

Test Report

Prepared for: Smart Route

Model: Thunder 255

Description: 4 Channel Base Station with Tetra Modulation

FCC ID: 2BFHD-THUNDER255

To

FCC_ Part 90

Date of Issue: June 24, 2024

On the behalf of the applicant:

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Greg Corbin
Project Test Engineer

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Test Result Summary

FCC Specification	Test Name	Pass, Fail, N/A	Comments
2.1046 90.205(s)	Carrier Output Power (Conducted)	Pass	
2.1051 90.221(d)	Unwanted Emissions (Transmitter Conducted)	Pass	
2.1051 90.21(d)	Field Strength of Spurious Radiation	Pass	
2.1049(i)	Occupied Bandwidth	Pass	
90.221(b)(1)	Adjacent Channel Power	Pass	
2.1047(a)	Audio Low Pass Filter (Voice Input)	N/A	No analog modulation
2.1047(a)	Audio Frequency Response	N/A	No analog modulation
2.1047(b)	Modulation Limiting	N/A	No analog modulation
2.1055(a)(1) 90.213(a)	Frequency Stability (Temperature Variation)	Pass	
2.1055(d)(1) 90.213(a)	Frequency Stability (Voltage Variation)	Pass	

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	6/24/2024	Greg Corbin	Original Document

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Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.



FCC Site Reg. #349717

IC Site Reg. #2044A-2

Test and Measurement Data

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Volume II, Part 2, Subpart J, Sections 2.947, 2.1033(c), 2.1041, 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, ANSI C63.26-2015, Part 90.

Standard Test Conditions and Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing.

In accordance with ANSI/TIA 603C, and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Environmental Conditions		
Temp (°C)	Humidity (%)	Pressure (mbar)
25.9 – 31.3	22.1 – 27.5	955.1 – 968.5

Measurement results, unless otherwise noted, are worst-case measurements.

EUT Description

Model: Thunder 255

Description: 4 Channel Base Station with Tetra Modulation

Serial Number: 0001

Additional Information:

The EUT is a 4-channel dual transmitter base station using Tetra modulation.

The frequency range, modulation and emission designators are listed in Table 1.

Table 1 – Frequency Range, Modulation, emission designators

Frequency Range (MHz)	Modulation	Emission Designator
450 – 470	Tetra	22K0D7D 22K0D7E 22K0D7W

The frequency range is further divided into 3 Bands as listed in Table 2. The test frequencies for 1 – 4 carriers are listed in Table 2.

The minimum channel spacing for the carriers is 200 kHz.

Table 2 – Test Frequencies

Band	Frequency range	Band 5 Test Freq – TX1				Band 5 Test Freq – TX2			
		1 CH	2 CH	3 CH	4 CH	1 CH	2 CH	3 CH	4 CH
5	451.01250 to 452.98750	451.0125	451.0125	451.0125	451.6125	451.2125	451.4125	451.6125	451.8125
			451.2125	451.2125	451.8125		451.6125	451.8125	452.0125
				451.4125	452.0125			452.0125	452.2125
					452.2125				452.4125

Band	Frequency range	Band 6 Test Freq – TX1				Band 6 Test Freq – TX2			
		1 CH	2 CH	3 CH	4 CH	1 CH	2 CH	3 CH	4 CH
6	460.41250 to 462.58750	460.4125	460.4125	460.4125	460.4125	460.6125	460.8125	461.0125	461.2125
			460.6125	460.6125	460.6125		461.0125	461.2125	461.4125
				460.8125	460.8125			461.4125	461.6125
					461.0125				461.8125

Band	Frequency range	Band 6 Test Freq – TX1				Band 6 Test Freq – TX2			
		1 CH	2 CH	3 CH	4 CH	1 CH	2 CH	3 CH	4 CH
7	467.51250 to 469.98750	468.9875	468.9875	468.9875	468.9875	468.7875	468.5875	468.3875	468.1875
			468.7875	468.7875	468.7875		468.3875	468.1875	467.9875
				468.5875	468.5875			467.9875	467.7875
					468.3875				467.5875

The output power is carrier dependent and listed in Table 3 per channel.
The output power is limited by the # of carriers and is reduced by ~ 3 dB per each additional carrier.

Table 3 – Output Power per carrier

Number of carriers	Maximum Output Power (dBm)
1	46
2	42
3	36
4	34

EUT Operation during tests:

The EUT is powered by 120 VAC 60 Hz.

The manufacturer was present and operating the EUT for all tests.

For Output Power_ each combination of carriers 1,2,3,4 at low, mid, high frequencies were tested.

For Conducted Spurious_ 1 and 4 carriers were tested at low, mid, high freq.

For Adjacent Channel Power (90.221)_ 1 and 4 carriers were tested at low, mid, high freq.

For Radiated Spurious__ 1 and 4 carriers were tested at low, mid, high freq with output terminated.

No antenna has been selected for the EUT.

