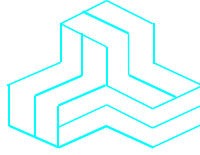


ENGINEERING TEST REPORT



Analog Multiband RF Module

Model:T6

FCC ID:IMA-T6

IC:120A-T6

Applicant:

Technisonic Industries Limited

240 Traders Blvd. E.

Mississauga, Ontario

Canada L4Z 1W7

Tested in Accordance With

**Federal Communications Commission (FCC)
47 CFR, Parts 2 and 87 (Subpart D) – Aviation Services
And
ISED, RSS-141, Issue 2**

UltraTech's File No.: 22TIL129_FCC87

This Test report is Issued under the Authority of
Tri M. Luu
Vice President of Engineering
UltraTech Group of Labs

Date: October 7, 2022

Report Prepared by: Santhosh Fernandez

Tested by: Nimisha Desai and Angus Au

Issued Date: October 7, 2022

Test Dates: August 17- Oct 7, 2022

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#0685



APEC
TEL#CA0001



1309



CA0001/2049



AT-1945



SL2-IN-E-1119R



CA000
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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. And ISED RSS-141, Issue 2
Test Procedures:	- ANSI/TIA-603-E - ANSI C63.26-2015

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

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2022	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 7	2016 Updated 2017	Information Technology Equipment (Including Digital Apparatus) — Limits and Methods of Measurement

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

Applicant	
Name:	Technisonic Industries Ltd.
Address:	240 Traders Blvd. E. Mississauga, Ontario Canada L4Z 1W7
Contact Person:	Mr. Steve McIntosh Phone #: 905-890-2113 ext 205 Fax #: 905-890-5338 Email Address: stevem@til.ca

Manufacturer	
Name:	Technisonic Industries Ltd.
Address:	240 Traders Blvd. E. Mississauga, Ontario Canada L4Z 1W7
Contact Person:	Mr. Steve McIntosh Phone #: 905-890-2113 ext 205 Fax #: 905-890-5338 Email Address: stevem@til.ca

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:	Technisonic Industries Limited
Product Name:	Analog Multiband RF Module
Model Name or Number:	T6
Serial Number:	FTD10001
Type of Equipment:	Licensed Non-Broadcast Station Transmitter
External Power Supply:	28 VDC nominal
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	RF Transceiver in multiple bands

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2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, industrial or business environment
Power Supply Requirement:	28 VDC nominal
RF Output Power Rating:	1 to 4.5 watts
Operating Frequency Range:	117.975 - 137 MHz
RF Output Impedance:	50 Ω
Channel Spacing:	25 kHz & 8.33 kHz
Modulation Employed:	Amplitude Modulation
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):

$B_n = 2M$

Where: B_n = Necessary bandwidth in hertz

M = Maximum modulation frequency in hertz

$M = 3000 \text{ Hz}$

$B_n = 2(3000) = 6000 \text{ Hz} = 6.00 \text{ kHz}$

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Shielded/Non-shielded
1	Power	1	8 pin header	Non-shielded
2	Audio / Data	1	10 pin header	Non-shielded
3	Antenna	1	BNC	Shielded

2.5. ANCILLARY EQUIPMENT

Ancillary Equipment # 1	
Equipment Make and Name:	Technisonic Industries Limited / Transceiver
Model Name or Number:	TDFM-9100
Serial Number:	FTD10001
Cable Type:	Shielded
Connected to EUT's Port #:(See above table)	1 and 2

Ancillary Equipment # 2	
Equipment Make and Name:	Technisonic Industries Limited / Transceiver test box
Model Name or Number:	TDFM-9000 Radio Test Jig
Cable Type:	25 pin D sub
Connected to EUT's Port #:(See above table)	None (connects to ancillary equipment #1 only)

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EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	28 VDC Nominal

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.
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ω Load.

Transmitter Test Signals	
Frequency Band(s):	117.975 – 137 MHz
Test Frequency(ies):	118.025 MHz, 127.500 MHz, 136.975 MHz
Transmitter Wanted Output Test Signals: - Transmitter Power (measured output power): - Normal Test Modulation: - Modulating signal source:	4.46 W AM or 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation External

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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 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
ICES-003	Radiated Emissions from Digital Apparatus – Radiated	Yes
RSS-Gen § 8.8 ICES-003	Power Line Conducted Emissions from Digital Apparatus	Yes
RSS-119 § 5.11 RSS-Gen, Section 7.3	Receiver Spurious Emissions (Radiated)	Yes
RSS-119 § 5.11 RSS-Gen, Section 7.4	Receiver Spurious Emissions (Antenna Conducted)	Yes
Model No.: T6, by Technisonic Industries Limited has also been tested and found to comply with FCC Part 15, Subpart B - Radio Receivers and Digital Devices. The engineering test report has been documented and kept on file and it is available upon request.		

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4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None.

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EXHIBIT 5. TEST DATA**5.1. RF POWER OUTPUT [§§ 2.1046 & 87.131] [RSS-141 § 5.1]****5.1.1. 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

5.1.2. Method of Measurements

TIA-603-E / ANSI C63.26

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5.1.3. Test Data

Supply Voltage (VDC)	Channel Spacing (kHz)	Channel	Frequency MHz	Power Rating		Measured Power	
				W	dBm	dBm	W
28	8.33	7(Dial 118.030)	118.025	4.5	36.53	36.44	4.41
	8.33	8(Dial 127.505)	127.500	4.5	36.53	36.47	4.44
	8.33	9(Dial 136.980)	136.975	4.5	36.53	36.49	4.46
	25	4	118.025	4.5	36.53	36.44	4.41
	25	5	127.500	4.5	36.53	36.47	4.44
	25	6	136.975	4.5	36.53	36.49	4.46
	8.33	7(Dial 118.030)	118.025	1.0	30.00	30.52	1.13
	8.33	8(Dial 127.505)	127.500	1.0	30.00	30.53	1.13
	8.33	9(Dial 136.980)	136.975	1.0	30.00	30.56	1.14
	25	4	118.025	1.0	30.00	30.54	1.13
	25	5	127.500	1.0	30.00	30.55	1.14
	25	6	136.975	1.0	30.00	30.56	1.14

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5.2. MODULATION CHARACTERISTICS – AUDIO FREQUENCY RESPONSE [§§ 2.1047(a) & 87.141(f)]**5.2.1. Limits**

§ 87.141(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.

5.2.2. 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.

5.2.3. Test Data

Remark: 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.

5.2.3.1. 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)	§ 87.141(f) Limit (dB)
0.1	-41.94	-21.68	20.3	-12.9	--
0.2	-41.94	-12.49	29.5	-3.7	--
0.4	-41.94	-13.39	28.6	-4.6	--
0.6	-41.94	-9.35	32.6	-0.6	--
0.8	-41.94	-12.58	29.4	-3.8	--
1.0	-41.94	-8.79	33.2	0.0	--
1.5	-41.94	-7.08	34.9	1.7	--
2.0	-41.94	-14.25	27.7	-5.5	--
2.5	-41.94	-17.01	24.9	-8.2	--
3.0	-41.94	-14.55	27.4	-5.8	0
3.5	-41.94	-18.19	23.8	-9.4	-3
4.0	-41.94	-24.54	17.4	-15.8	-5
4.5	-41.94	-32.34	9.6	-23.6	-7
5.0	-41.94	-42.82	-0.9	-34.0	-9
6.0	-41.94	-65.00	-23.1	-56.2	-12
7.0	-41.94	-70.00	-28.1	-61.2	-15
8.0	-41.94	-70.00	-28.1	-61.2	-17
9.0	-41.94	-70.00	-28.1	-61.2	-19
10.0	-41.94	-70.00	-28.1	-61.2	-21
12.0	-41.94	-70.00	-28.1	-61.2	-24
14.0	-41.94	-70.00	-28.1	-61.2	-27
16.0	-41.94	-70.00	-28.1	-61.2	-28
18.0	-41.94	-70.00	-28.1	-61.2	-28
20.0	-41.94	-70.00	-28.1	-61.2	-28
25.0	-41.94	-70.00	-28.1	-61.2	-28
30.0	-41.94	-70.00	-28.1	-61.2	-28
35.0	-41.94	-70.00	-28.1	-61.2	-28
40.0	-41.94	-70.00	-28.1	-61.2	-28
45.0	-41.94	-70.00	-28.1	-61.2	-28
50.0	-41.94	-70.00	-28.1	-61.2	-28

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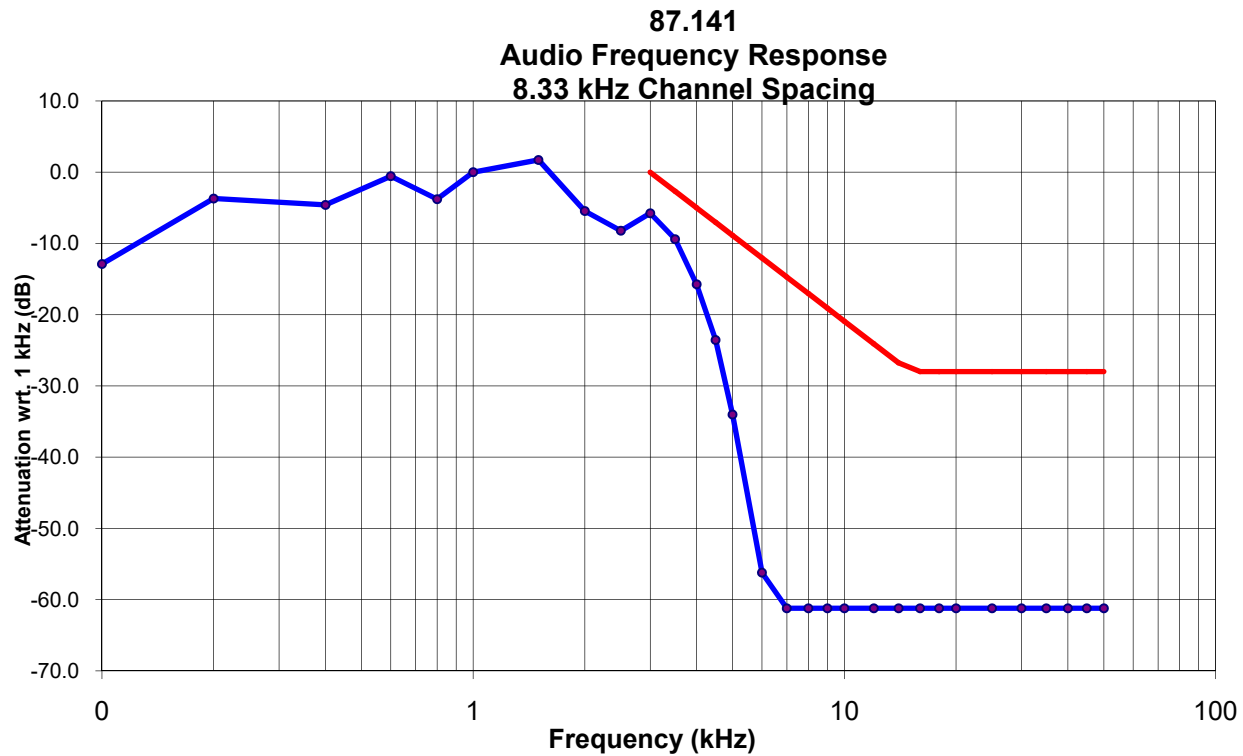
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5.2.3.2. Audio Frequency Response of All Modulation States for 25 kHz Channel Spacing

Frequency (kHz)	Audio IN (dBV)	Audio OUT (dBV)	Attenuation (OUT - IN) (dB)	Attenuation wrt. 1 kHz (dB)	§ 87.141(f) Limit (dB)
0.1	-41.94	-22.93	19.0	-14.1	--
0.2	-41.94	-12.46	29.5	-3.7	--
0.4	-41.94	-13.24	28.7	-4.5	--
0.6	-41.94	-9.35	32.6	-0.6	--
0.8	-41.94	-12.48	29.5	-3.7	--
1.0	-41.94	-8.79	33.2	0.0	--
1.5	-41.94	-7.02	34.9	1.8	--
2.0	-41.94	-14.20	27.7	-5.4	--
2.5	-41.94	-16.89	25.1	-8.1	--
3.0	-41.94	-14.23	27.7	-5.4	0
3.5	-41.94	-18.21	23.7	-9.4	-3
4.0	-41.94	-24.72	17.2	-15.9	-5
4.5	-41.94	-32.82	9.1	-24.0	-7
5.0	-41.94	-43.47	-1.5	-34.7	-9
6.0	-41.94	-65.00	-23.1	-56.2	-12
7.0	-41.94	-70.00	-28.1	-61.2	-15
8.0	-41.94	-70.00	-28.1	-61.2	-17
9.0	-41.94	-70.00	-28.1	-61.2	-19
10.0	-41.94	-70.00	-28.1	-61.2	-21
12.0	-41.94	-70.00	-28.1	-61.2	-24
14.0	-41.94	-70.00	-28.1	-61.2	-27
16.0	-41.94	-70.00	-28.1	-61.2	-28
18.0	-41.94	-70.00	-28.1	-61.2	-28
20.0	-41.94	-70.00	-28.1	-61.2	-28
25.0	-41.94	-70.00	-28.1	-61.2	-28
30.0	-41.94	-70.00	-28.1	-61.2	-28
35.0	-41.94	-70.00	-28.1	-61.2	-28
40.0	-41.94	-70.00	-28.1	-61.2	-28
45.0	-41.94	-70.00	-28.1	-61.2	-28
50.0	-41.94	-70.00	-28.1	-61.2	-28

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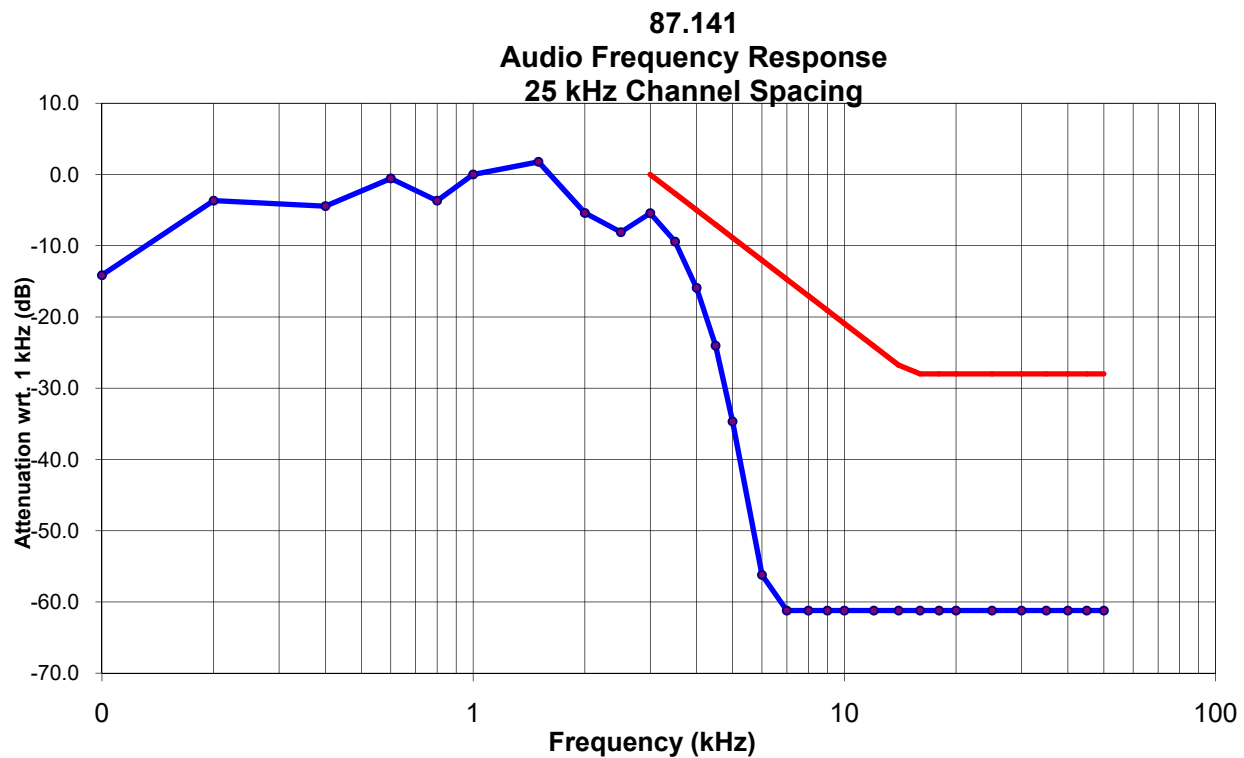
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5.3. MODULATION CHARACTERISTICS – MODULATION LIMITING [§§ 2.1047(a) & 87.141(a) & (c)] [RSS-141 § 5.1]

5.3.1. 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.

(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%

5.3.2. 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.

5.3.3. Test Data

5.3.3.1. Modulation Limiting at 8.33 kHz Channel Spacing

Modulating Signal Level (mVrms)	Peak Modulation depth %					Maximum Limit %
	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	
5	7.86	20.45	31.60	17.81	1.42	100
10	15.22	39.22	62.00	41.90	2.03	100
15	22.37	58.30	80.80	42.60	2.59	100
20	30.03	78.40	81.90	44.40	3.18	100
25	37.50	80.80	78.40	43.70	3.90	100
30	44.80	80.50	79.80	44.20	4.35	100
35	51.80	79.20	80.40	43.90	4.42	100
40	59.60	80.90	79.10	43.20	4.50	100
45	66.00	80.10	81.60	43.30	4.46	100
50	65.40	80.60	81.30	44.10	4.26	100
55	66.50	80.60	80.80	43.70	4.35	100
60	66.30	79.70	81.20	42.80	4.25	100
65	66.40	80.60	81.20	44.20	4.24	100
70	66.50	80.40	82.00	43.80	4.26	100
75	66.30	80.90	82.00	43.10	4.18	100
80	65.70	80.00	80.90	43.50	4.24	100
85	66.40	80.80	82.20	44.20	4.21	100
90	65.50	79.80	82.20	43.40	4.22	100
100	66.40	80.80	82.20	42.30	4.08	100

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Remarks

Standard Modulation Level: 8.00 mV

Voice Signal Input Level: Standard Modulation Level + 16 dB = 34.06 dB (mVrms)= 50.48mVrms

Modulation Frequency (kHz)	Peak Depth (%)	Maximum Limit (%)
0.1	64.20	100.0
0.2	75.70	100.0
0.4	80.00	100.0
0.6	78.70	100.0
0.8	74.50	100.0
1.0	79.70	100.0
1.2	75.20	100.0
1.4	79.80	100.0
1.6	72.60	100.0
1.8	74.00	100.0
2.0	63.60	100.0
2.5	51.30	100.0
3.0	43.50	100.0
3.5	31.65	100.0
4.0	19.91	100.0
4.5	8.86	100.0
5.0	4.23	100.0
6.0	1.33	100.0
7.0	0.89	100.0
8.0	0.87	100.0
9.0	0.92	100.0
10.0	0.87	100.0

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5.3.3.2. Modulation Limiting at 25 kHz Channel Spacing

Modulating Signal Level (mVrms)	Peak Modulation depth %					Maximum Limit %
	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	
5	8.03	20.63	30.98	18.68	1.36	100
10	15.42	39.90	60.80	35.89	1.89	100
15	22.58	59.90	80.10	44.50	2.46	100
20	30.96	80.30	80.80	43.60	2.88	100
25	38.31	81.70	77.80	43.50	3.44	100
30	46.20	81.50	79.50	43.80	3.96	100
35	53.60	77.30	79.90	43.50	4.33	100
40	60.90	81.60	79.00	44.20	4.22	100
45	67.70	80.50	81.50	44.20	4.22	100
50	66.30	80.90	81.10	43.90	4.23	100
55	67.20	81.20	82.00	44.60	4.08	100
60	67.50	80.40	82.20	44.80	4.03	100
65	67.30	80.90	82.30	44.60	4.01	100
70	66.50	80.90	82.00	44.30	4.04	100
75	67.10	81.60	80.30	44.30	4.04	100
80	66.70	80.90	80.90	44.70	4.07	100
85	66.80	81.40	78.90	44.00	4.06	100
90	67.40	81.60	81.90	44.70	4.06	100
100	66.40	80.10	82.40	44.70	4.04	100

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Remarks

Standard Modulation Level: 8.00 mV

Voice Signal Input Level: Standard Modulation Level + 16 dB = 34.06 dB (mVrms) + 16 = 50.48 (mVrms)

Modulation Frequency (kHz)	Peak Depth (%)	Maximum Limit (%)
0.1	64.40	100.0
0.2	76.80	100.0
0.4	80.10	100.0
0.6	80.50	100.0
0.8	74.80	100.0
1.0	82.00	100.0
1.2	75.50	100.0
1.4	80.20	100.0
1.6	72.10	100.0
1.8	74.00	100.0
2.0	63.80	100.0
2.5	51.40	100.0
3.0	43.70	100.0
3.5	31.82	100.0
4.0	19.54	100.0
4.5	8.63	100.0
5.0	4.04	100.0
6.0	1.20	100.0
7.0	0.84	100.0
8.0	0.83	100.0
9.0	0.89	100.0
10.0	0.82	100.0

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5.4. OCCUPIED BANDWIDTH AND EMISSION LIMITATIONS [§§ 2.1049, 87.135, 87.137 & 87.139] [RSS-141 §§ 5.1 & 5.2.2]

5.4.1. Limits

§ 87.135 Bandwidth of emission

- (a) Occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 percent of the total mean power of a given emission.
- (b) The authorized bandwidth is the maximum occupied bandwidth authorized to be used by a station.
- (c) The necessary bandwidth for a given class of emission is the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

§87.137 Types of emission

- (a) The assignable emissions, corresponding emission designators and authorized bandwidths are as follows:

Class of emission	Emission designator	Authorized bandwidth (kilohertz)		
		Below 50 MHz	Above 50 MHz	Frequency deviation
A3E ¹	6K00A3E		50 ²	
A3E	5K60A3E		8.33 kHz ³	

¹For use with an authorized bandwidth of 8.0 kilohertz at radiobeacon stations. A3E will not be authorized:

- (i) At existing radiobeacon stations that are not authorized to use A3 and at new radiobeacon stations unless specifically recommended by the FAA for safety purposes.
- (ii) At existing radiobeacon stations currently authorized to use A3, subsequent to January 1, 1990, unless specifically recommended by the FAA for safety purposes.

