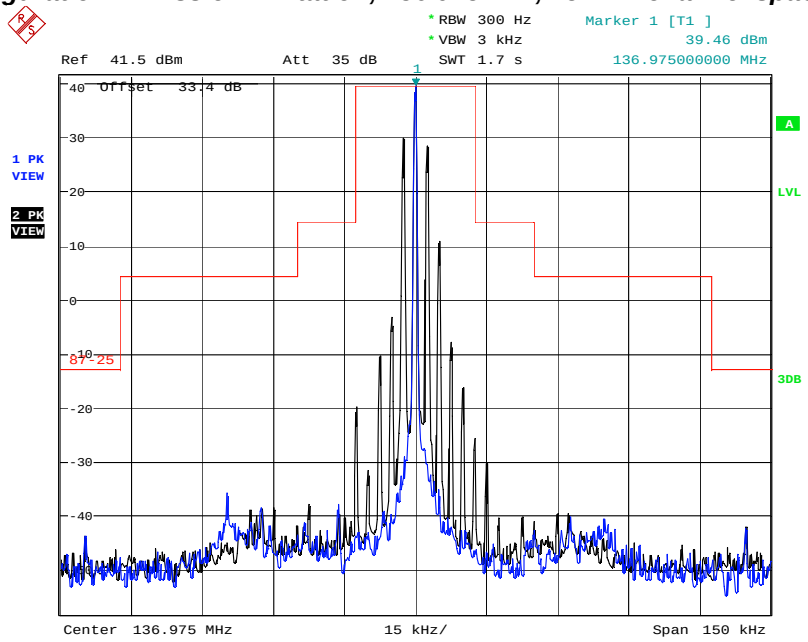
5.6.3.13. Configuration: Emission limitation, 136.975MHz, 25 KHz channel space



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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.7. MODULATION CHARACTERISTICS - AUDIO FREQUENCY RESPONSE [§§ 2.1047(a) & 87.141(a)]

5.7.1. Limits

87.141(a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.

(f) Each frequency modulated transmitter equipped with a modulation limiter must have a low pass filter between the modulation limiter and the modulated stage. At audio frequencies between 3 kHz and 15 kHz, the filter must have an attenuation greater than the attenuation at 1 kHz by at least 40 $\log_{10}$ (f/3) db where "f" is the frequency in kilohertz. Above 15 kHz, the attenuation must be at least 28 db greater than the attenuation at 1 kHz.

5.7.2. Method of Measurements

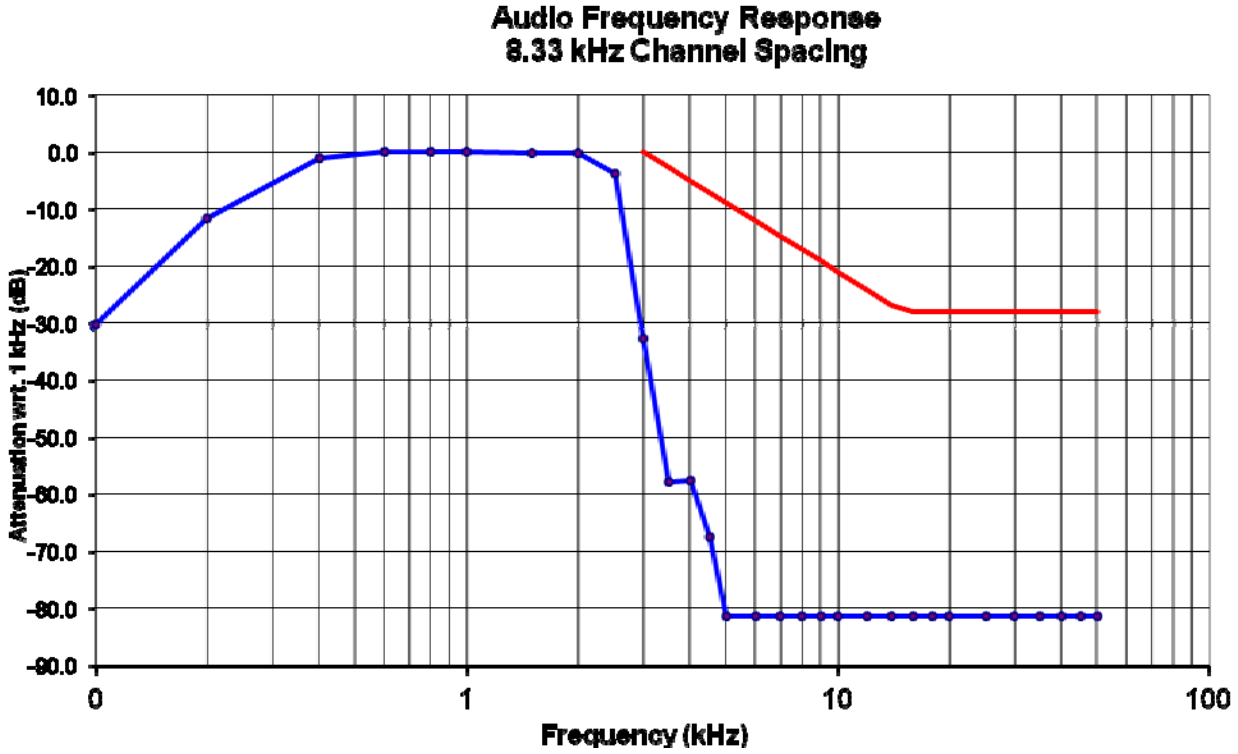
The rated audio input signal was applied to the input of the audio lowpass filter (or of all modulation stages) using an audio oscillator, this input signal level and its corresponding output signal were then measured and recorded using the FFT (Audio) spectrum analyzer. Tests were repeated at different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

5.7.3. Test Data

Note: Due to the difficulty of measuring the frequency response of the internal low-pass filter, the frequency response of all modulation states was performed to show the roll-off at 3 kHz in comparison with FCC Limit for audio low-pass filter.

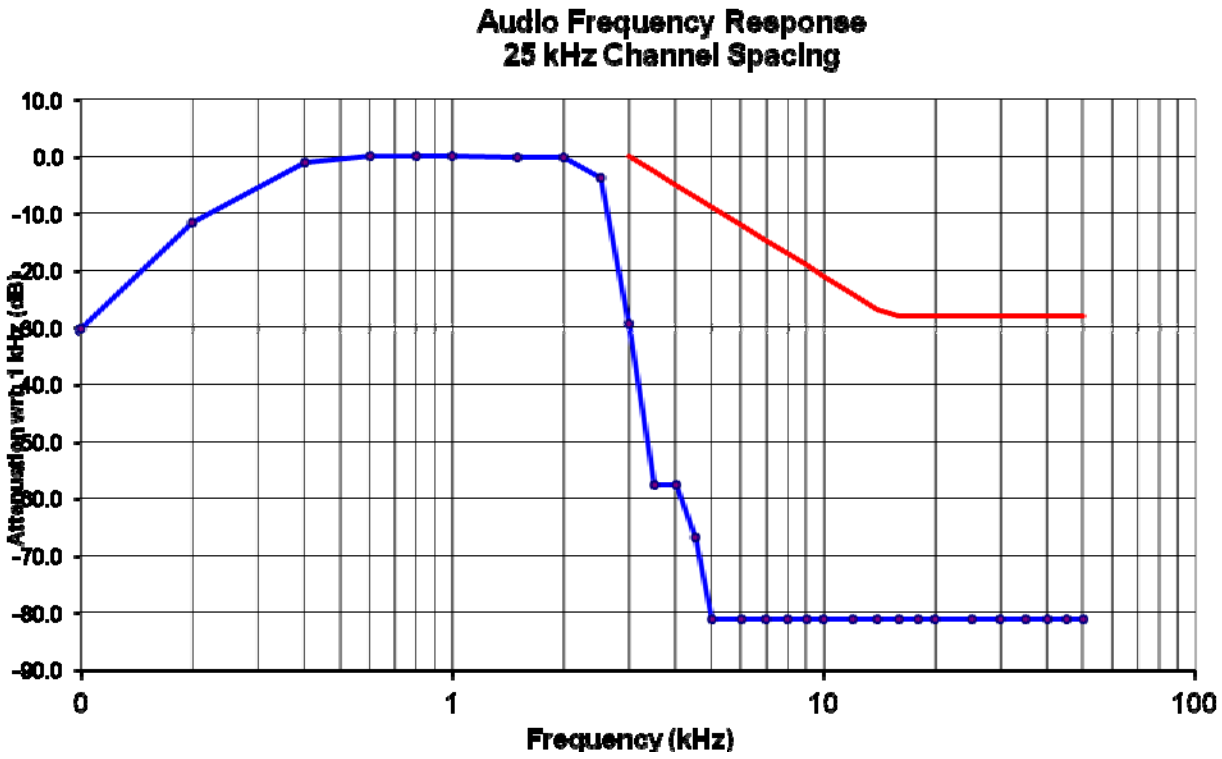
5.7.3.1. Audio Frequency Response of All Modulation States for 8.33 kHz Channel Spacing

Frequency (kHz)	Audio IN (dBV)	Audio OUT (dBV)	Attenuation (OUT - IN) (dB)	Attenuation wrt. 1 kHz (dB)	Recommended Attenuation wrt. 1 kHz (dB)
0.1	-24.88	-38.93	-14.1	-30.3	--
0.2	-24.88	-20.24	4.6	-11.6	--
0.4	-24.88	-9.77	15.1	-1.1	--
0.6	-24.88	-8.61	16.3	0.0	--
0.8	-24.88	-8.55	16.3	0.1	--
1.0	-24.88	-8.63	16.3	0.0	--
1.5	-24.88	-8.71	16.2	-0.1	--
2.0	-24.88	-8.67	16.2	0.0	--
2.5	-24.88	-12.30	12.6	-3.7	--
3.0	-24.88	-41.22	-16.3	-32.6	0
3.5	-24.88	-66.47	-41.6	-57.8	-3
4.0	-24.88	-66.17	-41.3	-57.5	-5
4.5	-24.88	-76.09	-51.2	-67.5	-7
5.0	-24.88	-90.00	-65.1	-81.4	-9
6.0	-24.88	-90.00	-65.1	-81.4	-12
7.0	-24.88	-90.00	-65.1	-81.4	-15
8.0	-24.88	-90.00	-65.1	-81.4	-17
9.0	-24.88	-90.00	-65.1	-81.4	-19
10.0	-24.88	-90.00	-65.1	-81.4	-21
12.0	-24.88	-90.00	-65.1	-81.4	-24
14.0	-24.88	-90.00	-65.1	-81.4	-27
16.0	-24.88	-90.00	-65.1	-81.4	-28
18.0	-24.88	-90.00	-65.1	-81.4	-28
20.0	-24.88	-90.00	-65.1	-81.4	-28
25.0	-24.88	-90.00	-65.1	-81.4	-28
30.0	-24.88	-90.00	-65.1	-81.4	-28
35.0	-24.88	-90.00	-65.1	-81.4	-28
40.0	-24.88	-90.00	-65.1	-81.4	-28
45.0	-24.88	-90.00	-65.1	-81.4	-28
50.0	-24.88	-90.00	-65.1	-81.4	-28


Audio Frequency Response
8.33 kHz Channel Spacing
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
Attenuation wrt. 1 kHz (dB)
0
1
10
100
Frequency (kHz)

5.7.3.2. Audio Frequency Response of All Modulation States for 25 kHz Channel Spacing

Frequency (kHz)	Audio IN (dBV)	Audio OUT (dBV)	Attenuation (OUT - IN) (dB)	Attenuation wrt. 1 kHz (dB)	Recommended Attenuation wrt. 1 kHz (dB)
0.1	-24.88	-38.95	-14.1	-30.2	--
0.2	-24.88	-20.28	4.6	-11.5	--
0.4	-24.88	-9.89	15.0	-1.1	--
0.6	-24.88	-8.75	16.1	0.0	--
0.8	-24.88	-8.71	16.2	0.1	--
1.0	-24.88	-8.78	16.1	0.0	--
1.5	-24.88	-8.87	16.0	-0.1	--
2.0	-24.88	-8.84	16.0	-0.1	--
2.5	-24.88	-12.44	12.4	-3.7	--
3.0	-24.88	-38.01	-13.1	-29.2	0
3.5	-24.88	-66.51	-41.6	-57.7	-3
4.0	-24.88	-66.31	-41.4	-57.5	-5
4.5	-24.88	-75.72	-50.8	-66.9	-7
5.0	-24.88	-90.00	-65.1	-81.2	-9
6.0	-24.88	-90.00	-65.1	-81.2	-12
7.0	-24.88	-90.00	-65.1	-81.2	-15
8.0	-24.88	-90.00	-65.1	-81.2	-17
9.0	-24.88	-90.00	-65.1	-81.2	-19
10.0	-24.88	-90.00	-65.1	-81.2	-21
12.0	-24.88	-90.00	-65.1	-81.2	-24
14.0	-24.88	-90.00	-65.1	-81.2	-27
16.0	-24.88	-90.00	-65.1	-81.2	-28
18.0	-24.88	-90.00	-65.1	-81.2	-28
20.0	-24.88	-90.00	-65.1	-81.2	-28
25.0	-24.88	-90.00	-65.1	-81.2	-28
30.0	-24.88	-90.00	-65.1	-81.2	-28
35.0	-24.88	-90.00	-65.1	-81.2	-28
40.0	-24.88	-90.00	-65.1	-81.2	-28
45.0	-24.88	-90.00	-65.1	-81.2	-28
50.0	-24.88	-90.00	-65.1	-81.2	-28



All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.8. MODULATION CHARACTERISTICS – MODULATION LIMITING [§§ 2.1047(b) & 87.141] [RSS-141 § 5.1]

§ 87.141

(a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.