Any calculations involving antenna gain will be calculated using 0 dBi antenna gain.

Accessories:

Qty	Description	Length	Model	S/N
1	Laptop PC with controller software (Client PC)	N/A	N/A	N/A
1	Ethernet cable_ EUT to PC	3m	N/A	N/A
2	Attenuator, 100 w 50 ohm (Mini-Circuits)	N/A	BW-30N100W+	N/A

Modifications: None

Carrier Output Power (Conducted)

Engineer: Greg Corbin

Test Date: 6/13/24

Measurement Procedure

The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator. All cable and attenuator losses were input into the spectrum analyzer as a reference level offset to ensure accurate readings were obtained.

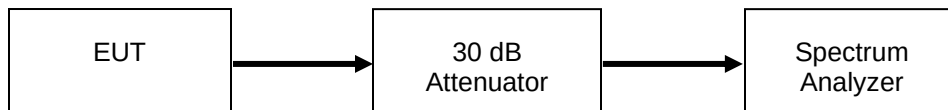
Output power was recorded with Tetra Modulation applied using the channel power tool on the spectrum analyzer. Each combination of carriers 1,2,3,4 at low, mid, high frequencies were tested.

Output Power per carrier

Number of carriers	Maximum Output Power (dBm)	Maximum Output Power (watts)
1	46	39.81
2	42	15.848
3	36	3.981
4	34	2.511

FCC Output Power Limit = 47.77 w (manufacturer rated power + 20%)

Test Setup



ERP Output power Test Results

Band 5 – TX1	1 carrier	2 carriers			3 carriers				4 Carriers				
Number of carriers	1	1	2	1+2	1	2	3	1+2+3	1	2	3	4	1+2+3+4
Conducted Output Power (dBm)	46.48	42.17	42.73	45.80	36.46	36.34	36.56	41.61	32.05	32.32	32.57	32.86	38.59
Antenna Gain (dBi)	0	0	0	0	0	0	0	0	0	0	0	0	0
ERP Output Power (dBm)	46.48	42.17	42.73	45.80	36.46	36.34	36.56	41.61	32.05	32.32	32.57	32.86	38.59
Limit (dBm)	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77
Margin (dB)	-1.3	-5.6	-5.0	-2.0	-11.3	-11.4	-11.2	-6.2	-15.7	-15.5	-15.2	-14.9	-9.2

Band 5 – TX2	1 carrier	2 carriers			3 carriers				4 Carriers				
Number of carriers	1	1	2	1+2	1	2	3	1+2+3	1	2	3	4	1+2+3+4
Output Power (dBm)	45.65	42.24	42.42	45.35	35.51	36.11	36.20	40.88	31.76	31.81	32.09	32.15	38.18
Antenna Gain (dBi)	0	0	0	0	0	0	0	0	0	0	0	0	0
ERP Output Power (dBm)	45.65	42.24	42.42	45.35	35.51	36.11	36.20	40.88	31.76	31.81	32.09	32.15	38.18
Limit (dBm)	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77
Margin (dB)	-2.1	-5.5	-5.4	-2.4	-12.3	-11.7	-11.6	-6.9	-16.0	-16.0	-15.7	-15.6	-9.6

Band 6 – TX1	1 carrier	2 carriers			3 carriers				4 Carriers				
Number of carriers	1	1	2	1+2	1	2	3	1+2+3	1	2	3	4	1+2+3+4
Output Power (dBm)	45.64	41.74	41.84	44.73	35.60	35.71	35.81	40.57	31.46	31.59	31.82	31.96	37.67
Antenna Gain (dBi)	0	0	0	0	0	0	0	0	0	0	0	0	0
ERP Output Power (dBm)	45.64	41.74	41.84	44.73	35.60	35.71	35.81	40.57	31.46	31.59	31.82	31.96	37.67
Limit (dBm)	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77
Margin (dB)	-2.1	-6.0	-5.9	-3.0	-12.2	-12.1	-12.0	-7.2	-16.3	-16.2	-16.0	-15.8	-10.1

Band 6 – TX2	1 carrier	2 carriers			3 carriers				4 Carriers				
Number of carriers	1	1	2	1+2	1	2	3	1+2+3	1	2	3	4	1+2+3+4
Output Power (dBm)	45.76	42.10	42.43	45.68	36.05	36.31	36.48	41.07	32.24	32.40	32.36	32.28	38.28
Antenna Gain (dBi)	0	0	0	0	0	0	0	0	0	0	0	0	0
ERP Output Power (dBm)	45.76	42.10	42.43	45.68	36.05	36.31	36.48	41.07	32.24	32.40	32.36	32.28	38.28
Limit (dBm)	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77
Margin (dB)	-2.0	-5.7	-5.3	-2.1	-11.7	-11.5	-11.3	-6.7	-15.5	-15.4	-15.4	-15.5	-9.5

