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 90 (Subpart I) &
ISED RSS-119, Issue 12

UltraTech's File No.: 22TIL129-F90

This Test report is Issued under the Authority of Tri M. Luu Vice President of Engineering UltraTech Group of Labs Date: September 29, 2022	
Report Prepared by: Santhosh Fernandez Issued Date: September 29, 2022	Tested by: Nimisha Desai and Angus Au Test Dates: August 17- Sep 21, 2022

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Parts 2 and 90, RSS-119
Title:	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 & 90 Land Mobile and Fixed Radio Transmitters and Receivers Operating in the Frequency Range 27.41-960 MHz and RSS -119
Purpose of Test:	To obtain FCC Certification Authorization for Radio operating in the Frequency Band 30-50 MHz and RSS -119
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard, TIA-603-E – Land Mobile FM or PM Communications Equipment Measurement and performance Standards.

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

None.

1.3. NORMATIVE REFERENCES

1.4.

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2022	Code of Federal Regulations – 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-119, Issue 12	2015	Land Mobile and Fixed Transmitters and Receivers, 27.41-960 MHz
RSS-Gen, Issue 5	2018	General Requirements for Compliance of Radio Apparatus
ICES-003, ISSUE 7	2020	Information Technology Equipment (Including Digital Apparatus) — Limits and Methods of Measurement

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 M^{c}Intosh 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 M^{c}Intosh 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

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, Industrial or Business
Power Supply Requirement:	28.0 VDC nominal
RF Output Power Rating:	1 to 10 Watts
Operating Frequency Range:	30-50 MHz
RF Output Impedance:	50 Ω
Channel Spacing:	25 kHz
Occupied Bandwidth (99%):	15.45kHz
Emission Designation*:	16K0F3E
Oscillator Frequency(ies):	VCO up to 490 MHz
Antenna Connector Type:	BNC

* For an average case of commercial telephony, the necessary bandwidth is calculated as follows:

Bn = 2M + 2DK
Channel Spacing = 20 kHz, D = 5 kHz, K = 1, M = 3 kHz
B_n = 2M + 2DK = 2(3) + 2(5)(1) = 16 kHz
Designation of emission: 16K0F3E

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)

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:	N/A
Transmitter Test Antenna:	The EUT is tested with the antenna port terminated to a 50 Ω RF Load.

Transmitter Test Signals	
Frequency Band(s):	30-50 MHz
Test Frequencies: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	30.6 MHz, 40 MHz, 49.6 MHz
Transmitter Wanted Output Test Signals:	
Transmitter Power (measured maximum output power):	10.23 Watts High
Normal Test Modulation:	FM
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 EMISSION TEST RESULTS

FCC/RSS Section(s)	Test Requirements	Applicability (Yes/No)
1.1307, 1.1310, 2.1091 & 2.1093 RSS-Gen, §3.4 & RSS-102	RF Exposure Limit	Yes
2.1046, 22.565, 74.461, 80.215 & 90.205 RSS-119 § 5.4	RF Power Output	Yes
2.1047(a), 80.213(e) & 90.242(b)(8)	Audio Frequency Response	Not applicable to new standard. However, tests are conducted under FCC's recommendation.
2.1047(b), 74.463, 80.213 & 90.210	Modulation Limiting	Yes
2.1049, 74.462, 80.211(f), 90.209 & 90.210 RSS-Gen § 6.7 RSS-119 § 5.5	Emission Limitation & Emission Mask	Yes
2.1051, 2.1057, 80.211(f)(3), & 90.210 RSS-119 § 5.8	Emission Limits - Spurious Emissions at Antenna Terminal	Yes
2.1053, 2.1057, 22.359, 80.211(f)(3), & 90.210 RSS-119 § 5.8	Emission Limits - Field Strength of Spurious Emissions	Yes
2.1055, 22.355, 74.464 80.209 & 90.213 RSS-119 § 5.3	Frequency Stability	Yes
74.462(c) & 90.214 RSS-119 § 5.9	Transient Frequency Behavior	N/A
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.

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 requirements of UKAS Document NIS 81 with a confidence level of 95%. Please 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

Multiband RF Module

5.5. RF POWER OUTPUT [§§ 2.1046 & 90.205] [RSS-Gen § 4.8 & RSS-119 § 5.4]

5.5.1. Limits

Please refer to FCC 47 CFR 90.205 for specification details.
RSS-119 The output power shall be within + 1.0 dB of the manufacturer's rated power and RSS 119 Section 5.4 table 2

5.5.2. Method of Measurements

Refer to Exhibit 8, Section 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

5.5.3. Test Data

Channel	Frequencies MHz	Power Rating Watts	Power Rating dBm	Actual Power dBm	Actual Power Watts
High Power Level, 10 Watts					
20	30.600	10.0	40.00	40.04	10.09
21	40.000	10.0	40.00	40.08	10.19
22	49.600	10.0	40.00	40.10	10.23
Low Power Level, 1 Watt					
20	30.600	1.0	30.00	30.44	1.11
21	40.000	1.0	30.00	30.41	1.10
22	49.600	1.0	30.00	30.42	1.10

5.6. FREQUENCY STABILITY [§§ 2.1055 & 90.213] [RSS-119 § 5.3]

5.6.1. Limits

Refer to FCC 47 CFR 90.213 for specification details.

Frequency Range (MHz)	Frequency Tolerance (ppm)		
	Fixed and Base Stations	Mobile Stations	
		> 2 W	≤ 2 W
25-50 MHz	20	20	50

[RSS-119 § 5.3]
The carrier frequency shall not depart from the reference frequency in excess of the values given in Table 1.

Table 1 - Transmitter Frequency Stability

Frequency Band (MHz)	Channel Bandwidth (kHz)	Frequency Stability (ppm)		
		Base/Fixed	Mobile Station	
			>2 watts	≤ 2 watts
27.41-28 and 29.7-50	20	20	20	50

5.6.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 of this report for measurement details

5.6.3. Test Data

Center Frequency:	30.6 MHz
Full Power Level:	10.09W
Frequency Tolerance Limit:	± 2.5 ppm or ± 76.5 Hz (from manufacturer)
Max. Frequency Tolerance Measured:	-21 Hz or 0.69 ppm
Input Voltage Rating:	28 VDC (nominal)

Ambient Temperature (°C)	**Frequency Drift (Hz)**		
	Supply Voltage (Nominal) 28 Vdc	**Supply Voltage (85% of nominal) 23.8 Vdc**	**Supply Voltage (115% of nominal) 32.2 Vdc**
-30	-21	--	--
-20	-16	--	--
-10	-11	--	--
0	-7	--	--
10	-6	--	--
20	-7	-6	-6
30	-6	--	--
40	-7	--	--
50	-8	--	--
60	-9	--	--

5.7. AUDIO FREQUENCY RESPONSE [§ 2.1047(a)]

5.7.1. Limits

Recommended audio filter attenuation characteristics are given below:

Audio band	Minimum Attenuation Rel. to 1 kHz Attenuation
3 - 20 KHz	60 $\log_{10}$(f/3) dB where f is in KHz
20 - 30 KHz	50dB

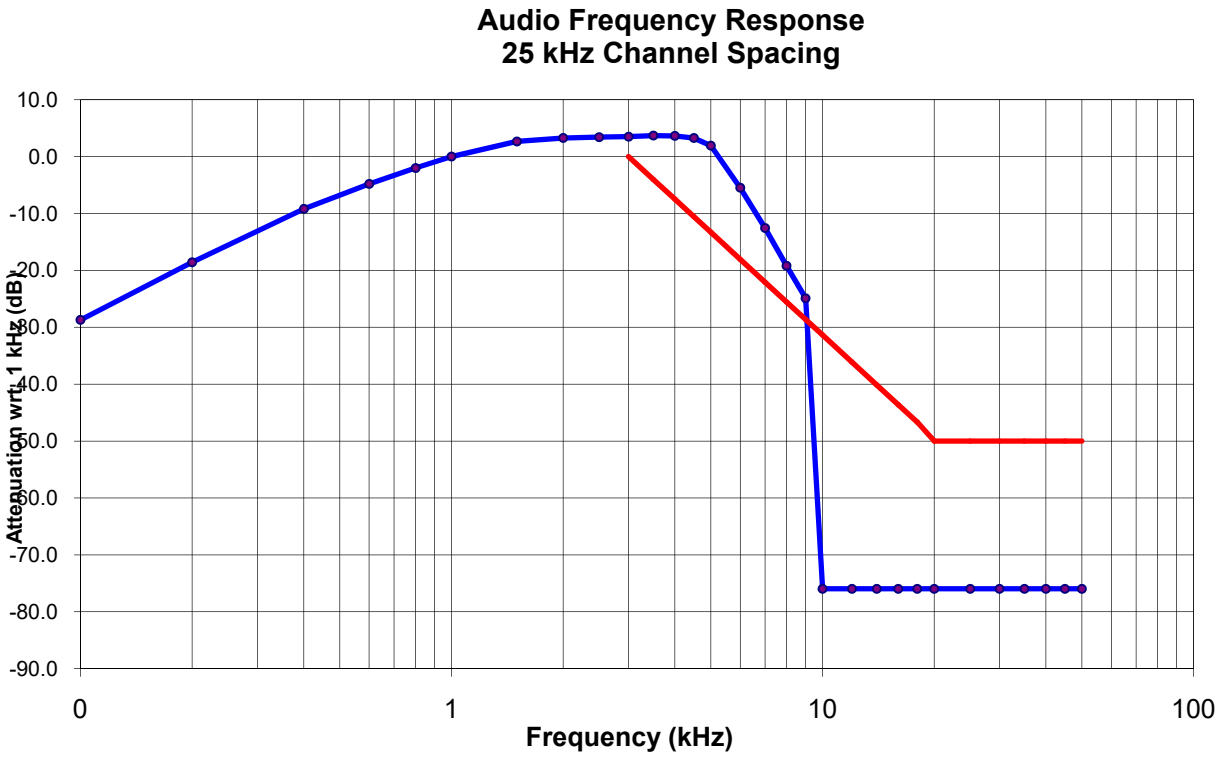
5.7.2. Method of Measurements

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

5.7.3. 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 is performed to show the roll off at 3 kHz in comparison with the recommended audio filter attenuation.

Frequency (kHz)	Audio In (dBV)	Audio Out (dBV)	Attenuation (Out - In) (dB)	Attenuation Rel. to 1 kHz (dB)	Recommended Attenuation (dB)
0.1	-10.75	-22.75	-12.0	-28.7	--
0.2	-10.75	-12.61	-1.9	-18.6	--
0.4	-10.75	-3.24	7.5	-9.2	--
0.6	-10.75	1.15	11.9	-4.8	--
0.8	-10.75	3.95	14.7	-2.0	--
1.0	-10.75	5.96	16.7	0.0	--
1.5	-10.75	8.62	19.4	2.7	--
2.0	-10.75	9.22	20.0	3.3	--
2.5	-10.75	9.38	20.1	3.4	--
3.0	-10.75	9.46	20.2	3.5	0
3.5	-10.75	9.64	20.4	3.7	-4
4.0	-10.75	9.59	20.3	3.6	-7
4.5	-10.75	9.22	20.0	3.3	-11
5.0	-10.75	7.87	18.6	1.9	-13
6.0	-10.75	0.48	11.2	-5.5	-18
7.0	-10.75	-6.59	4.2	-12.6	-22
8.0	-10.75	-13.24	-2.5	-19.2	-26
9.0	-10.75	-18.94	-8.2	-24.9	-29
10.0	-10.75	-70.00	-59.3	-76.0	-31
12.0	-10.75	-70.00	-59.3	-76.0	-36
14.0	-10.75	-70.00	-59.3	-76.0	-40
16.0	-10.75	-70.00	-59.3	-76.0	-44
18.0	-10.75	-70.00	-59.3	-76.0	-47
20.0	-10.75	-70.00	-59.3	-76.0	-50
25.0	-10.75	-70.00	-59.3	-76.0	-50
30.0	-10.75	-70.00	-59.3	-76.0	-50
35.0	-10.75	-70.00	-59.3	-76.0	-50
40.0	-10.75	-70.00	-59.3	-76.0	-50
45.0	-10.75	-70.00	-59.3	-76.0	-50
50.0	-10.75	-70.00	-59.3	-76.0	-50



5.8. MODULATION LIMITING [§§ 2.1047(b) & 90.210]

5.8.1. Limits

Recommended frequency deviation characteristics are given below: ±5 kHz

5.8.2. 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.

5.8.3. Test Data

5.8.3.1. Voice Modulation Limiting

Modulating Signal Level	Peak Frequency Deviation (kHz) at the following modulating frequency:					Maximum Limit
(mVrms)	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	(kHz)
50	0.04	0.264	0.55	1.23	0.72	5.0
60	0.03	0.30	0.65	1.46	0.85	5.0
70	0.04	0.35	0.76	1.70	0.98	5.0
80	0.05	0.42	0.88	1.98	1.14	5.0
90	0.05	0.44	0.96	2.14	1.23	5.0
100	0.05	0.49	1.07	2.40	1.37	5.0
150	0.07	0.72	1.59	3.57	2.01	5.0
200	0.09	0.98	2.15	4.15	2.68	5.0
250	0.11	1.22	2.67	4.23	3.29	5.0
300	0.13	1.46	3.20	4.31	3.81	5.0
350	0.15	1.77	3.84	4.36	3.99	5.0
400	0.17	1.92	4.01	4.42	4.13	5.0
450	0.19	2.23	4.05	4.47	4.25	5.0
500	0.20	2.53	4.08	4.48	4.36	5.0
600	0.24	3.13	4.12	4.51	4.56	5.0
700	0.28	3.67	4.15	4.52	4.60	5.0
800	0.33	4.00	4.17	4.53	4.60	5.0
900	0.36	4.03	4.19	4.53	4.61	5.0
1000	0.40	4.06	4.20	4.54	4.61	5.0
1100	0.47	4.08	4.22	4.53	4.61	5.0
1200	0.53	4.10	4.23	4.54	4.61	5.0
1300	0.59	4.12	4.24	4.54	4.61	5.0
1400	0.66	4.14	4.25	4.54	4.61	5.0
1500	0.70	4.14	4.25	4.54	4.61	5.0

Voice Signal Input Level = STD MOD Level + 16 dB
= 65.25 dB(mVrms)
= 1829.78 mVrms

Modulation Frequency (kHz)	Peak Deviation (kHz)	Maximum Limit (kHz)
0.1	0.86	5.0
0.3	2.63	5.0
0.4	3.73	5.0
0.6	3.81	5.0
0.8	3.85	5.0
1.0	3.87	5.0
1.2	3.88	5.0
1.4	3.87	5.0
1.6	3.89	5.0
1.8	3.92	5.0
2.0	3.96	5.0
2.5	4.07	5.0
3.0	4.13	5.0
3.5	4.28	5.0
4.0	4.46	5.0
4.5	4.60	5.0
5.0	4.61	5.0
6.0	4.15	5.0
7.0	2.31	5.0
8.0	1.31	5.0
9.0	0.78	5.0
10.0	0.48	5.0

5.9. OCCUPIED BANDWIDTH & EMISSION MASK [§§ 2.1049, 90.209 & 90.210] [RSS-119 § 5.5 & 5.8]

5.9.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

Frequency Band (MHz)	Channel Spacing (kHz)	Authorized Bandwidth (kHz)	Mask for equipment with Audio low pass filter	Mask for equipment Without audio low pass filter
25-50	20	20	B	C

RSS119

Table 3 - Channel Spacing, Authorized Bandwidths and Applicable Spectrum Masks

Frequency Band (MHz)	Related SRSP for Channelling Plan and e.r.p.	Channel Spacing (kHz)	Authorized Bandwidth (kHz)	Spectrum Masks with Audio Filter	Spectrum Masks Without Audio Filter
27.41-28.0 and 29.7-50.0	N/A	20	20	B	C

5.9.2. Method of Measurements

Refer to Exhibit 8, Section 8.4 of this report for measurement details and TIA-603-C.