(c) If any licensed radiotelephone transmitter causes harmful interference to any authorized radio service because of excessive modulation, the Commission will require the use of the transmitter to be discontinued until it is rendered capable of automatically preventing modulation in excess of 100 percent.

[RSS-141 § 5.1]
Modulation Index for A3E and A9W Emissions: Shall not exceed 100%

5.8.1. Method of Measurements

For Audio Transmitter:- The carrier frequency deviation was measured with the tone input signal level varied from 0 Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.
For Data Transmitter with Maximum Frequency Deviation set by Factory:- The EUT was set at maximum frequency deviation, and its peak frequency deviation was then measured using EUT's internal random data source.

5.8.2. Test Data

5.8.2.1. Modulation Limiting at 8.33 kHz Channel Spacing

Modulating Signal Level	Peak Modulation depth %					Maximum Limit
(mVrms)	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	%
1	0.29	1.20	1.13	0.33	0.28	100
2	0.34	2.10	2.06	0.32	0.26	100
4	0.36	3.96	3.89	0.37	0.27	100
6	0.38	5.77	5.72	0.43	0.28	100
8	0.42	7.71	7.66	0.49	0.28	100
10	0.49	9.35	9.28	0.58	0.28	100
15	0.54	13.76	13.79	0.74	0.28	100
20	0.68	18.48	18.53	0.88	0.28	100
25	0.88	22.89	22.90	1.04	0.28	100
30	1.08	27.12	27.24	1.20	0.28	100
35	1.18	31.35	31.54	1.37	0.28	100
40	1.35	35.61	35.86	1.56	0.28	100
45	1.51	39.82	40.20	1.69	0.27	100
50	1.70	43.90	44.40	1.83	0.27	100
55	1.88	48.50	49.10	2.05	0.27	100
60	2.02	52.70	53.40	2.18	0.27	100
65	2.18	57.00	57.80	2.33	0.27	100
70	2.35	61.20	62.30	2.50	0.27	100
75	2.46	64.80	65.80	2.64	0.26	100
80	2.61	70.90	72.40	2.88	0.26	100
85	2.77	73.70	75.50	2.97	0.26	100
90	2.89	76.60	78.30	3.11	0.26	100
100	3.14	78.30	79.80	3.12	0.26	100
120	3.96	78.6	80.20	3.14	0.26	100
200	5.45	79.1	80.20	3.15	0.26	100
250	5.36	79.3	80.20	3.15	0.26	100

Voice Signal Input Level = STD MOD Level + 16 dB
= 57.0 mV+ 16 dB
= 51.12 dB(m Vrms)
= 359.65 mVrms

Standard Modulation Level measured at 50% Modulation @ 1.0 kHz.

Modulation Frequency (kHz	Peak Depth (%)	Maximum Limit (%)
0.1	5.49	100.0
0.2	32.90	100.0
0.4	75.70	100.0
0.6	81.10	100.0
0.8	81.10	100.0
1.0	81.30	100.0
1.2	81.40	100.0
1.4	81.60	100.0
1.6	81.80	100.0
1.8	81.60	100.0
2.0	80.70	100.0
2.5	55.50	100.0
3.0	3.13	100.0
3.5	0.29	100.0
4.0	0.31	100.0
4.5	0.25	100.0
5.0	0.21	100.0
6.0	0.22	100.0
7.0	0.23	100.0
8.0	0.22	100.0
9.0	0.22	100.0
10.0	0.22	100.0

5.8.2.2. Modulation Limiting at 25 kHz Channel Spacing

Modulating Signal Level	Peak Modulation depth %					Maximum Limit
(mVrms)	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	%
1	0.30	1.17	1.16	0.30	0.28	100
2	0.30	2.12	2.06	0.34	0.29	100
4	0.34	3.94	3.88	0.38	0.29	100
6	0.42	5.81	5.79	0.45	0.28	100
8	0.47	7.76	7.68	0.52	0.28	100
10	0.48	9.36	9.27	0.56	0.27	100
15	0.58	13.85	13.78	0.78	0.27	100
20	0.83	18.60	18.53	0.88	0.27	100
25	0.93	23.00	22.93	1.05	0.27	100
30	1.09	27.27	27.26	1.23	0.27	100
35	1.27	31.50	31.59	1.37	0.27	100
40	1.39	35.86	35.88	1.55	0.27	100
45	1.53	40.00	40.10	1.71	0.27	100
50	1.71	44.20	44.30	1.87	0.27	100
55	1.87	48.80	48.90	2.04	0.27	100
60	1.91	53.20	53.40	2.18	0.27	100
65	2.14	57.50	57.80	2.35	0.27	100
70	2.30	61.60	62.20	2.50	0.28	100
75	2.44	65.50	65.80	2.66	0.28	100
80	2.60	71.30	72.40	2.89	0.28	100
85	2.76	74.20	75.40	3.02	0.28	100
90	2.90	77.10	78.10	3.15	0.28	100
100	3.25	78.80	80.00	3.12	0.28	100
120	3.89	79.00	80.00	3.12	0.28	100
200	5.40	79.20	80.20	3.17	0.28	100
250	5.30	79.50	80.40	3.18	0.28	100
300	5.31	79.50	80.40	3.13	0.28	100

Voice Signal Input Level = STD MOD Level + 16 dB
= 57.0 mV+ 16 dB
= 51.12 dB(m Vrms)
= 359.65 mVrms

Standard Modulation Level measured at 50% Modulation @ 1.0 kHz.

Modulation Frequency (kHz	Peak Depth (%)	Maximum Limit (%)
0.1	5.57	100.0
0.2	32.95	100.0
0.4	75.90	100.0
0.6	81.30	100.0
0.8	81.40	100.0
1.0	81.50	100.0
1.2	81.70	100.0
1.4	81.80	100.0
1.6	82.10	100.0
1.8	81.80	100.0
2.0	80.80	100.0
2.5	55.60	100.0
3.0	3.16	100.0
3.5	0.32	100.0
4.0	0.27	100.0
4.5	0.25	100.0
5.0	0.23	100.0
6.0	0.23	100.0
7.0	0.23	100.0
8.0	0.23	100.0
9.0	0.23	100.0
10.0	0.23	100.0

5.9. FIELD STRENGTH OF SPURIOUS EMISSIONS [§§ 2.1053, 87.139] [RSS-141 § 5.2]

5.9.1. Limits @ FCC 87.139

§ 87.139(a)(3) - When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least 43 + 10 log10 pY dB.

[RSS-141 § 5.2]
Transmitter with A3E or A9W Emissions:
When the frequency is removed from the equipment's channel centre frequency by more than 250% of the channel bandwidth, the attenuation for on-board aircraft transmitters shall be at least 40 dB; and the attenuation for ground transmitters shall be at least 43 + 10 log10 P (in watts) dB, measured with a bandwidth of 3 kHz.

5.9.2. Method of Measurements

TIA-603-E / ANSI C63.26.

5.9.3. Test Data

Remark(s):
- The emissions were scanned from 30 MHz to 6 GHz; all spurious emissions that are in excess of 20dB below the specified limit shall be recorded.
- There was no difference in spurious/harmonic emissions on the pre-scans for different channel spacing and input voltage levels. Therefore, the RF spurious/harmonic emissions in this section would be performed for 25 KHz channel spacing with 27.5 VDC level and limit of 43 + 10 log10 pY dB applied for worst case.

Carrier Frequency:	118.025 MHz
Power:	8.26 W
Limit:	-13 dBm
* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.	

Carrier Frequency:	127.5 MHz
Power:	7.91 W
Limit:	-13 dBm
* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.	

Carrier Frequency:	136.975 MHz
Power:	7.96 W
Limit:	-13 dBm
* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.	

5.10. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051, 87.139] [RSS-141 § 5.2]

5.10.1. Limits

§§ 87.139(a)(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least 43 + 10 log10 pY dB.
[RSS-141 § 5.2]
Transmitter with A3E or A9W Emissions:
When the frequency is removed from the equipment's channel centre frequency by more than 250% of the channel bandwidth, the attenuation for on-board aircraft transmitters shall be at least 40 dB; and the attenuation for ground transmitters shall be at least 43 + 10 log10 P (in watts) dB, measured with a bandwidth of 3 kHz.

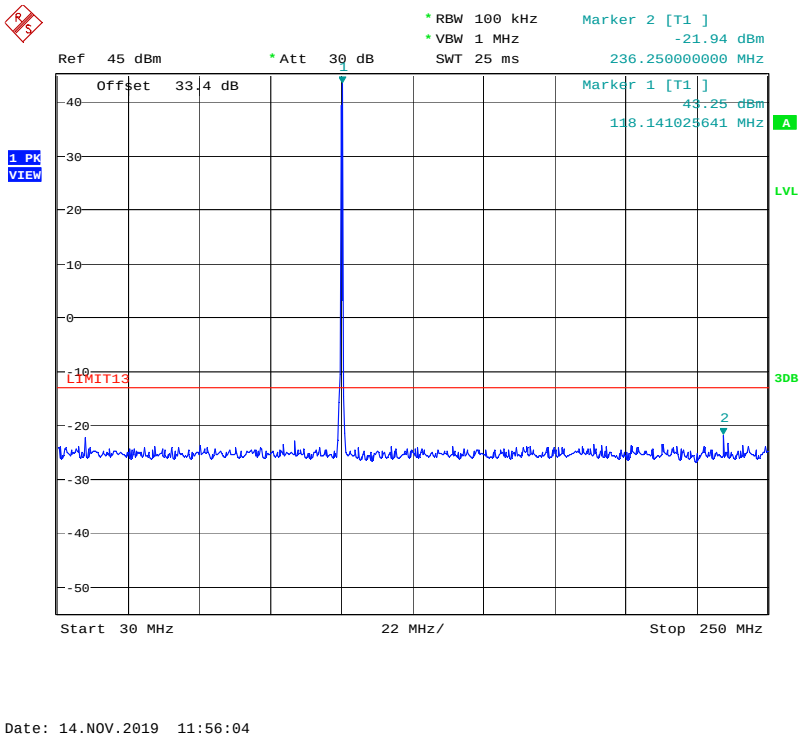
5.10.2. Method of Measurements

TIA-603-E / ANSI C63.26

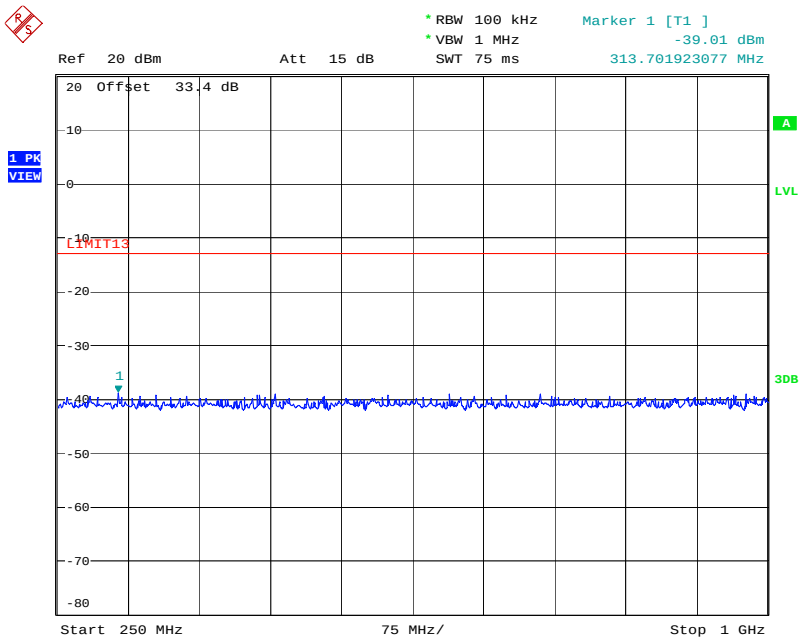
5.10.3. Test Data

Note: There was no difference in spurious/harmonic emissions on the pre-scans for different channel spacing and input voltage levels. Therefore, the RF spurious/harmonic emissions in this section would be performed for 25 KHz channel spacing with 27.5 VDC level and limit of 43 + 10 log10 pY dB applied for worst case.