Band 7 – TX1	1 carrier	2 carriers			3 carriers				4 Carriers				
Number of carriers	1	1	2	1+2	1	2	3	1+2+3	1	2	3	4	1+2+3+4
Output Power (dBm)	46.42	42.28	42.18	45.56	36.37	36.32	35.96	40.96	31.76	31.54	31.44	31.48	37.35
Antenna Gain (dBi)	0	0	0	0	0	0	0	0	0	0	0	0	0
ERP Output Power (dBm)	46.42	42.28	42.18	45.56	36.37	36.32	35.96	40.96	31.76	31.54	31.44	31.48	37.35
Limit (dBm)	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77
Margin (dB)	-1.4	-5.5	-5.6	-2.2	-11.4	-11.5	-11.8	-6.8	-16.0	-16.2	-16.3	-16.3	-10.4

Band 7 – TX2	1 carrier	2 carriers			3 carriers				4 Carriers				
Number of carriers	1	1	2	1+2	1	2	3	1+2+3	1	2	3	4	1+2+3+4
Output Power (dBm)	46.86	43.51	43.35	46.62	35.77	35.60	35.34	40.27	32.20	31.98	31.75	31.08	37.85
Antenna Gain (dBi)	0	0	0	0	0	0	0	0	0	0	0	0	0
ERP Output Power (dBm)	46.86	43.51	43.35	46.62	35.77	35.60	35.34	40.27	32.20	31.98	31.75	31.08	37.85
Limit (dBm)	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77	47.77
Margin (dB)	-0.9	-4.3	-4.4	-1.2	-12.0	-12.2	-12.4	-7.5	-15.6	-15.8	-16.0	-16.7	-9.9

Annex A Output Power

Refer to Annex A for Output power test data

Conducted Spurious Emissions

Engineer: Greg Corbin

Test Date: 6/13/2024

Test Procedure

The EUT was connected directly to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions. The resolution bandwidth was set for 100 kHz or 1 MHz as required per the rule section and the reference level was adjusted to ensure the system had sufficient dynamic range to measure spurious emissions.

A 1 GHz highpass filter was used for measurements above 1 GHz.

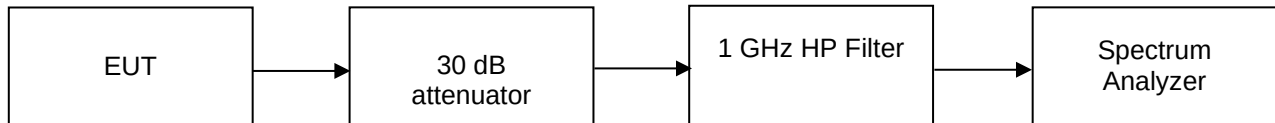
The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed and plotted.

The conducted spurious emissions were recorded for TX1 and TX2 with 1 and 4 carriers.

The limit per FCC part 90.221 (d) is – 13 dBm.

Note: A marker was placed on the fundamental frequency and the highest spurious emission. Only the fundamental TX signal exceeded the limit as shown in the spectrum analyzer screenshots.

Test Setup



Conducted Spurious Emissions Summary Table
Conducted Spurious

Band 5	Frequency	Emission Level	Limit	Margin	Pass / Fail
	MHz	dBm	dBm	dB	
TX1 - 1 carrier	902.06	-24.9	-13	-11.9	Pass
TX1 - 4 carrier	1353.6	-19.8	-13	-6.8	Pass
TX2 - 1 carrier	902.42	-25.0	-13	-12	Pass
TX2 - 4 carrier	386.33	-31.4	-13	-18.4	Pass

Band 6	Frequency	Emission Level	Limit	Margin	Pass / Fail
	MHz	dBm	dBm	dB	
TX1 - 1 carrier	437.97	-25.7	-13	-12.7	Pass
TX1 - 4 carrier	909.76	-30.9	-13	-17.9	Pass
TX2 - 1 carrier	438.20	-24.1	-13	-11.1	Pass
TX2 - 4 carrier	913.20	-31.0	-13	-18	Pass

Band 7	Frequency	Emission Level	Limit	Margin	Pass / Fail
	MHz	dBm	dBm	dB	
TX1 - 1 carrier	937.95	-28.4	-13	-15.4	Pass
TX1 - 4 carrier	422.45	-31.4	-13	-18.4	Pass
TX2 - 1 carrier	937.59	-25.4	-13	-12.4	Pass
TX2 - 4 carrier	393.2	31.0	-13	-18	Pass

Annex B Conducted Spurious Emission

Refer to Annex B for Conducted Spurious Emission plots.

Note: Marker 1 on the graphs in Annex B are the fundamental transmit signals and are exempt for the spurious emission limits.