²In the band 117.975-136 MHz, the authorized bandwidth is 25 kHz for transmitters approved after January 1, 1974.

³In the band 117.975-137 MHz, the Commission will not authorize any 8.33 kHz channel spaced transmissions or the use of their associated emission designator within the U.S. National Airspace System, except, on an optional basis, by Aeronautical Enroute Stations and Flight Test Stations, or by avionics equipment manufacturers which are required to perform installation and checkout of such radio systems prior to delivery to their customers. For transmitters certificated to tune to 8.33 kHz channel spacing as well as 25 kHz channel spacing, the authorized bandwidth is 8.33 kHz when tuned to an 8.33 kHz channel.

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§87.139 Emission limitations

- (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 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions 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.
 - (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 $43 + 10 \log_{10} pY$ dB.

[RSS-141 §§ 5.1 & 5.2.2]

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 $43 + 10 \log_{10} P$ (in watts) dB, measured with a bandwidth of 3 kHz.

5.4.2. Method of Measurements

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

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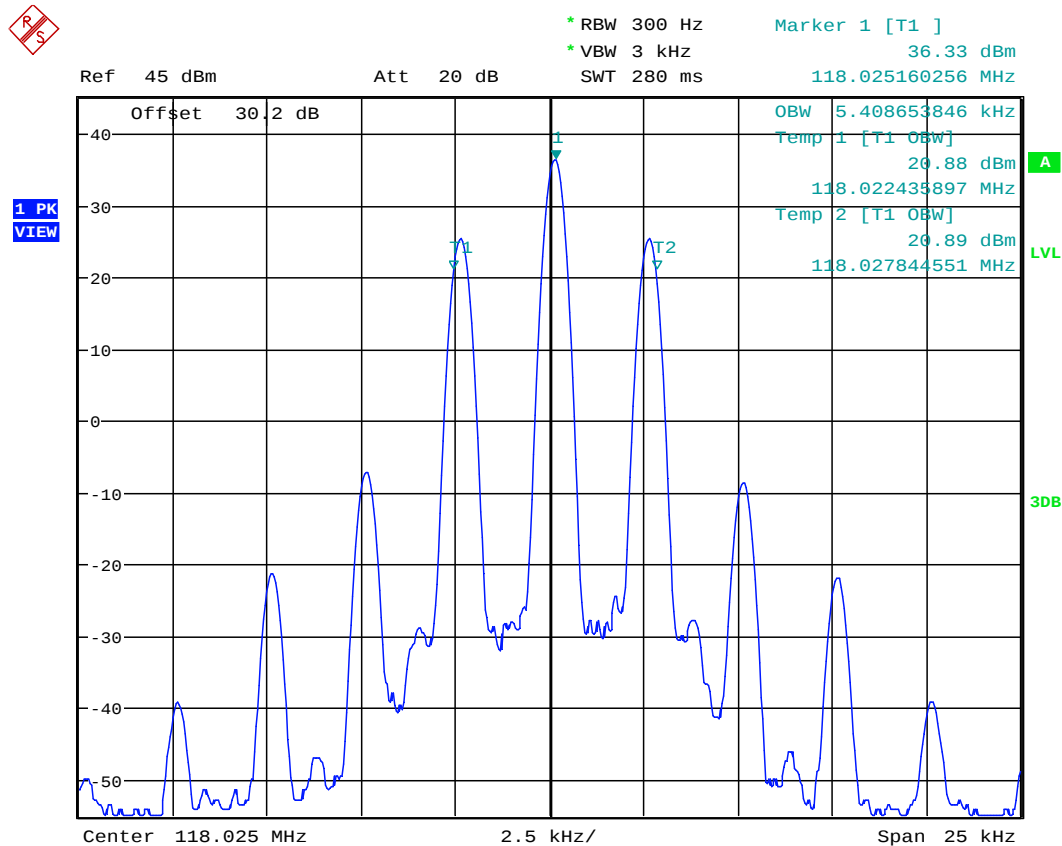
5.4.3. Test Data**5.4.3.1. 99% Occupied Bandwidth**

Channel Spacing (kHz)	Frequency (MHz)	*Measured 99% Occupied Bandwidth (kHz)	Authorized Bandwidth (kHz)
8.33	118.025	5.41	8.33
	127.500	5.41	8.33
	136.975	5.41	8.33
25	118.025	5.41	25
	127.500	5.41	25
	136.975	5.41	25

* See the following plots for details of measurements

5.4.3.2. Configuration: 99% OBW, 118.025MHz, 25 KHz, Analog, High power

OBW: 5.408 KHz



Date: 24.AUG.2022 15:20:51

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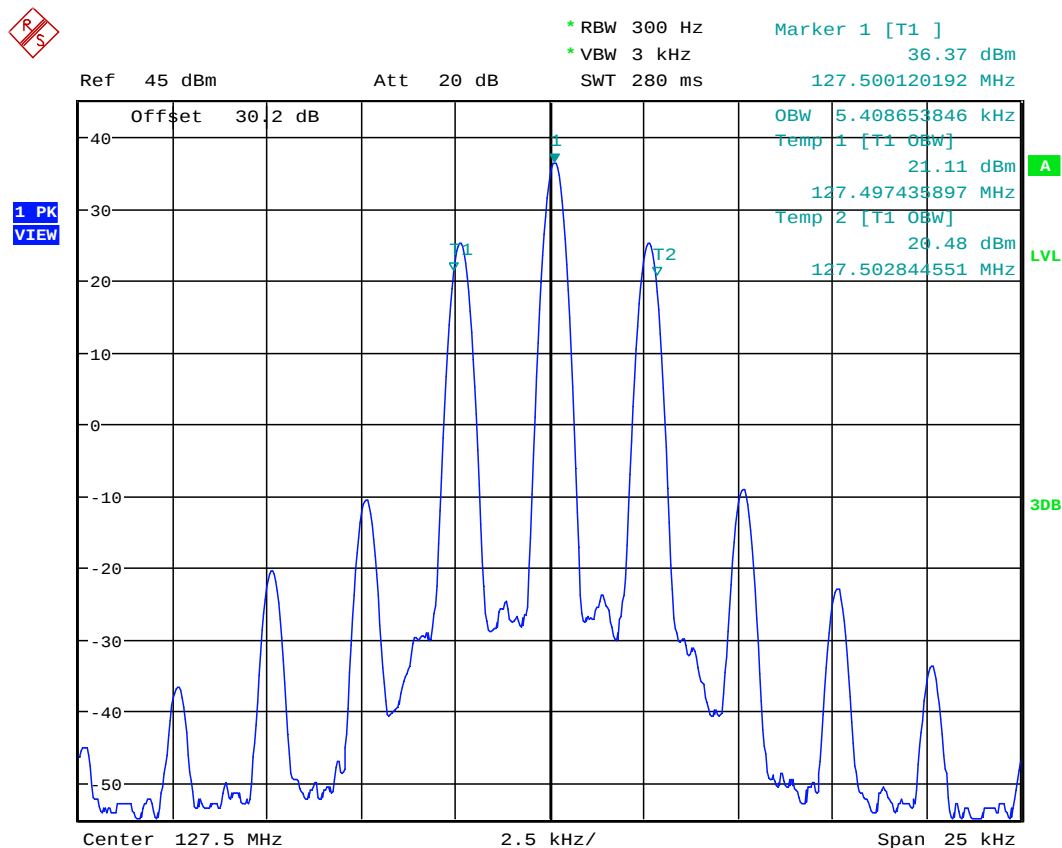
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5.4.3.3. Configuration: 99% OBW, 127.5MHz, 25 KHz, Analog, High power

OBW: 5.408 KHz



Date: 24.AUG.2022 15:21:49

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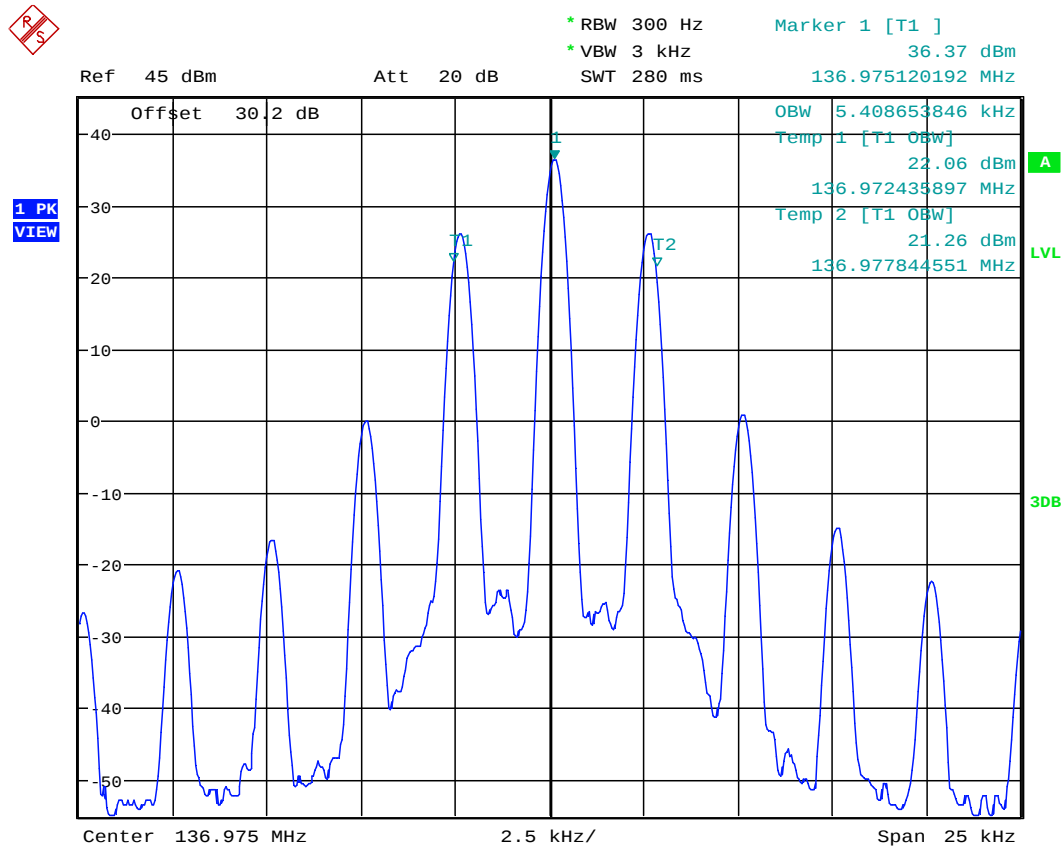
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5.4.3.4. Configuration: 99% OBW, 136.975MHz, 25 KHz, Analog, High power

OBW: 5.408 KHz



Date: 24.AUG.2022 15:22:46

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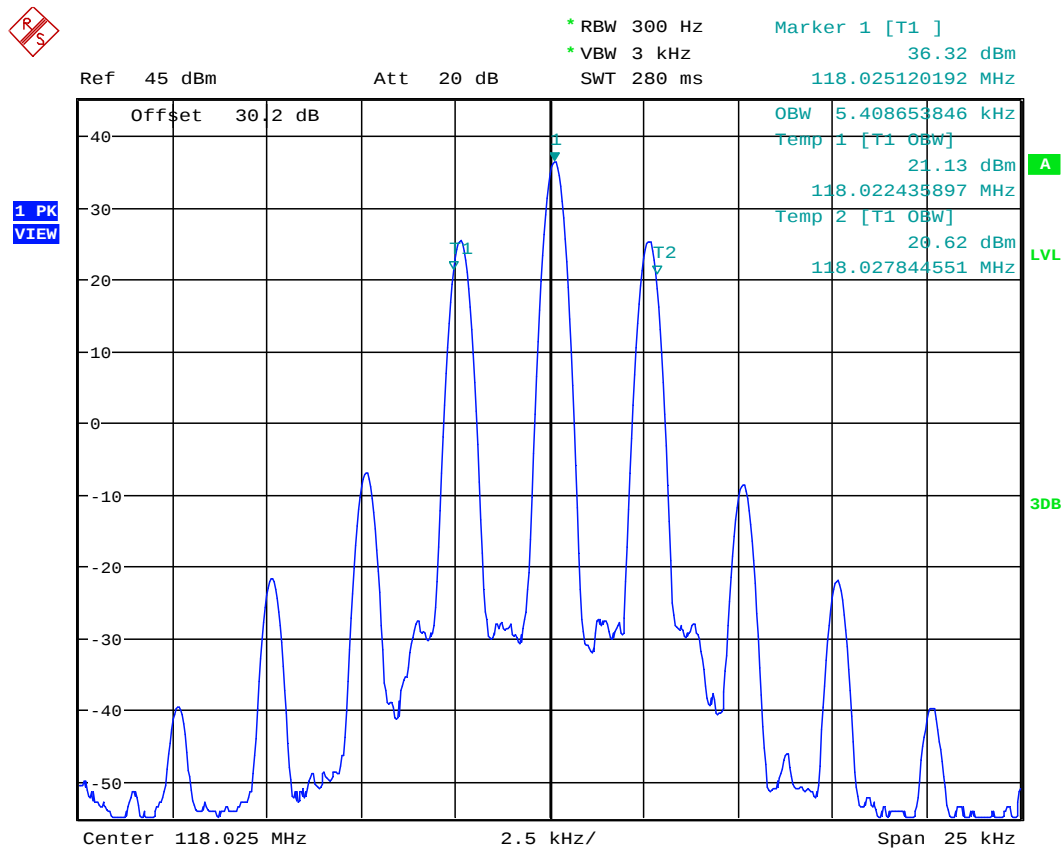
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5.4.3.5. Configuration: 99% OBW, 118.025MHz, 8.33 KHz, Analog, High power

OBW: 5.408 KHz



Date: 24.AUG.2022 15:23:56

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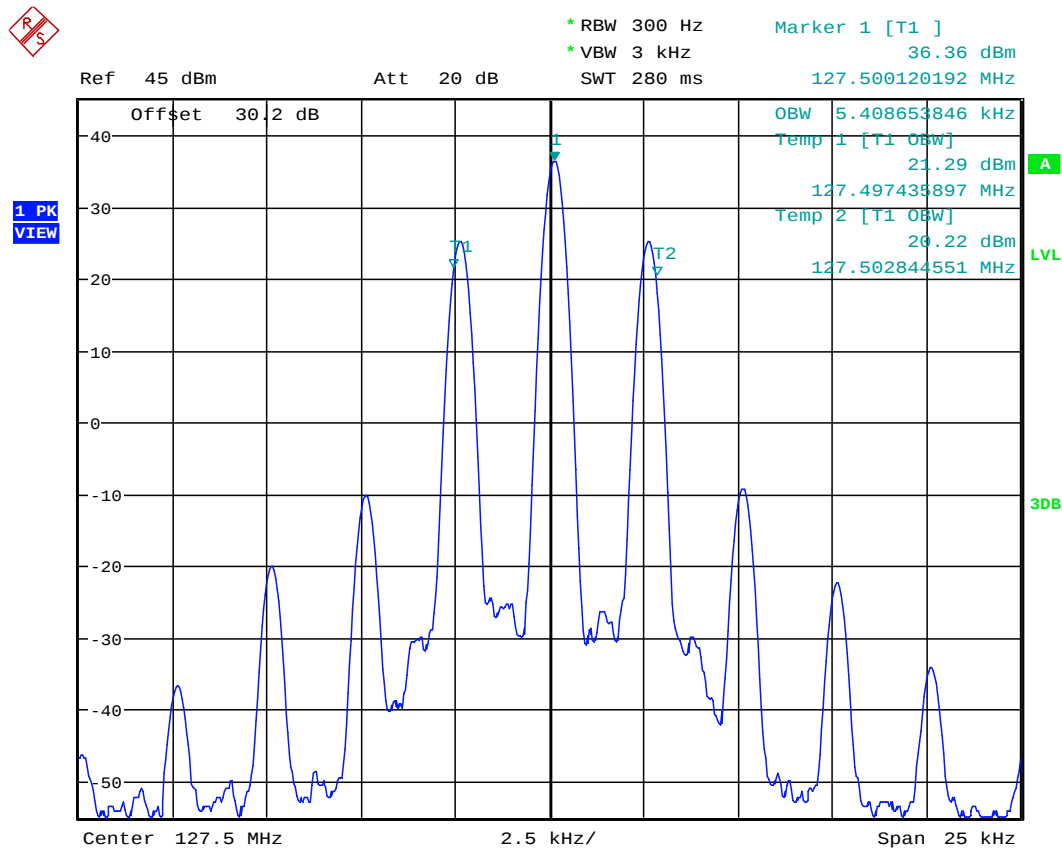
File #: 22TIL129_FCC87

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5.4.3.6. Configuration: 99% OBW, 127.5MHz, 8.33 KHz, Analog, High power