5.10.3.1. Configuration: Tx Conducted, 118.025MHz, 25 KHz channel space



All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



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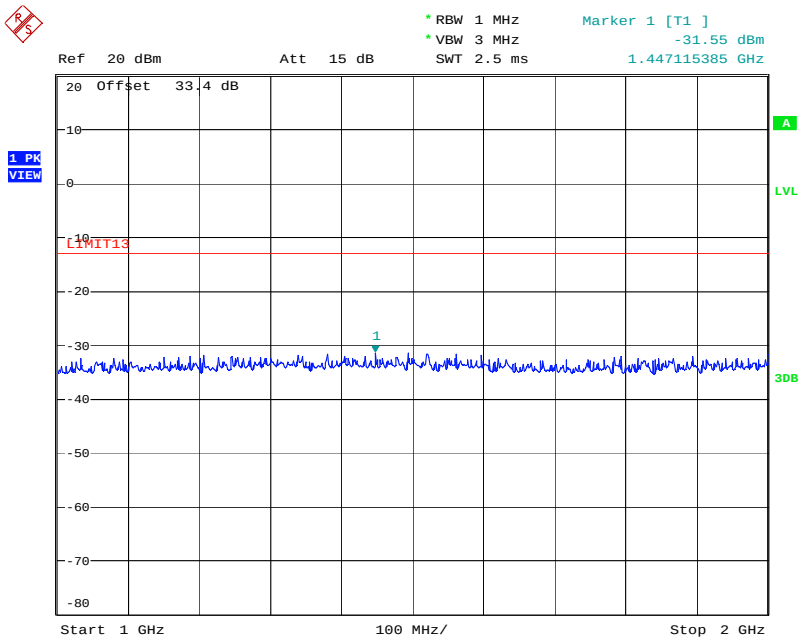
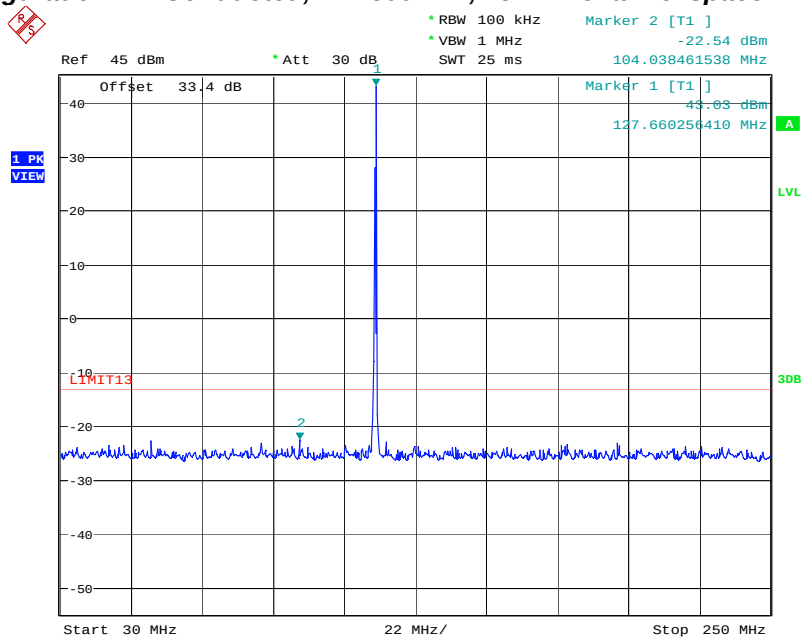


Date: 14.NOV.2019 12:07:49

5.10.3.2. Configuration: Tx Conducted, 127.500MHz, 25 KHz channel space



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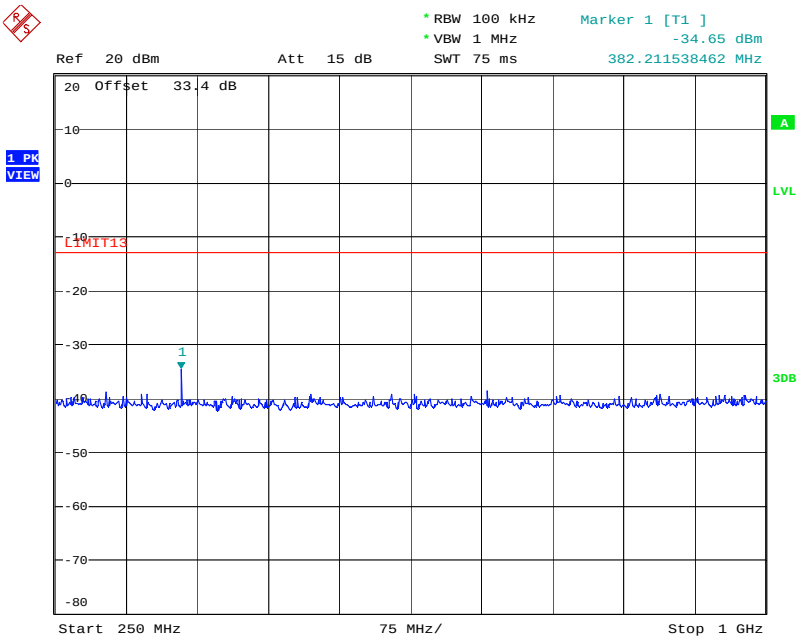

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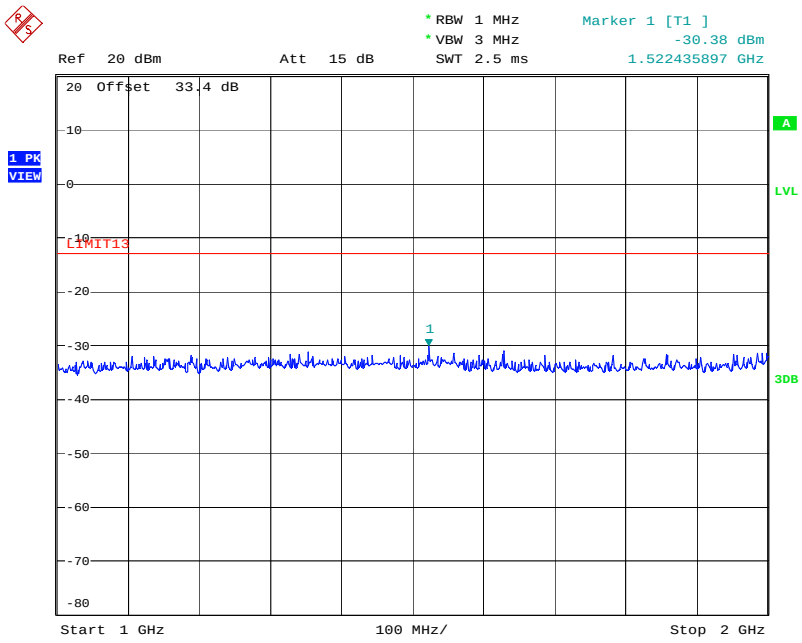
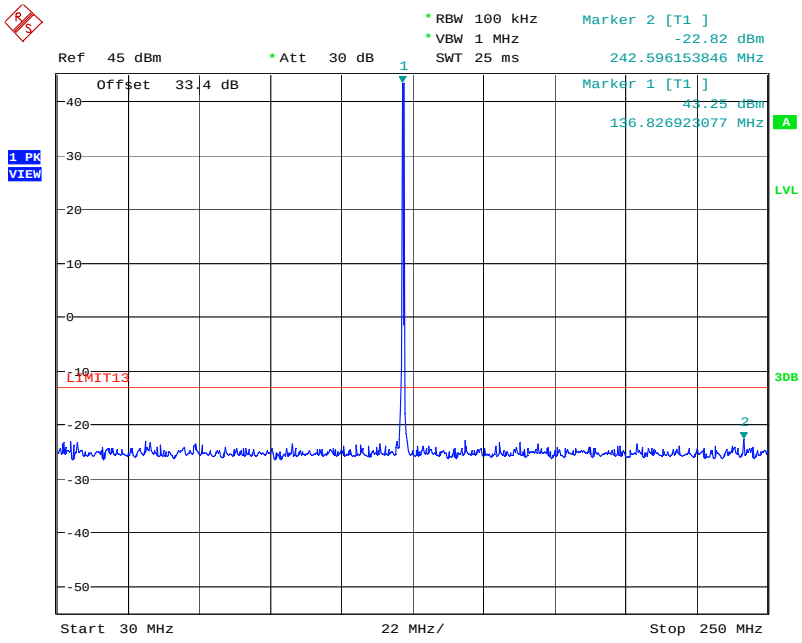


Date: 14.NOV.2019 12:08:45

5.10.3.3. Configuration: Tx Conducted, 136.975MHz, 25 KHz channel space



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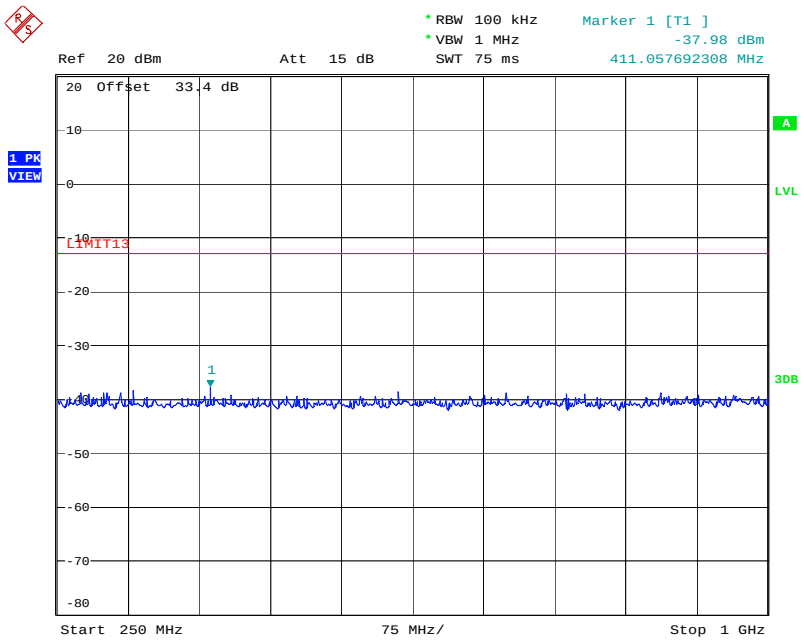

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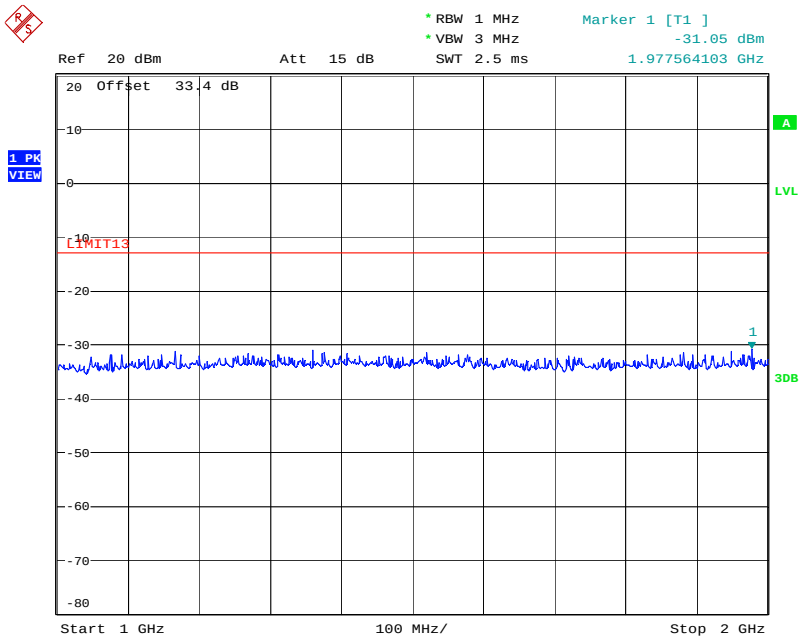

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5.11. FREQUECNY STABILITY [§§ 2.1055 & 87.133] [RSS-141 § 5.1]

5.11.1. Limits

§ 87.133 The carrier frequency of each station must be maintained within the tolerance in the following table:

Frequency band (lower limit exclusive, upper limit inclusive), and categories of station	Tolerance (ppm)
(5) Band - 108 to 137 MHz: Aircraft and other mobile stations in the Aviation Services.	*30

* For emissions G1D and G7D, the tolerance is 5 parts per 10^6.