Field Strength of Spurious Radiation

Engineer: Greg Corbin

Test Date: 6/17/2024

Test Procedure

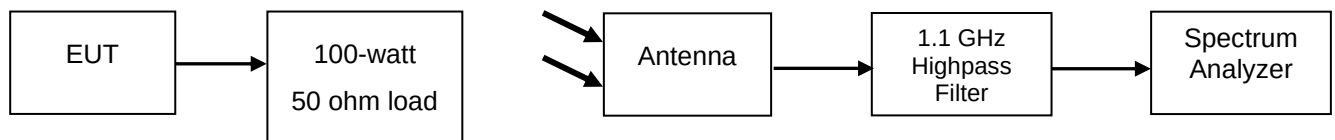
The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure that the signal levels were maximized. All cable and antenna correction factors were input into the spectrum analyzer before recording final data.

The EUT was set to transmit at maximum power with the RF output terminated into a 200-watt 50-ohm load. TX1 and TX2 were set to transmit at the same time.

Spurious emissions were measured with TX1 and TX2 set to 1 carrier and repeated with 4 carriers. The RBW was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz. The VBW was set to 3 times the RBW.

Spurious Emissions were measured from 30 MHz to 5 GHz.
The limit per FCC part 90.221 (d) is – 13 dBm.

Test Setup



Radiated Spurious Emissions Summary Table

Band 5	Frequency	Emission Level	Limit	Margin	Pass / Fail
	MHz	dBm	dBm	dB	
TX1 / TX2 - 1 carrier	3110.2	-46.6	-13	-33.6	Pass
TX1 / TX2 - 4 carrier	3112	-45.4	-13	-32.4	Pass

Band 6	Frequency	Emission Level	Limit	Margin	Pass / Fail
	MHz	dBm	dBm	dB	
TX1 / TX2 - 1 carrier	3111	-46.2	-13	-33.2	Pass
TX1 / TX2 - 4 carrier	3111	-46.5	-13	-33.5	Pass

Band 7	Frequency	Emission Level	Limit	Margin	Pass / Fail
	MHz	dBm	dBm	dB	
TX1 / TX2 - 1 carrier	3111	-47.0	-13	-34	Pass
TX1 / TX2 - 4 carrier	3456.6	-46.3	-13	-33.3	Pass

Annex C Radiated Spurious Emission

Refer to Annex C for Radiated Spurious Emission plots.

Note: Marker 1 on the graphs in Annex C are the fundamental transmit signals and are exempt for the spurious emission limits.

Occupied Bandwidth

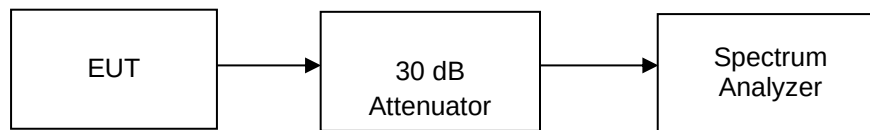
Engineer: Greg Corbin

Test Date: 6/13/2024

Measurement Procedure

The occupied bandwidth was recorded for TX1 and TX2 (single carrier) for Bands 5, 6, 7.
The occupied bandwidth tool on the spectrum analyzer was used to record the 99% and -26 dB bandwidth.
Due to the Tetra modulation the adjacent channel power per 90.221 was recorded in place of an emission mask.

Test Setup



Occupied Bandwidth Summary Table

	99% (kHz)	-26 dB (kHz)
Band 5 - TX1	25.709	32.721
Band 5 - TX2	25.798	32.869
Band 6 - TX1	25.722	32.671
Band 6 - TX2	25.586	32.514
Band 7 - TX1	25.745	33.034
Band 7 - TX2	25.293	32.494

Annex D Occupied Bandwidth

Refer to Annex D for Occupied Bandwidth plots.

Adjacent Channel power

Engineer: Greg Corbin

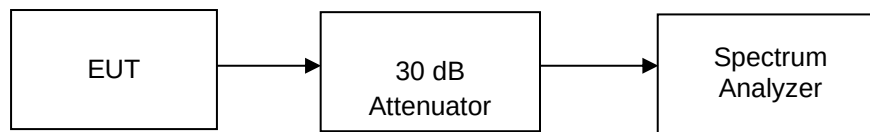
Test Date: 6/13/2024

Measurement Procedure

The EUT was connected directly to a spectrum analyzer to verify that the EUT meets the required Adjacent Channel Power requirements for FCC Part 90.221.

For TX1 and TX2, a single carrier and the 4 carrier ACP measurement were recorded for Bands 5, 6, 7. For the 4 carrier measurement the 4 carriers were transmitting and the ACP for each carrier was recorded.

