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EMC-EMF Safety Approvals

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RADIO REPORT FOR CERTIFICATION
to
47 CFR Part 25 Subpart C
Satellite Communications

FCC ID: YP9CIOF1701

Device under Test / PMN: Thuraya WE
Model Number / HVIN: CIOF1701
Tested For: Beam Communications

Report Number: M161205-2R1
(This report supersedes M161205-2)
Issue Date: 07 August 2017

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RADIO REPORT FOR CERTIFICATION

47 CFR Part 25 Subpart C Satellite Communications

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RADIO REPORT FOR CERTIFICATION

Issued by: EMC TECHNOLOGIES PTY. LTD.

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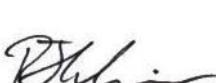
FCC registration number: 90560 and ISED Canada iOATS number: IC 3569B

Device under Test: Thuraya WE**Model Number / HVIN:** CIOF1701**Manufacturer:** Beam Communications**FCC ID:** YP9CIOF1701**Tested for:** Beam Communications**Address:** Unit 5, 8 Anzed Crt, Mulgrave

Victoria 3170, AUSTRALIA

Phone: +61 (0)3 985884500**Contact:** Greg Incoll

greg.incoll@beamcommunications.com.au

Standards: **47 CFR Part 25 – Satellite Communications**
Subpart C – Technical Standards**Test Dates:** 21 June to 11 July 2017**Issue Date:** 07 August 2017**Attestation:** I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.**Test Engineer:**_____
William Alam
EMC Test Engineer**Checked By:**_____
Rob Weir
Wireless Certification Manager
EMC TECHNOLOGIES PTY. LTD.

RADIO REPORT FOR CERTIFICATION
to
47 CFR Part 25 Subpart C

1.0 INTRODUCTION

Radio tests were performed on the CIOF1701 Thuraya WE in accordance with the applicable requirements of 47 CFR, Part 25 Subpart C for a 1.5/1.6 GHz Mobile-Satellite Service.

1.1 Test Procedure

Radio measurements were performed in accordance with the appropriate procedures of ANSI C63.26: 2015.

The measurement instrumentation conformed to the requirements of ANSI C63.2: 2009.

1.2 Summary of 47 CFR Part 25 Subpart C

FCC Part 25 Subpart C	Test Performed	Results
25.202 (a)	Frequency Band	1.5 / 1.6 GHz
25.202 (d)	Frequency Tolerance	Complied
25.202 (f)	Emission Limitations	Complied
25.204	Power Limits for Earth stations	Complied – 16.1 dBW
25.216	Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service	Complied
2.1049	Occupied Bandwidth	220 kHz

1.3 Modifications

No modifications were performed.

2.0 GENERAL INFORMATION

(Information supplied by the Client)

2.1 EUT (Transmitter) Details

Radio Module:	AFTERBURNER Satellite Transceiver
Operating Band:	1626.5 MHz to 1660.5 MHz
Modulation type:	Pi/4 CQPSK
Nominal Channel Bandwidth:	27.7 kHz
Antenna:	Directive Stacked Patch
Antenna Assembly Gain:	11.1 dBi
Operating Temperature Range:	-20°C to +55°C (-4°F to +131°F)

2.2 EUT (Host) Details

Device under Test / PMN:	Thuraya WE
Model Number / HVIN:	CIOF1701
Manufacturer:	Beam Communications
Power Supply:	Internal 7.4 volt battery or external AC plug pack with 12 VDC output.

The Cioffi device accesses the Thuraya satellite network while at the same time establishing a Wi-Fi link to a Smartphone. This allowed the user (via a propriety application) to place calls from their Smartphone that are then routed via the satellite network. The device also incorporates a cellular modem which can operate in the same manner if a network is present.

2.3 Test Configuration

An engineering mode was accessible allowing for programming of the radio enabling channel selection. The sample would transmit continuously with typical modulation on the programmed channel.

2.4 Test Facility

2.4.1 General

EMC Technologies Pty Ltd is listed by the FCC as a test laboratory able to perform compliance testing for the public. EMC Technologies is listed as an FCC part 47CFR 2.948 test lab – **FCC Registration Number 90560**.

EMC Technologies indoor open air test site (iOATS) have been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS-Gen, Issue 8 - **Industry Canada iOATS number - IC 3569B**

Measurements in this report were performed at EMC Technologies' laboratory in Keilor Park, Victoria Australia.