[RSS-141 § 5.1]
The RF carrier frequency shall not depart from the reference frequency (reference frequency is the frequency at 20°C and rated supply voltage) in excess of the values given below:

Ground Equipment: **± 20** ppm for A3E and A9W emissions
±2 ppm for G1D and G7D emissions

Airborne Equipment: ± 30 ppm for A3E and A9W emissions
± 5 ppm for G1D and G7D emissions

5.11.2. Method of Measurements

47 CFR 2.1049, ANSI C63.26 and TIA-603-E

5.11.3. Test Data

Center Frequency:	118.025 MHz
Full Power Level:	8.26 dBm
Frequency Tolerance Limit (Worst Case):	5 ppm or 590.125 Hz (Manufacturer's rating: ± 5 ppm)
Max. Frequency Tolerance Measured:	-77 Hz or -0.65 ppm
Input Voltage Rating:	13.8 / 27.5 V DC

Ambient Temperature (^{o}C)	**Frequency Drift (Hz)**		
	Supply Voltage (Nominal) 27.5 VDC	**Supply Voltage (Lowest, 85% of 13.8V) 11.73 VDC**	**Supply Voltage (115% of Nominal) 31.625 VDC**
-30	-70	--	--
-20	-77	--	--
-10	-52	--	--
0	-50	--	--
10	-17	--	--
20	-12	-9	-11
30	-25	--	--
40	-37	--	--
50	-40	--	--
60	-39	--	--

5.12. EXPOSURE OF HUMANS TO RF FIELD [[§§ 1.1310 & 2.1091] [RSS Gen Sec 5.6 & RSS-102]

The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation.

FCC 47 CFR § 1.1310:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

[RSS Gen Sec 5.6 & RSS-102]
The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in RSS-102.

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Table 6: RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[23]	170	180	-	Instantaneous*
0.1-10	-	$1.6/f$	-	6**
1.29-10	$193/f^{0.5}$	-	-	6**
10-20	61.4	0.163	10	6
20-48	$129.8/f^{0.25}$	$0.3444/f^{0.25}$	$44.72/f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	$15.60f^{0.25}$	$0.04138f^{0.25}$	$0.6455f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/f^{1.2}$
150000-300000	$0.354f^{0.5}$	$9.40 \times 10^{-4} f^{0.5}$	$3.33 \times 10^{-4} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient
through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

5.12.1. Method of Measurements

See RSS-102 & FCC 47 CFR §§ 1.1310, 2.1091

In order to demonstrate compliance with MPE requirements, the following information is typically needed:

(1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
(2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
(3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
(4) Any other RF exposure related issues that may affect MPE compliance

Calculation Method of RF Safety Distance:

$$S = \frac{P \cdot G}{4 \cdot \pi \cdot r^2} = \frac{EIRP}{4 \cdot \pi \cdot r^2}$$

Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

5.12.2. RF Evaluation

5.12.2.1. FCC

Frequency (MHz)	Max. Conducted Power (dBm)	Max. Antenna Gain (dBi)	EIRP (dBm)	EIRP* (mW)	Evaluation Distance, r (cm)	Power Density, S (mW/cm^2)	MPE Limit (mW/cm2)
118.000	39.17	0	39.17	8260/2*	56	0.105	0.2

*50% duty cycle applied

5.12.2.2. RSS 102 (ISED Canada)

Frequency (MHz)	Max. Conducted Power (dBm)	Max. Antenna Gain (dBi)	EIRP (dBm)	EIRP* (mW)	Evaluation Distance, r (cm)	Power Density, S (mW/cm^2)	MPE Limit (mW/cm2)
118.000	39.17	0	39.17	8260/2*	56	0.105	0.1291

*50% duty cycle applied

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.1. RECEIVER SPUROUS EMISSIONS (RADIATED) [RSS-141 § 5.3]

5.1.1. Limits

Spurious emissions from receivers shall not exceed the radiated emissions limits shown in RSS-Gen table 3.

RSS-Gen Table 3 - Receiver radiated emissions limits

Frequency (MHz)	Field strength (at 3 metres)[Note 1]	
	μV/m	dBμV/m
30 - 88	100	40
88 - 216	150	43.52
216 - 960	200	46.02
Above 960	500	53.98

Note 1: Measurements for compliance with the limits in table 3 may be performed at distances other than 3 metres, in accordance with section 6.6.

5.1.2. Method of Measurements

ANSI C63.4.

5.1.3. Test Data

Remarks:
- The measuring receiver shall be tuned over the frequency range 30 MHz to 2GHz.
- All emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT was set in receive mode
- IF=38.85 MHz

Rx Test Frequency (MHz)	Frequency (MHz)	Peak Measurement		QP/Avg Measurement		Limit QP	Margin	
		Vertical	Horizontal	Vertical	Horizontal		Vertical	Horizontal
118.025	784.375	30.59	-	--	--	46	-15.41	--
127.500	499.050	-	30.34	--	--	46	--	-15.66
	831.750	31.47	28.57	--	--	46	-14.53	-17.43
136.975	175.825	-	33.44	--	--	43.52	--	-10.08
	351.650	-	33.2	--	--	46	--	-12.8
	527.475	-	31.87	--	--	46	--	-14.13
	703.300	29.89	30.35	--	--	46	-16.11	-15.65
161.650	All emissions are lower than 20 dB below the specified limit.							
163.275	All emissions are lower than 20 dB below the specified limit.							

5.2. RECEIVER SPUROUS EMISSIONS (CONDUCTED) [RSS-141 § 5.3]

5.2.1. Limits

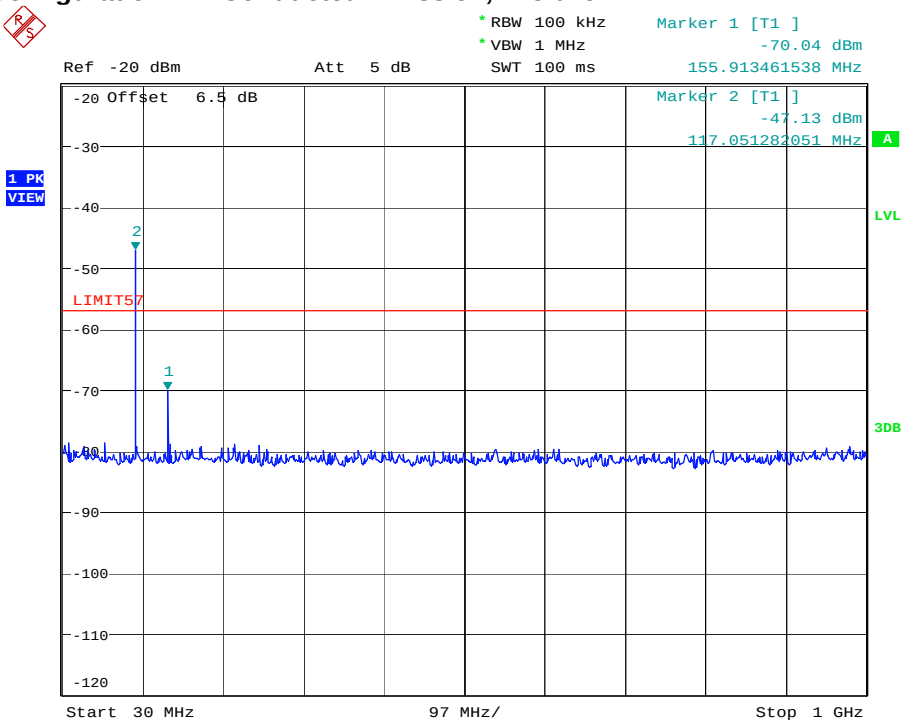
The spurious emissions from the receiver at any discrete frequency, measured at the antenna port by the antenna-conducted method, shall not exceed 2 nW in the frequency range 30-1000 MHz and 5 nW above 1 GHz.

5.2.2. Method of Measurements

TIA-603-E

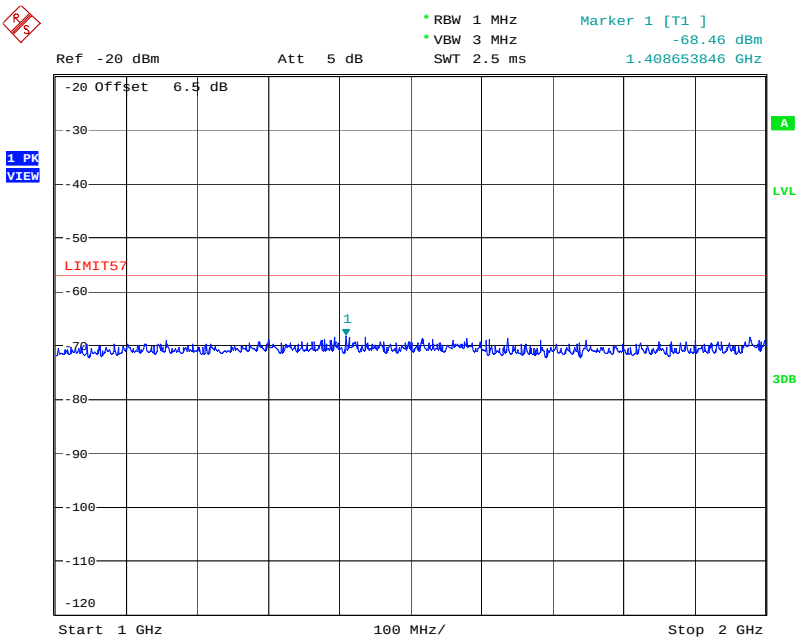
5.2.3. Test Data

5.2.3.1. Configuration: Rx Conducted Emission, 118.025 MHz.



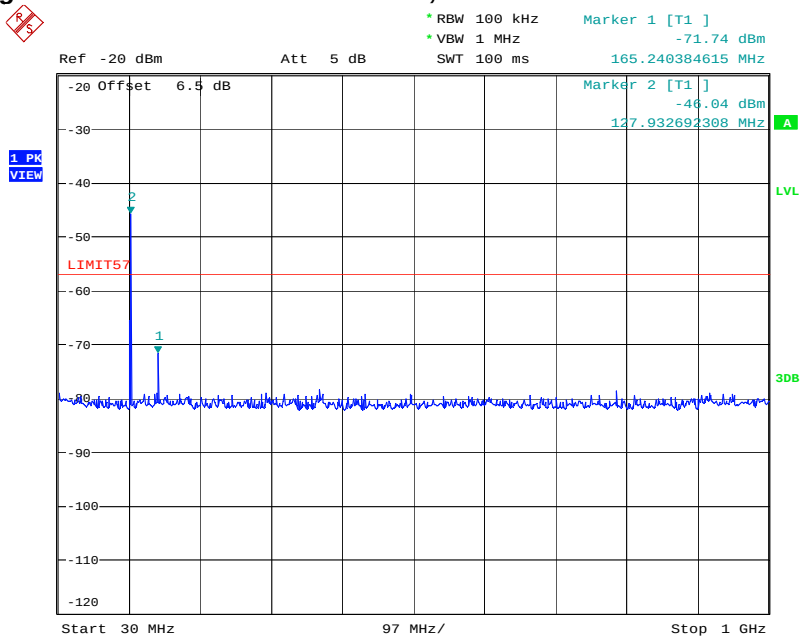
Highest peak is Rx Signal input (1mV rms)