Test Setup



Adjacent Channel Power summary Table – Band 5

Band	TX1 / TX2	Carrier number	Offset Freq kHz	ACP level		Limit dBc	Margin		Pass / Fail
				Lower dBc	Upper dBc		Lower dB	Upper dB	
5	TX1 – 1 carrier	1	25	-65.15	-65.40	-60	-5.15	-5.4	Pass
5	TX1 – 1 carrier	1	50	-73.80	-74.17	-70	-3.8	-4.17	Pass
5	TX1 – 1 carrier	1	75	-78.10	-78.26	-70	-8.1	-8.26	Pass
5	TX1 – 4 carrier	1	25	-68.91	-67.77	-60	-8.91	-7.77	Pass
5	TX1 – 4 carrier	1	50	-75.05	-74.90	-70	-5.05	-4.9	Pass
5	TX1 – 4 carrier	1	75	-78.44	-77.04	-70	-8.44	-7.04	Pass
5	TX1 – 4 carrier	2	25	-69.79	-68.44	-60	-9.79	-8.44	Pass
5	TX1 – 4 carrier	2	50	-75.30	-75.06	-70	-5.3	-5.06	Pass
5	TX1 – 4 carrier	2	75	-77.32	-77.22	-70	-7.32	-7.22	Pass
5	TX1 – 4 carrier	3	25	-65.91	-68.46	-60	-5.91	-8.46	Pass
5	TX1 – 4 carrier	3	50	-75.01	-75.17	-70	-5.01	-5.17	Pass
5	TX1 – 4 carrier	3	75	-77.23	-77.23	-70	-7.23	-7.23	Pass
5	TX1 – 4 carrier	4	25	-69.39	-68.19	-60	-9.39	-8.19	Pass
5	TX1 – 4 carrier	4	50	-75.25	-75.41	-70	-5.25	-5.41	Pass
5	TX1 – 4 carrier	4	75	-77.52	-78.66	-70	-7.52	-8.66	Pass
5	TX2 – 1 carrier	1	25	-68.74	-69.77	-60	-8.74	-9.77	Pass
5	TX2 – 1 carrier	1	50	-76.03	-75.83	-70	-6.03	-5.83	Pass
5	TX2 – 1 carrier	1	75	-79.42	-79.49	-70	-9.42	-9.49	Pass
5	TX2 – 4 carrier	1	25	-70.57	-69.96	-60	-10.57	-9.96	Pass
5	TX2 – 4 carrier	1	50	-75.65	-75.35	-70	-5.65	-5.35	Pass
5	TX2 – 4 carrier	1	75	-78.71	-77.48	-70	-8.71	-7.48	Pass
5	TX2 – 4 carrier	2	25	-70.34	-69.60	-60	-10.34	-9.6	Pass
5	TX2 – 4 carrier	2	50	-75.49	-75.34	-70	-5.49	-5.34	Pass
5	TX2 – 4 carrier	2	75	-77.34	-77.27	-70	-7.34	-7.27	Pass
5	TX2 – 4 carrier	3	25	-70.78	-70.05	-60	-10.78	-10.05	Pass
5	TX2 – 4 carrier	3	50	-75.39	-75.42	-70	-5.39	-5.42	Pass
5	TX2 – 4 carrier	3	75	-77.31	-77.61	-70	-7.31	-7.61	Pass
5	TX2 – 4 carrier	4	25	-70.89	-70.33	-60	-10.89	-10.33	Pass
5	TX2 – 4 carrier	4	50	-75.54	-75.71	-70	-5.54	-5.71	Pass
5	TX2 – 4 carrier	4	75	-77.42	-78.73	-70	-7.42	-8.73	Pass