OBW: 5.408 KHz



Date: 24.AUG.2022 15:25:46

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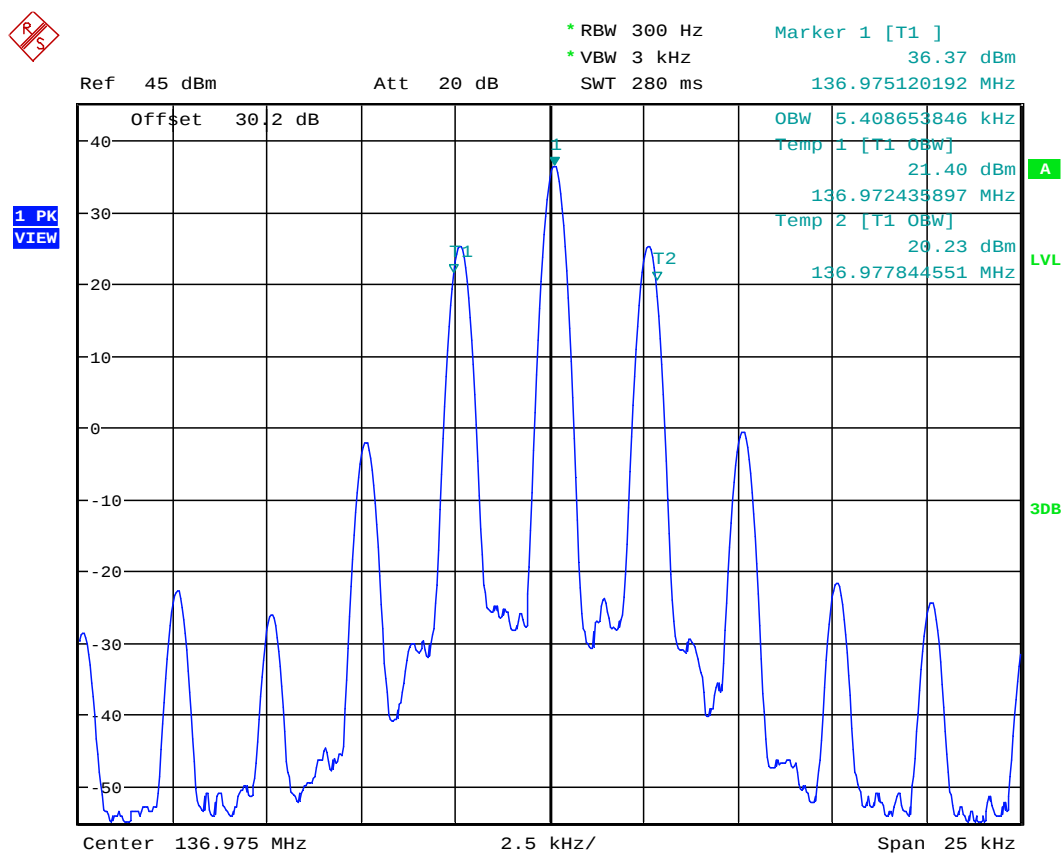
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5.4.3.7. Configuration: 99% OBW, 136.975MHz, 8.33 KHz, Analog, High power

OBW: 5.408 KHz



Date: 24.AUG.2022 15:26:46

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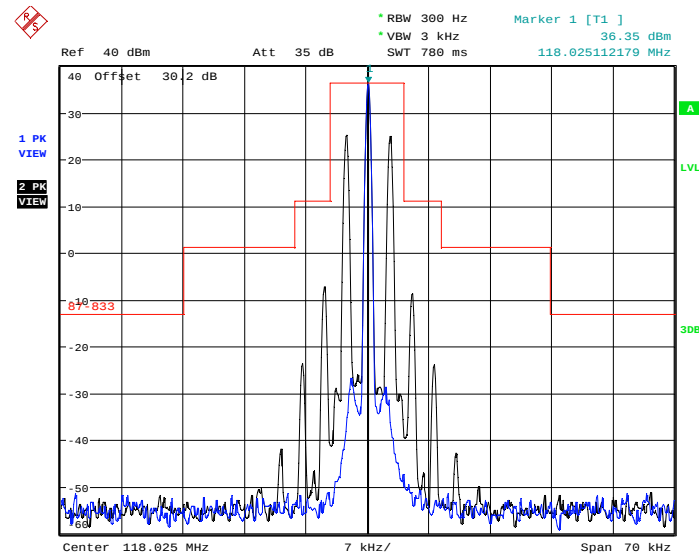
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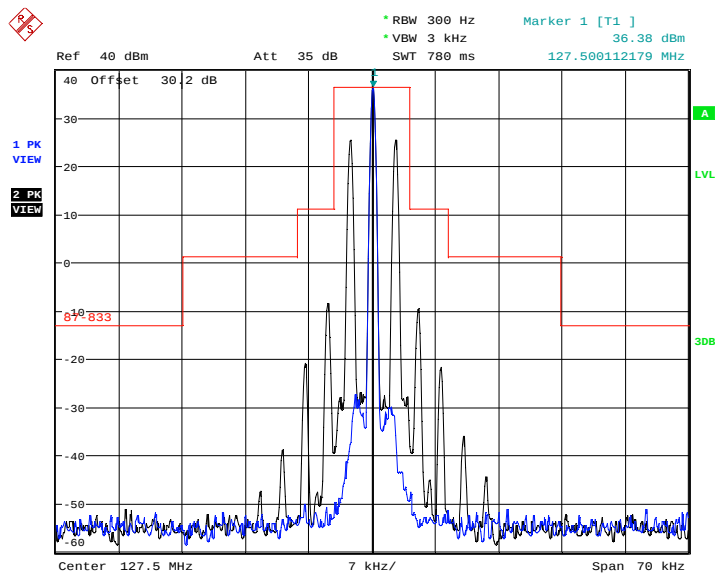
5.4.3.8. Emission Limitations

5.4.3.9. Configuration: Emission Limitation, 118.025MHz, 8.33 KHz, Analog, High power



Date: 24.AUG.2022 16:23:55

5.4.3.10. Configuration: Emission Limitation, 127.5MHz, 8.33 KHz, Analog, High power



Date: 24.AUG.2022 16:25:30

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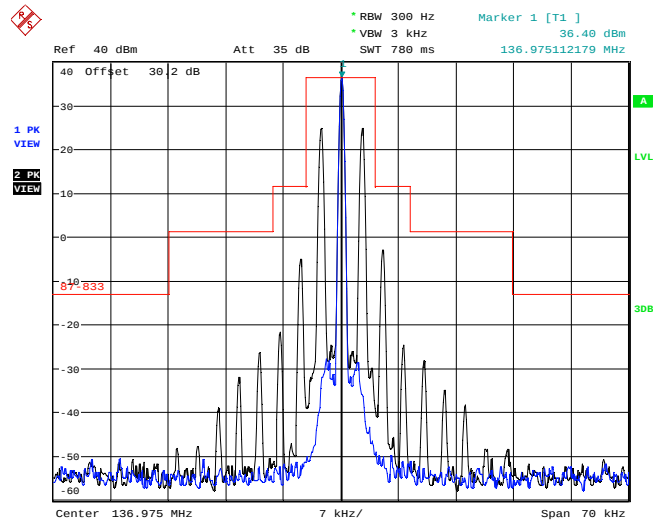
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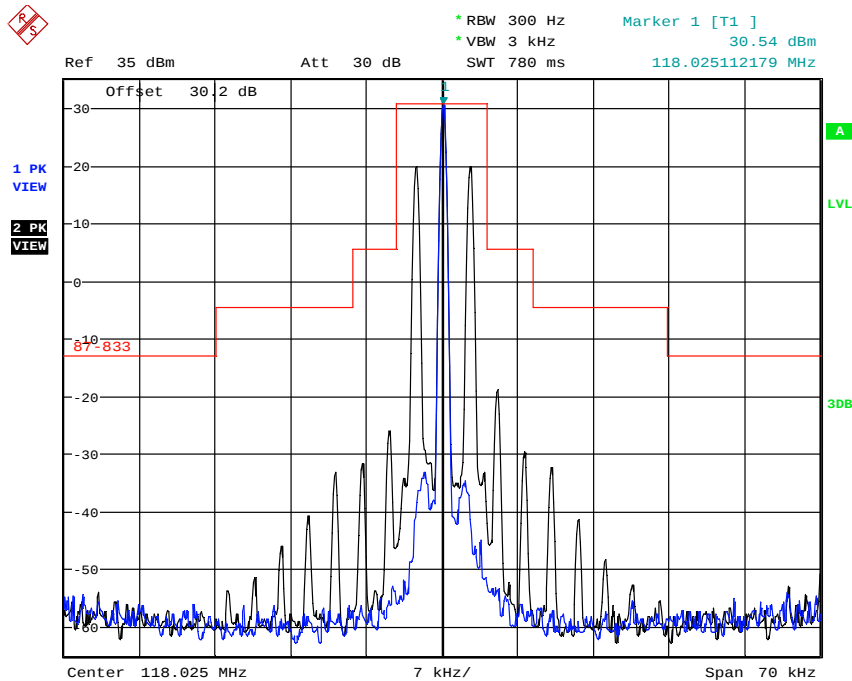
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5.4.3.11. Configuration: Emission Limitation, 136.975MHz, 8.33 KHz, Analog, High power



Date: 24.AUG.2022 16:27:00

5.4.3.12. Configuration: Emission Limitation, 118.025MHz, 8.33 KHz, Analog, Low power



Date: 25.AUG.2022 09:09:25

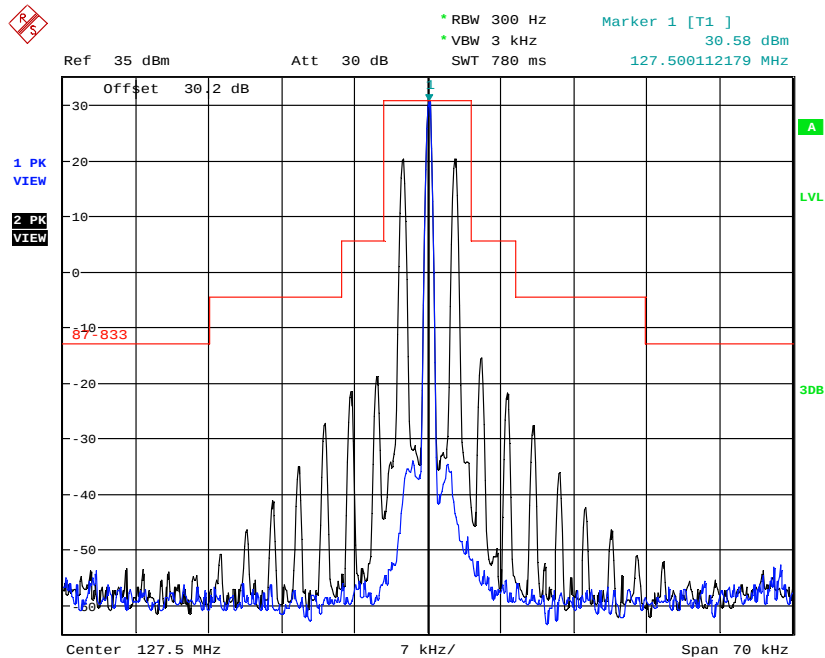
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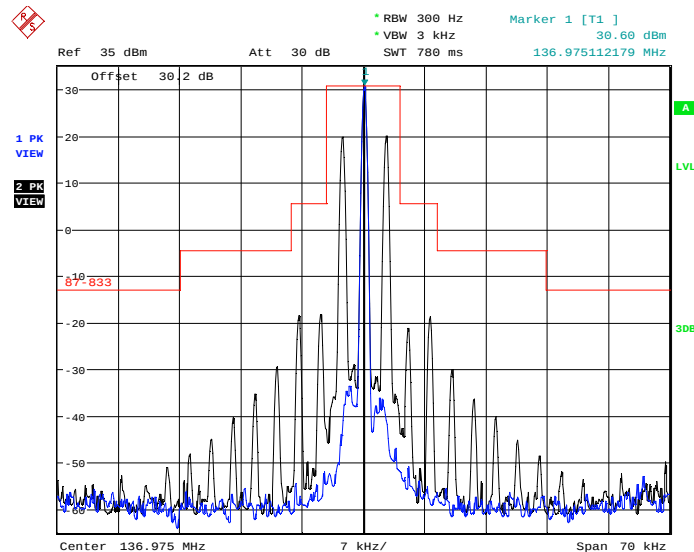
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5.4.3.13. Configuration: Emission Limitation, 127.5MHz, 8.33 KHz, Analog, Low power



Date: 25.AUG.2022 09:11:28

5.4.3.14. Configuration: Emission Limitation, 136.975MHz, 8.33 KHz, Analog, Low power



Date: 25.AUG.2022 09:13:06

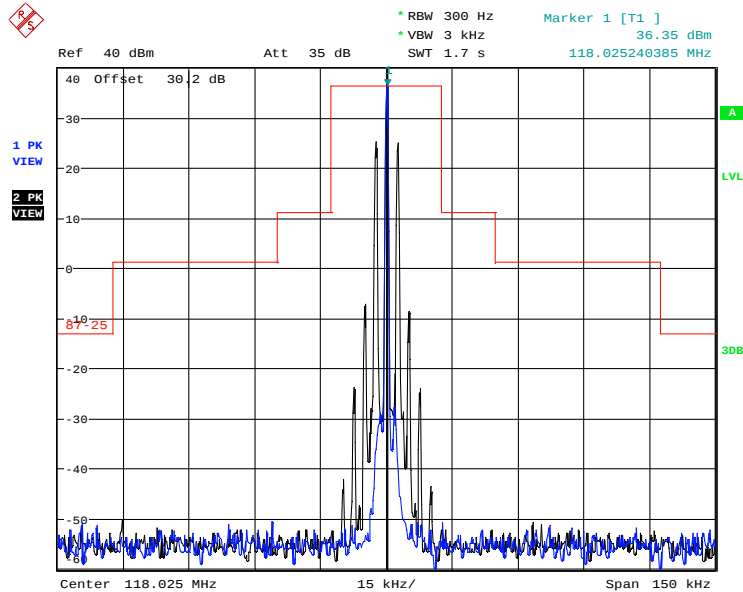
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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87
October 7, 2022

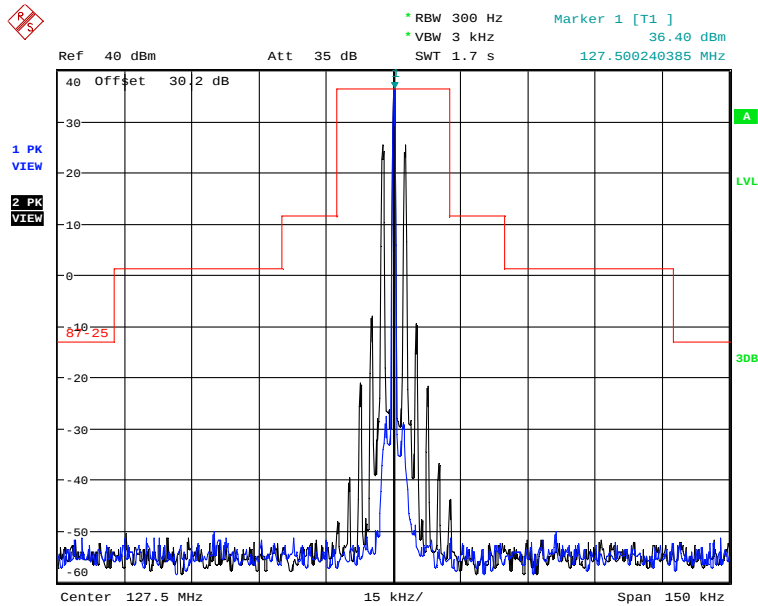
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.4.3.15. Configuration: Emission Limitation, 118.025MHz, 25 KHz, Analog, High power



Date: 24.AUG.2022 15:48:46

5.4.3.16. Configuration: Emission Limitation, 127.5MHz, 25 KHz, Analog, High power



Date: 24.AUG.2022 15:50:46

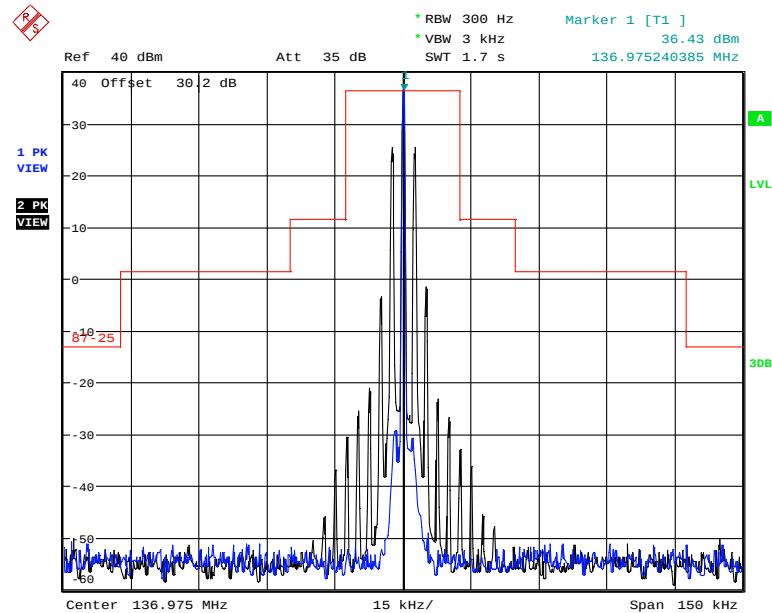
ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87
October 7, 2022

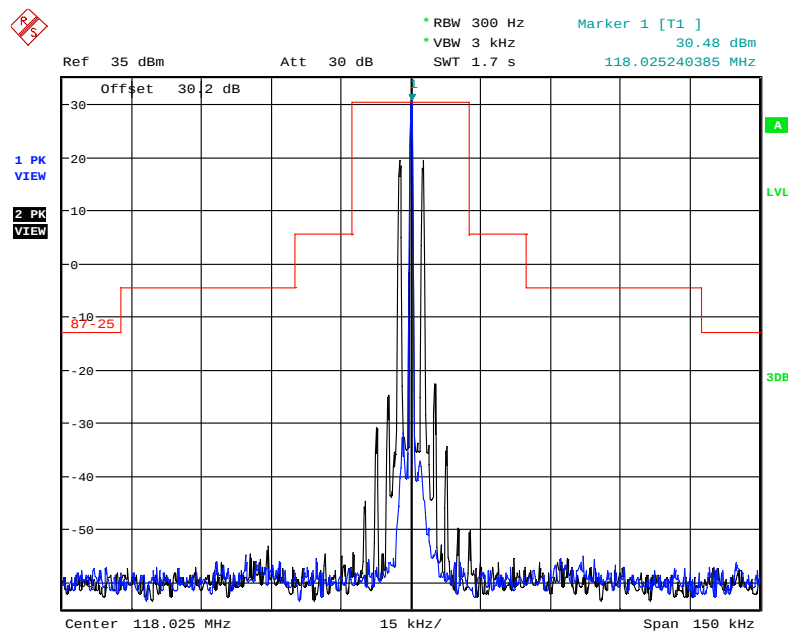
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.4.3.17. Configuration: Emission Limitation, 136.975MHz, 25 KHz, Analog, High power