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



Date: 14.NOV.2019 13:29:40

5.2.3.2. Configuration: Rx Conducted Emission, 127.5 MHz



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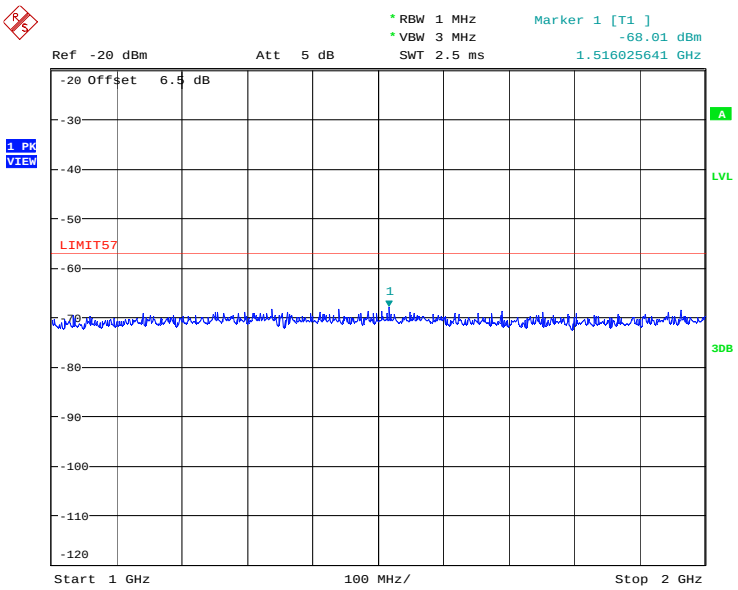
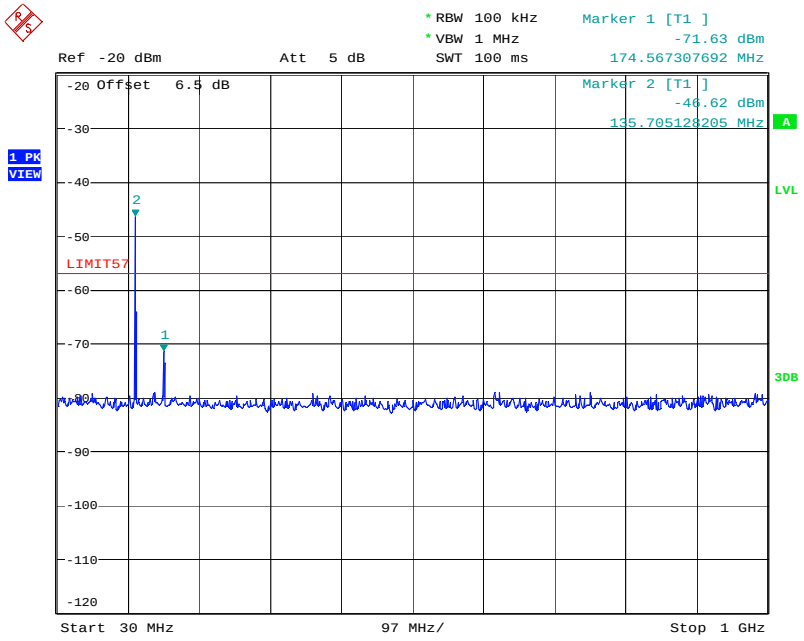
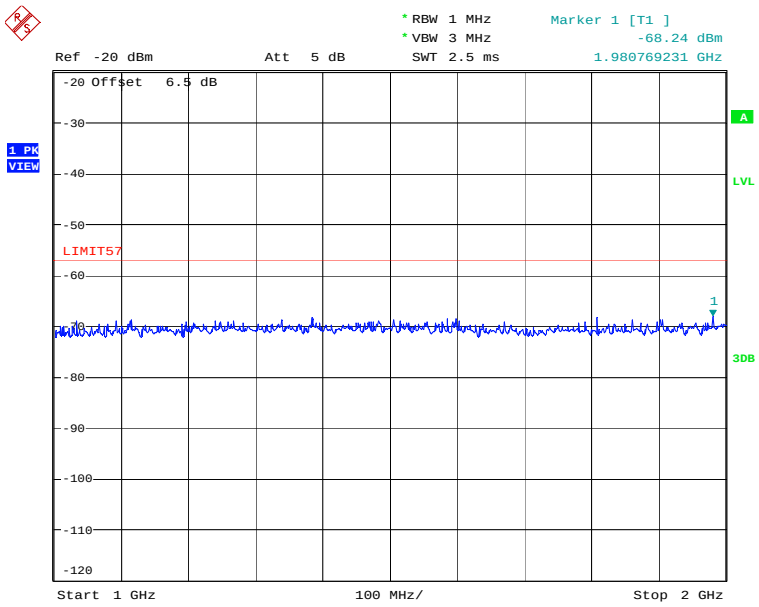
Highest peak is Rx Signal input (1mV rms)



5.2.3.3. Configuration: Rx Conducted Emission, 136.975 MHz



Highest peak is Rx Signal input (1mV rms)



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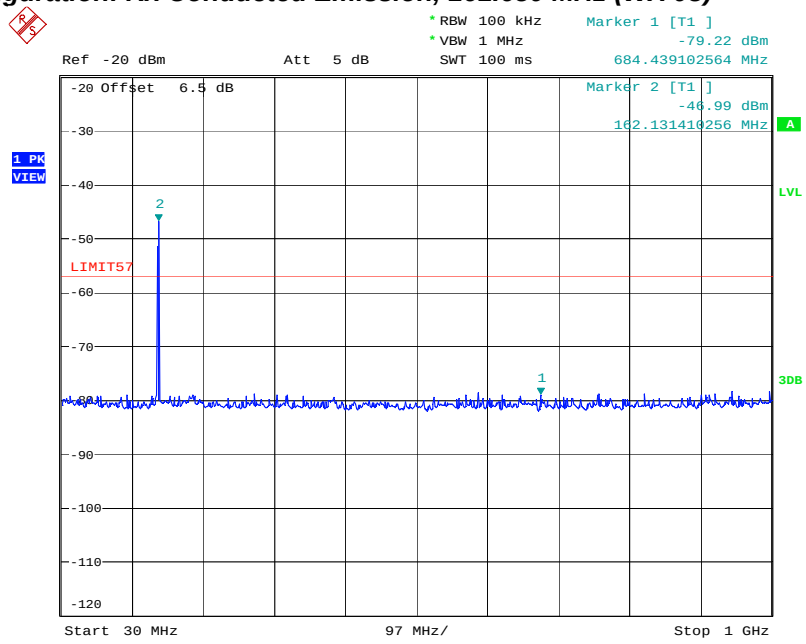
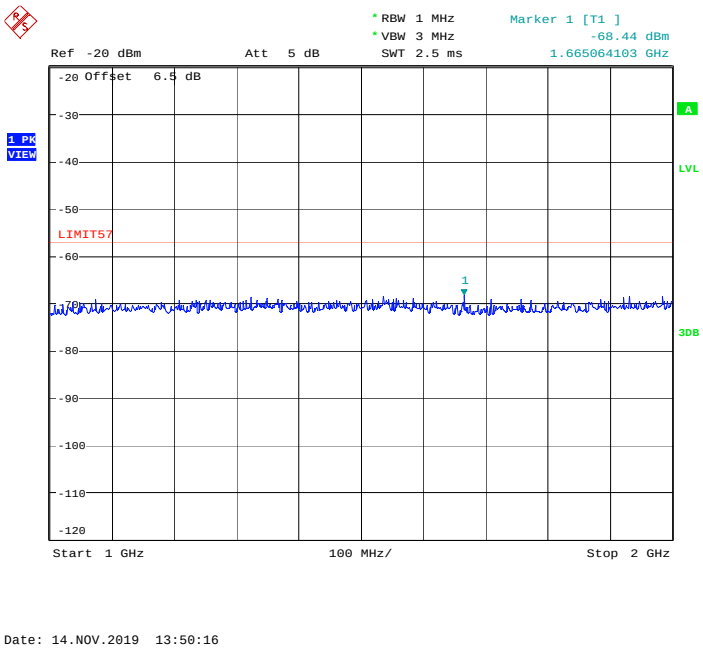
5.2.3.4. Configuration: Rx Conducted Emission, 161.650 MHz (WX 08)

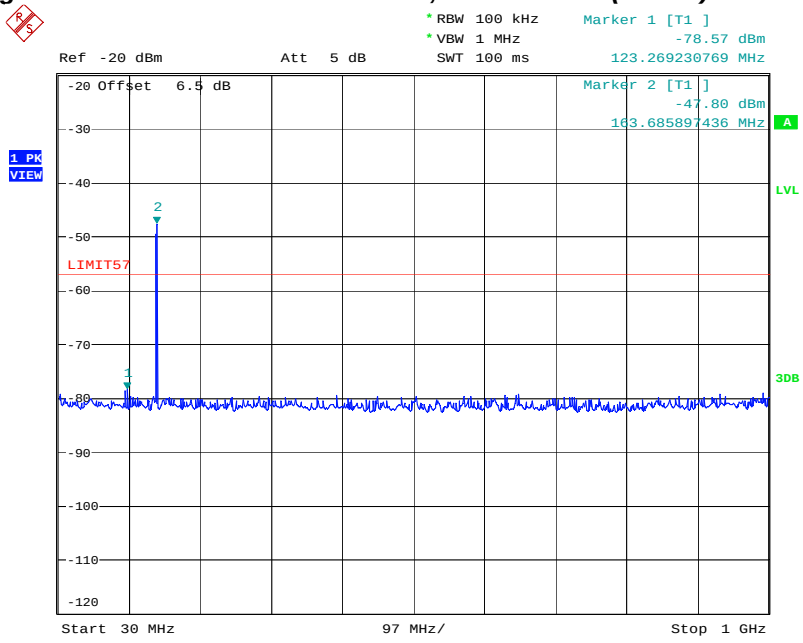


Date: 14.NOV.2019 13:46:01

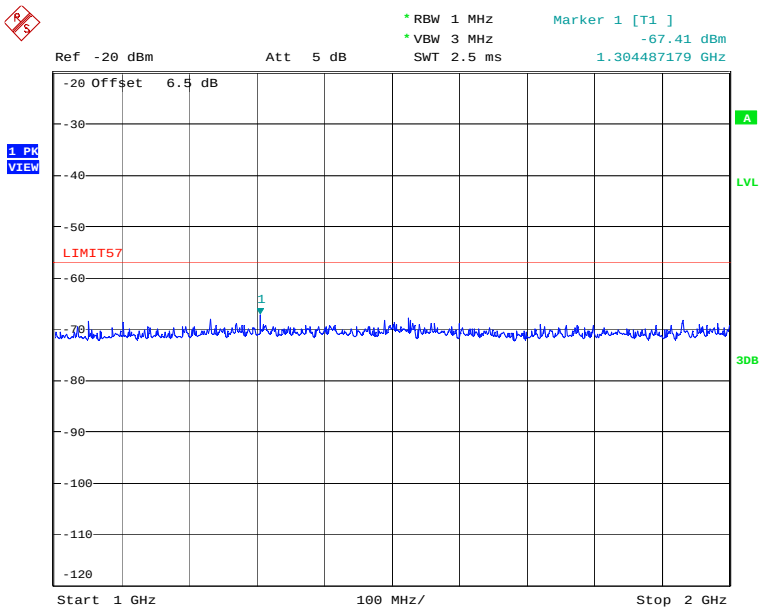
Highest peak is Rx Signal input (1mV rms)



5.2.3.5. Configuration: Rx Conducted Emission, 163.275 MHz (WX 10)



Highest peak is Rx Signal input (1mV rms)



Date: 14.NOV.2019 13:49:08

5.3. POWERLINE CONDUCTED EMISSIONS FROM UNINTENTIONAL RADIATORS (DIGITAL DEVICES) [RSS-Gen § 8.8 & ICES-003, ISSUE 6]

5.3.1. Limits

The equipment shall meet the limits of the following table:

	CLASS B LIMITS		
Test Frequency Range (MHz)	**Quasi-Peak (dBμV)**	**Average* (dBμV)**	**Measuring Bandwidth**
0.15 to 0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 to 5	56	46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
5 to 30	60	50	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average

* Decreasing linearly with logarithm of frequency

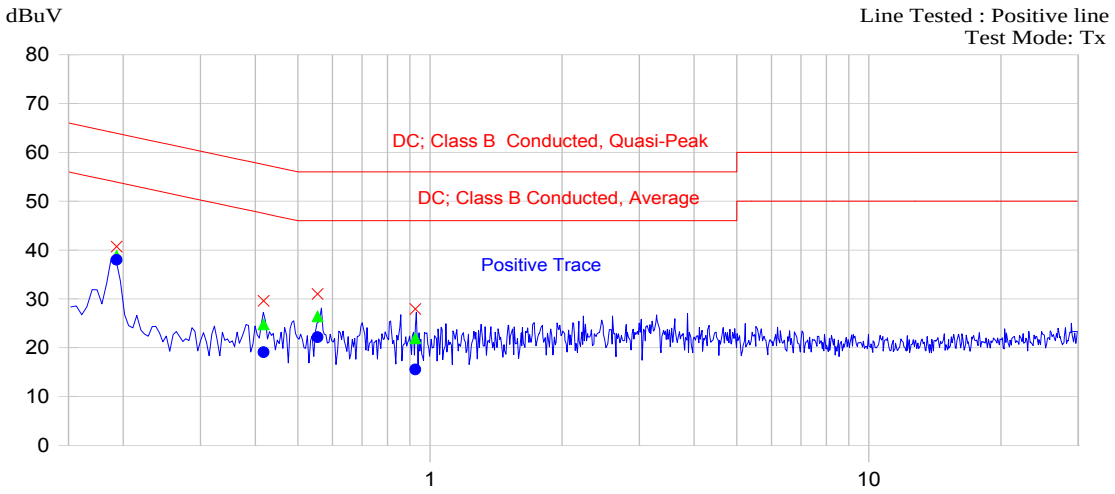
5.3.2. Method of Measurements

Refer to Ultratech Test Procedures ULTR-P001-2004 & ANSI C63.4 for method of measurements.