Adjacent Channel Power summary Table – Band 6

Band	TX1 / TX2	Carrier number	Offset Freq kHz	ACP level		Limit dBc	Margin		Pass / Fail
				Lower	Upper		Lower	Upper	
				dBc	dBc		dB	dB	
6	TX1 – 1 carrier	1	25	-69.90	-68.63	-60	-9.9	-8.63	Pass
6	TX1 – 1 carrier	1	50	-74.93	-75.06	-70	-4.93	-5.06	Pass
6	TX1 – 1 carrier	1	75	-78.51	-78.66	-70	-8.51	-8.66	Pass
6	TX1 – 4 carrier	1	25	-69.94	-68.92	-60	-9.94	-8.92	Pass
6	TX1 – 4 carrier	1	50	-75.48	-74.99	-70	-5.48	-4.99	Pass
6	TX1 – 4 carrier	1	75	-78.31	-76.99	-70	-8.31	-6.99	Pass
6	TX1 – 4 carrier	2	25	-69.60	-68.69	-60	-9.6	-8.69	Pass
6	TX1 – 4 carrier	2	50	-74.99	-74.93	-70	-4.99	-4.93	Pass
6	TX1 – 4 carrier	2	75	-77.12	-76.94	-70	-7.12	-6.94	Pass
6	TX1 – 4 carrier	3	25	-70.10	-68.77	-60	-10.1	-8.77	Pass
6	TX1 – 4 carrier	3	50	-75.12	-74.95	-70	-5.12	-4.95	Pass
6	TX1 – 4 carrier	3	75	-77.00	-77.04	-70	-7	-7.04	Pass
6	TX1 – 4 carrier	4	25	-69.47	-67.81	-60	-9.47	-7.81	Pass
6	TX1 – 4 carrier	4	50	-75.21	-75.07	-70	-5.21	-5.07	Pass
6	TX1 – 4 carrier	4	75	-76.88	-78.31	-70	-6.88	-8.31	Pass
6	TX2 – 1 carrier	1	25	-68.64	-70.76	-60	-8.64	-10.76	Pass
6	TX2 – 1 carrier	1	50	-75.09	-75.18	-70	-5.09	-5.18	Pass
6	TX2 – 1 carrier	1	75	-78.94	-79.13	-70	-8.94	-9.13	Pass
6	TX2 – 4 carrier	1	25	-69.59	-68.27	-60	-9.59	-8.27	Pass
6	TX2 – 4 carrier	1	50	-75.58	-75.34	-70	-5.58	-5.34	Pass
6	TX2 – 4 carrier	1	75	-78.64	-77.28	-70	-8.64	-7.28	Pass
6	TX2 – 4 carrier	2	25	-66.58	-66.69	-60	-6.58	-6.69	Pass
6	TX2 – 4 carrier	2	50	-75.34	-75.10	-70	-5.34	-5.1	Pass
6	TX2 – 4 carrier	2	75	-77.35	-77.08	-70	-7.35	-7.08	Pass
6	TX2 – 4 carrier	3	25	-63.01	-63.12	-60	-3.01	-3.12	Pass
6	TX2 – 4 carrier	3	50	-75.21	-75.20	-70	-5.21	-5.2	Pass
6	TX2 – 4 carrier	3	75	-77.33	-77.23	-70	-7.33	-7.23	Pass
6	TX2 – 4 carrier	4	25	-62.48	-62.55	-60	-2.48	-2.55	Pass
6	TX2 – 4 carrier	4	50	-75.27	-75.60	-70	-5.27	-5.6	Pass
6	TX2 – 4 carrier	4	75	-77.28	-78.54	-70	-7.28	-8.54	Pass

Adjacent Channel Power summary Table – Band 7

Band	TX1 / TX2	Carrier number	Offset Freq kHz	ACP level		Limit dBc	Margin		Pass / Fail
				Lower	Upper		Lower	Upper	
				dBc	dBc		dB	dB	
7	TX1 – 1 carrier	1	25	-68.42	-66.84	-60	-8.42	-6.84	Pass
7	TX1 – 1 carrier	1	50	-73.74	-73.64	-70	-3.74	-3.64	Pass
7	TX1 – 1 carrier	1	75	-78.15	-78.20	-70	-8.15	-8.2	Pass
7	TX1 – 4 carrier	1	25	-70.74	-69.49	-60	-10.74	-9.49	Pass
7	TX1 – 4 carrier	1	50	-75.50	-75.79	-70	-5.5	-5.79	Pass
7	TX1 – 4 carrier	1	75	-77.35	-78.77	-70	-7.35	-8.77	Pass
7	TX1 – 4 carrier	2	25	-70.51	-69.30	-60	-10.51	-9.3	Pass
7	TX1 – 4 carrier	2	50	-75.31	-75.20	-70	-5.31	-5.2	Pass
7	TX1 – 4 carrier	2	75	-77.18	-45.80	-70	-7.18	24.2	Pass
7	TX1 – 4 carrier	3	25	-70.41	-69.34	-60	-10.41	-9.34	Pass
7	TX1 – 4 carrier	3	50	-75.27	-75.14	-70	-5.27	-5.14	Pass
7	TX1 – 4 carrier	3	75	-77.29	-77.18	-70	-7.29	-7.18	Pass
7	TX1 – 4 carrier	4	25	-70.97	-69.92	-60	-10.97	-9.92	Pass
7	TX1 – 4 carrier	4	50	-75.67	-75.22	-70	-5.67	-5.22	Pass
7	TX1 – 4 carrier	4	75	-78.64	-77.22	-70	-8.64	-7.22	Pass
7	TX2 – 1 carrier	1	25	-70.33	-68.60	-60	-10.33	-8.6	Pass
7	TX2 – 1 carrier	1	50	-75.57	-75.25	-70	-5.57	-5.25	Pass
7	TX2 – 1 carrier	1	75	-79.17	-78.97	-70	-9.17	-8.97	Pass
7	TX2 – 4 carrier	1	25	-63.71	-64.25	-60	-3.71	-4.25	Pass
7	TX2 – 4 carrier	1	50	-75.48	-75.40	-70	-5.48	-5.4	Pass
7	TX2 – 4 carrier	1	75	-77.46	-78.63	-70	-7.46	-8.63	Pass
7	TX2 – 4 carrier	2	25	-66.24	-66.96	-60	-6.24	-6.96	Pass
7	TX2 – 4 carrier	2	50	-75.21	-75.07	-70	-5.21	-5.07	Pass
7	TX2 – 4 carrier	2	75	-77.23	-77.17	-70	-7.23	-7.17	Pass
7	TX2 – 4 carrier	3	25	70.78	-70.28	-60	-10.78	-10.28	Pass
7	TX2 – 4 carrier	3	50	-75.33	-75.37	-70	-5.33	-5.37	Pass
7	TX2 – 4 carrier	3	75	-77.32	-77.24	-70	-7.32	-7.24	Pass
7	TX2 – 4 carrier	4	25	-68.27	-69.12	-60	-8.27	-9.12	Pass
7	TX2 – 4 carrier	4	50	-75.67	-75.34	-70	-5.67	-5.34	Pass
7	TX2 – 4 carrier	4	75	-78.47	-77.24	-70	-8.47	-7.24	Pass

Annex E Adjacent Channel Power

Refer to Annex E for Adjacent Channel Power plots.

