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Product Compliance Solutions

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FCC/ISED Test Report

Prepared for: **Garmin International, Inc.**

Address: **1200 E. 151st Street**
Olathe, Kansas, 66062, USA

Product: **AA4264**

Test Report No: **R20220615-20-E3D**

Approved by:

Nic Johnson
Technical Manager

DATE: **February 7, 2023**

Total Pages: **34**

ilac-MRA A2LA ACCREDITED TESTING LABORATORY CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	30 November 2022	Issued by FLane Reviewed by KVepuri Prepared by Flane
A	1 December 2022	Corrected Signature/revision descriptions - FL
B	7 December 2022	Corrected margin in figure 8 - FL
C	3 February 2023	Updated to reference certified module -NJ
D	7 February 2023	Corrected FCC ID

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The equipment under test (EUT) was tested for compliance to FCC Part 25 and Part 2 as well as RSS-170, Issue 3. Below is a summary of the test results. Complete results can be found in Section 3.

Report Section	47 CFR FCC Rule Part	Description	Results
4.1	FCC Part 25.204 FCC Part 25.202 (f) RSS-170 Issue 3, Section 5.4.3	Output Power and Emissions Mask	Compliant
4.2	FCC Part 25.216 (c) RSS-170 Issue 3, Section 5.4.3	Emissions Limits for Mobile Earth Stations	Compliant
4.3	FCC Part 25.216 (g) RSS-170 Issue 3, Section 5.4.4 RSS Gen 7.1, 7.3	Receive Emissions Limits for Mobile Earth Stations	Compliant
4.4	FCC Part 25.202 (f) RSS Gen 7.4 RSS-170 Issue 3, Section 5.4.3	Conducted Spurious Emissions	Compliant
4.5	FCC 25.202 (d) RSS Gen 6.11 RSS-170 Issue 3, Section 5.2	Frequency Stability	Compliant
4.6	FCC Part 2.1047(d) FCC Part 15.202	Modulation Characteristics Occupied Bandwidth	Compliant

Test Methods:

(1) ANSI C63.26-2015

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	AA4264
IC	1792A-A4624
FCC ID	IPH-A4624
Module IC	1792A-03302
Module FCC ID	IPH-03302
EUT Received	29 August 2022
EUT Tested	5 September 2022- 27 October 2022
Serial No.	3426363242 (Radiated Measurements) 3426363185 (Conducted Measurements)
Operating Band	1616 – 1626 MHz
Device Type	☒ Iridium
Power Supply / Voltage	Internal Battery / 5VDC Charger: Garmin (Phi Hong) Model: LACA046 GPN: 362-00112-00 (Representative Power Supply)
Antenna Gain (dBi)	1.396dBi

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

Iridium Transmissions:

Channel	Frequency
Low	1616.020833 MHz
Mid	1620.979167 MHz
High	1625.979167 MHz

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY AND GENERAL TEST 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

No.	PERSONNEL	TITLE	ROLE
1	Fox Lane	Test Engineer	Testing and Report

Notes: All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (44GHz)	N9038A	MY59050109	July 21, 2021	July 21, 2023
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2023
Keysight EXA Signal Analyzer	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 2023
EMCO Horn Antenna	3116	2576	March 9, 2020	March 9, 2023
Com-Power LISN 50µH / 250µH - 50Ω	LI-220C	20070017	September 22, 2020	September 22, 2022
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	March 21, 2022	March 21, 2024
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	March 21, 2022	March 21, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)**	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)**	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization

Notes:
All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Figure 1 - Bandwidth Measurements Test Setup

4.0 RESULTS

4.1 OUTPUT POWER AND EMISSION MASK

Test Method:

Output Power:

Output Power measurements were performed using section 5.2.4.3.1 from ANSI C63.26.

Emissions Mask:

FCC Part 25.202(f) – emissions mask
FCC Part 25.204, 2.1046 – output power

(f) Emission limitations. Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;

(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

Test procedures:

All the measurements were done as conducted measurements. Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Modulation	Frequency	Conducted Peak Output Power (dBm)	Conducted Peak Output Power (dBm) +1.00 dB measurement uncertainty See Annex B	Conducted Peak Output Power (mW)	Antenna Gain (dBi)**	EIRP (dBm)
iridium - LOW*	1616.020833	30.539	31.539	1425.279	1.396	32.935
iridium - MID*	1620.979167	30.449	31.449	1396.047	1.396	32.845
iridium - HIGH*	1625.979167	30.346	31.346	1363.327	1.396	32.742
	*Interpolated antenna gain **See section 4.7 for more information					