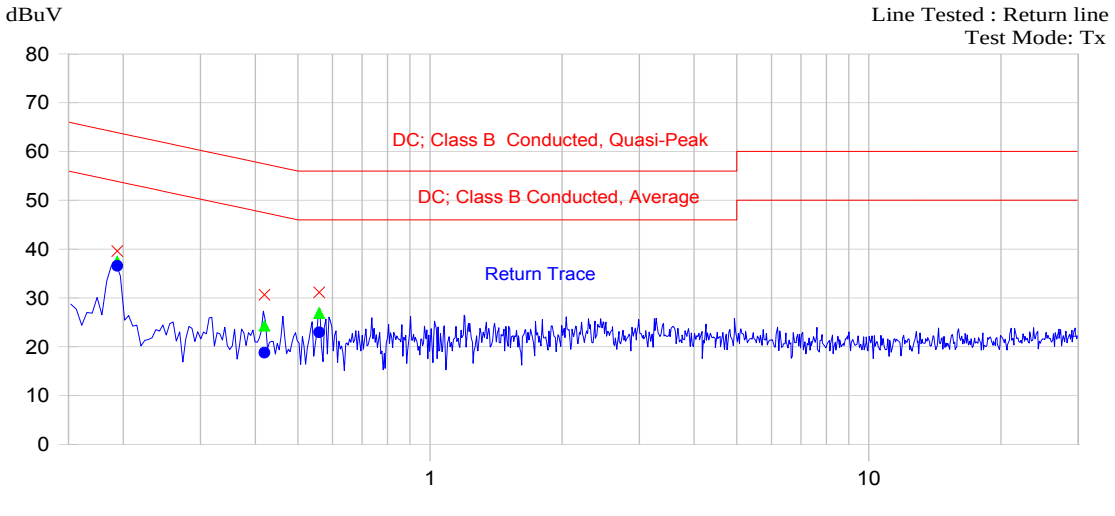
5.3.3. Test Data

TX Mode

13.8 V Dc

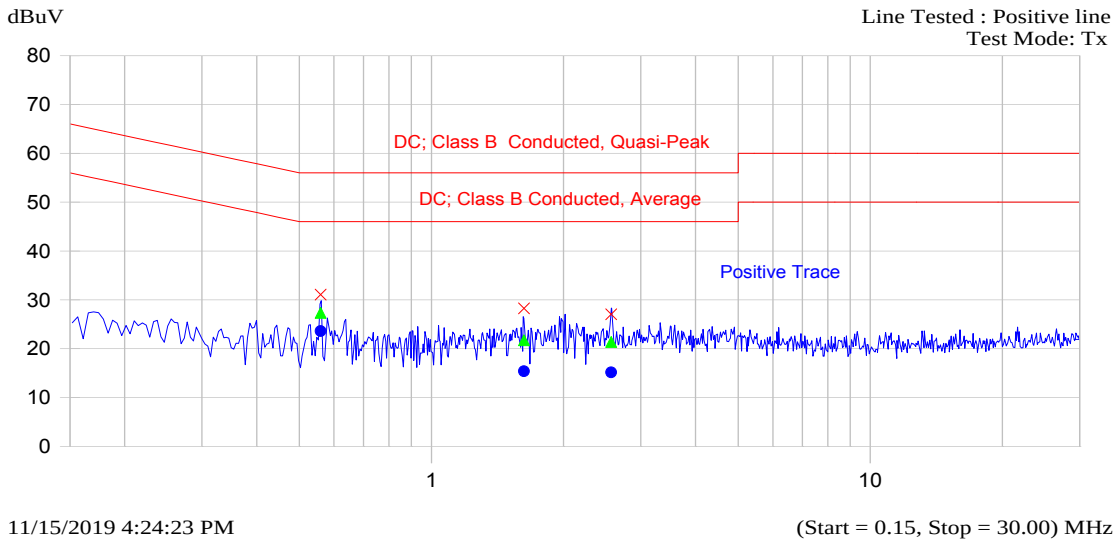


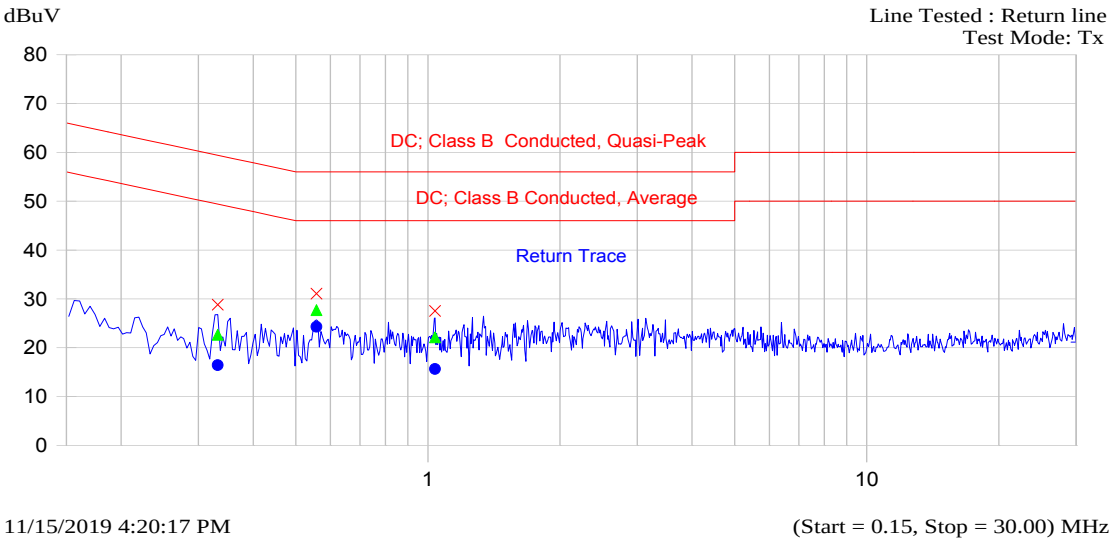
Frequency MHz	Peak dBuV	QP dBuV	Qp-Qp Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.193	40.7	38.8	-25.1	38.0	-15.9	Positive Trace



Frequency MHz	Peak dBuV	QP dBuV	Qp-Qp Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.194	39.6	37.5	-26.4	36.6	-17.3	Return Trace

