Project 21627-15

FreeFlight

RANGR-XVR DB, FDL-DB Series

UAT Transceiver

Wireless Certification Report

Prepared for:

FreeFlight Systems
8080 Tristar, Suite 100
Irving TX 75063

By

Professional Testing (EMI), Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

1 May 2020

Reviewed by

Shakil Murad
Lead EMC Engineer

Written by

Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
Final		31 Jul 2020

Errata:

All citations of RANGR-AVX applies to the RANGR-XVR.

The FCC ID T7YFDLDBXXXX cited in this document is correct as shown.

Table of Contents

Certificate of Compliance

FCC MRA Designation Number: US5270
NVLAP Accreditation Number: 200062-0

Applicant	Device & Test Identification	
FreeFlight Systems 8080 Tristar, Suite 100 Irving TX 75063 Certificate Date: 1 May 2020	Model(s): FCC ID: Laboratory Project ID:	RANGR-XVR DB, FDL-DB Series T7YFDLDBXXXX 21627-15

The EUT model(s) listed above were tested utilizing the following documents and found to be in compliance with the required criteria.

47 CFR, FCC, Part 87 and Part 2	
Section	**Description**
87.131; 2.1046	Power and emissions; conducted output power
87.135; 87.137; 2.1049	Bandwidth of emission; type of emission; occupied bandwidth
87.139(l)(1); 2.1047	UAT modulation mask; modulation characteristics
87.139; 2.1051	Emission limitations; Spurious/harmonic emissions at antenna terminals
87.139; 2.1053	Emission limitations; radiated emissions 30 MHz - 10 GHz
87.133; 2.1055(a)(1)	Frequency stability (Radionavigation 960 to 1215 MHz; 20 ppm)
87.143	Transmitter control requirements

I, Eric Lifsey, for Professional Testing (EMI), Inc., being familiar with the above rules and test procedures have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

NVLAP
TESTING
NVLAP LAB CODE 200062-0

Eric Lifsey
EMC Engineer

This report has been reviewed and accepted by the Applicant. The undersigned is responsible for ensuring that this device will continue to comply with the requirements listed above.

_____
Representative of Applicant

1.0 Introduction

1.1 Scope

This report describes the extent to which the equipment under test (EUT) conformed to the intentional radiator requirements of the United States.

1.2 EUT Description

Table 1.2.1 Equipment Under Test		
Manufacturer & Description	**Model(s)**	**Serial #**
FreeFlight Systems UAT Transceiver for 978 MHz	RANGR-XVR DB, FDL-DB Series: • 87334-00-FX00, Transceiver with internal GPS • 87334-10-FX10, Transceiver without internal GPS • 87334-00-FR00, Receiver only with internal GPS • 87334-10-FR10, Receiver only without internal GPS	1948X016
Operating Voltage: 10 to 40 VDC		

Table 1.2.2 EUT Options		
Description	**Gain**	**Notes**
Selected by installer.	N/A	Antenna and cable installation details are provided in the user manual.

1.3 EUT User Control Requirement

Power is removed at the aircraft operator's position by disconnection of the associated circuit breaker. This satisfies control requirements of FCC 87.143.

1.4 EUT Operation

The EUT was exercised in a manner consistent with normal operations. To insure accurate measurement, the EUT was placed into higher than normal duty cycle modes. Continuous high duty cycle transmit would cause immediate catastrophic failure of the sample.

The EUT utilizes two antenna ports in an alternating fashion for transmission. Amplitude dependent parameters were measured for both ports. Ports are designated as Bottom and Top.

The EUT contains a GPS receiver that is used to determine a TDMA style transmission collision-avoidance time slots for the UAT protocol.

The EUT additionally receives on 1019 MHz.

1.5 Modifications to EUT

None.

1.6 Measurement Correction Methods

Table 1.6 1 Measurement Corrections	
Parameter	**From Sums Of**
Radiated Field Strength	Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain
Conducted Antenna Port	Raw Measured Level + Attenuator Factor + Cable Losses
Conducted Mains Port	Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses

Additionally, measurement distance extrapolation factors (such as 1/d above 30 MHz) are applied and documented where used.

1.7 Test Site

Radiated measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RS-GEN and is subsequently confirmed by laboratory accreditation (NVLAP 200026-0). The test site is located at 11400 Burnet Road, Austin, Texas 78758, while the main office is located at 1601 North A.W. Grimes Boulevard, Suite B, Round Rock, Texas, 78665.

Professional Testing (EMI), Inc., (PTI) follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing.

2.0 Applicable Documents

Table 2.0.1: Applicable Documents	
Document #	**Title/Description**
ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
47 CFR	FCC Part 87 – Subpart D – Technical requirements FCC Part 2 – Subpart J – Equipment authorization procedures

3.0 Conducted Output Power at Antenna Terminal

3.1 Test Procedure

The output of the EUT was connected directly to an attenuator and then to the spectrum analyzer. A peak detector was used for the measurement. The transmitter was switched on, and the measurement receiver was tuned to the frequency of the transmitter under test. The loss of the attenuator was compensated by adding an offset to the analyzer amplitude. Power was measured directly with the spectrum analyzer using a resolution bandwidth greater than the occupied bandwidth of the transmitter.

