FCC Test Report

Quake Global Inc
Q4000 Modem, Model: Q4000

In accordance with FCC 47 CFR Part 2 and FCC 47 CFR Part 25
(Iridium)

Prepared for: Quake Global Inc
4711 Viewridge Avenue, Suite 150,
San Diego, California
CA92123, UNITED STATES

FCC ID: PB5Q4000

Add value.
Inspire trust.

COMMERCIAL-IN-CONFIDENCE

Document 75958309-01 Issue 02

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Steve Marshall	Senior Engineer	Authorised Signatory	13 July 2023

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT
The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 2 and FCC 47 CFR Part 25. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Neil Rousell	13 July 2023	
	Thomas Biddlecombe	13 July 2023	
	Ahmad Javid	13 July 2023	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with FCC 47 CFR Part 2: 2021 and FCC 47 CFR Part 25: 2021 for the tests detailed in section 1.3.

TÜV SÜD
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuvsud.com/en

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	12-July-2023
2	Changing Part Number from 1135-5xxx & 1162-xxxx to 1137-5XXX & 1162-XXXX	13-July-2023

Table 1

1.2 Introduction

Applicant	Quake Global Inc
Manufacturer	Quake Global Inc
Model Number(s)	Q4000
Serial Number(s)	KQ3500000504 and KQ3500000516
Hardware Version(s)	Rev A6
Software Version(s)	V 3.5
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 2: 2021and FCC 47 CFR Part 25: 2021
Order Number	PO13056
Date	12-April-2023
Date of Receipt of EUT	04-May-2023
Start of Test	25-May-2023
Finish of Test	04-July-2023
Name of Engineer(s)	Neil Rousell, Thomas Biddlecombe and Ahmad Javid
Related Document(s)	ANSI C63.26 (2015)

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 2 and FCC 47 CFR Part 25 and is shown below.

Section	Specification Clause		Test Description	Result	Comments/Base Standard
	Part 2	Part 25			
Configuration and Mode: Iridium - Transceiver					
2.1	2.1046	25.204	Equivalent Isotropic Radiated Power	Pass	ANSI C63.26 (2015)
2.2	2.1047 (d)	-	Modulation Characteristics	Declaration	
2.3	2.1049	-	Occupied Bandwidth	Pass	ANSI C63.26 (2015)
2.4	2.1051	25.202(f)	Spurious Emissions at Antenna Terminals	Pass	ANSI C63.26 (2015)
2.5	2.1053	25.202(f)	Radiated Spurious Emissions	Pass	ANSI C63.26 (2015)
2.6	2.1055	25.202(d)	Frequency Tolerance	Pass	ANSI C63.26 (2015)
2.7	-	25.216	Limits on Emissions from Mobile Earth Stations for Protection of Aeronautical Radionavigation-Satellite Service	Pass	ANSI C63.26 (2015)

Table 2

1.4 Application Form

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment including the technologies the product supports)*	The QUAKE Q4000TM is a complete, fully programmable, dual mode capable solution ready for global use. The Q4000 is designed to communicate with terrestrial network systems when a cell signal is available and slide seamlessly into satellite mode when a cell signal is not available. Besides this advanced modem functionality, the Q4000 has the additional processing power, memory, and I/Os that allow sophisticated customer applications to run within the modem. Using an integrated power regulator, the Q4000 is designed to operate over a 6.5-32volt input range. It has been specifically designed to meet the demanding requirements of vehicular environments and directly supports communication over a vehicle bus using industry or customer proprietary standards. The Q40000 is also fully programmable via a comprehensive API to realize any application need		
Manufacturer:	Quake Global, Inc		
Model:	QPRO & Q4000		
Part Number:	1137-5XXX & 1162-XXXX		
Hardware Version:	Rev A6		
Software Version:	V 3.5		
FCC ID of the product under test – see guidance here		PB5Q4000	
IC ID of the product under test – see guidance here		4650A-Q4000	
Device Category	Mobile ☐	Portable ☒	Fixed ☐
Equipment is fitted with an Audio Low Pass Filter		Yes ☐	No ☒

Table 3

Intentional Radiators

Technology	Iridium SBD	GSM850	EGSM900	DCS-1800	PCS-1900
Frequency Range (MHz to MHz)	1616 / 1626.5	824.2 / 848.8	890.0 / 914.8	1710.2 / 1784.8	1850.2 / 1909.8
Conducted Declared Output Power (dBm)	31.7 +/- 0.5	33 dBm	33dBm	30dBm	30dBm
Antenna Gain (dBi)	3 dBi	<3 dBi	<3 dBi	<3 dBi	<3 dBi
Supported Bandwidth(s) (MHz) (e.g. 1 MHz, 20 MHz, 40 MHz)	2.4 kbps	200 kHz	200 kHz	200 kHz	200 kHz
Modulation Scheme(s) (e.g. GFSK, QPSK etc)	FDMA/RDMA	GMSK	GMSK	GMSK	GMSK
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)	19K0F1D	200K0G1D	200K0G1D	200K0G1D	200K0G1D
Bottom Frequency (MHz)	1616	824.2	890	1710.2	1850.2
Middle Frequency (MHz)	1617.5	824.2	925.2	1805.2	1805.2
Top Frequency (MHz)	1626.5	848.8	914.8	1784.8	1909.8

Table 4

Technology	UMTS-FDD 1	UMTS-FDD 2	UMTS-FDD 4	UMTS-FDD 5	UMTS-FDD 6	UMTS-FDD 8	UMTS-FDD 19
Frequency Range (MHz to MHz)	1920 – 1980	1850 – 1910	1710 – 1755	824 – 849	830 – 840	880 – 915	830 – 845
Conducted Declared Output Power (dBm)	24 dBm	24 dBm	24 dBm	24 dBm	24 dBm	24 dBm	24 dBm
Antenna Gain (dBi)	<3 dBi	<3 dBi	<3 dBi	<3 dBi	<3 dBi	<3 dBi	<3 dBi
Supported Bandwidth(s) (MHz) (e.g. 1 MHz, 20 MHz, 40 MHz)	5MHZ	5MHZ	5MHZ	5MHZ	5MHZ	5MHZ	5MHZ
Modulation Scheme(s) (e.g. GFSK, QPSK etc)	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)							
Bottom Frequency (MHz)	1980	1900	2110	869	875	1844.9	876.4
Middle Frequency (MHz)	1957.6	1877.6	2087.6	846.6	852.6	1822.5	854.0
Top Frequency (MHz)	1935.2	1855.2	2065.2	824.2	830.2	1800.1	831.6

Table 5

Technology	LTE FDD Band 2	LTE FDD Band 4	LTE FDD Band 12
Frequency Range (MHz to MHz)	1850 - 1910	1710 - 1755	698 - 716
Conducted Declared Output Power (dBm)	+21/+23 dBM MIN/MAX	+21/+23 dBM MIN/MAX	+21/+23 dBM MIN/MAX
Antenna Gain (dBi)	<3 dBi	<3 dBi	<3 dBi
Supported Bandwidth(s) (MHz) (e.g. 1 MHz, 20 MHz, 40 MHz)	60MHz	45MHz	18MHz
Modulation Scheme(s) (e.g. GFSK, QPSK etc)	QAM	QAM	QAM
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)	20M0G7W	20M0G7W	20M0G7W
Bottom Frequency (MHz)	1900	2110	729
Middle Frequency (MHz)	1930	2130	728
Top Frequency (MHz)	1850	2090	717

Table 6

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	2570
Lowest frequency generated or used in the device or on which the device operates or tunes	703
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

Table 7

AC Power Source

AC supply frequency:		Hz
Voltage		V
Max current:		A
Single Phase ☐ Three Phase ☒		

Table 8

DC Power Source

Nominal voltage:	24	V
Extreme upper voltage:	32	V
Extreme lower voltage:	9	V
Max current:	2	A

Table 9

Battery Power Source

Voltage:		V
End-point voltage:		V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☐ Lithium ☐ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*		
Other ☐ Please detail:		

Table 10

Charging

Can the EUT transmit whilst being charged	Yes ☐ No ☒

Table 11

Temperature

Minimum temperature:	-40	°C
Maximum temperature:	+85	°C

Table 12

Cable Loss

Adapter Cable Loss (Conducted sample)		dB

Table 13

Antenna Characteristics

Antenna connector ☒ SMA-Female, SMB-Jack, MCX-Female			State impedance	50	Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☐	Type:		Gain		dBi
External antenna ☒	Type:	User defined	Gain	<3 dBi	dBi
For external antenna only: Standard Antenna Jack ☒ If yes, describe how user is prohibited from changing antenna (if not professional installed): Equipment is only ever professionally installed ☐ Non-standard Antenna Jack ☐ All part 15 applications will need to show how the antenna gain was derived either from a manufacturer data sheet or a measurement. Where the gain of the antenna is inherently accounted for as a result of the measurement, such as field strength measurements on a part 15.249 or 15.231 device, so the gain does not necessarily need to be verified. However, enough information regarding the construction of the antenna shall be provided. Such information maybe photographs, length of wire antenna etc.					

Table 14

Ancillaries (if applicable)

Manufacturer:		Part Number:	
Model:		Country of Origin:	

Table 15

I hereby declare that the information supplied is correct and complete.

Name: Louay Alakhras
Position held: Compliance Engineer
Date: 04-26-2023

1.5 Product Information

1.5.1 Technical Description

The QUAKE Q4000TM is a complete, fully programmable, dual mode capable solution ready for global use. The Q4000 is designed to communicate with terrestrial network systems when a cell signal is available and slide seamlessly into satellite mode when a cell signal is not available. Besides this advanced modem functionality, the Q4000 has the additional processing power, memory, and I/Os that allow sophisticated customer applications to run within the modem. Using an integrated power regulator, the Q4000 is designed to operate over a 6.5-32volt input range. It has been specifically designed to meet the demanding requirements of vehicular environments and directly supports communication over a vehicle bus using industry or customer proprietary standards. The Q40000 is also fully programmable via a comprehensive API to realize any application need.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: Q4000, Serial Number: KQ3500000516			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Q4000, Serial Number: KQ3500000504			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 16

1.8 Test Location

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Iridium - Transceive		
Modulation Characteristics	Neil Rousell	UKAS
Occupied Bandwidth	Thomas Biddlecombe	UKAS
Spurious Emissions at Antenna Terminals	Neil Rousell	UKAS
Radiated Spurious Emissions	Ahmad Javid	UKAS
Frequency Tolerance	Thomas Biddlecombe	UKAS
Equivalent Isotropic Radiated Power	Thomas Biddlecombe	UKAS
Limits on Emissions from Mobile Earth Stations for Protection of Aeronautical Radionavigation-Satellite Service	Neil Rousell	UKAS

Table 17

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Equivalent Isotropic Radiated Power

2.1.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1046
FCC 47 CFR Part 25, Clause 25.204

2.1.2 Equipment Under Test and Modification State

Q4000, S/N: KQ3500000516 - Modification State 0

2.1.3 Date of Test

04-July-2023

2.1.4 Test Method

The test was performed in accordance with ANSI C63.26, clause 5.2.3.5.

2.1.5 Environmental Conditions

Ambient Temperature	21.5 °C
Relative Humidity	55.5 %

2.1.6 Test Results

Iridium - Transceiver

EIRP (dBm/4 kHz)		
1616.020833 MHz	1621.020833 MHz	1625.979167 MHz
32.25	32.39	32.42

Table 18

FCC 47 CFR Part 25, Limit Clause 25.204

+40 dBW in any 4 kHz band for $\theta \leq 0°$
+40 + 3θ dBW in any 4 kHz band for $0° < \theta \leq 5°$
For angles of elevation of the horizon greater than 5° there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
Multimeter	Iso-tech	IDM101	2424	12	20-Feb-2024
Hygrometer	Rotronic	I-1000	3220	12	15-Nov-2023
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	13-Jul-2023
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	21-Mar-2024
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	5759	12	05-Jul-2023
Modular Power System Mainframe	Keysight Technologies	N6701C	5835	-	TU
Meter	ETI Ltd	Therma Elite	6326	12	27-Mar-2024

Table 19

O/P Mon – Output Monitored using calibrated equipment
TU - Traceability Unscheduled

2.2 Modulation Characteristics

2.2.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1047 (d)

2.2.2 Equipment Under Test and Modification State

Q4000, S/N: KQ3500000516 - Modification State 0

2.2.3 Date of Test

27-June-2023

2.2.4 Test Method

The description below of the modulation used was declared by the manufacturer.

To support this description, plots of the transmitted burst in the time and frequency domains have been provided.

2.2.5 Environmental Conditions

Ambient Temperature	22.8 °C
Relative Humidity	53.1 %

2.2.6 Test Results

Iridium - Transceive

Modulation characteristics description as provided by the customer...
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.

Table 20

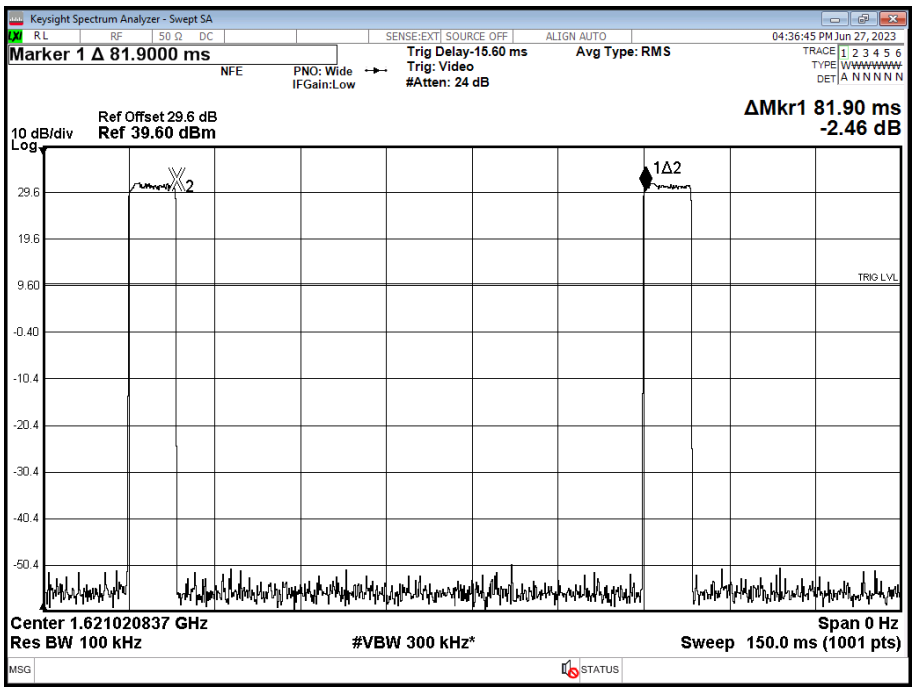


Figure 1 – Modulated burst power off period

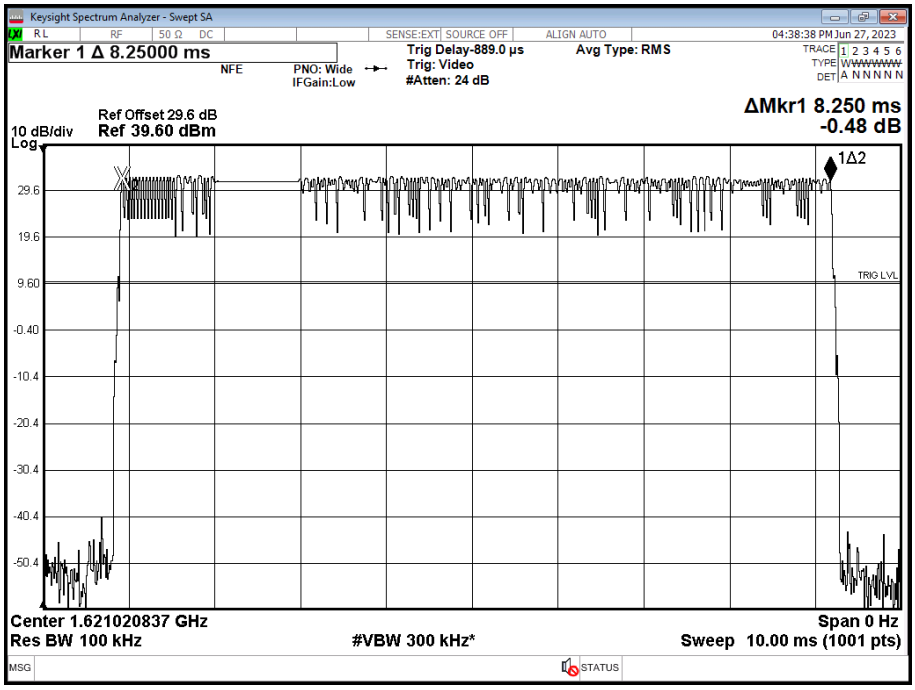


Figure 2 – Modulated burst width

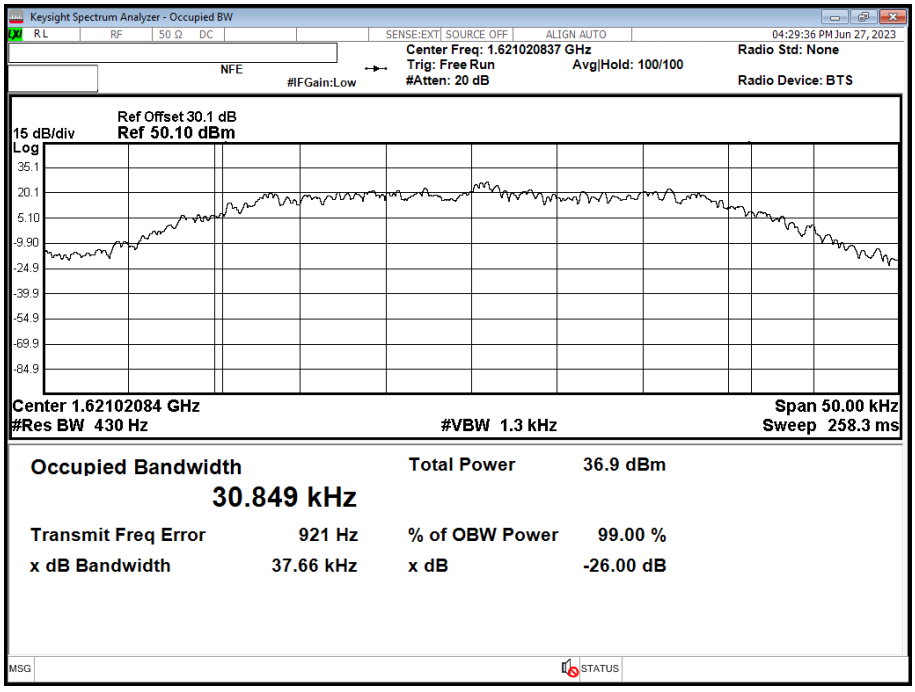


Figure 3 – Modulated burst emission bandwidth

FCC 47 CFR Part 2, Limit Clause 2.1047 (d)

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.

2.3 Occupied Bandwidth

2.3.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1049

2.3.2 Equipment Under Test and Modification State

Q4000, S/N: KQ3500000516 - Modification State 0

2.3.3 Date of Test

04-July-2023

2.3.4 Test Method

This test was performed in accordance with ANSI C63.26 clause 5.4.4, with 5.4.3 also available in the screenshots.

2.3.5 Environmental Conditions

Ambient Temperature	21.5 °C
Relative Humidity	55.5 %

2.3.6 Test Results

Iridium - Transceiver

1616.020833 MHz	1621.020833 MHz	1625.979167 MHz
31.537 kHz	31.323 kHz	31.630 kHz

Table 21 - Occupied Bandwidth Results

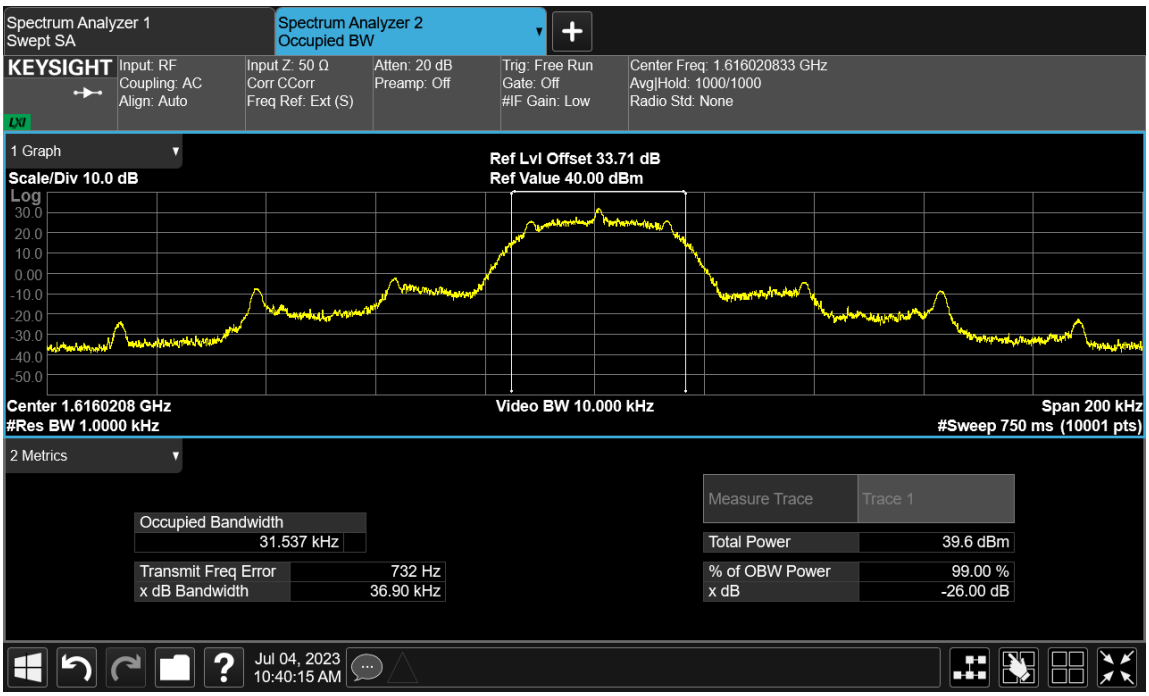


Figure 4 - 1616.020833 MHz

Figure 5 - 1621.020833 MHz

Figure 6 - 1625.979167 MHz

FCC 47 CFR Part 2, Limit Clause 2.1049

None specified.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
Multimeter	Iso-tech	IDM101	2424	12	20-Feb-2024
Hygrometer	Rotronic	I-1000	3220	12	15-Nov-2023
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	13-Jul-2023
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	21-Mar-2024
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	5759	12	05-Jul-2023
Modular Power System Mainframe	Keysight Technologies	N6701C	5835	-	TU
Meter	ETI Ltd	Therma Elite	6326	12	27-Mar-2024

Table 22

O/P Mon – Output Monitored using calibrated equipment
TU - Traceability Unscheduled

2.4 Spurious Emissions at Antenna Terminals

2.4.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1051
FCC 47 CFR Part 25, Clause 25.202(f)

2.4.2 Equipment Under Test and Modification State

Q4000, S/N: KQ3500000516 - Modification State 0

2.4.3 Date of Test

20-June-2023

2.4.4 Test Method

This test was performed in accordance with ANSI C63.26 clause 5.7.
Note that the duty cycle was measured and added as a correction factor for average measurements.

2.4.5 Environmental Conditions

Ambient Temperature	22.3 °C
Relative Humidity	38.3 %

2.4.6 Test Results

Iridium - Transceiver

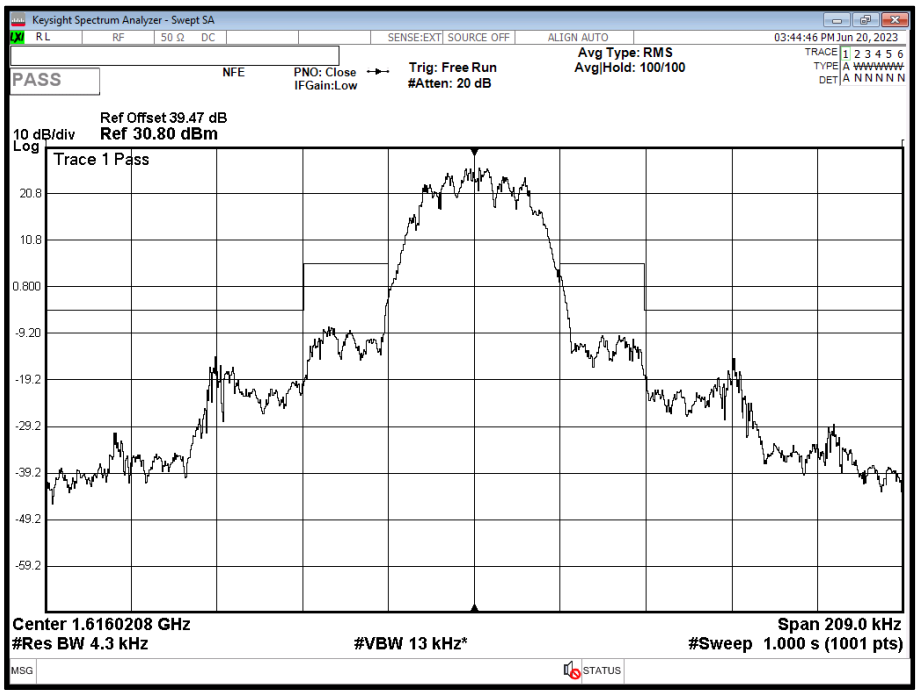


Figure 7 – 1616.020833 MHz - Emission Mask

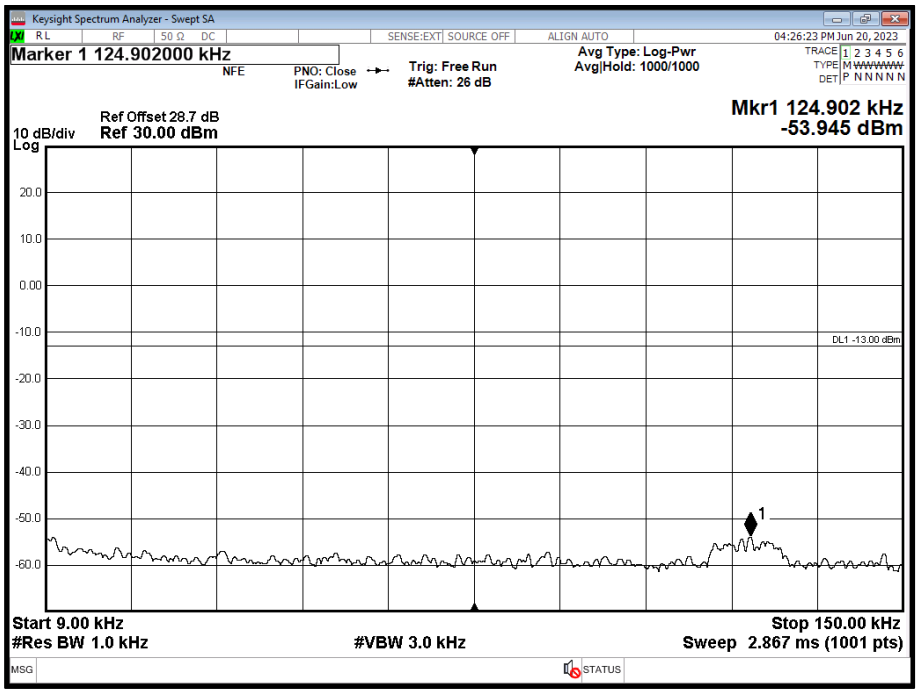


Figure 8 - 1616.020833 MHz - 9 kHz to 150 kHz

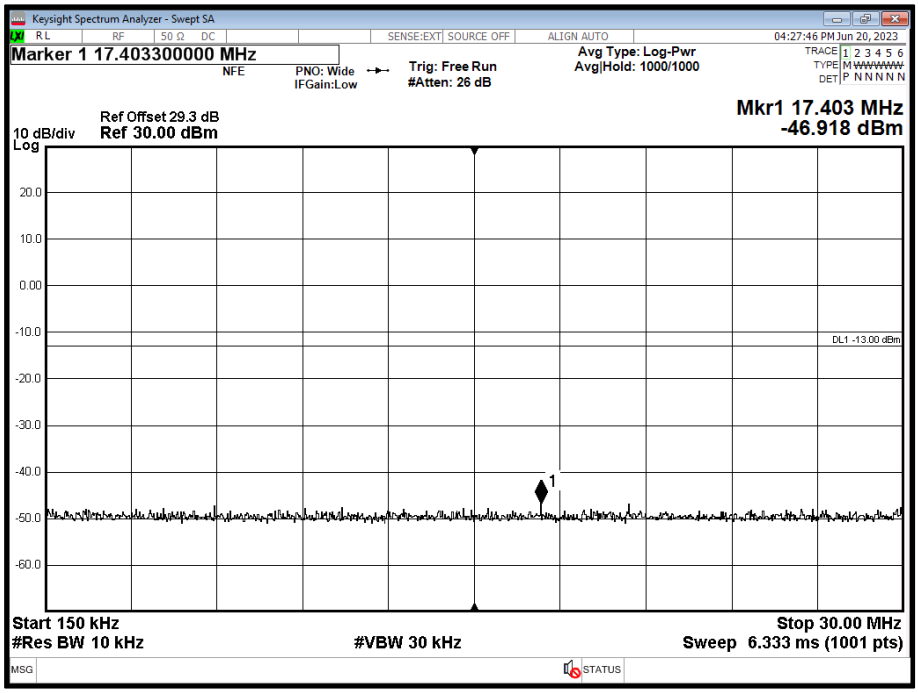


Figure 9 - 1616.020833 MHz - 150 kHz to 30 MHz

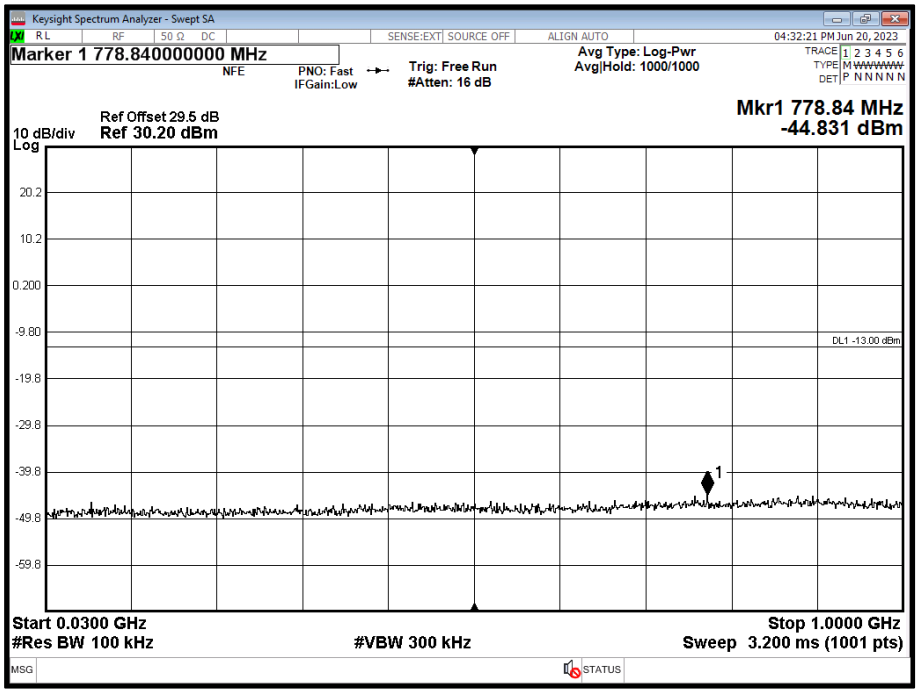


Figure 10 - 1616.020833 MHz - 30 MHz to 1 GHz

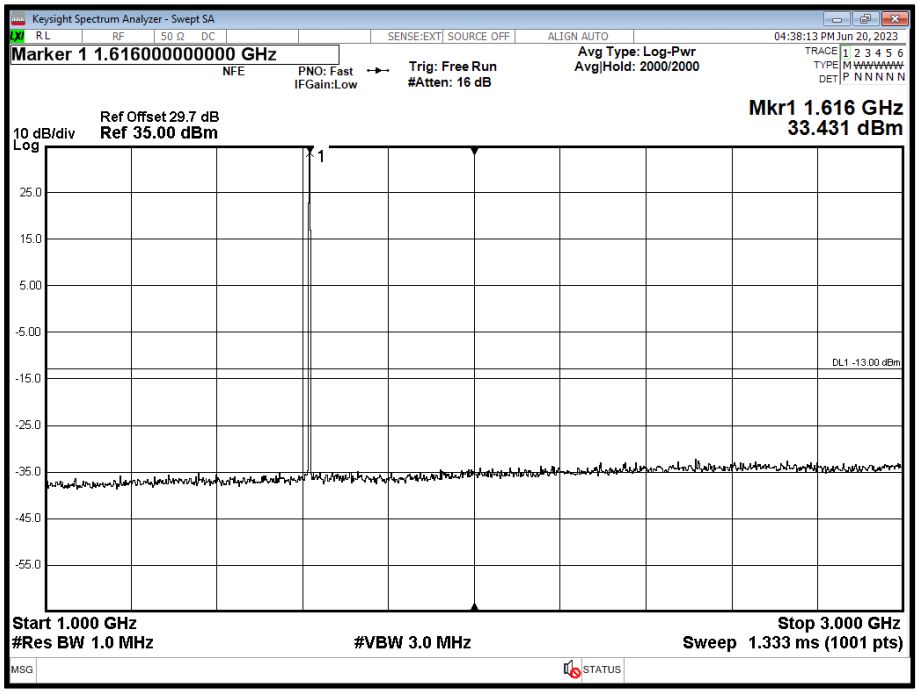


Figure 11 - 1616.020833 MHz - 1 GHz to 3 GHz

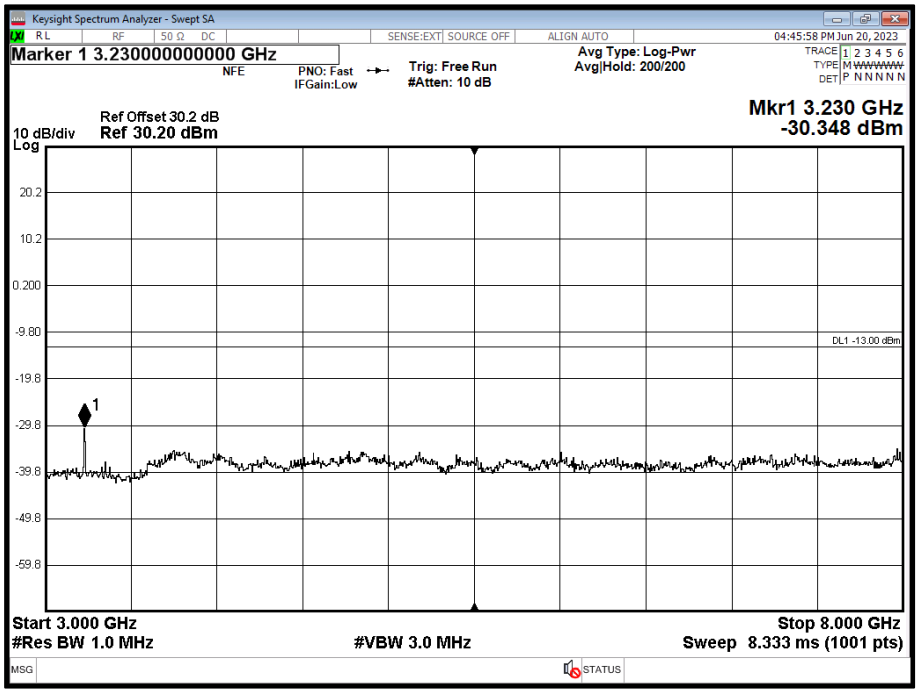


Figure 12 - 1616.020833 MHz - 3 GHz to 8 GHz

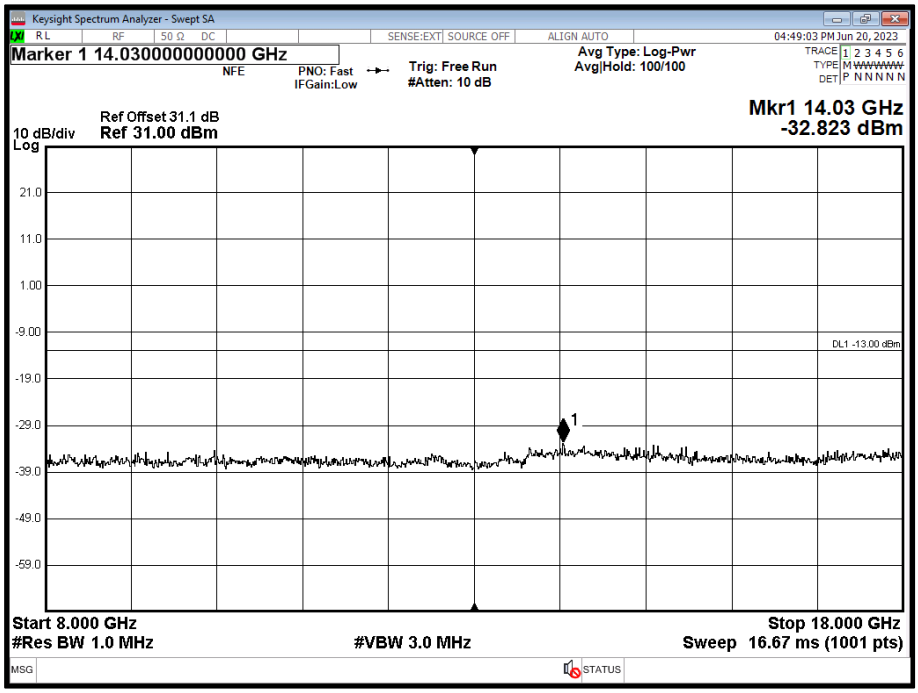


Figure 13 - 1616.020833 MHz - 8 GHz to 18 GHz

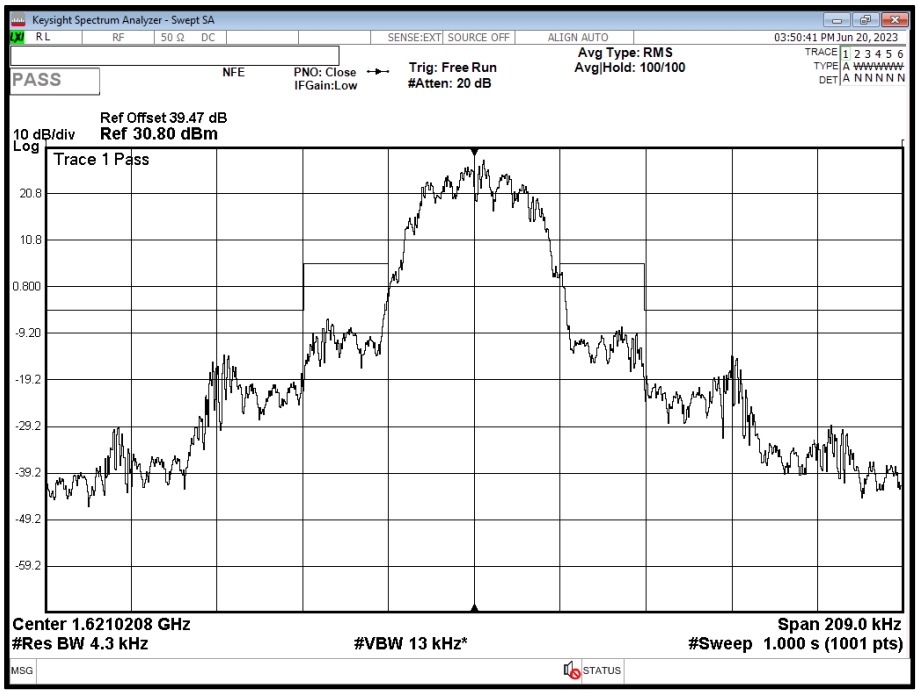


Figure 14 – 1621.020833 MHz - Emission Mask

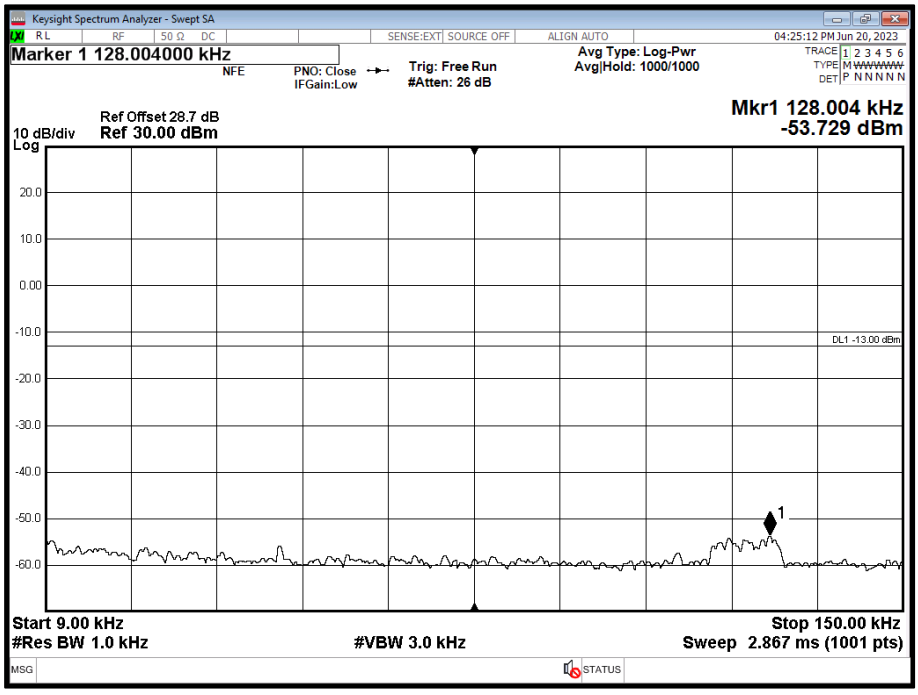


Figure 15 - 1621.020833 MHz - 9 kHz to 150 kHz

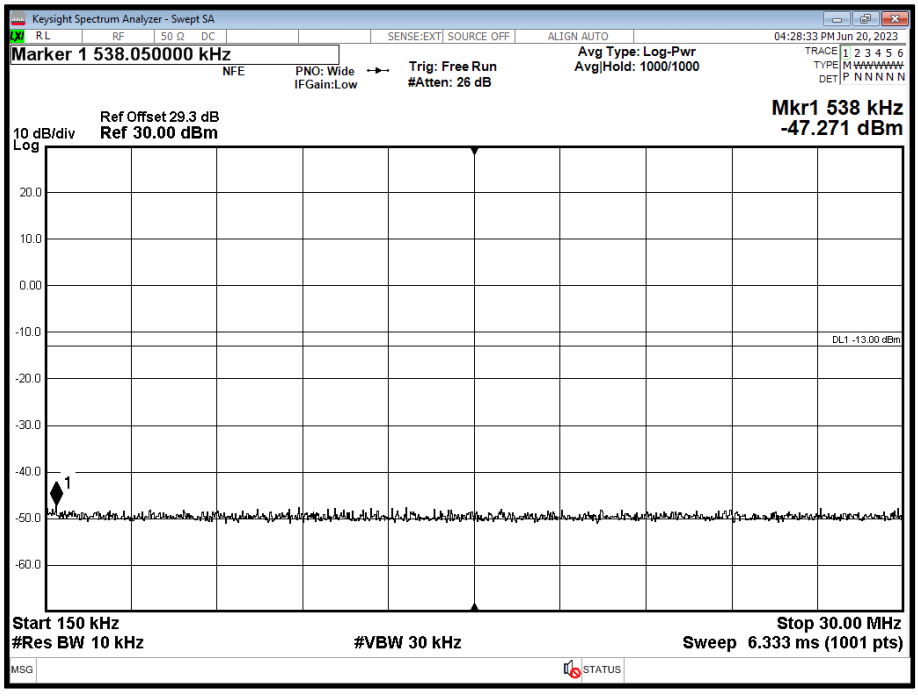


Figure 16 - 1621.020833 MHz - 150 kHz to 30 MHz

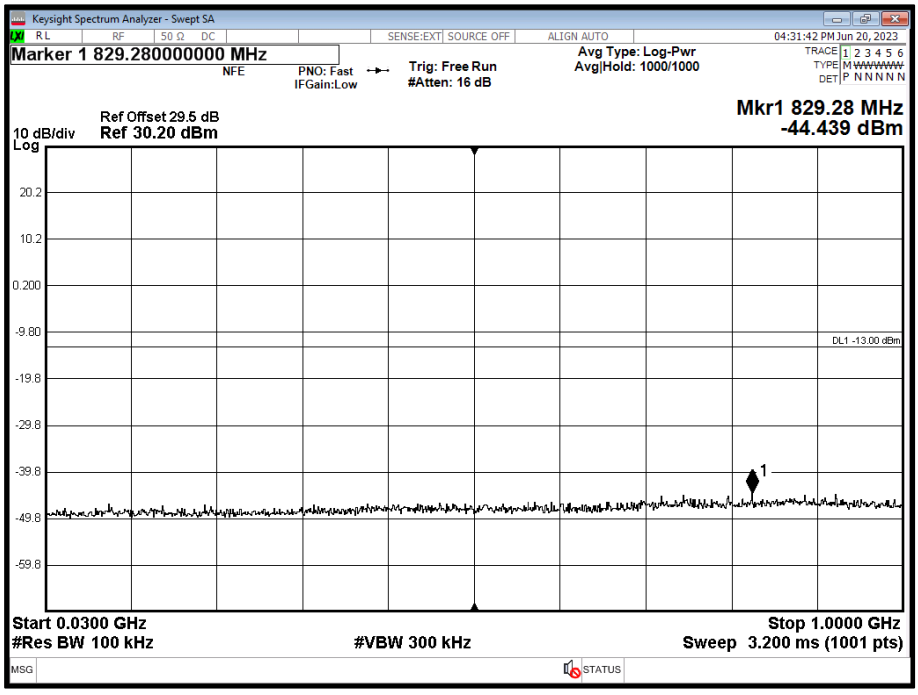


Figure 17 - 1621.020833 MHz - 30 MHz to 1 GHz

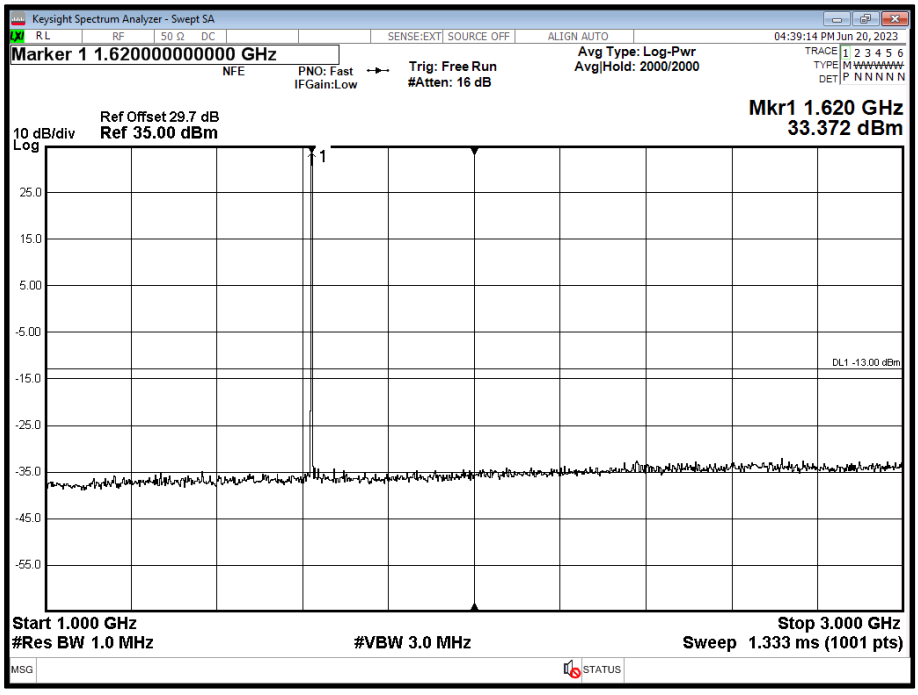


Figure 18 - 1621.020833 MHz - 1 GHz to 3 GHz

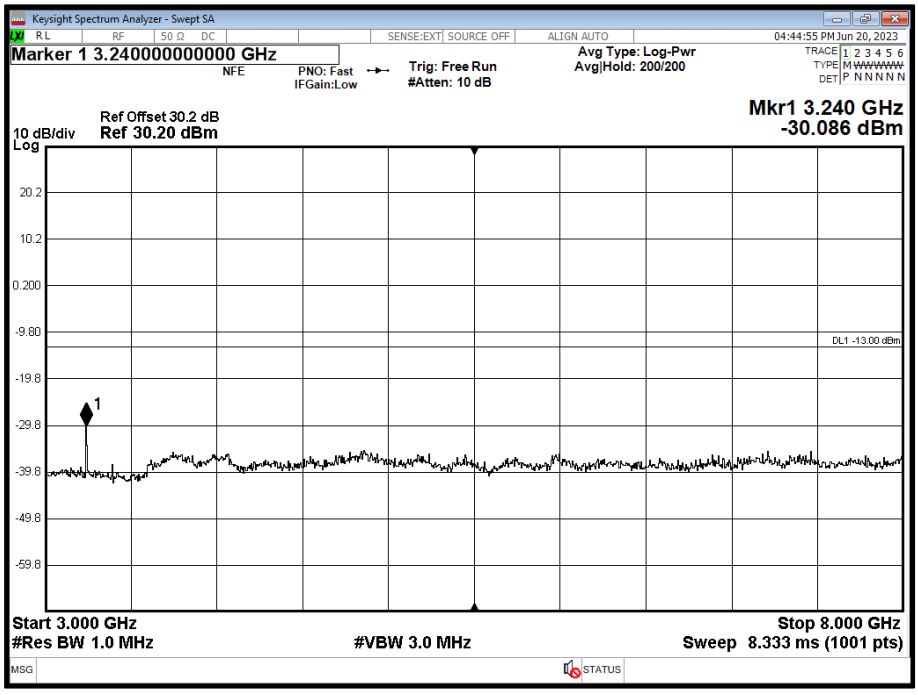


Figure 19 - 1621.020833 MHz - 3 GHz to 8 GHz

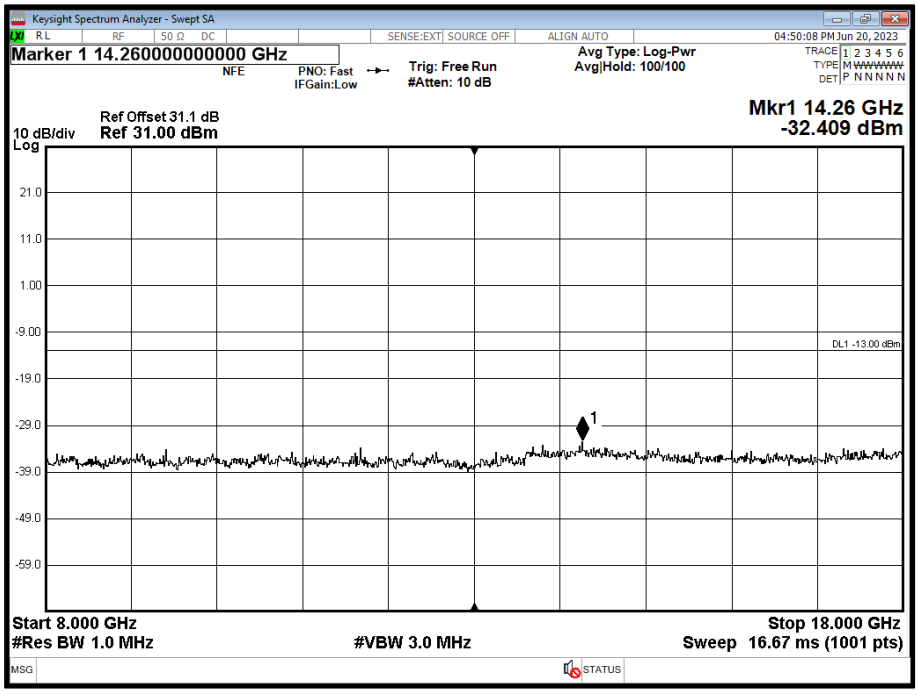


Figure 20 - 1621.020833 MHz - 8 GHz to 18 GHz

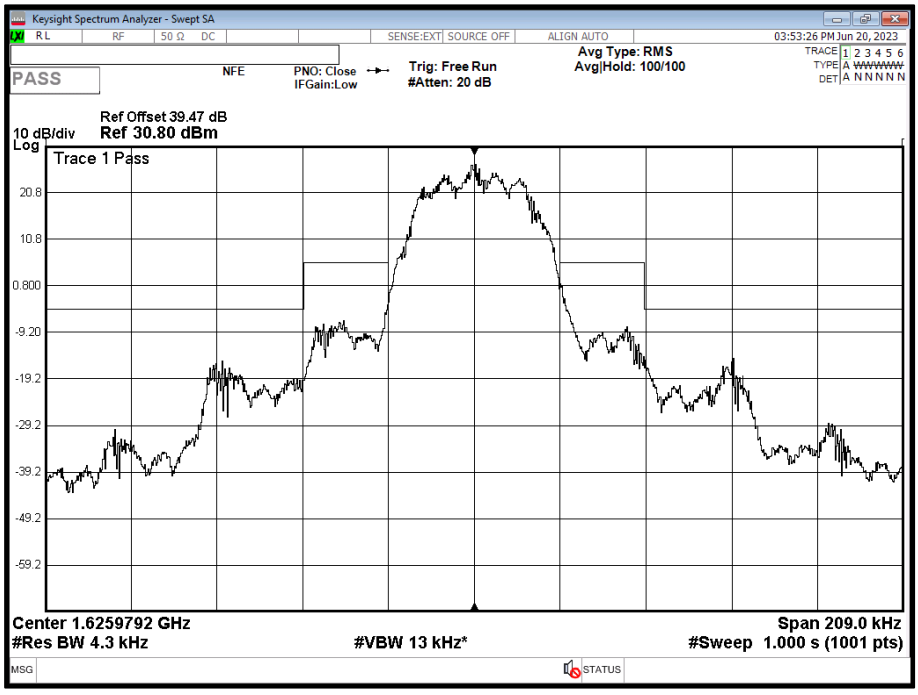


Figure 21 - 1625.979167 MHz - Emission Mask

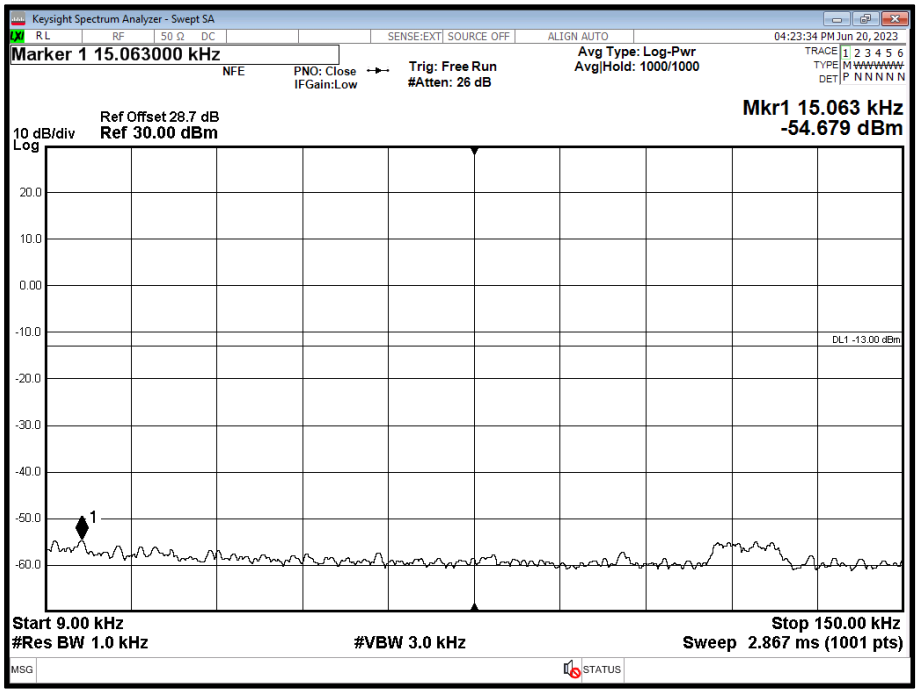


Figure 22 - 1625.979167 MHz - 9 kHz to 150 kHz

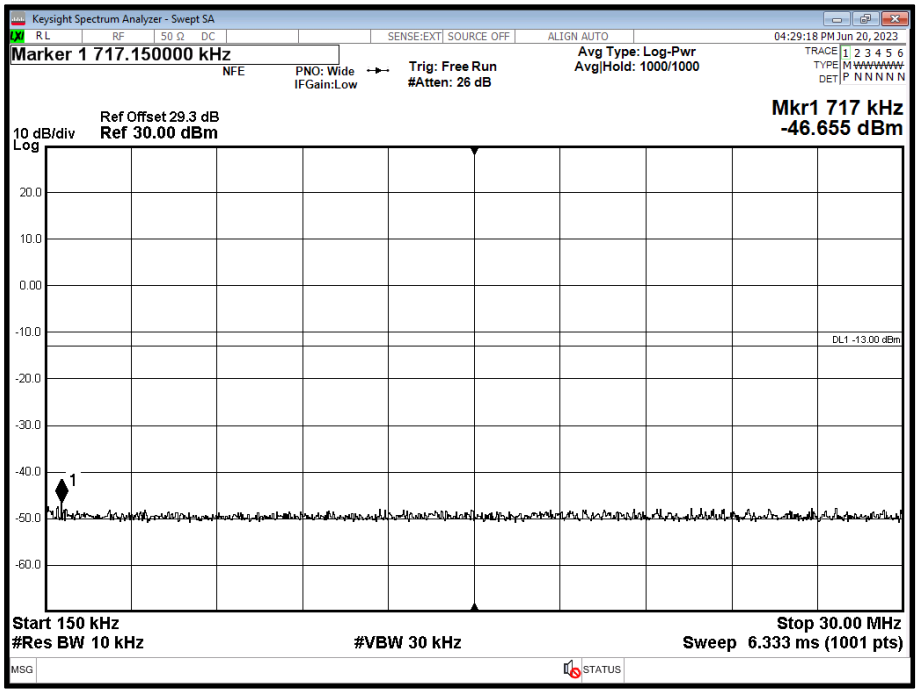


Figure 23 - 1625.979167 MHz - 150 kHz to 30 MHz

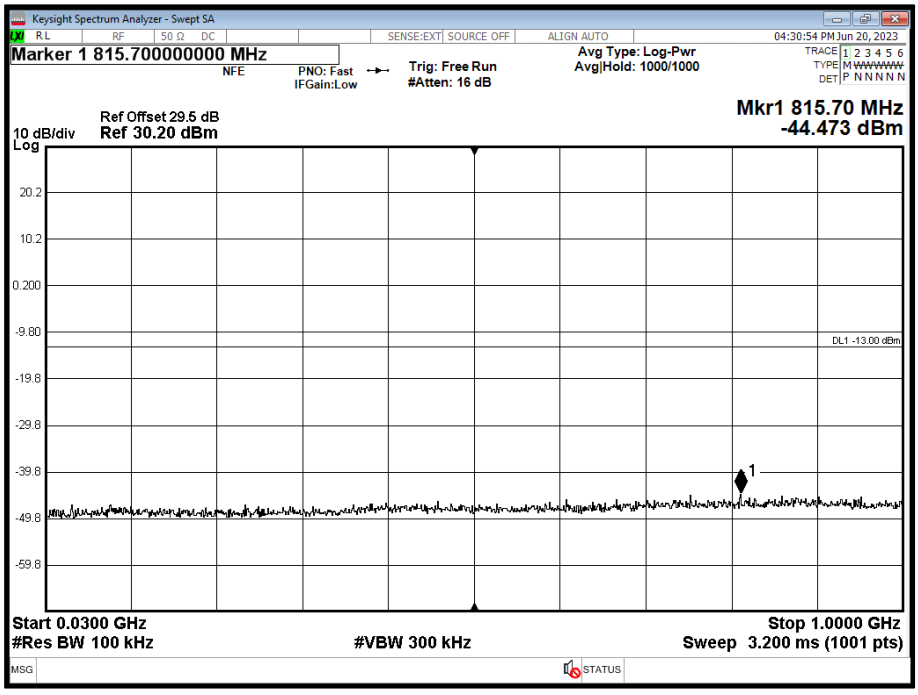


Figure 24 - 1625.979167 MHz - 30 MHz to 1 GHz

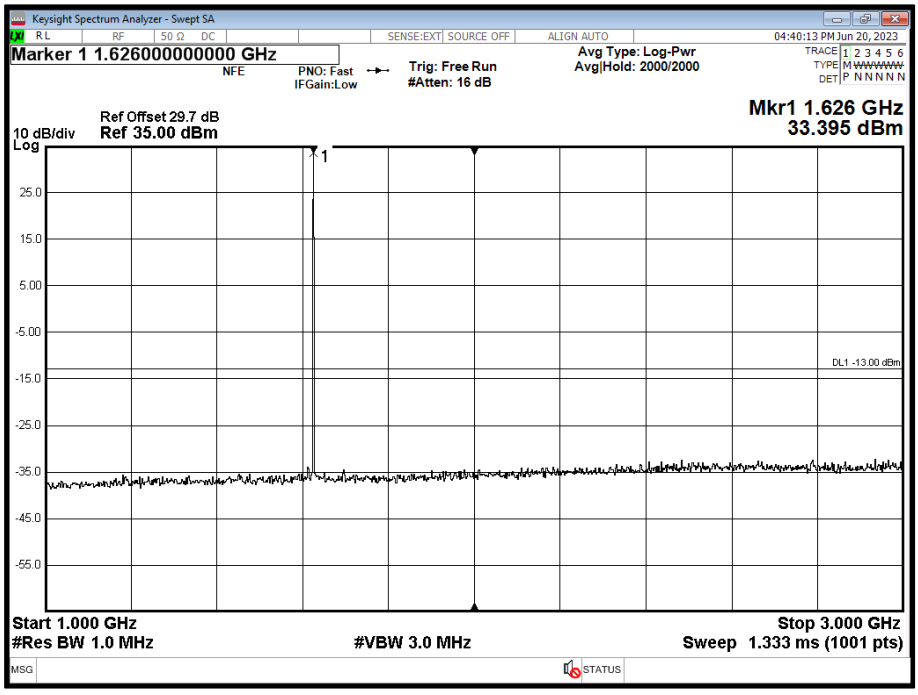


Figure 25 - 1625.979167 MHz - 1 GHz to 3 GHz

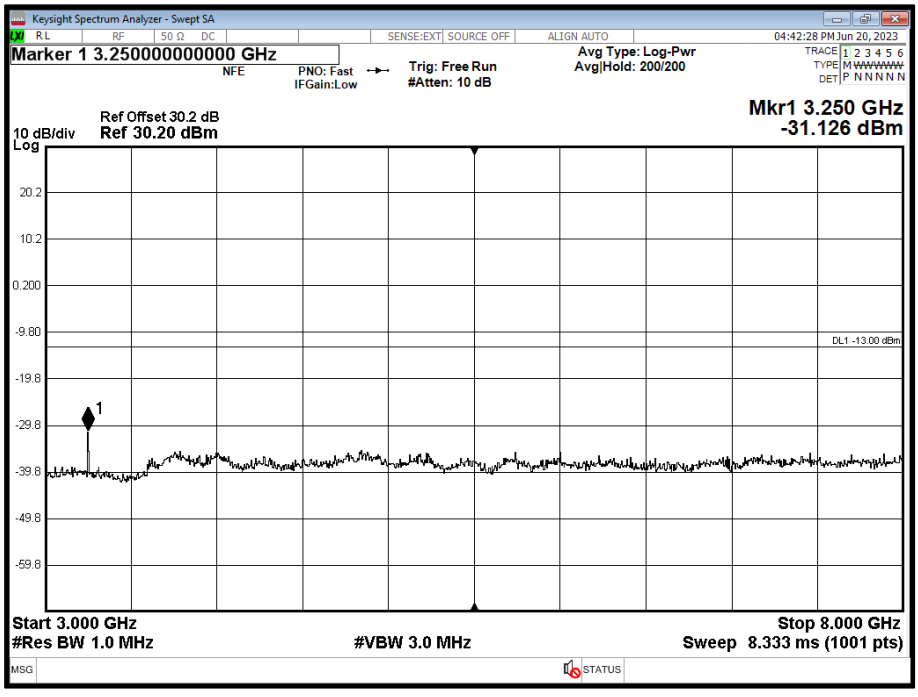


Figure 26 - 1625.979167 MHz - 3 GHz to 8 GHz

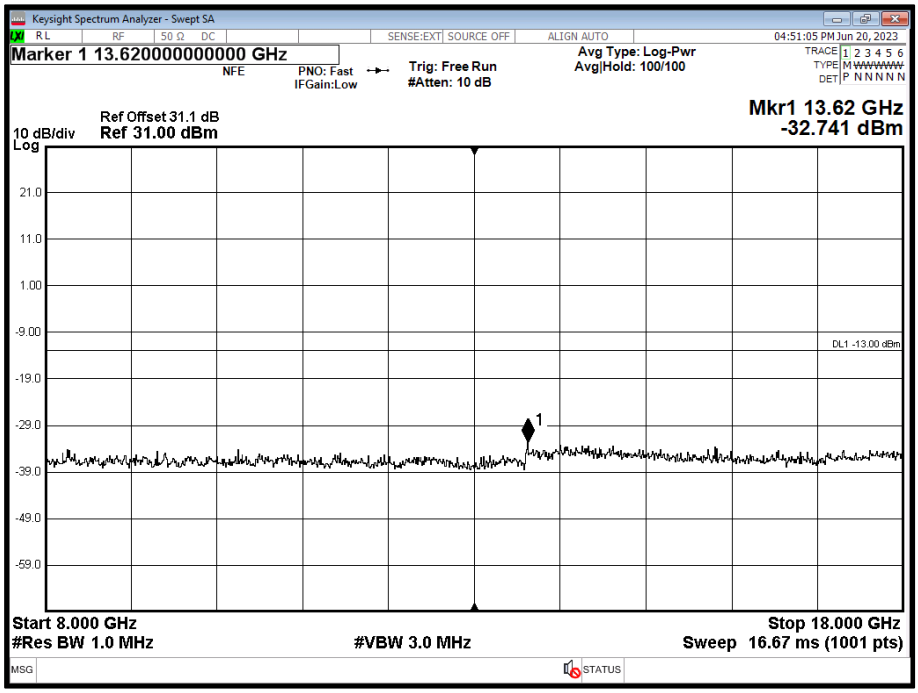


Figure 27 - 1625.979167 MHz - 8 GHz to 18 GHz

FCC 47 CFR Part 2, Limit Clause 25.202(f)

The average power of unwanted emissions shall be attenuated below the average output power, P(dBW), of the transmitter, as specified below:

1) 25 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 50%, up to and including 100% of the authorised bandwidth;
2) 35 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 100%, up to and including 250% of the authorised bandwidth;
3) 43 + 10 Log p (watts) in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 250% of the authorised bandwidth.

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Dual Power Supply Unit	Hewlett Packard	6253A	271	-	O/P Mon
Multimeter	Iso-tech	IDM101	2424	12	20-Feb-2024
HygroPalm	Rotronic	HygroPalm 0	3484	12	30-Aug-2023
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	06-Mar-2024
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2024
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	13-Jul-2023
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	16-Jan-2024
3.5 mm 1m Cable	Junkosha	MWX221-01000DMS	5420	12	23-Oct-2023
Attenuator 5W 30dB DC-18GHz	Aaren	AT40A-4041-D18-30	5502	12	14-Jun-2024

Table 23

O/P Mon – Output Monitored using calibrated equipment

2.5 Radiated Spurious Emissions

2.5.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1053
FCC 47 CFR Part 25, Clause 25.202(f)

2.5.2 Equipment Under Test and Modification State

Q4000, S/N: KQ3500000504 - Modification State 0

2.5.3 Date of Test

26-May-2023 to 29-May-2023

2.5.4 Test Method

A preliminary profile of the Radiated Spurious Emissions was obtained up to the 10th harmonic by operating the EUT on a remotely controlled turntable within a semi-anechoic chamber.

Measurements of emissions from the EUT were obtained with the Measurement Antenna in both Horizontal and Vertical Polarisations. The profiling produced a list of the worst-case emissions together with the EUT azimuth and antenna polarisation.

Testing was performed in accordance with ANSI C63.26, Clause 5.5.

Prescans and final measurements were performed using the direct field strength method.

Field strength measurements were performed and then converted to Equivalent Power Measurements in accordance with ANSI C63.26, Clause 5.2.7 equation c)

Example calculation:

E (dBuV/m) + 20log(d) - 104.8 = EIRP (dBm) where (d) is the measurement distance.

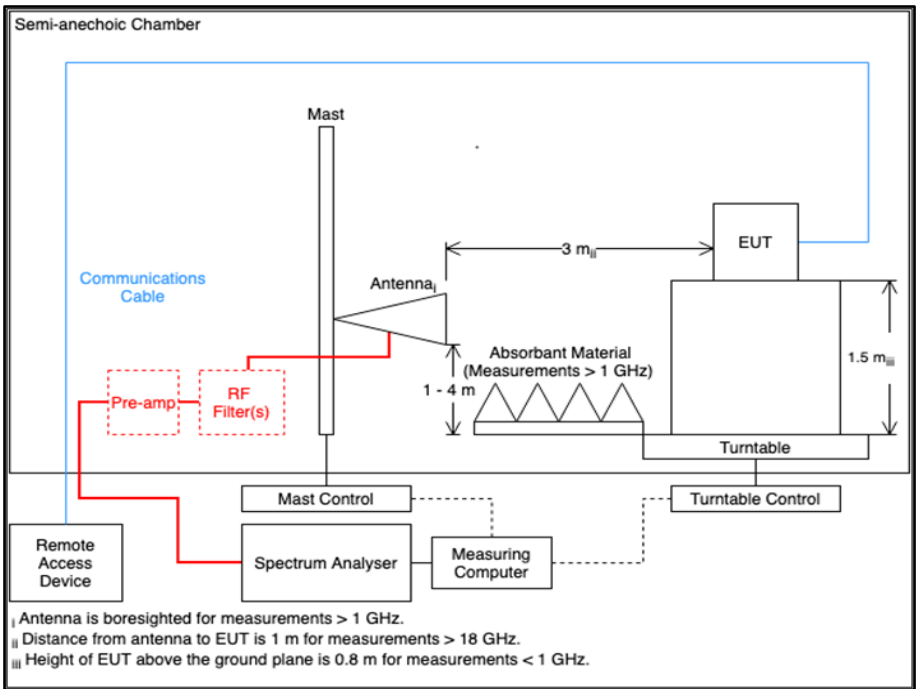
82.2 (dBuV/m) + 20log(3) – 104.8 = EIRP (dBm)

-13.0 = EIRP (dBm)

2.5.5 Environmental Conditions

Ambient Temperature	20.3 - 21.3 °C
Relative Humidity	39.8 - 40.2 %

2.5.6 Example Test Setup Diagram



2.5.7 Test Results

Iridium - Transceive

Frequency (MHz)	Level (dBm)
*	

Table 24 – 1616.020833 MHz, 30 MHz to 1 GHz, Results Table

*No emissions were found within 10 dB of the limit.

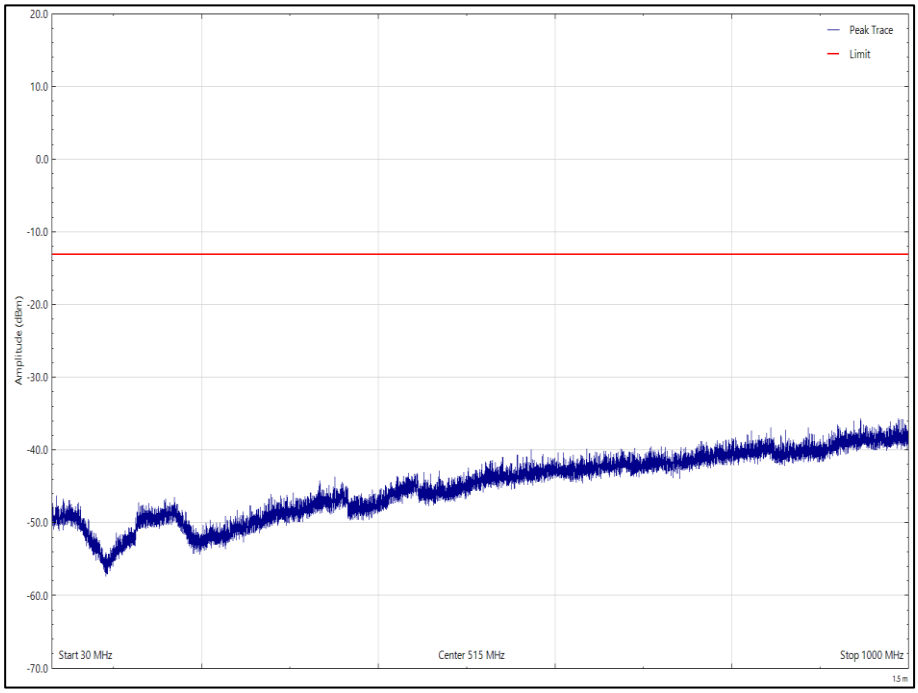


Figure 28 - 1616.020833 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: X

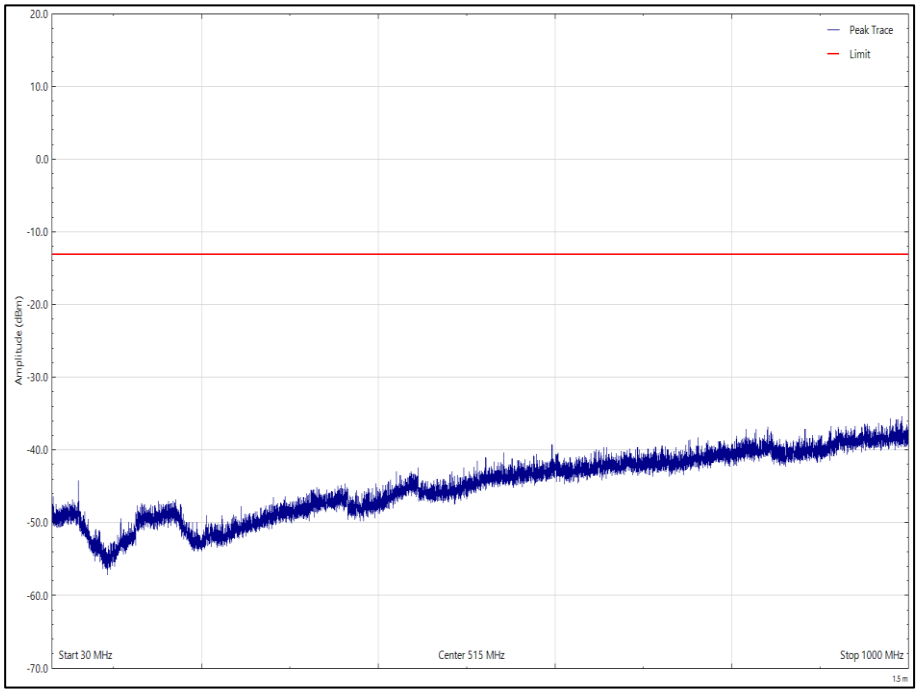


Figure 29 - 1616.020833 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: X

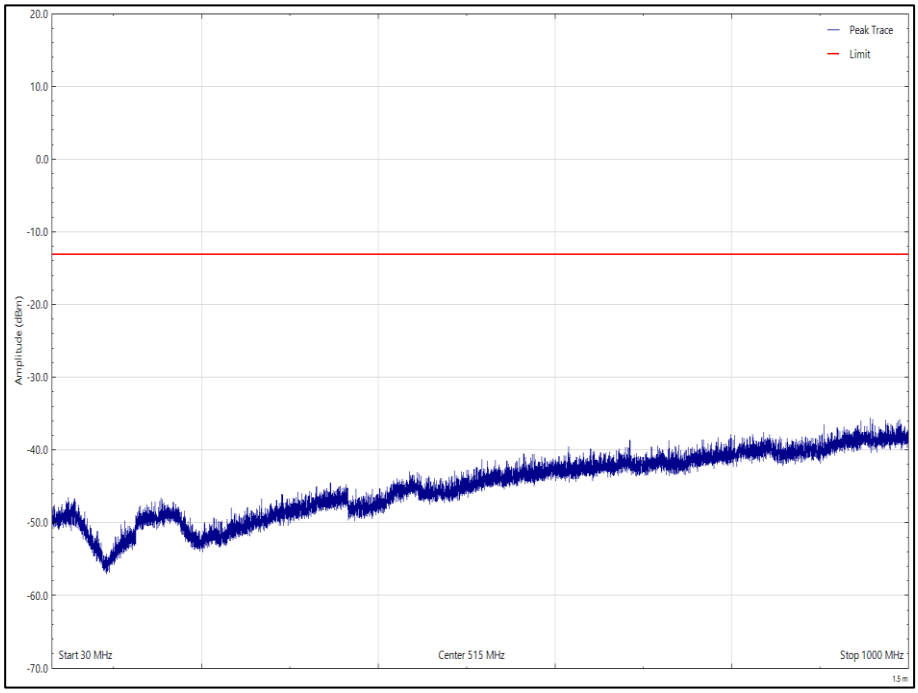


Figure 30 - 1616.020833 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: Y

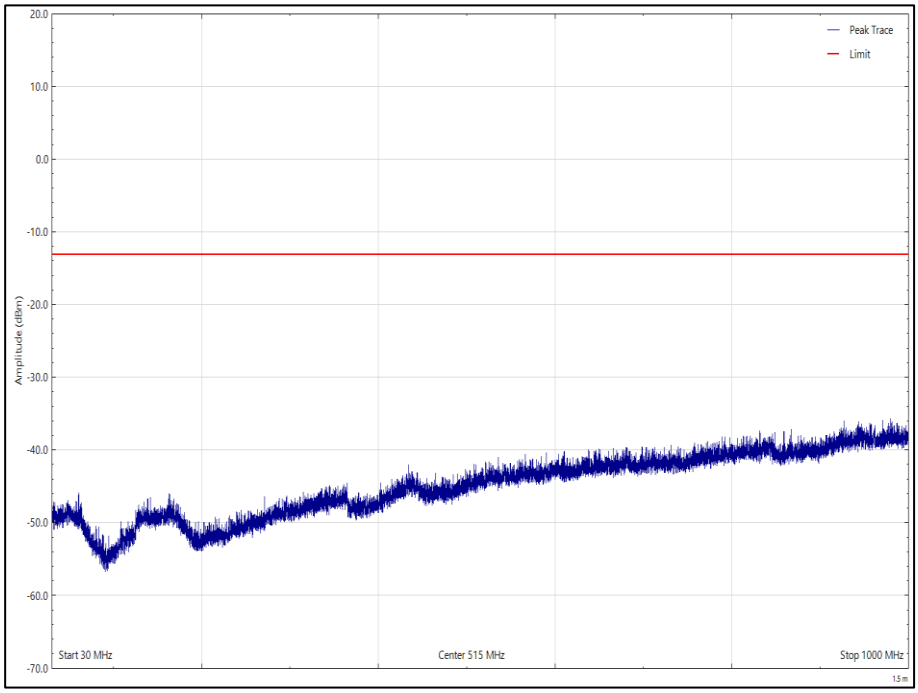


Figure 31 - 1616.020833 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: Y

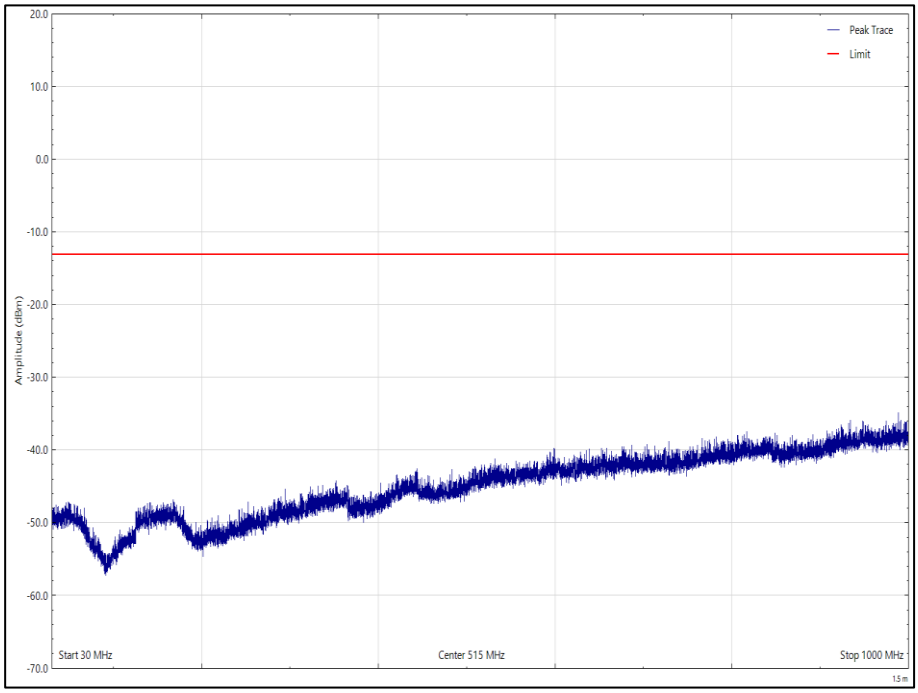


Figure 32 - 1616.020833 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: Z

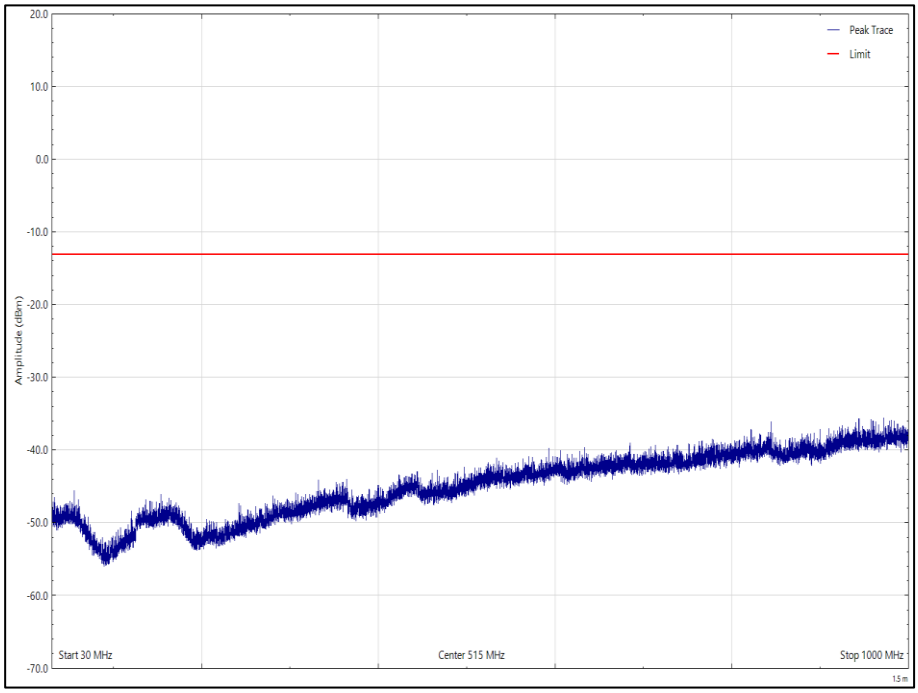


Figure 33 - 1616.020833 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: Z

Frequency (MHz)	Level (dBm)
*	

Table 25- 1616.020833 MHz, 1 GHz to 18 GHz - Results Table

*No emissions were found within 10 dB of the limit.

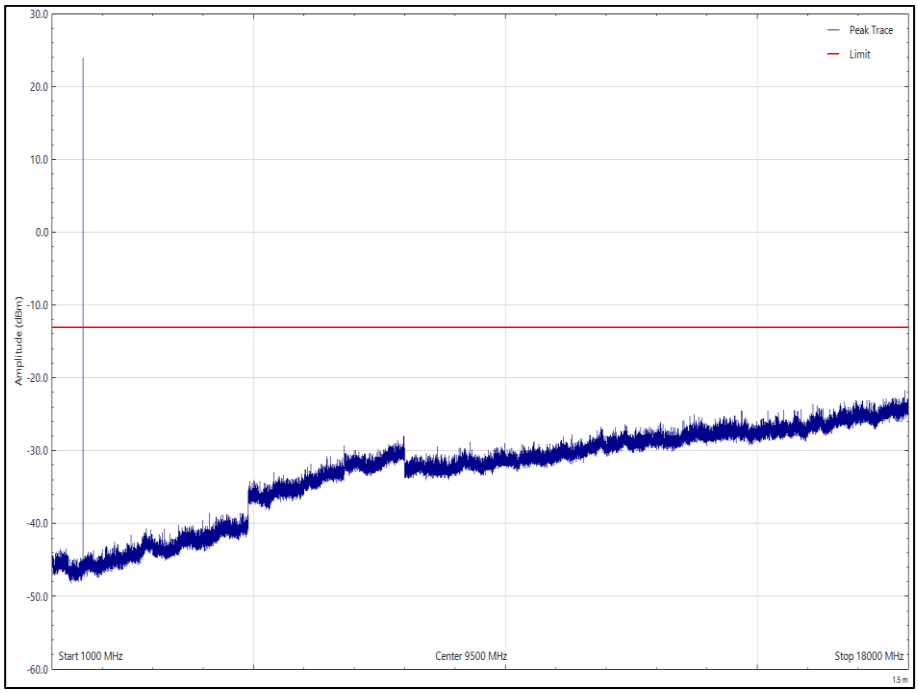


Figure 34 - 1616.020833 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: X

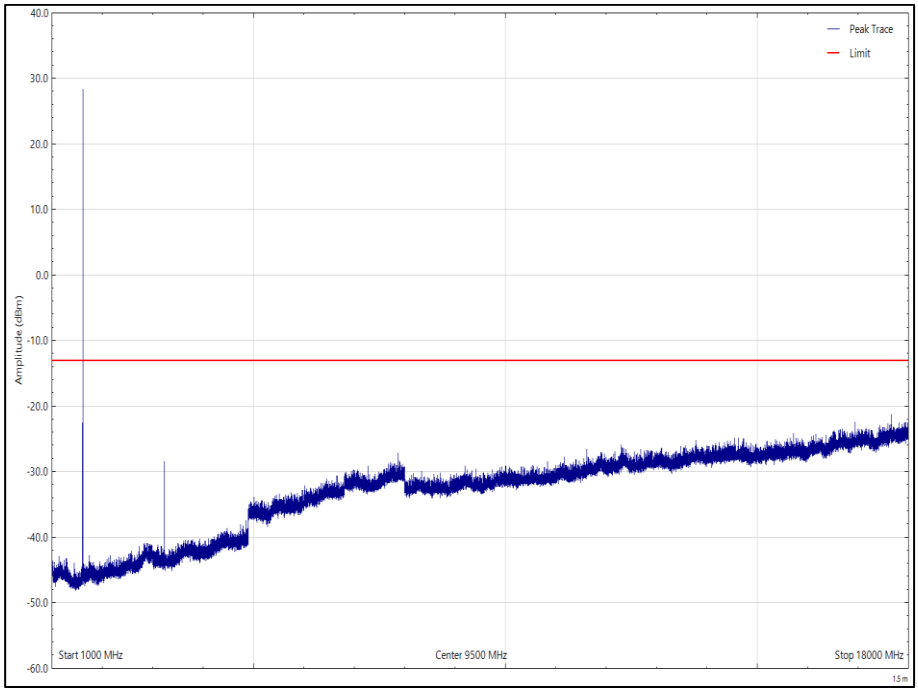


Figure 35 - 1616.020833 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: X

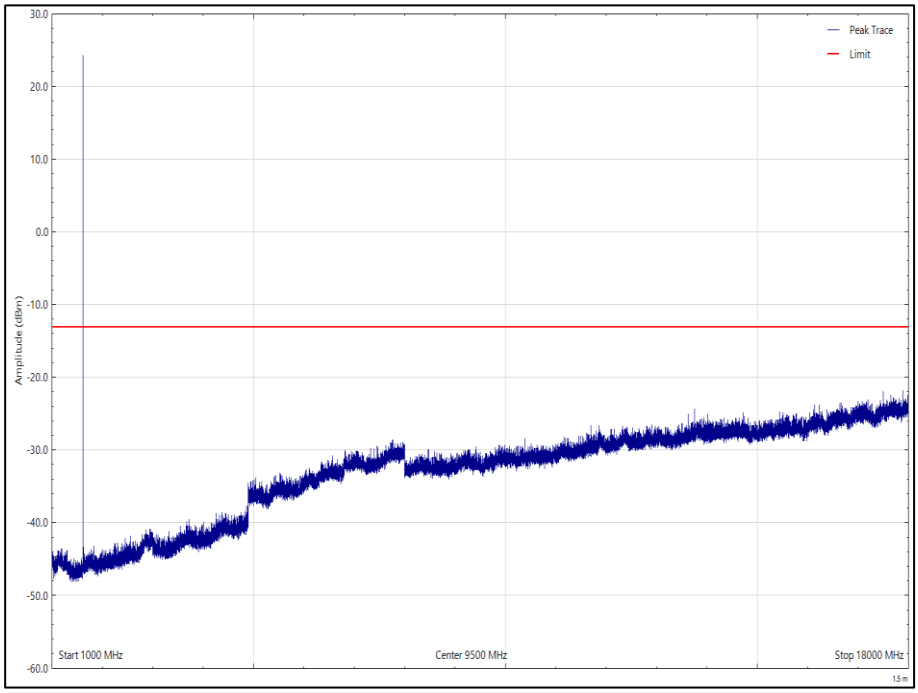


Figure 36 - 1616.020833 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: Y

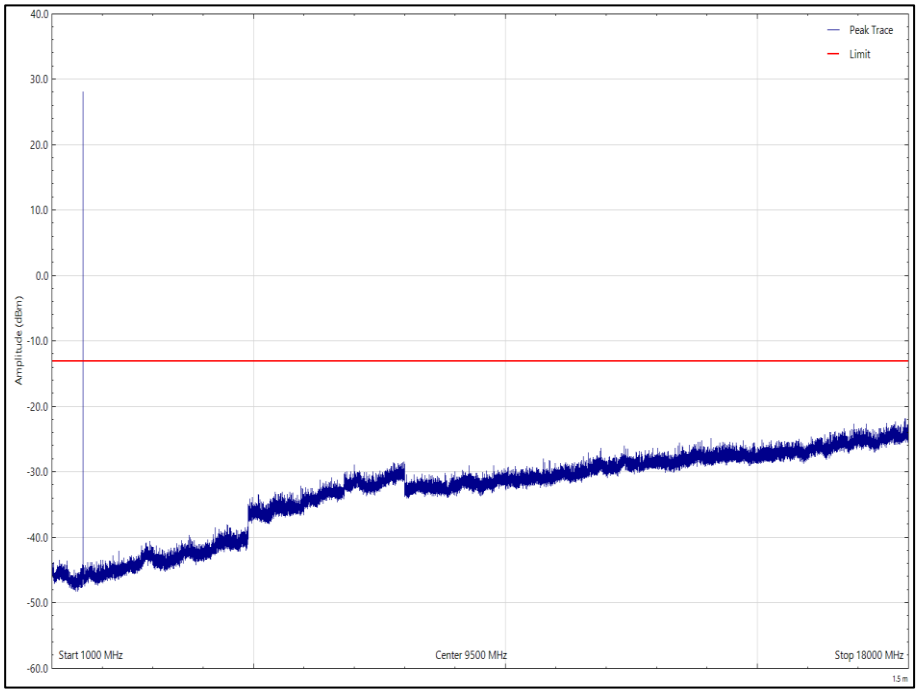


Figure 37 - 1616.020833 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: Y

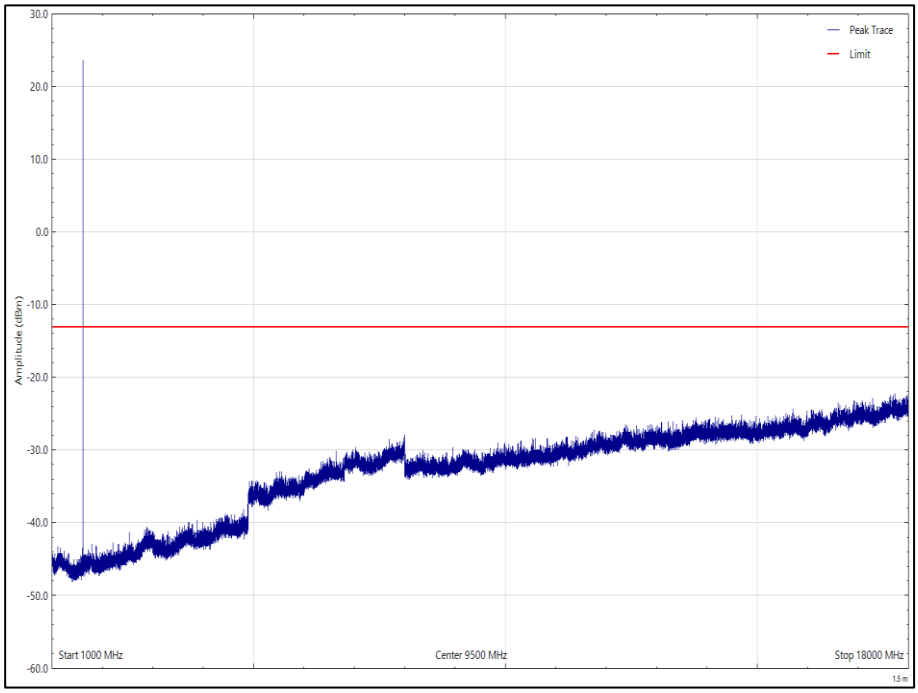


Figure 38 - 1616.020833 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: Z

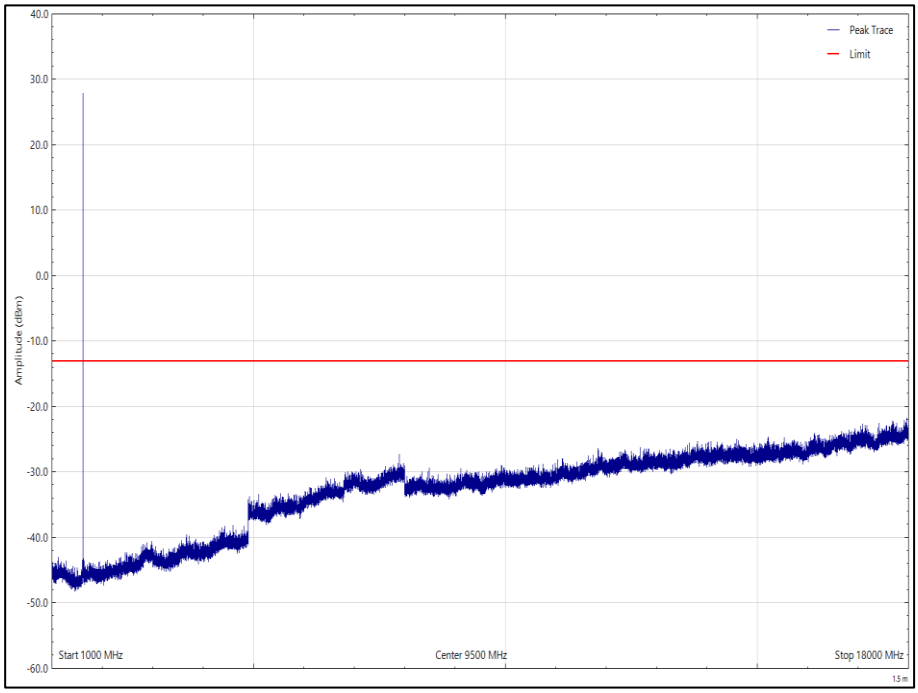


Figure 39 - 1616.020833 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: Z

Frequency (MHz)	Level (dBm)
*	

Table 26 - 1621.020833 MHz, 30 MHz to 1 GHz, Results Table

*No emissions were found within 10 dB of the limit.

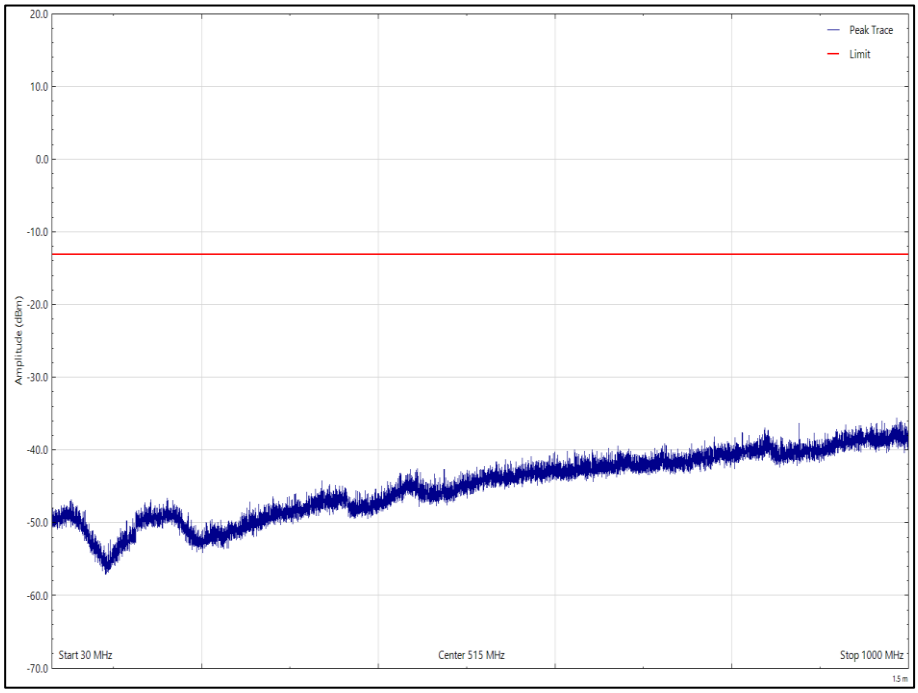


Figure 40 - 1621.020833 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: X

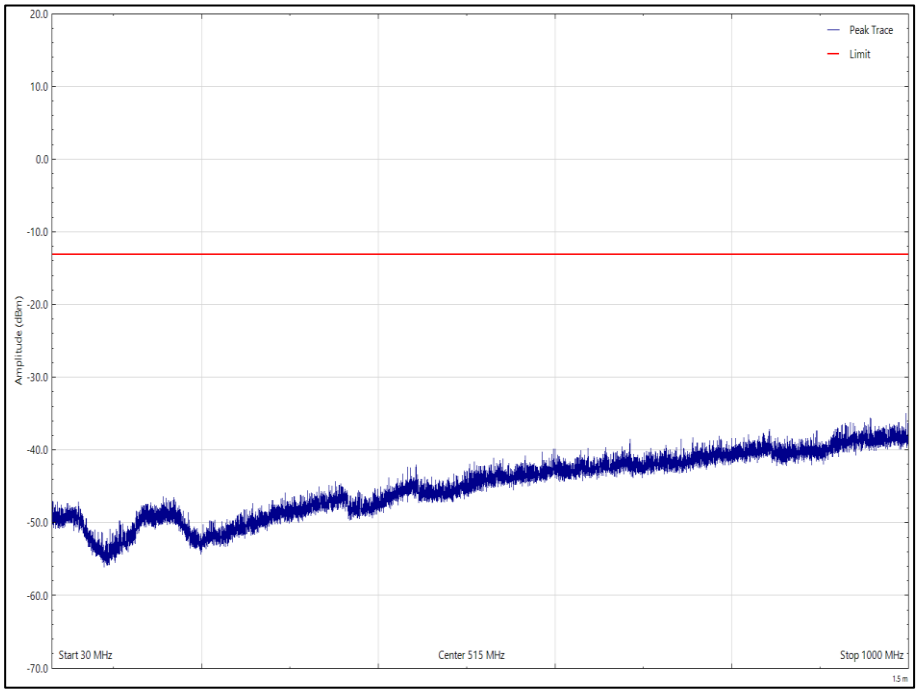


Figure 41 - 1621.020833 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: X

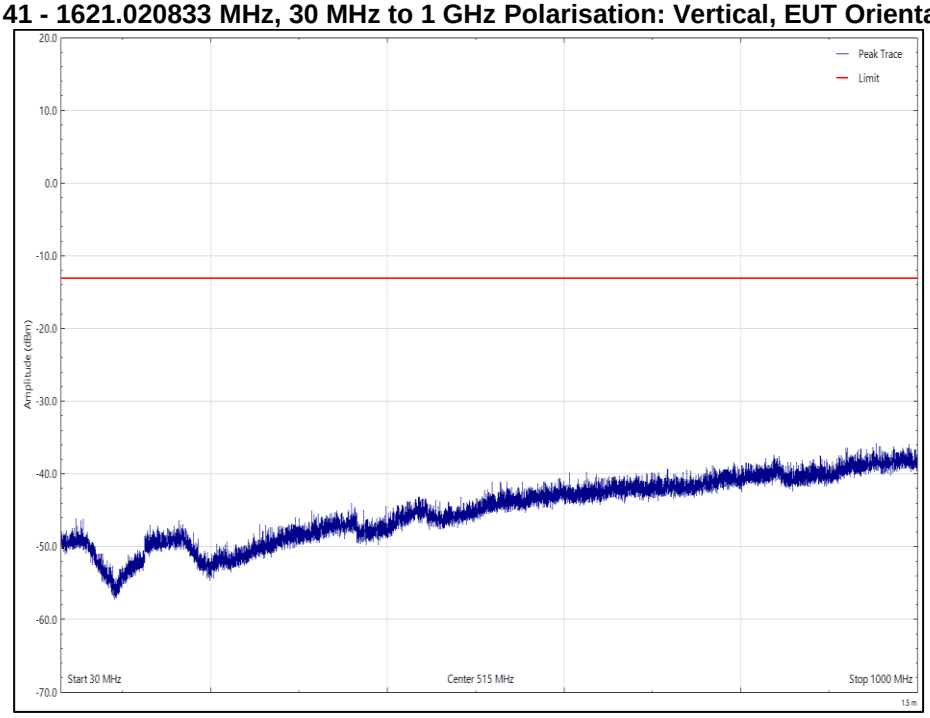


Figure 42 - 1621.020833 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: Y

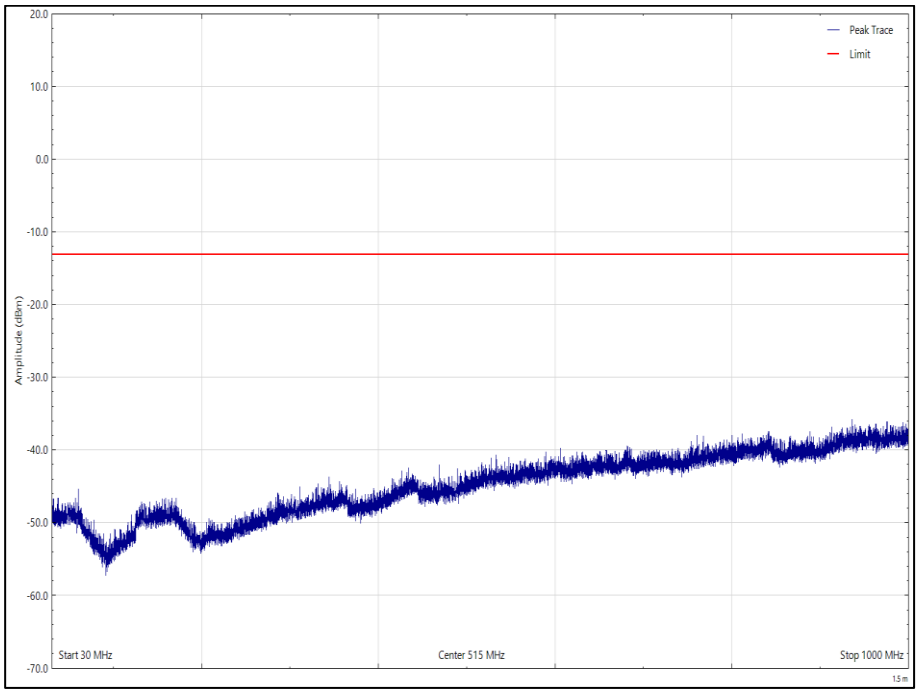


Figure 43 - 1621.020833 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: Y

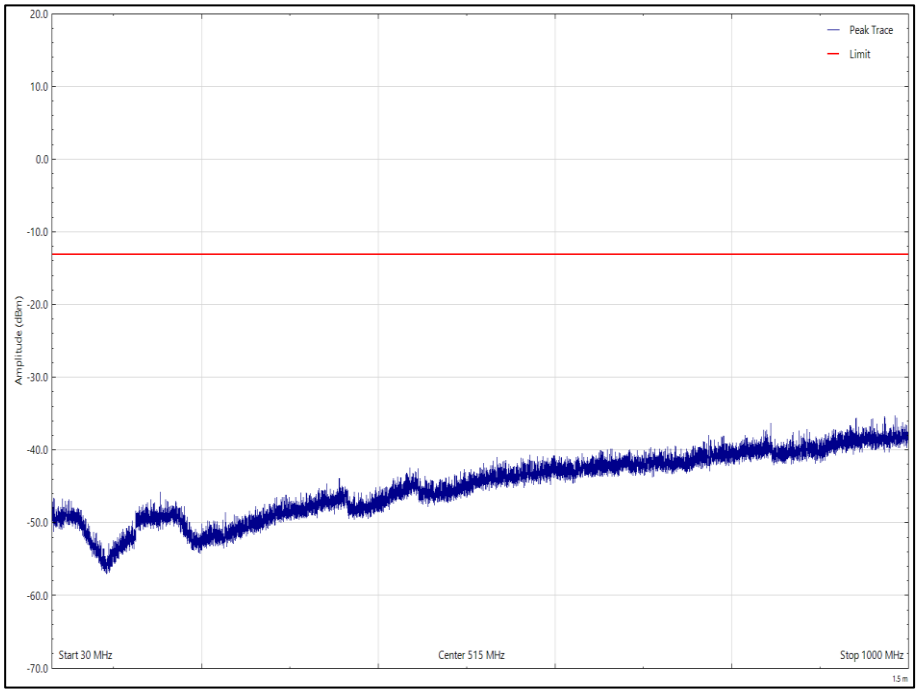


Figure 44 - 1621.020833 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: Z

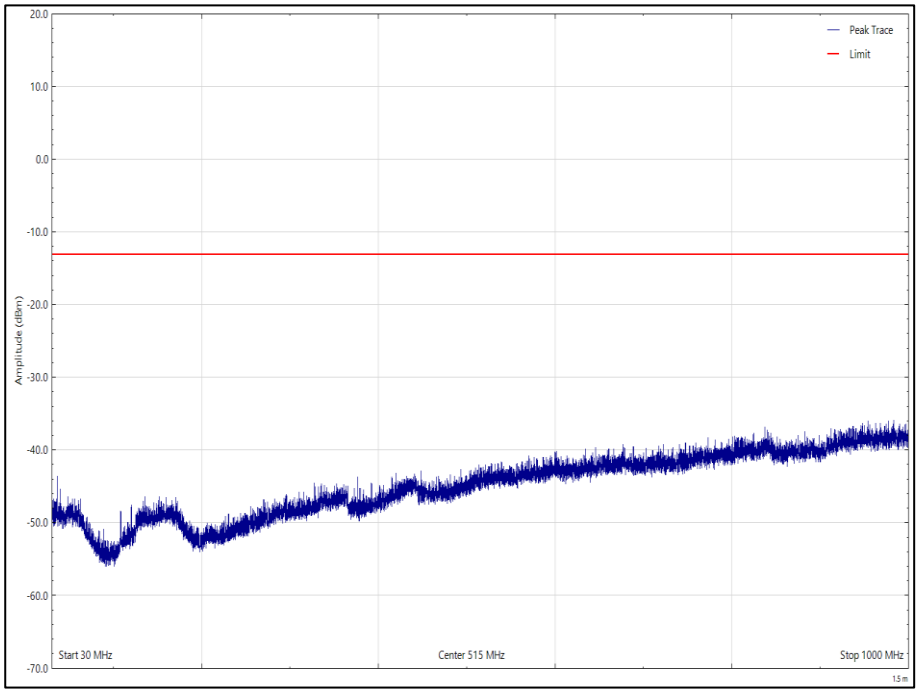


Figure 45 - 1621.020833 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: Z

Frequency (MHz)	Level (dBm)
*	

Table 27 - 1621.020833 MHz, 1 GHz to 18 GHz - Results Table

*No emissions were found within 10 dB of the limit.

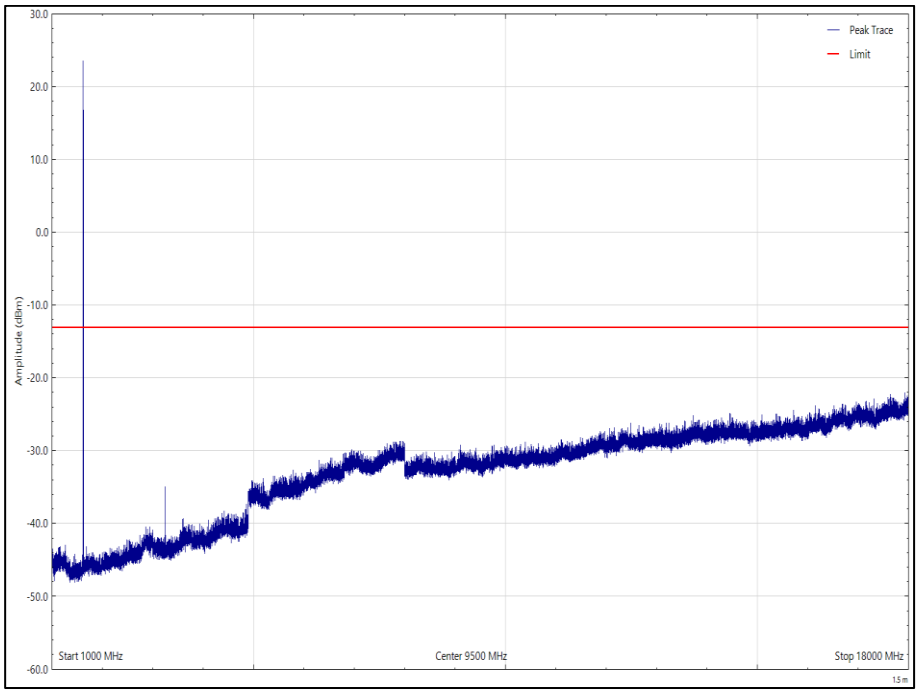


Figure 46 - 1621.020833 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: X

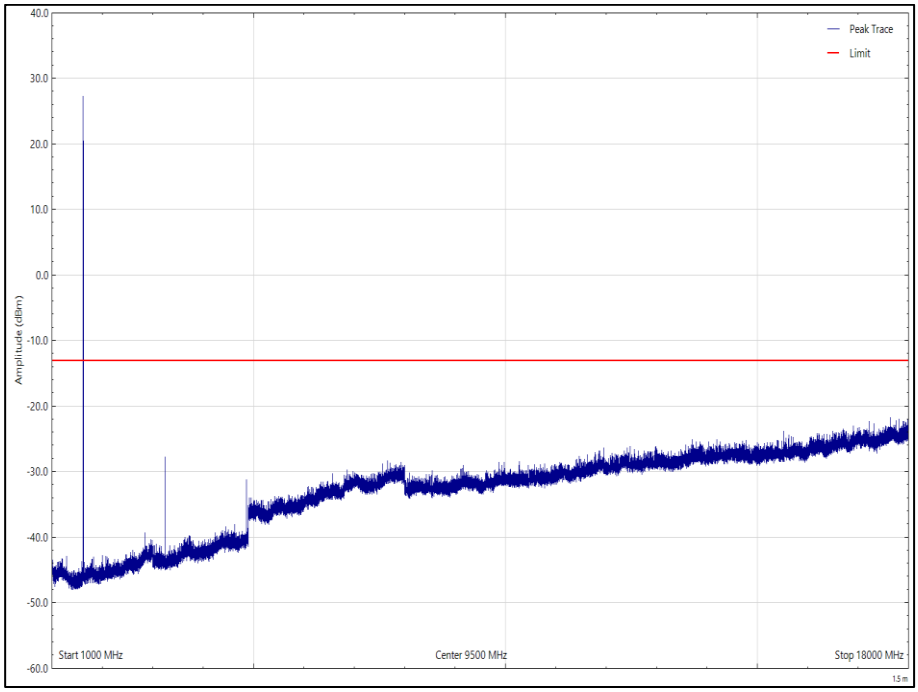


Figure 47 - 1621.020833 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: X

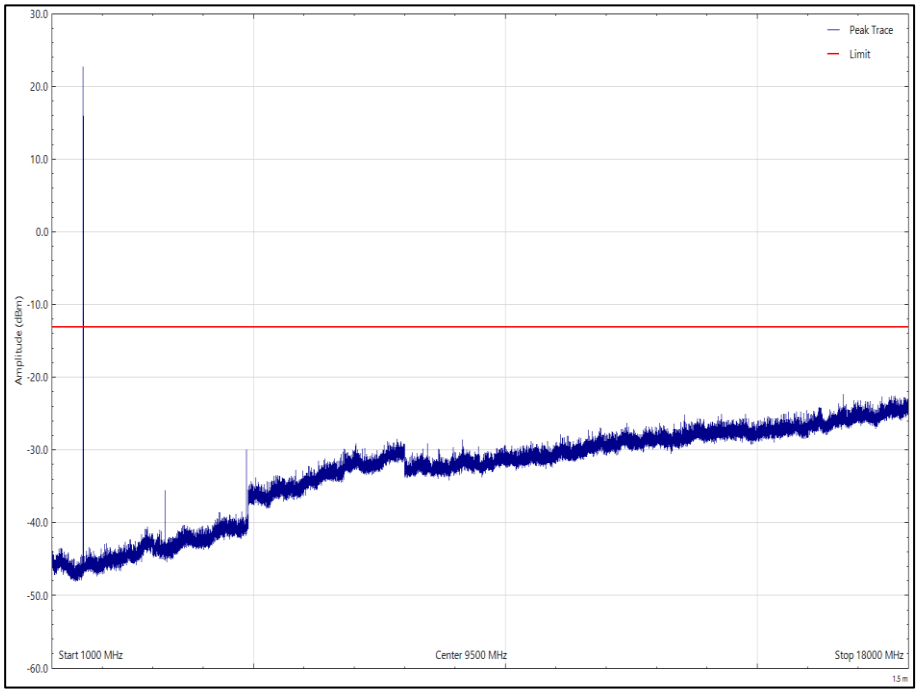


Figure 48 - 1621.020833 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: Y

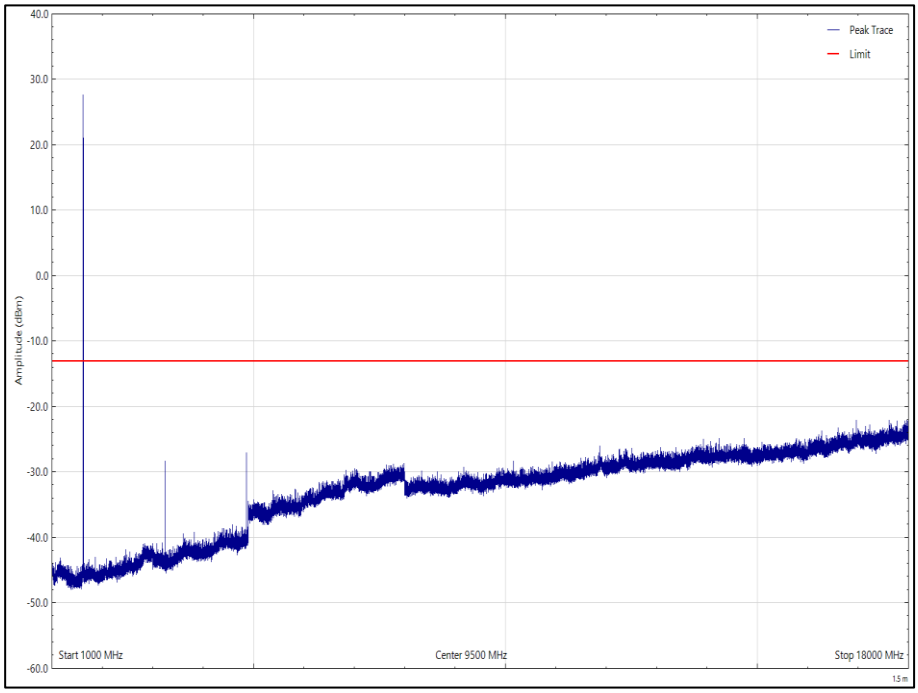


Figure 49 - 1621.020833 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: Y

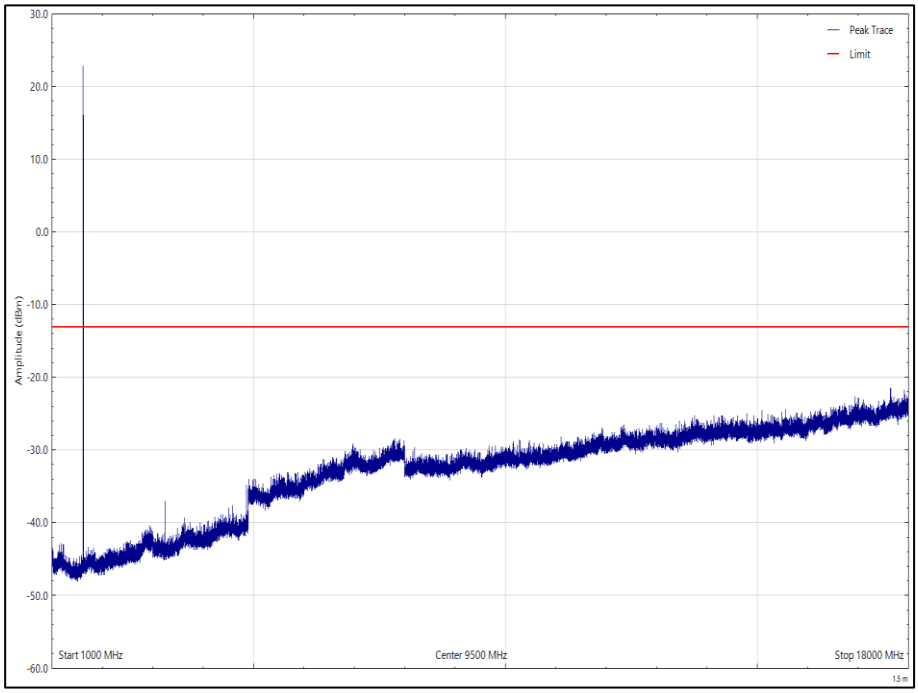


Figure 50 - 1621.020833 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: Z

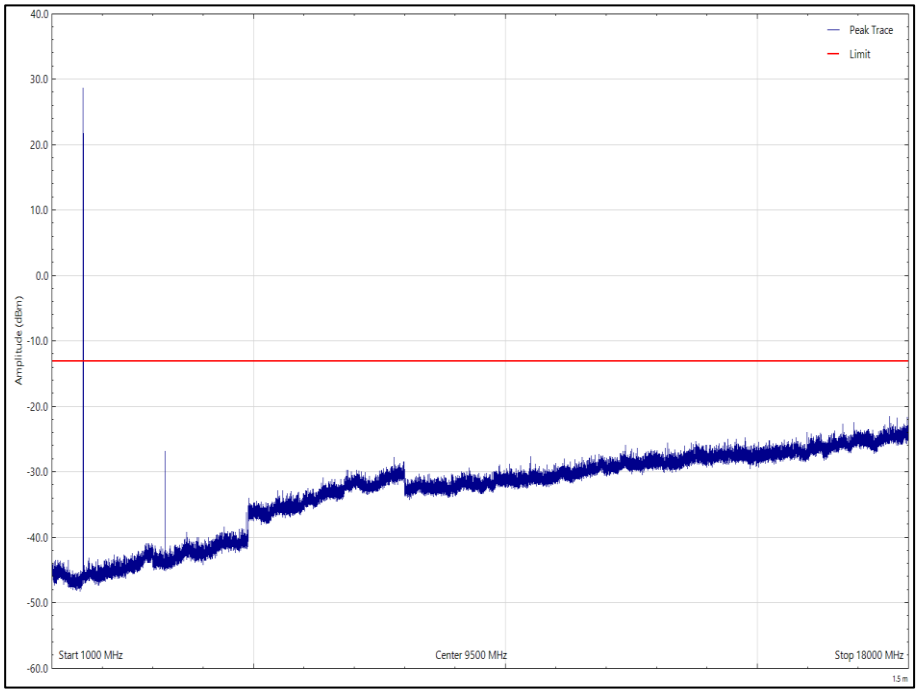


Figure 51 - 1621.020833 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: Z

Frequency (MHz)	Level (dBm)
*	

Table 28 - 1625.979167 MHz, 30 MHz to 1 GHz, Results Table

*No emissions were found within 10 dB of the limit.

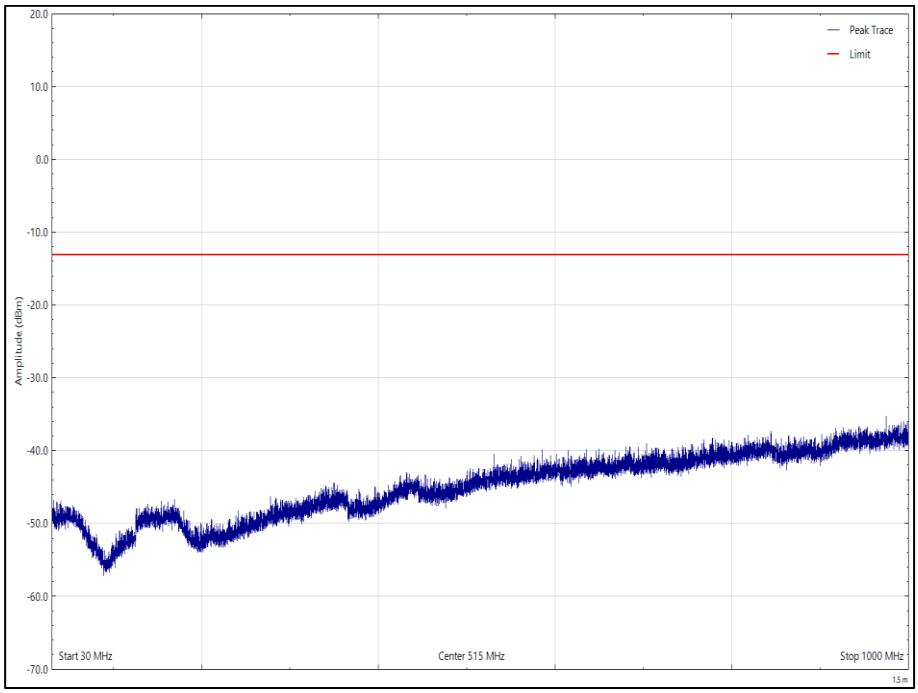


Figure 52 - 1625.979167 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: X

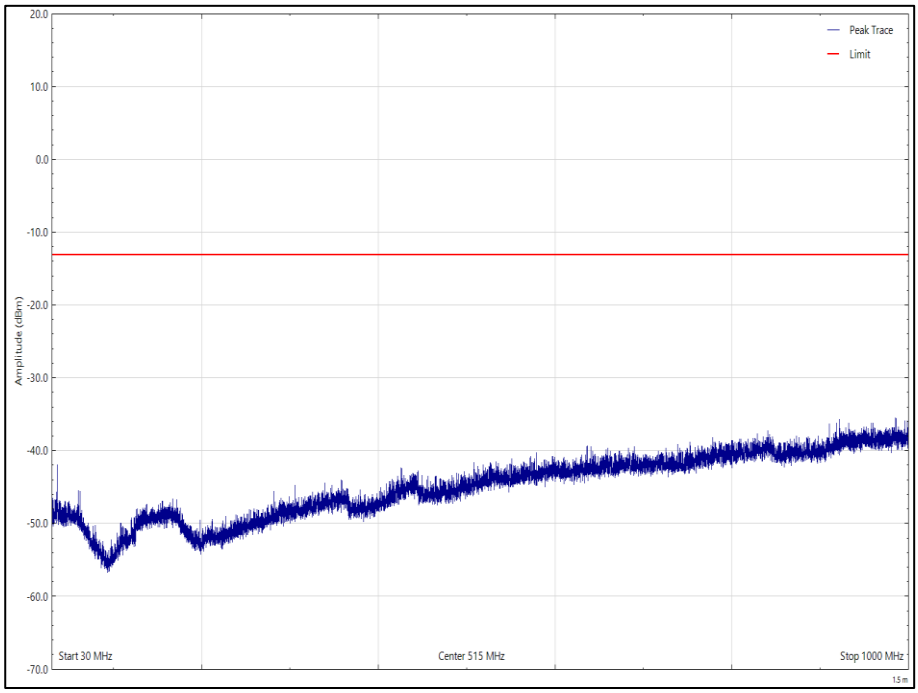


Figure 53 - 1625.979167 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: X

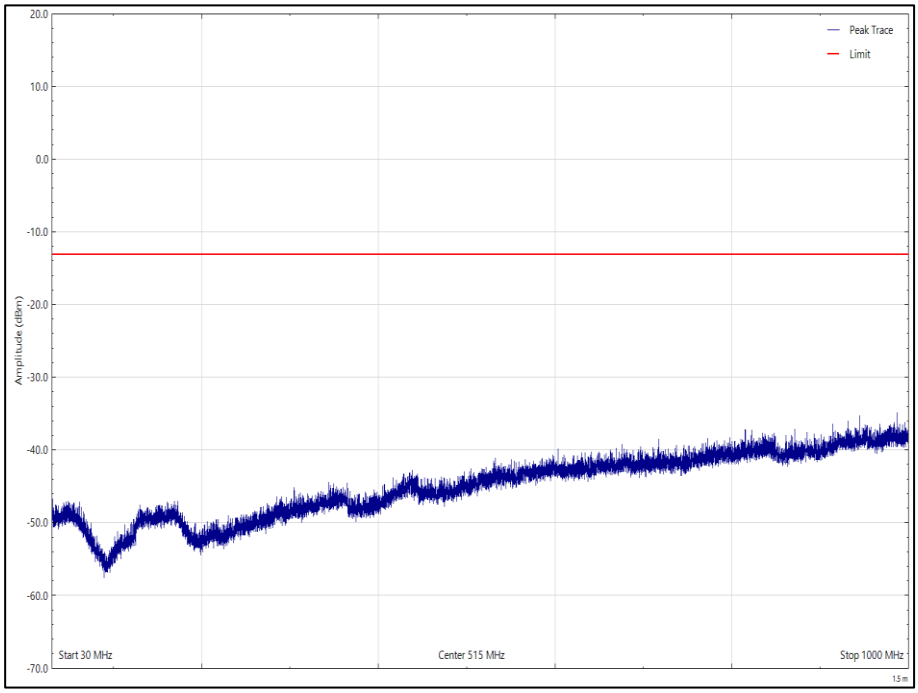


Figure 54 - 1625.979167 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: Y

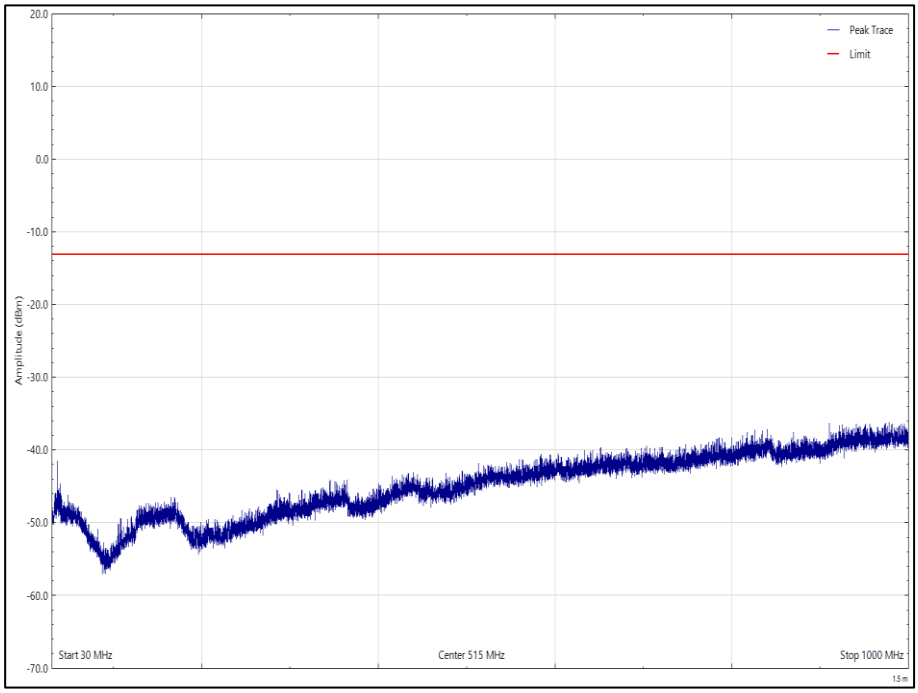


Figure 55 - 1625.979167 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: Y

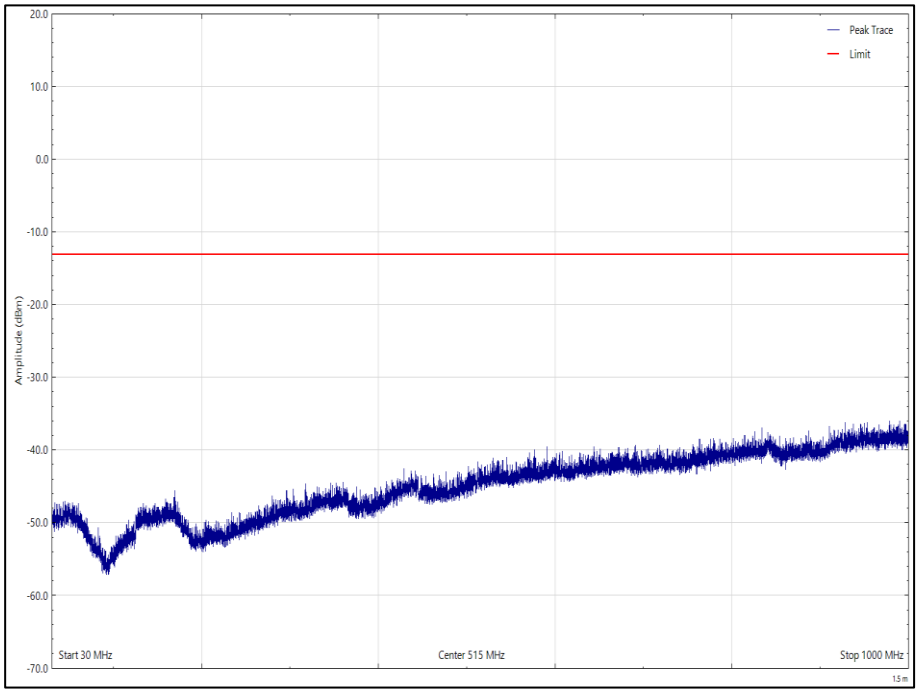


Figure 56 - 1625.979167 MHz, 30 MHz to 1 GHz Polarisation: Horizontal, EUT Orientation: Z

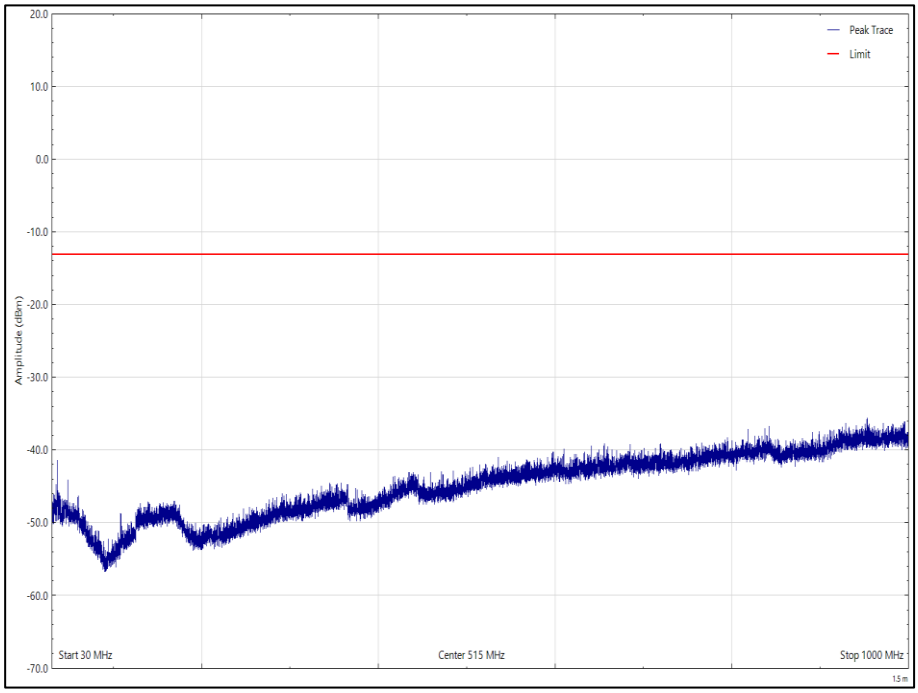


Figure 57 - 1625.979167 MHz, 30 MHz to 1 GHz Polarisation: Vertical, EUT Orientation: Z

Frequency (MHz)	Level (dBm)
*	

Table 29 - 1625.979167 MHz, 1 GHz to 18 GHz - Results Table

*No emissions were found within 10 dB of the limit.

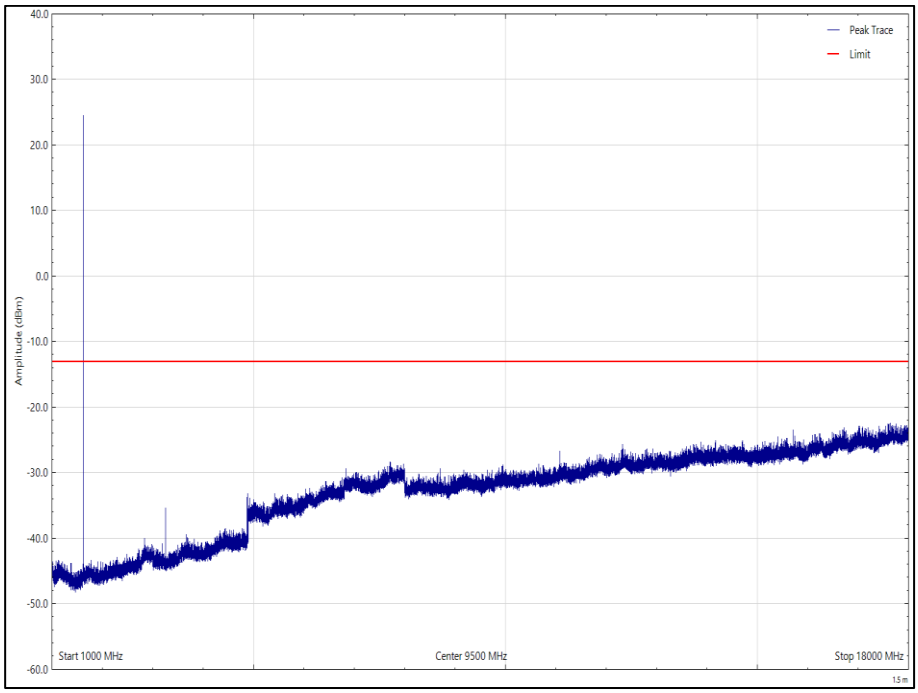


Figure 58 - 1625.979167 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: X

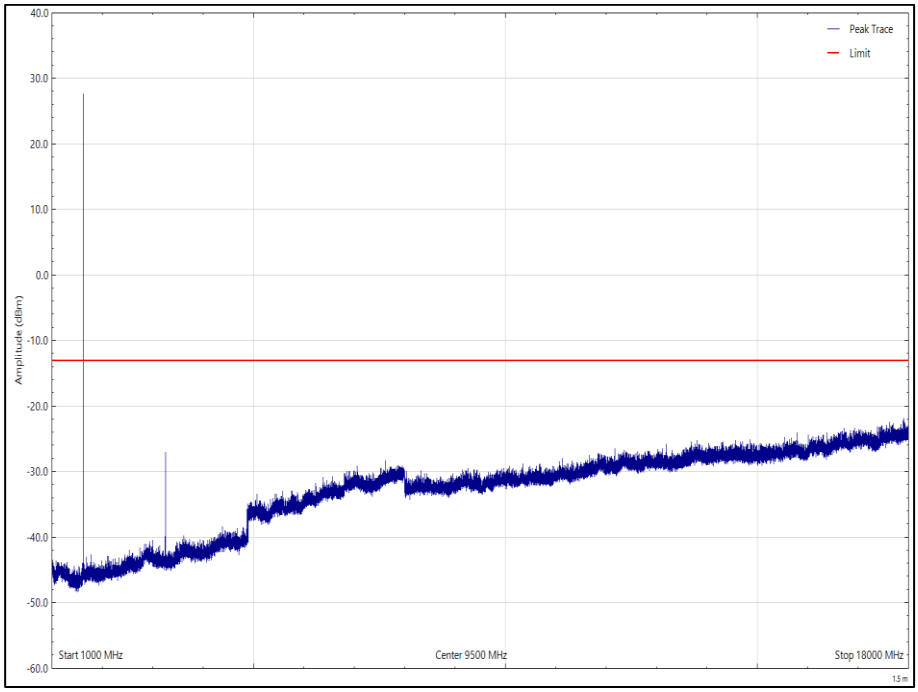


Figure 59 - 1625.979167 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: X

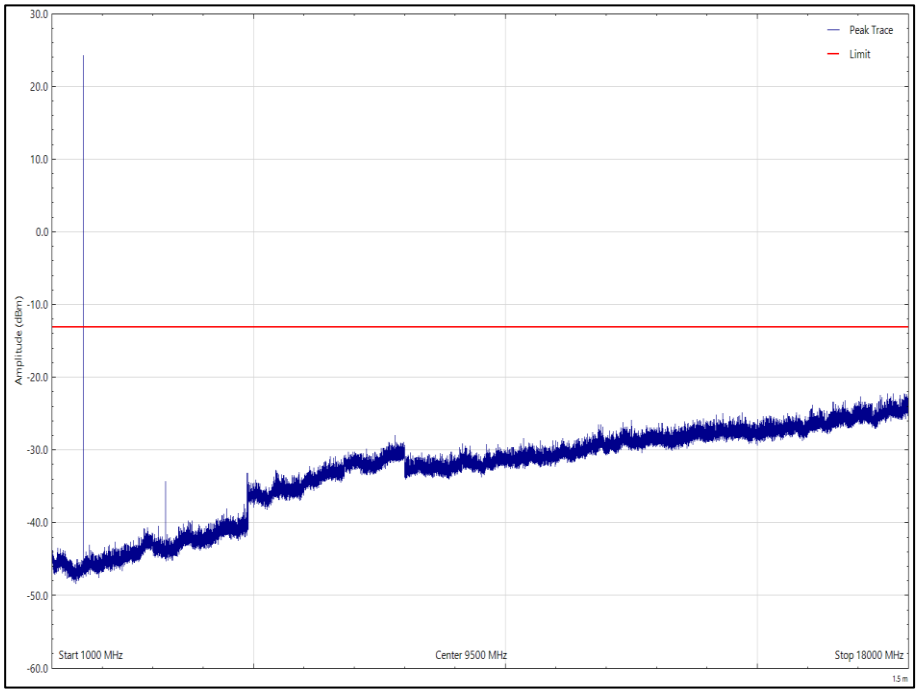


Figure 60 - 1625.979167 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: Y

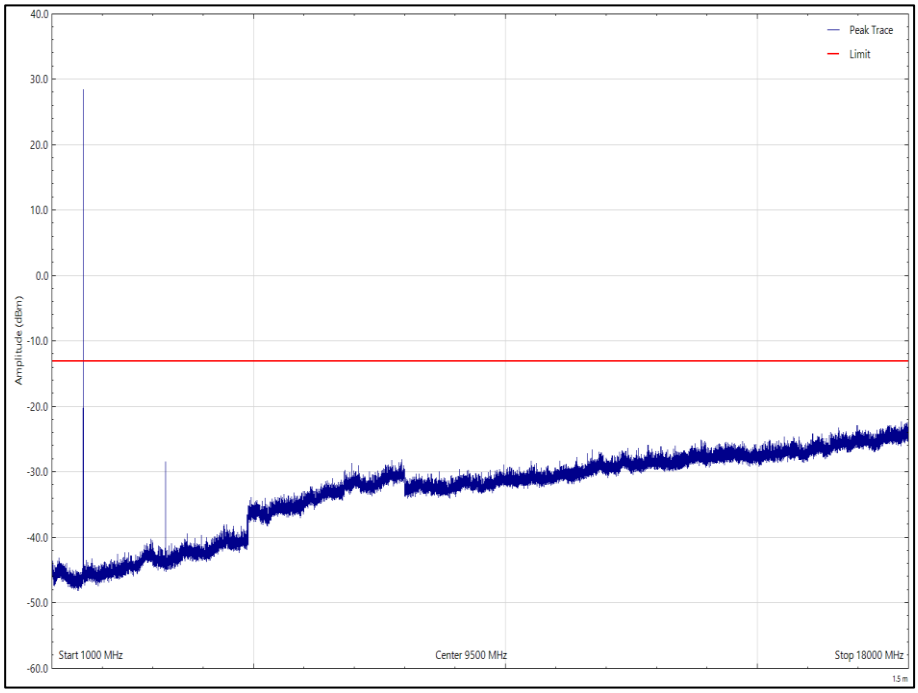


Figure 61 - 1625.979167 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: Y

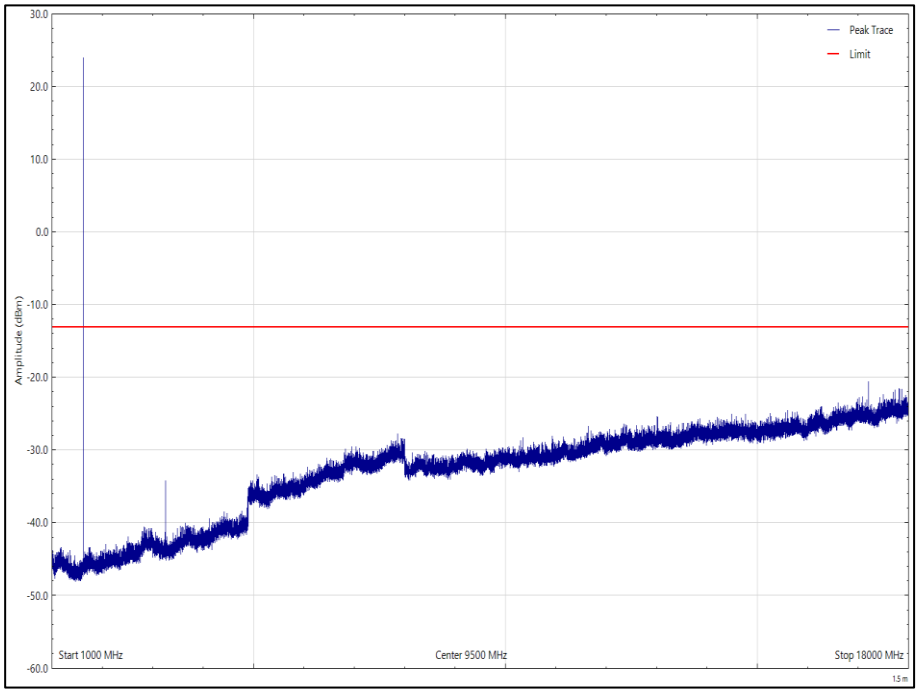


Figure 62 - 1625.979167 MHz - 1 GHz to 18 GHz Polarisation: Horizontal, EUT Orientation: Z

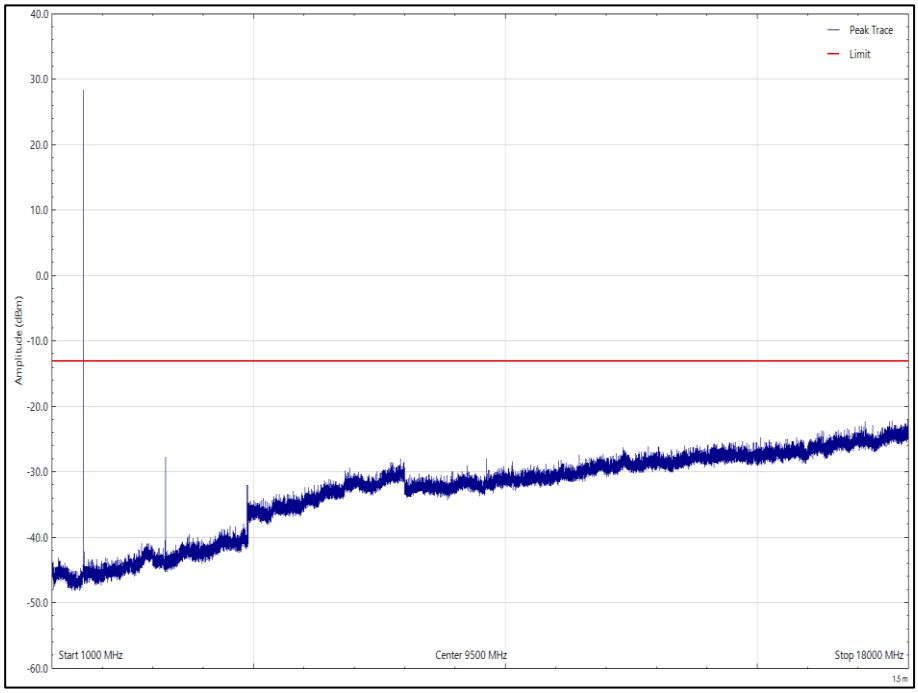


Figure 63 - 1625.979167 MHz - 1 GHz to 18 GHz Polarisation: Vertical, EUT Orientation: Z

FCC 47 CFR Part 2, Limit Clause 25.202(f)

The average power of unwanted emissions shall be attenuated below the average output power, P(dBW), of the transmitter, as specified below:

25 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 50%, up to and including 100% of the authorised bandwidth;
35 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 100%, up to and including 250% of the authorised bandwidth;
43 + 10 Log p (watts) in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 250% of the authorised bandwidth.

2.5.8 Test Location and Test Equipment Used

This test was carried out in RF Chamber 11.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Dual Power Supply Unit	Hewlett Packard	6253A	292	-	O/P Mon
True RMS Multimeter	Fluke	179	4007	12	18-Nov-2023
Test Receiver	Rohde & Schwarz	ESW44	5084	12	12-Jul-2023
Emissions Software	TUV SUD	EmX V3.1.12 V.	5125	-	N/A - Software
Screened Room (11)	Rainford	Rainford	5136	36	24-Nov-2024
Mast	Maturo	TAM 4.0-P	5158	-	TU
Mast and Turntable Controller	Maturo	Maturo NCD	5159	-	TU
Turntable	Maturo	TT 15WF	5160	-	TU
Antenna (DRG, 7.5 GHz to 18 GHz)	Schwarzbeck	HWRD750	5216	12	29-May-2023
3 GHz High pass filter	Wainwright	WHKX12-2580-3000-18000-80SS	5220	12	28-Mar-2024
Thermo-Hygro-Barometer	PCE Instruments	OCE-THB-40	5470	12	20-Apr-2024
Cable (SMA to SMA, 2 m)	Junkosha	MWX221-02000AMSAMS/A	5518	12	14-Apr-2024
Cable (N-Type to N-Type, 8 m)	Junshoka	MWX221-08000NMSNMS/B	5522	12	14-Apr-2024
Antenna (DRG, 1 GHz to 10.5 GHz)	Schwarzbeck	BBHA9120B	5611	12	16-Oct-2023
Antenna (Tri-log, 30 MHz to 1 GHz)	Schwarzbeck	VULB 9168	5942	24	03-Feb-2024
Attenuator (4 dB)	Pasternack	PE7074-4	6202	24	16-Jul-2024

Table 30

O/P Mon – Output Monitored using calibrated equipment
TU - Traceability Unscheduled

2.6 Frequency Tolerance

2.6.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1055
FCC 47 CFR Part 25 Clause 25.202(d)

2.6.2 Equipment Under Test and Modification State

Q4000, S/N: KQ3500000516 - Modification State 0

2.6.3 Date of Test

26-May-2023 to 29-May-2023

2.6.4 Test Method

This test was performed in accordance with ANSI C63.26 clause 5.6.

2.6.5 Environmental Conditions

Ambient Temperature	22.6 - 23.1 °C
Relative Humidity	40.7 %

2.6.6 Test Results

Iridium - Transceive

Frequency Stability over Variation in Temperature

Test Condition	1621.020833 MHz	
Temperature	Frequency Error (%)	Frequency Error (ppm)
-30°C	0.000055214	0.552135
-20°C	0.000049661	0.496613
-10°C	0.000030846	0.308456
0°C	0.000040716	0.407161
10°C	0.000064467	0.644672
20°C	0.000052129	0.521290
30°C	0.000045035	0.450345
40°C	0.000040099	0.400992
50°C	0.000047194	0.471937

Table 31

Frequency Stability when Varying Supply Voltage

Test Condition	1621.020833 MHz	
Supply Voltage	Frequency Error (%)	Frequency Error (ppm)
9V DC	0.000037632	0.376316
24V DC	0.000037323	0.373231
32V DC	0.000038248	0.382485

Table 32

FCC 47 CFR Part 25, Limit Clause 25.202(d)

The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent of the reference frequency.

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
Multimeter	Iso-tech	IDM101	2424	12	20-Feb-2024
Hygrometer	Rotronic	I-1000	3220	12	15-Nov-2023
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	13-Jul-2023
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	21-Mar-2024
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	5759	12	5-Jul-2023
Modular Power System Mainframe	Keysight Technologies	N6701C	5835	-	TU
Meter	ETI Ltd	Therma Elite	6326	12	27-Mar-2024

Table 33

O/P Mon – Output Monitored using calibrated equipment
TU - Traceability Unscheduled

2.7 Limits on Emissions from Mobile Earth Stations for Protection of Aeronautical Radionavigation-Satellite Service

2.7.1 Specification Reference

FCC 47 CFR Part 25, Clause 25.216

2.7.2 Equipment Under Test and Modification State

Q4000, S/N: KQ3500000516 - Modification State 0

2.7.3 Date of Test

21-June-2023

2.7.4 Test Method

This test was performed in accordance with ANSI C63.26 clause 5.7.

2.7.5 Environmental Conditions

Ambient Temperature	22.1 °C
Relative Humidity	62.8 %

2.7.6 Test Results

Iridium - Transceiver

Frequency (MHz)	Level (dBW)
*	

Table 34

*No emissions were detected within 6 dB of the limit.

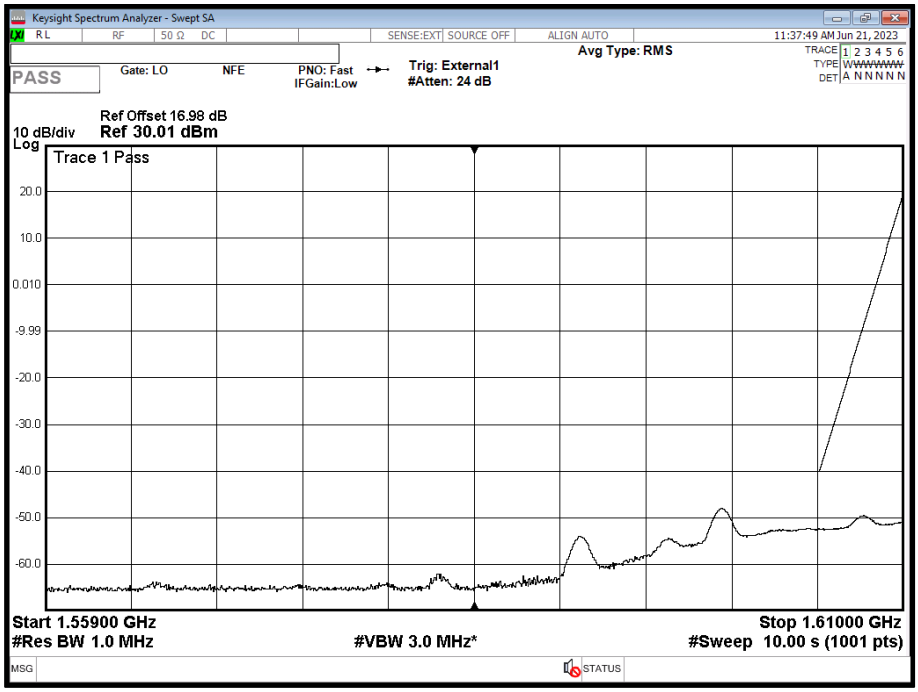


Figure 64 – 1616.020833 MHz - Broadband Emission Results

Frequency (MHz)	Level (dBW)
1599.2227	-84.9

Table 35

No other emissions were detected within 6 dB of the limit.

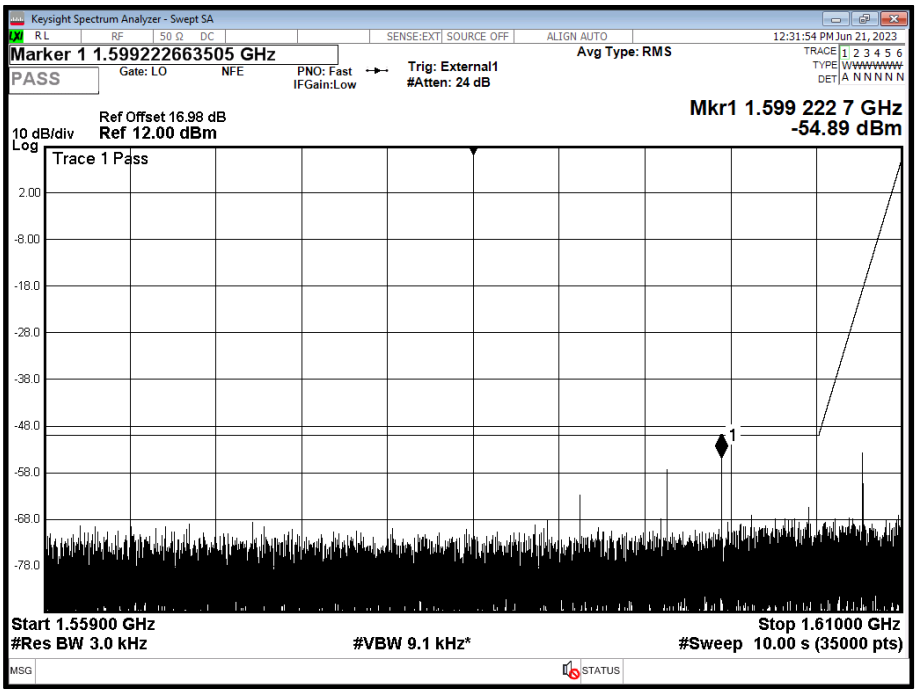


Figure 65 – 1616.020833 MHz - Discrete Emission Results

Frequency (MHz)	Level (dBW)
*	

Table 36

*No emissions were detected within 6 dB of the limit.

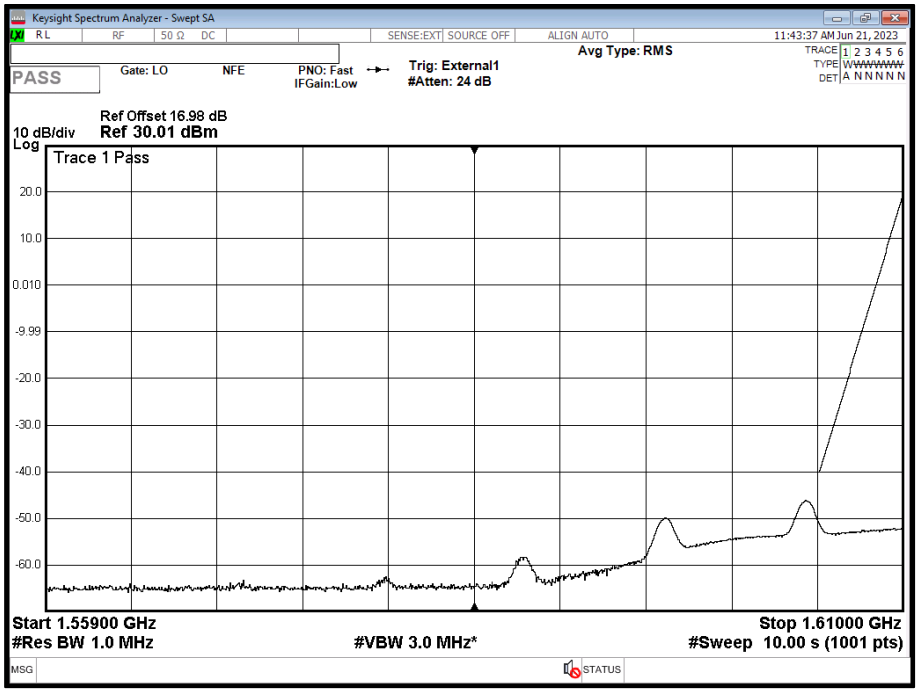


Figure 66 – 1621.020833 MHz - Broadband Emission Results

Frequency (MHz)	Level (dBW)
1604.2179	-84.3

Table 37

No other emissions were detected within 6 dB of the limit.

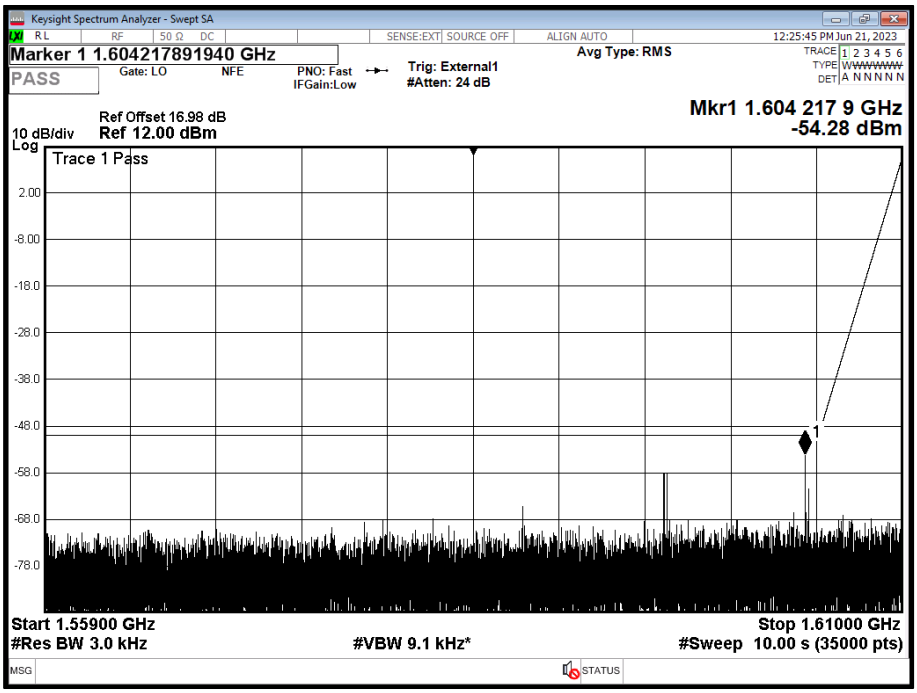


Figure 67 – 1621.020833 MHz - Discrete Emission Results

Frequency (MHz)	Level (dBW)
*	

Table 38

*No emissions were detected within 6 dB of the limit.

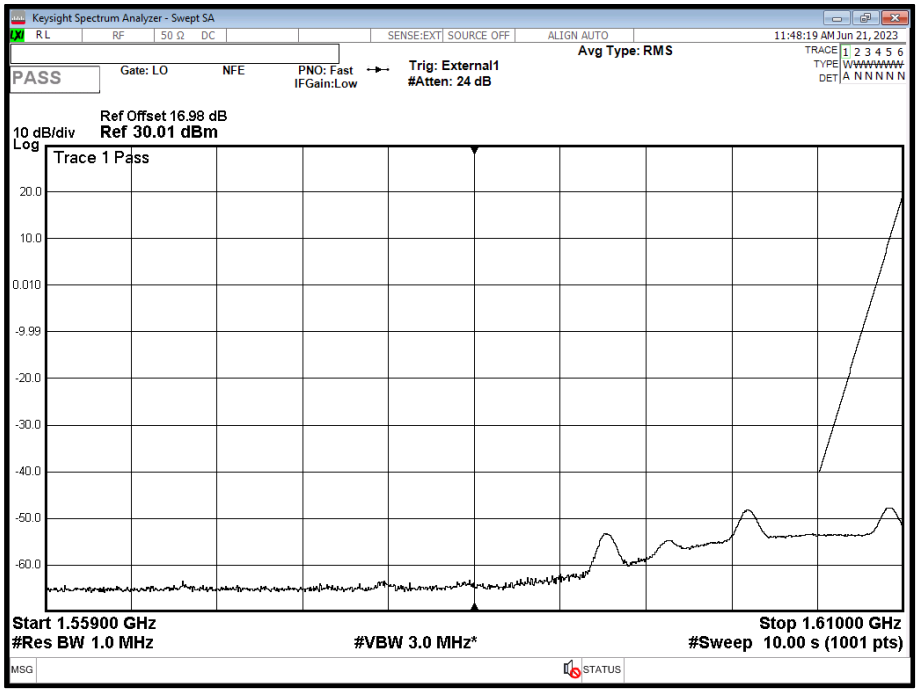


Figure 68 – 1625.979167 MHz - Broadband Emission Results

Frequency (MHz)	Level (dBW)
1600.7775	-85.9

Table 39

No other emissions were detected within 6 dB of the limit.

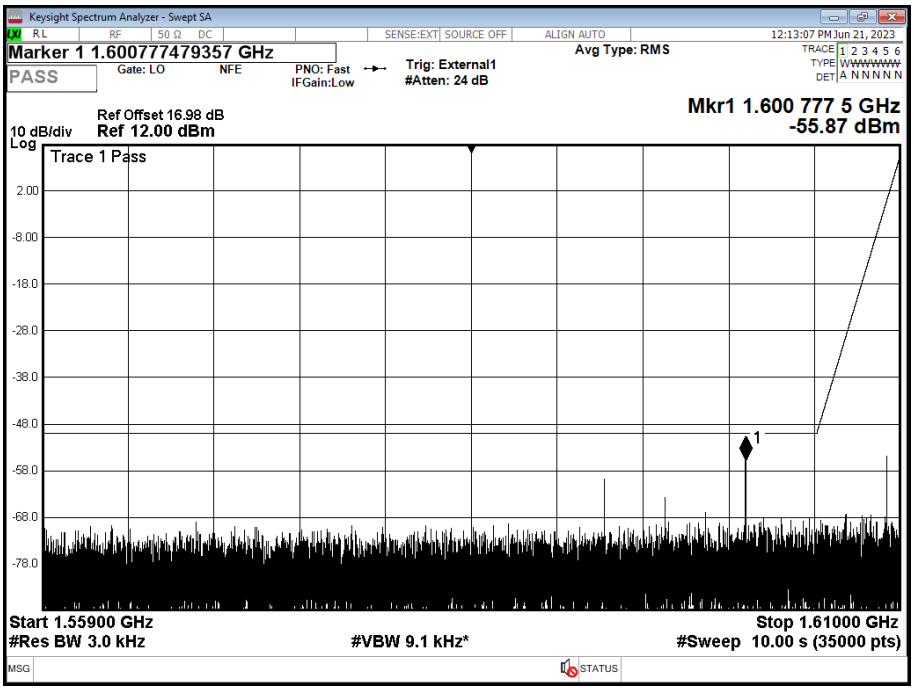


Figure 69 – 1625.979167 MHz - Discrete Emission Results

Frequency (MHz)	Level (dBW)
*	

Table 40

*No emissions were detected within 10 dB of the limit.

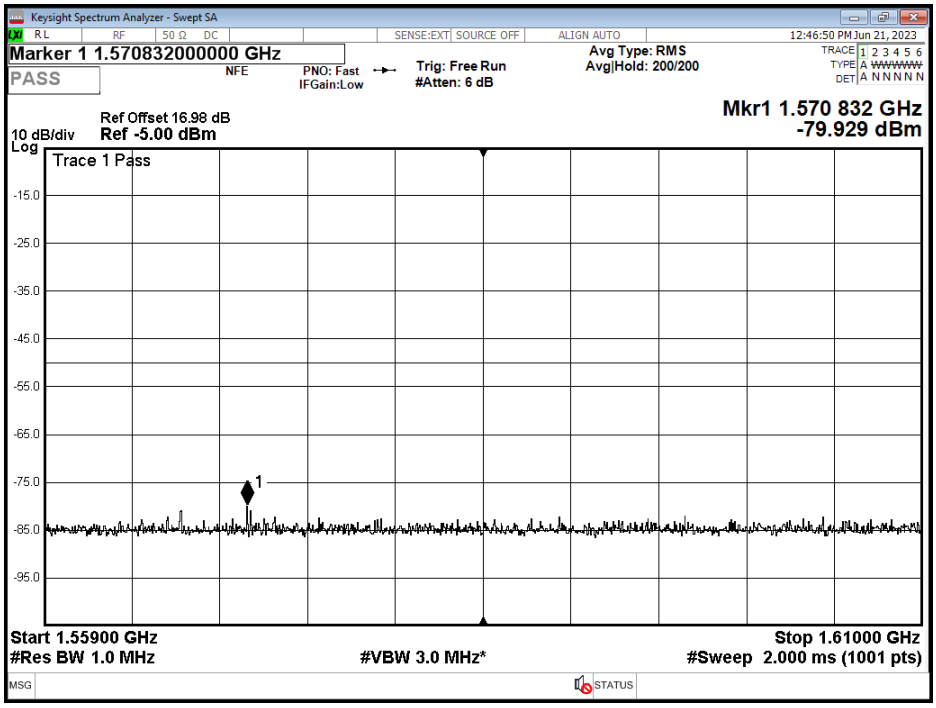


Figure 70 - Carrier-off state

FCC 47 CFR Part 25, Limit Clause 25.216

25.216(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.

25.216(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-millisecond active transmission interval.

25.216(i) The e.i.r.p density of carrier-off state emissions from 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 between 1 and 3 GHz shall not exceed -80 dBW/MHz in the 1559–1610 MHz band averaged over any 2-millisecond interval.

2.7.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Dual Power Supply Unit	Hewlett Packard	6253A	271	-	O/P Mon
Crystal Detector	Hewlett Packard	8470B	1320	12	16-Jan-2024
Multimeter	Iso-tech	IDM101	2424	12	20-Feb-2024
HygroPalm	Rotronic	HygroPalm 0	3484	12	30-Aug-2023
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	06-Mar-2024
Combiner/Splitter	Weinschel	1506A	3877	12	08-Aug-2023
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2024
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	13-Jul-2023
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	16-Jan-2024
Attenuator 5W 10dB DC-18GHz	Aaren	AT40A-4041-D18-10	5493	12	18-Apr-2024

Table 41

O/P Mon – Output Monitored using calibrated equipment

3 Photographs

3.1 Test Setup Photographs

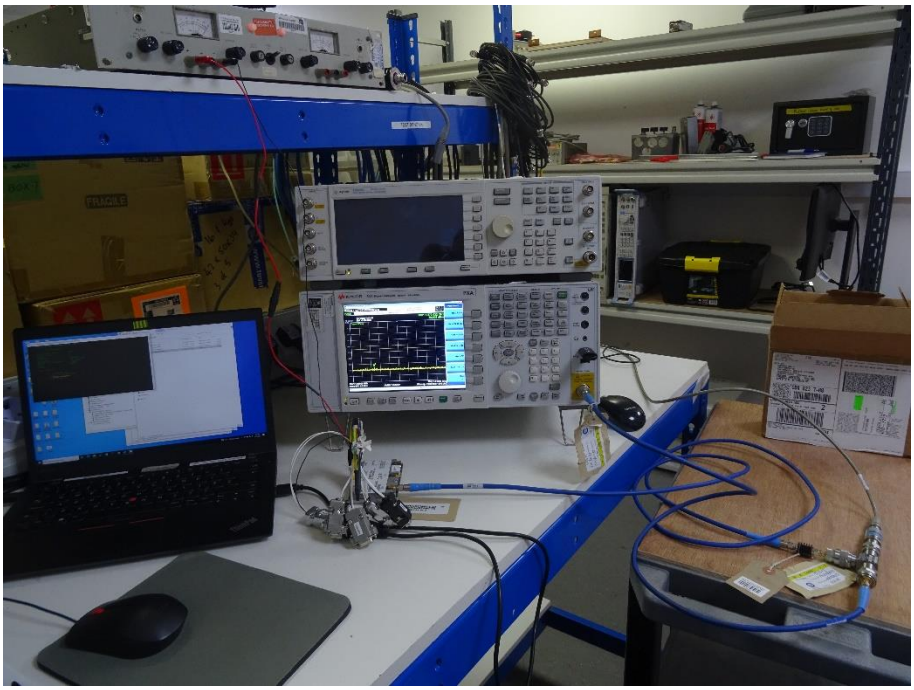


Figure 71 – Photograph of the Equipment Under Test

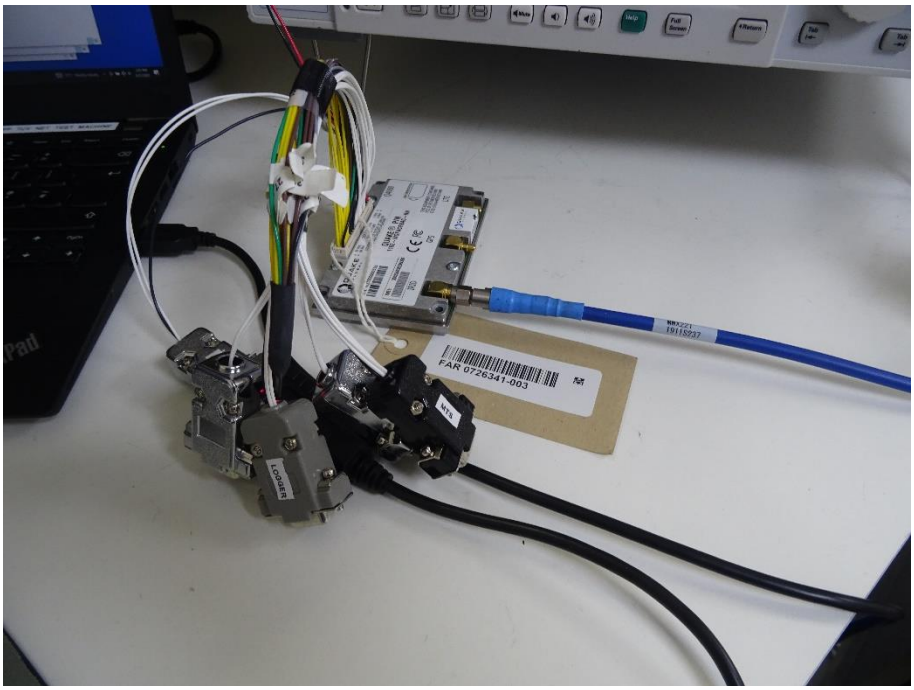


Figure 72 - Photograph of the Equipment Under Test

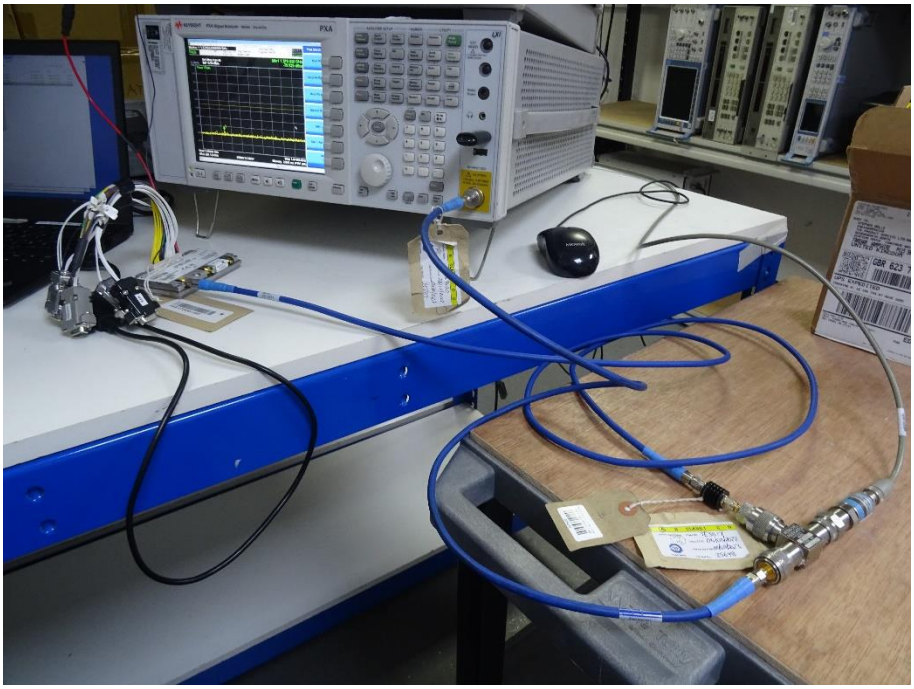


Figure 73 - Photograph of the Equipment Under Test

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Modulation Characteristics	-
Occupied Bandwidth	± 16.74 kHz
Spurious Emissions at Antenna Terminals	± 3.08 dB
Radiated Spurious Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 18 GHz: ± 6.3 dB
Frequency Tolerance	± 3.54 Hz
Equivalent Isotropic Radiated Power	Conducted: ± 3.2 dB Radiated: ± 6.3 dB (1 GHz to 18 GHz)
Limits on Emissions from Mobile Earth Stations for Protection of Aeronautical Radionavigation-Satellite Service	Radiated: ± 6.3 dB Conducted: ± 3.45 dB

Table 42

Measurement Uncertainty Decision Rule – Accuracy Method

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115:2021, Clause 4.4.3 (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.