Date: 24.AUG.2022 15:52:48

5.4.3.18. Configuration: Emission Limitation, 118.025MHz, 25 KHz, Analog, Low power



Date: 24.AUG.2022 16:05:44

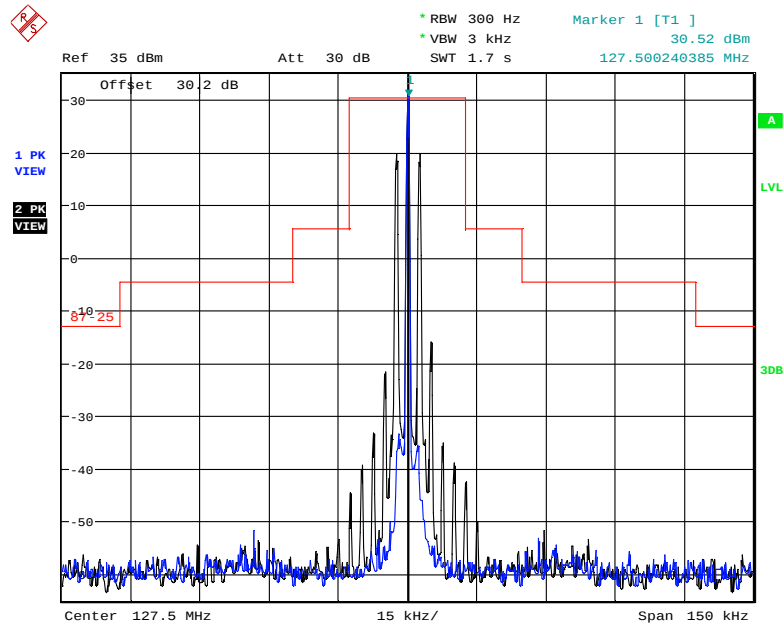
ULTRATECH GROUP OF LABS

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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87
October 7, 2022

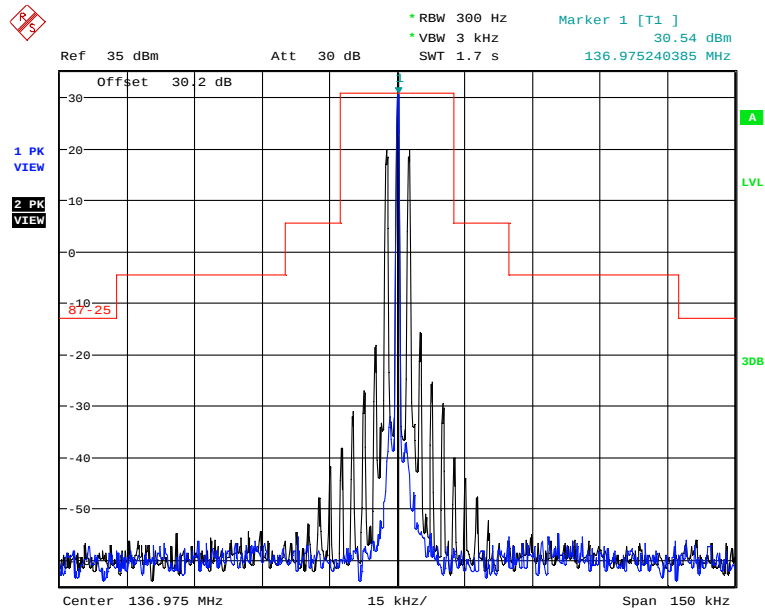
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.4.3.19. Configuration: Emission Limitation, 127.5MHz, 25 KHz, Analog, Low power



Date: 24.AUG.2022 16:09:16

5.4.3.20. Configuration: Emission Limitation, 136.975MHz, 25 KHz, Analog, Low power



Date: 24.AUG.2022 16:10:58

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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87
October 7, 2022

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5.5. TRANSMITTER SPURIOUS EMISSIONS AT ANTENNA TERMINALS [§§ 2.1053 & 87.139] [RSS-141 § 5.2]

5.5.1. 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 $43 + 10 \log_{10} P$ dB.

RSS-141 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 $43 + 10 \log_{10} P$ (in watts) dB, measured with a bandwidth of 3 kHz.

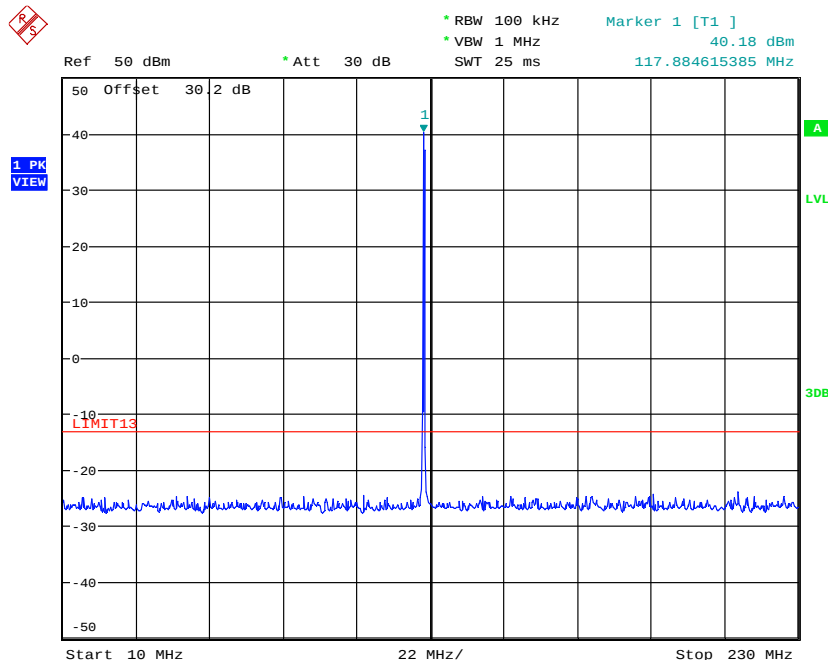
5.5.2. Method of Measurements

TIA-603-E / ANSI C63.26

5.5.3. Test Data

High Power

5.5.3.1. Configuration: Tx Conducted, 118.025MHz, 25 KHz, High power



Date: 25.AUG.2022 09:32:03

ULTRATECH GROUP OF LABS

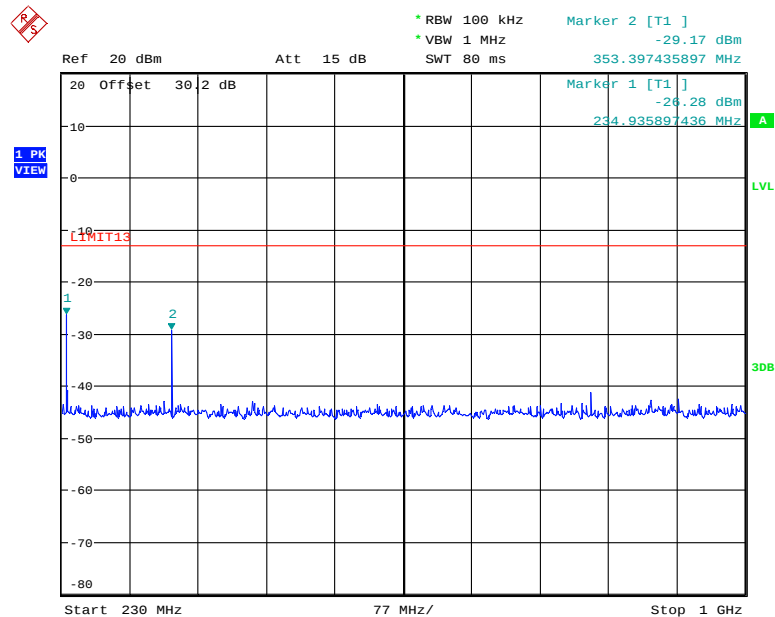
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

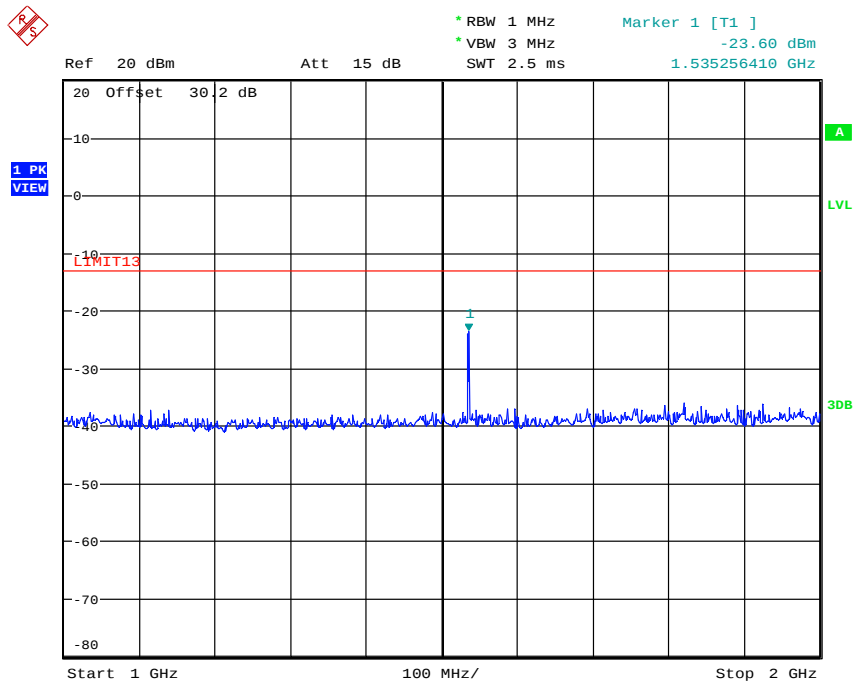
File #: 22TIL129_FCC87

October 7, 2022

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



Date: 25.AUG.2022 09:41:14



Date: 25.AUG.2022 09:48:13

ULTRATECH GROUP OF LABS

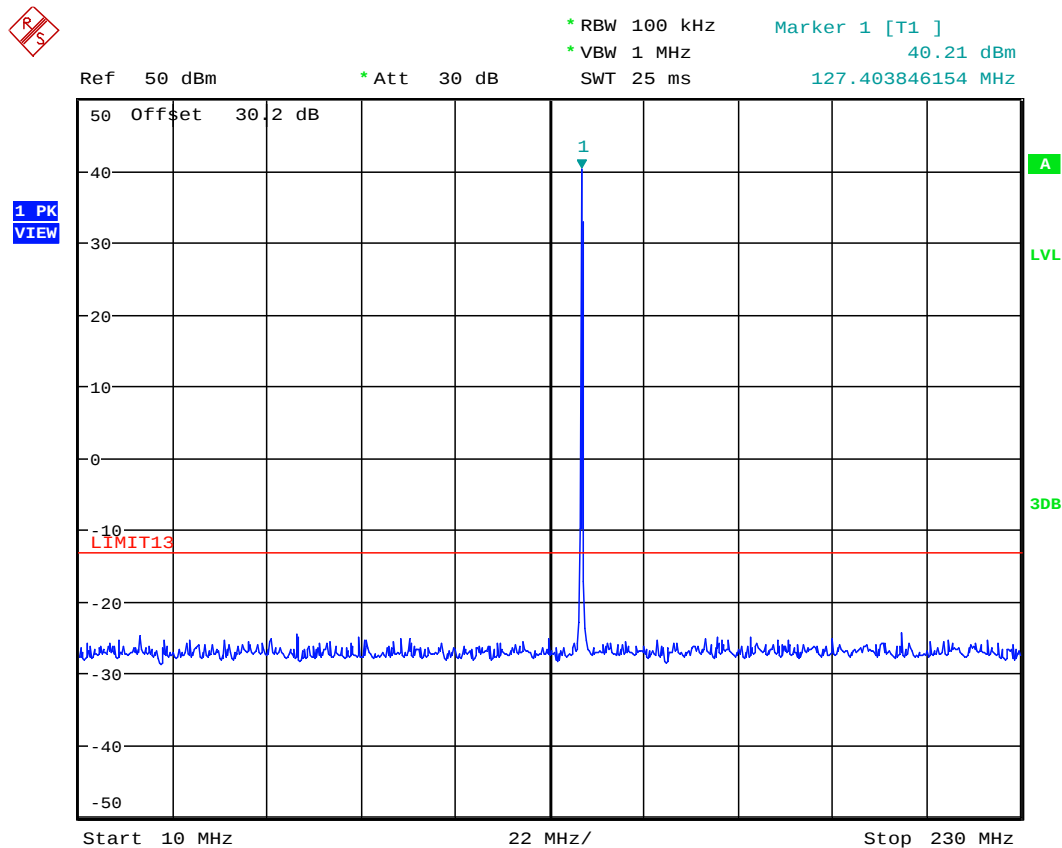
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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5.5.3.2. Configuration: Tx Conducted, 127.5MHz, 25 KHz, High power

Date: 25.AUG.2022 09:34:43

ULTRATECH GROUP OF LABS

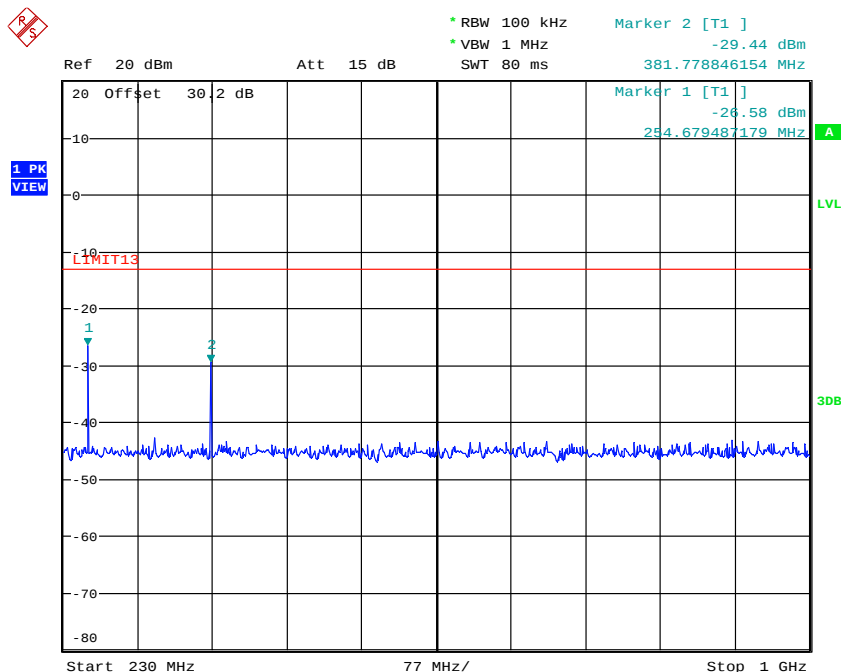
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

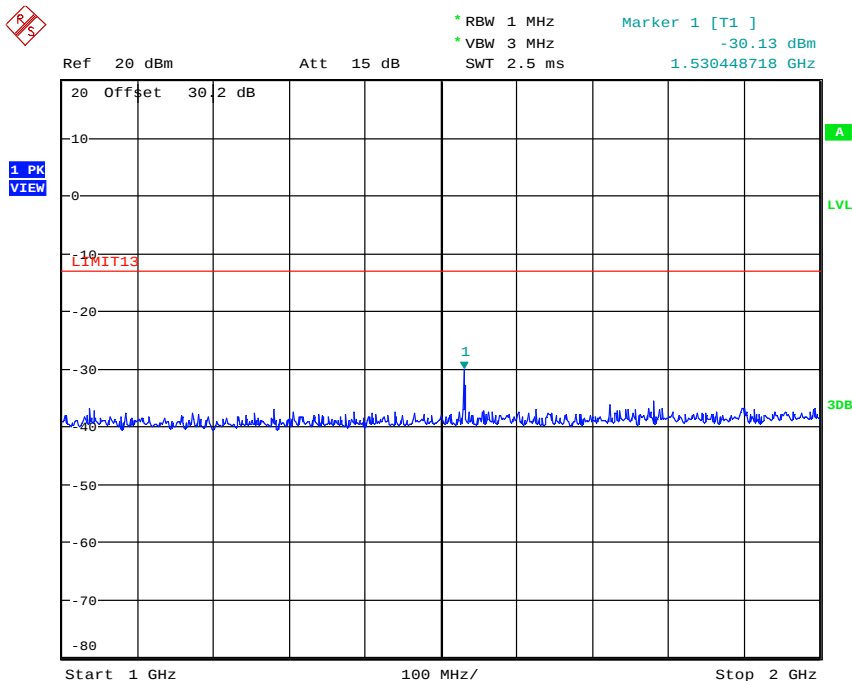
File #: 22TIL129_FCC87

October 7, 2022

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



Date: 25.AUG.2022 09:42:07



Date: 25.AUG.2022 09:49:43

ULTRATECH GROUP OF LABS

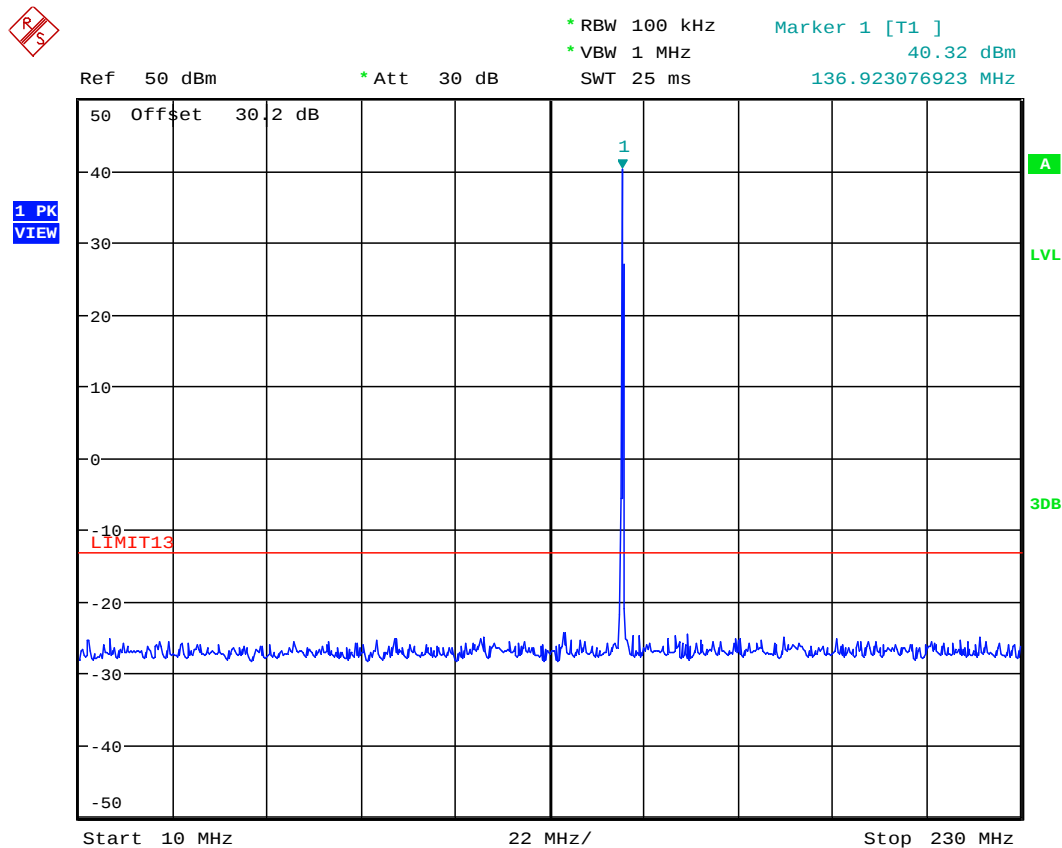
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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