Frequency Stability (Temperature Variation)

Engineer: Greg Corbin

Test Date: 6/14/2024

Measurement Procedure

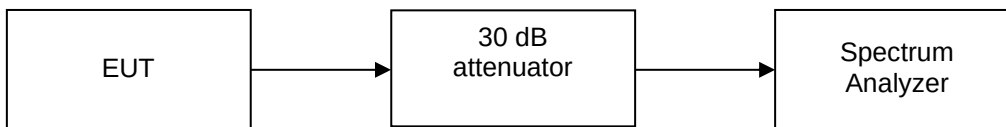
The EUT was placed in an environmental test chamber and the RF output was connected directly to a spectrum analyzer. The temperature was varied from -30°C to 50°C in 10°C increments.

After a sufficient time for temperature stabilization the RF output frequency was recorded.

At 20°C the power supply voltage to the EUT was varied from 85% to 115% of the nominal value and the RF output frequency was recorded.

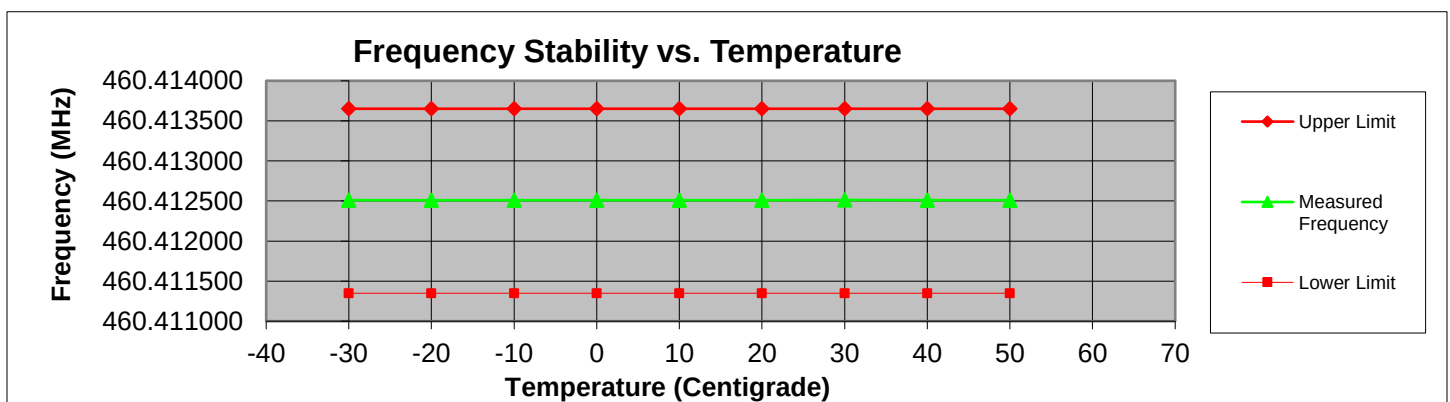
The transmitter is powered by 120 VAC 60 Hz.