5.9.3. Test Data

5.9.3.1. 99% Occupied Bandwidth

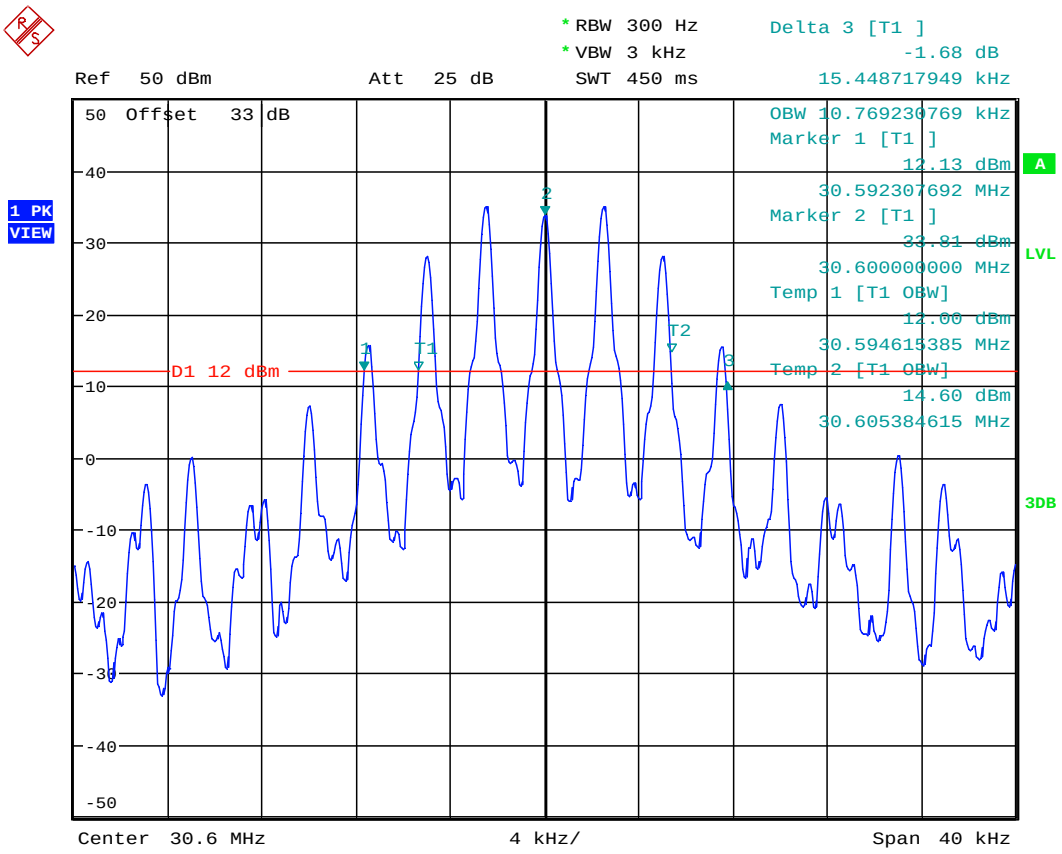
Frequency (MHz)	*Measured 99% OBW at Maximum Freq. Deviation (kHz)	Maximum Authorized Bandwidth (kHz)
30.6	15.45	20
40	15.45	20
49.6	15.45	20

Note: 99% Occupied Bandwidth measurements were done using the built-in auto function of the spectrum analyzer.

*Refer to the following test data plots for details.

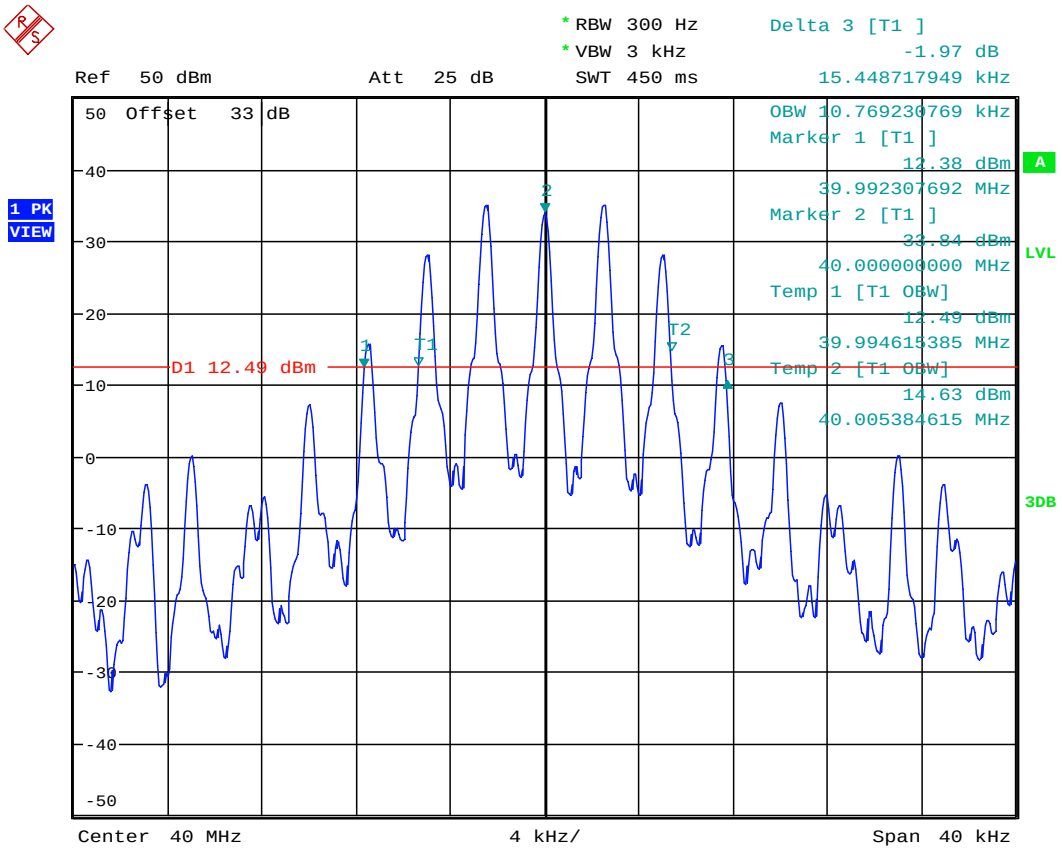
5.9.3.2. Configuration: 99% OBW, 30.6MHz, 25 KHz, Analog, High power

OBW: 15.448 KHz



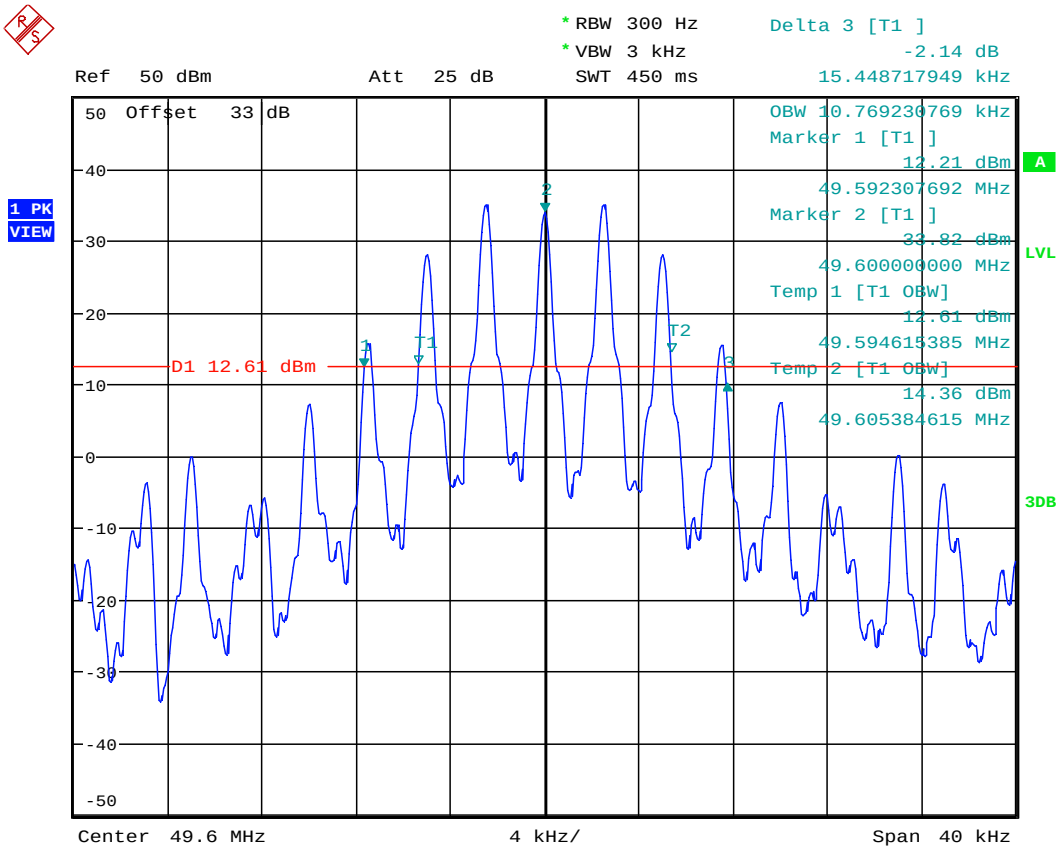
5.9.3.3. Configuration: 99% OBW, 40MHz, 25 KHz, Analog, High power

OBW: 15.448 KHz



5.9.3.4. Configuration: 99% OBW, 49.6MHz, 25 KHz, Analog, High power

OBW: 15.448 KHz



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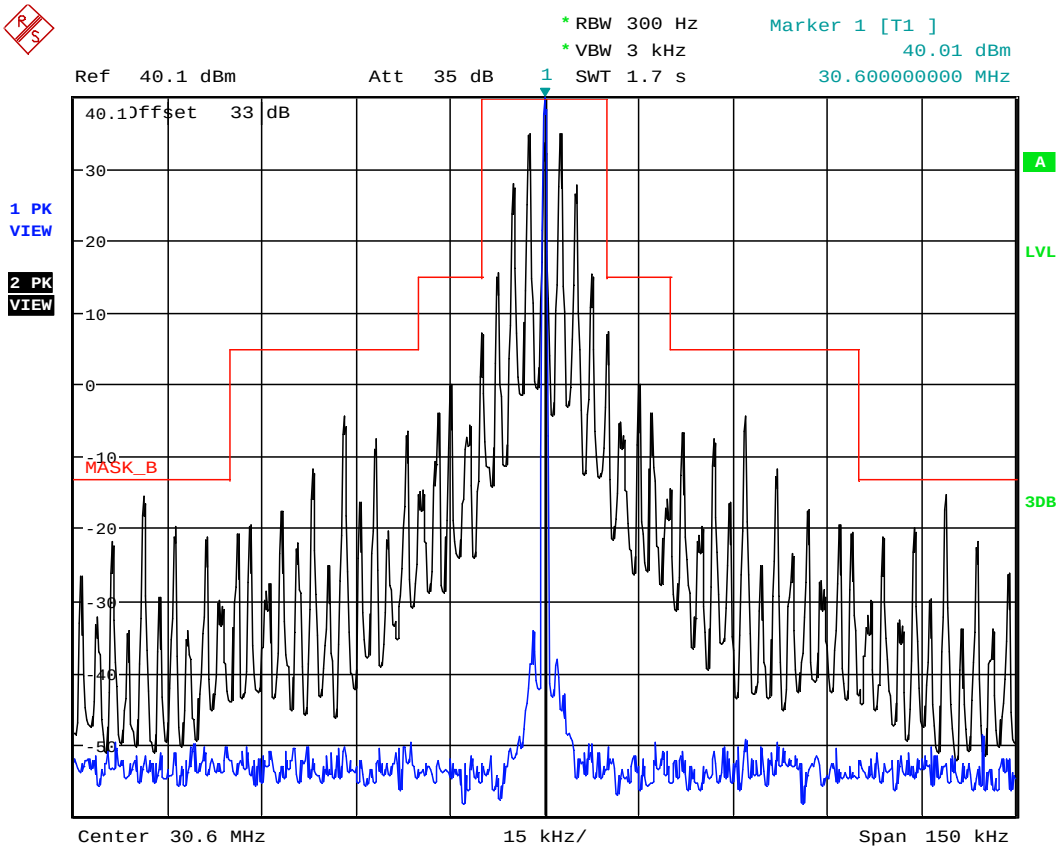
5.9.3.5. Emission Masks

High Power

5.9.3.5.1. Configuration: Mask B, 30.6MHz, 25 KHz, Analog, High power



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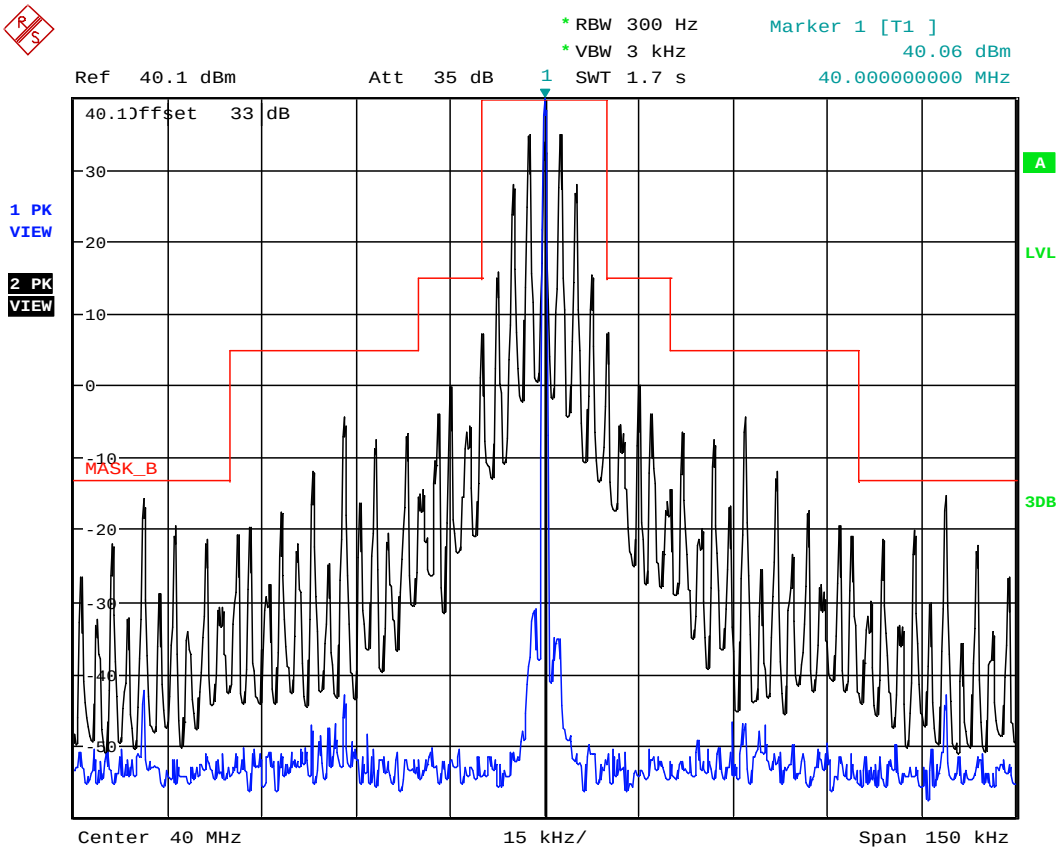
5.9.3.5.2. Configuration: Mask B, 40MHz, 25 KHz, Analog, High power



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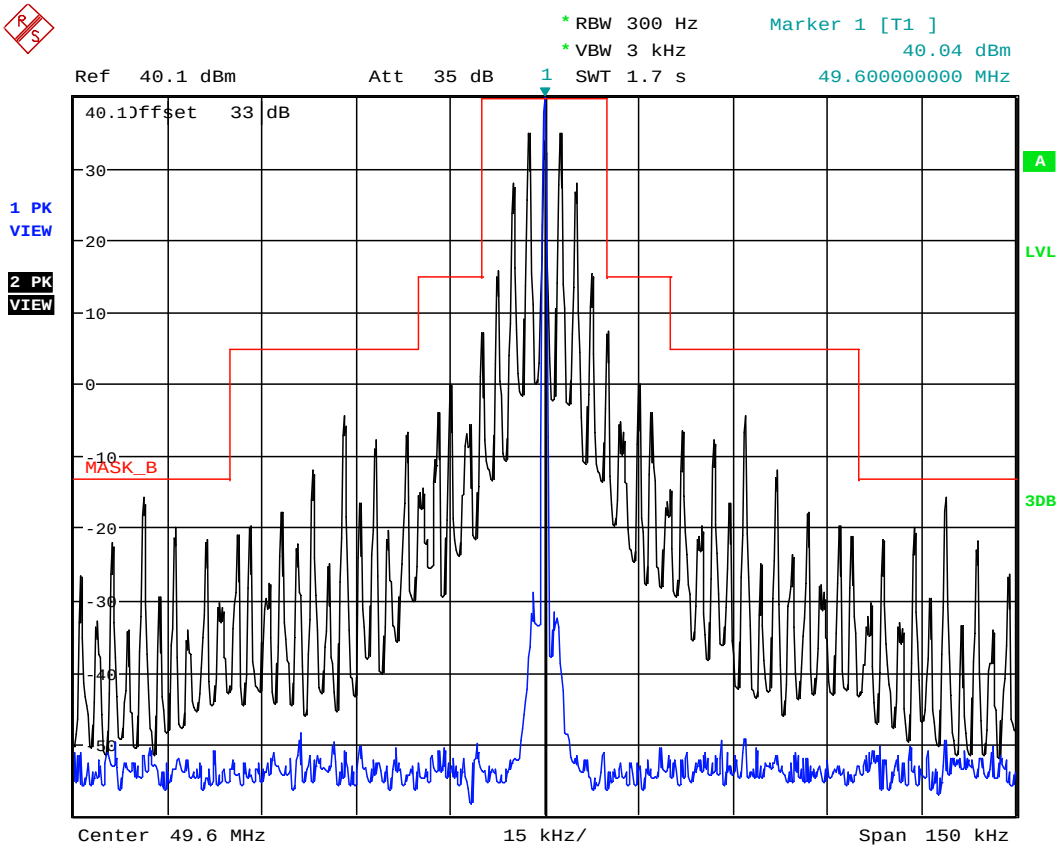
5.9.3.5.3. Configuration: Mask B, 49.6MHz, 25 KHz, Analog, High power



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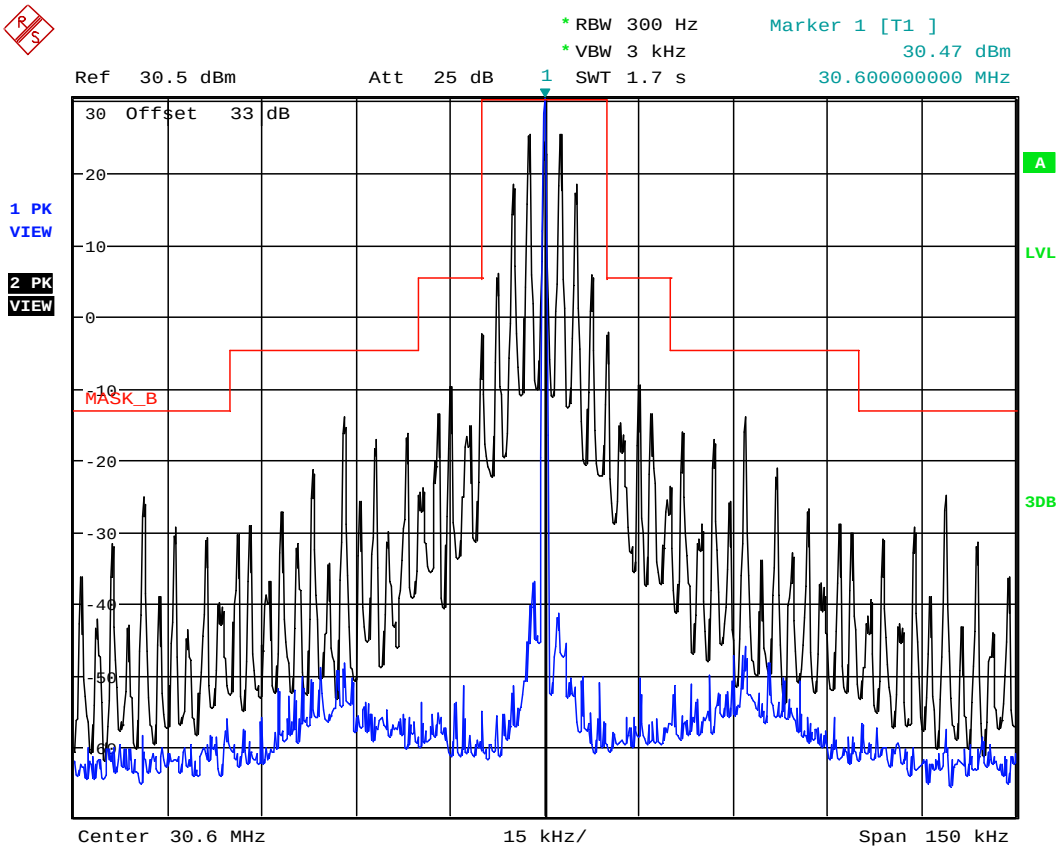
Low Power

5.9.3.5.4. Configuration: Mask B, 30.6MHz, 25 KHz, Analog, Low power



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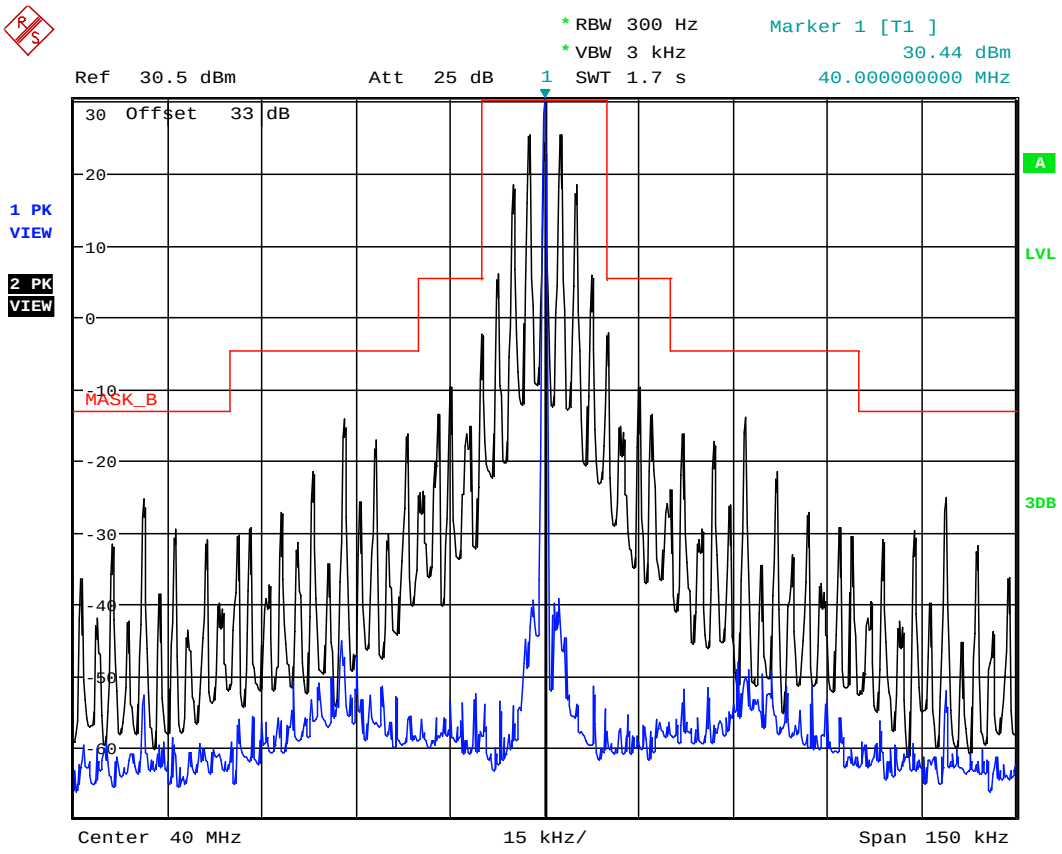
5.9.3.5.5. Configuration: Mask B, 40MHz, 25 KHz, Analog, Low power



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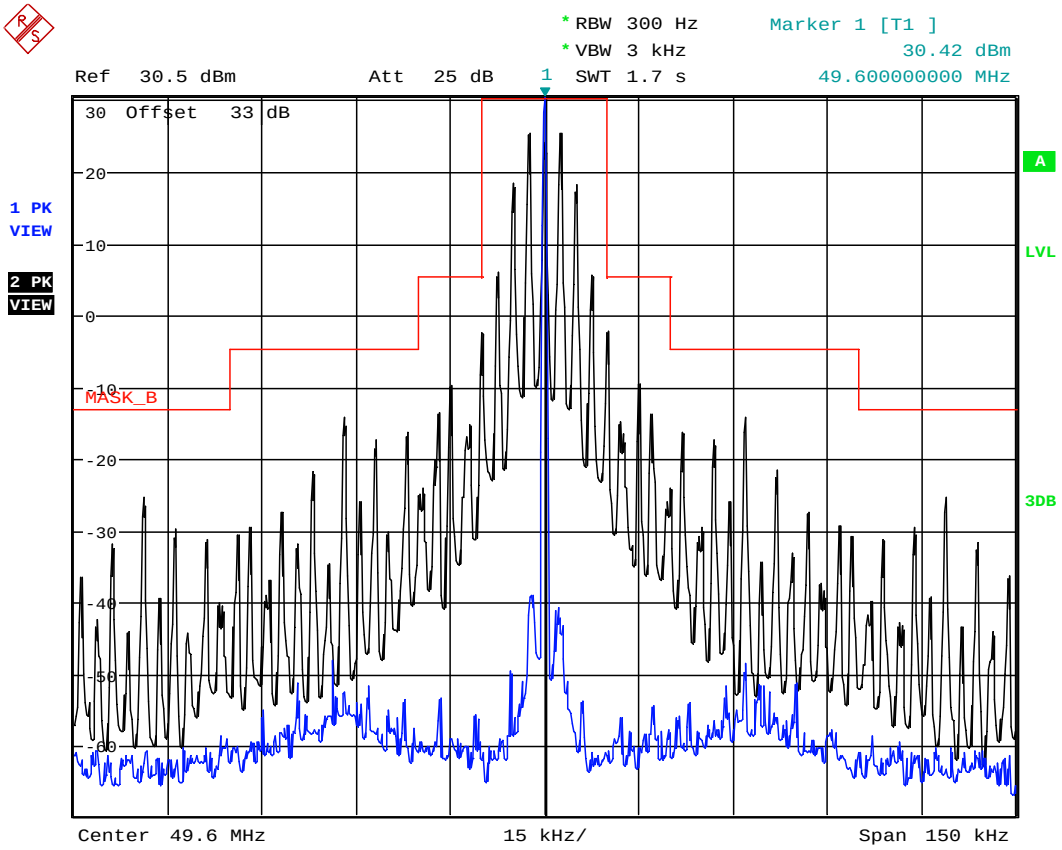
5.9.3.5.6. Configuration: Mask B, 49.6MHz, 25 KHz, Analog, Low power



Date: 24.AUG.2022 11:00:22

5.10. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051 & 90.210] [RSS-119 § 5.8]

5.10.1. Limits

The power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
90.210(b)	From the lowest radio frequency signal generated in the device to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.	At least 43 + 10 log(P) or -13 dBm

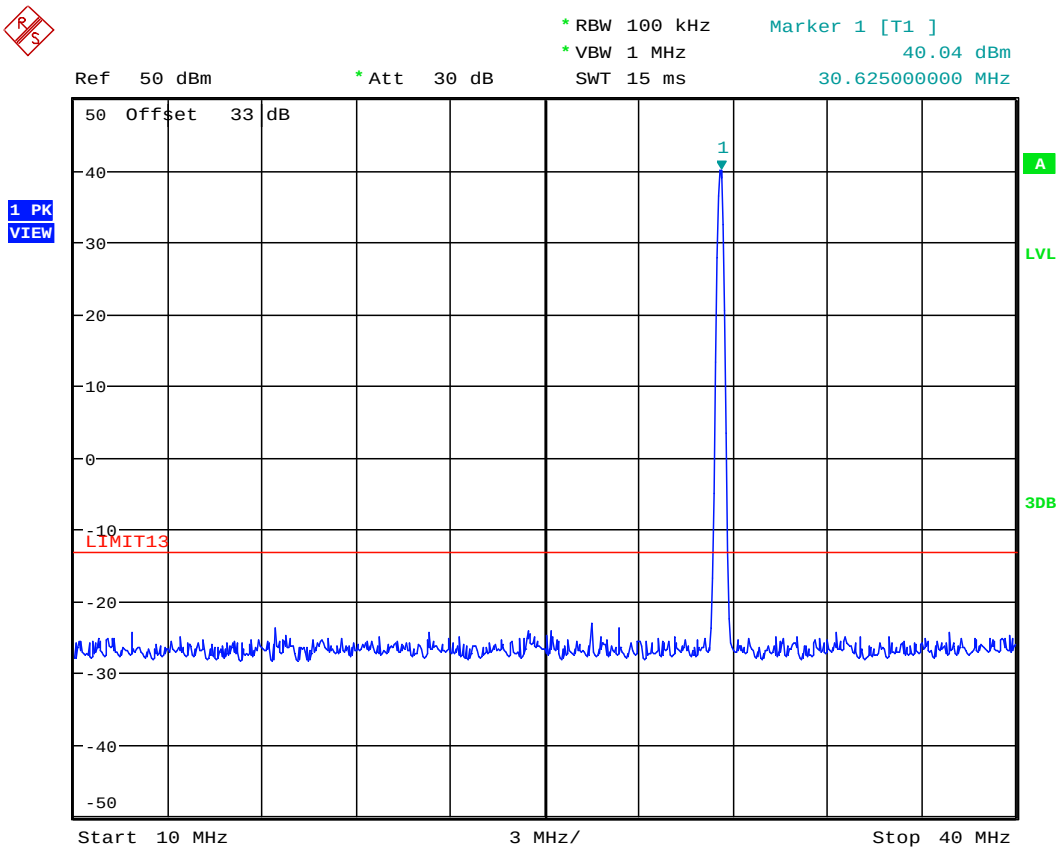
5.10.2. Method of Measurements

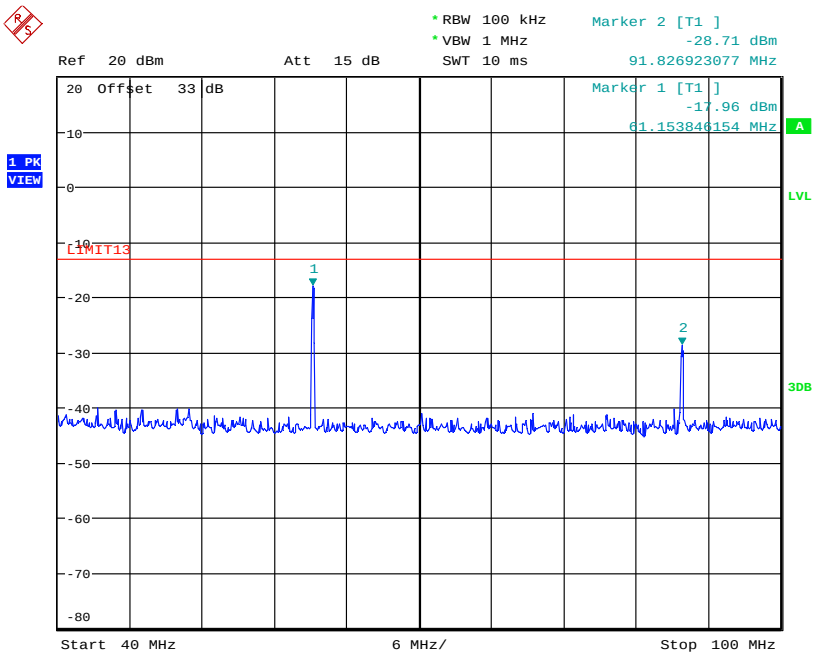
Refer to Exhibit 8 Section 8.5 of this report for measurement details