27.5 Vdc

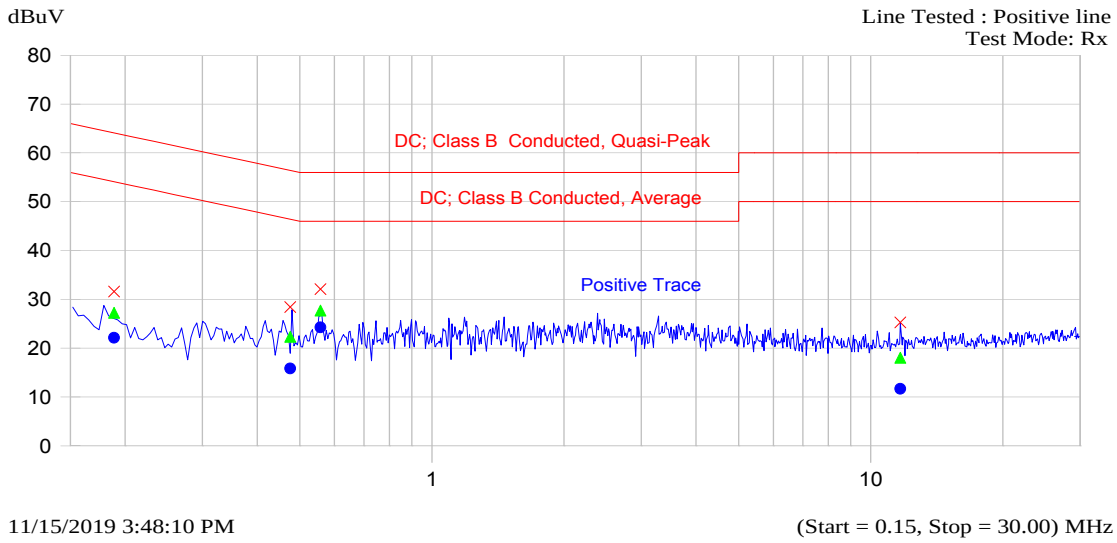


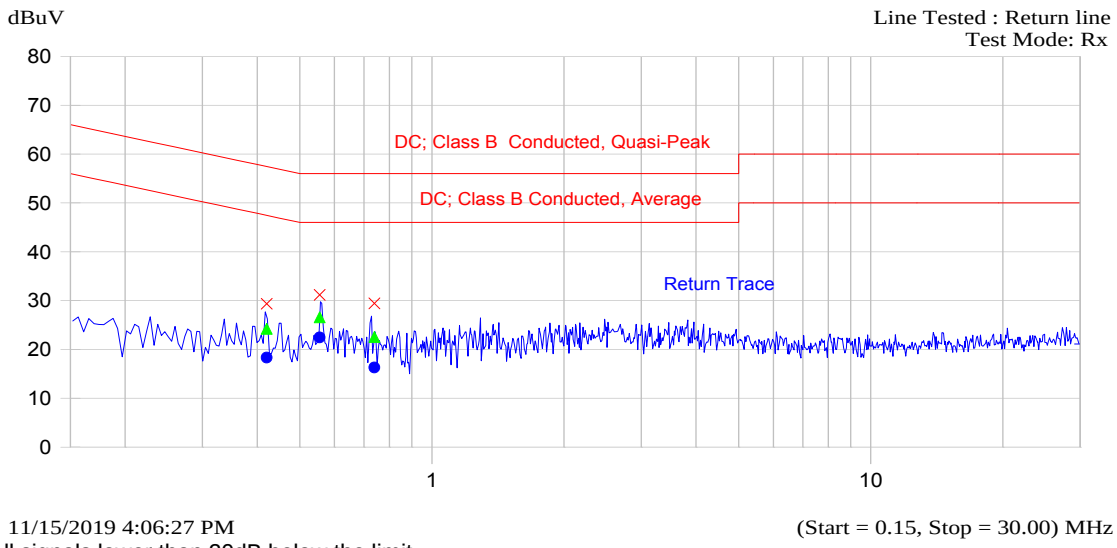


All signals lower than 20dB below the limit

RX Mode

13.8 V Dc

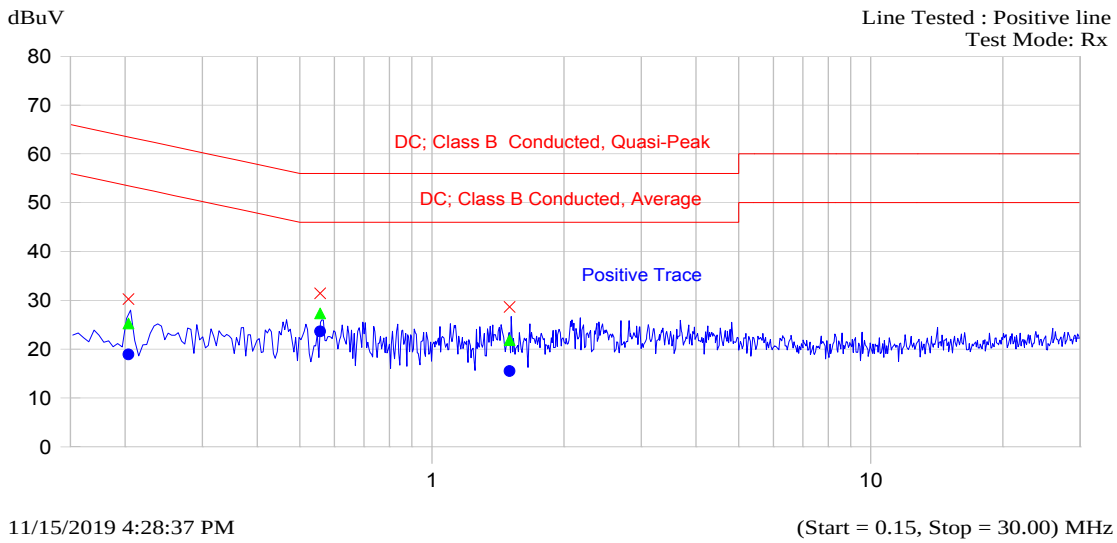


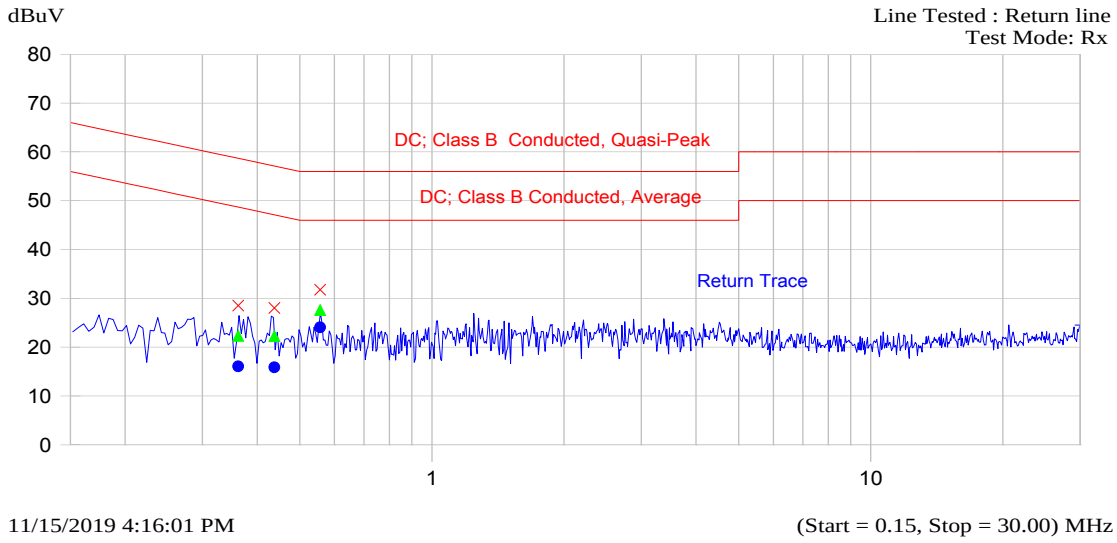


All signals lower than 20dB below the limit

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

27.5 Vdc





All signals lower than 20dB below the limit

5.4. RADIATED EMISSIONS FROM UNINTENTIONAL RADIATORS (DIGITAL APPARATUS) [ICES-003, ISSUE 6]

5.4.1. Limits

The equipment shall meet the limits of the following tables determined at a distance of 3 metres.

Class B Radiated Limits below 1 GHz

Frequency (MHz)	Class B Radiated Limit (dBµV/m)
	Quasi-peak
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
960 - 1000	54.0

Class B Radiated Limits above 1 GHz

Frequency (MHz)	Class B Radiated Limit (dBµV/m)	
	Linear Average Detector	Peak Detector
> 1000	54	74

5.4.2. Method of Measurements

ANSI C63.4.

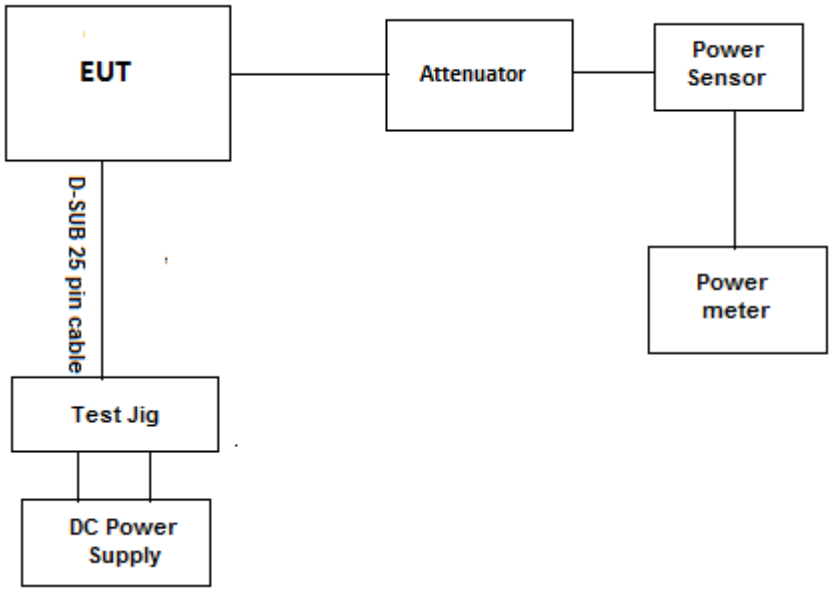
5.4.3. Test Data

Remarks:
- The measuring receiver shall be tuned over the frequency range 30 MHz to 6 GHz.
- All emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT was set in receive mode

Frequency (MHz)	RF Level (dBµV/m)	Detector Used (Peak/QP/Avg)	Antenna Plane (H/V)	Limit (dBµV/m)	Margin (dB)
40.88	37.16	Peak	V	40	-2.84
40.88	37.16	Peak	H	40	-2.84
75.08	26.85	Peak	V	40	-13.15
75.08	26.85	Peak	H	40	-13.15
93.73	27.36	Peak	V	43.5	-16.14
93.73	27.36	Peak	H	43.5	-16.14
113.94	28.27	Peak	V	43.5	-15.23
113.94	28.27	Peak	H	43.5	-15.23

EXHIBIT 6. TEST EQUIPMENT LIST AND SETUP

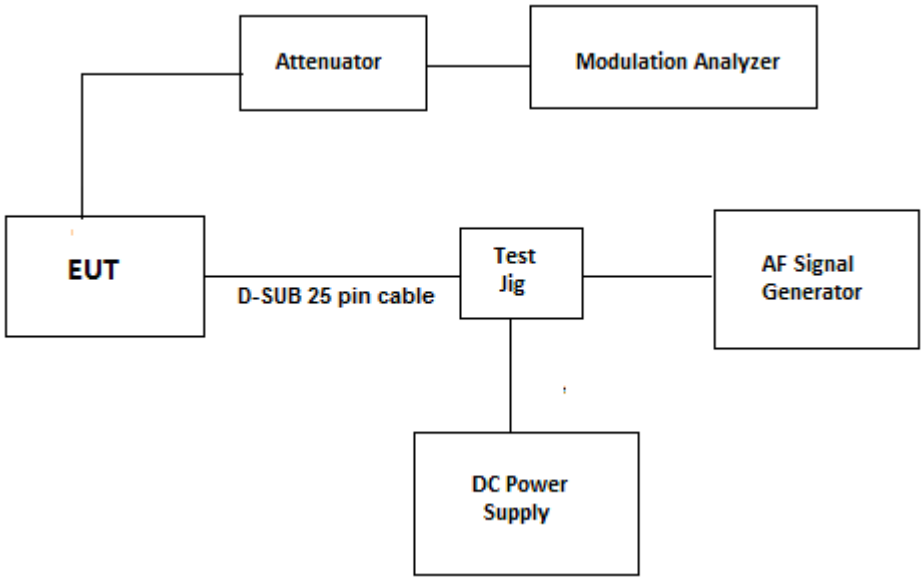
6.1. Conducted Power



Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Power Meter	HP	436A	2016A07747	100KHz-sensor dependant	29 Mar 2020
Power Sensor	HP	8482A	2652A14099	10MHz-4.2GHz	20 Feb 2020
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Attenuator(3dB)	Aeroflex\Weinschel	23-3-34	AN2549	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

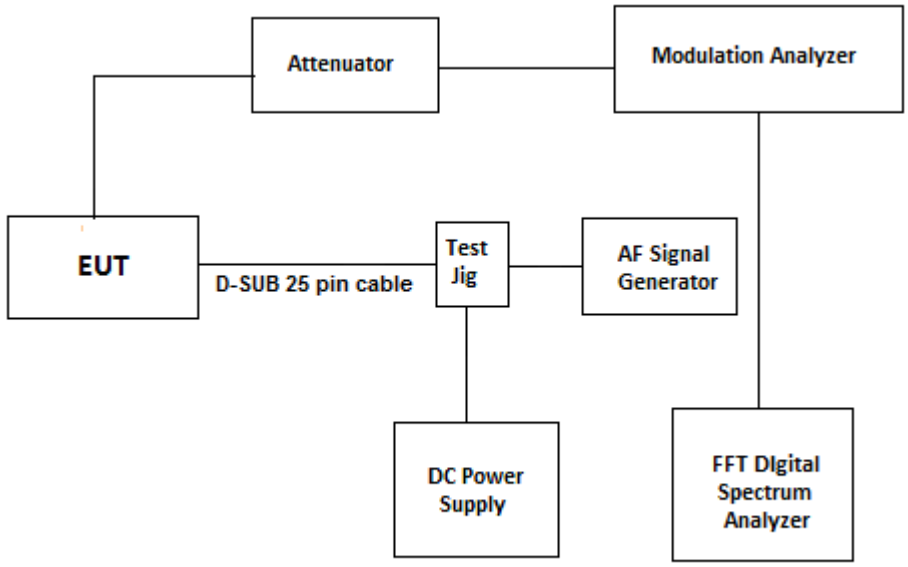
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

6.2. Modulation Limit



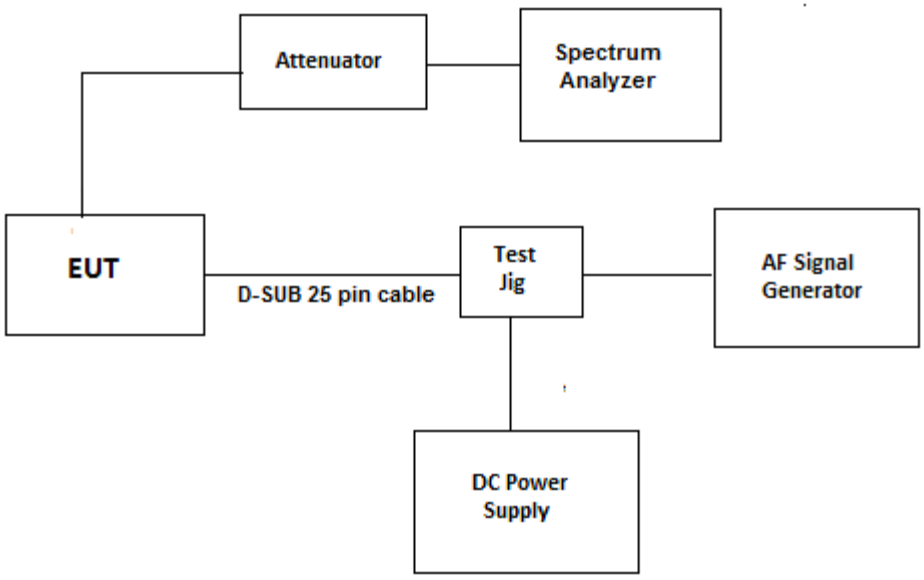
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Modulation Analyzer	HP	HP-8901B	3226A04606	150KHz-1300MHz	23 Mar 2020
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	20 Mar 2020
Digital Voltmeter	HP	3456A	2015A04523	--	19 Dec 2019
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Attenuator(3dB)	Aeroflex\Weinschel	23-3-34	AN2549	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

6.3. Audio Frequency Response



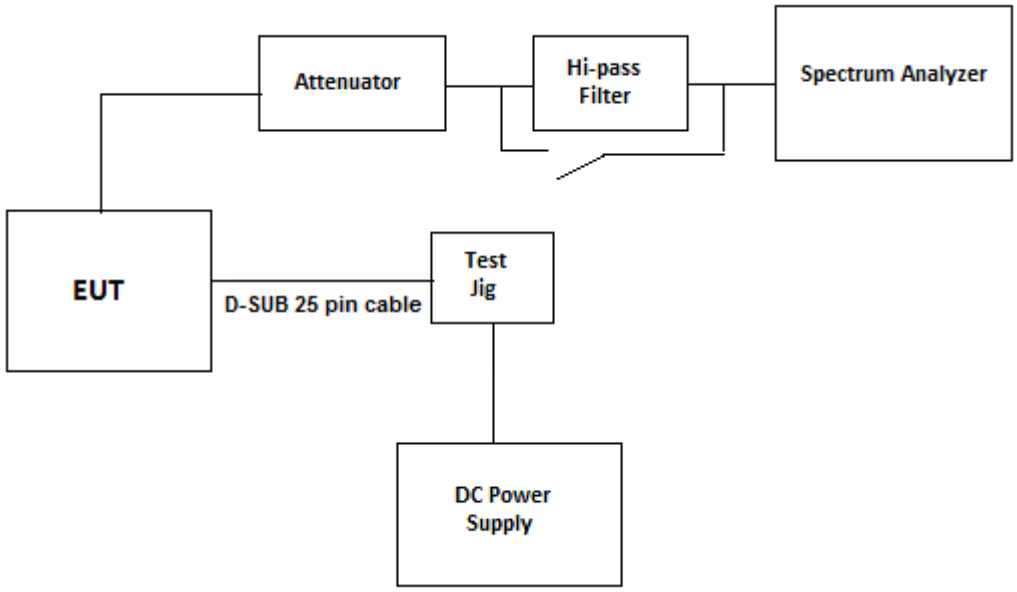
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Modulation Analyzer	HP	HP-8901B	3226A04606	150KHz-1300MHz	23 Mar 2020
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	20 Mar 2020
Digital Voltmeter	HP	3456A	2015A04523	--	19 Dec 2019
FFT Digital Spectrum Analyzer	Advantest	R9211E	8202336	10MHz-100KHz	12 Sep 2020
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Attenuator(3dB)	Aeroflex\Weinschel	23-3-34	AN2549	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