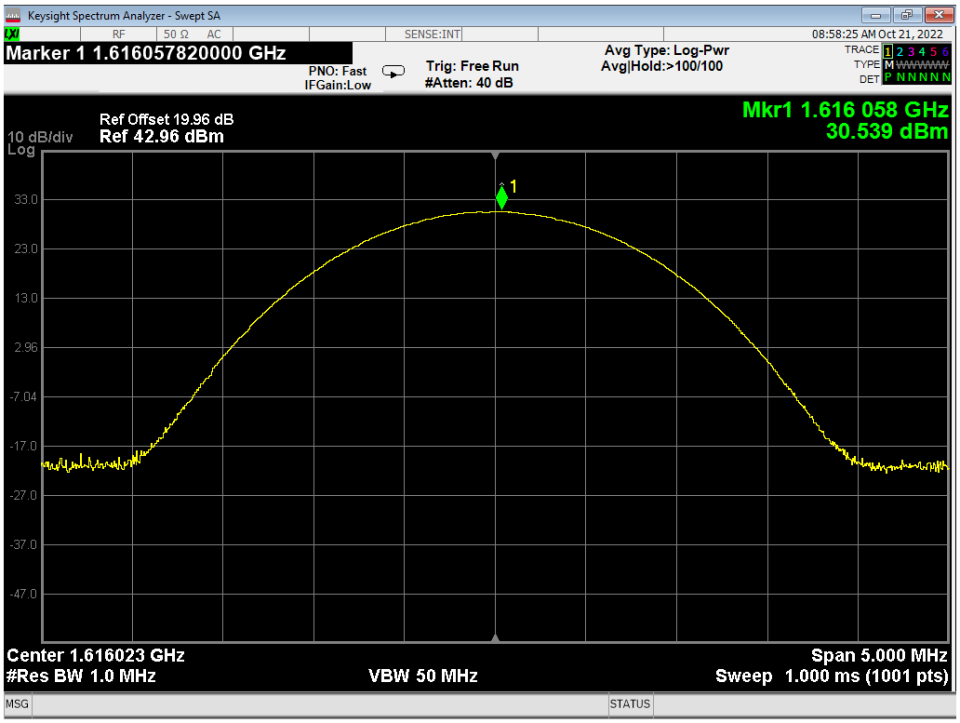

Figure 2 – Conducted Average Output Power, Transmitting at 1616.020833 MHz

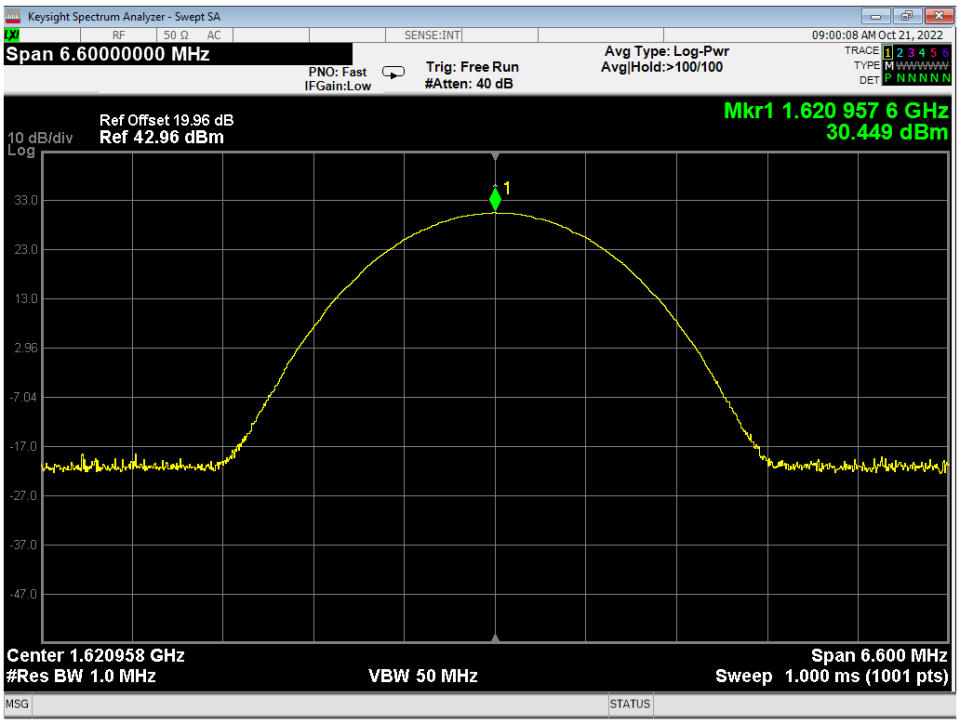

Figure 3 – Conducted Average Output Power, Transmitting at 1620.979167 MHz

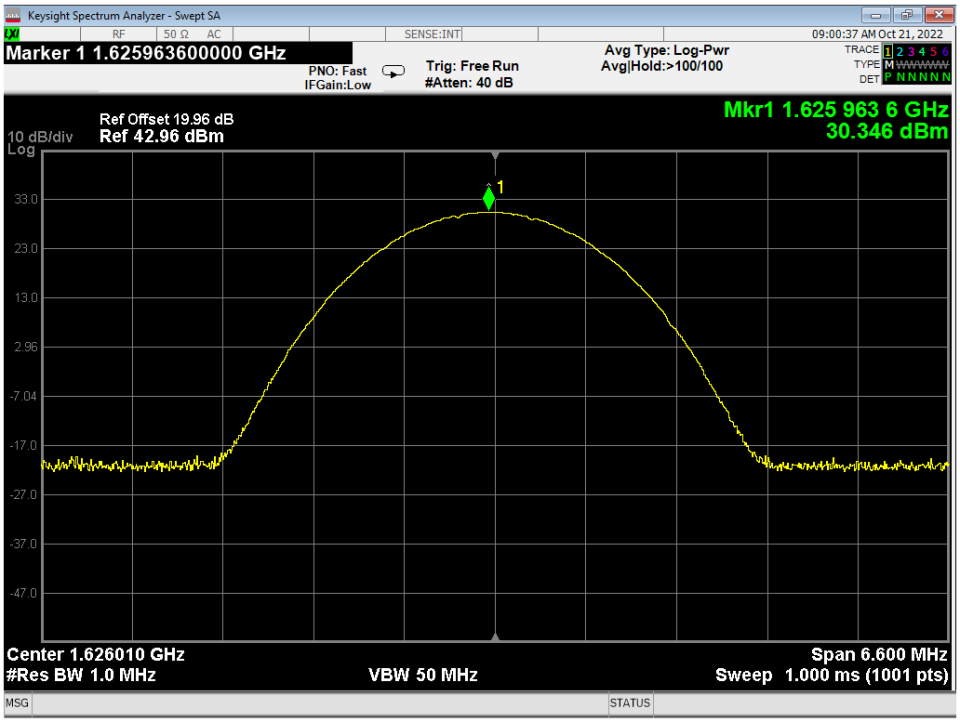

Figure 4 – Conducted Average Output Power, Transmitting at 1625.979167 MHz

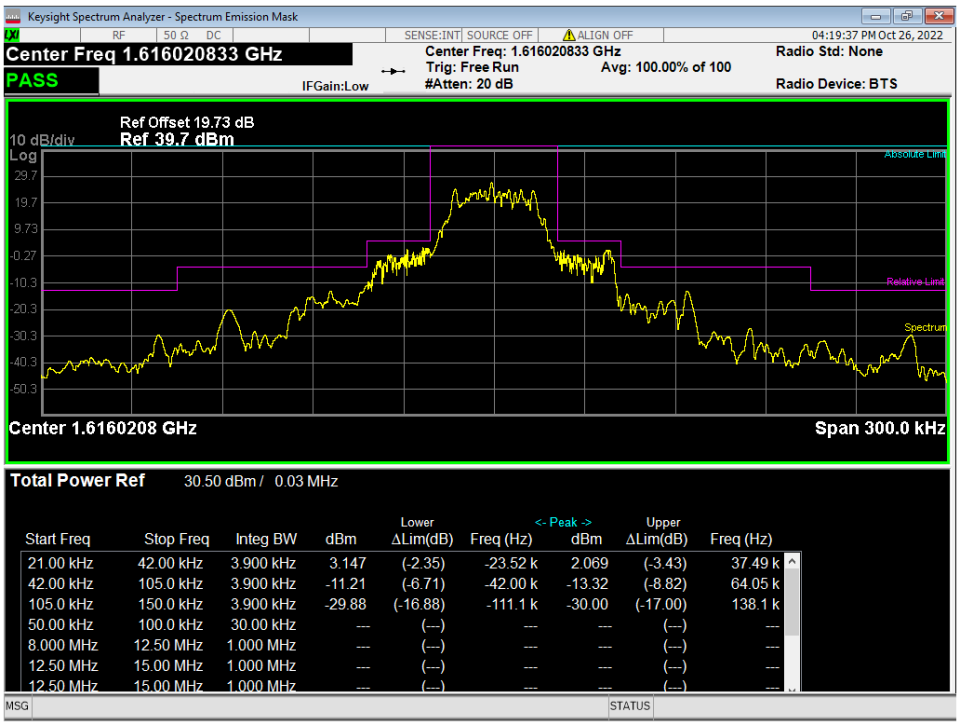

Figure 5 – Part 25.202(f) Mask, Transmitting at 1616.020833 MHz

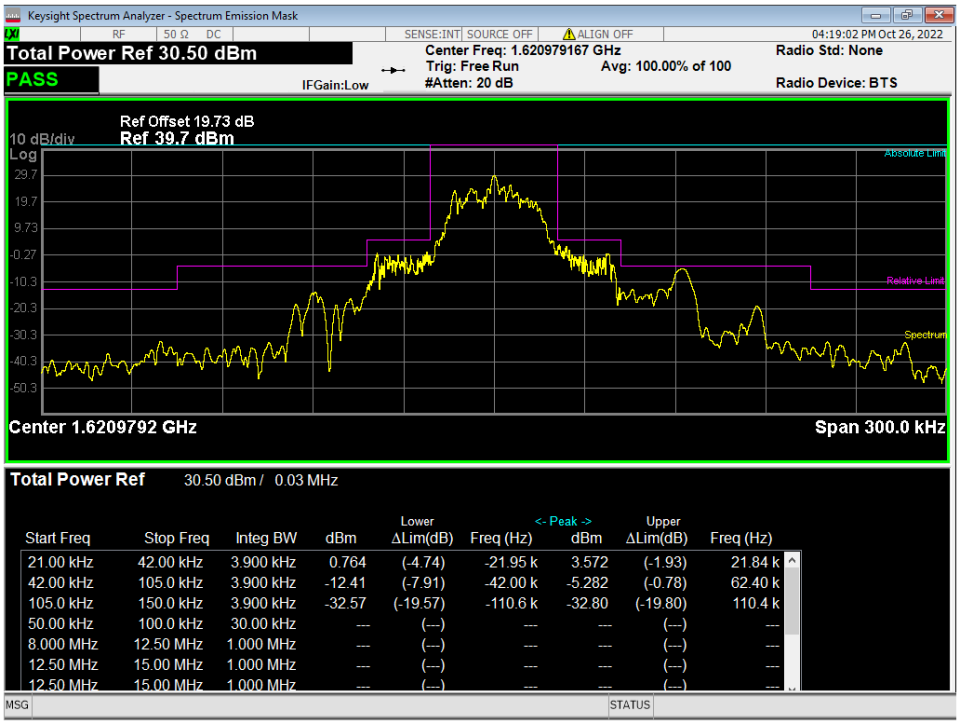

Figure 6 – Part 25.202(f) Mask, Transmitting at 1620.979167 MHz

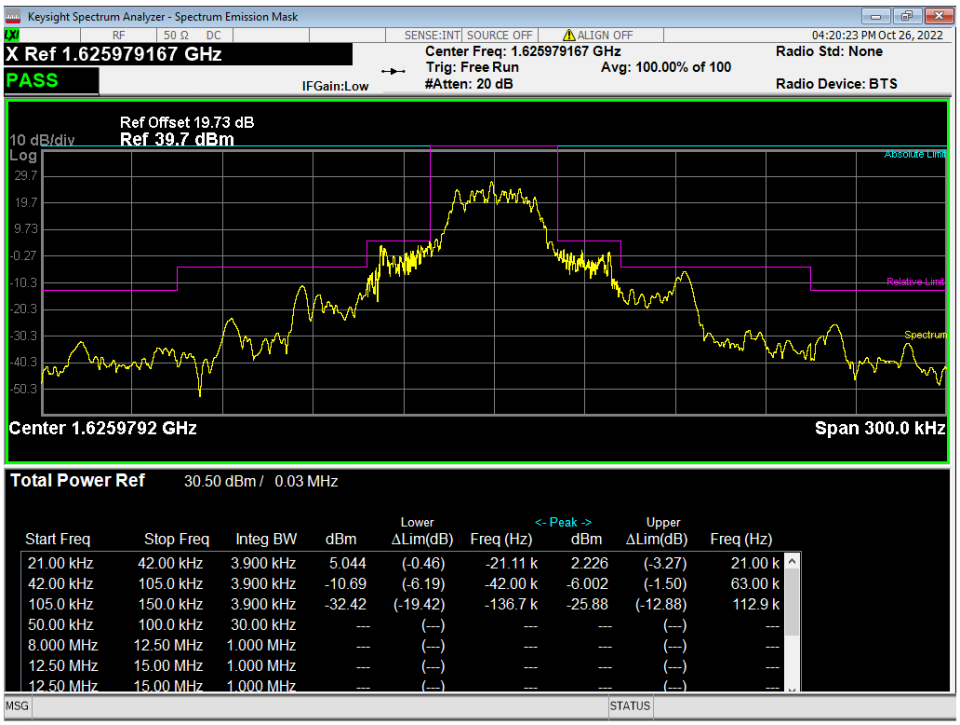

Figure 7 – Part 25.202(f) Mask, Transmitting at 1625.979167 MHz

4.2 EMISSIONS LIMITS FOR MOBILE EARTH STATIONS FCC PART 25.216 (c)

Test Method:
(c) The e.i.r.p. density of emissions from mobile earth stations placed in service after July 21, 2002 with assigned uplink frequencies between 1610 MHz