5.5.3.3. Configuration: Tx Conducted, 136.975MHz, 25 KHz, High power

Date: 25.AUG.2022 09:35:19

ULTRATECH GROUP OF LABS

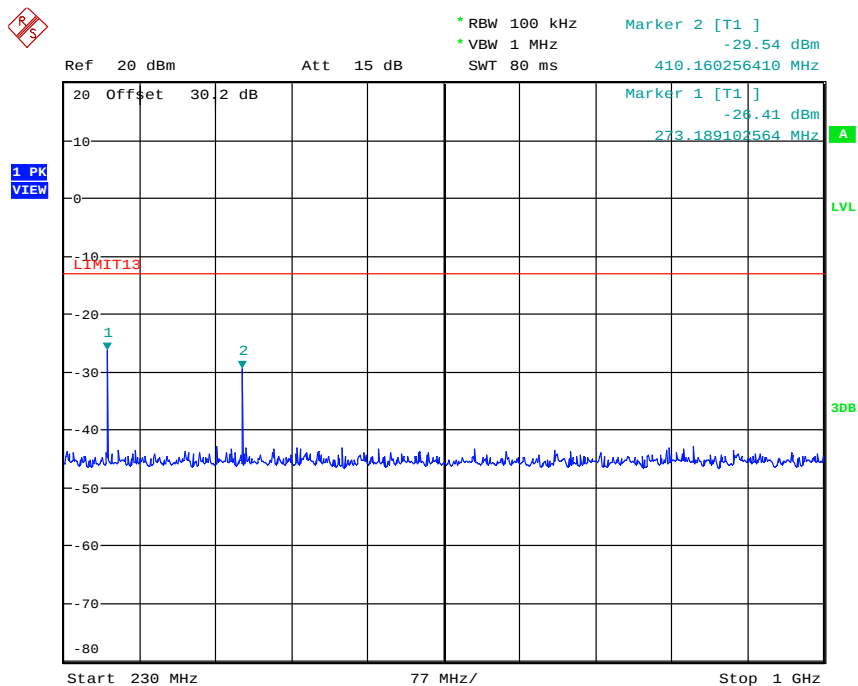
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

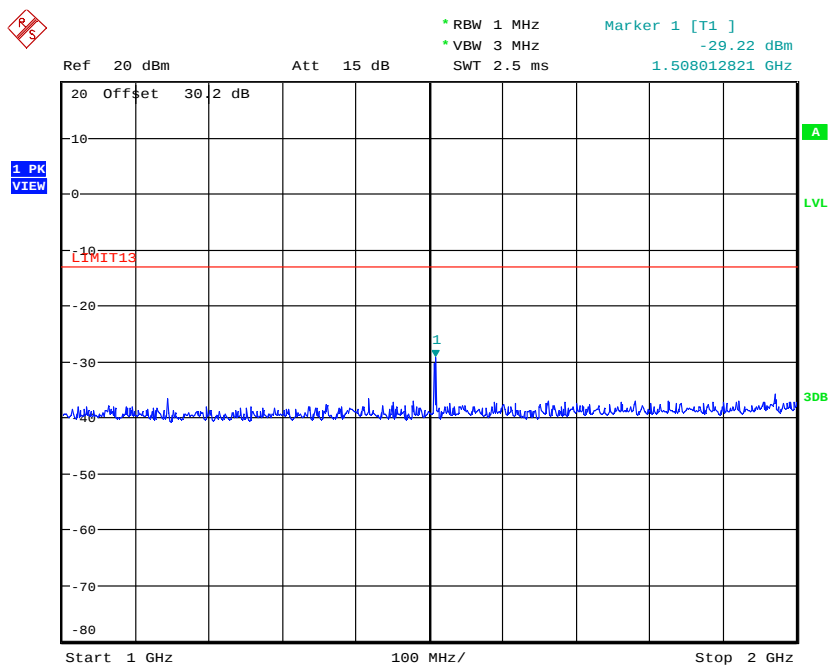
File #: 22TIL129_FCC87

October 7, 2022

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



Date: 25.AUG.2022 09:43:39



Date: 25.AUG.2022 09:50:32

ULTRATECH GROUP OF LABS

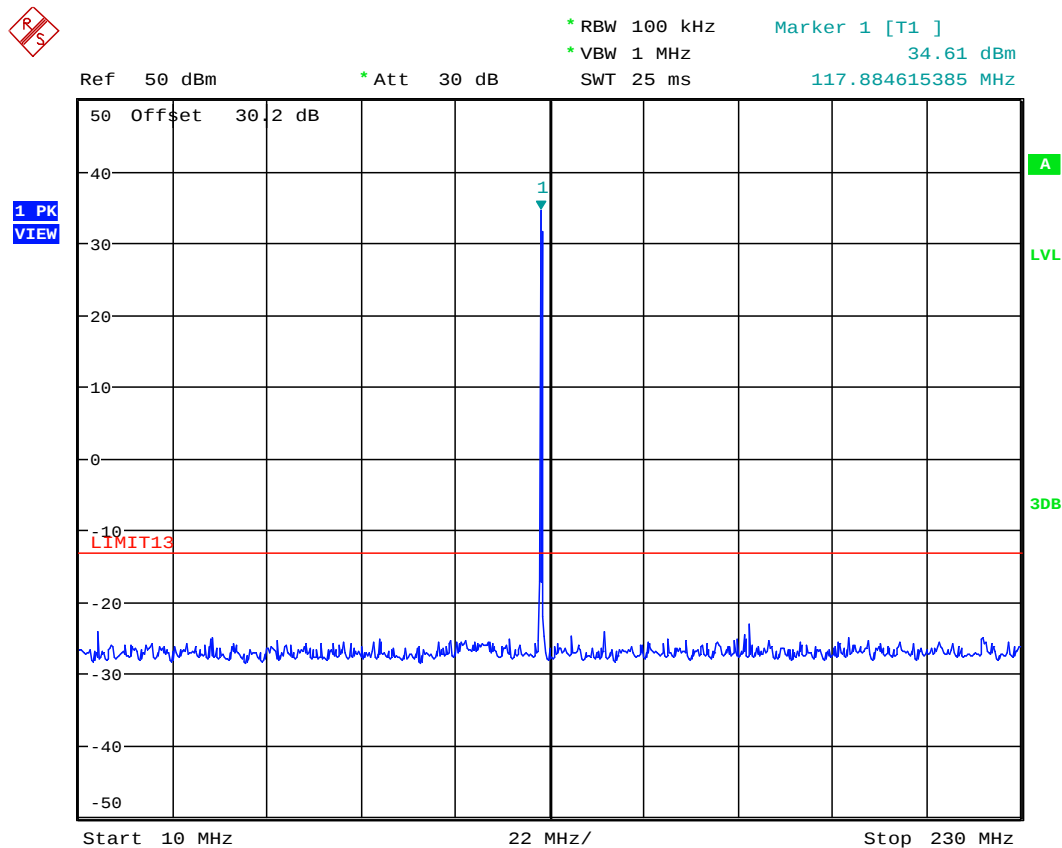
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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

Low Power**5.5.3.4. Configuration: Tx Conducted, 118.025MHz, 25 KHz, Low power**

Date: 25.AUG.2022 09:36:01

ULTRATECH GROUP OF LABS

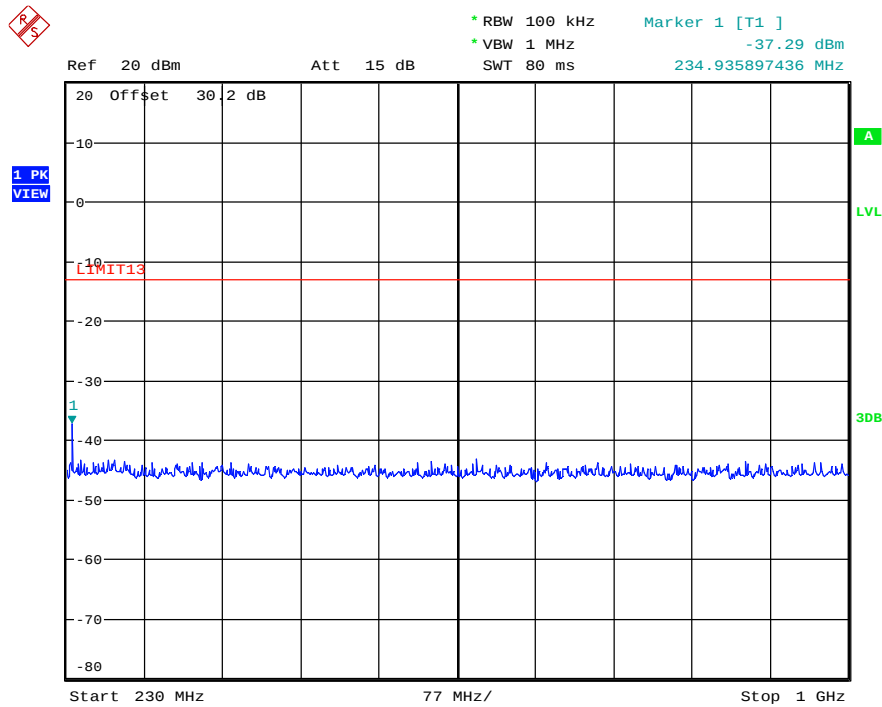
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

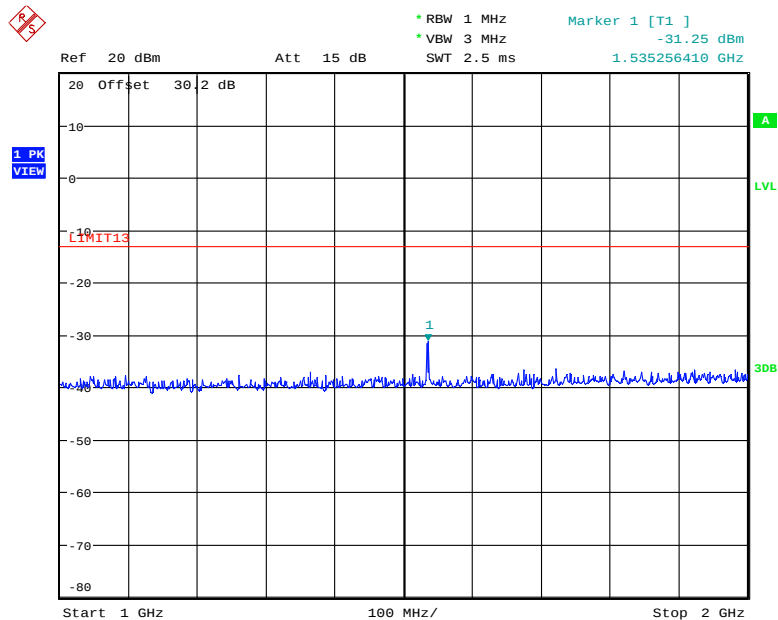
File #: 22TIL129_FCC87

October 7, 2022

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



Date: 25.AUG.2022 09:44:36



Date: 25.AUG.2022 09:51:23

ULTRATECH GROUP OF LABS

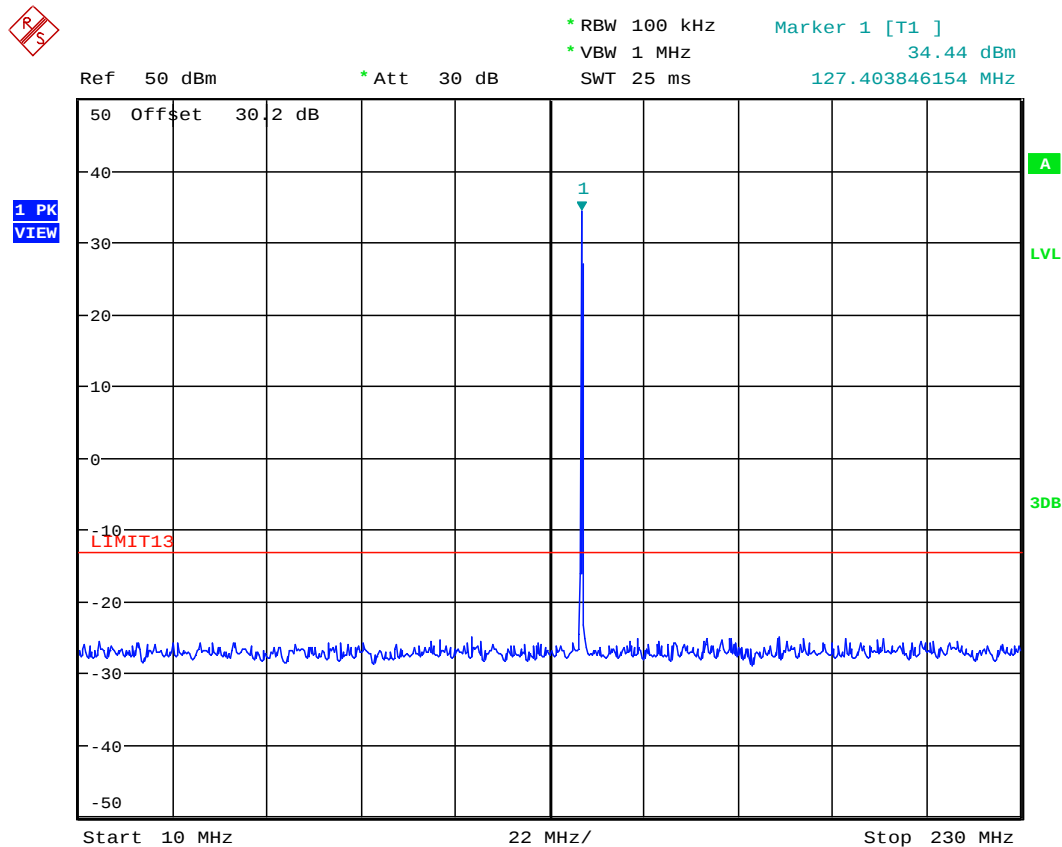
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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

5.5.3.5. Configuration: Tx Conducted, 127.5MHz, 25 KHz, Low power

Date: 25.AUG.2022 09:36:33

ULTRATECH GROUP OF LABS

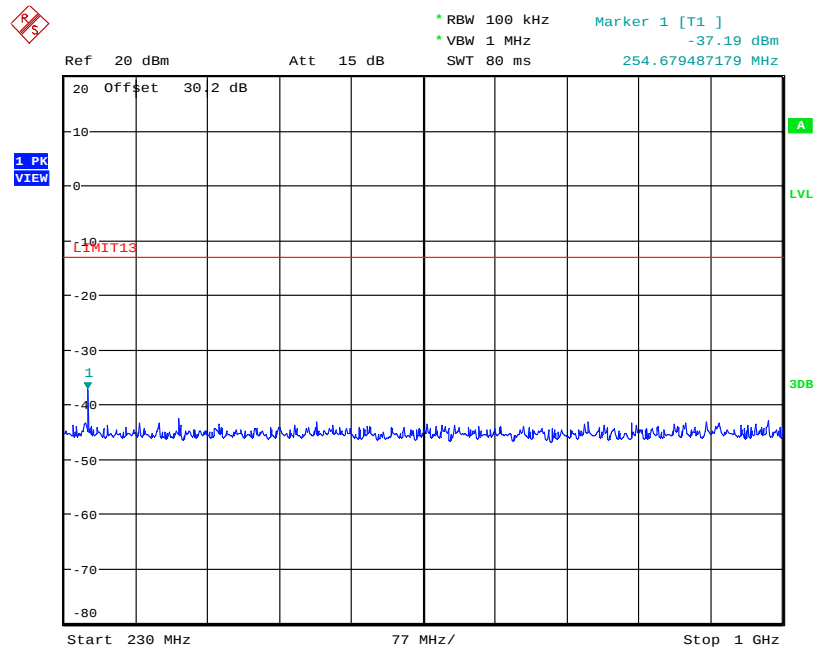
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

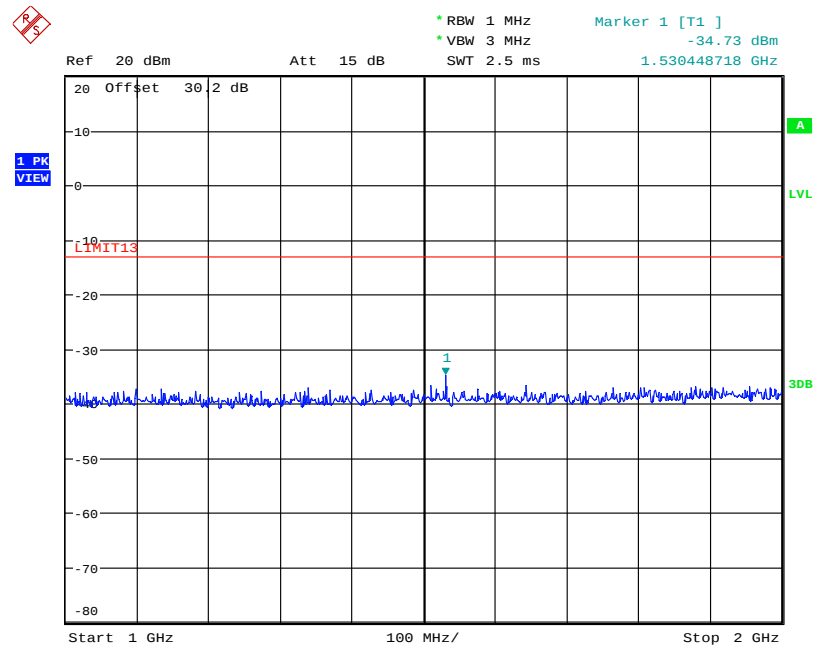
File #: 22TIL129_FCC87

October 7, 2022

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



Date: 25.AUG.2022 09:45:16



Date: 25.AUG.2022 09:52:14

ULTRATECH GROUP OF LABS

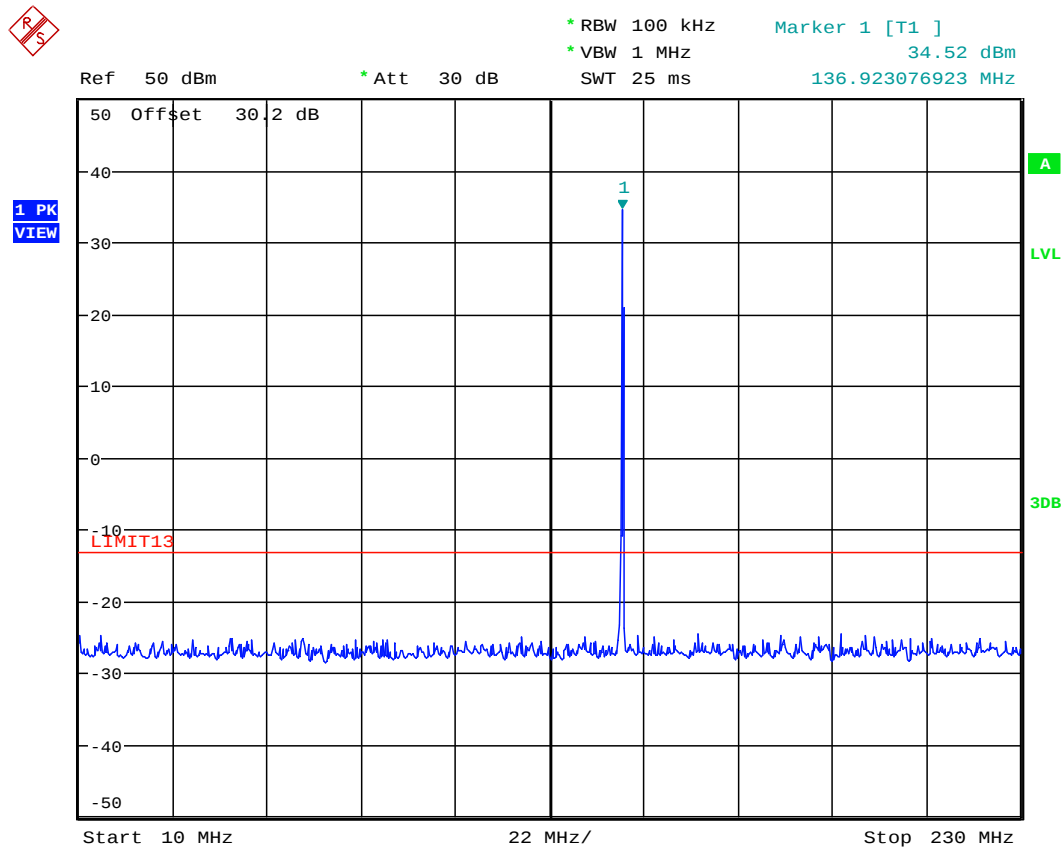
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