3.2 Test Criteria

Table 3.2.1 Authorized Power, 87.131 (Radionavigation Unspecified), FAA Minimum, 2.1046
Minimum 16 Watts per FAA

3.3 Test Results

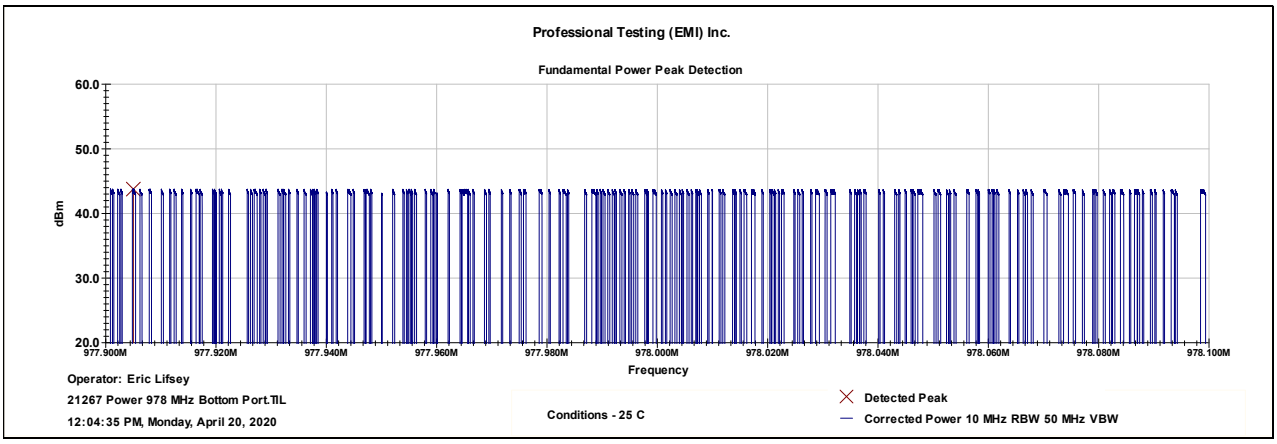
Table 3.3.1 Power Measured In 3 MHz RBW/VBW	
Measured Power (Peak), Bottom Port	43.8 dBm or 24.0 Watts
Measured Power (Peak), Top Port	43.9 dBm or 24.6 Watts

Table 3.3.2 Calculated Duty Cycle and Average Power	
Measured Power (peak)	43.9 dBm or 24.6 Watts
Transmit Period (ms)*	200.25 ms (0.41856 ms + 199.83 ms) (rounded to 5 digits)
Total Transmit Time (ms)*	0.41856 ms
Maximum Duty Cycle	0.41856 / 200.25 = 0.21 % (rounded to 2 digits)
Averaging Factor	$10\log_{10}(0.21\ \%) = -26.78$ dB (rounded to 4 digits)
Average Power	$P_{peak} + Factor_{avg} = 43.9 - 26.78 = 17.12$ dBm or 51.52 mW

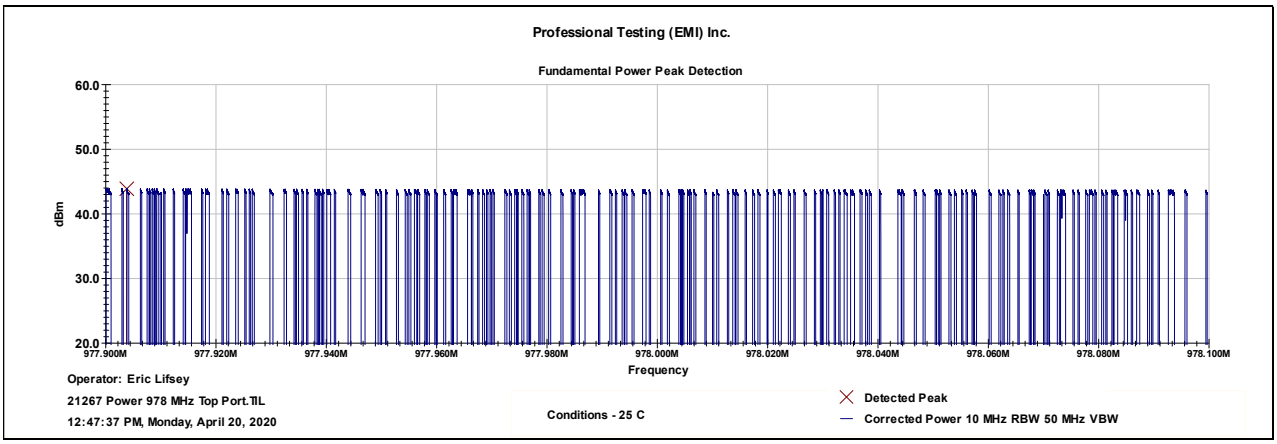
*See supporting document *21627 Duty Cycle.pdf* for details.

Due to the short duty cycle, power measurement was taken by maximizing spectrum analyzer bandwidth beyond the operating bandwidth, reducing the span to almost zero-span point, and sweeping over a long period of time.

The EUT satisfied the requirements. Plotted results included below.



Bottom Antenna Port



Top Antenna Port

4.0 Occupied Bandwidth

4.1 Test Procedure

The output of the EUT was connected to an attenuator and then to the spectrum analyzer. The spectrum analyzer was tuned to the frequency of the transceiver under test and the EUT activated in continuous transmit mode. Bandwidth is measured relative to the peak power measurement measured separately in full bandwidth.