and 1660.5 MHz shall not exceed −70 dBW/MHz, averaged over any 2-millisecond active transmission interval, in the band 1559-1605 MHz. The e.i.r.p. of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed −80 dBW, averaged over any 2-millisecond active transmission interval, in the 1559-1605 MHz band.

Test procedures:
All the measurements were done as conducted measurements. Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

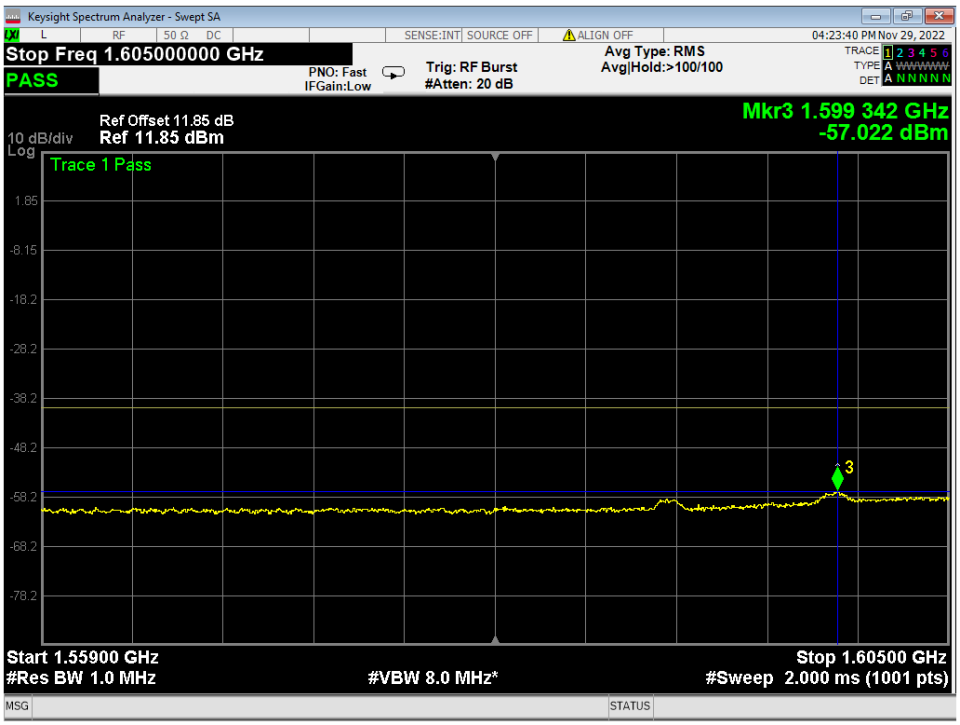

Figure 8 – Part 25.216(c), Transmitting at 1616.020833 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Antenna Gain = 1.396 dB; Limit = -40.00 dBm; Margin=-40.00-(-57.022+1.396) = 18.418 dB

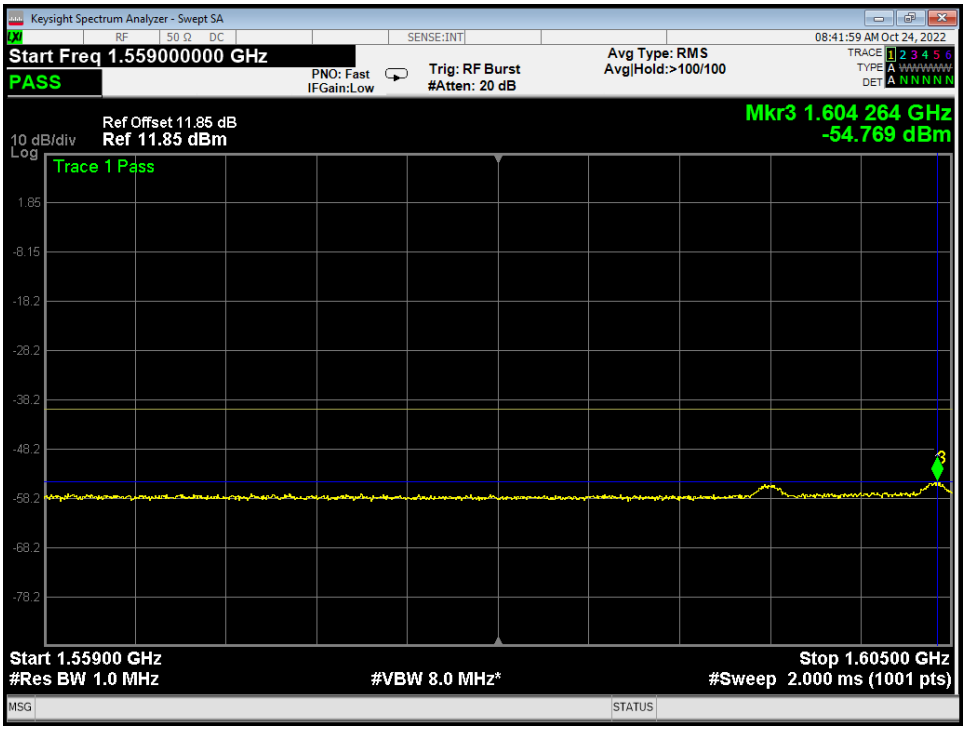

Figure 9 – Part 25.216(c), Transmitting at 1620.979167 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Antenna Gain = 1.396 dB; Limit = -40.00 dBm; Margin=-40.00-(-54.769+1.396) =16.17 dB