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5.5.3.6. Configuration: Tx Conducted, 136.975MHz, 25 KHz, Low power

Date: 25.AUG.2022 09:37:13

ULTRATECH GROUP OF LABS

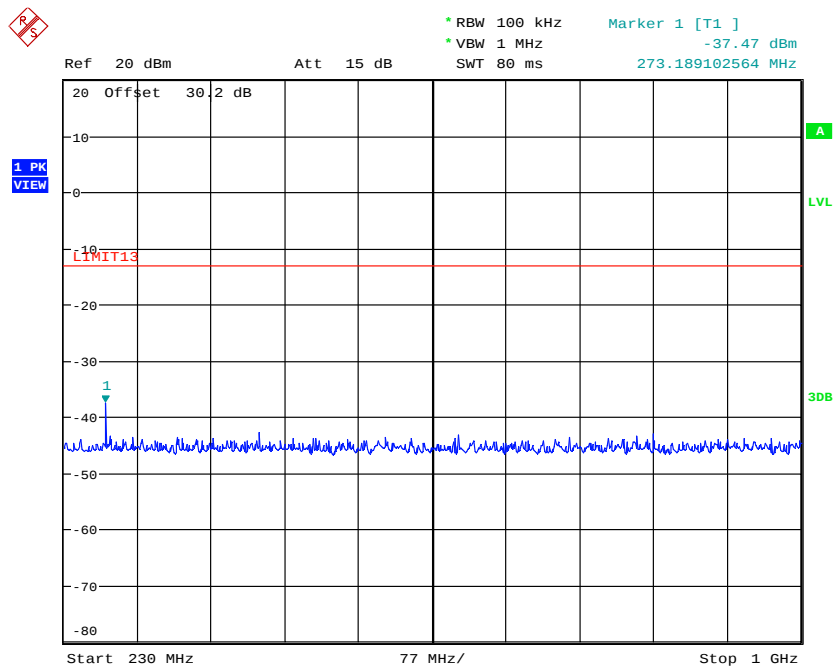
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

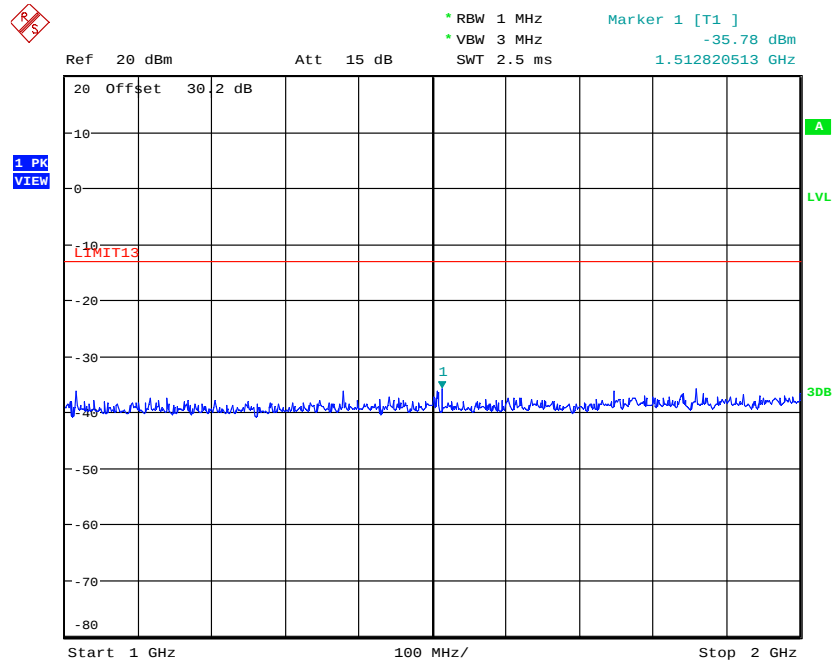
File #: 22TIL129_FCC87

October 7, 2022

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



Date: 25.AUG.2022 09:46:06



Date: 25.AUG.2022 09:53:05

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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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5.6. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053 & 87.139]**5.6.1. 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 $43 + 10 \log_{10} P$ dB.

RSS-141 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 $43 + 10 \log_{10} P$ (in watts) dB, measured with a bandwidth of 3 kHz.

5.6.2. Method of Measurements

TIA-603-E / ANSI C63.26

5.6.3. Test Data**Remark(s):**

- Test conducted at 25 kHz channel spacing.
- The emissions were scanned from 30 MHz to 2 GHz; all spurious emissions that are in excess of 20dB below the specified limit shall be recorded.

Carrier Frequency:		118.025 MHz				
Power:		High				
Limit:		-13 dBm				
Frequency (MHz)	E-Field (dB μ V/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
1062.225	67.36	Peak	V	-29.09	-13	-16.09
1062.225	66.54	Peak	H	-31.70	-13	-18.70

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

Carrier Frequency:		127.500 MHz				
Power:		High				
Limit:		-13 dBm				
Frequency (MHz)	E-Field (dB μ V/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
30 - 6000	*	Peak	H/V	*	-13	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

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October 7, 2022

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

Carrier Frequency:		136.975 MHz				
Power:		High				
Limit:		-13 dBm				
Frequency (MHz)	E-Field (dBμV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
30 - 6000	*	Peak	H/V	*	-13	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

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5.7. FREQUENCY STABILITY [§§ 2.1055 & 87.133] [RSS-141 § 5.1]**5.7.1. 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

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

5.7.2. Method of Measurements

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

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5.7.3. Test Data

Center Frequency:		118.025 MHz	
Full Power Level:		4.41W	
Frequency Tolerance Limit (Worst Case):		30 ppm or 3540 Hz (Manufacturer's rating: $\pm$ 2.5 ppm)	
Max. Frequency Tolerance Measured:		0.89 ppm or +105 Hz	
Input Voltage Rating:		28 VDC	
Ambient Temperature (°C)	Frequency Drift (Hz)		
	Supply Voltage (Nominal) 28 VDC	Supply Voltage (85%) 23.8 VDC	Supply Voltage (115%) 32.2VDC
-30	88	--	--
-20	100	--	--
-10	101	--	--
0	105	--	--
10	101	--	--
20	98	97	97
30	98	--	--
40	91	--	--
50	90	--	--
60	92	--	--

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5.8. 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.

5.8.1. Method of Measurements

Refer to Sections 1.1310, 2.1091

In order to demonstrate compliance with MPE requirements (see Section 2.1091), 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

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File #: 22TIL129_FCC87
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

RSS Gen Sec 5.6 & 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	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10 ⁻⁴ $f^{0.5}$	6.67 x 10 ⁻⁵ 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 cannot exercise control over their exposure.

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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>**File #: 22TIL129_FCC87****October 7, 2022**

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

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/cm²
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

5.8.2. RF Evaluation

Maximum RF Power conducted, P_{conducted}[W]:	4.50
Maximum Antenna Gain, G[dBi]:	3
Maximum EIRP, P_{EIRP}[W]:	8.974

MPE Environment	FCC Power Density limit, S (mW/m²)	FCC Minimum Distance (Cm)	Distance In user's manual (Cm)	Power Density at user's manual distance, S (mW/m²)
General Population/Uncontrolled Exposure	0.2	60	113	0.06

MPE Environment	ISED Power Density limit, S (mW/m²)	ISED Minimum Distance (Cm)	Distance In user's manual (Cm)	Power Density at user's manual distance, S (mW/m²)
General Population/Uncontrolled Exposure	0.1291	75	113	0.06

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October 7, 2022

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5.9. RECEIVER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [RSS-119 § 5.11, RSS-Gen §§ 4.10 & 6]

5.9.1. Limits

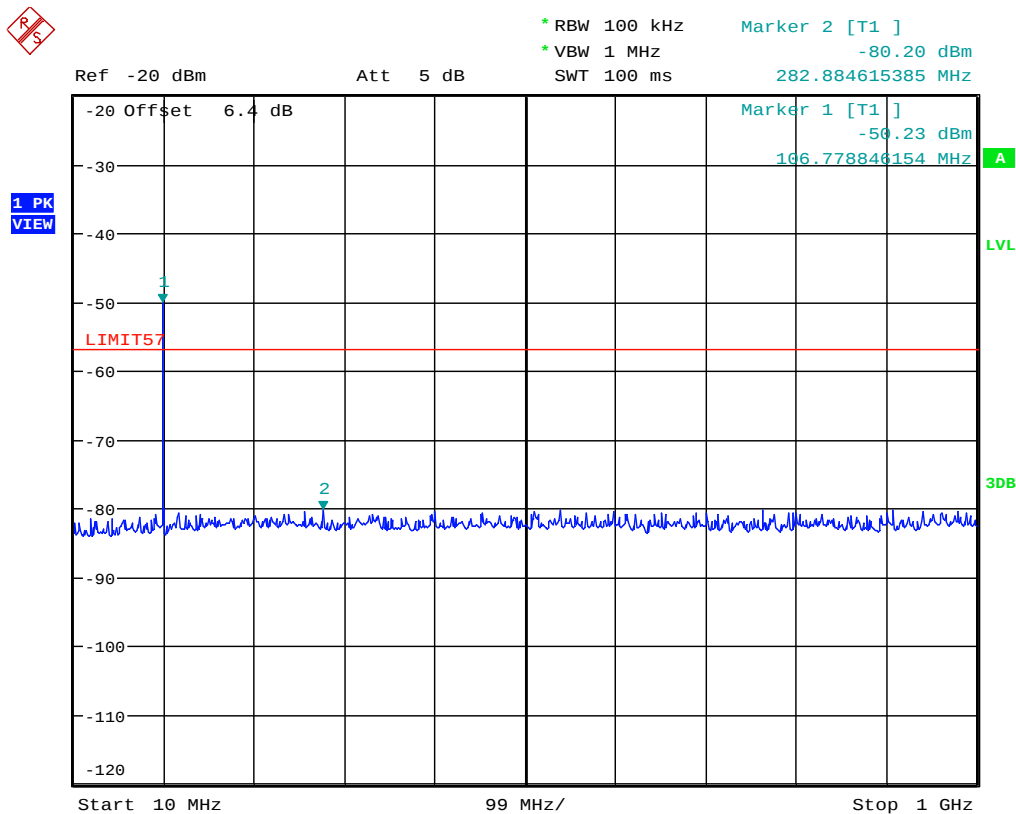
No spurious output signals appearing at the antenna terminals shall exceed 2 nanowatts per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5 nanowatts above 1 GHz.

5.9.2. Method of Measurements

Refer to Industry Canada RSS-119, Issue 9 and ANSI C63.4.

5.9.3. Test Data

5.9.3.1. Configuration: Rx Conducted, 108.025MHz



Date: 7.OCT.2022 11:41:45

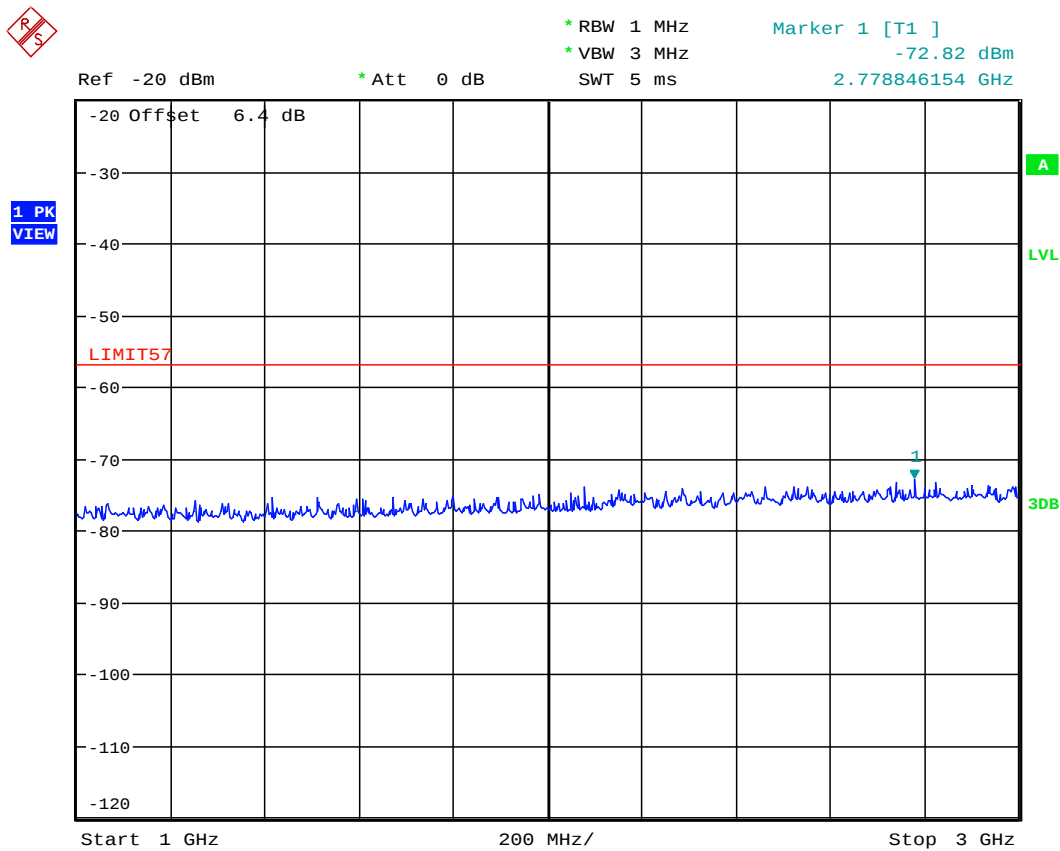
Highest peak is Rx Signal input (1mV rms)

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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87
October 7, 2022

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Date: 7.OCT.2022 11:43:17

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

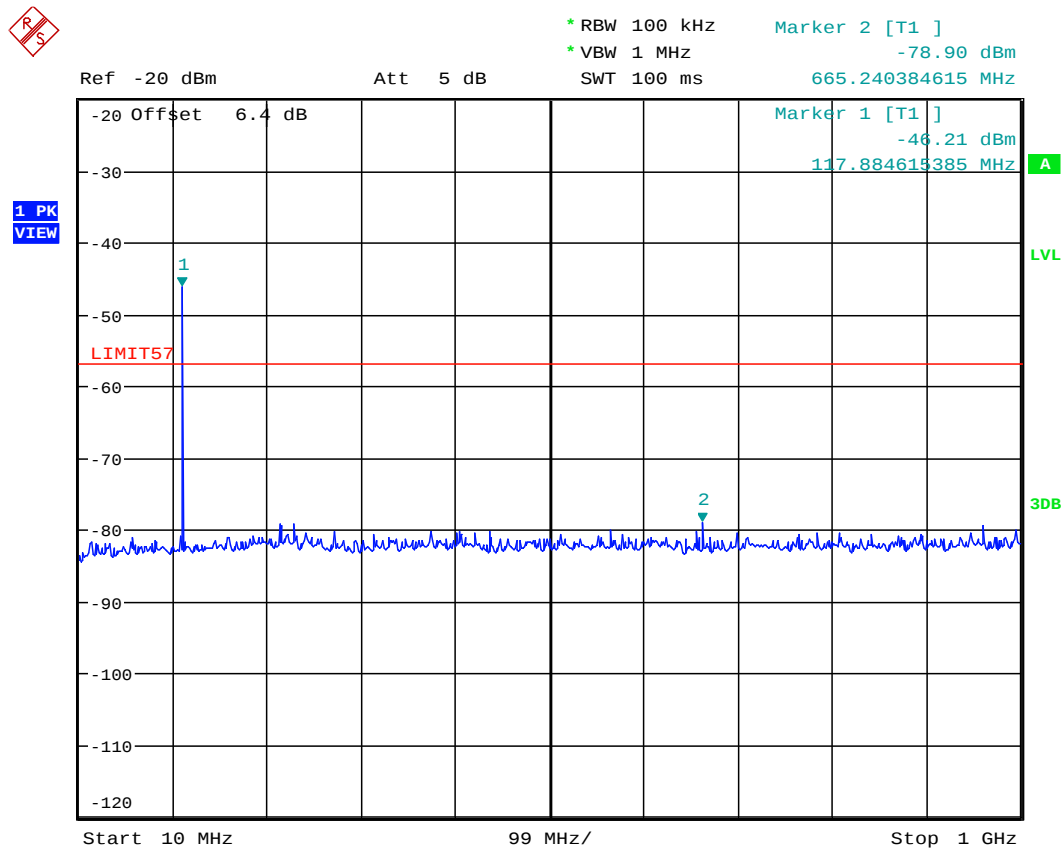
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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5.9.3.2. Configuration: Rx Conducted, 118.025MHz



Date: 25.AUG.2022 10:12:48

Highest peak is Rx Signal input (1mV rms)

ULTRATECH GROUP OF LABS

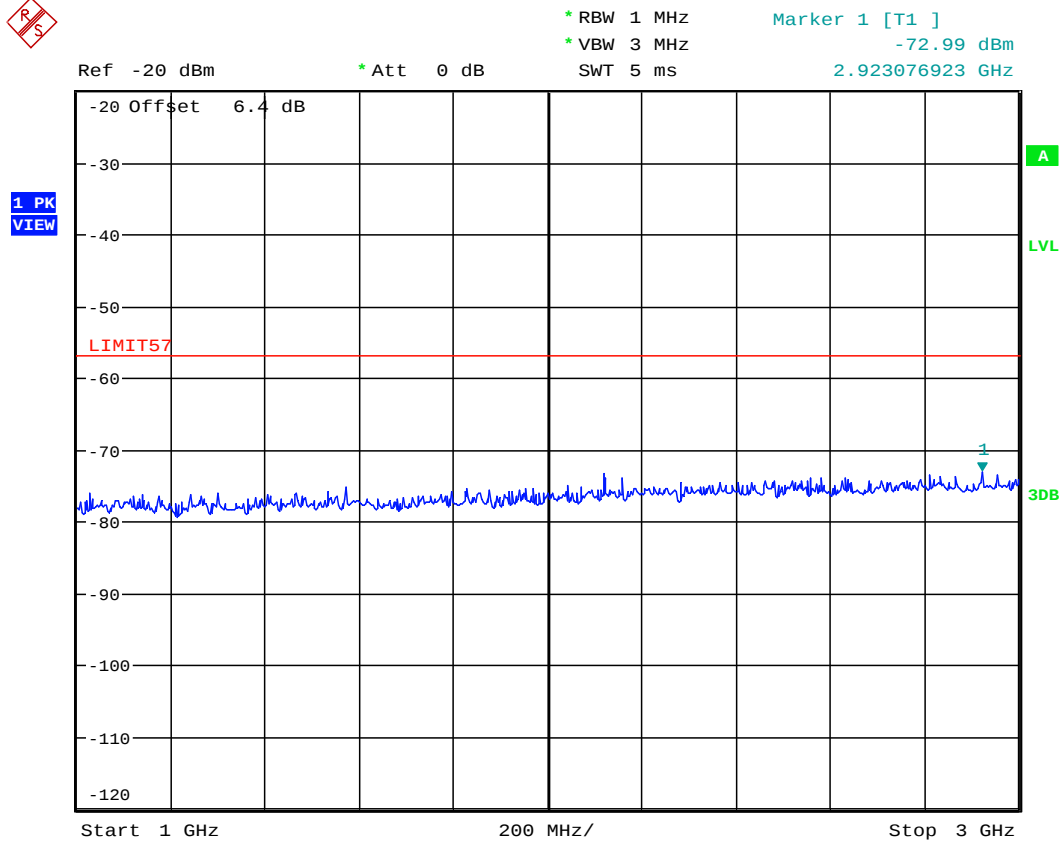
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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Date: 25.AUG.2022 10:19:42