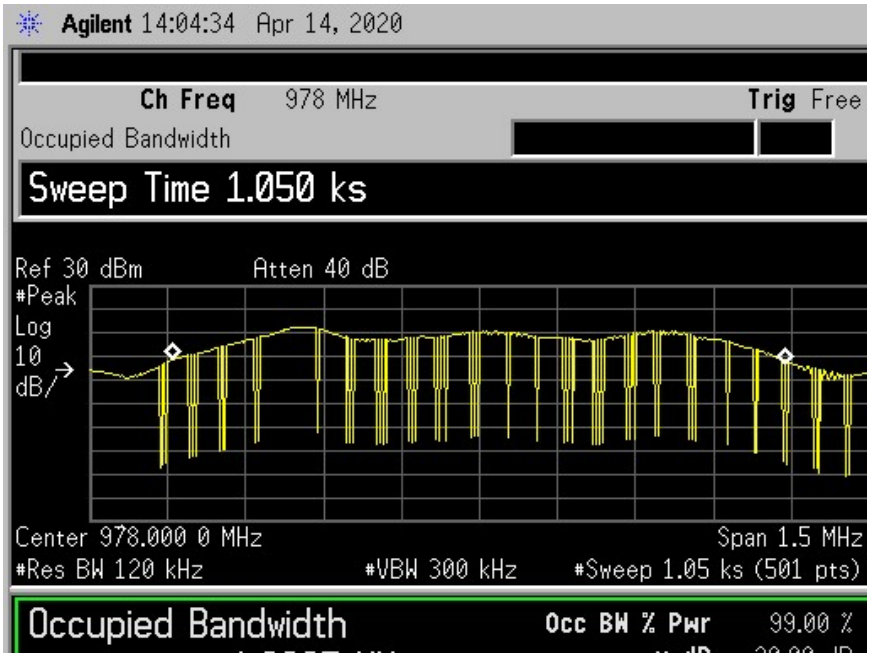
4.2 Test Criteria

Table 4.2.1 Authorized Bandwidth, 87.135; 87.137; 2.1049
1.3 MHz

4.3 Test Results

Table 4.3.1 Bandwidth In 99% (100 kHz RBW 300 kHz VBW)	
Measured Bandwidth	1204 kHz

The EUT satisfied the requirements. As bandwidth is not affected by antenna port, one measurement is made. Results appear below.



Bandwidth 99%

5.0 Modulation Characteristics, UAT Emission Mask

5.1 Test Procedure

The output of the EUT was connected to an attenuator and then to the spectrum analyzer. The spectrum analyzer was tuned to the frequency of the transceiver under test and the EUT activated in continuous transmit mode. Software is used to operate the spectrum analyzer to produce a measurement with superimposed mask limits and to apply correction factors.

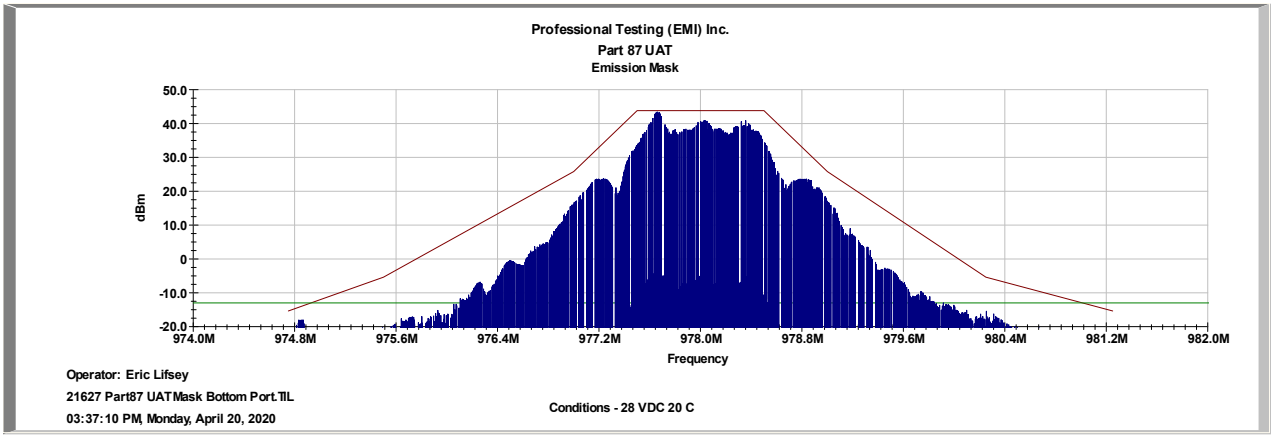
5.2 Test Criteria

Table 5.2.1 Mask Definition, 87.139(l)(1)

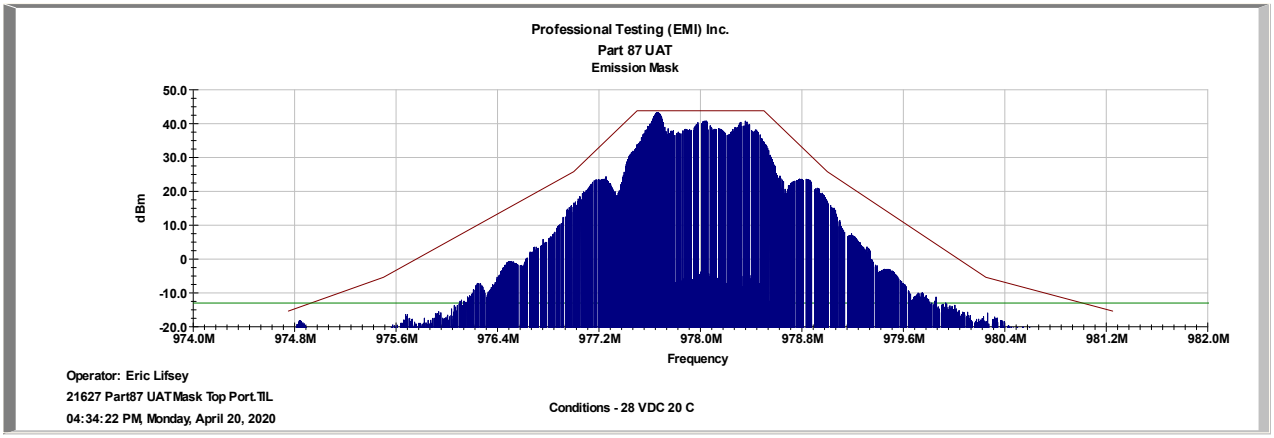
UAT Transmit Shape (Measured in 100 kHz RBW.)			Measured Crossing Point in Shape (MHz)	
Table Citation Line	Attenuation (dB)	Frequency Span (MHz)	To Lower Freq Limit	To Upper Freq Limit
1	0	+/- 0.50	0.453	0.463
2	18	+/- 1.00	0.644	0.602
3	50	+/- 2.25	1.890	1.876
4	60	+/- 3.25	2.464	2.394