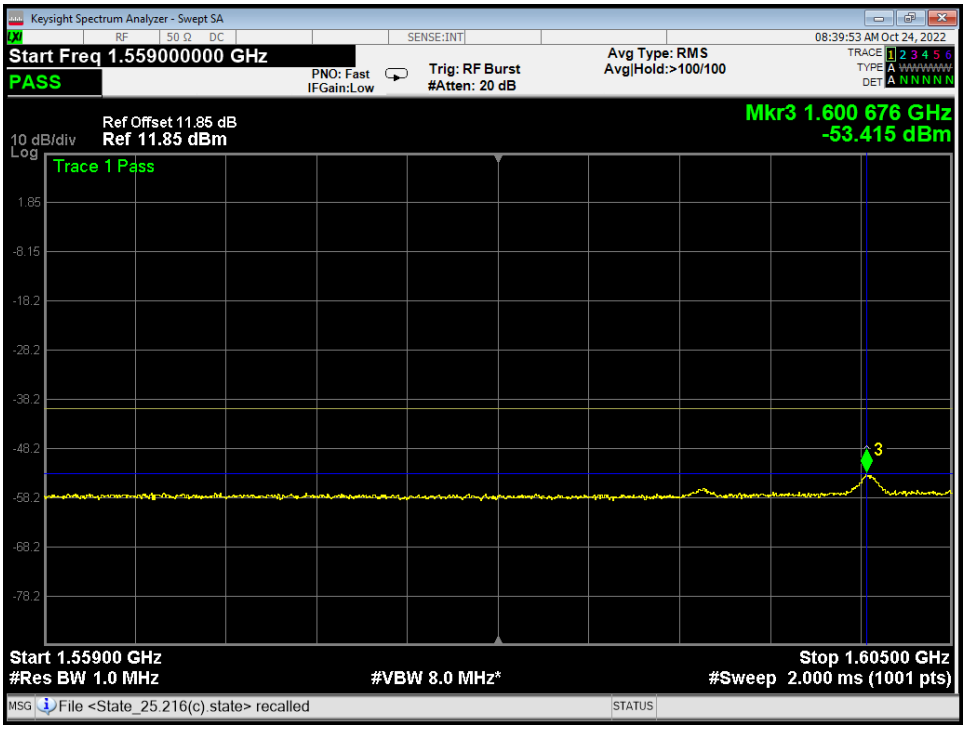

Figure 10 – Part 25.216(c), Transmitting at 1625.979167 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Antenna Gain = 1.396 dB; Limit = -40.00 dBm; Margin=-40.00-(-53.415+1.396) = 14.811 dB

4.3 EMISSIONS LIMITS FOR MOBILE EARTH STATIONS FCC PART 25.216 (g)

Test Method:
(g) Mobile earth stations manufactured more than six months after FEDERAL REGISTER publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies in the 1610-1626.5 MHz band shall suppress the power density of emissions in the 1605-1610 MHz band-segment to an extent determined by linear interpolation from −70 dBW/MHz at 1605 MHz to −10 dBW/MHz at 1610 MHz averaged over any 2-millisecond active transmission interval. The e.i.r.p of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed a level determined by linear interpolation from −80 dBW at 1605 MHz to −20 dBW at 1610 MHz, averaged over any 2 milli-second active transmission interval.

Test procedures:
All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

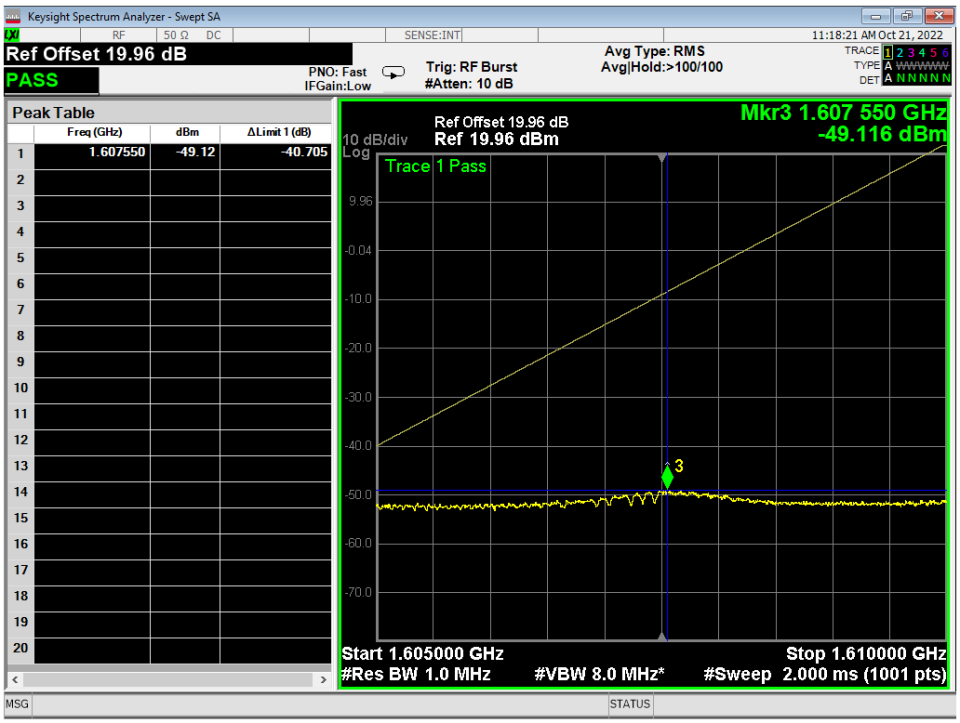

Figure 11 – Part 25.216(g), Transmitting at 1616.020833 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Margin shown in the plot does not include antenna gain.