5.10.3. Test Data

High Power

5.10.3.1. Configuration: Tx Conducted, 30.6MHz, 25 KHz, Analog, High power





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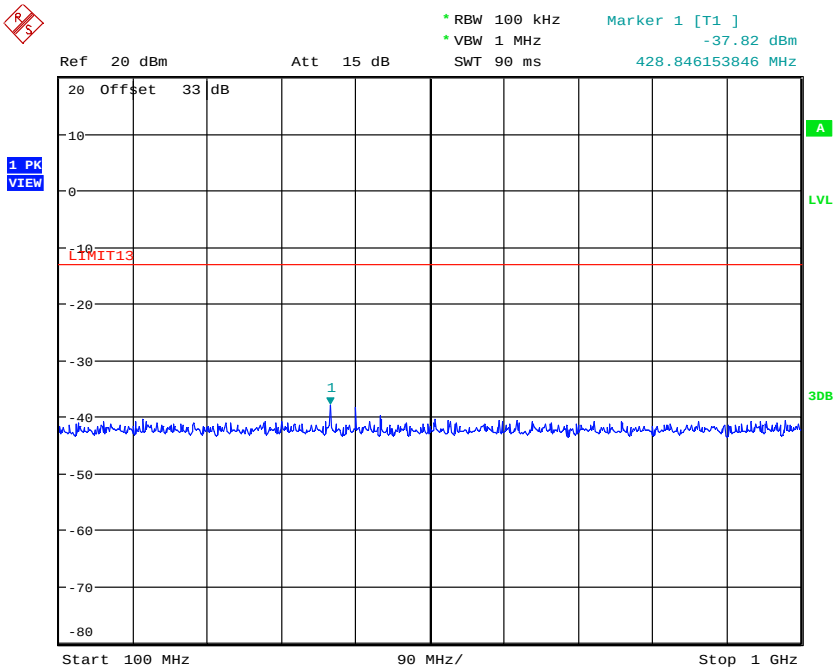
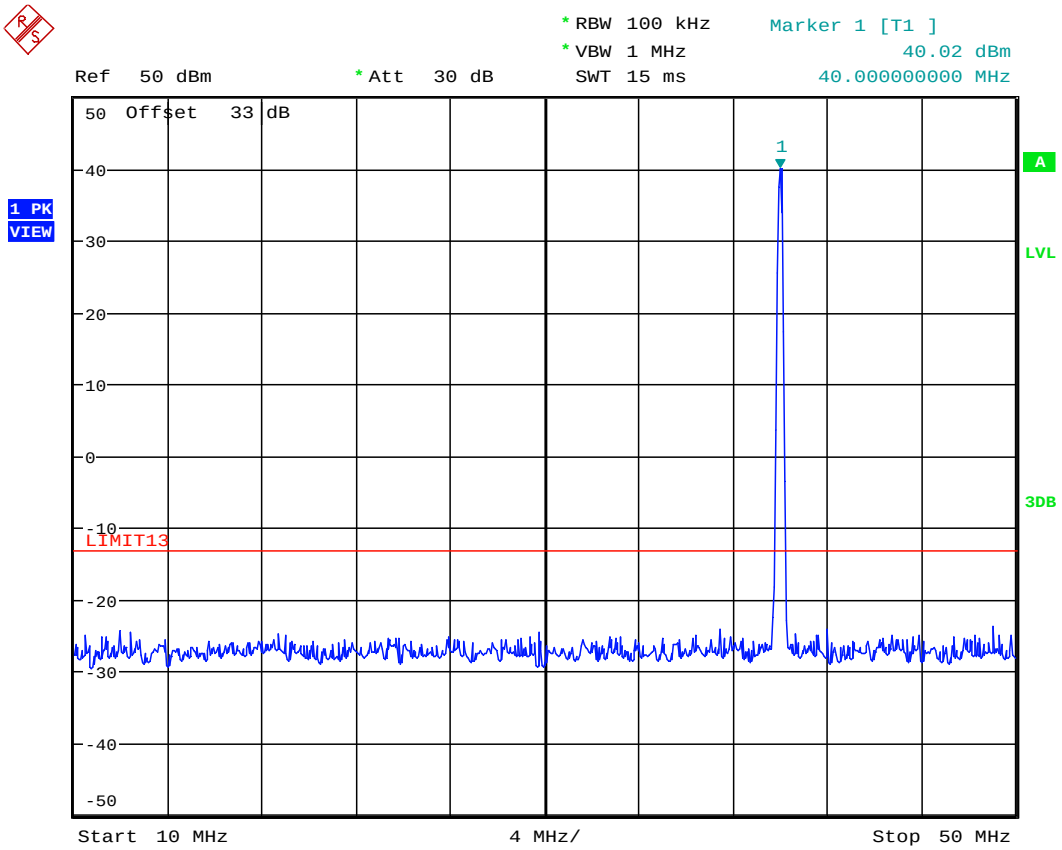


Date: 24.AUG.2022 14:17:01

5.10.3.2. Configuration: Tx Conducted, 40MHz, 25 KHz, Analog, High power



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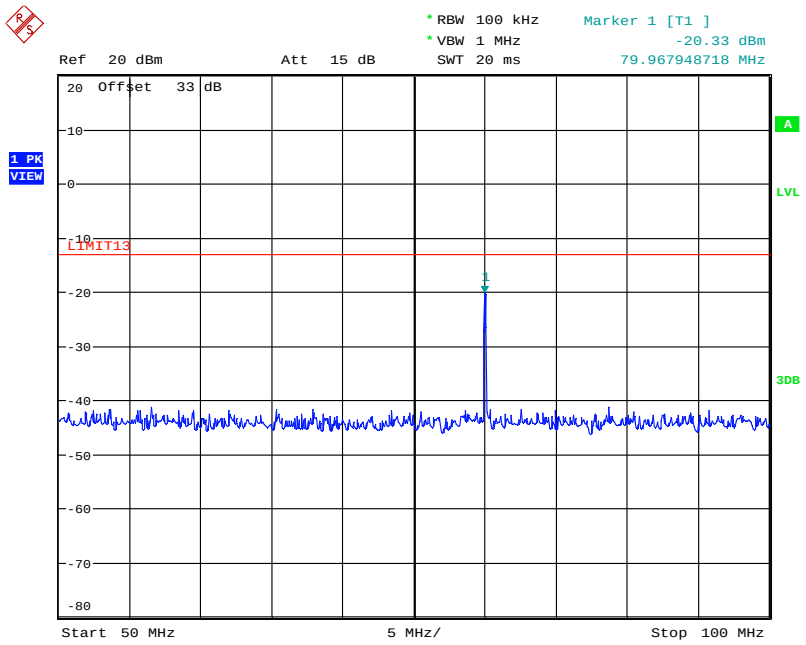
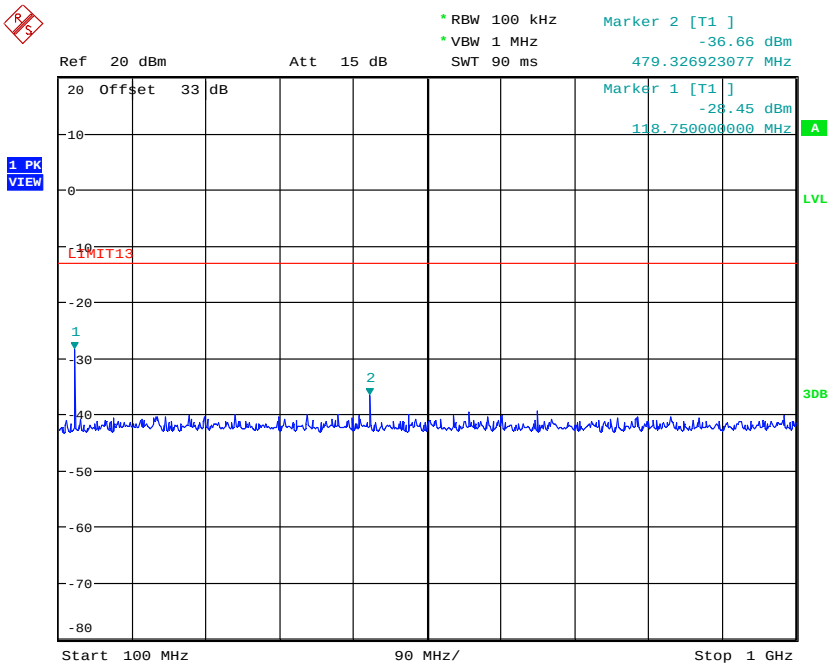
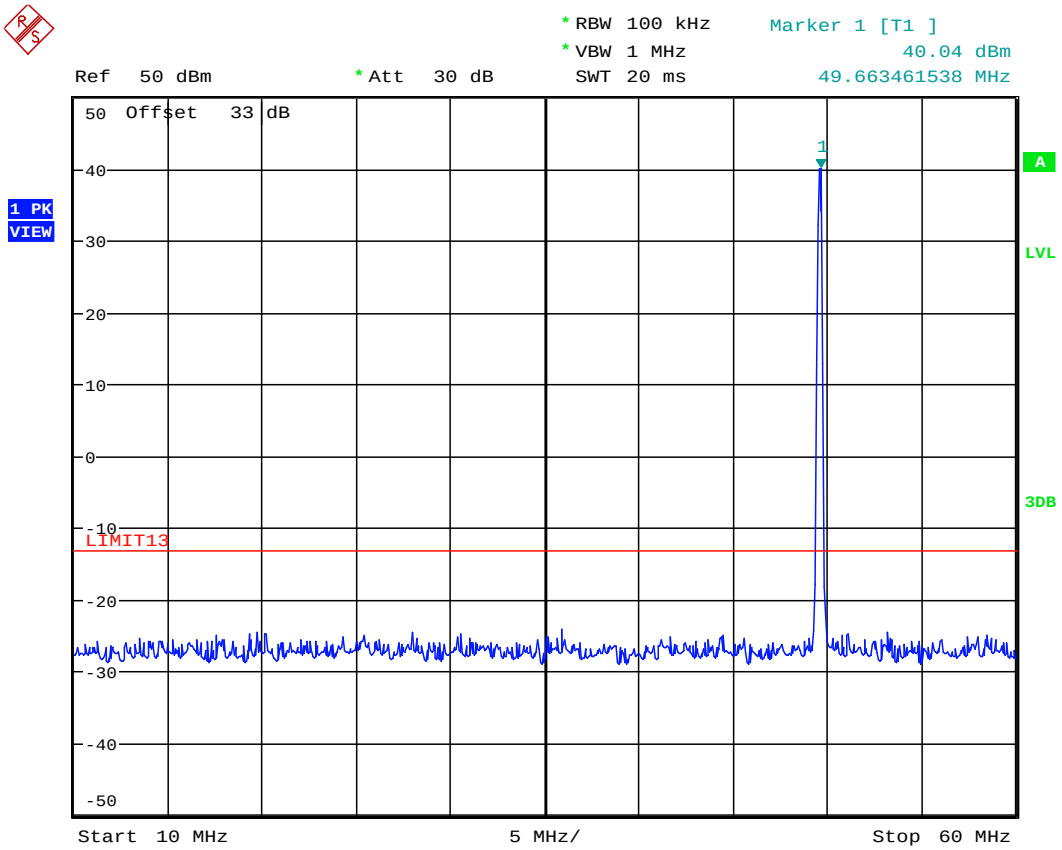


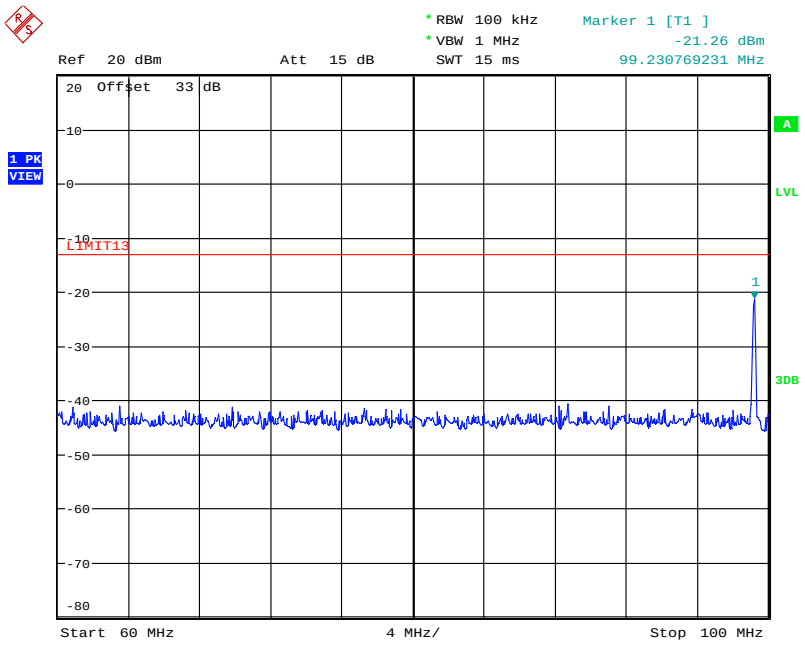
Date: 24.AUG.2022 14:03:17



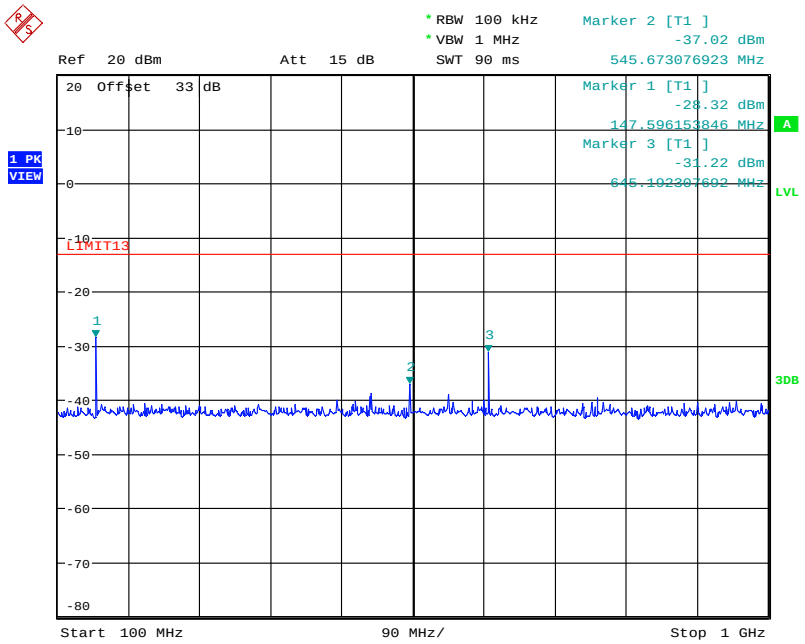
Date: 24.AUG.2022 14:35:11

5.10.3.3. Configuration: Tx Conducted, 49.6MHz, 25 KHz, Analog, High power





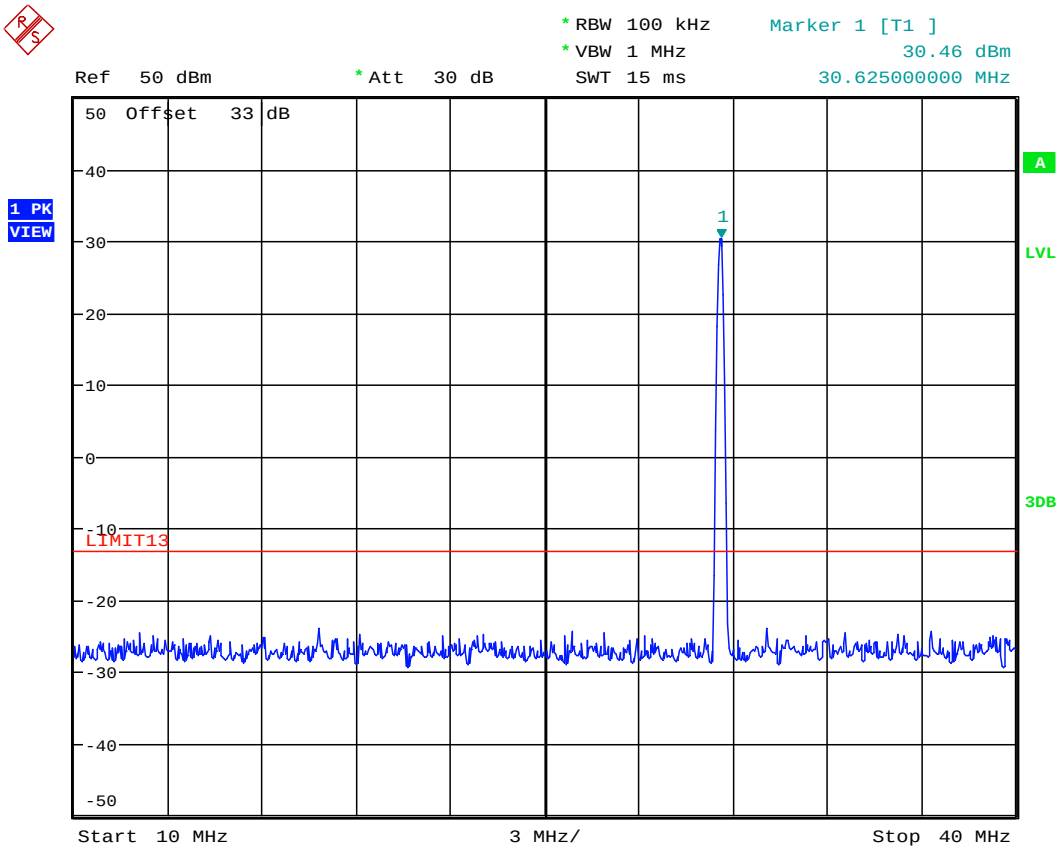
Date: 24.AUG.2022 14:08:31



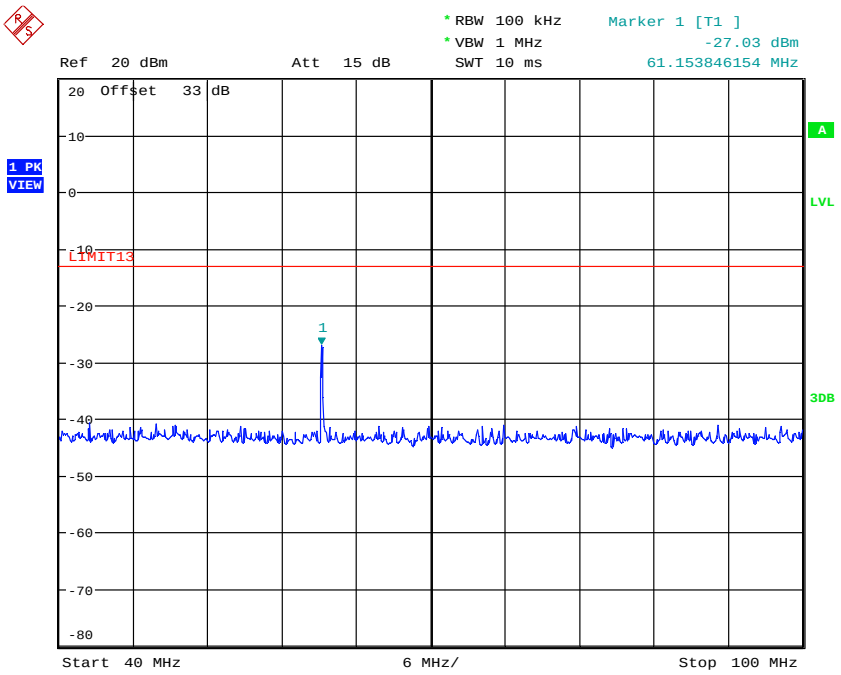
Date: 24.AUG.2022 14:23:38

Low Power

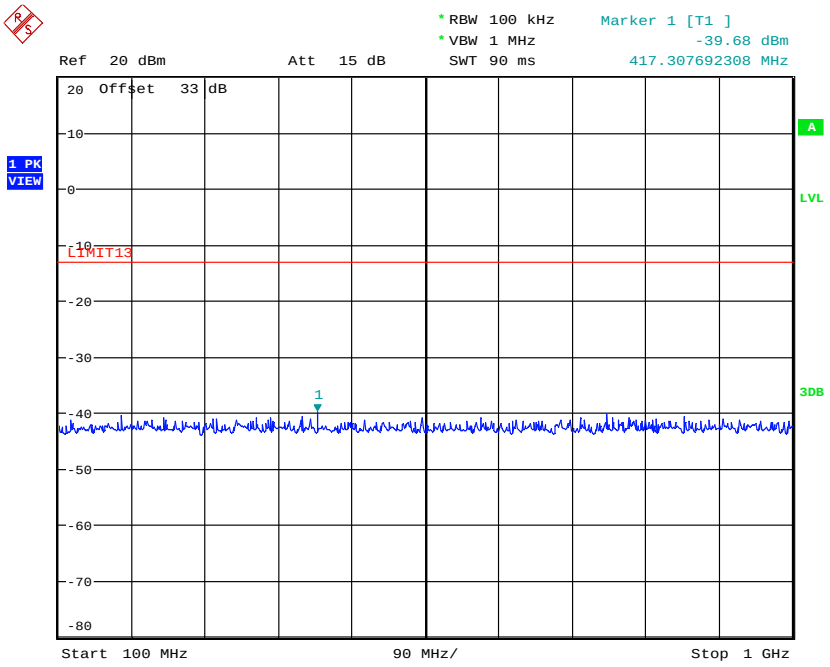
5.10.3.4. Configuration: Tx Conducted, 30.6MHz, 25 KHz, Analog, Low power



Date: 24.AUG.2022 13:15:50

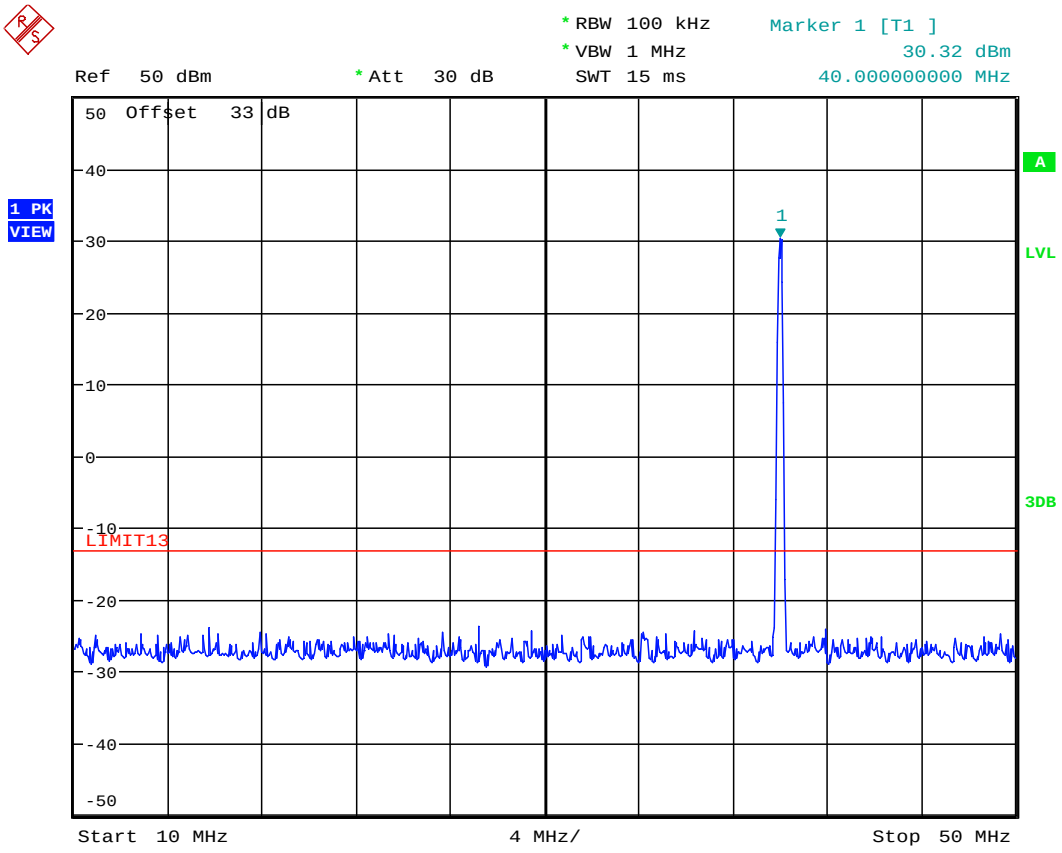


Date: 24.AUG.2022 14:01:00

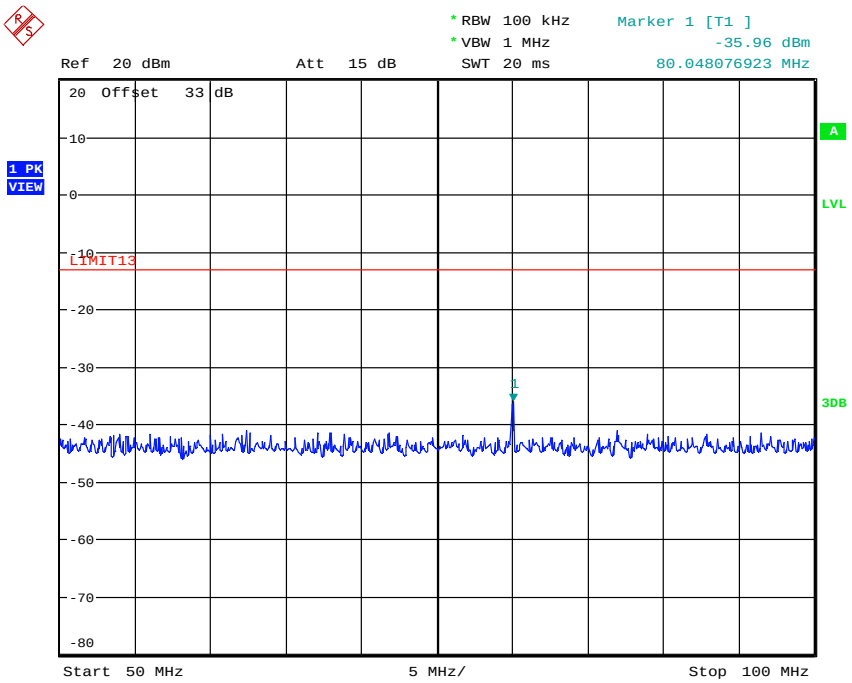


Date: 24.AUG.2022 14:17:55

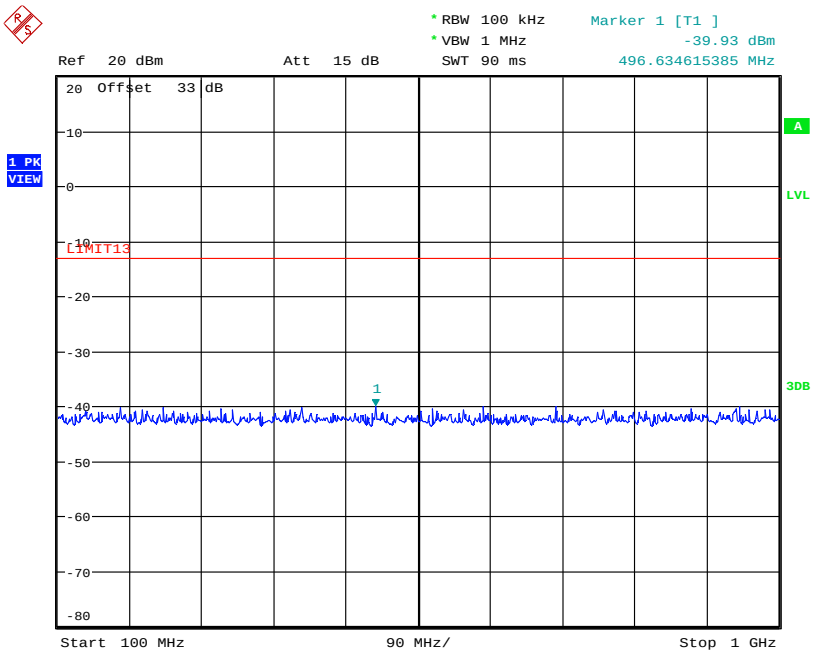
5.10.3.5. Configuration: Tx Conducted, 40MHz, 25 KHz, Analog, Low power



Date: 24.AUG.2022 13:17:28

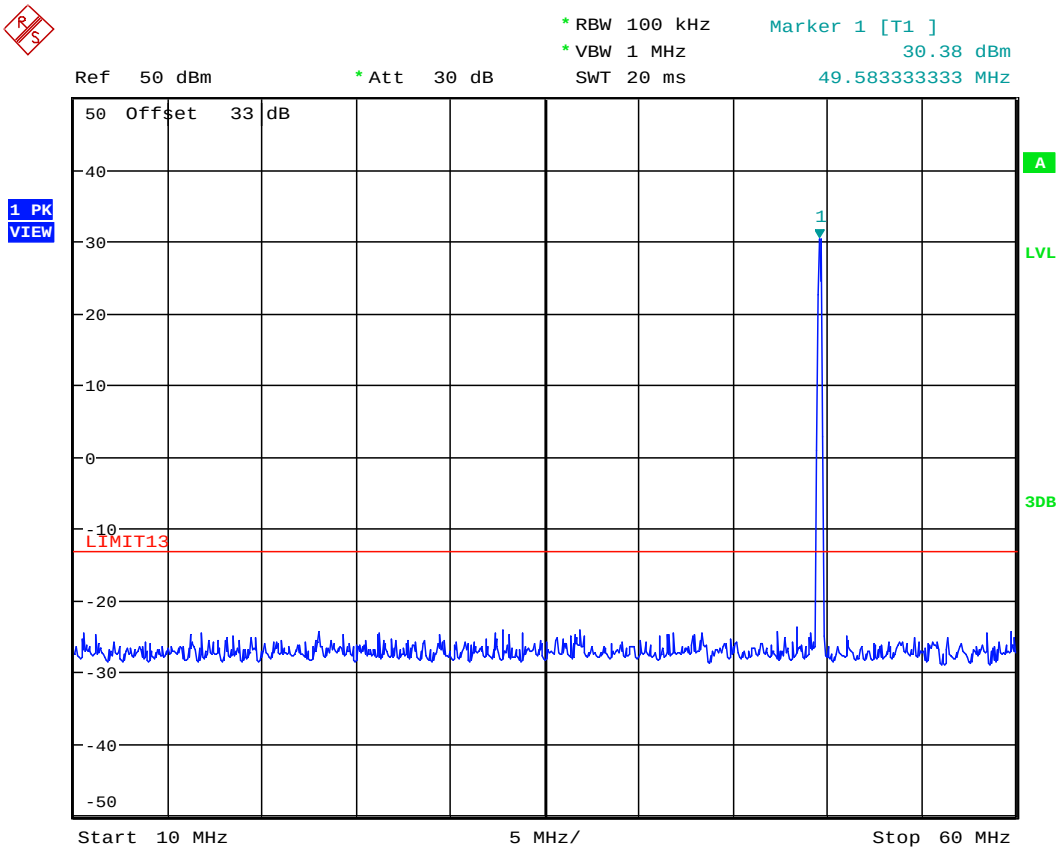


Date: 24.AUG.2022 14:06:19

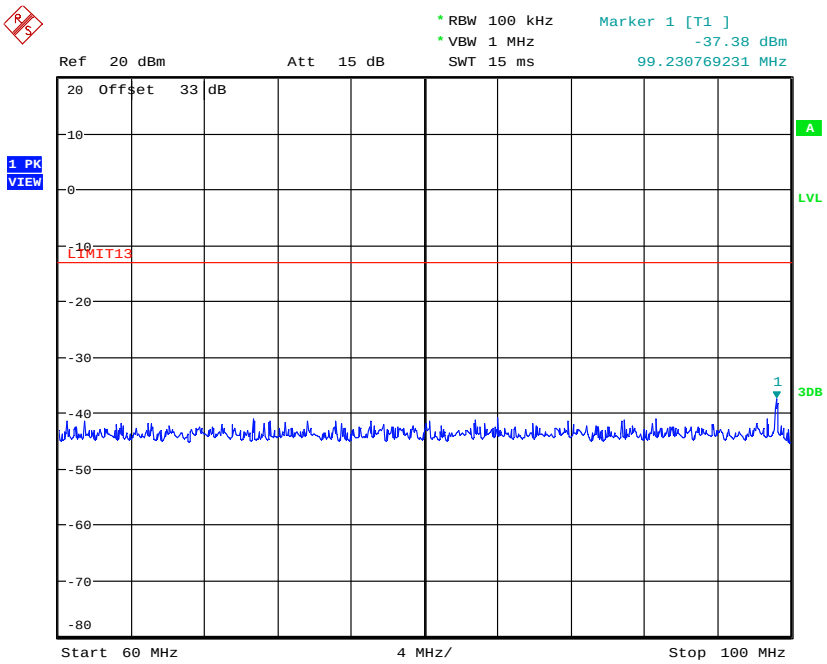


Date: 24.AUG.2022 14:21:09

5.10.3.6. Configuration: Tx Conducted, 49.6MHz, 25 KHz, Analog, Low power



Date: 24.AUG.2022 13:19:04



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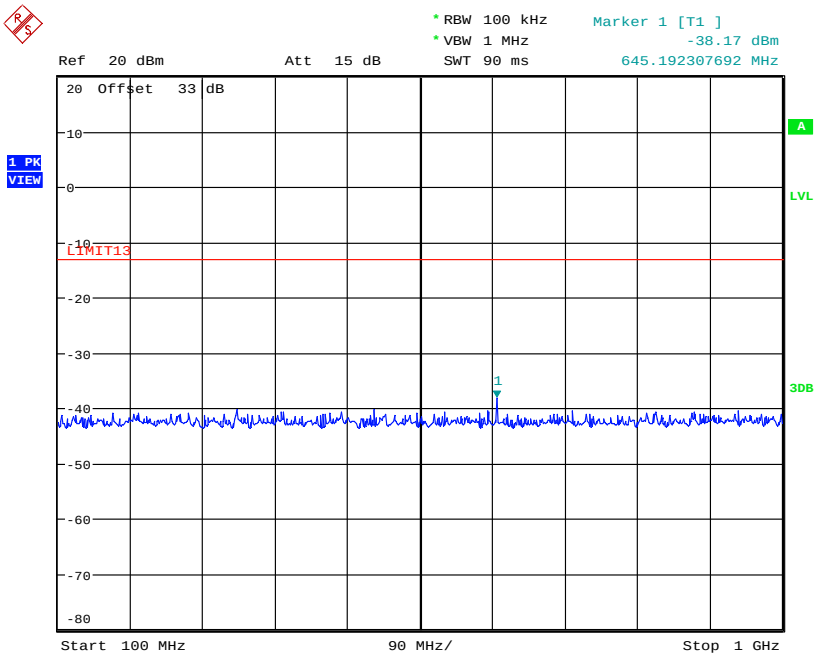


Date: 24.AUG.2022 14:24:47

5.11. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053 & 90.210] [RSS-119, § 5.5 & 5.8]

5.11.1. Limits

The power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

FCC Rules	Frequency Range	Attenuation Limit (dB)
90.210(b)	From the lowest radio frequency signal generated in the device to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.	At least 43 + 10 log(P) or -13 dBm

5.11.2. Method of Measurements

Refer to Exhibit 8 Section 8.2 of this report for measurement details.

5.11.3. Test Data

- The radiated emissions were performed with high power setting (10 Watts) at 3 m distance to represents the worst-case test configuration.
- The emissions were scanned from 30 MHz to 1 GHz; all significant emissions were recorded.

5.11.3.1. Near Lowest Frequency (30.6 MHz)

Carrier Frequency (MHz):	30.6
Power :	High
Limit (dBm):	-13
No significant spurious emissions were found with 20dB of the limits	

5.11.3.2. Near Middle Frequency (40 MHz)

Carrier Frequency (MHz):	40
Power :	High
Limit (dBm):	-13
No significant spurious emissions were found with 20dB of the limits	

5.11.3.3. Near Highest Frequency (49.6MHz)

Carrier Frequency (MHz):	49.6
Power :	High
Limit (dBm):	-13
No significant spurious emissions were found with 20dB of the limits	

5.12. RF EXPOSURE REQUIRMENTS [§§ 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.

5.12.1. 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

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	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	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).

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.

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

Maximum RF Power conducted, **$P_{conducted}$[W]:**	10.23
Maximum Antenna Gain, **G[dBi]**:	3
Maximum EIRP, **P_{EIRP}[W]**:	20.42

MPE Environment	FCC Power Density limit , S (mW/m^2)	FCC Minimum Distance (Cm)	Distance In user's manual (Cm)	Power Density at user's manual distance, S (mW/m^2)
General Population/Uncontrolled Exposure	**0.2**	**91**	**113**	**0.127**

MPE Environment	ISED Power Density limit , S (mW/m^2)	ISED Minimum Distance (Cm)	Distance In user's manual (Cm)	Power Density at user's manual distance, S (mW/m^2)
General Population/Uncontrolled Exposure	**0.1291**	**113**	**113**	**0.127**

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

5.13.1. Limits

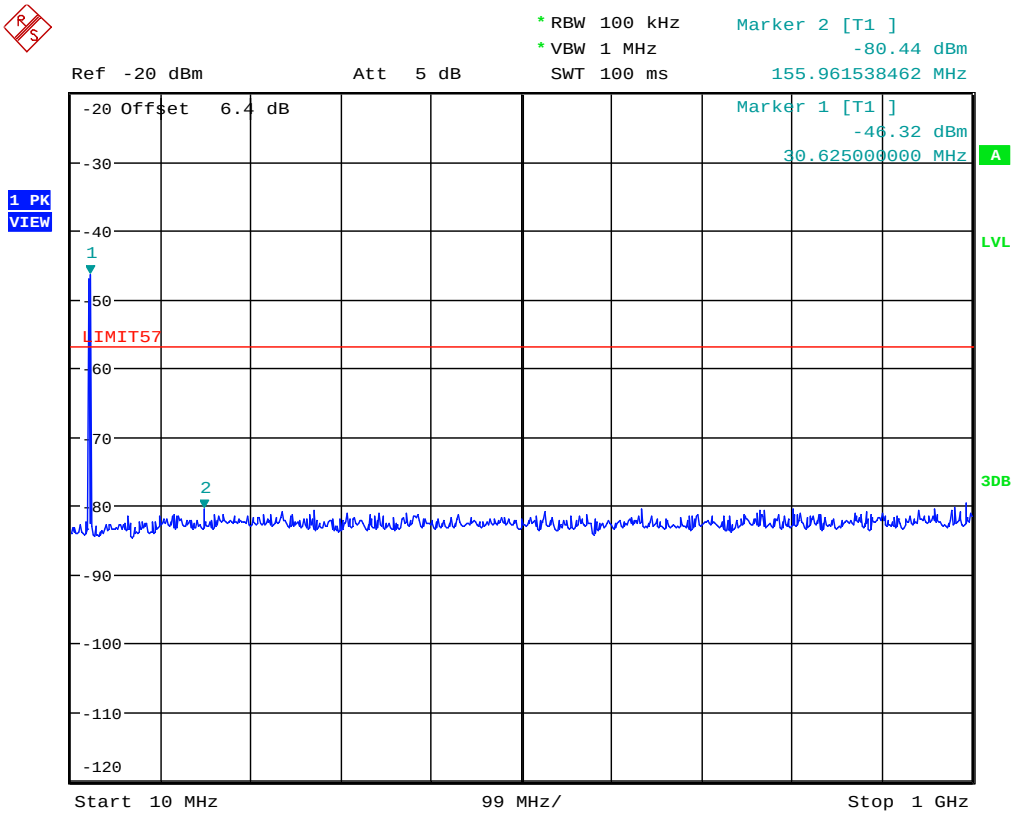
No spurious output signals appearing at the antenna terminals shall exceed 2 nanowatts per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5 nanowatts above 1 GHz.

5.13.2. Method of Measurements

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

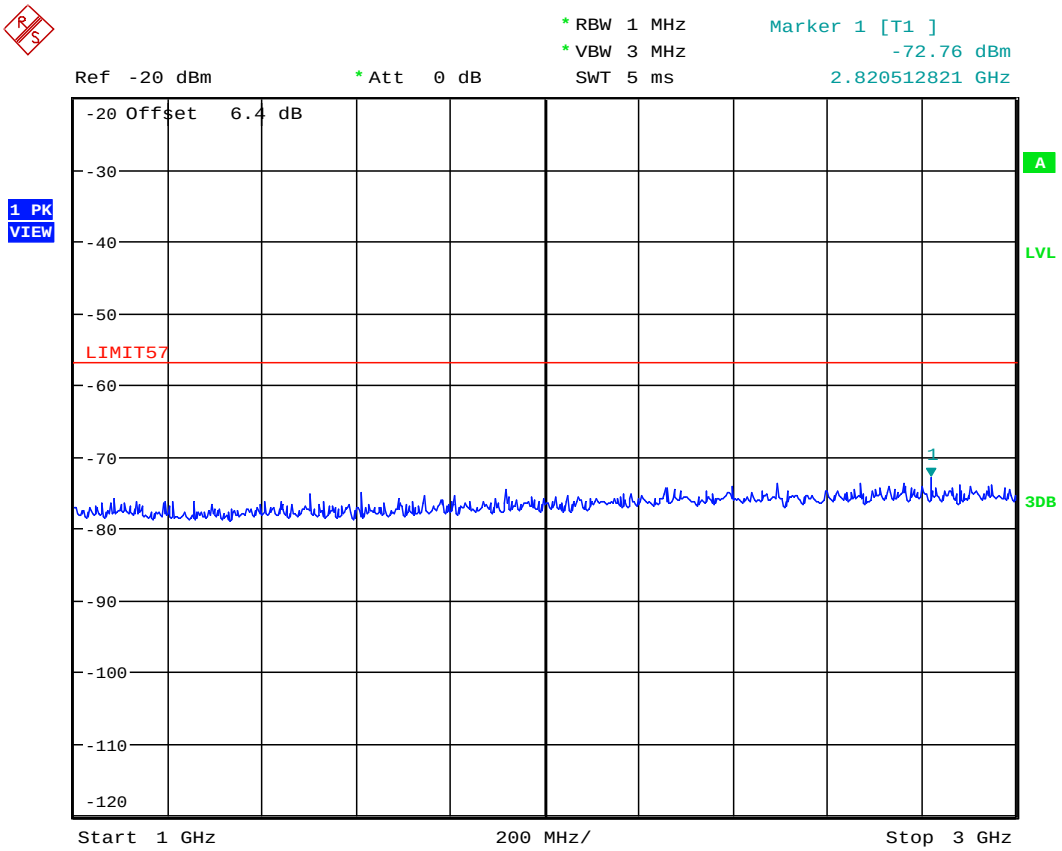
5.13.3. Test Data

5.13.3.1. Configuration: Rx Conducted, 30.6MHz



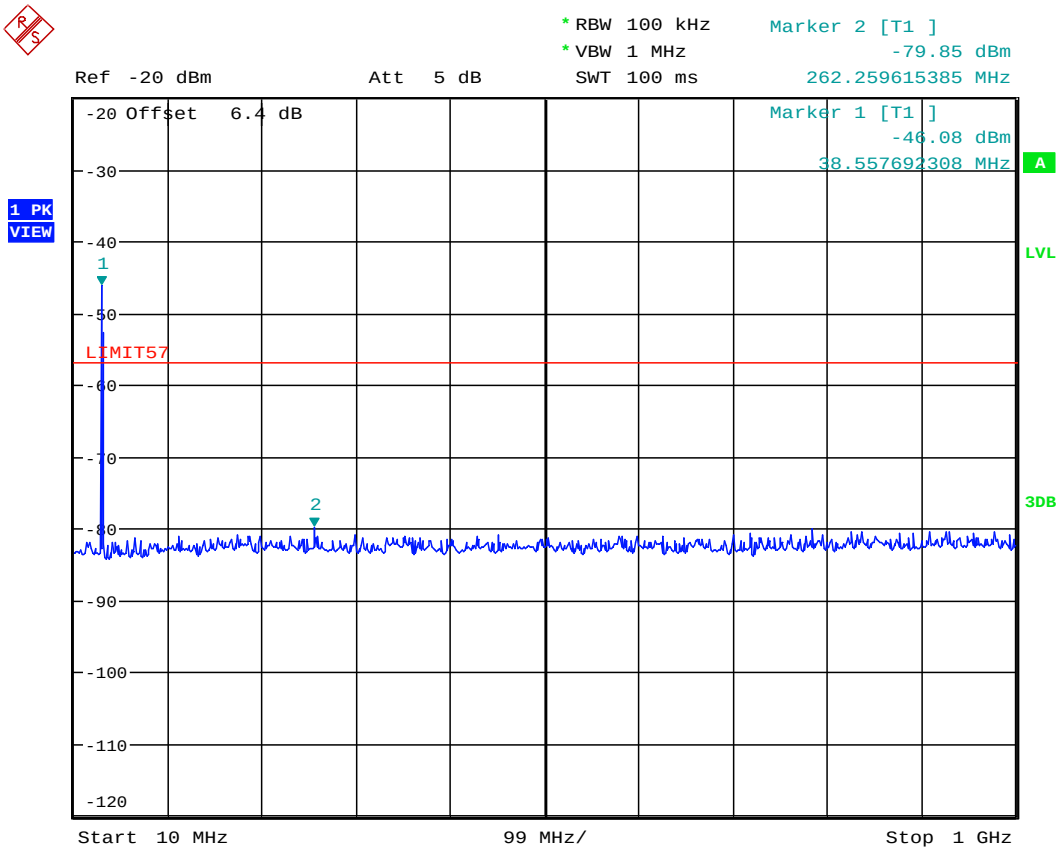
Date: 25.AUG.2022 10:27:28

Highest peak is Rx Signal input (1mV rms)



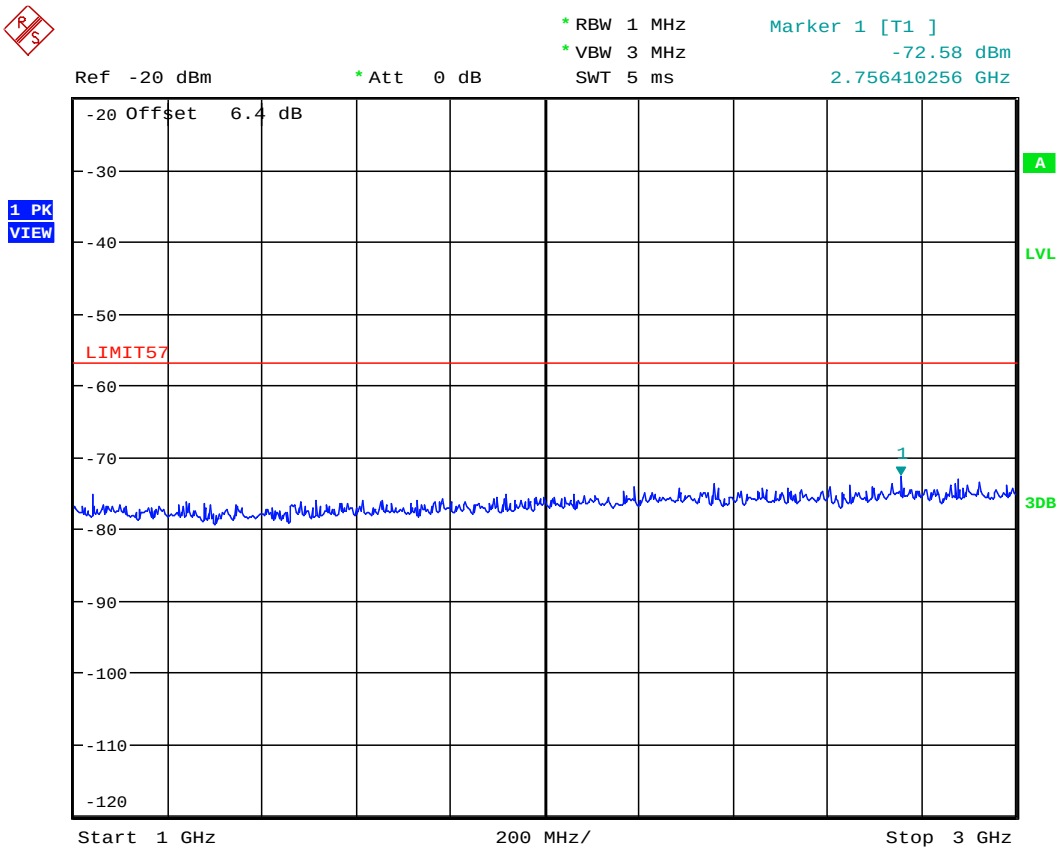
Date: 25.AUG.2022 10:32:58

5.13.3.2. Configuration: Rx Conducted, 40MHz



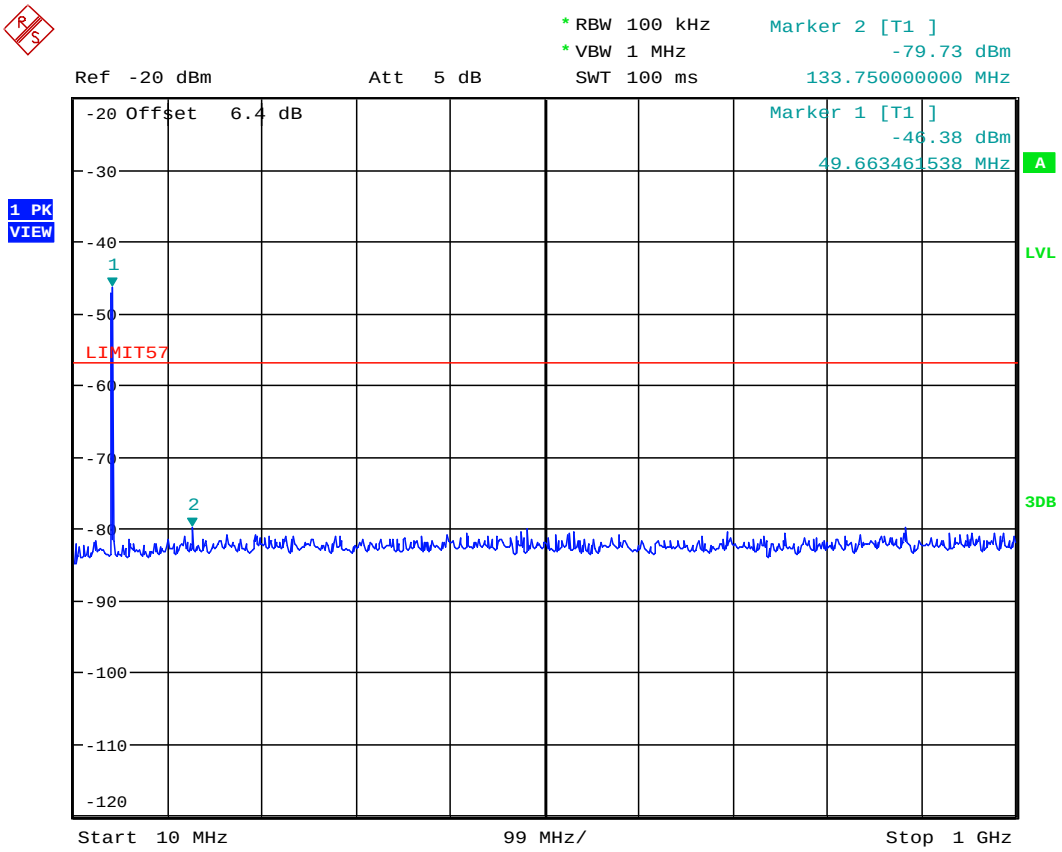
Date: 25.AUG.2022 10:28:58

Highest peak is Rx Signal input (1mV rms)