6.4. 99% OBW and Mask



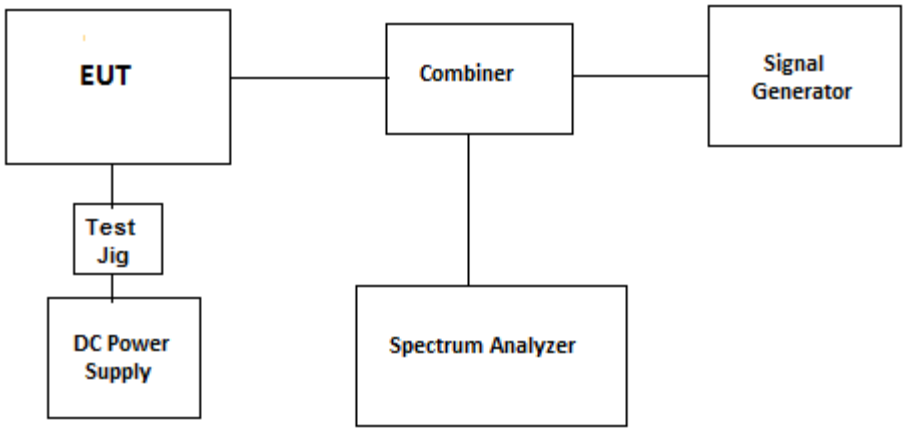
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	20 Mar 2020
Digital Voltmeter	HP	3456A	2015A04523		19 Dec 2019
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Attenuator(3dB)	Aeroflex\Weinschel	23-3-34	AN2549	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

6.5. Tx Conducted Emission



Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	20 Mar 2020
Hi-pass filter	Mini-Circuit	SHP-250	--	Cut off 250MHz	Cal on use
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Attenuator(3dB)	Aeroflex\Weinschel	23-3-34	AN2549	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

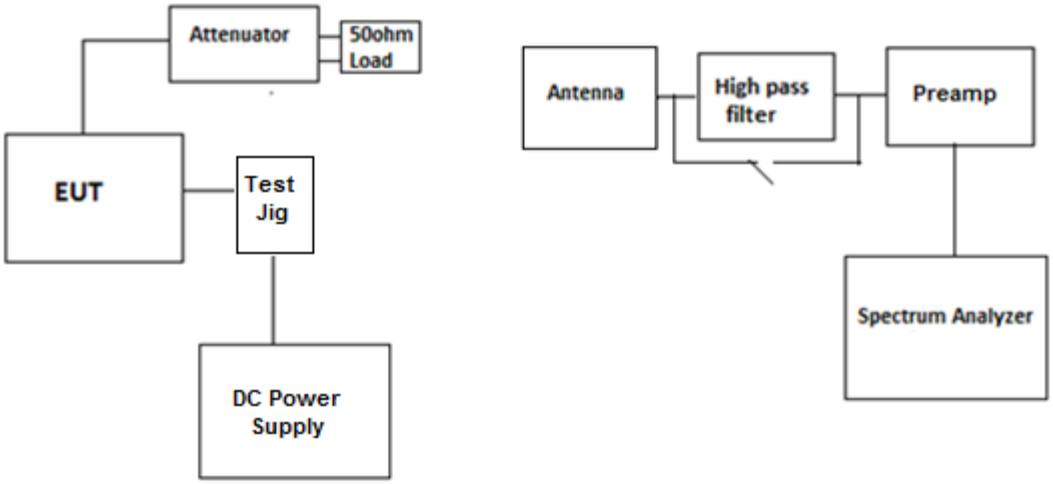
6.6. Rx Conducted Emission



Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
Signal Generator	Marconi	2024	112255/164	9KHz-2.4GHz	19 Sep 2021
Combiner	Weinschel 93458	1515	PS119	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

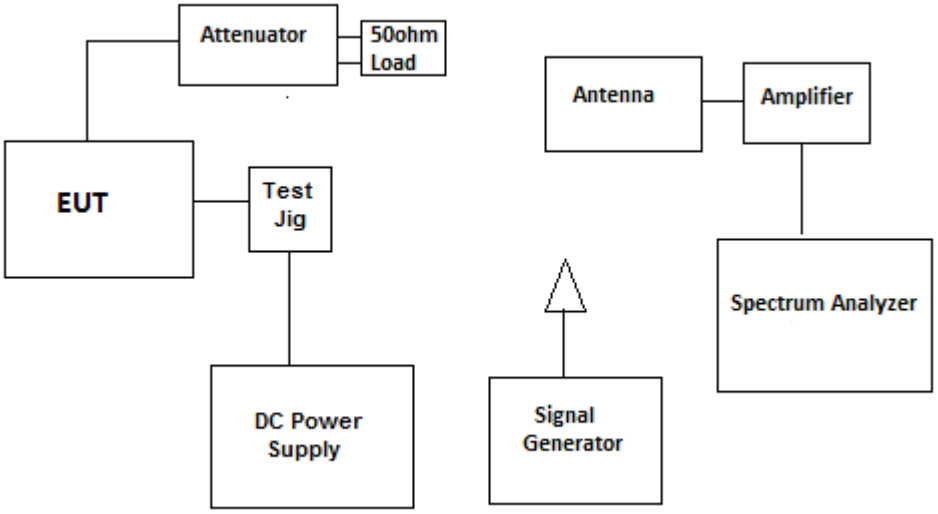
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

6.7. TX Radiated



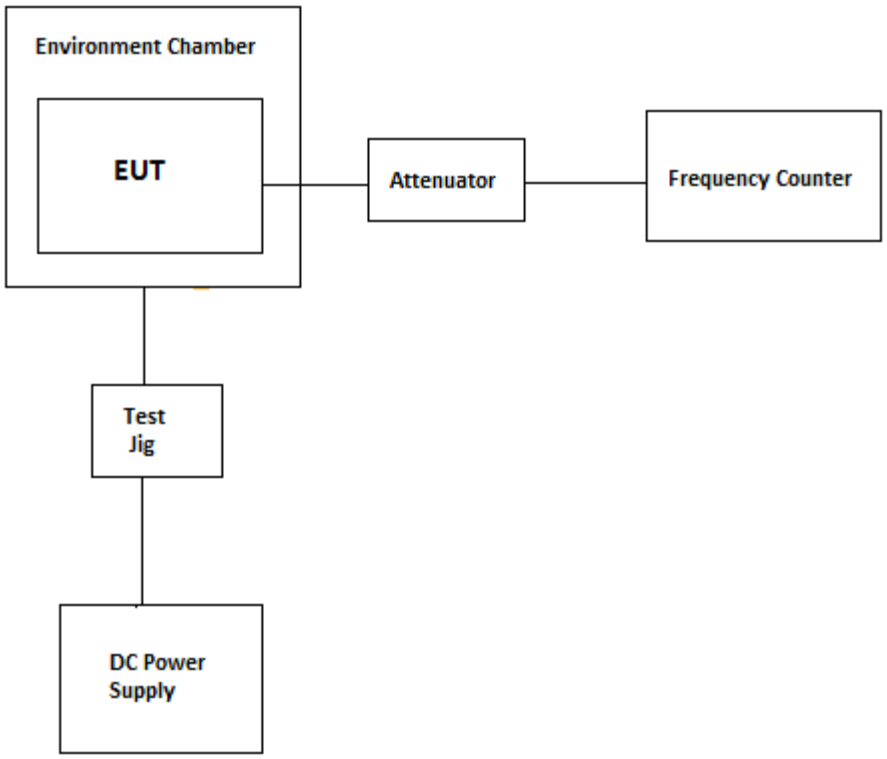
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
Bicon Antenna	ETS	3110B	3379	30-200MHz	06 Feb 2020
Log Periodic Antenna	ETS	3148	00023845	200-2000MHz	02 Aug 2020
Horn Antenna	ETS	3117	00119425	1-18GHz	25 July 2021
Preamplifier	Com-Power	PAM-118A	551016	500MHz-18GHz	18 Mar 2020
Preamplifier	Com-Power	PA-103	161040	1-1000MHz	12 Apr 2020
Hi-pass filter	Mini-Circuit	SHP-250	--	Cut off 250MHz	Cal on use
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Attenuator(3dB)	Aeroflex\Weinschel	23-3-34	AN2549	DC-18GHz	Cal on use
Load(50ohm)	Mini-Circuits	KARN-50+	--	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

6.8. Rx Radiated



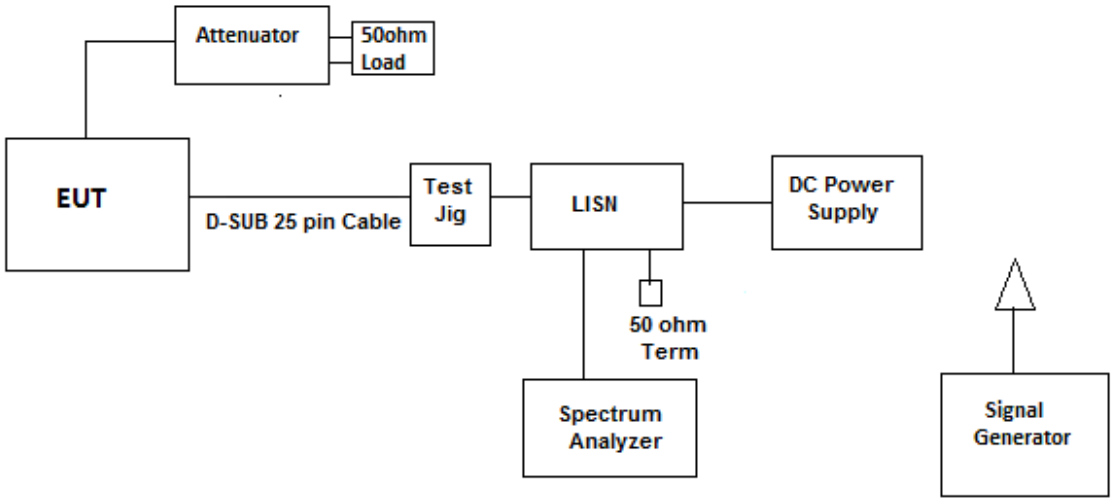
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
Bicon Antenna	ETS	3110B	3379	30-200MHz	06 Feb 2020
Log Periodic Antenna	ETS	3148	00023845	200-2000MHz	02 Aug 2020
Horn Antenna	ETS	3117	00119425	1-18GHz	25 July 2021
Preamplifier	Com-Power	PAM-118A	551016	500MHz-18GHz	18 Mar 2020
Preamplifier	Com-Power	PA-103	161040	1-1000MHz	12 Apr 2020
Signal Generator	Marconi	2024	112255/164	9KHz-2.4GHz	19 Sep 2021
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Attenuator(3dB)	Aeroflex\Weinschel	23-3-34	AN2549	DC-18GHz	Cal on use
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020
Load(50ohm)	Mini-Circuits	KARN-50+	--	DC-18GHz	Cal on use

6.9. Frequency Stability



Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Environmental Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177° C	10 Jun 2021
Frequency Counter	EIP	545A	2683	10MHz-1GHz	07 Aug 2020
Attenuator(20dB)	Aeroflex\Weinschel	34-20-34	BP6023	DC-18GHz	Cal on use
Attenuator(20dB)	Narda	26298	A577	DC-1GHz	Cal on use
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----

6.10. Power line Conducted emissions



Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	HP	8593E	3710A00223	9KHz-1.5GHz	13 May 2020
LISN	Schwarzbeck	NSLK 8127	8127276	9KHz-30MHz	11 Dec 2019
Attenuator	Weinschel	24-20-34	BK2804	DC-18GHz	02 May 2020
Power Supply	XANTREX	XKW 60-50	---	0-60V,50A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY (0.15-30 MHz)

	Line Conducted Emission Measurement Uncertainty (9 kHz – 30 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 1.44**	**± 1.8**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 2.89**	**± 3.6**

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 2.15**	**± 2.6**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 4.30**	**± 5.2**

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 2.14**	**± 2.6**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 4.29**	**± 5.2**

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 1.52**	**Under consideration**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 3.04**	**Under consideration**

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