2.4.2 NATA Accreditation

NATA is the Australian National laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A²LA).

EMC Technologies is accredited in Australia by the National Association of Testing Authorities (NATA). All testing in this report has been conducted in accordance with EMC Technologies' scope of NATA accreditation.

The current full scope of accreditation can be found on the NATA website: www.nata.asn.au



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2.5 Test Equipment Calibration

Measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI) or in-house. All equipment calibration is traceable to Australian national standards at the National Measurements Institute.

Equipment Type	Make/Model/Serial Number	Last Cal. dd/mm/yyyy	Due Date dd/mm/yyyy	Cal. Interval
Temperature Chamber	Heraeus HT4033 (E-005)	Calibration not required		
EMI Receiver	R&S ESR7 9 kHz – 7 GHz Sn: 101804 (R-142)	10/04/2017	10/04/2018	1 Year, *2
	R&S ESW26 2 Hz – 26.5 GHz Sn: 100011 (R-143)	31/03/2017	31/03/2018	1 Year, *2
Attenuators	Radial R415.720.000 (A-379)	Prior to testing		
	Radial R415.720.000 (A-380)	Prior to testing		
Chamber	Frankonia SAC-10-2 (R-139)	22/03/2017	22/03/2018	1 Year, *1
Antennas	EMCO 6502 Active Loop 9 kHz – 30 MHz Sn: 9311-2801 (A-231)	20/07/2015	20/07/2018	3 Year, *2
	SUNOL JB6, Biconilog, 30 – 6000 MHz Sn: A012312 (A-363)	26/05/2016	26/05/2018	2 Year, *2
	EMCO 3115 Horn, 1 – 18 GHz Sn: 8908-3282 (A-004)	15/07/2016	15/07/2019	3 Year, *1
Cables	Room 12 inbuilt cable Panel 1 to 10 m (C-422)	31/05/2017	31/05/2018	1 Year, *1
	Room 12 inbuilt cable Panel 1 to 3 m (C-421)	31/05/2017	31/05/2018	1 Year, *1
	Room 12 Antenna cable (C-437)	31/05/2017	31/05/2018	1 Year, *1
	Sucoflex 104 Huber & Suhner 18 GHz, 5 m cable (C-337)	03/01/2017	03/01/2018	1 Year, *1

Note *1. Internal NATA calibration.

Note *2. External NATA / A2LA calibration

3.0 TEST RESULTS

3.1 §25.202 Frequencies, frequency tolerance and emission limits

3.1.1 Frequency band

The CIOF1701 operated in the 1.5/1.6 GHz Mobile-Satellite Service:

1525-1559 MHz: space-to-Earth

1626.5-1660.5 MHz: Earth-to-space

3.1.2 Frequency Tolerance

The carrier frequency tolerance for Earth stations was 0.001% of the reference frequency.

The sample was placed within an environmental chamber and the temperature was varied over the specified operating range of -20°C (-4°F) to +55°C (+131°F). the sample was configured to transmit on channel 1 (1626.5 MHz) and the Occupied Bandwidth was measured. The frequency of the markers indicating the 99% power points were recorded and compared at different temperatures.

Limit:

Reference frequency = 1626.5 MHz
Limit = $\pm 0.001\% = \pm 16 \text{ kHz}$

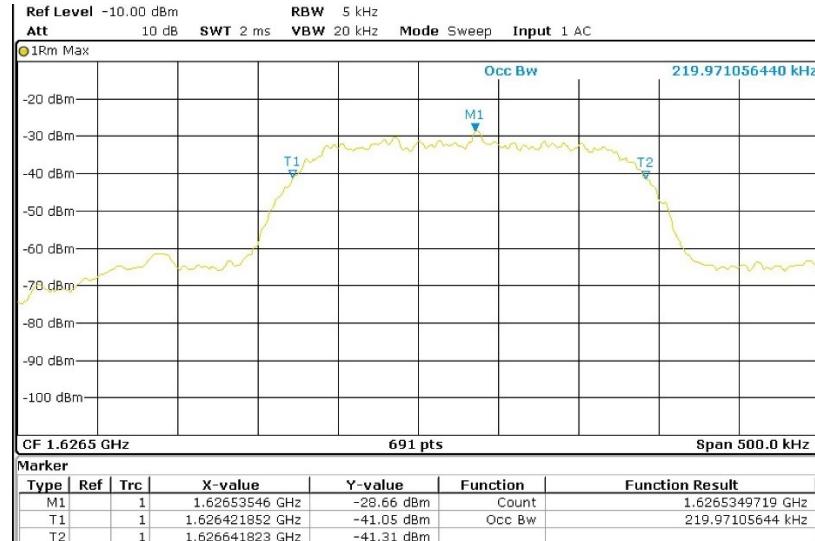
Results:

Temperature [°C]	Lower Freq. [kHz]	Upper Freq. [kHz]
+55	1,626,422	1,626,641
+45	1,626,422	1,626,640
+35	1,626,421	1,626,642
+25	1,626,421	1,626,640
+15	1,626,422	1,626,640
+5	1,626,421	1,626,641
-5	1,626,422	1,626,641
-15	1,626,422	1,626,641
-20	1,626,422	1,626,641
Range:	1 kHz	2 kHz

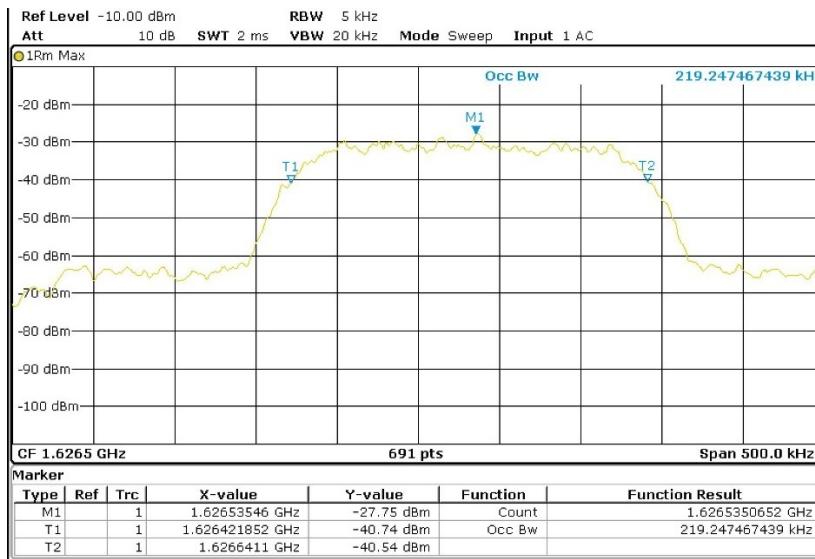
Conclusion:

The sample complied with the frequency tolerance requirement of 25.202(d).

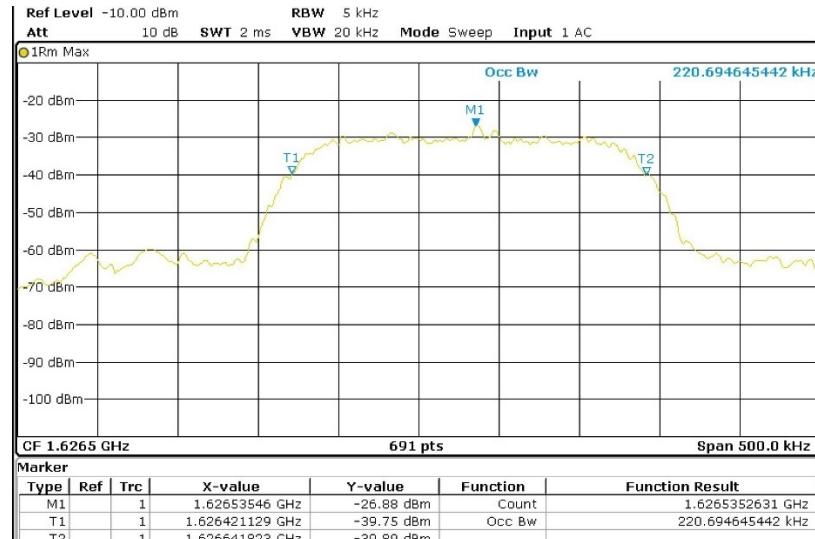
+55°C:



+45°C:



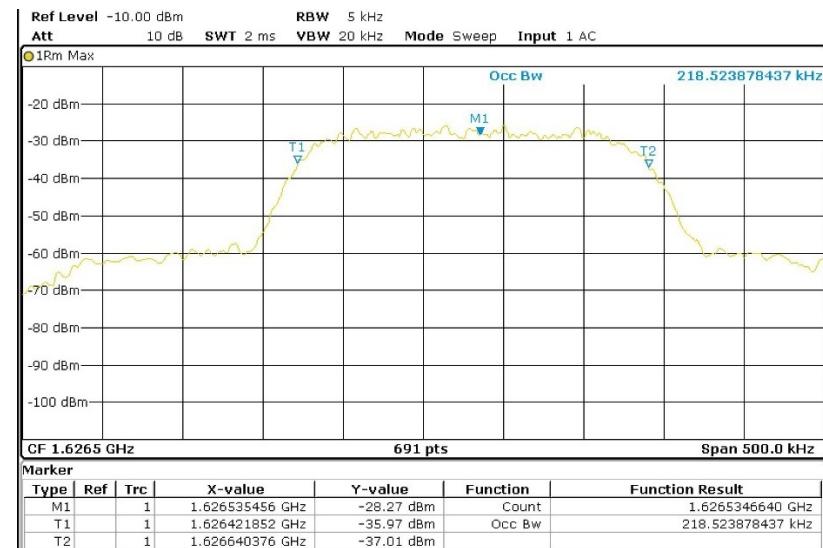
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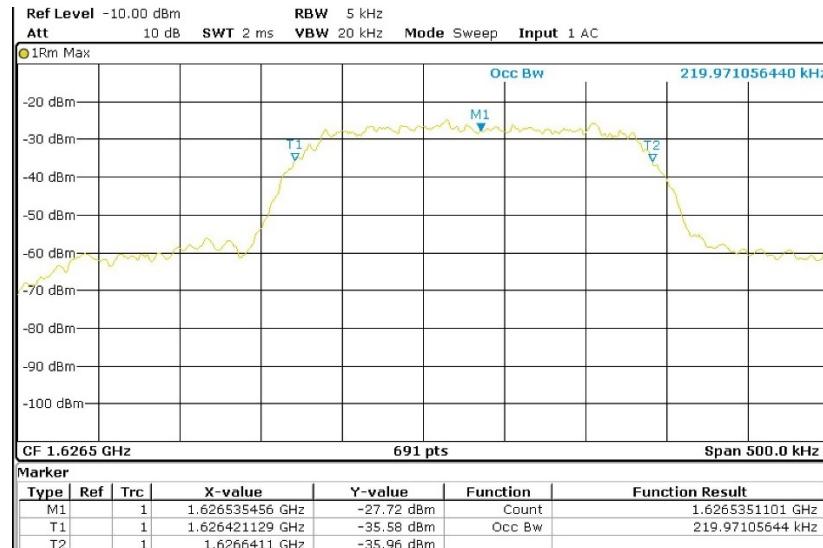
+25°C:



+15°C:



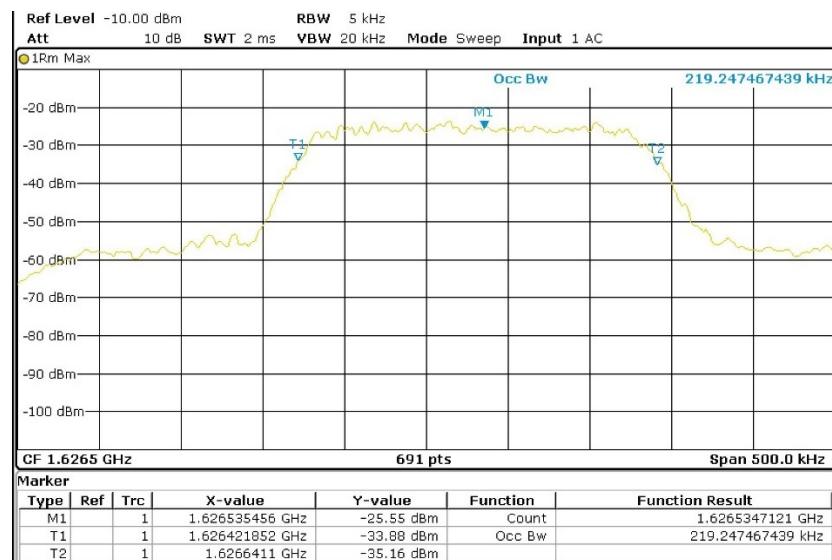
+5°C:



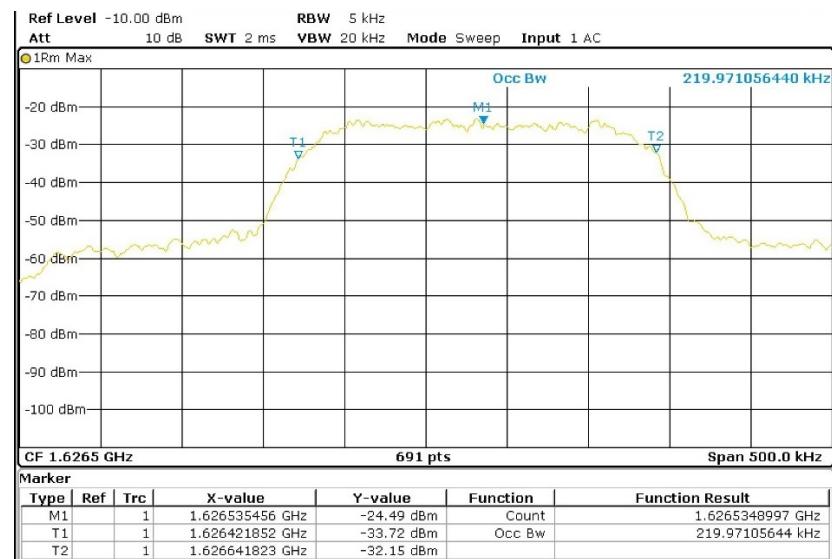
-5°C:



-15°C:



-20°C:



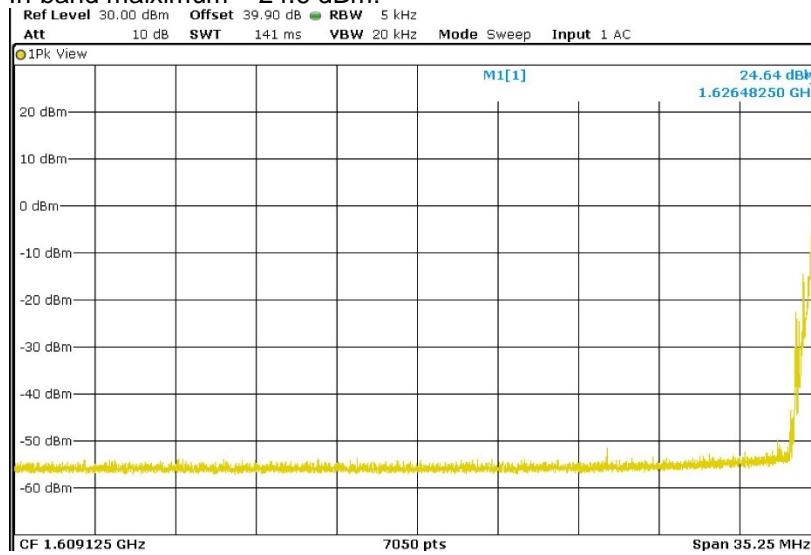
3.1.3 Emission Limitations - Conducted

The out-of-band emissions were measured at the antenna port of the sample over the range 9 kHz to 18 GHz. The measurements were repeated with the sample transmitting on the low, middle and high channels.