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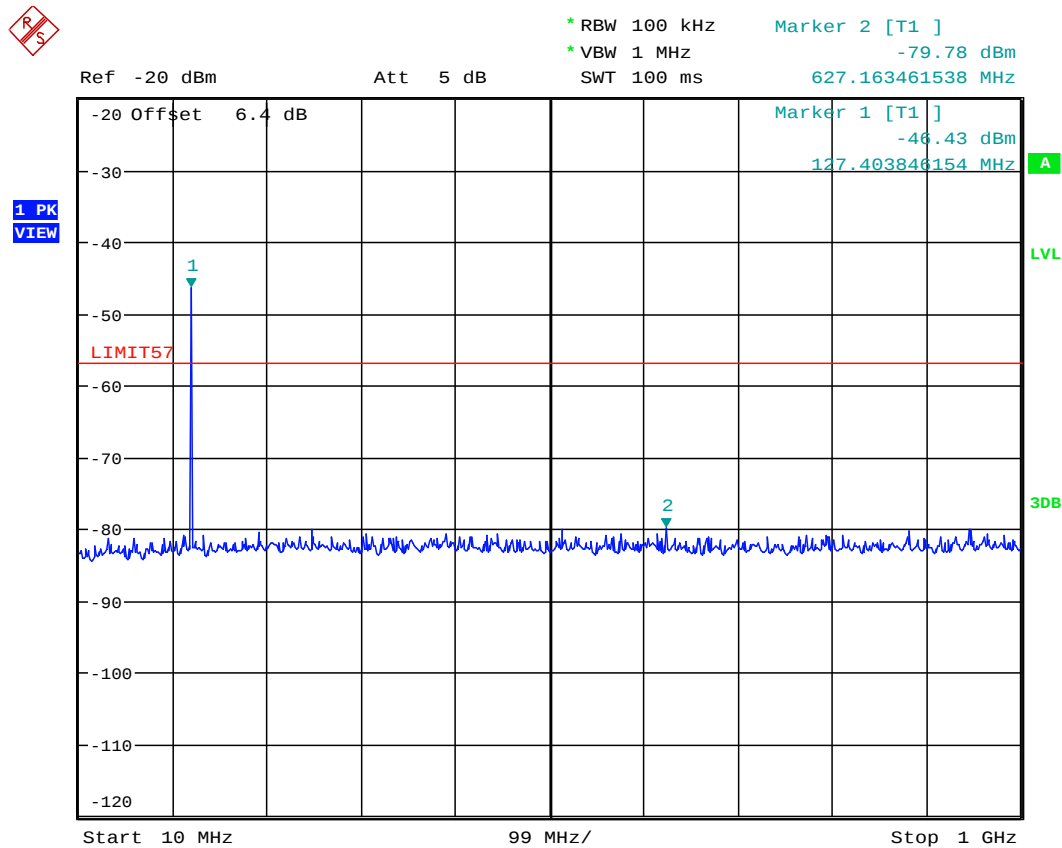
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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

5.9.3.3. Configuration: Rx Conducted, 127.5MHz



Date: 25.AUG.2022 10:14:33

Highest peak is Rx Signal input (1mV rms)

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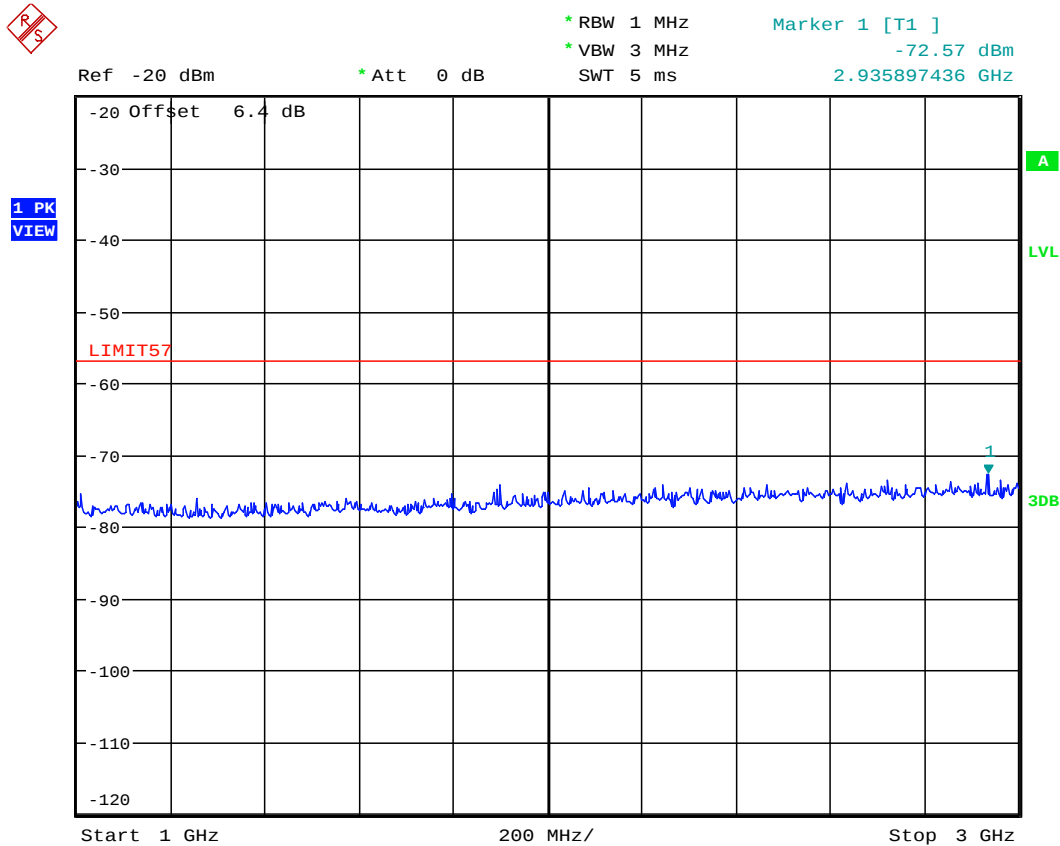
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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



Date: 25.AUG.2022 10:18:44

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

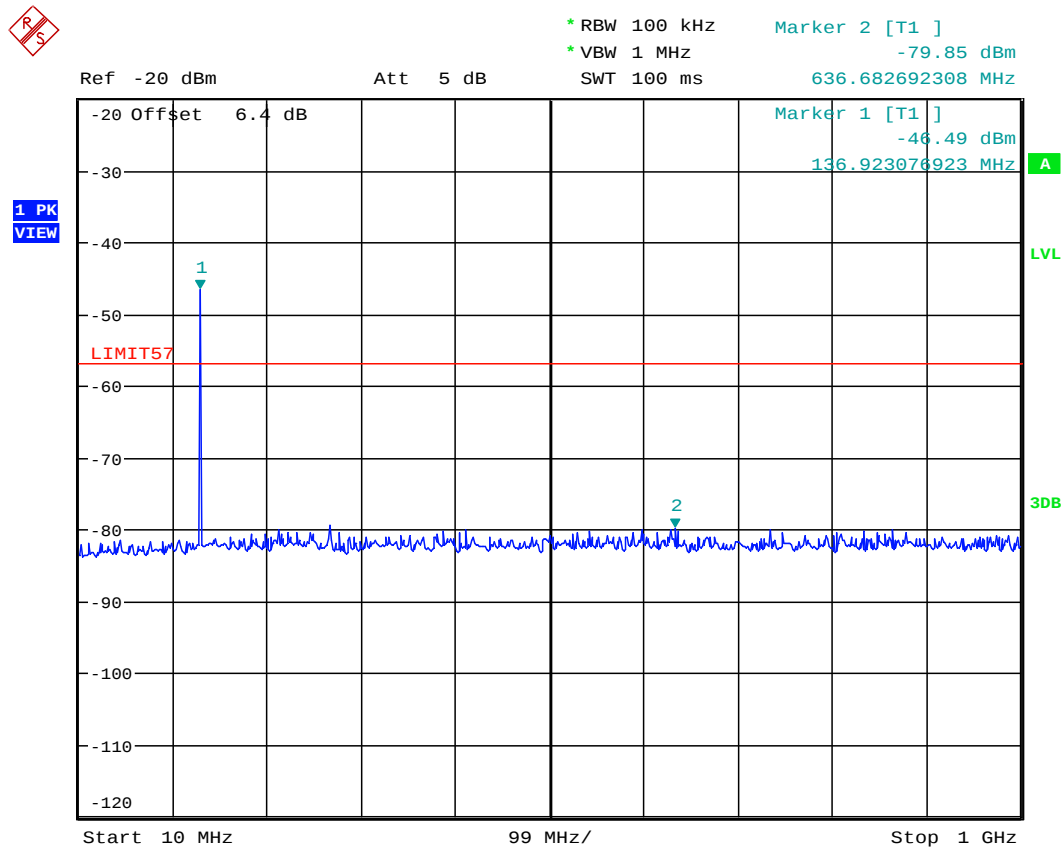
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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

5.9.3.4. Configuration: Rx Conducted, 136.975MHz



Date: 25.AUG.2022 10:15:58

Highest peak is Rx Signal input (1mV rms)

ULTRATECH GROUP OF LABS

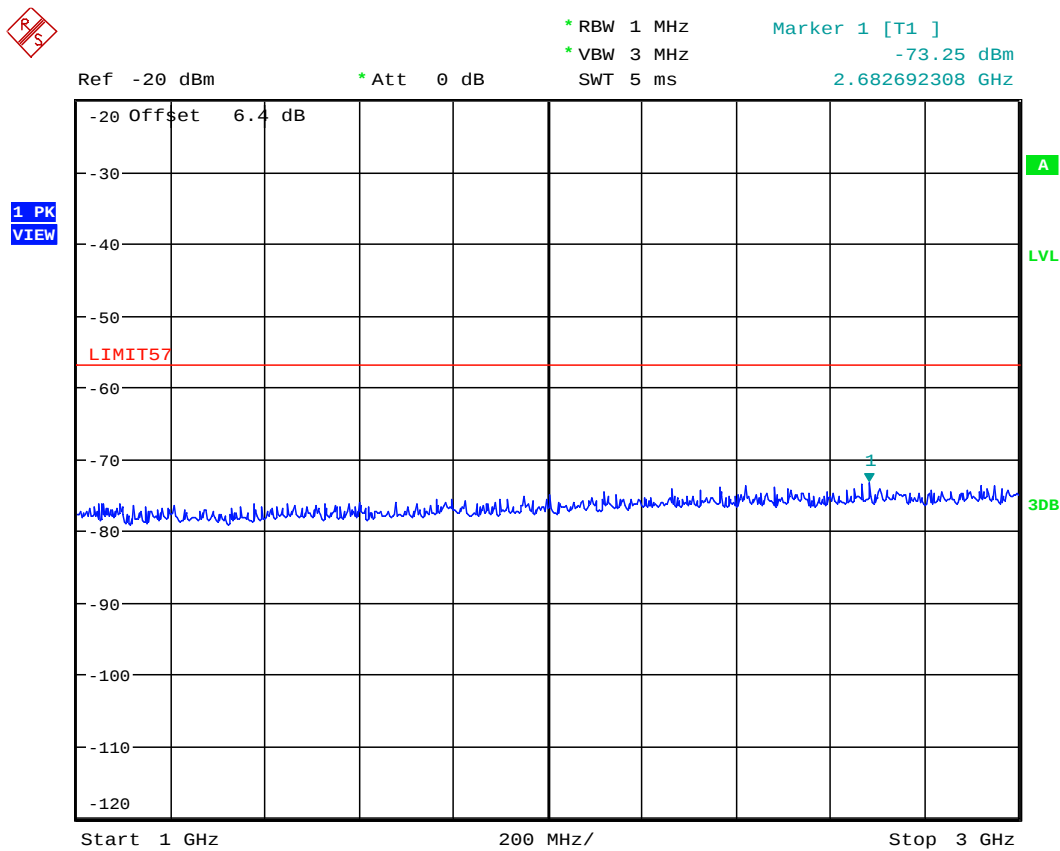
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

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



Date: 25.AUG.2022 10:17:24

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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

5.10. RECEIVER SPURIOUS EMISSIONS (RADIATED) [RSS-119 § 5.11, RSS-Gen §§ 4.10 & 6]

5.10.1. Limits

The equipment shall meet the limits of the following table:

Spurious Frequency (MHz)	Field Strength at 3 meters	
	(μ V/m)	(dB μ V/m)
30 – 88	100	40.0
88 – 216	150	43.5
216 – 960	200	46.0
Above 960	500	54.0

5.10.2. Method of Measurements

RSS-Gen and ANSI C63.4

5.10.3. Test Data

The emissions were scanned from 30 MHz to 2.0 GHz at 3 Meters distance and all emissions less than 20 dB below the limits were recorded.

(IF=45 MHz)

Rx Test Frequency 108.025 MHz						
FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
1683.275	42.36	PEAK	V	54	-11.64	PASS

Rx Test Frequency 118.025 MHz						
FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
1793.275	42.90	PEAK	V	54	-11.10	PASS
1793.275	44.54	PEAK	H	54	-9.46	PASS

Rx Test Frequency 127.50 MHz						
All emissions were observed to be less than 20dB below the limit						

Rx Test Frequency 136.975 MHz						
All emissions were observed to be less than 20dB below the limit						

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File #: 22TIL129_FCC87
October 7, 2022

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

5.11. POWER LINE CONDUCTED EMISSIONS [ICES-003, RSS-Gen § 7.2.2]

5.11.1. Limit(s)

The equipment shall meet the limits of the following table:

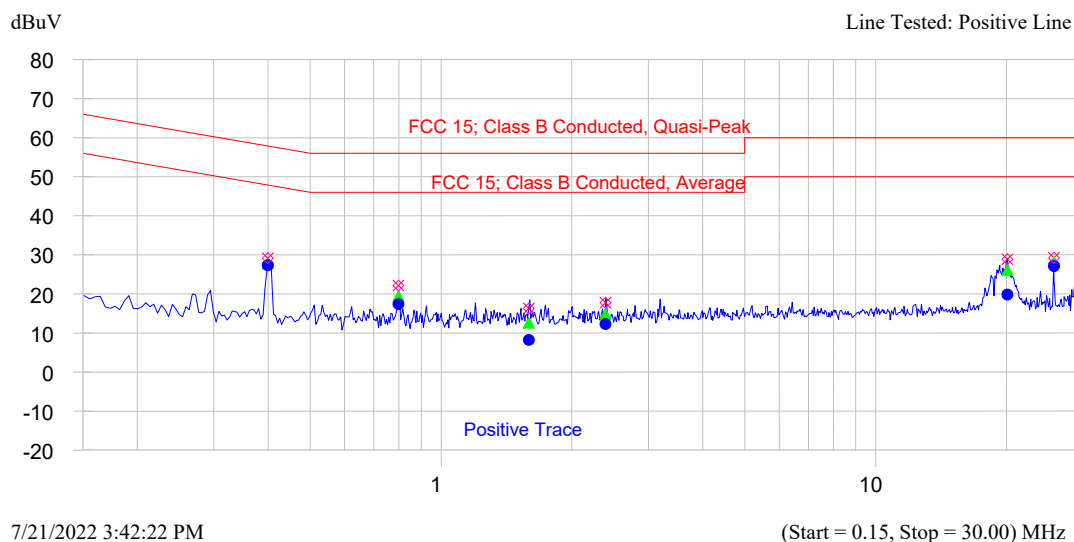
Frequency of emission (MHz)	Conducted Limits (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency

5.11.2. Method of Measurements

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

5.11.3. Test Data



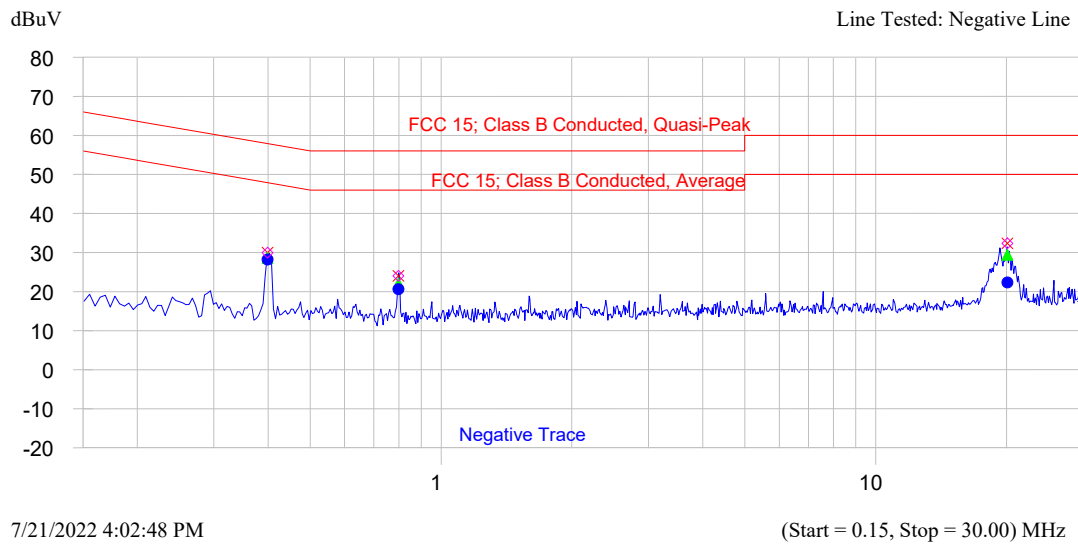
Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.399	29.1	27.8	-30.1	27.3	-20.5	Positive Trace

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Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.399	29.9	28.6	-29.3	28.2	-19.7	Negative Trace

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5.12. RADIATED EMISSIONS FROM UNINTENTIONAL RADIATORS [ICES-003]

5.12.1. Limits

The equipment shall meet the limits of the following table:

Frequency of emission (MHz)	Class B Limits	
	(dB μ V/m at 3 m)	(dB μ V/m at 10 m)
30 – 88	40.0	29.5
88 – 216	43.5	33.1
216 – 960	46.0	35.6
Above 960	54.0	43.5

5.12.2. Method of Measurements

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

5.12.3. Test Data

The emissions were scanned from 30 MHz to 3.0 GHz at 3m. All emissions found above than 20 dB below the permissible limits were recorded