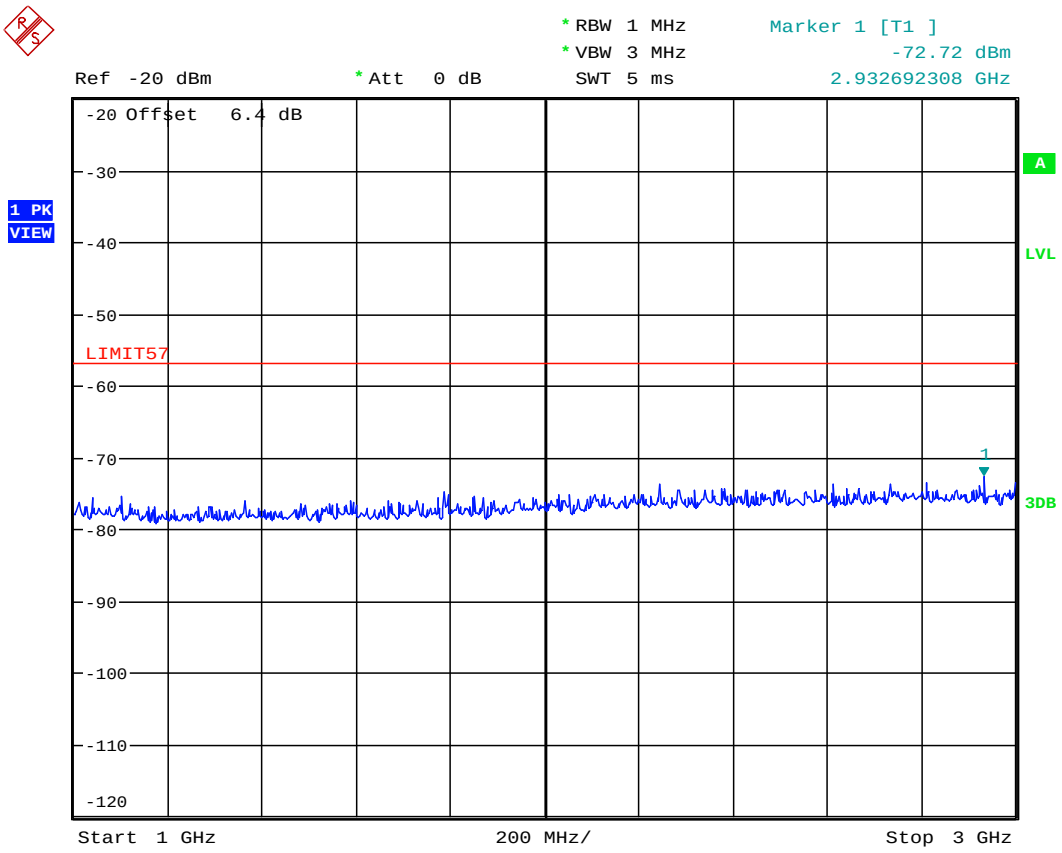
Date: 25.AUG.2022 10:32:04

5.13.3.3. Configuration: Rx Conducted, 49.6MHz



Date: 25.AUG.2022 10:30:14

Highest peak is Rx Signal input (1mV rms)



Date: 25.AUG.2022 10:31:13

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

5.14.1. Limits

The equipment shall meet the limits of the following table:

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

5.14.2. Method of Measurements

RSS-Gen and ANSI C63.4

5.14.3. Test Data

The emissions were scanned from 30 MHz to 1.0 GHz at 3 Meters distance and all emissions less than 20 dB below the limits were recorded.

(IF=45 MHz)

Rx Test Frequency	Result
30.6 MHz	All emissions were observed to be less than 20dB below the limit
40 MHz	All emissions were observed to be less than 20dB below the limit
49.6 MHz	All emissions were observed to be less than 20dB below the limit

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

5.15.1. Limit(s)

The equipment shall meet the limits of the following table:

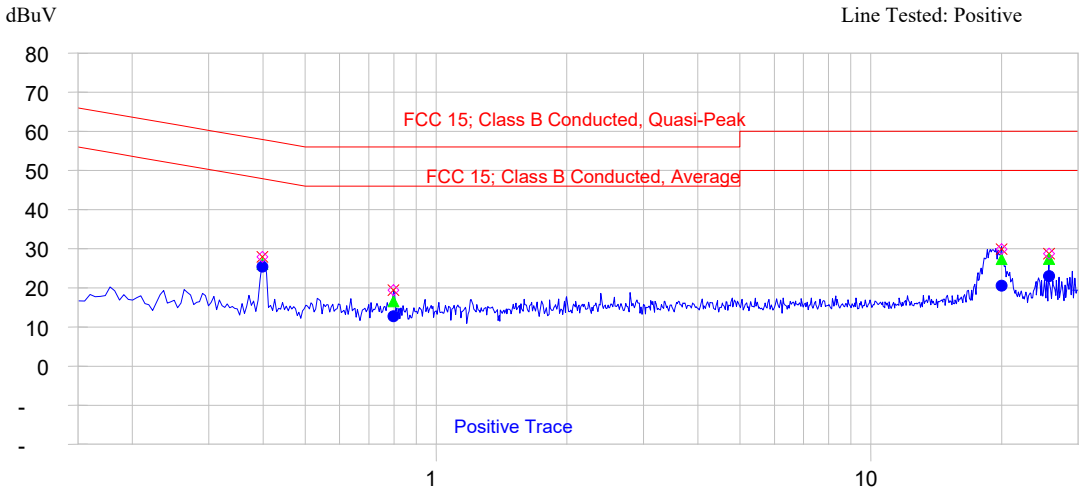
Frequency of emission (MHz)	Conducted Limits (dBμV)	
	Quasi-peak	Average
0.15–0.5 .....……..	66 to 56*	56 to 46*
0.5–5 .....……..	56	46
5-30 ……..	60 ..……..	50

*Decreases with the logarithm of the frequency

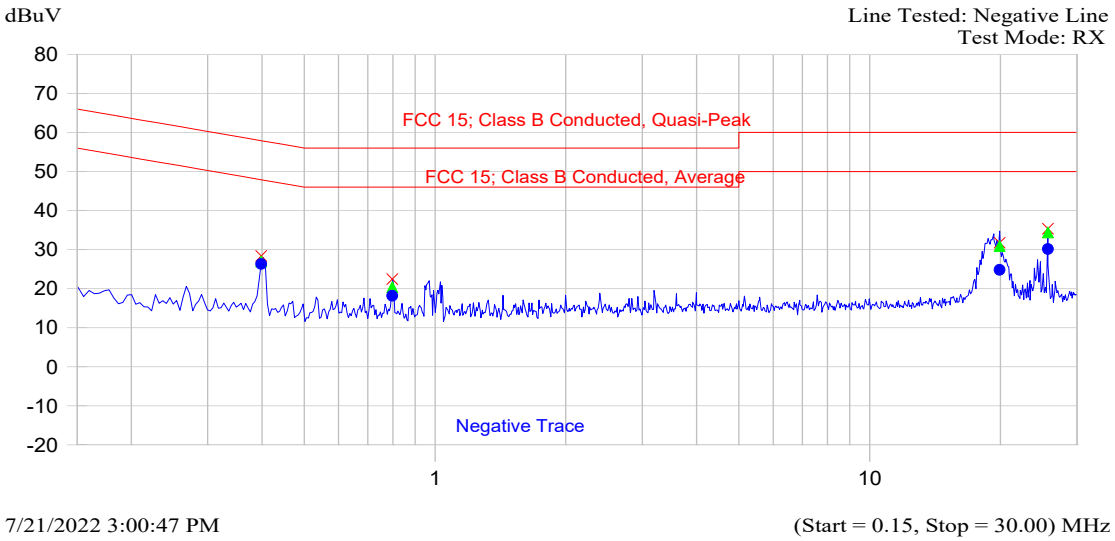
5.15.2. Method of Measurements

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

5.15.3. Test Data



Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.399	27.9	26.1	-31.8	25.4	-22.5	Positive Trac



Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
25.714	35.4	34.4	-25.6	30.1	-19.9	Negative Trace

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

5.16.1. Limits

The equipment shall meet the limits of the following table:

Frequency of emission (MHz)	Class B Limits	
	(dBμV/m at 3 m)	(dBμV/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

5.16.2. Method of Measurements

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

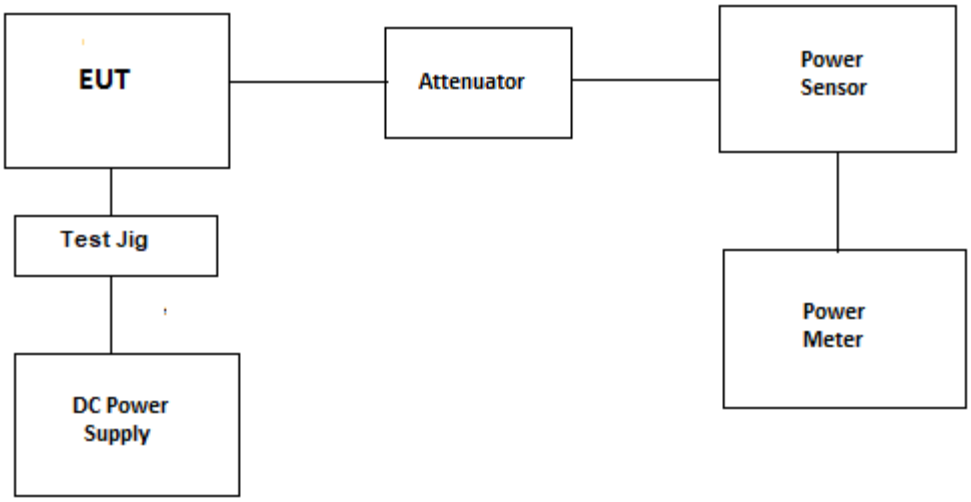
5.16.3. Test Data

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	40	-8.45	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

EXHIBIT 6. TEST SETUP AND EQUIPMENT LIST

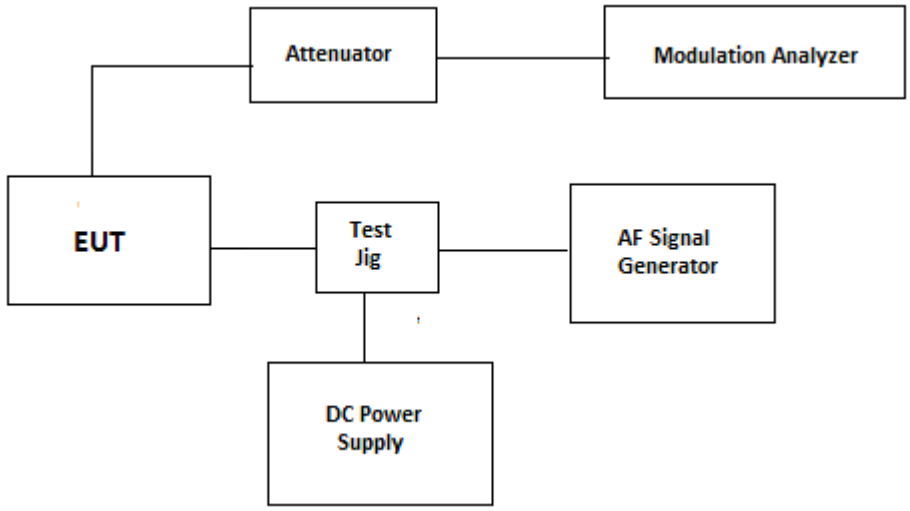
6.1. Conducted Power



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 23-3-34	BR9127 AM2548	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

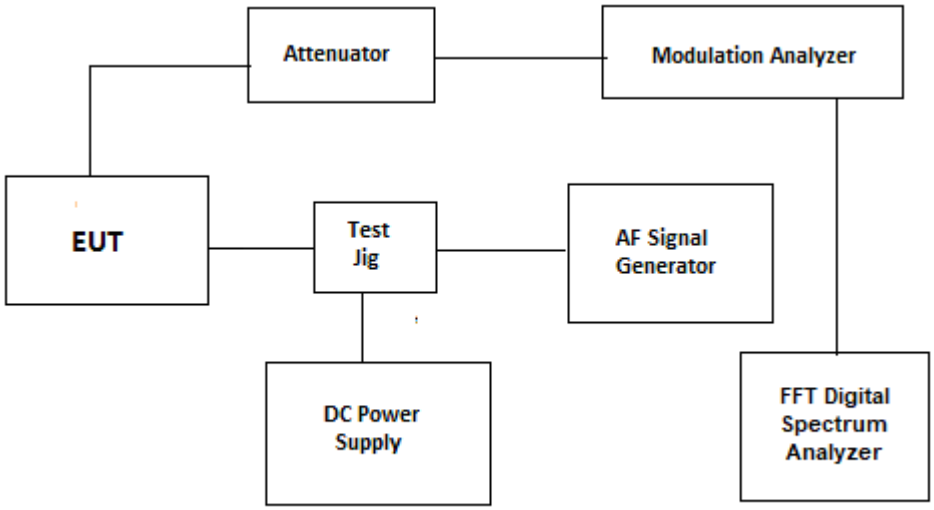
6.2. Modulation Limit



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	Aeroflex\Weinschel	46-30-34 23-3-34	BR9127 AM2548	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

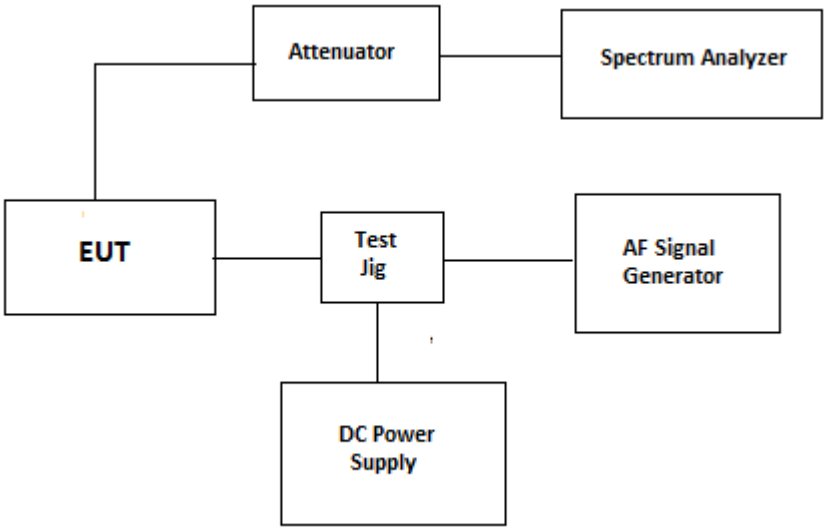
6.3. Audio Frequency Response



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	Aeroflex\Weinschel	46-30-34 23-3-34	BR9127 AM2548	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