5.3 Test Results

The EUT satisfied the requirements. Plotted result appears below.



Bottom Port



Top Port

6.0 Spurious Emissions at Antenna Terminals

6.1 Test Procedure

The output of the EUT was connected directly to an attenuator and then to the spectrum analyzer. A peak detector was used for the measurement. The transmitter was switched on, and the measurement receiver was tuned to the frequency of the transmitter under test. The loss of the attenuator was compensated by adding an offset to the analyzer amplitude. Spurious power was then measured directly with the spectrum analyzer.

6.2 Test Criteria

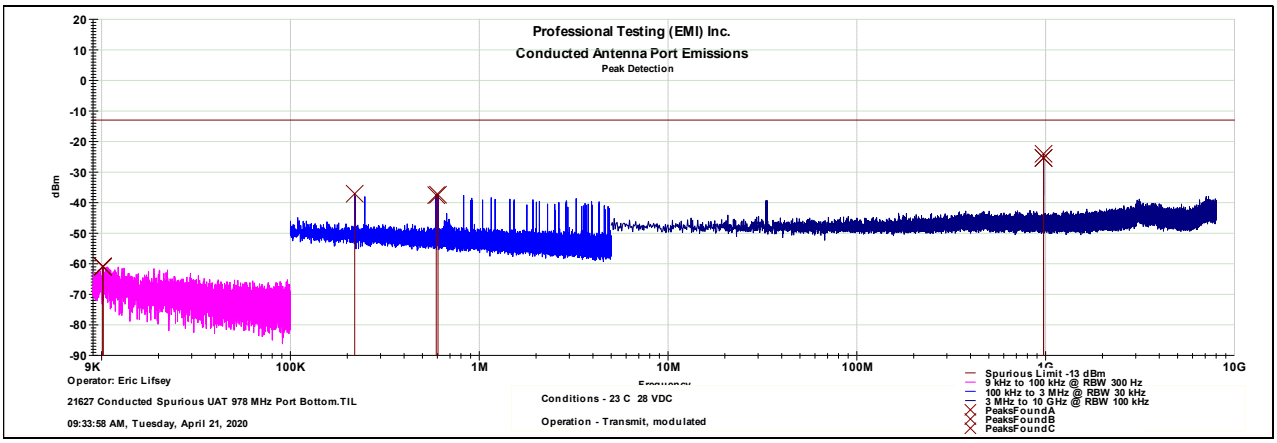
Table 6.2.1 Spurious Limit, 87.139 UAT Transmitter > 5 Watts Power	
Measured Maximum Transmitter Power:	P_t = 17.12 dBm or 51.52 mW
Method of FCC Part 87.139 for P_t > 5 W:	43 + 10 $\log_{10}$ (P_t) dB
Find Required Attenuation:	43 + 10 $\log_{10}$ (0.05152 W) = 30.12 dB
Deduct Attenuation from Measured Power:	17.12 dBm – 30.12 dB = –13 dBm
Spurious Limit for Emissions Beyond 250% of Authorized BW:	-13 dBm

As the required attenuation is scaled in proportion to power the resulting spurious limit must calculate to be -13 dBm.

6.3 Test Results

The EUT satisfied the requirements. Plotted measurements appear below.

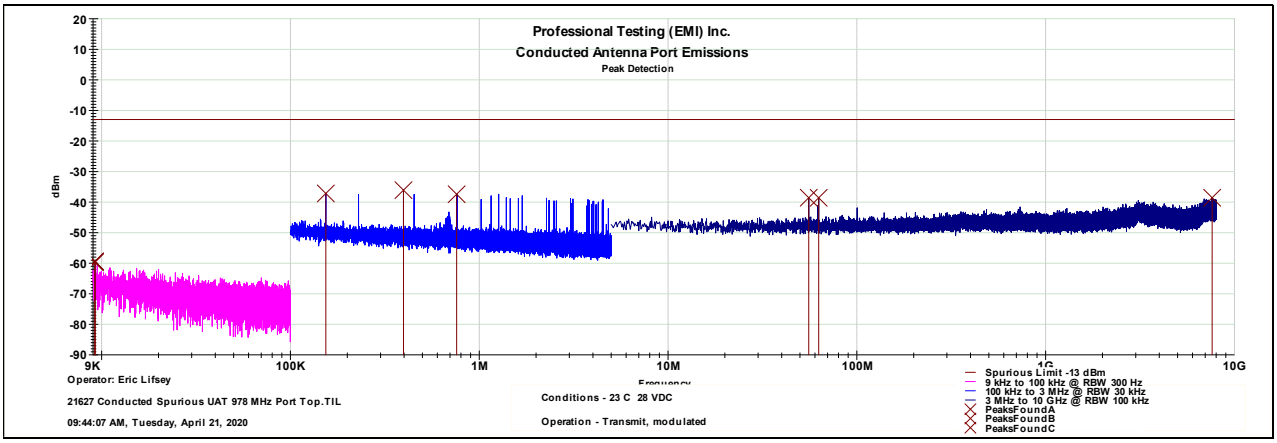
6.3.1 Bottom Port



Bottom Port Measured and Corrected Levels	
Frequency	Corrected Level
MHz	dBm
0.0101565	-60.9
0.0101602	-60.9
0.010164	-61.1
0.218947	-37.1
0.591715	-37.6
0.604945	-37.4

Note that the markers on 978 MHz fundamental do not apply.

6.3.2 Top Port

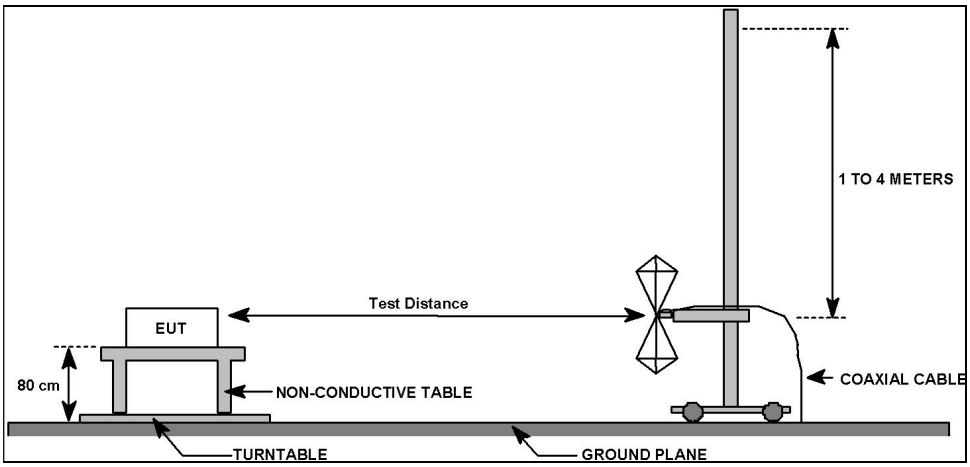


Bottom Port Measured and Corrected Levels	
Frequency	Corrected Level
MHz	dBm
0.00921613	-59.8
0.00921992	-59.5
0.00922371	-59.5
0.1539	-37.2
0.39694	-36.1
0.75905	-37.4
55.5934	-38.6
62.7764	-38.6
7615.99	-38.6

7.0 Field Strength of Spurious Emissions

7.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a rotating turntable at a distance of 10 meters from the measurement antenna. The EUT was placed into transmit mode with the antenna removed and a resistive terminator substituted.



Field Strength of Radiated Emissions Test Setup

7.2 Test Criteria

Table 7.2.1 Radiated Spurious Limit, 87.139	
Method:	$P_r = P_t + G_t + G_r + 20\log_{10}$
Path Loss Term:	20 $\log_{10}$ (λ/ 4πR) = 20 $\log_{10}$ (0.30675 / 4π10) = -52.25 dB
Power at *R*:	-13 dBm + 0 dB + 0 dB + [-52.25 dB] = -65.25 dBm
Field Strength Limit Conversion Formula:	$E(dB\mu V/m) = P_{meas}(dBm) - P_{gain}(dB) + 77.2dB + 20\log(f, MHz) - G_{ant}(dB)$
Field Strength Limit Calculation:	[-65.25 dBm] – 0 dB + 77.2 dB + 20 $\log_{10}$ (978 MHz) - 0 dB = 71.5 dBµV/m

7.3 Test Results

The EUT satisfied the requirements. Plotted measurements of peak emissions appear below.

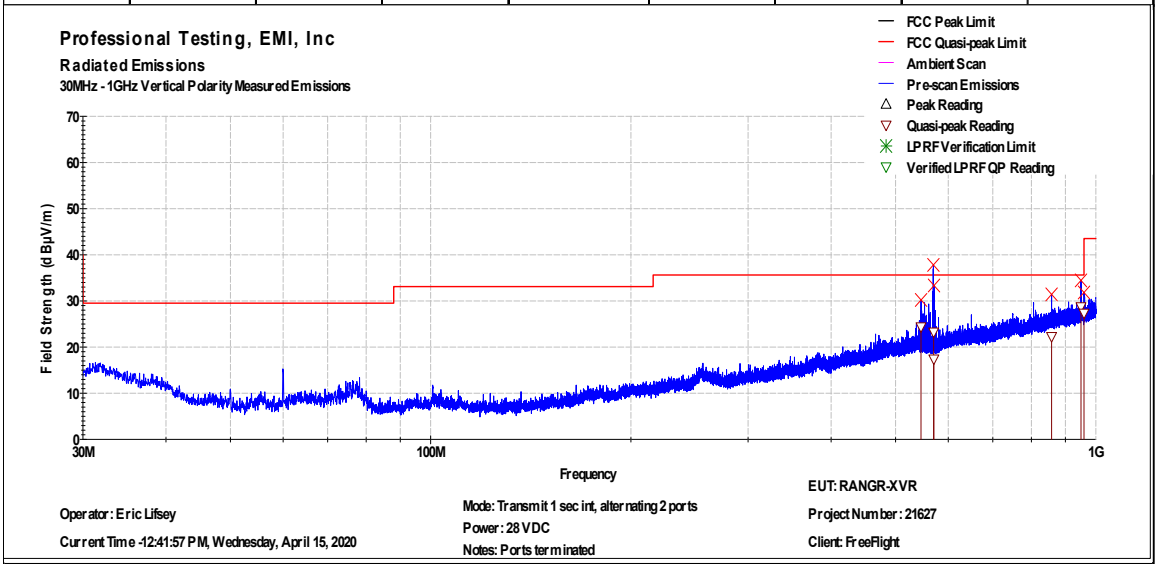
Note that the averaging factor previous determined is -26.78 dB and can be applied to the peak measurements presented below. The average levels then are on the order of ~20 dB or more below the limit.

7.3.1 Up to 1 GHz

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.26		
In accordance with:	FCC Part 87 and Part 15.209		
Section:	15.209		
Test Date(s):	4/15/2020	**EUT Serial #:**	0
Customer:	FreeFlight	**EUT Part #:**	0
Project Number:	21627	**Test Technician:**	Eric Lifsey
Purchase Order #:	0	**Supervisor:**	Shakil Murad
Equip. Under Test:	RANGR-AVX	**Witness' Name:**	0

Radiated Emissions Test Results Data Sheet			
EUT Line Voltage:	28 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Vertical	**Frequency Range:**	30MHz to 1GHz
EUT Mode of Operation:		Transmit 789 MHz, Rec 1190 MHz	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
545.974	10	329	1.29	Quasi-peak	24.38	35.6	-11.2	Pass
570.342	10	223	3.61	Quasi-peak	23.248	35.6	-12.4	Pass
570.689	10	354	1.28	Quasi-peak	17.4	35.6	-18.2	Pass
857.958	10	287	1.28	Quasi-peak	22.285	35.6	-13.3	Pass
949.98	10	323	2.02	Quasi-peak	28.725	35.6	-6.9	Pass
960.015	10	356	2.59	Quasi-peak	27.337	43.5	-16.2	Pass



≤ 1GHz Vertical Antenna Polarity Measured Emissions

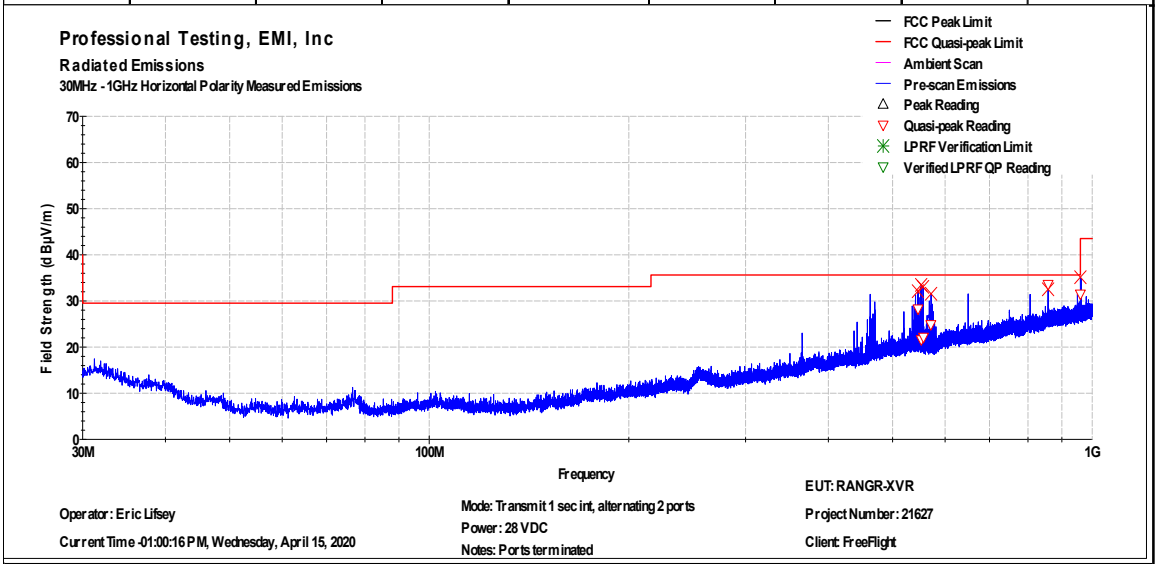
Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26		
In accordance with:	FCC Part 87 and Part 15.209		
Section:	15.209		
Test Date(s):	4/15/2020	**EUT Serial #:**	0
Customer:	FreeFlight	**EUT Part #:**	0
Project Number:	21627	**Test Technician:**	Eric Lifsey
Purchase Order #:	0	**Supervisor:**	Shakil Murad
Equip. Under Test:	RANGR-AVX	**Witness' Name:**	0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage:	28 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Horizontal	**Frequency Range:**	30MHz to 1GHz
EUT Mode of Operation:		Transmit 789 MHz, Rec 1190 MHz	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
546.05	10	308	1.02	Quasi-peak	28.249	35.6	-7.4	Pass
552.42	10	300	1.26	Quasi-peak	21.588	35.6	-14.0	Pass
556.599	10	283	1.77	Quasi-peak	22.124	35.6	-13.5	Pass
570.995	10	269	1.26	Quasi-peak	24.859	35.6	-10.7	Pass
857.999	10	14	1.26	Quasi-peak	33.571	35.6	-2.0	Pass
959.954	10	319	1.26	Quasi-peak	31.481	35.6	-4.1	Pass



≤ 1GHz Horizontal Antenna Polarity Measured Emissions

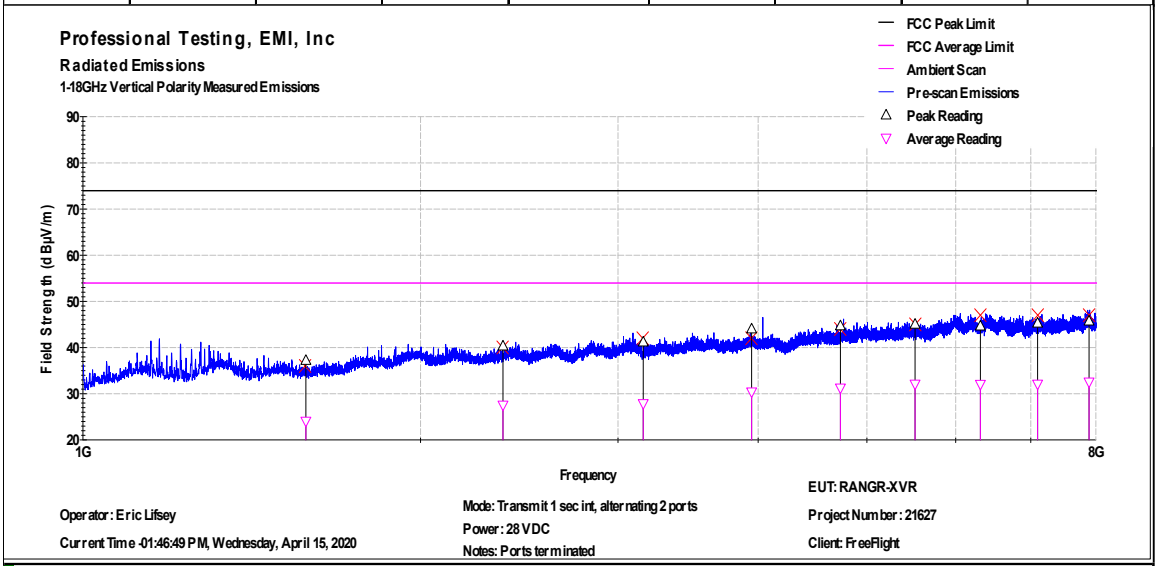
7.3.2 Up to 10 GHz

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.26		
In accordance with:	FCC Part 87 and Part 15.209		
Section:	15.209		
Test Date(s):	4/15/2020	EUT Serial #:	0
Customer:	FreeFlight	EUT Part #:	0
Project Number:	21627	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Shakil Murad
Equip. Under Test:	RANGR-AVX	Witness' Name:	0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage:	28 VDC	EUT Power Frequency:	0 N/A
Antenna Orientation:	Vertical	Frequency Range:	Above 1GHz
EUT Mode of Operation:		Transmit 789 MHz, Rec 1190 MHz	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1580.71	3	160	3.22	Peak	37.209	74.0	-36.7	Pass
2368.87	3	3	3.21	Peak	40.33	74.0	-33.6	Pass
3159.08	3	215	3.15	Peak	41.199	74.0	-32.8	Pass
3946.73	3	20	1.26	Peak	44.024	74.0	-29.9	Pass
4735.32	3	210	2.13	Peak	44.705	74.0	-29.3	Pass
5520.04	3	72	1.79	Peak	45.052	74.0	-28.9	Pass
6312.65	3	316	1.02	Peak	44.667	74.0	-29.3	Pass
7099.42	3	89	1.37	Peak	45.29	74.0	-28.7	Pass
7889.3	3	3	2.78	Peak	45.73	74.0	-28.2	Pass



> 1GHz Vertical Antenna Polarity Measured Emissions

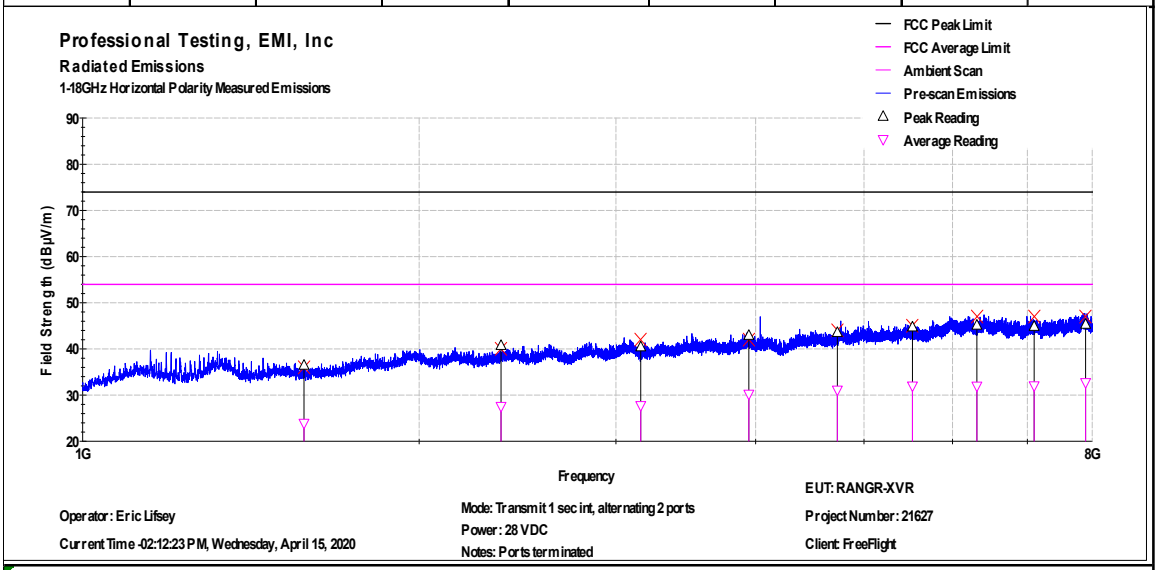
Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26		
In accordance with:	FCC Part 87 and Part 15.209		
Section:	15.209		
Test Date(s):	4/15/2020	**EUT Serial #:**	0
Customer:	FreeFlight	**EUT Part #:**	0
Project Number:	21627	**Test Technician:**	Eric Lifsey
Purchase Order #:	0	**Supervisor:**	Shakil Murad
Equip. Under Test:	RANGR-AVX	**Witness' Name:**	0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage:	28 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Horizontal	**Frequency Range:**	Above 1GHz
EUT Mode of Operation:		Transmit 789 MHz, Rec 1190 MHz	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1577.83	3	133	3.24	Peak	36.466	74.0	-37.5	Pass
2367.48	3	3	3.18	Peak	40.738	74.0	-33.2	Pass
3156.72	3	20	3.16	Peak	40.429	74.0	-33.5	Pass
3944.61	3	322	1.02	Peak	42.932	74.0	-31.0	Pass
4733.36	3	97	1.02	Peak	43.549	74.0	-30.4	Pass
5524.51	3	343	1.38	Peak	44.746	74.0	-29.2	Pass
6308.78	3	272	2.6	Peak	45.129	74.0	-28.8	Pass
7098.34	3	238	1.68	Peak	44.88	74.0	-29.1	Pass
7892.23	3	253	3.45	Peak	45.329	74.0	-28.6	Pass



> 1GHz Horizontal Antenna Polarity Measured Emissions

8.0 Frequency Stability

8.1 Test Procedure

The EUT is placed into a temperature chamber and connected by cable to a spectrum analyzer; attenuation added if needed. On reaching each set point temperature, the EUT is allowed to soak at least 15 minutes without power applied. After soak time was satisfied, the EUT is powered on in transmit mode and the frequency is observed until it becomes stable; then the measurement of frequency is taken.

Operating voltage stability was also measured for selected extremes based on operating design. This device operates over a wide voltage range greater than the FCC requirement.

The EUT is operated in unmodulated mode and continuous transmit.

8.2 Test Criteria

Table 8.2.1 Frequency Stability Criteria, 87.133; 2.1055(a)(1)
Parameter: Frequency Tolerance
20 ppm or ±19,560 Hz for 978 MHz

Table 8.2.2 Test Conditions, Temperatures
-30 C to 50 C and by 10 C steps

Table 8.2.3 Test Conditions, Voltage	
Low Voltage	10 V
Nominal Voltage	28 VDC
High Voltage	40 VDC

8.3 Test Results

The EUT satisfies the requirement. As the antenna port has no effect on frequency one port was tested. Tabular results appear below.

8.3.1 Temperature

			17-Apr-2020
Condition	**Frequency**		**Deviation**
Temperature (C)	Reference Center Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
-30	978.000000	978.004747	4747
-20	978.000000	978.001799	1799
-10	978.000000	978.002418	2418
0	978.000000	978.008148	8148
10	978.000000	977.998138	-1862
20	978.000000	978.002974	2974
30	978.000000	978.003788	3788
40	978.000000	978.002202	2202
50	978.000000	978.001916	1916

Max Deviation (Hz)	8148
Min Deviation (Hz)	-1862

8.3.2 Voltage

				17-Apr-2020
Condition	**Voltage**	**Frequency**		
Voltage Extreme	Voltage (V DC)	Reference Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
Low	10.0	978.000000	977.997471	-2529
Nominal	28.0	978.000000	978.000463	463
High	40.0	978.000000	978.001236	1236

9.0 Equipment Lists

Table 9.1 Equipment List; Power, Bandwidth, and Mask				
Asset #	**Manufacturer**	**Model #**	**Description**	**Calibration Due**
1937	Agilent	E4440A	Spectrum Analyzer	8 Nov 2020
A105	Narda	768A-20	Attenuator, 20 W, 20 dB	23 Sep 2020
0463	Fluke	77A	DMM	10 Jul 2020
1268	HP	6291A	DC Power Supply	CIU

Table 9.2 Equipment List; Frequency Stability				
Asset #	**Manufacturer**	**Model #**	**Description**	**Calibration Due**
1937	Agilent	E4440A	Spectrum Analyzer	8 Nov 2020
A105	Narda	768A-20	Attenuator, 20 W, 20 dB	23 Sep 2020
2134	Tenny	TPC T2C	Temperature Chamber	8 Oct 2020
C247	Pasternack	RG type	Coaxial Cable, double shielded	CNR
0463	Fluke	77A	DMM	10 Jul 2020
1268	HP	6291A	DC Power Supply	CIU

Table 9.3 Equipment List; Radiated Emissions

Radiated Emissions Test Equipment List					
Tile! Software Version:	**Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM**				
Test Profile:	**2019_May_Unintentional RE_TILE7_v2.5.til**				
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
1509A	Braden	TDK 10M	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	9/17/2021
1890	HP	8447F-H64	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	1/9/2022
2295	Keysight	E4440A-AYZ	PSA Spectrum Analyzer	MY46186204	11/6/2020
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	3/11/2021
C027	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/9/2020
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1509B	Braden	TDK 10M	TDK 10M Chamber,sVSWR > 1 GHz	DAC-012915-005	9/21/2021
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/9/2022
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/9/2020
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	3/11/2021

Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11: 2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	2.8
Radiated Emissions	30 to 1,000 MHz	10 m	4.8
	1 to 18 GHz	3 m	5.7

End of Report

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