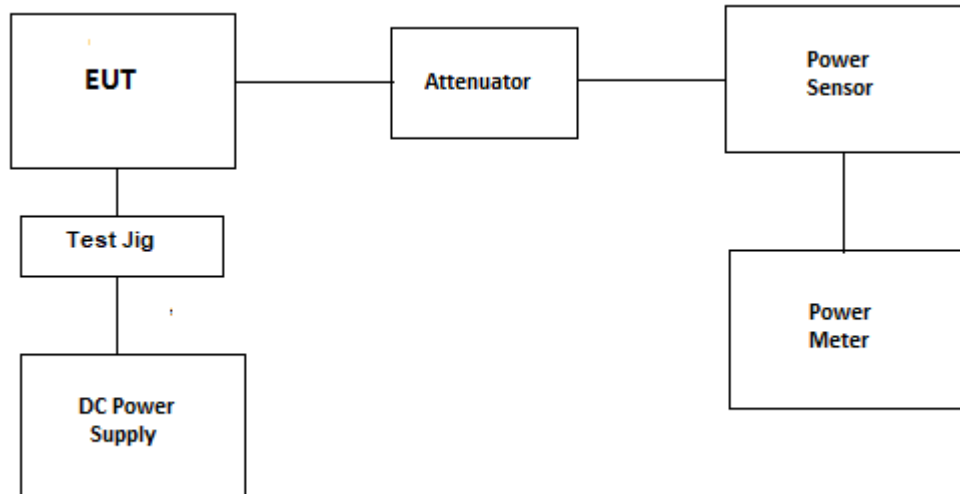
FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
34.63	25.98	PEAK	V	40	-14.02	PASS
34.63	25.86	PEAK	H	40	-14.14	PASS
47.71	31.55	PEAK	V	46	-14.45	PASS
82.85	25.21	PEAK	H	40	-14.79	PASS
102.74	24.64	PEAK	H	43.5	-18.86	PASS
102.74	31.41	PEAK	V	43.5	-12.09	PASS
122.36	24.53	PEAK	H	43.5	-18.97	PASS
122.36	30.48	PEAK	V	43.5	-13.02	PASS
144.42	29.52	PEAK	H	43.5	-13.98	PASS
144.42	27.57	PEAK	V	43.5	-15.93	PASS
162.13	32.36	PEAK	V	43.5	-11.14	PASS
233.64	28.29	PEAK	H	46	-17.71	PASS
1467.95	36.02	PEAK	H	54	-17.98	PASS
1791.67	39.42	PEAK	V	54	-14.58	PASS
1791.67	37.78	PEAK	H	54	-16.22	PASS
2118.59	41.19	PEAK	V	54	-12.81	PASS
2118.59	40.9	PEAK	H	54	-13.1	PASS
2301.49	40.14	PEAK	V	54	-13.86	PASS
2301.49	37.64	PEAK	H	54	-16.36	PASS

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October 7, 2022

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EXHIBIT 6. TEST SETUP AND EQUIPMENT LIST**6.1. Conducted Power****Test Date: Aug 17, 2022**

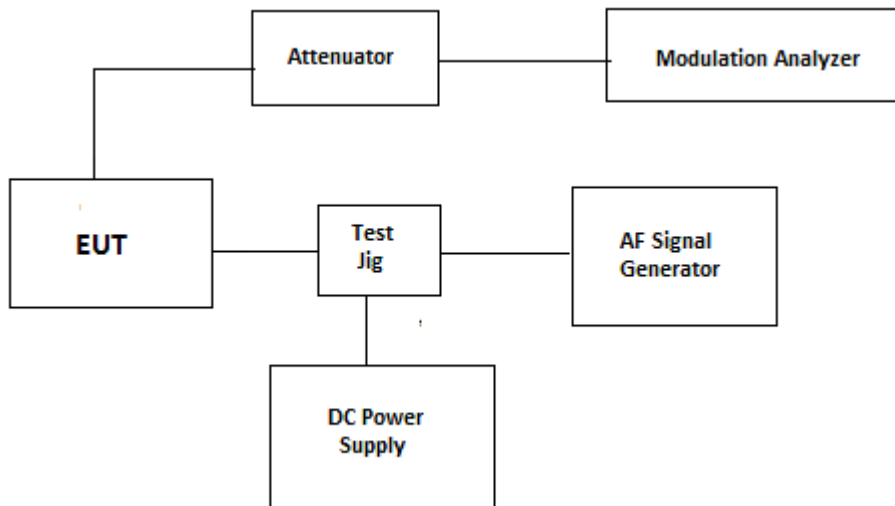
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Power Meter	HP	436A	2016A07747	100KHz-sensor dependant	22 Oct 2023
Power Sensor	HP	8482A	MY44175182	0.1MHz-4.2GHz	21 Jan 2023
Attenuator	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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6.2. Modulation Limit



Test Date: Aug 18, 2022

Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Modulation Analyzer	HP	HP-8901B	3226A04606	150KHz-1300MHz	29 Mar 2024
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	29 Mar 2024
Digital Voltmeter	HP	3456A	2015A04523	--	08 Feb 2024
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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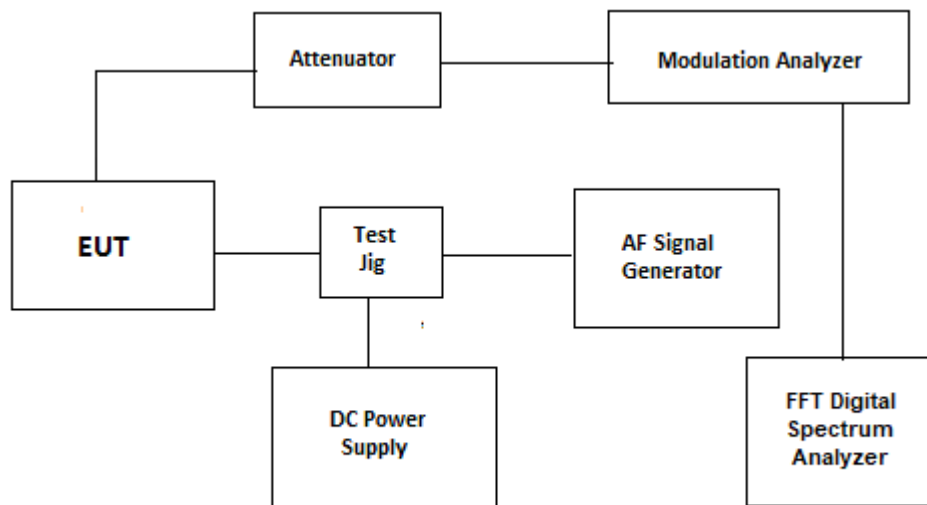
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 22TIL129_FCC87

October 7, 2022

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6.3. Audio Frequency Response



Test Date: Aug 18, 2022

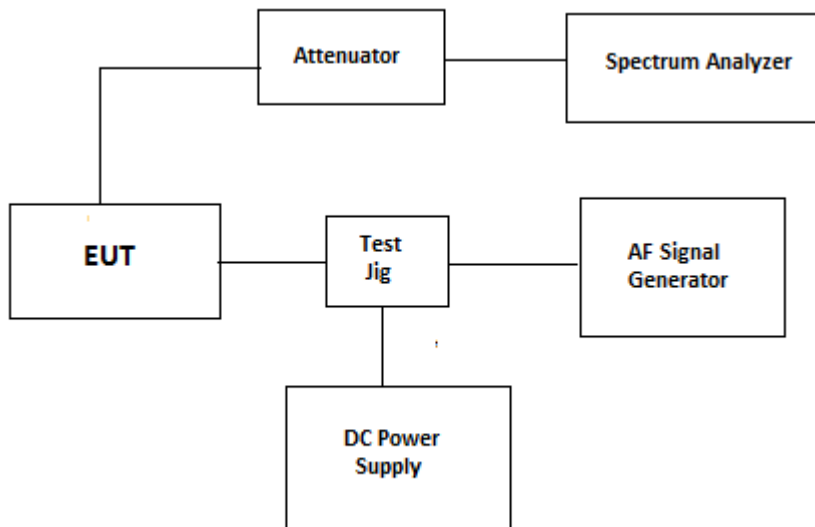
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Modulation Analyzer	HP	HP-8901B	3226A04606	150KHz-1300MHz	29 Mar 2024
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	29 Mar 2024
Digital Voltmeter	HP	3456A	2015A04523	--	08 Feb 2024
FFT Digital Spectrum Analyzer	Advantest	R9211E	8202336	10MHz-100KHz	02 Nov 2022
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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File #: 22TIL129_FCC87
October 7, 2022

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6.4. 99% OBW and Mask**Test Date: Aug 24, 2022**

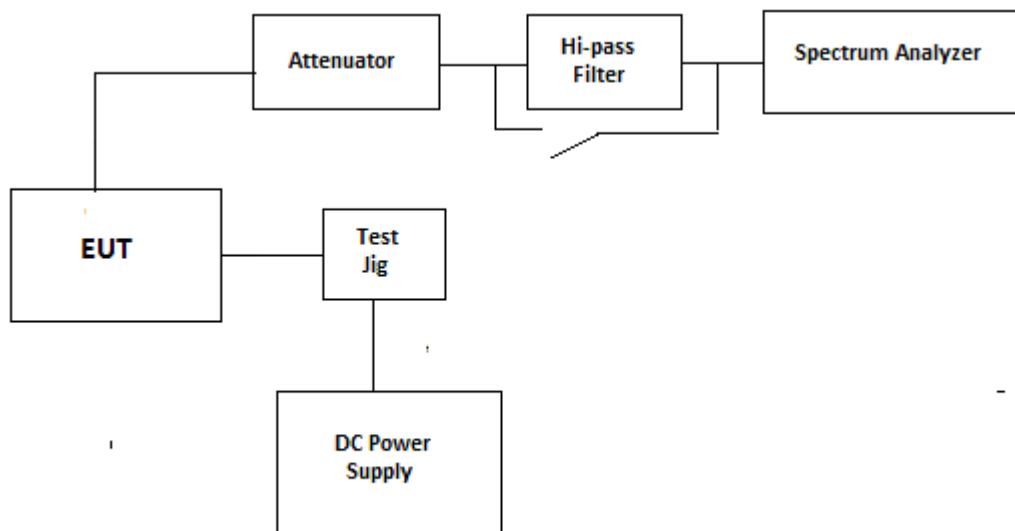
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	20 Sep 2023
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	29 Mar 2024
Digital Voltmeter	HP	3456A	2015A04523	---	08 Feb 2024
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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6.5. Tx Conducted Emission



Test Date: Aug 25, 2022

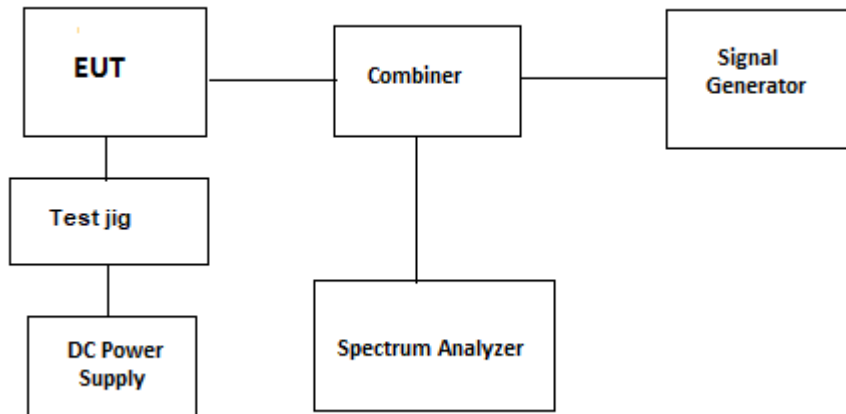
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	20 Sep 2023
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	29 Mar 2024
Hi-pass filter	Mini-Circuit	SHP-250	--	Cut off 250MHz	Cal on use
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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File #: 22TIL129_FCC87
October 7, 2022

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

6.6. Rx Conducted Emission**Test Date: Aug 26 and October 7, 2022**

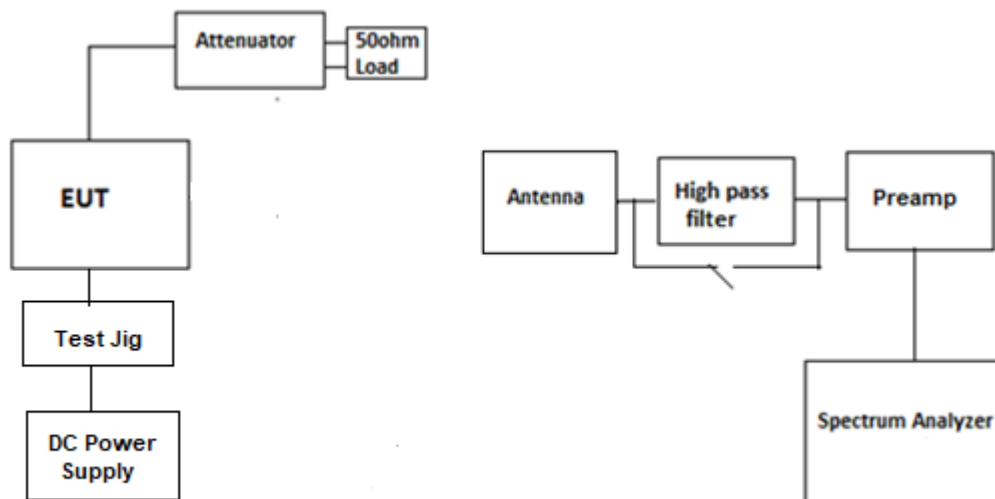
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	20 Sep 2023
Signal Generator	IFR	2025	202304/141	9KHz-2.5GHz	02 Dec 2023
Combiner	Weinschel 93458	1515	PS119	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	5021295	---	12 Jan 2023

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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>**File #: 22TIL129_FCC87****October 7, 2022***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

6.7. TX Radiated



Test Date: Aug 26, 2022

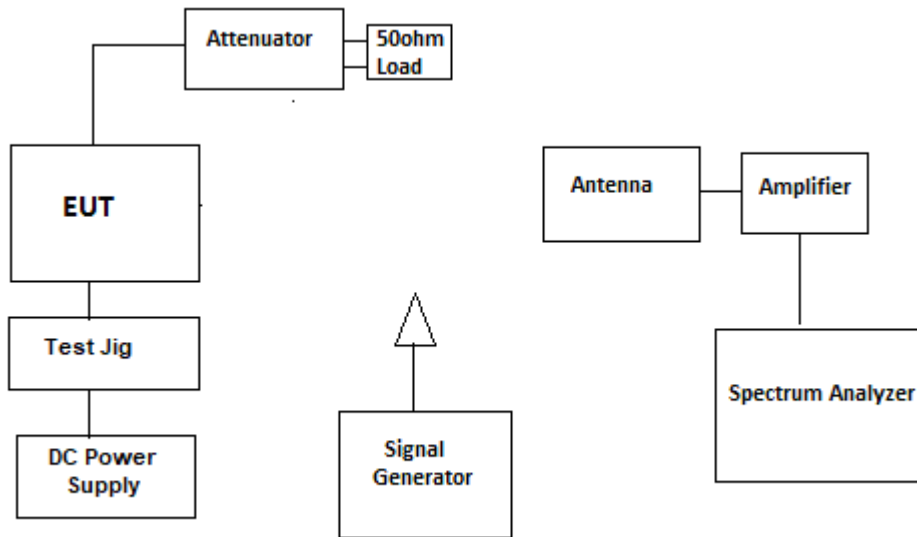
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	20 Sep 2023
Spectrum Analyzer	Rohde & Schwarz	ESU40	100037	20Hz-40GHz	01 Sep 2022
Biconilog Antenna	EMCO	3142C	00026873	26-2000MHz	16 Dec 2023
Log Periodic Antenna	ETS	3148	00023845	200-2000MHz	14 Apr 2023
Horn Antenna	ETS	3115	5955	1-18GHz	12 Oct 2022
Horn Antenna	ETS	3117	00119425	1-18GHz	20 Jan 2024
Preamplifier	Com-Power	PAM-118A	551016	500MHz-18GHz	04 Mar 2023
Preamplifier	Com-Power	PA-103	161040	1-1000MHz	04 Mar 2023
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
Load(50ohm)	Mini-Circuits	KARN-50+	--	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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6.8. Rx Radiated, Unintentional Radiated**Test Date: Aug 26, 2022, Unintentional: Sep 21, 2022**

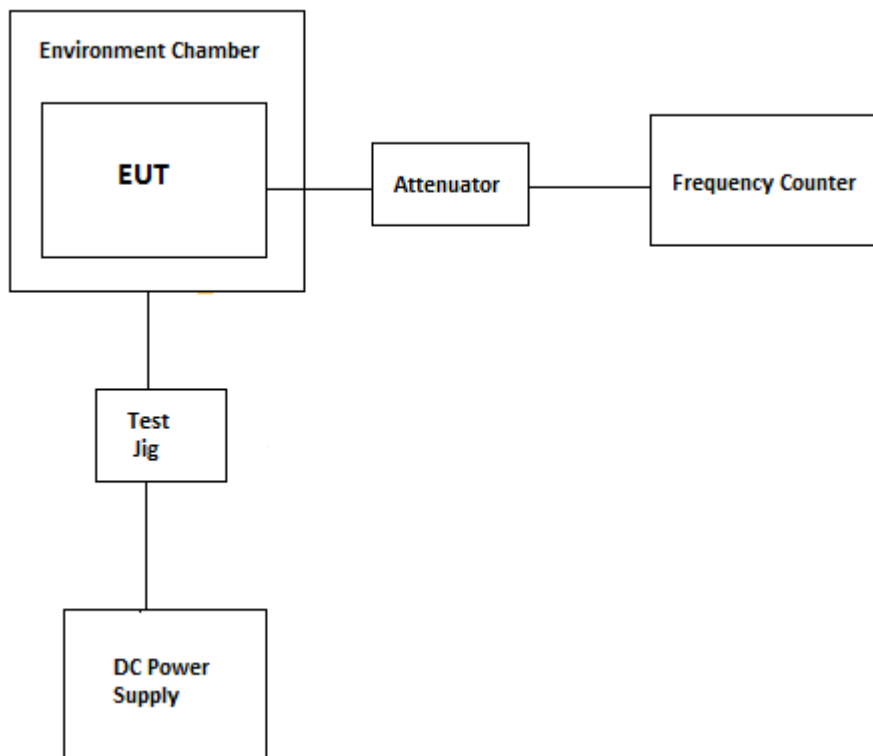
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	20 Sep 2023
Spectrum Analyzer	Rohde & Schwarz	ESU40	100037	20Hz-40GHz	27 Sep 2022
Biconilog Antenna	EMCO	3142C	00026873	26-2000MHz	16 Dec 2023
Log Periodic Antenna	ETS	3148	00023845	200-2000MHz	14 Apr 2023
Horn Antenna	ETS	3115	5955	1-18GHz	12 Oct 2022
Horn Antenna	ETS	3117	00119425	1-18GHz	20 Jan 2024
Preamplifier	Com-Power	PAM-118A	551016	500MHz-18GHz	04 Mar 2023
Preamplifier	Com-Power	PA-103	161040	1-1000MHz	04 Mar 2023
Signal Generator	IFR	2025	202304/141	9KHz-2.5GHz	02 Dec 2023
Attenuator(30dB)	Aeroflex\Weinschel	46-30-34	BR9127	DC-18GHz	Cal on use
Load(50ohm)	Mini-Circuits	KARN-50+	--	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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6.9. Frequency Stability



Test Date: Sep 12~14, 2022

Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Environmental Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177° C	25 Aug 2023
Frequency Counter	EIP	545A	2683	10MHz-1GHz	06 Sep 2024
Attenuator(20dB)	Aeroflex\Weinschel	34-20-34	BP6023	DC-18GHz	Cal on use
Attenuator(20dB)	Narda	26298	A577	DC-1GHz	Cal on use
Power Supply	BK Precision	1740	1550497	0-60V, DC 4 A	--
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

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EXHIBIT 7. MEASUREMENT UNCERTAINTY

Test description		Uncertainty
Conducted Output Power		+/- 0.62 dB
Occupied bandwidth		+/-0.2Hz
Emission Mask	Amplitude	+/- 0.63 dB
	Frequency	+/-0.2Hz
Conducted Out of Band/Spurious Emissions		+/- 0.72 dB
Radiated Out of Band/Spurious Emissions	<30 MHz	+/-2.69dB
	30-1000 MHz	+/-4.20dB
	>1 GHz	+/-2.70dB
Frequency Stability		+/-1.2 Hz
Transient Frequency Behavior		+/- 0.05%
Power Line Conducted Emission		+ 2.62dB

All uncertainty values are expanded standard uncertainty to give a confidence level of 95%, based on coverage factor k=2

END OF REPORT

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