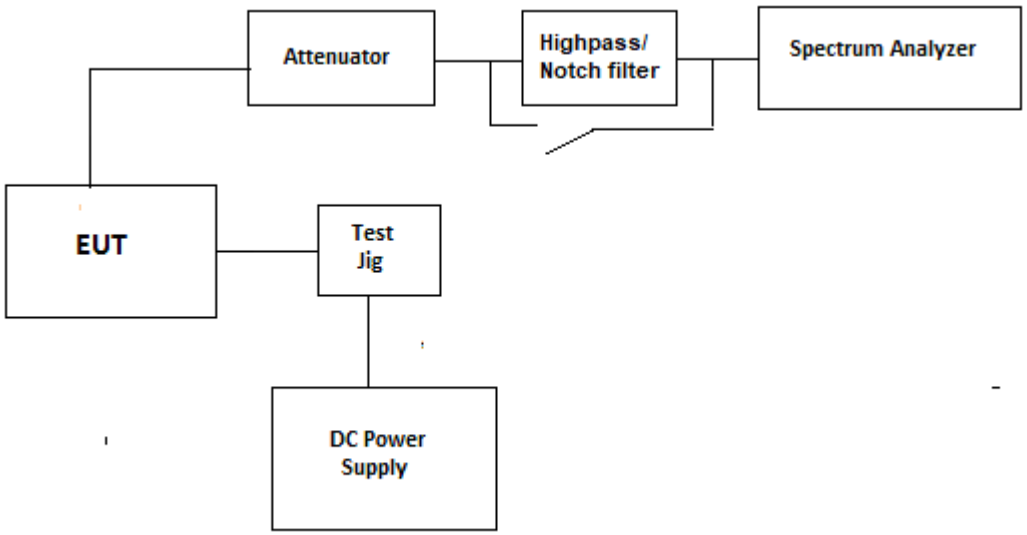
6.4. 99% OBW and Mask



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	Aeroflex\Weinschel	46-30-34 23-3-34	BR9127 AM2548	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

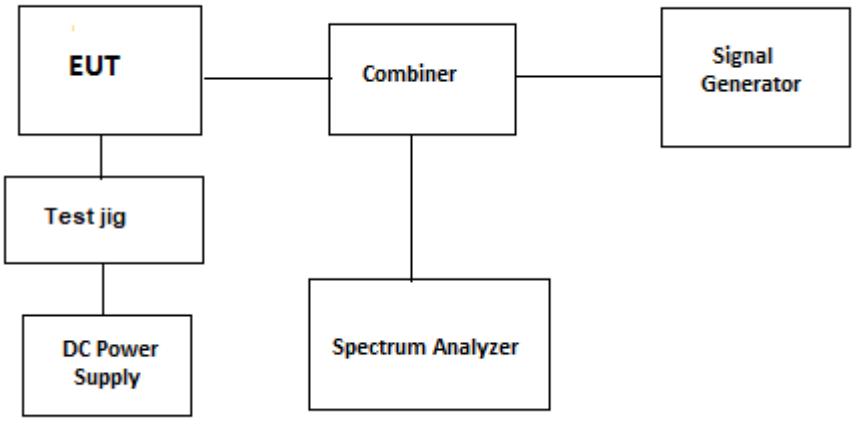
6.5. Tx Conducted Emission



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
Notch filter	K &L	3TNF-30/76-N/N	36	30-76MHz	Cal on use
Hi-pass filter	Mini-Circuit	BHP-100	--	Cut off 90MHz	Cal on use
Attenuator	Aeroflex\Weinschel	46-30-34 23-3-34	BR9127 AM2548	DC-18GHz	Cal on use
Power Supply	HQ Power	PS613U	-	1-30V, DC 3A	----
Multimeter	Fluke	8842A	4142058	---	01 Oct 2022

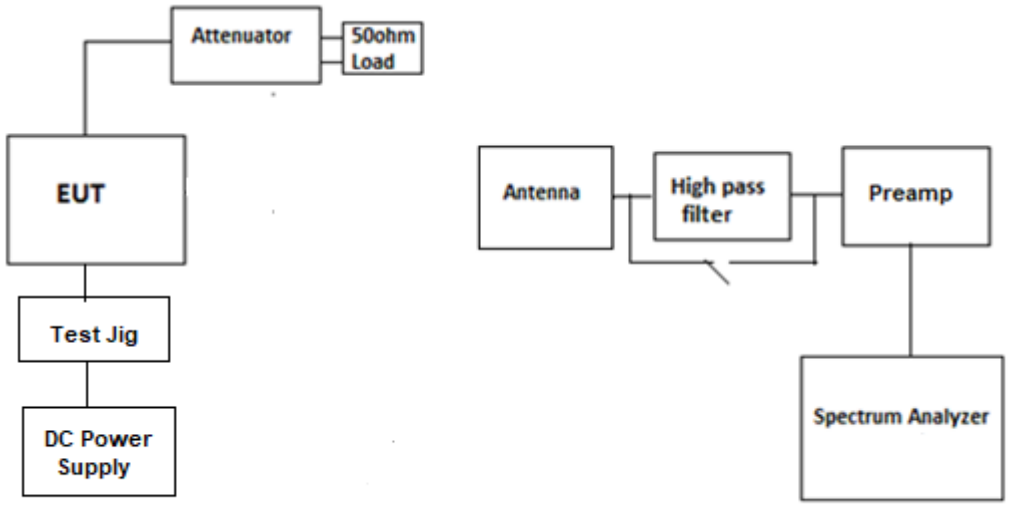
6.6. Rx Conducted Emission



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
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	4142058	---	01 Oct 2022

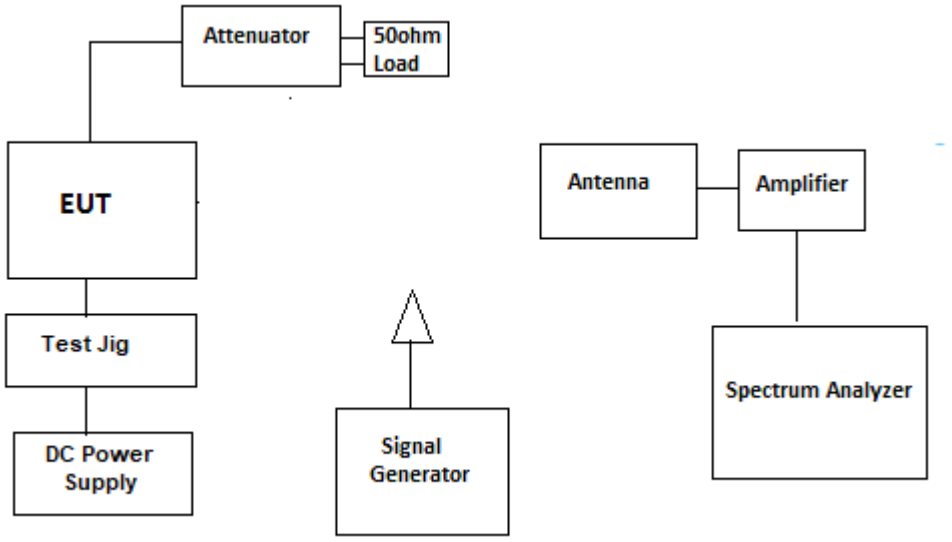
6.7. TX Radiated



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	BHP-100	--	Cut off 90MHz	Cal on use
Attenuator	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

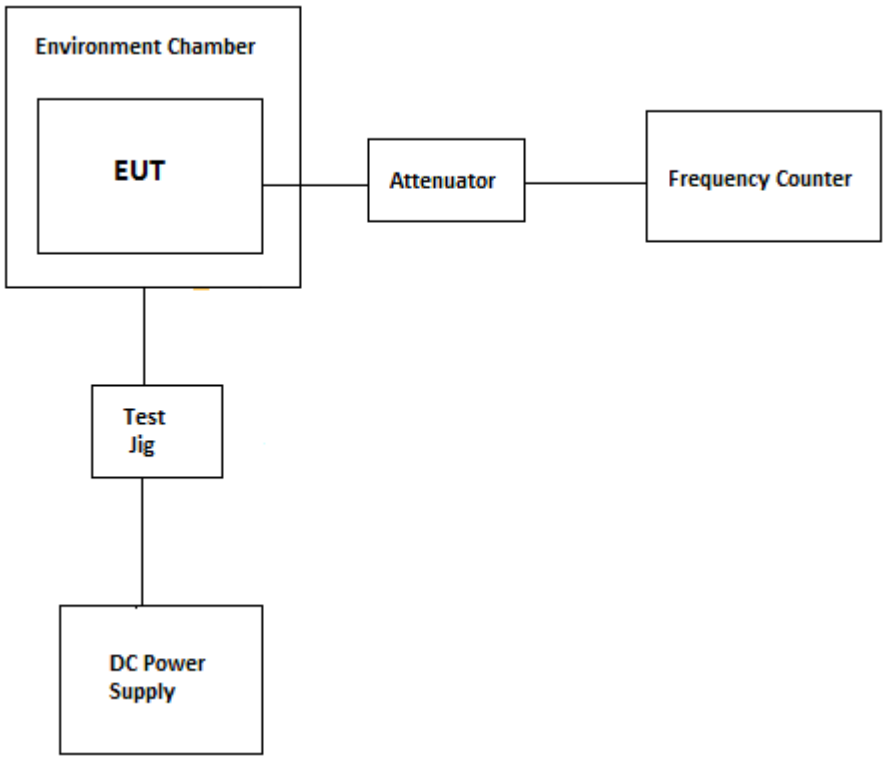
6.8. Rx Radiated, Unintentional Radiated



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

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

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

EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER MEASUREMENTS

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- I f the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

Step 1: Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with 0<x<1, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

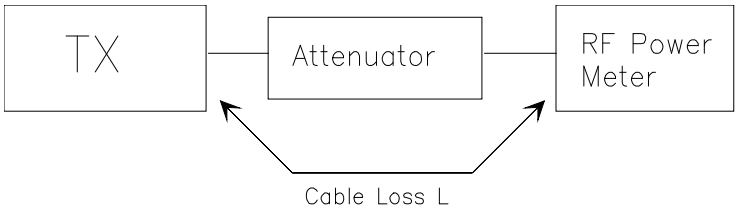
Step 2: Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

EIRP = A + G + 10log(1/x)

{X = 1 for continuous transmission => 10log(1/x) = 0 dB}

Figure 1.



8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

8.2.1. MAXIMIZING RF EMISSION LEVEL (E-FIELD)

(a) The measurements were performed with full rf output power and modulation.
(b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
(c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
(d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
(e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBμV/m) = Reading (dBμV) + Total Correction Factor (dB/m)

(f) Set the EMI Receiver and #2 as follows:

Center Frequency:	test frequency
Resolution BW:	100 KHz
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
(h) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.
(i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
(j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
(k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
(l) Repeat for all different test signal frequencies.

8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

(a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency:	equal to the signal source
Resolution BW:	100 KHz
Video BW:	VBW > RBW
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
- DIPOLE antenna for frequency from 30-1000 MHz or
- HORN antenna for frequency above 1 GHz }.

(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
(f) Use one of the following antenna as a receiving antenna:
- DIPOLE antenna for frequency from 30-1000 MHz or
- HORN antenna for frequency above 1 GHz }.

(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
(i) Tune the EMI Receivers to the test frequency.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

P = P1 - L1 = (P2 + L2) – L1 = P3 + A + L2 - L1
EIRP = P + G1 = P3 + L2 - L1 + A + G1
ERP = EIRP – 2.15 dB
Total Correction factor in EMI Receiver # 2 = L2 – L1 + G1

Where:	P:	Actual RF Power fed into the substitution antenna port after corrected.
	P1:	Power output from the signal generator
	P2:	Power measured at attenuator A input
	P3:	Power reading on the Average Power Meter
	EIRP:	EIRP after correction
	ERP:	ERP after correction

(o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
(p) Repeat step (d) to (o) for different test frequency
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

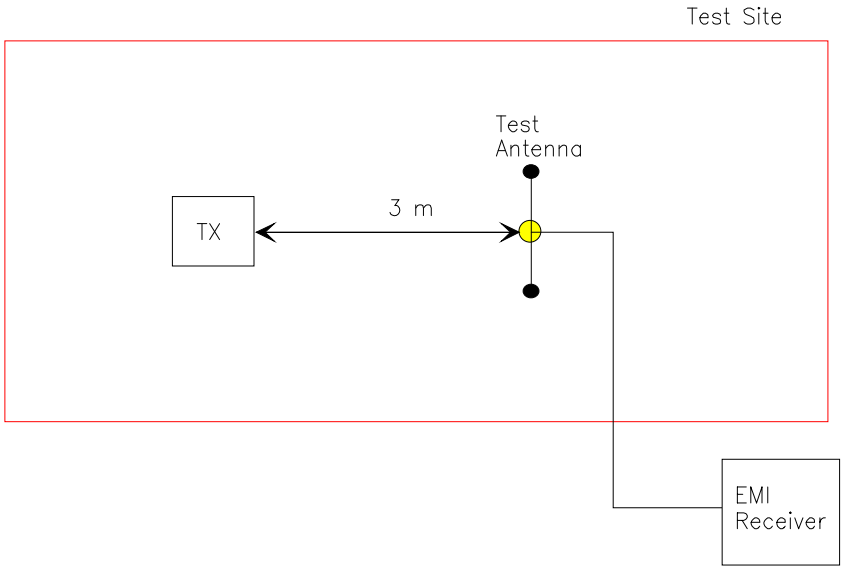
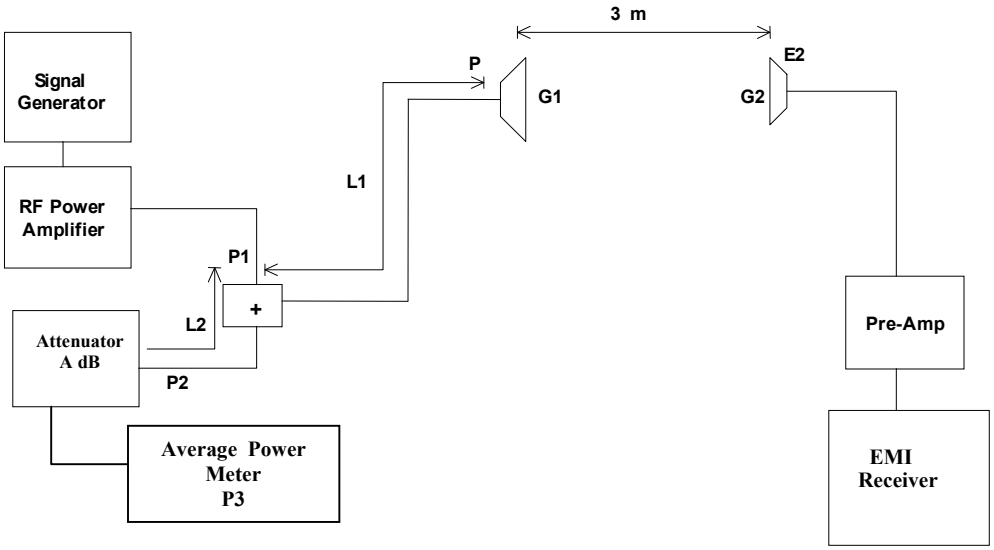


Figure 3



8.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

(a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.

(b) Frequency measurements shall be made at extremes of the specified temperature range and at intervals of not more than 10 centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short-term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stability circuitry need be subjected to the temperature variation test.

(d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

8.4. EMISSION MASK

Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i):- The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.: ±2.5 KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

Digital Modulation Through a Data Input Port @ 2.1049(h):- Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

(1) For 25 KHz Channel Spacing: RBW = 300 Hz
(2) For 12.5 KHz or 6.25 KHz Channel Spacings: RBW = 100 Hz

The all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.

8.5. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the EMI Receiver controls set as RBW = 30 KHz minimum , VBW ≥ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC 47 CFR 2.1057 - Frequency spectrum to be investigated: The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC 47 CFR 2.1051 - Spurious Emissions at Antenna Terminal: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions, which are attenuated more than 20 dB below the permissible value, need not be specified.

8.6. TRANSIENT FREQUENCY BEHAVIOR

1. Connect the transmitter under tests as shown in the above block diagram
2. Set the signal generator to the assigned frequency and modulate with a 1 KHz tone at ±12.5 KHz deviation and its output level to be 50 dB below the transmitter rf output at the test receiver end.
3. Set the horizontal sweep rate on the storage scope to 10 milliseconds per division and adjust the display to continuously view the 1000 Hz tone from the Demodulator Output Port (DOP) of the Test Receiver. Adjust the vertical scale amplitude control of the scope to display the 1000 Hz at ±4 divisions vertical Center at the display.
4. Adjust the scope so it will trigger on an increasing magnitude from the RF trigger signal of the transmitter under test when the transmitter was turned on. Set the controls to store the display.
5. The output at the DOP, due to the change in the ratio of the power between the signal generator input power and transmitter output power will, because of the capture effect of the test receiver, produce a change in display: For the first part of the sweep it will show the 1 KHz test signal. Then once the receiver's demodulator has been captured by the transmitter power, the display will show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1 KHz test signal is completely suppressed (including any capture time due to phasing) is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2.
6. During the time from the end of t_2 to the beginning of t_3 the frequency difference should not exceed the limits set by the FCC in Part 90.214 and the outlined in the Carrier Frequency Stability sections. The allowed limit is equal to FCC frequency tolerance limits specified in FCC 90.213.
7. Repeat the above steps when the transmitter was turned off for measuring t_3.

END OF REPORT