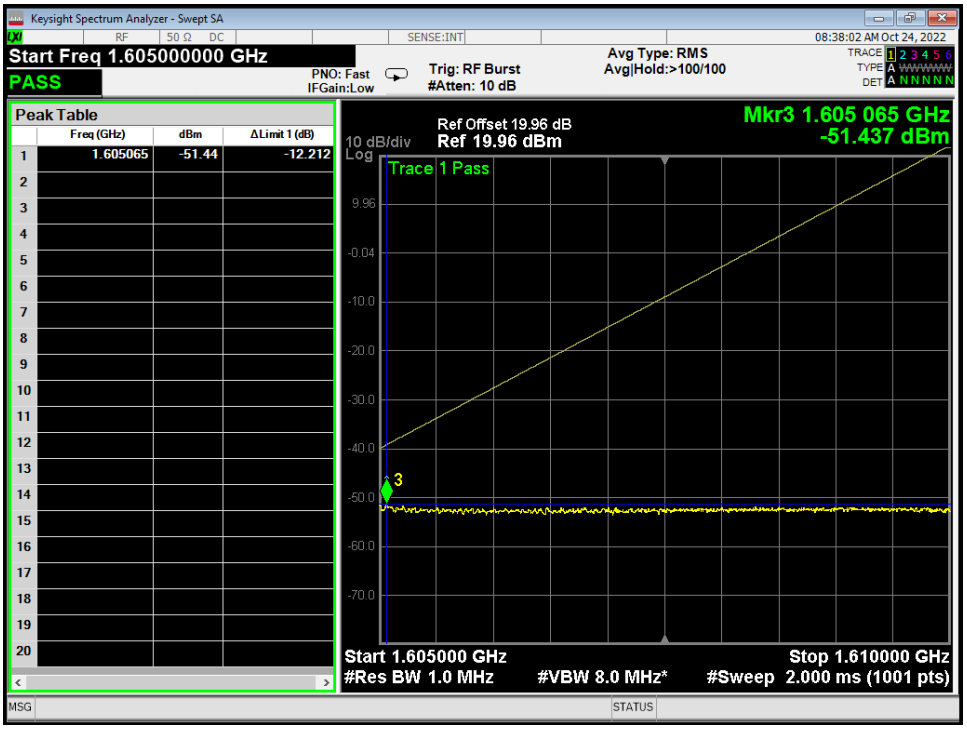

Figure 12 – Part 25.216(g), Transmitting at 1620.979167 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Figure 13 – Part 25.216(g), Transmitting at 1625.979167 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

4.4 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.26-2015, Section 5.7.4

Limits of spurious emissions:

FCC Part 25.202(f)

43+10*Log (Power in Watts) = 43+10*Log (1.645508) =45.163 dBc

Absolute Limit= 32.163 dBm-45.163 dBc = -13 dBm

Test procedures:

All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
NA

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

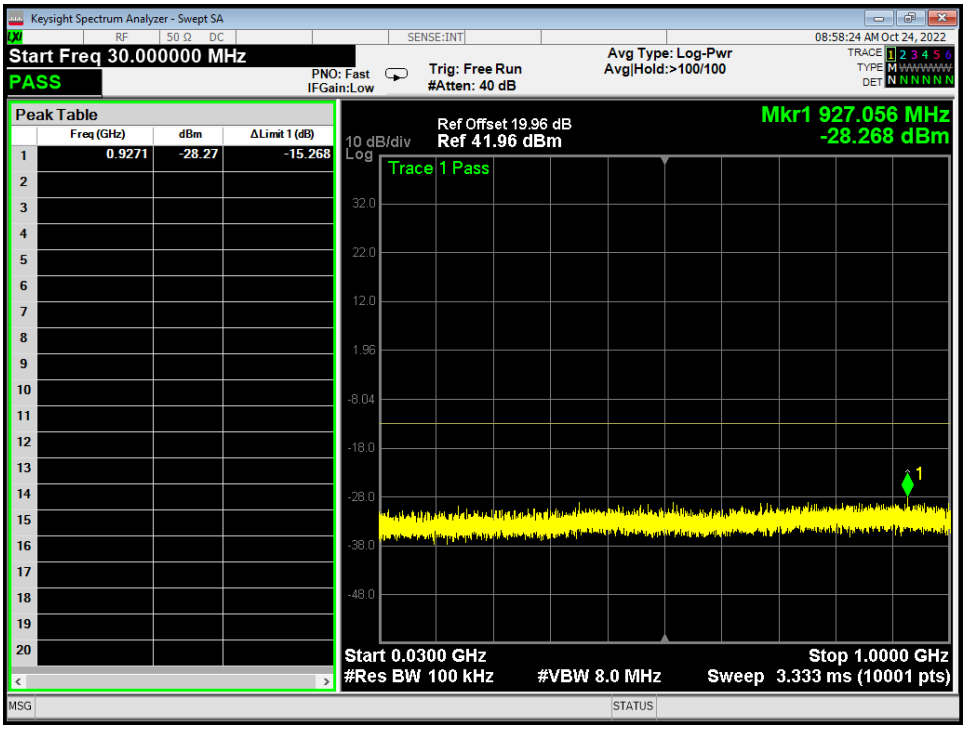

Figure 14 - Conducted Spurious Plot, 30M – 1G

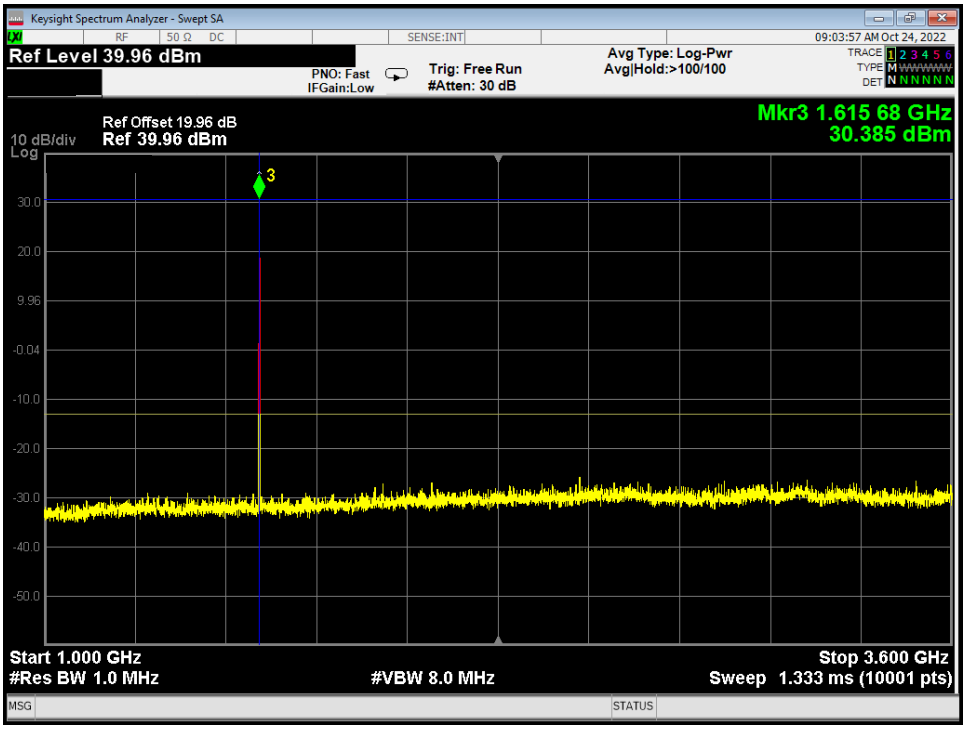

Figure 15 - Conducted Spurious Plot, 1G – 3.6G, Fundamental

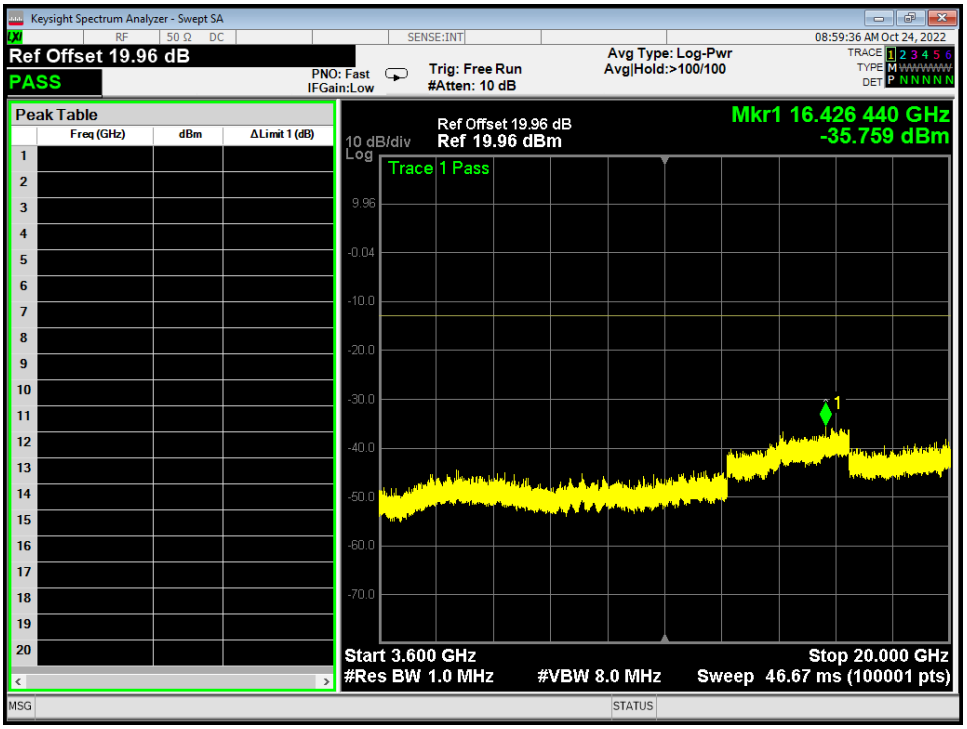

Figure 16 – Conducted Spurious Plot, 3.6G – 20G

4.5 FREQUENCY STABILITY

Test Method: ANSI C63.26-2015, Section 5.7.4

Limits of spurious emissions:

Frequency stability is tested:
a) At 10 C intervals of temperatures between -30 C and +50 C at the manufacturer's rated supply voltage, and
b) At +20 C temperature and ±15% supply voltage variations. If a product is specified to operate over a range of input voltage, then the -15% variation is applied to the lowermost voltage and the +15% is applied to the uppermost voltage.

Limit: 10 ppm

Test procedures:

All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
NA

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

Iridium				
	Voltage	Frequency Error (Hz)		
Temperature (°C)	(VDC)	Ch 1	Ch 2	Ch 3
	Nom=	1616.020833 MHz	1620.979167 MHz	1625.979167 MHz
-30	5	703	1008	649
-20	5	552	171	41
-10	5	159	84	117
0	5	123	159	221
10	5	127	210	128
20	5	364	101	103
30	5	128	40	234
40	5	147	155	144
50	5	127	100	161
Limit = 10 PPM		Pass	Pass	Pass

Iridium				
	Voltage	Frequency Error (Hz)		
Temperature (°C)	(VDC)	Ch 1	Ch 2	Ch 3
	Nom=	1616.020833 MHz	1620.979167 MHz	1625.979167 MHz
20	4.25	234	202	164
20	5	176	210	168
20	5.75	155	98	128
Worst case PPM		0.469053383	0.402842942	0.402219186
Limit = 10 PPM		Pass	Pass	Pass

4.6 MODULATION CHARACTERISTICS AND OCCUPIED BANDWIDTH

Test Method: FCC Part 2.1047(d)

Requirements:

Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

Test procedures:

All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
NA

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

The manufacturer provided the following modulation details:

Traffic, broadcast, and ring alert channels use differentially encoded quaternary phase shift keyed (DE-QPSK) modulation with 40% square root raised cosine pulse shaping. The burst transmission rate is 25ksps or 50 kbps. The phase of the QPSK symbol states relative to the carrier phase is (Symbol State/Phase in deg): 00/0, 01/-90, 10/+90, 11/180.

The acquisition channel uses differentially encoded binary phase shift keyed (DE-BPSK) with 40% square root raised cosine pulse shaping. The burst rate on these channels is 25 kbps. The sync channel uses 25 kbps DE-BPSK on the uplink and 50 kbps DE-QPSK on the downlink. Both with 40% square root raised cosine pulse shaping.

Following plots are provided supporting the modulation description provided by the manufacturer:

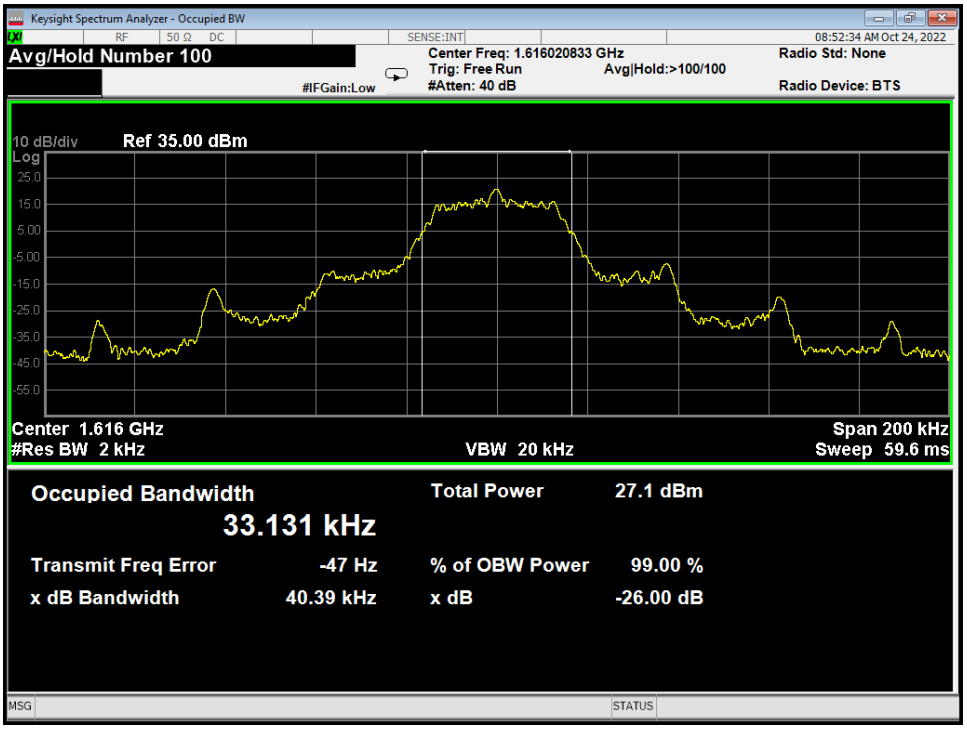

Figure 17 – Supporting Plots for modulation characteristic, Low Channel

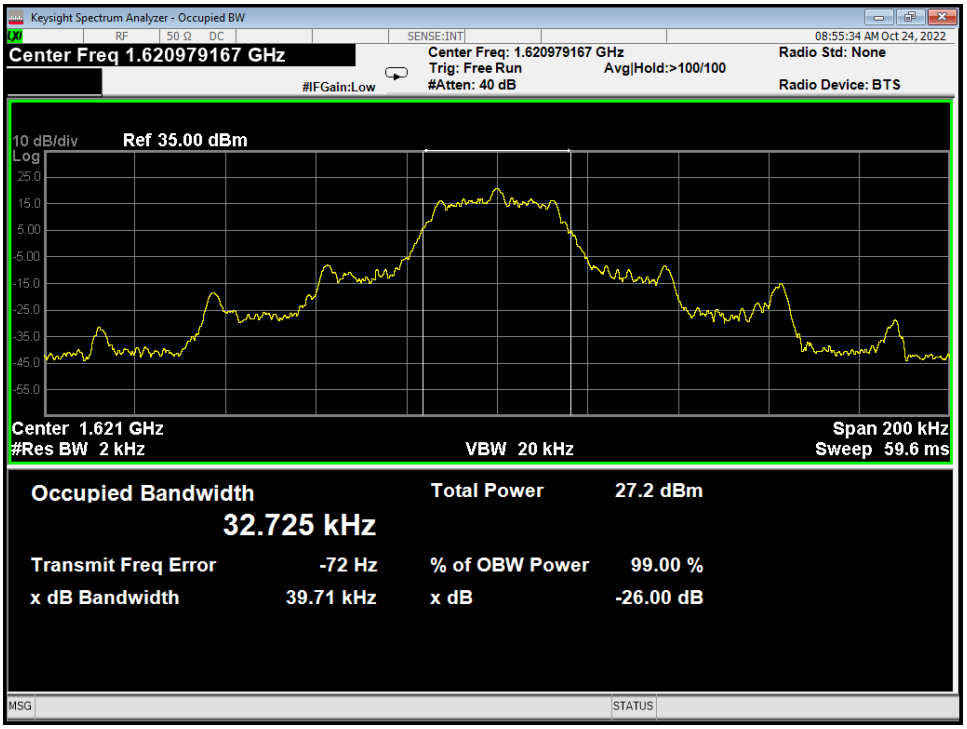

Figure 18 – Supporting Plots for modulation characteristic, Mid Channel

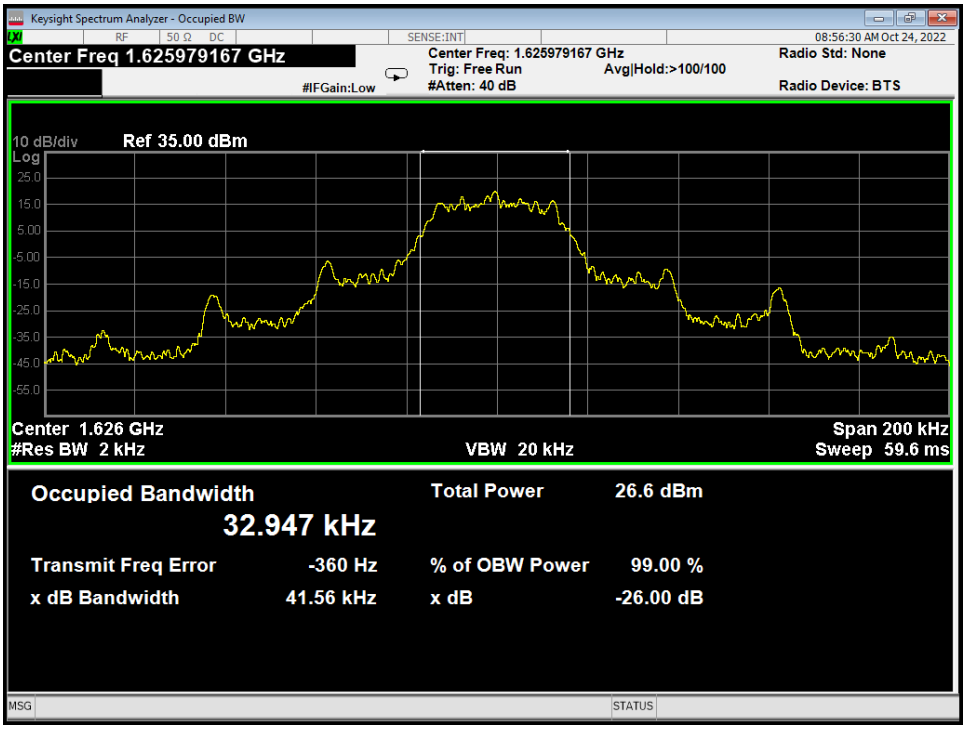

Figure 19 – Supporting Plots for modulation characteristic, High Channel

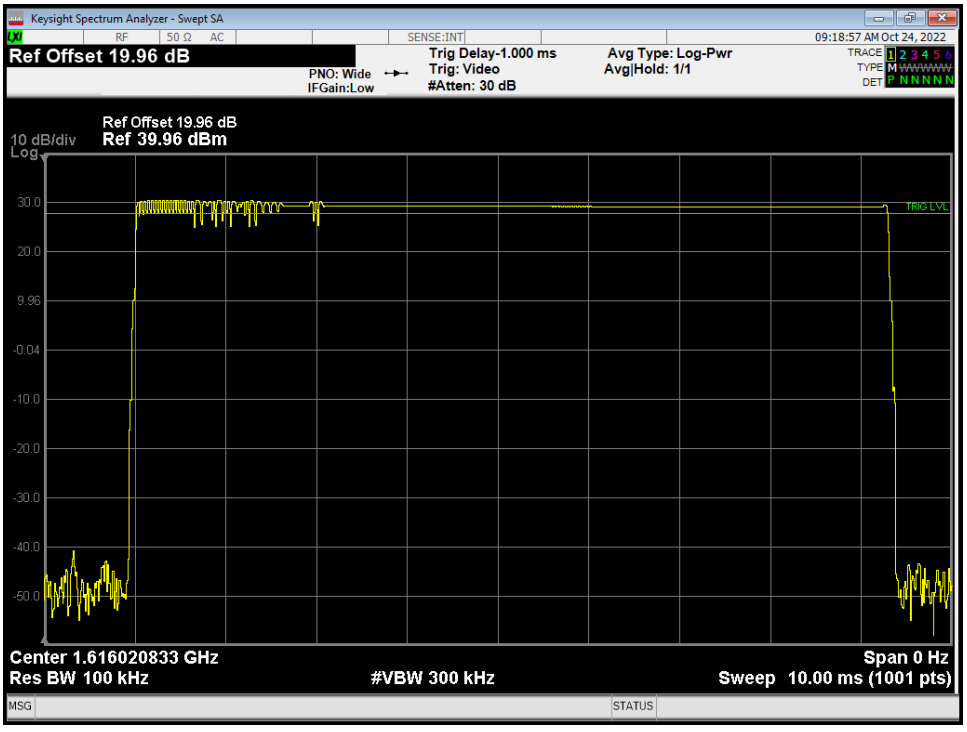

Figure 20 – Supporting Plots for modulation characteristic, Low Channel

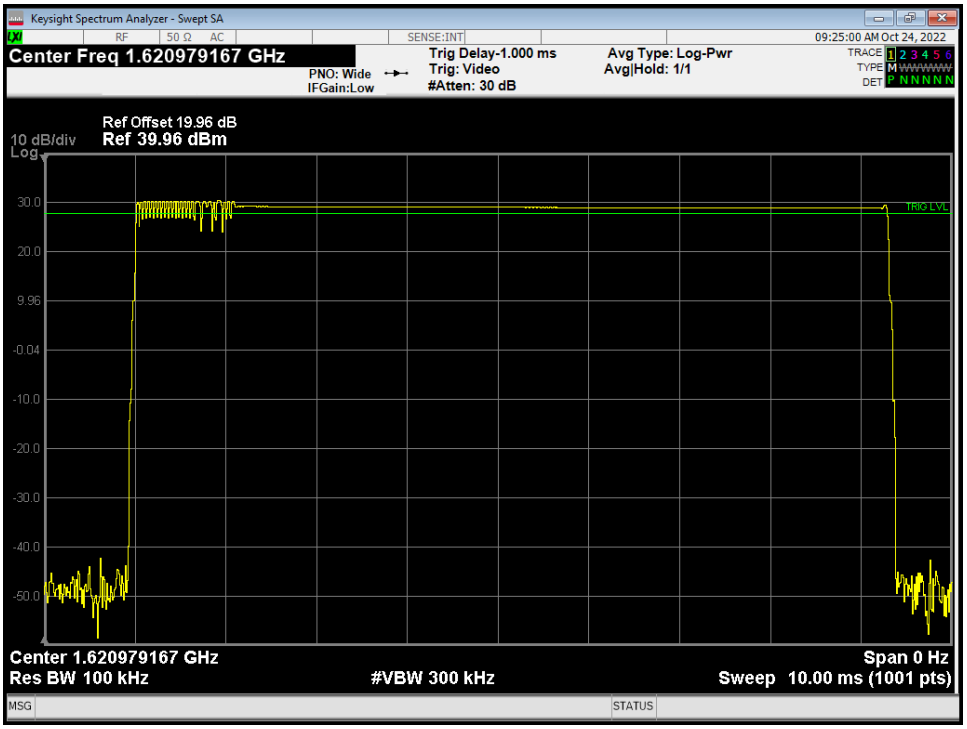

Figure 21 – Supporting Plots for modulation characteristic, Mid Channel

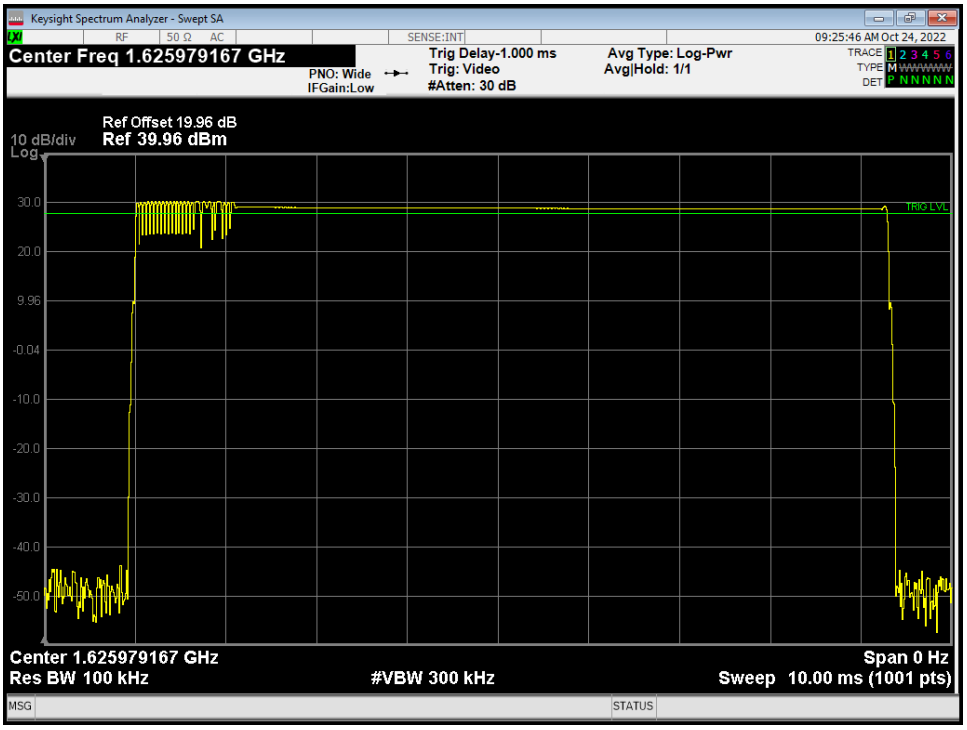

Figure 22 – Supporting Plots for modulation characteristic, High Channel

4.7 ANTENNA GAIN

Test procedures:
Device's conducted power was measured then then same measurement was repeated on a radiated sample at 3m test distance and converted to E.I.R.P.

Test setup:
Details can be found in section 2.1 of this report.

EUT operating conditions:
Details can be found in section 2.1 and 2.2 of this report.

Test results:

Antenna Gain:
Radiated Average power – Conducted Average Power = Antenna gain
31.935 dBm – 30.539 dBm = **1.396 dBi**

Comments:

1. None

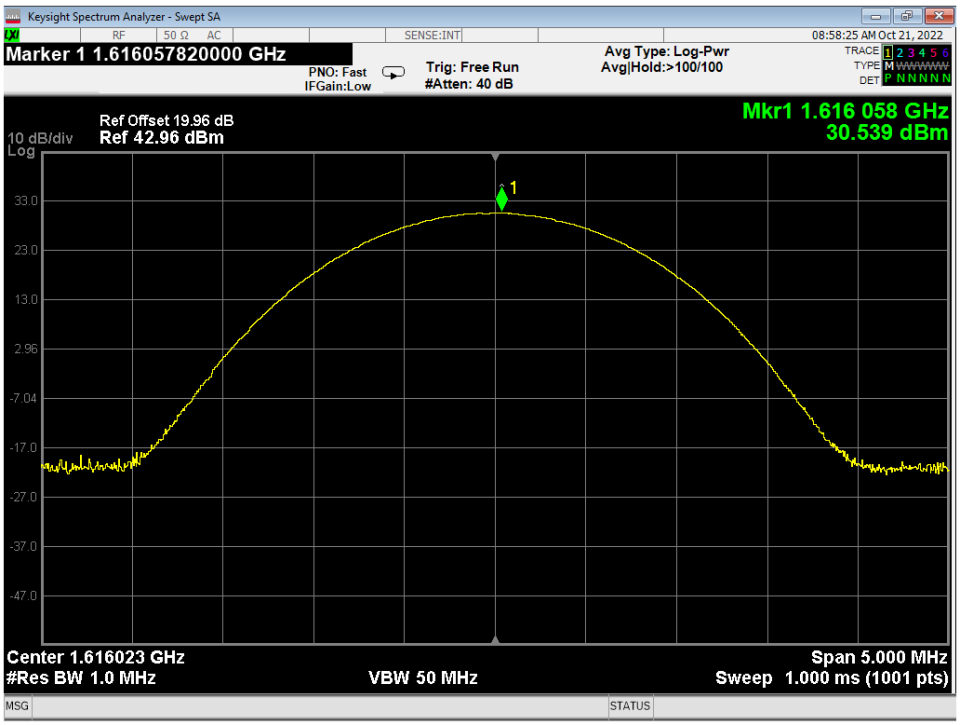

Figure 23 – Conducted Average Power Measurement, Iridium, Low

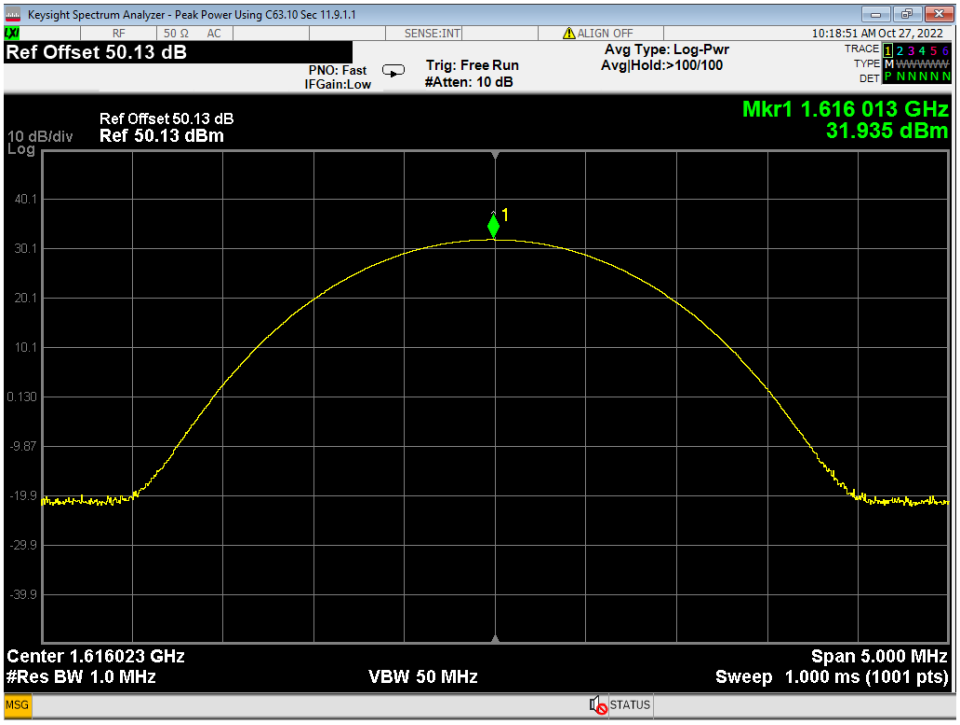

Figure 24 – Radiated Average Power Measurement, Iridium, Low

Reference offset includes EIRP conversion and corrections

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	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	150kHz – 30MHz	±3.03
RF Conducted	30MHz – 18GHz	±1.00

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

REPORT END