Measurement Setup



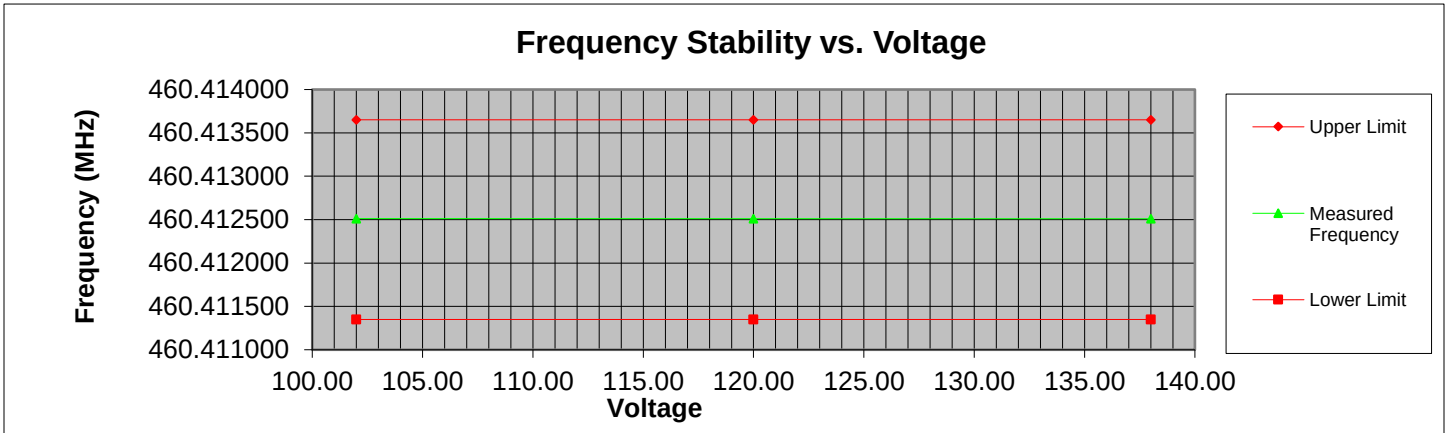
Frequency Stability vs Temperature

Tuned Frequency	Temperature	Tolerance	Measured Frequency	Upper Limit	Lower Limit	Upper Margin	Lower Margin
(MHz)	(deg C)	(PPM)	(MHz)	(MHz)	(MHz)	(MHz)	(MHz)
460.4125	-30	2.5	460.412510	460.413651	460.411349	-0.001141	0.001161
460.4125	-20	2.5	460.412511	460.413651	460.411349	-0.001140	0.001162
460.4125	-10	2.5	460.412510	460.413651	460.411349	-0.001141	0.001161
460.4125	0	2.5	460.412510	460.413651	460.411349	-0.001141	0.001161
460.4125	10	2.5	460.412510	460.413651	460.411349	-0.001141	0.001161
460.4125	20	2.5	460.412511	460.413651	460.411349	-0.001140	0.001162
460.4125	30	2.5	460.412512	460.413651	460.411349	-0.001139	0.001163
460.4125	40	2.5	460.412510	460.413651	460.411349	-0.001141	0.001161
460.4125	50	2.5	460.412510	460.413651	460.411349	-0.001141	0.001161



Frequency Stability vs Voltage

Tuned Frequency (MHz)	Tolerance (PPM)	Voltage (PPM)	Measured Frequency (MHz)	Upper Limit (MHz)	Lower Limit (MHz)	Upper Margin (MHz)	Lower Margin (MHz)
460.4125	2.5	102.00	460.412512	460.413651	460.411349	-0.001139	0.001163
460.4125	2.5	120.00	460.412511	460.413651	460.411349	-0.001140	0.001162
460.4125	2.5	138.00	460.412510	460.413651	460.411349	-0.001141	0.001161



Measurement Uncertainty

Measurement Uncertainty (U_{lab}) for Compliance Testing is listed in the table below.

Measurement	U_{lab}
Radio Frequency	$\pm 3.3 \times 10^{-8}$
RF Power, conducted	± 1.5 dB
RF Power Density, conducted	± 1.0 dB
Conducted Emissions	± 1.8 dB
Radiated Emissions 9kHz-30MHz	± 3.6 dB
Radiated Emissions 30MHz-1000MHz	± 4.25 dB
Radiated Emissions – 1GHz-18GHz	± 4.5 dB
Temperature	± 1.5 deg C
Humidity	± 4.3 %
DC voltage	± 0.20 VDC
AC Voltage	± 1.2 VAC

The reported expanded uncertainty $\pm U_{lab}$ (dB) has been estimated at a 95% confidence level ($k=2$)

U_{lab} is less than or equal to U_{ETSI} therefore

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit
- Non-Compliance is deemed to occur if any measured disturbance exceeds the disturbance limit

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	8/11/22	8/11/24
Voltmeter	Fluke	87-iii	i00319	5/21/24	5/21/25
Data Logger	Fluke	Hydra Data Bucket	i00343	6/28/23	6/28/24
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	2/7/23	2/7/25
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	6/27/23	6/27/24
Highpass Filter (1 GHz)	K&L	7IH40-980/T6000-O/O	i00432	Verified on: 6/13/24	
PSA Spectrum Analyzer	Agilent	E4445A	i00471	1/5/24	1/5/25
MXE EMI receiver	Keysight	N9038A	i00552	3/1/24	3/1/25
Preamplifier	RF Lambda	RLNA00M45GA	i00555	Verified on: 2/19/24	
Temperature Chamber	Thermotron	SE-1000-3-3	I00557	Verified on: 6/14/2024	
Temp./humidity/pressure monitor	Omega Engineering	iBTHX-W-5	i00686	1/25/24	1/25/25
Preamplifier	Eravant	SBB-0115034019-2F2F-E3	i00722	Verified on: 2/7/24	
Attenuator, 30 dB, 100W	Mini-Circuits	BW-30N100W+	Mfr EQ	Verified on: 6/13/24	
Attenuator, 30 dB, 100W	Mini-Circuits	BW-30N100W+	Mfr EQ	Verified on: 6/13/24	

In addition to the equipment listed above standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT