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FCC TEST REPORT

Prepared for:	**Garmin International, Inc.**
Address:	**1200 E. 151st Street** **Olathe, Kansas, 66062, USA**
Product:	**A04041**
Test Report No:	**R20190619-20-E1B**
Approved By:	 **Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**8 March 2021**
Total Pages:	**43**

ilac-MRA A2LA ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	13 July 2020	Original – NJohnson Prepared by KVepuri/CFarrington
A	18 January 2021	1. Added conducted spurious emissions to section 4.1 2. Added limit calculation to section 4.1 3. Bandwidth table was updated in section 4.3 4. Added supplemental plots in section 4.3 5. Frequency accuracy with voltage variation was added to section 4.5
B	8 March 2021	Notes that spurious emissions was investigated with both FM modulation and analog modulation.

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. The EUT has been tested according to the following specifications:

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 2.1046 FCC Part 95.2767	Output Power	PASS
FCC Part 2.1033 (c)(14) FCC Part 2.1053	Conducted Spurious Emissions	PASS
FCC Part 2.1053 FCC Part 95.2779	Radiated Spurious Emissions	PASS
FCC Part 2.1049 FCC Part 95.2773, 95.2779	Emissions Masks/ Occupied Bandwidth	PASS
FCC Part 2.1055 (a)(1), (b) FCC Part 95.2765	Frequency Stability Under Voltage and Temp Variation	PASS
FCC Part 15.209	Receiver Spurious Emissions	PASS

See Section 4 for details on the test methods used for each test.

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a portable transceiver from Garmin.

Model	A04041
EUT Received	17 June 2020
EUT Tested	17 June 2020- 11 January 2021
Serial No.	00114, 00115, 00156 (Used for Conducted Radio Measurements)
Operating Band	151.820 MHz – 154.600 MHz
Device Type	VHF
Power Supply	12V Battery

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual. The serial numbers are assigned by test lab.

2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency (MHz)
Channel 1	151.820
Channel 2	151.880
Channel 3	151.940
Channel 4	154.570
Channel 5	154.600

These channels are described in FCC Part 95.2763 “MURS Channels”

This EUT was set to transmit in a worse-case scenario with modulation on.

The EUT was tested using digital modulation and throughout the entire frequency range of analog modulation. It was found that 2.9 kHz analog modulation produced the widest bandwidth and that was used for bandwidth and emissions mask measurements as well as output power, which did not deviate by more than 0.1 dB between modes.

Spurious emissions were also investigated with digital + analog modulation and with only digital (FM) modulation. It was found that the results did not deviate by more than 0.1 dB between mdoes.

2.3 DESCRIPTION OF SUPPORT UNITS

NA

3.0 LABORATORY DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number: 1953.01
FCC Accredited Test Site Designation No: US1060
Industry Canada Test Site Registration No: 4294A-1
NCC CAB Identification No: US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 35 ± 4%
Temperature of 22 ± 3° Celsius

3.2 TEST PERSONNEL

All testing was performed by Karthik Vepuri, and Fox Lane of NCEE Labs. The results were reviewed by Nic Johnson.

3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer	N9038A	MY59050109	April 23, 2019	April 23, 2021
Keysight EXA Signal Analyzer	N9010A	MY56070862	December 14, 2018	December 14, 2021
HP RF Communications Test Set**	8920B	4915	December 12, 2018	December 15, 2021
Tektronix USB Power Meter	PSM3110	118674	March 10, 2020	March 10, 2021
SunAR RF Motion	JB1	A091418	March 6, 2020	March 6, 2021
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 2022
EMCO Horn Antenna	3116	2576	March 9, 2020	March 9, 2022
Rohde & Schwarz LISN	ESH3-Z5	836679/010	July 25, 2019	July 25, 2020
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	April 14, 2020	April 14, 2022
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	April 14, 2020	April 14, 2022
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	April 14, 2020	April 14, 2022
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	April 14, 2020	April 14, 2022
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	April 14, 2020	April 14, 2022
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	April 14, 2020	April 14, 2022
N connector bulkhead (control room)*	PE9128	NCEEBH2	April 14, 2020	April 14, 2022
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Internal Characterization
**Owned and maintained by the manufacturer

4.0 DETAILED RESULTS

4.1 RADIATED SPURIOUS EMISSIONS AND CONDUCTED SPURIOUS

Test Method: ANSI C63.26:2015:

1. Section 5.5, “Radiated Emissions Testing”

Limits for spurious emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 95.2779 as followed:

Transmitting Frequency (MHz)	Frequency Band	Limit (dB)
151.820 151.880 151.940	≥12.5kHz removed from center frequency	50 + 10log(P)
154.570 154.600	≥50kHz removed from center frequency	43 + 10log(P)

Where P is equal to the output power of the transmitter in Watts.

Rated output power of transmitter is 1.5 W thus making the worst-case radiated emissions limit 44.76dB. Emissions were also compared to FCC Part 15 limits. Worst case limits were considered.

Limit = 50 + 10log(P) = 51.76; P = 1.5 W
Conducted Limit in dBm=P (dBm)-51.76=31.76-51.76=-20 dBm
Radiated Limit @ 3 m Test Distance=-20 dBm+95.23=75.23 dBµV/m

Limit = 43 + 10log(P) = 44.76; P = 1.5 W
Conducted Limit in dBm=P (dBm)-44.76=31.76-44.76=-13 dBm
Radiated Limit @ 3 m Test Distance=-13 dBm+95.23=82.23 dBµV/m

Test procedures for conducted spurious emissions:

The EUT was connected to a spectrum analyzer directly with a low-loss shielded coaxial cable and sufficient attenuator with following settings:

120 kHz RBW and 1 MHz VBW for 30 MHz -1 GHz.

1 MHz RBW and 8 MHz VBW for 1 GHz – 2 GHz.

Test procedures for radiated spurious emissions:

a. The EUT was placed on the top of a rotating table above the ground plane in a 10-meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise, the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

Test setup:

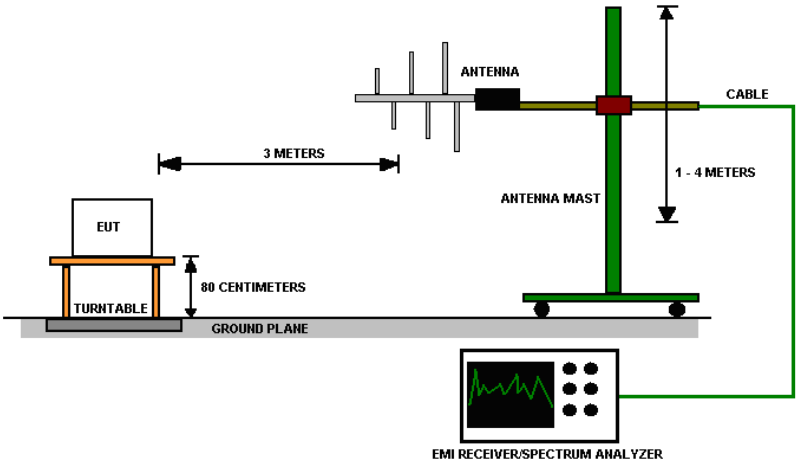
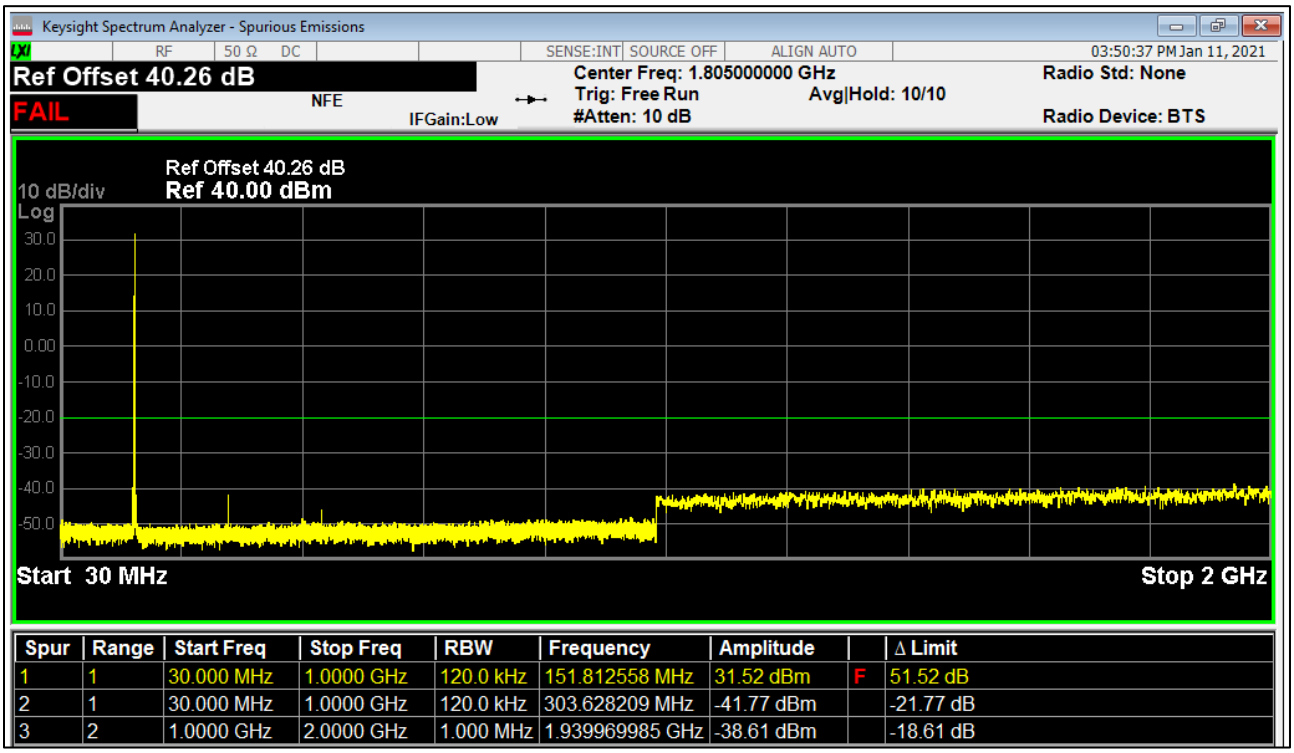


Figure 1 - Radiated Emissions Test Setup

EUT operating conditions

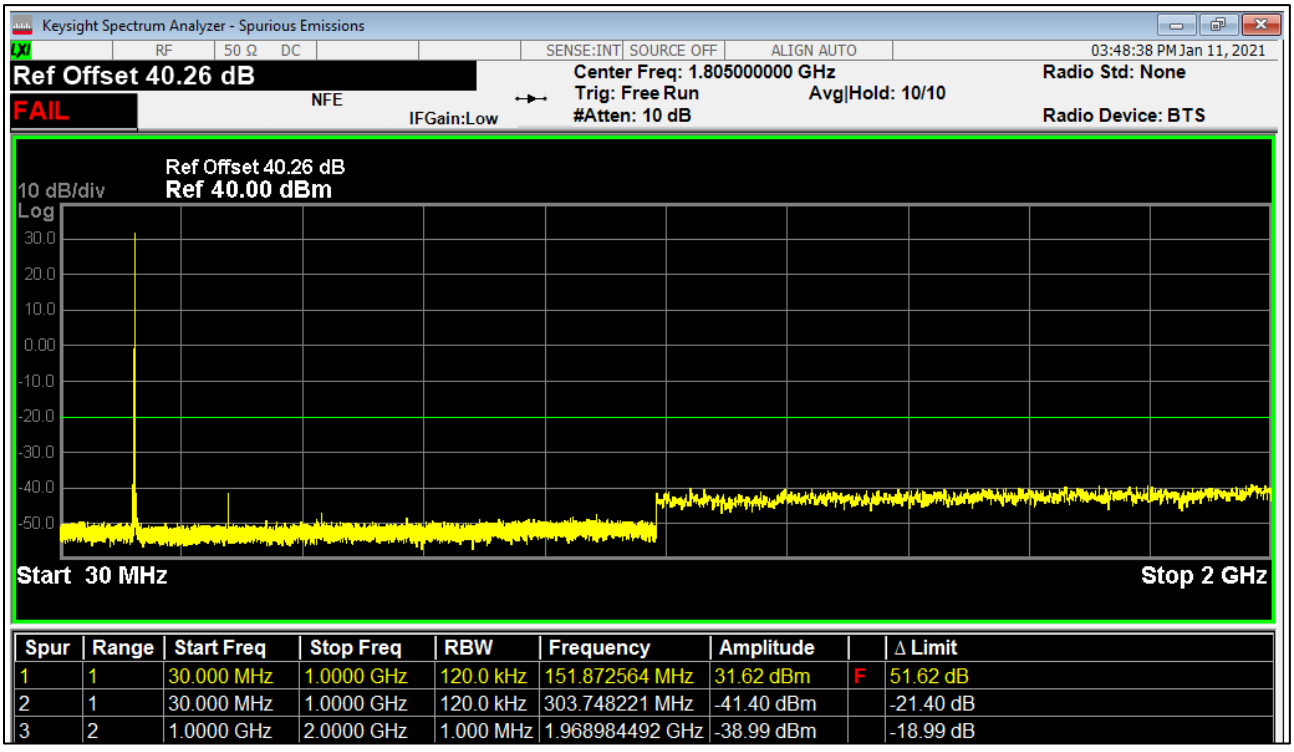
EUT was powered by 12V battery. Device was set to transmit in the lowest and highest frequencies in its operating range.

Conducted spurious test results:



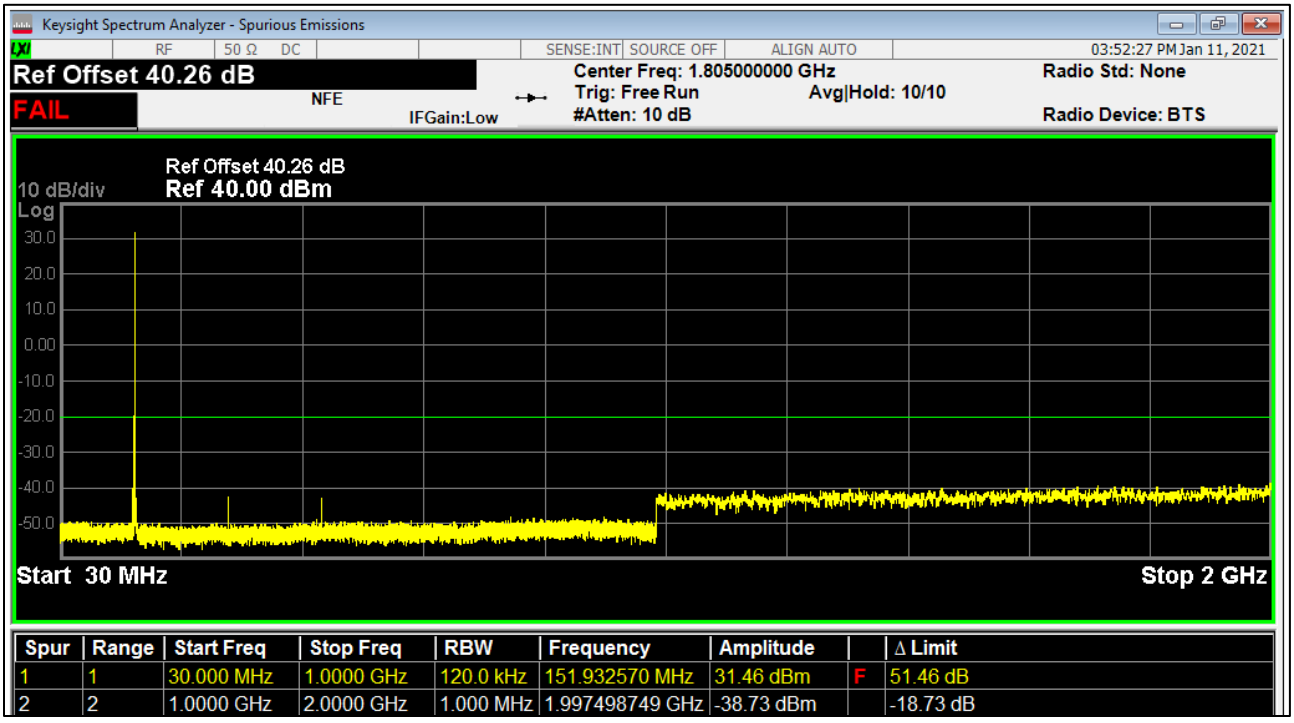
Spur	Range	Start Freq	Stop Freq	RBW	Frequency	Amplitude		Δ Limit
1	1	30.000 MHz	1.0000 GHz	120.0 kHz	151.812558 MHz	31.52 dBm	F	51.52 dB
2	1	30.000 MHz	1.0000 GHz	120.0 kHz	303.628209 MHz	-41.77 dBm		-21.77 dB
3	2	1.0000 GHz	2.0000 GHz	1.000 MHz	1.939969985 GHz	-38.61 dBm		-18.61 dB

Figure 2 – Conducted Spurious Emissions, 151.82 MHz



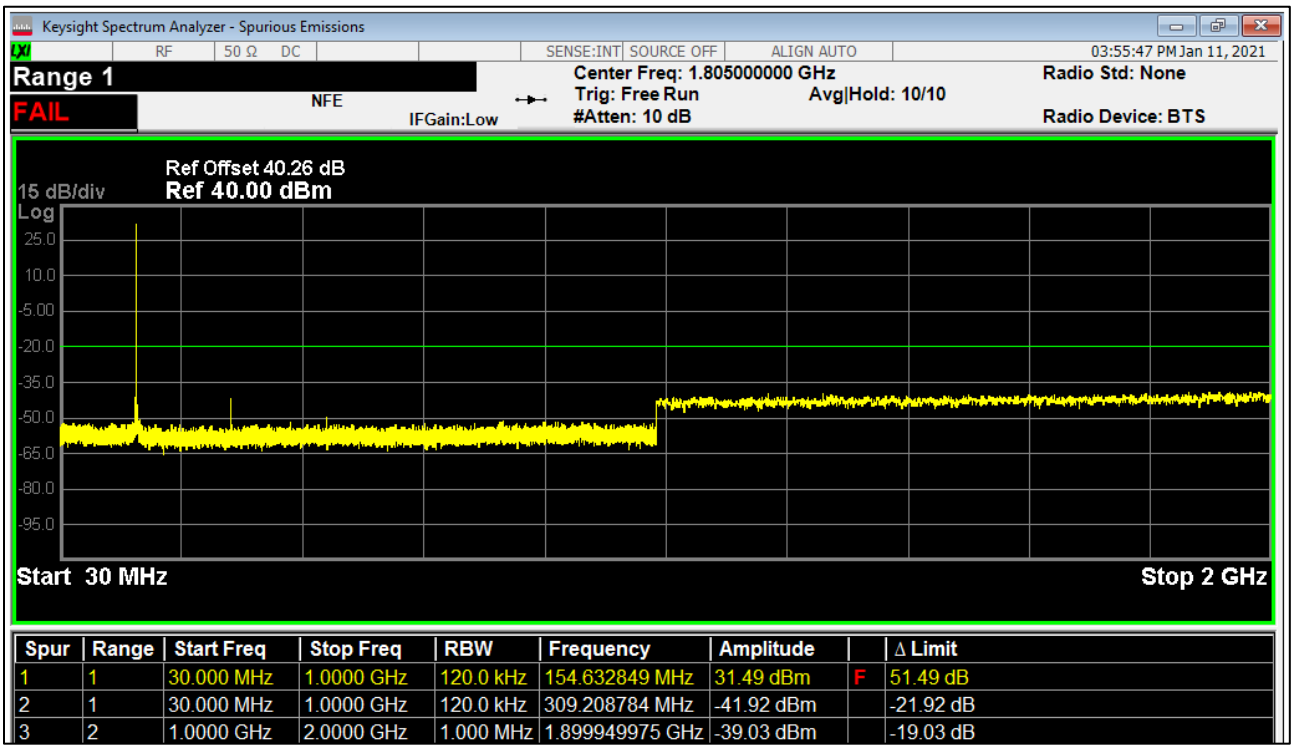
Spur	Range	Start Freq	Stop Freq	RBW	Frequency	Amplitude		Δ Limit
1	1	30.000 MHz	1.0000 GHz	120.0 kHz	151.872564 MHz	31.62 dBm	F	51.62 dB
2	1	30.000 MHz	1.0000 GHz	120.0 kHz	303.748221 MHz	-41.40 dBm		-21.40 dB
3	2	1.0000 GHz	2.0000 GHz	1.000 MHz	1.968984492 GHz	-38.99 dBm		-18.99 dB

Figure 3 – Conducted Spurious Emissions, 151.88 MHz



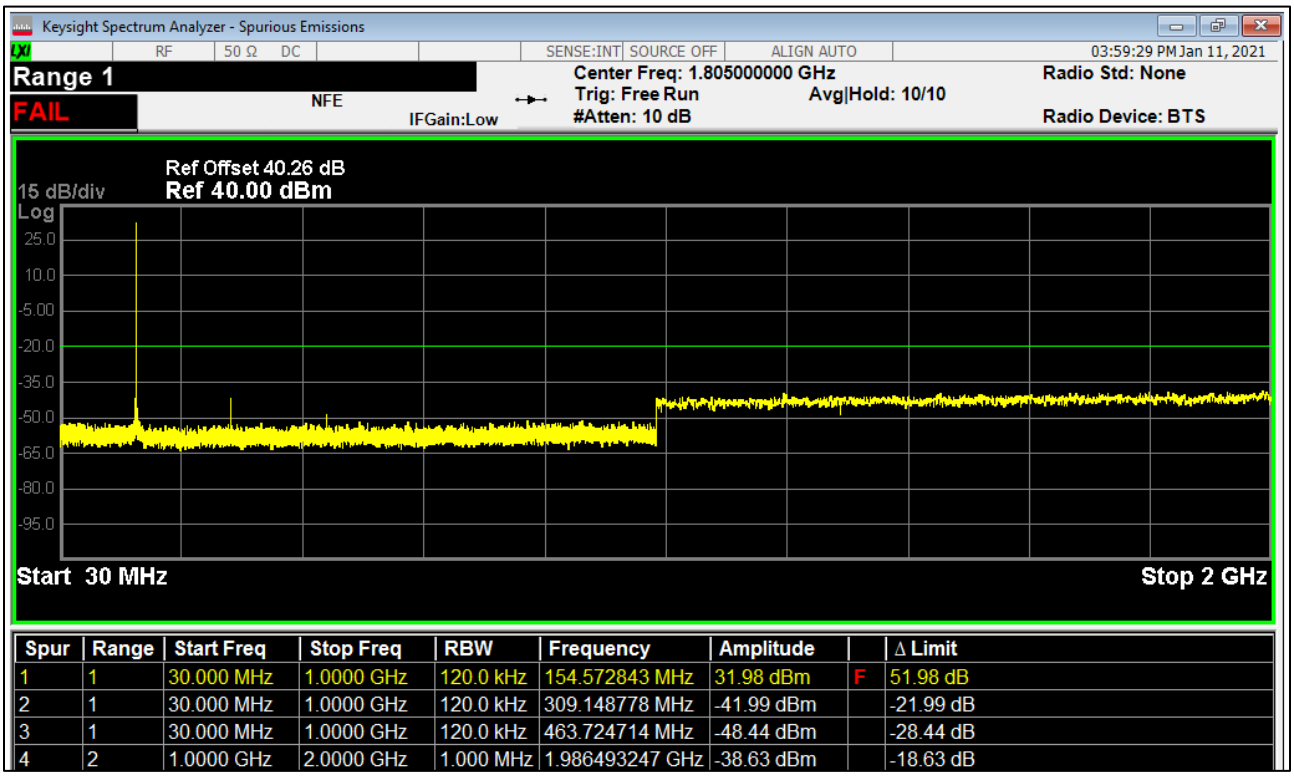
Spur	Range	Start Freq	Stop Freq	RBW	Frequency	Amplitude		Δ Limit
1	1	30.000 MHz	1.0000 GHz	120.0 kHz	151.932570 MHz	31.46 dBm	F	51.46 dB
2	2	1.0000 GHz	2.0000 GHz	1.000 MHz	1.997498749 GHz	-38.73 dBm		-18.73 dB

Figure 4 – Conducted Spurious Emissions, 151.94 MHz



Spur	Range	Start Freq	Stop Freq	RBW	Frequency	Amplitude		Δ Limit
1	1	30.000 MHz	1.0000 GHz	120.0 kHz	154.632849 MHz	31.49 dBm	F	51.49 dB
2	1	30.000 MHz	1.0000 GHz	120.0 kHz	309.208784 MHz	-41.92 dBm		-21.92 dB
3	2	1.0000 GHz	2.0000 GHz	1.000 MHz	1.899949975 GHz	-39.03 dBm		-19.03 dB

Figure 5 – Conducted Spurious Emissions, 154.6 MHz



Spur	Range	Start Freq	Stop Freq	RBW	Frequency	Amplitude		Δ Limit
1	1	30.000 MHz	1.0000 GHz	120.0 kHz	154.572843 MHz	31.98 dBm	F	51.98 dB
2	1	30.000 MHz	1.0000 GHz	120.0 kHz	309.148778 MHz	-41.99 dBm		-21.99 dB
3	1	30.000 MHz	1.0000 GHz	120.0 kHz	463.724714 MHz	-48.44 dBm		-28.44 dB
4	2	1.0000 GHz	2.0000 GHz	1.000 MHz	1.986493247 GHz	-38.63 dBm		-18.63 dB

Figure 6 – Conducted Spurious Emissions, 154.57 MHz

Note: The conducted spurious emissions plots show fundamental to be over the spurious limit, which is expected. The worst-case spurious measurements are presented in the tables under the graphs in white. All other emissions were found to be at least 10dB below the limit.

Radiated spurious test results:

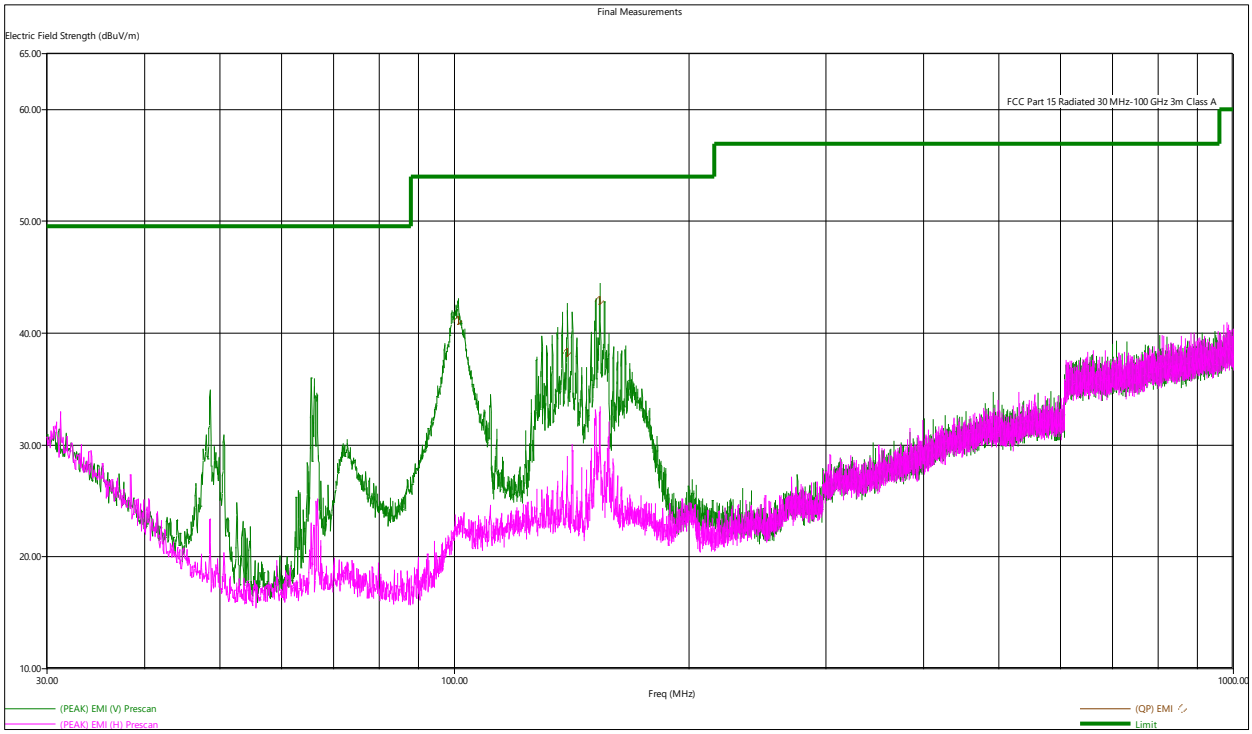


Figure 7 – Receiver Spurious Emissions

Quasi-Peak Data						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
101.224320	41.06	53.98	12.92	108	62	V
139.712640	38.23	53.98	15.75	110	195	V
153.849840	42.84	53.98	11.14	107	131	V

No emissions were found within 10dB of the limit.

Peak Spurious Emissions – 151.82 MHz			
Frequency	**Level**	**Limit**	**Margin**
MHz	**dBµV/m**	**dBµV/m**	**dB**
303.660	55.129	75.23	20.101
455.464	56.871	75.23	18.359
755.100	44.572	75.23	30.658
1366.380	56.487	75.23	18.743

All other emissions were found to be at least 10dB below the limit.

Limit = 50 + 10log(P) = 51.76; P = 1.5 W
Limit in dBm=P (dBm)-51.76=31.76-51.76=-20 dBm
Limit @ 3 m Test Distance=-20 dBm+95.23=75.23 dBµV/m

Peak Spurious Emissions – 154.60 MHz			
Frequency	**Level**	**Limit**	**Margin**
MHz	**dBµV/m**	**dBµV/m**	**dB**
309.210	51.642	82.23	30.588
463.810	65.296	82.23	16.934
773.000	47.559	82.23	34.671
1391.400	58.778	82.23	23.452

All other emissions were found to be at least 10dB below the limit.

Limit = 43 + 10log(P) = 44.76; P = 1.5 W
Limit in dBm=P (dBm)-44.76=31.76-44.76=-13 dBm
Limit @ 3 m Test Distance=-13 dBm+95.23=82.23 dBµV/m

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

4.2 OUTPUT POWER

Test Method: ANSI C63.26:
Section(s) 5.2.4.2 “General procedure for measuring average power with an average power meter”

FCC Part 95.2767 MURS transmitting power limit:
Each MURS transmitter type must be designed such that the transmitter power output does not exceed 2 Watts under normal operating conditions.

Test procedures:
The EUT was connected to a RF power meter directly with a low-loss shielded coaxial cable.

Deviations from test standard:
No deviation.

Test setup:

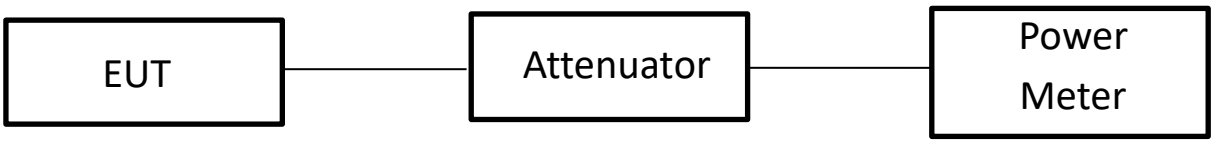


Figure 8 – Peak Output Power Measurements Test Setup

EUT operating conditions:
EUT was connected to a 12V battery. Device was set to transmit in each of its five allocated frequencies.

Test results:

Output Power

CHANNEL FREQUENCY (MHz)	OUTPUT POWER (dBm)	OUTPUT POWER (W)	Method	RESULT
151.820	31.52	1.42	Conducted	PASS
151.880	31.69	1.48	Conducted	PASS
151.940	31.64	1.46	Conducted	PASS
154.570	31.72	1.49	Conducted	PASS
154.600	31.68	1.47	Conducted	PASS

4.3 BANDWIDTH AND EMISSIONS MASK

Test Method: ANSI C63.26,
1. Section(s) 5.4.3, 5.4.4

Limits:
FCC Part 95.2773 MURS authorized bandwidths:

Each MURS transmitter type must be designed to meet the emission bandwidth limitations in this section.

(a) The occupied bandwidth of emissions transmitted on the center frequencies 151.820 MHz, 151.880 MHz, and 151.940 MHz must not exceed 11.25 kHz.

(b) The occupied bandwidth of emissions transmitted on the center frequencies 154.570 MHz and 154.600 MHz must not exceed 20.0 kHz.

FCC Part 95.2773 MURS authorized bandwidths:

Channel Center Frequencies	Paragraphs
151.820, 151.880 and 151.940	(1), (2)
154.570 & 154.600, without audio filter	(5), (6), (7)

(1) 7.27(fd−2.88 kHz) dB on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 5.625 kHz, but not more than 12.5 kHz.

(2) 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation, on any frequency removed from the channel center frequency by more than 12.5 kHz.

(5) 83 log (fd ÷ 5) dB on any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) that is more than 5 kHz, but not more than 10 kHz.

(6) 29 log (fd2 ÷ 11) dB or 50 dB, whichever is the lesser attenuation on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 10 kHz, but not more than 50 kHz.

(7) 43 + 10 log(P) dB on any frequency removed from the channel center frequency by more than 50 kHz.

Test procedures:
The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 1 kHz RBW and 10 kHz VBW. The bandwidth measurements were done using the automatic bandwidth measurement of the receiver.

Deviations from test standard:
No deviation

Test setup:

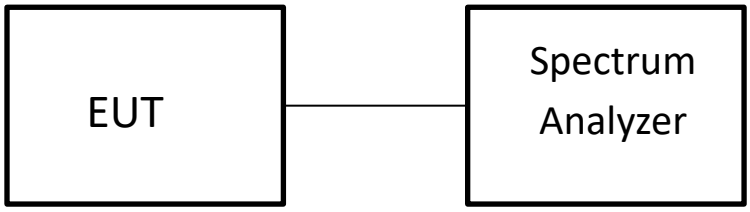


Figure 9 –Measurements Test Setup

EUT operating conditions:
EUT was powered by a 12V battery. Device was set to transmit in each of its five allocated frequencies.

Test results:
99% Occupied Bandwidth

CHANNEL FREQUENCY (MHz)	99% Occupied BW (kHz)
151.820	7.417
151.880	7.423
151.940	7.400
154.570	7.418
154.600	7.430

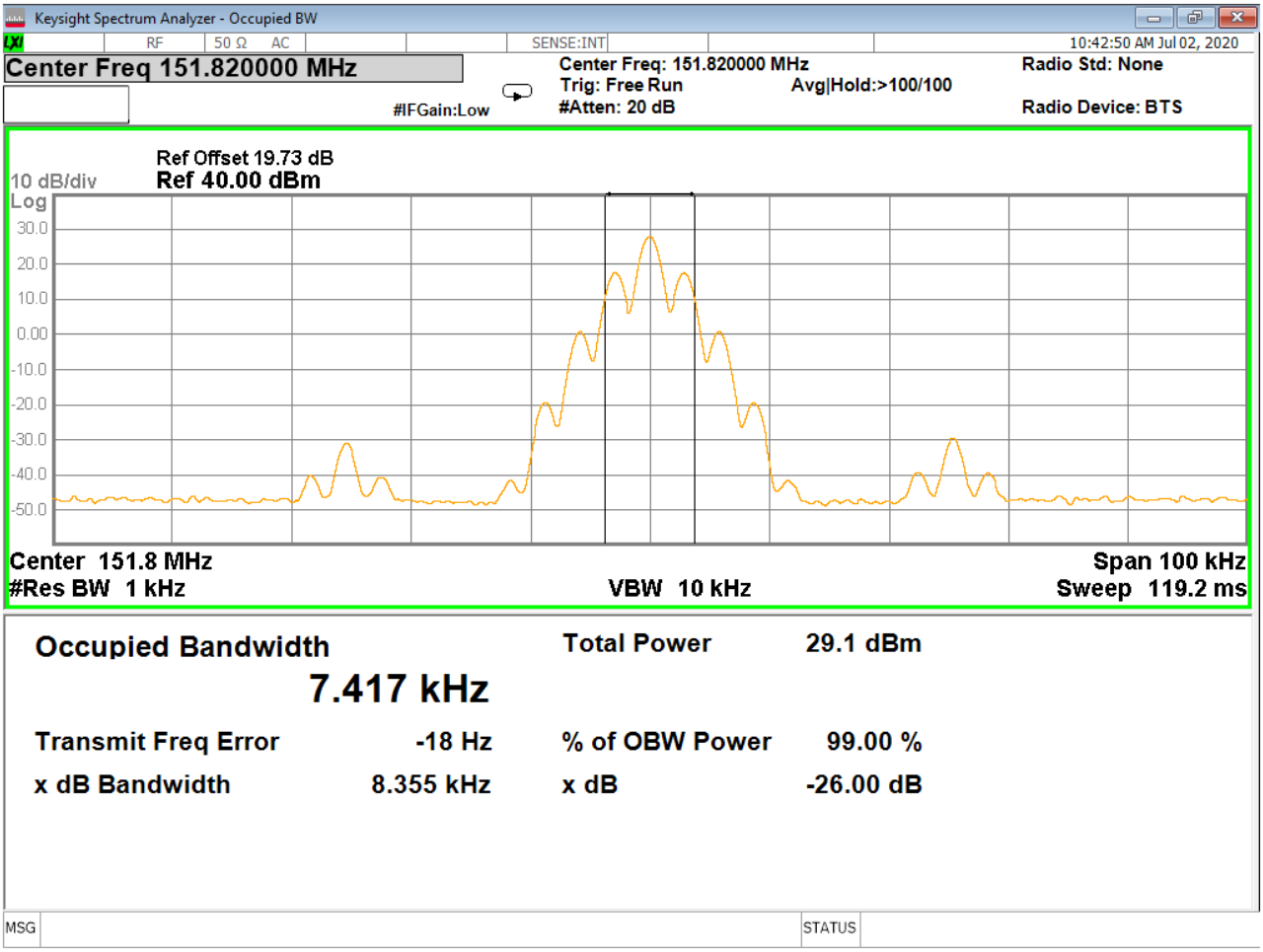


Figure 10 - Bandwidth, 151.820 MHz

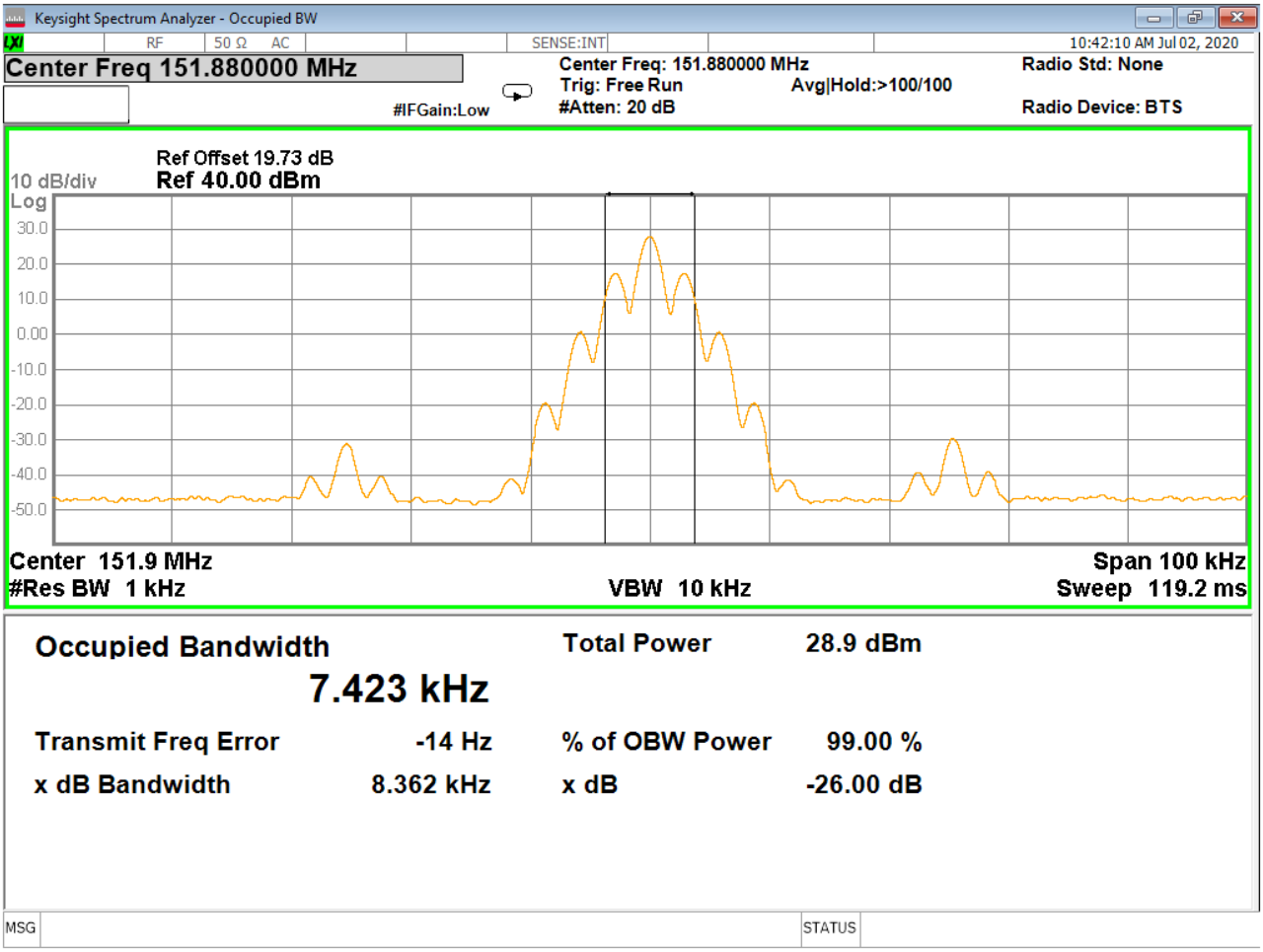


Figure 11 - Bandwidth, 151.880 MHz

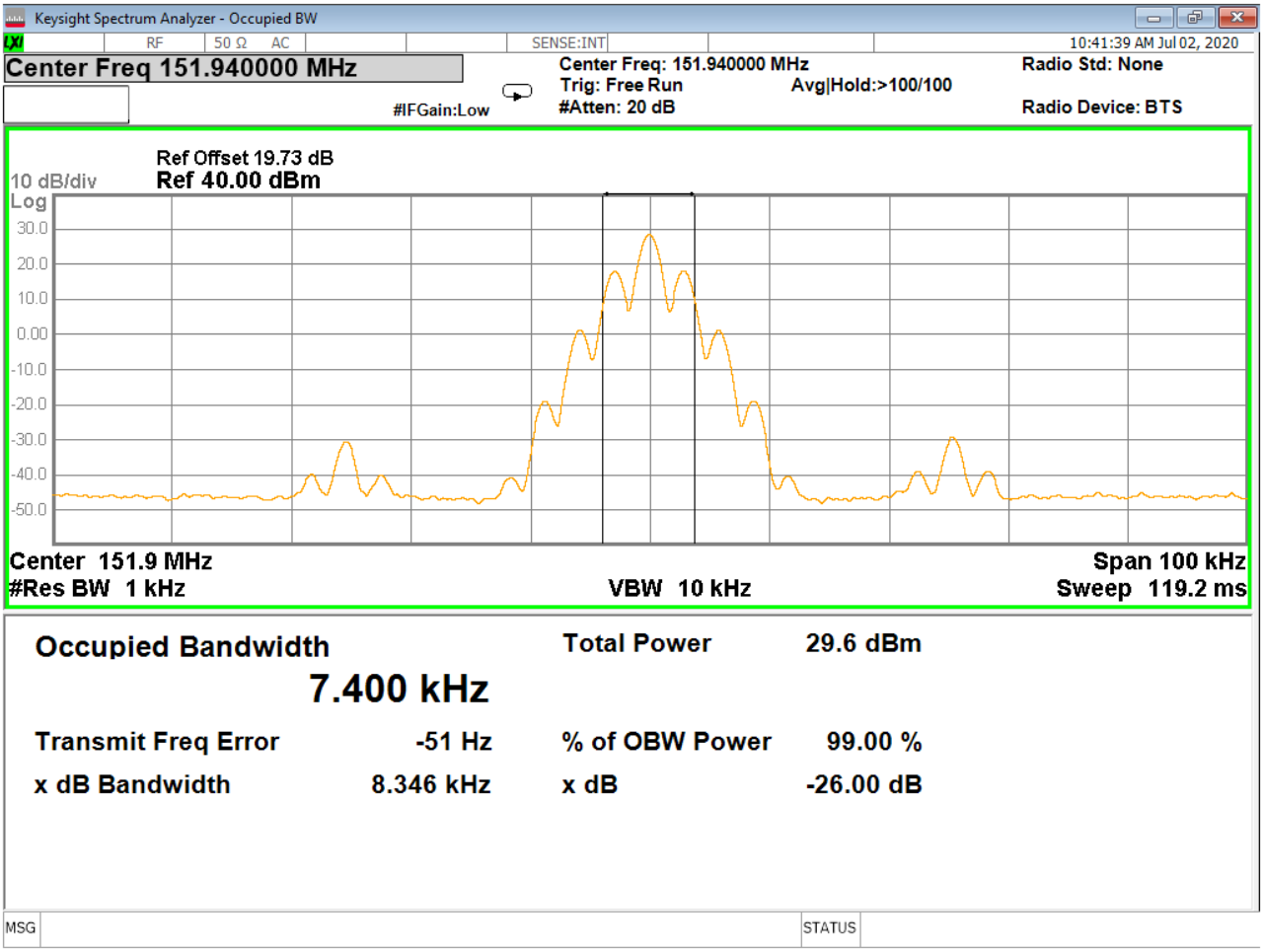


Figure 12 - Bandwidth, 151.940 MHz

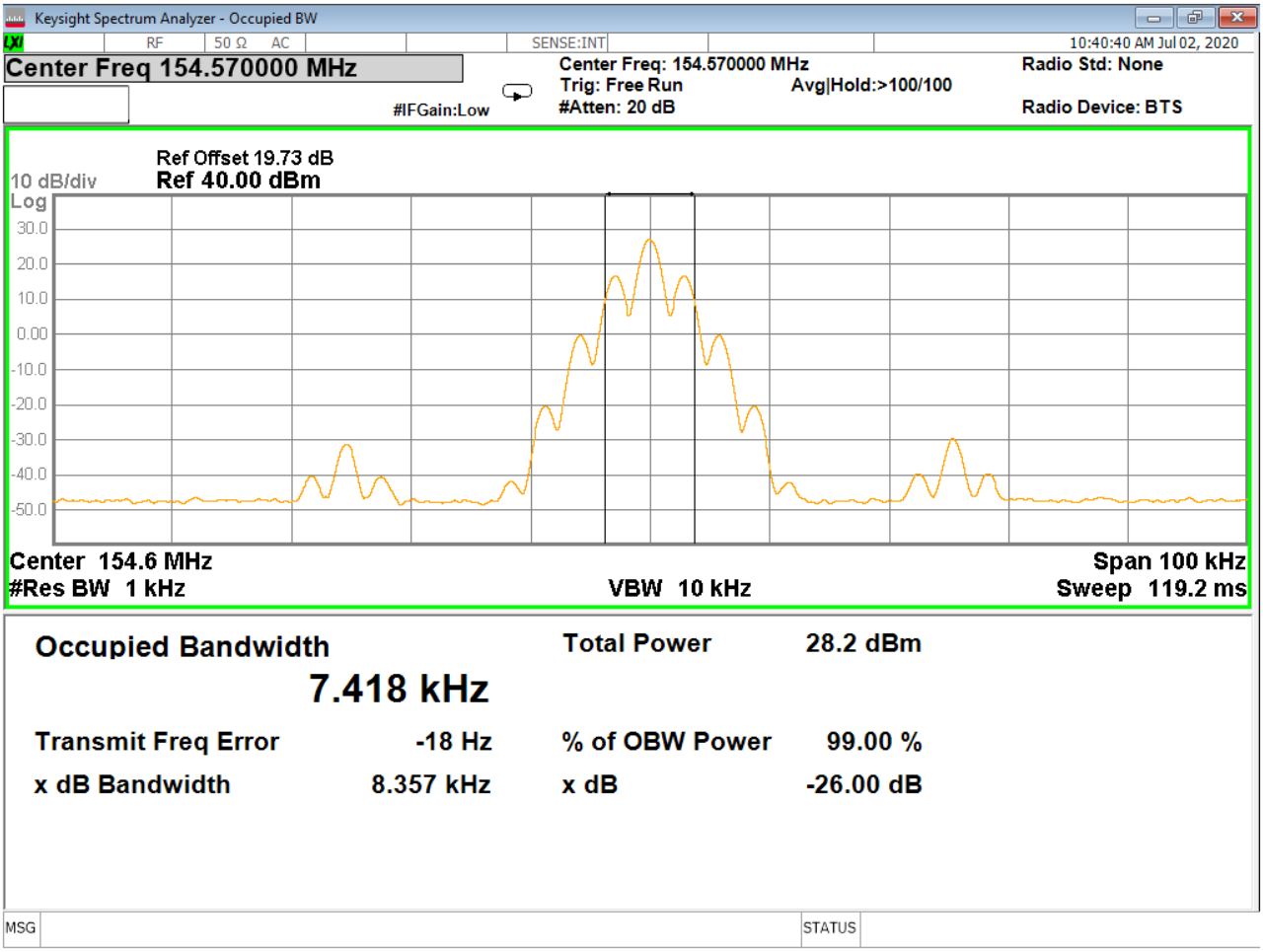


Figure 13 - Bandwidth, 154.570 MHz

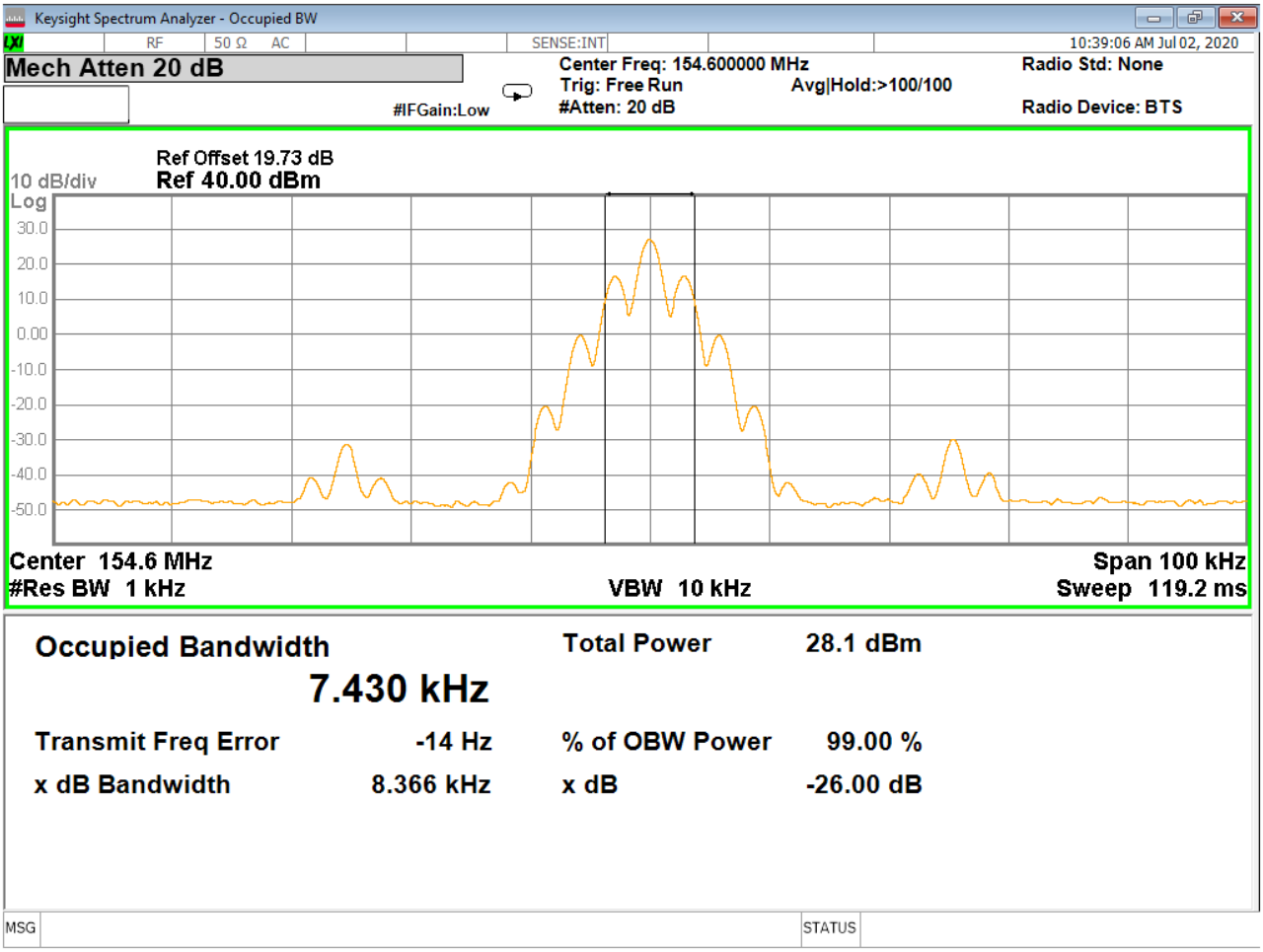


Figure 14 - Bandwidth, 154.600 MHz

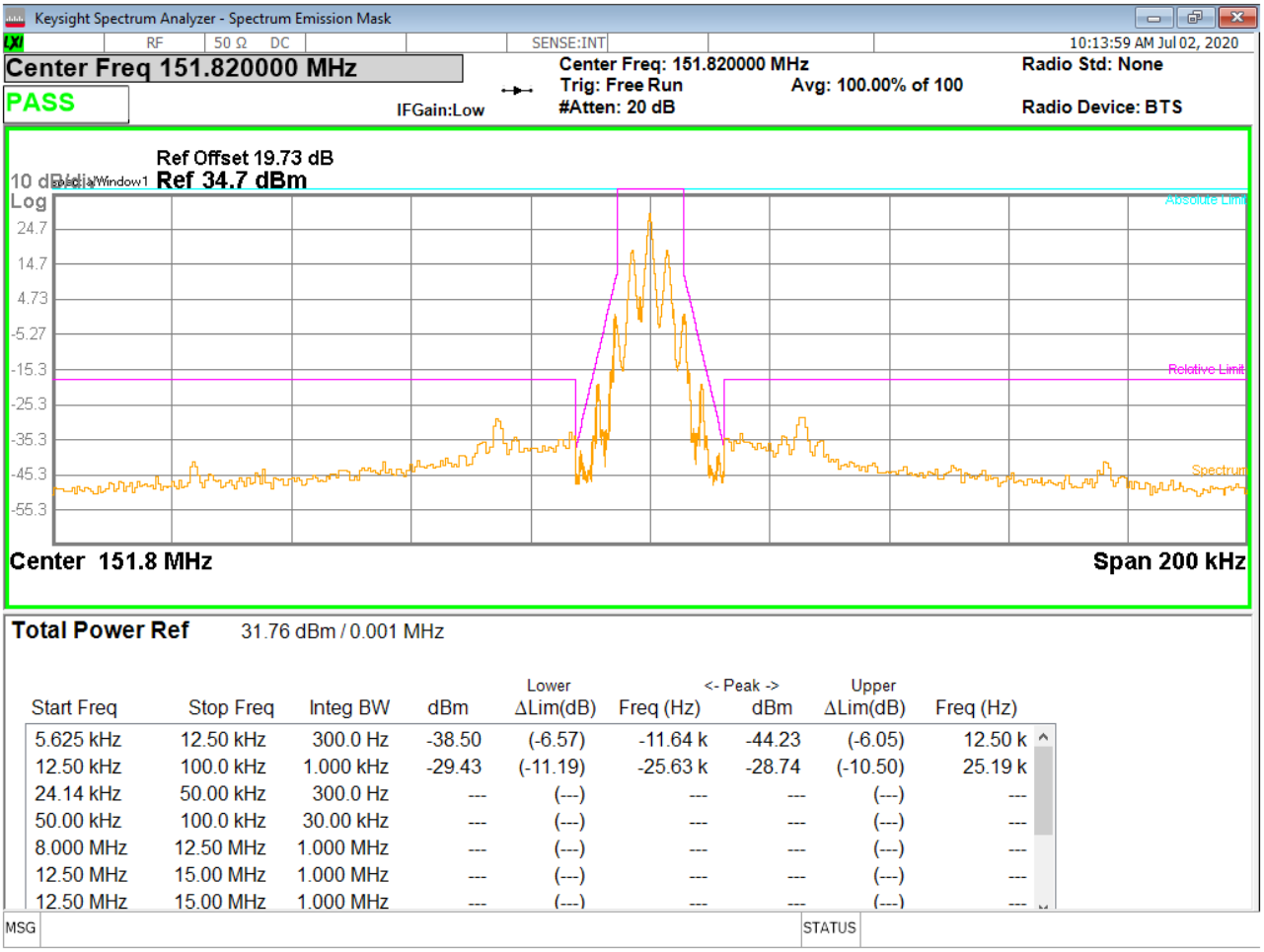


Figure 15 – Emissions Mask, 151.820 MHz

The above plot is intended to show that the radio meets the following requirement:

(1) 7.27(fd−2.88 kHz) dB on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 5.625 kHz, but not more than 12.5 kHz.

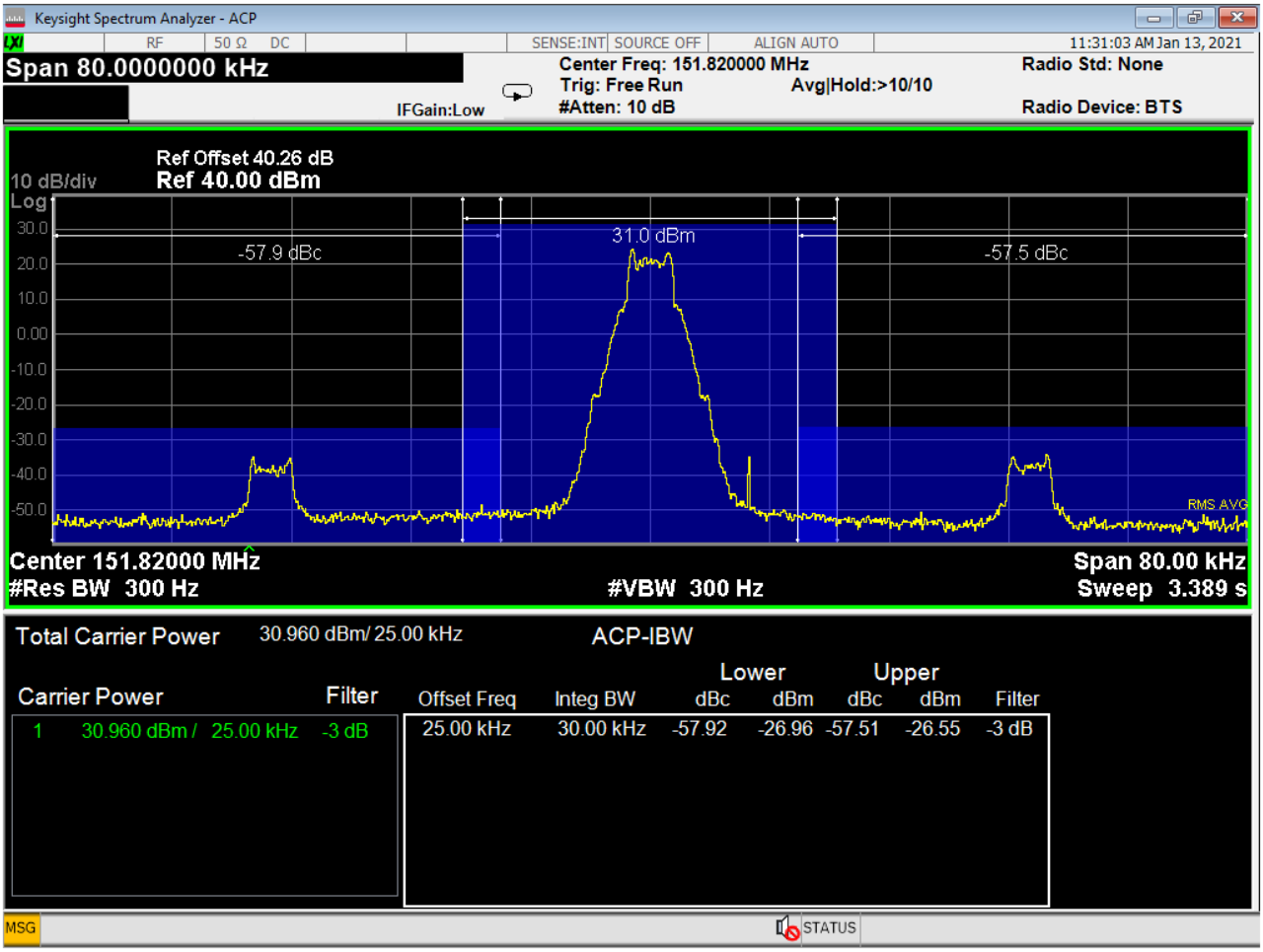


Figure 16 – Emissions Mask, 151.820 MHz

The above plot is intended to show that the radio meets the following requirement:

(2) 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation, on any frequency removed from the channel center frequency by more than 12.5 kHz.

Worst case Limit = 50 + 10log(P) = 51.76; P = 1.5 W

Worst case is 57.5 dBc; So, Pass.

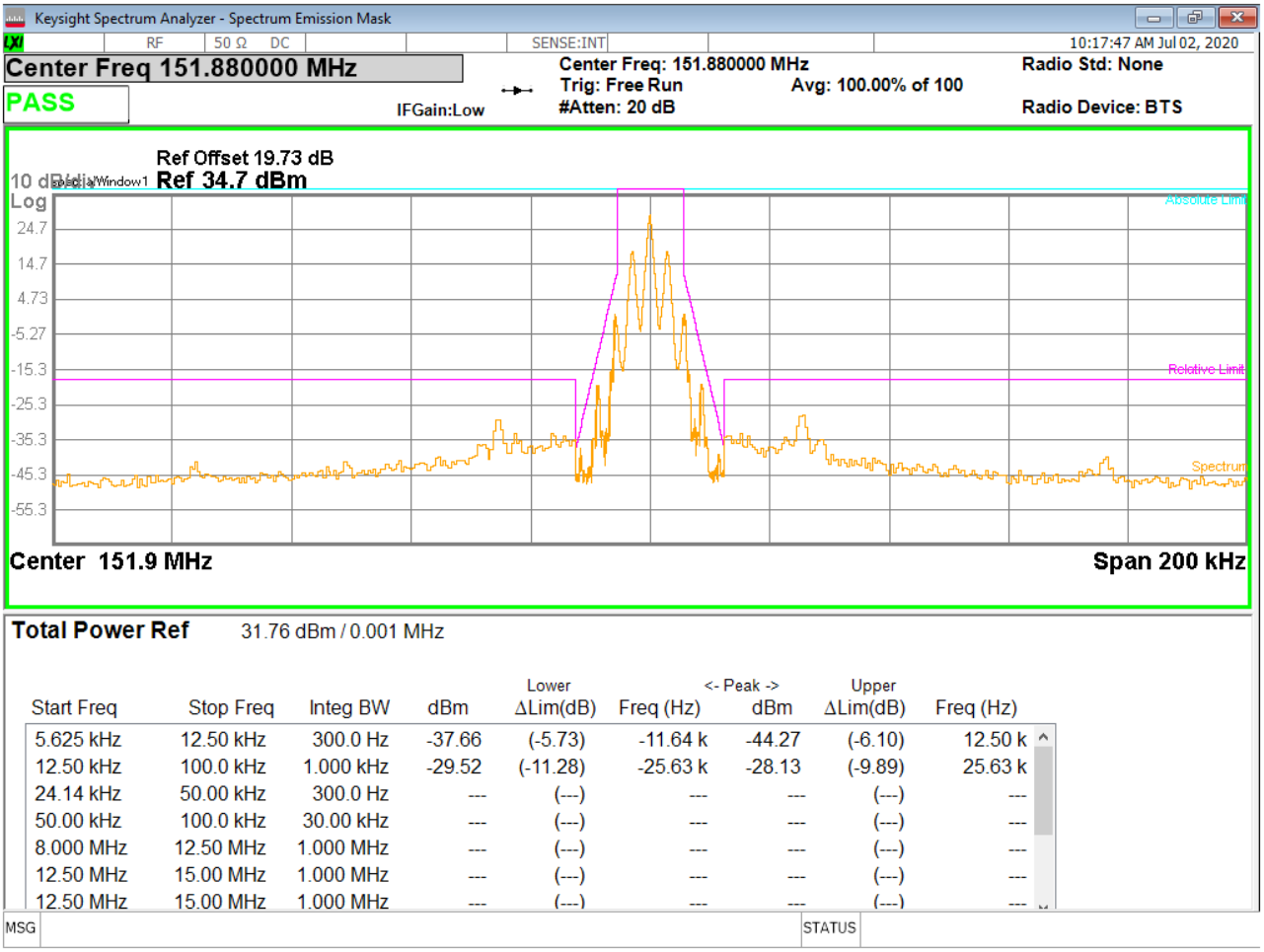


Figure 17 - Emissions Mask, 151.880 MHz

The above plot is intended to show that the radio meets the following requirement:

(1) 7.27(fd−2.88 kHz) dB on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 5.625 kHz, but not more than 12.5 kHz.

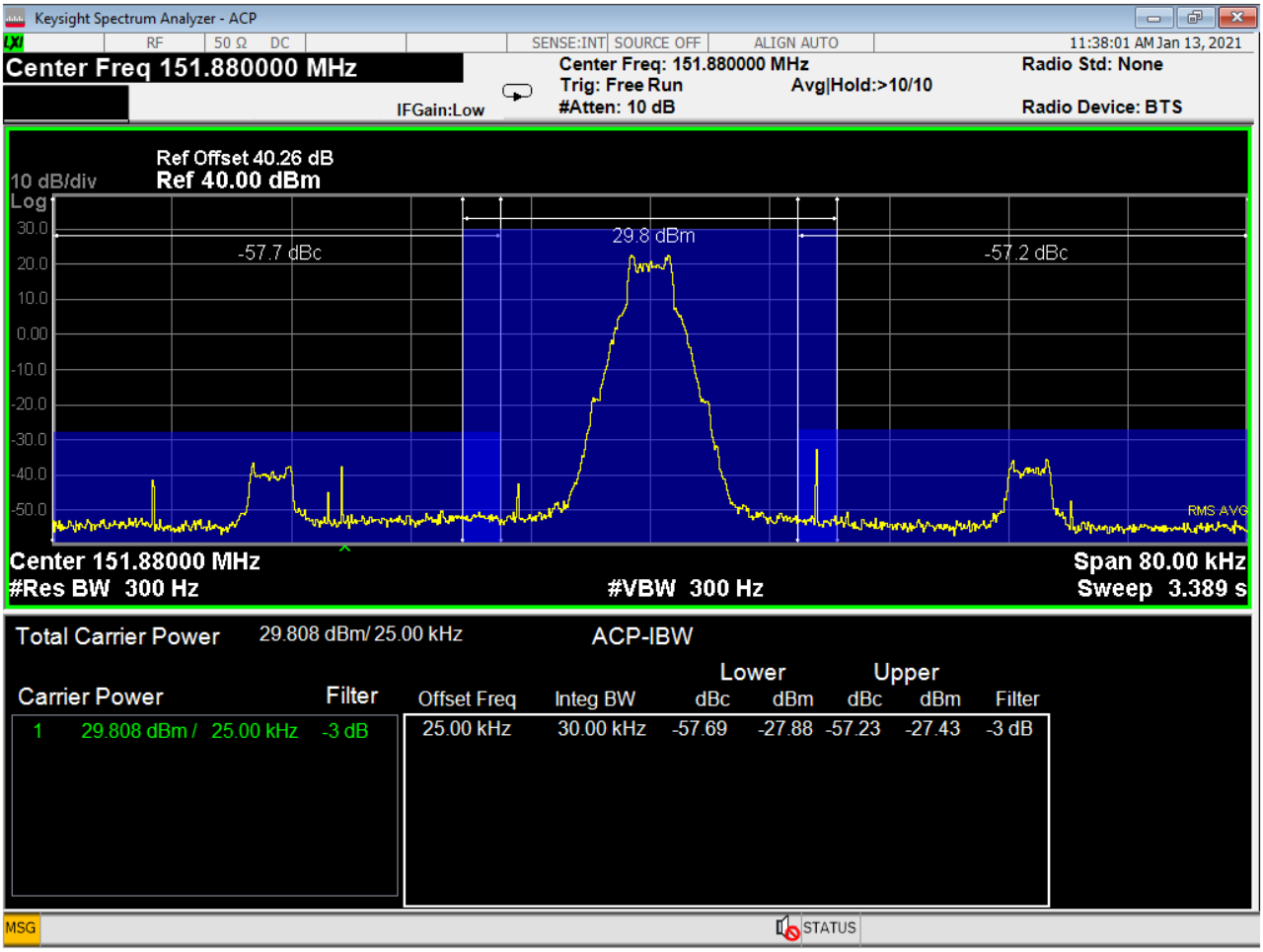


Figure 18 - Emissions Mask, 151.880 MHz

The above plot is intended to show that the radio meets the following requirement:

(2) 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation, on any frequency removed from the channel center frequency by more than 12.5 kHz.

Worst case Limit = 50 + 10log(P) = 51.76; P = 1.5 W

Worst case is 57.2 dBc; So, Pass.

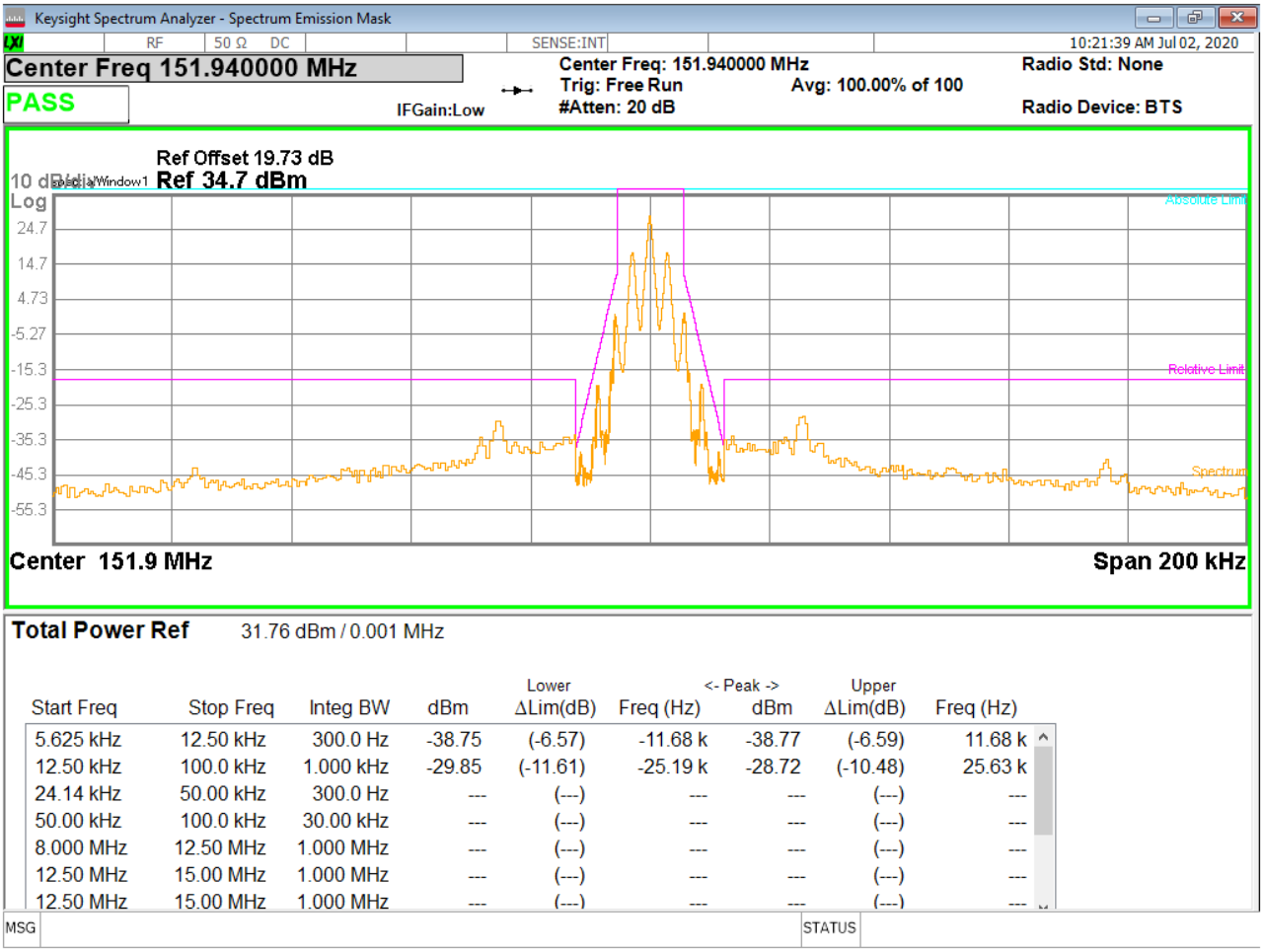


Figure 19 - Emissions Mask, 151.940 MHz

The above plot is intended to show that the radio meets the following requirement:

(1) 7.27(fd−2.88 kHz) dB on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 5.625 kHz, but not more than 12.5 kHz.

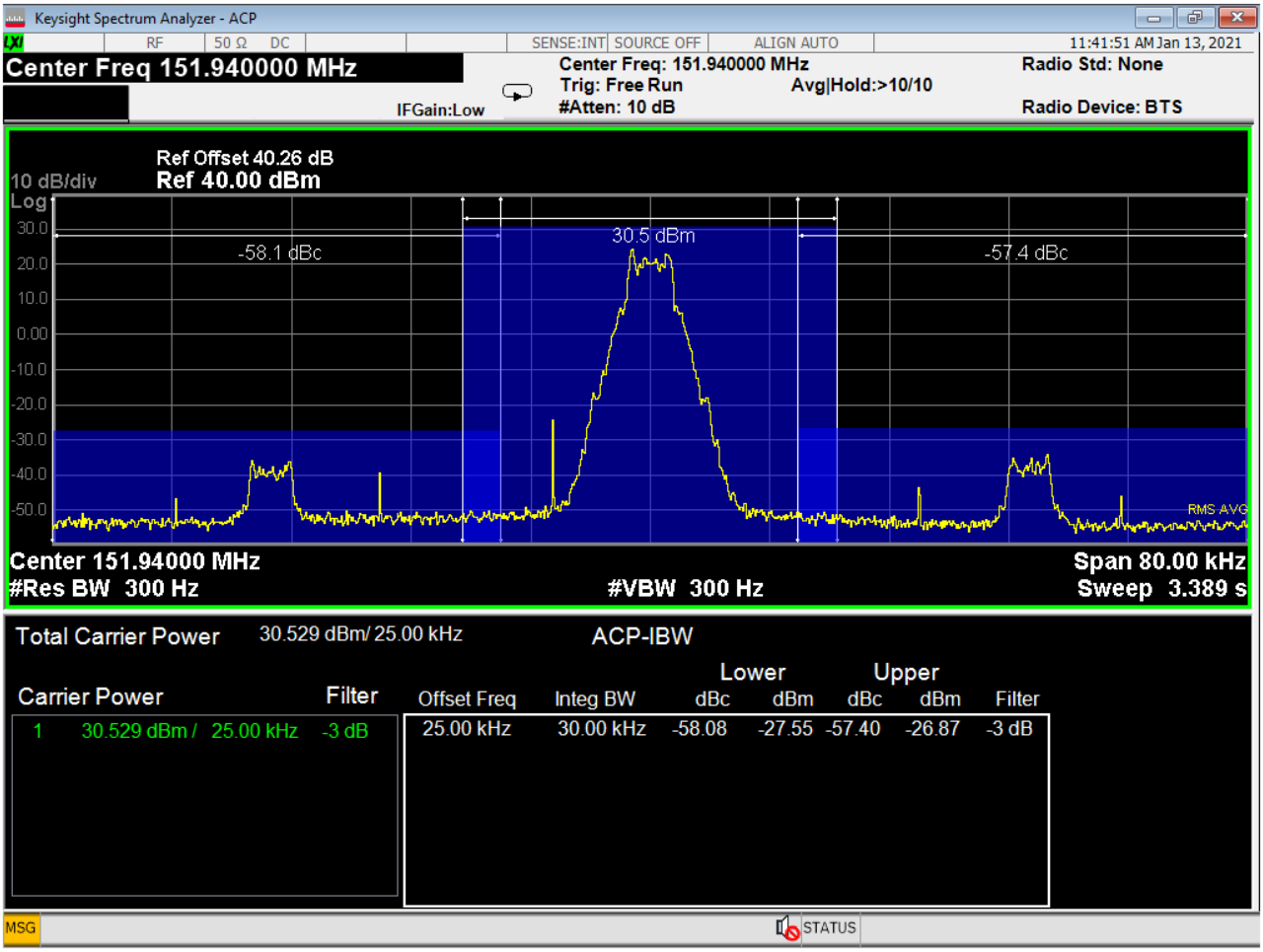


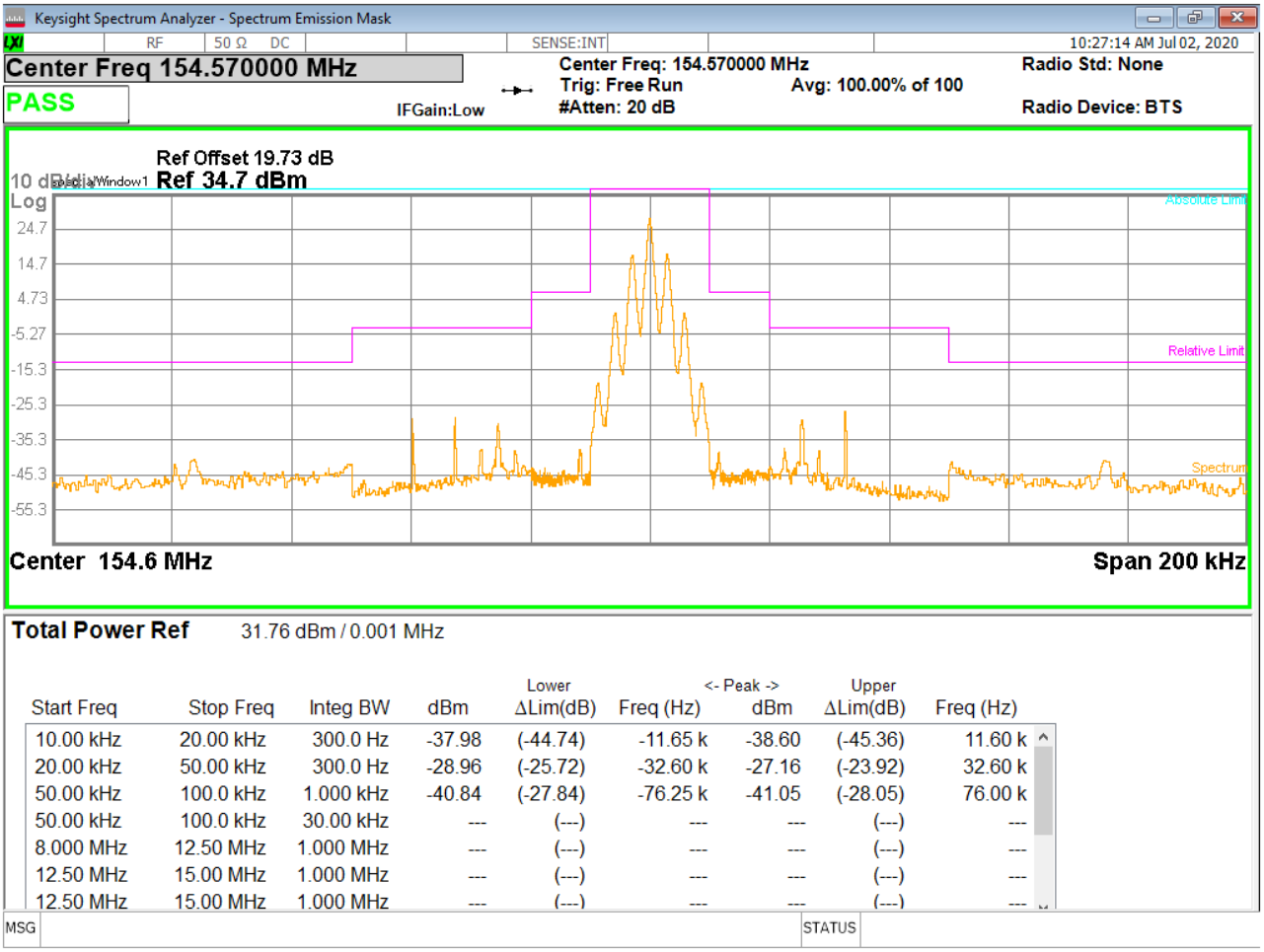
Figure 20 - Emissions Mask, 151.940 MHz

The above plot is intended to show that the radio meets the following requirement:

(2) 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation, on any frequency removed from the channel center frequency by more than 12.5 kHz.

Worst case Limit = 50 + 10log(P) = 51.76; P = 1.5 W

Worst case is 57.4 dBc; So, Pass.



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
10.00 kHz	20.00 kHz	300.0 Hz	-37.98	(-44.74)	-11.65 k	-38.60	(-45.36)	11.60 k
20.00 kHz	50.00 kHz	300.0 Hz	-28.96	(-25.72)	-32.60 k	-27.16	(-23.92)	32.60 k
50.00 kHz	100.0 kHz	1.000 kHz	-40.84	(-27.84)	-76.25 k	-41.05	(-28.05)	76.00 k
50.00 kHz	100.0 kHz	30.00 kHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Figure 21 - Emissions Mask, 154.570 MHz

The above plot is intended to show that the radio meets the following requirement:

(5) 83 log (fd ÷ 5) dB on any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) that is more than 5 kHz, but not more than 10 kHz.

(6) 29 log (fd2 ÷ 11) dB or 50 dB, whichever is the lesser attenuation on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 10 kHz, but not more than 50 kHz.

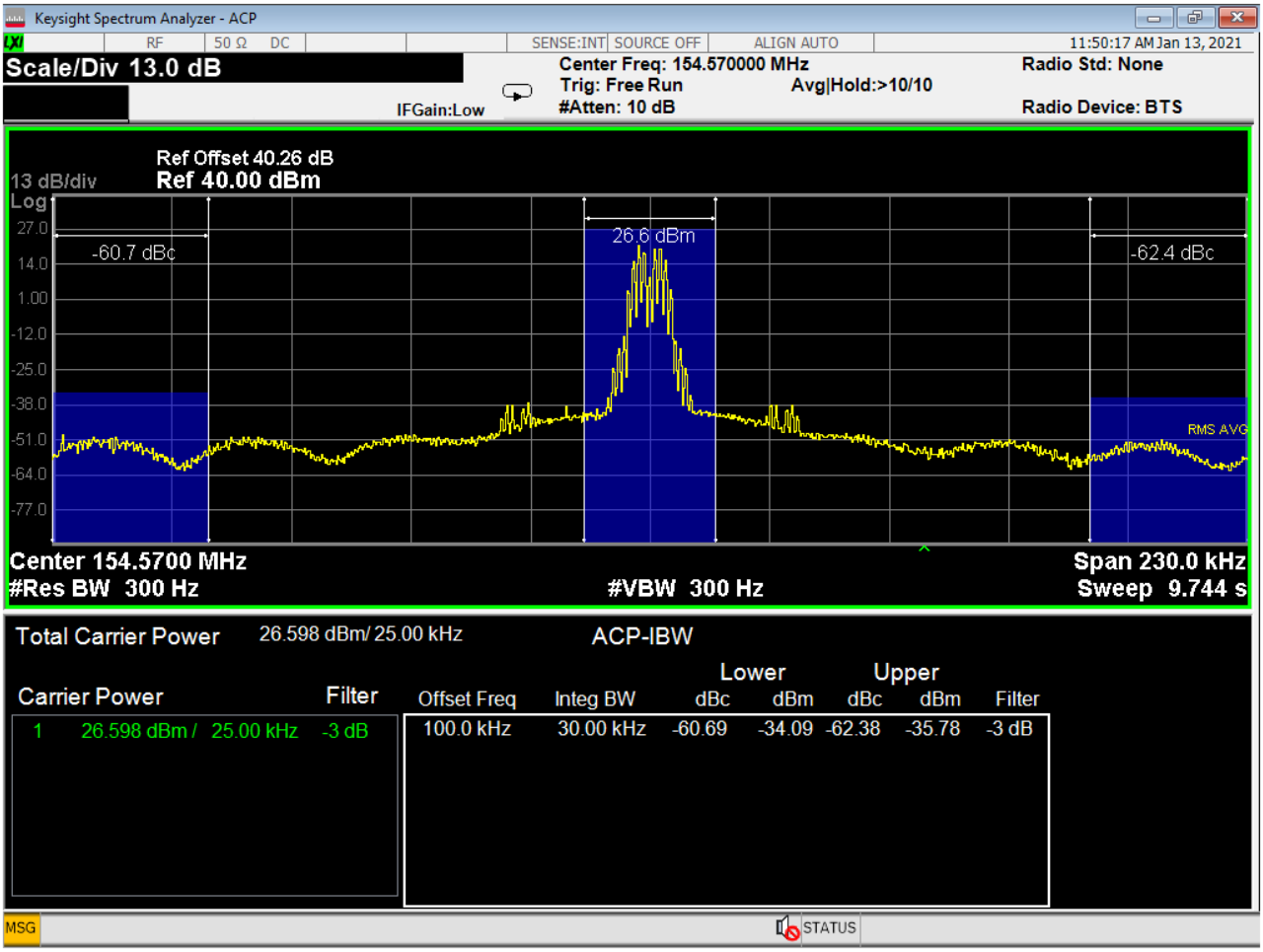


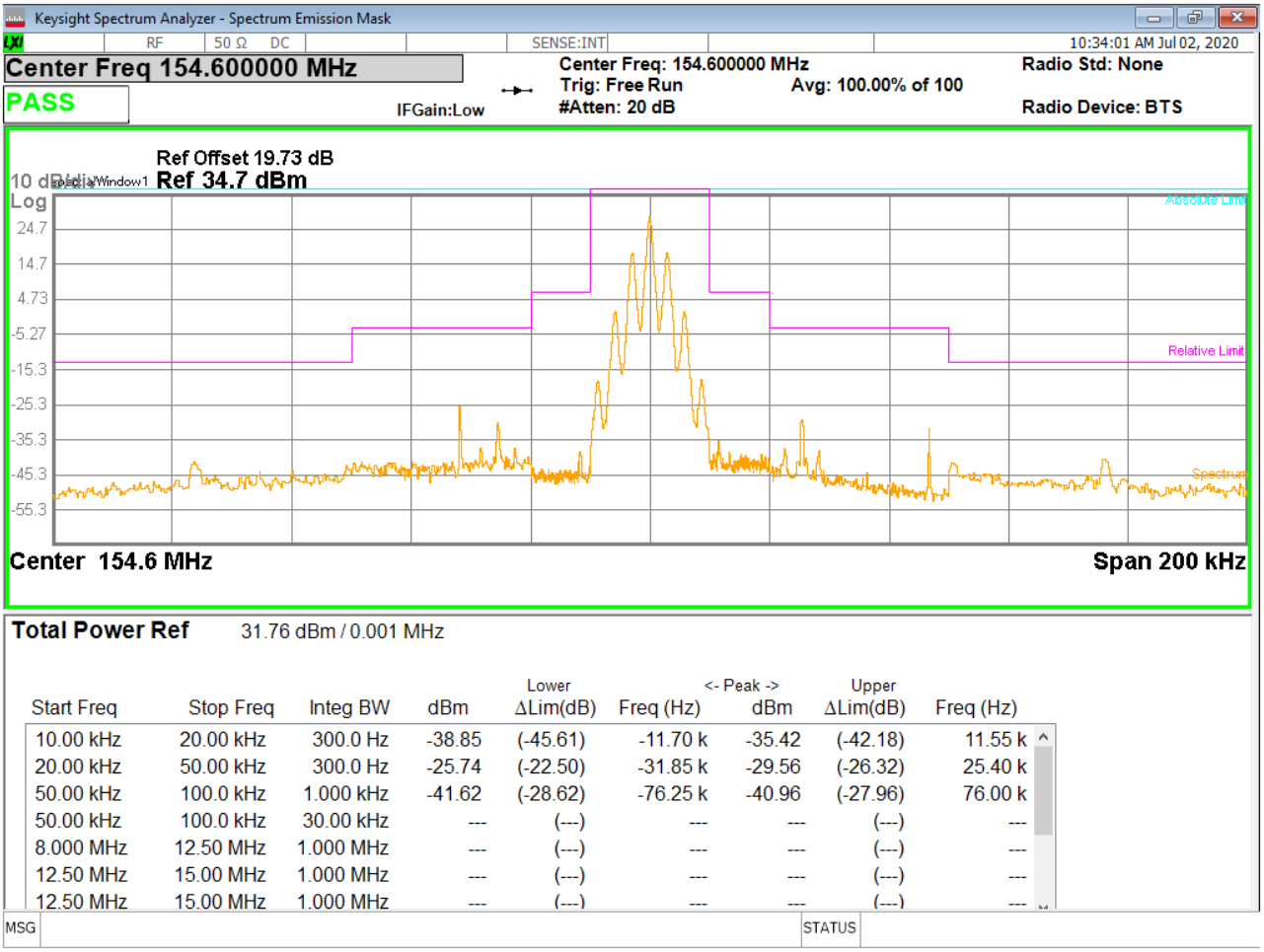
Figure 22 - Emissions Mask, 154.570 MHz

The above plot is intended to show that the radio meets the following requirement:

(7) 43 + 10 log(P) dB on any frequency removed from the channel center frequency by more than 50 kHz.

Worst case Limit = 43 + 10log(P) = 44.76; P = 1.5 W

Worst case is 60.7 dBc; So, Pass.



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
10.00 kHz	20.00 kHz	300.0 Hz	-38.85	(-45.61)	-11.70 k	-35.42	(-42.18)	11.55 k
20.00 kHz	50.00 kHz	300.0 Hz	-25.74	(-22.50)	-31.85 k	-29.56	(-26.32)	25.40 k
50.00 kHz	100.0 kHz	1.000 kHz	-41.62	(-28.62)	-76.25 k	-40.96	(-27.96)	76.00 k
50.00 kHz	100.0 kHz	30.00 kHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Figure 23 - Emissions Mask, 154.600 MHz

The above plot is intended to show that the radio meets the following requirement:

(5) 83 log (fd ÷ 5) dB on any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) that is more than 5 kHz, but not more than 10 kHz.

(6) 29 log (fd2 ÷ 11) dB or 50 dB, whichever is the lesser attenuation on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 10 kHz, but not more than 50 kHz.

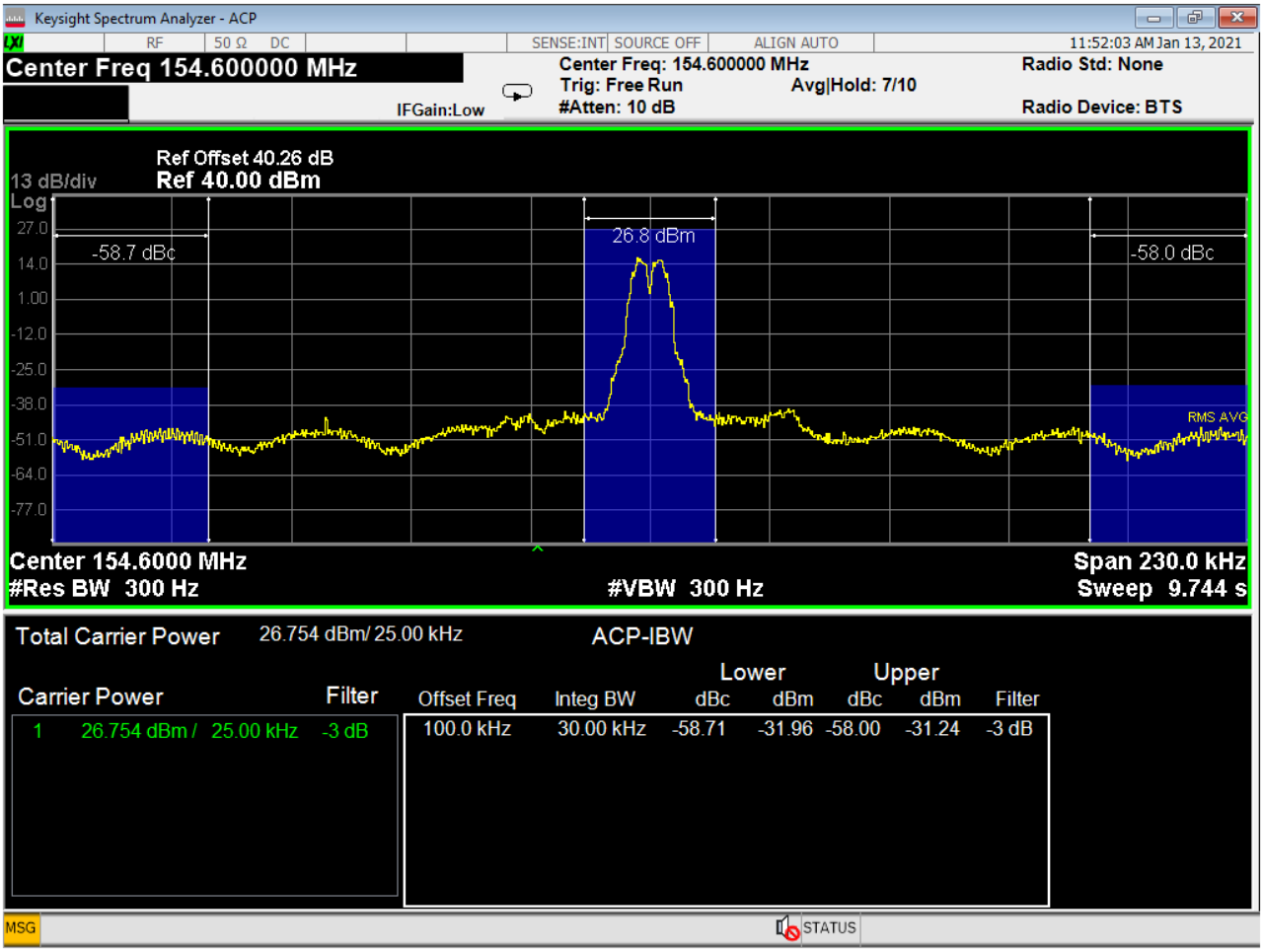


Figure 24 - Emissions Mask, 154.600 MHz

The above plot is intended to show that the radio meets the following requirement:

(7) 43 + 10 log(P) dB on any frequency removed from the channel center frequency by more than 50 kHz.

Worst case Limit = 43 + 10log(P) = 44.76; P = 1.5 W

Worst case is 58.0 dBc; So, Pass.

4.4 MODULATION CHARECTERISTICS

Test Method: ANSI C63.26:
Section(s) 5.3.2 “Modulation limiting test methodology” and 5.3.3” Audio frequency response”

Limits:
A maximum deviation of ±75 kHz is permitted when frequency modulation is employed.

-Voice modulated communication equipment. A curve or equivalent data showing the frequency response
of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to
have an audio low-pass filter, a curve showing the frequency response of the filter or of all circuitry installed
between the modulation limiter and the modulated stage shall be submitted.

- Equipment which employs modulation limiting. A curve or family of curves showing the percentage of
modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

Test procedures:

Refer to Section 5.3.3 of C63.26, 2015. The equipment is required to have an audio filter and the test was performed on the audio filter and all circuitry.

Deviations from test standard:
No deviation.

Test setup:

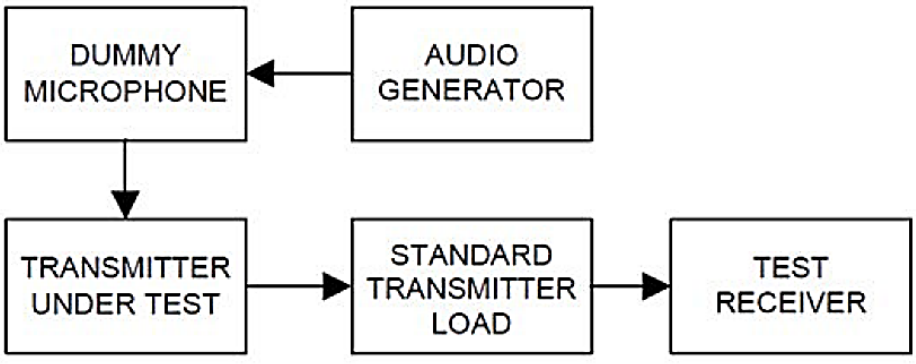


Figure 25 – Modulation Limiting and Audio Frequency Response Test Setup

EUT operating conditions:
The EUT was powered by 12 VDC battery power unless specified and set to transmit continuously.

Test results:

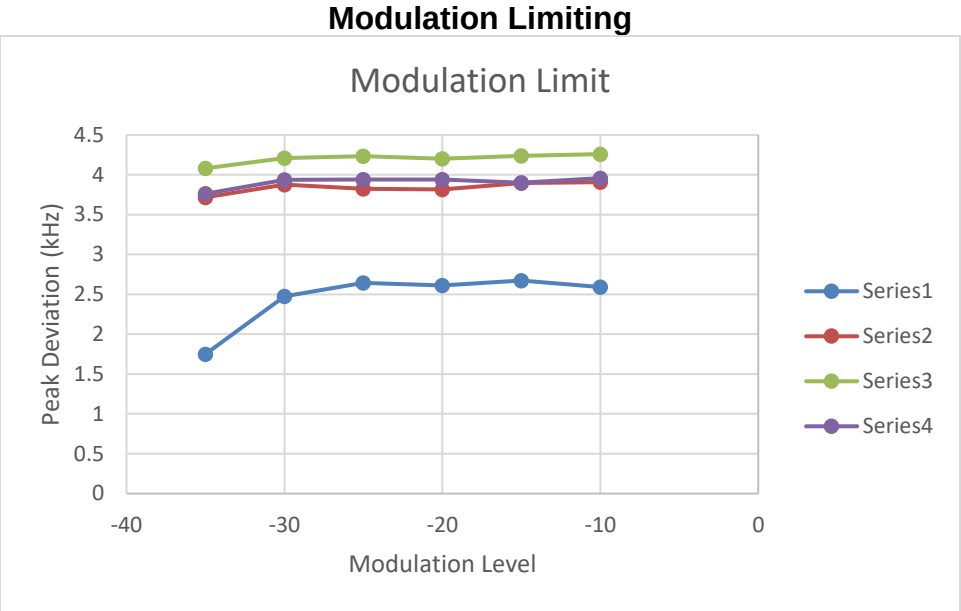


Figure 26 – Modulation Limiting, Mid Channel

Modulation Limit					
Modulation Level (dBm)	Peak Frequency Deviation (kHz)				Limit (kHz)
	300Hz	1000Hz	2500Hz	3000Hz	
-35	1.75	3.717	4.081	3.762	±75
-30	2.474	3.878	4.211	3.936	±75
-25	2.642	3.823	4.233	3.94	±75
-20	2.611	3.815	4.201	3.941	±75
-15	2.673	3.895	4.238	3.902	±75
-10	2.591	3.907	4.259	3.958	±75

Audio Frequency Response

Modulation Frequency (kHz)	Max Deviation (kHz)	Audio Frequency Response (dB)
0.10	0.632	-9.706
0.20	0.977	-5.922
0.30	1.291	-3.502
0.40	1.651	-1.365
0.50	1.775	-0.736
0.60	1.883	-0.223
0.70	1.920	-0.054
0.80	1.852	-0.367
0.90	1.891	-0.186
1.00	1.932	0.000
1.50	2.044	0.489
2.00	2.057	0.545
2.50	2.101	0.728
3.00	1.943	0.049
3.50	0.384	-14.034
4.00	0.363	-14.522
4.50	0.387	-13.966
5.00	0.369	-14.380

4.5 FREQUECY ACCURACY

Test Method: ANSI C63.26,

1. Section(s) 5.6.3 “Procedure for frequency stability testing”

Limits:
FCC Part 95.2765 MURS frequency accuracy:

Each MURS transmitter type must be designed to meet the applicable frequency tolerance and stability requirements of this section.

MURS transmitters that operate with an emission bandwidth greater than 6.25 kHz must be designed such that the carrier frequencies remain within ±2.0 ppm of the channel center frequencies specified in §95.2763 during normal operating conditions.

Test procedures:
Radiated power was measured on a spectrum analyzer with resolution bandwidth and video bandwidth set to 500 Hz and 1 kHz respectively. The frequency error functionality on the receiver was used. The temperature was varied from -30°C to -50°C.

Deviations from test standard:
No deviation

Test setup:

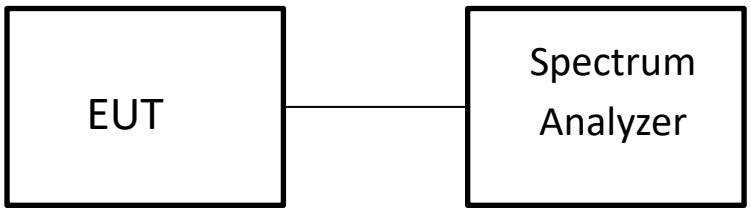


Figure 27 –Measurements Test Setup

EUT operating conditions:
EUT was powered by a 12V battery. Device was set to transmit in each of its five allocated frequencies.

Test results:

Frequency Stability, Temperature Variation

Temp in C°	-30	-20	-10	0	10	20	30	40	50			
Freq (MHz)	**Deviation (Hz)**									**limit (Hz)**	**limit (ppm)**	**Result**
151.820	29	36	48	44	58	54	56	56	52	303.64	2	Pass
151.940	36	36	43	53	59	58	58	56	64	303.88	2	Pass
154.600	37	50	38	57	54	57	58	54	64	309.20	2	Pass

Frequency Stability, Voltage Variation

Voltage in VDC	10.2	12	13.8			
Freq (MHz)	**Deviation (Hz)**			**limit (Hz)**	**limit (ppm)**	**Result**
151.820	57	33	16	303.64	2	Pass
151.940	35	30	51	303.88	2	Pass
154.600	30	25	27	309.20	2	Pass

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / 30
Power (watts) = 10^[Power (dBm)/10] / 1000
Voltage (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)
Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6
Gain = 1 (numeric gain for isotropic radiator)
Conversion from 3m field strength to EIRP (d=3):

EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/m) - 95.23

10log(10^9) is the conversion from micro to milli

APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±3.82 dB
Radiated Emissions, 3m	1GHz - 18GHz	±4.44 dB
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB
Antenna port conducted	9 kHz – 25 GHz	±0.50 dB

Values were calculated per CISPR 16-4-2:2011

Expanded uncertainty values are calculated to a confidence level of 95%.

REPORT END