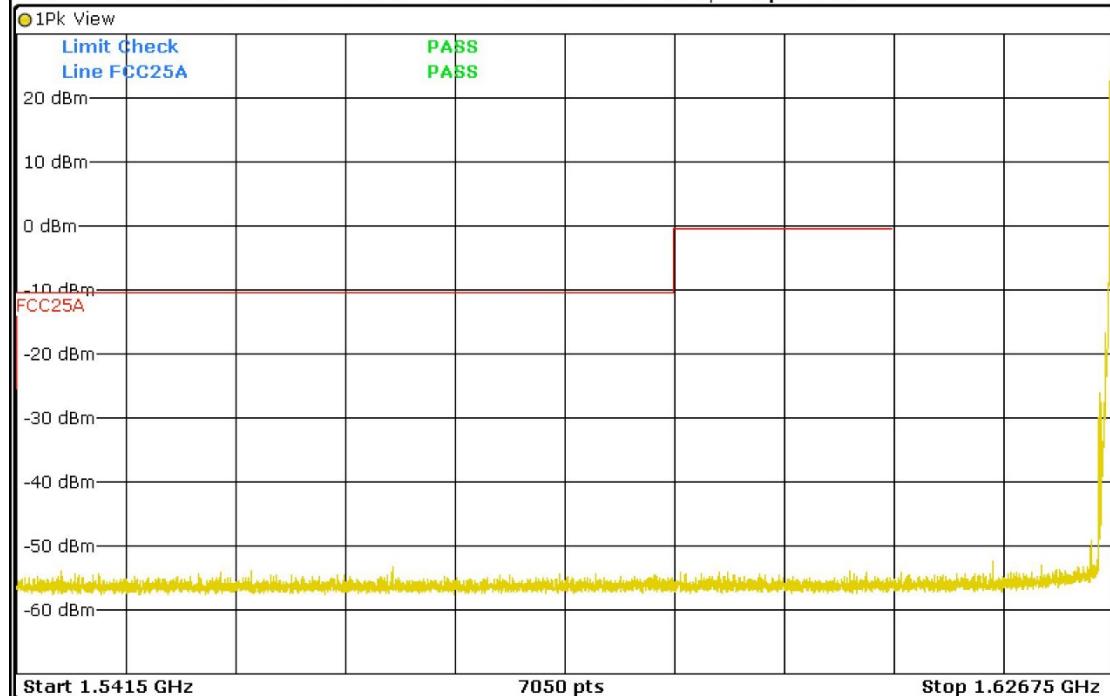
The limit was calculated by first measuring the highest in-band level with a 5 kHz bandwidth (test receiver would not measure with a 4 kHz resolution bandwidth). Attenuator and cable losses were accounted for by applying an amplitude offset allowing direct readings from the display. Peak detector was utilised.

Lower Band-edge, 25.202 (f)(1 and 2)

In-band maximum = 24.6 dBm:



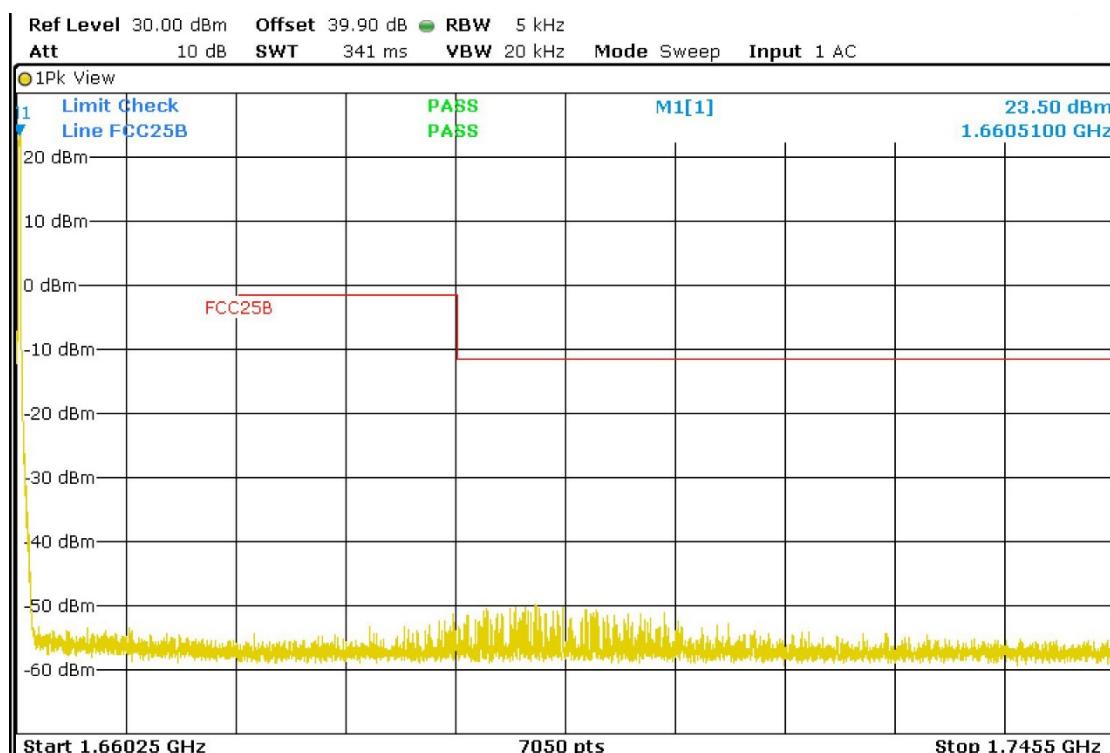
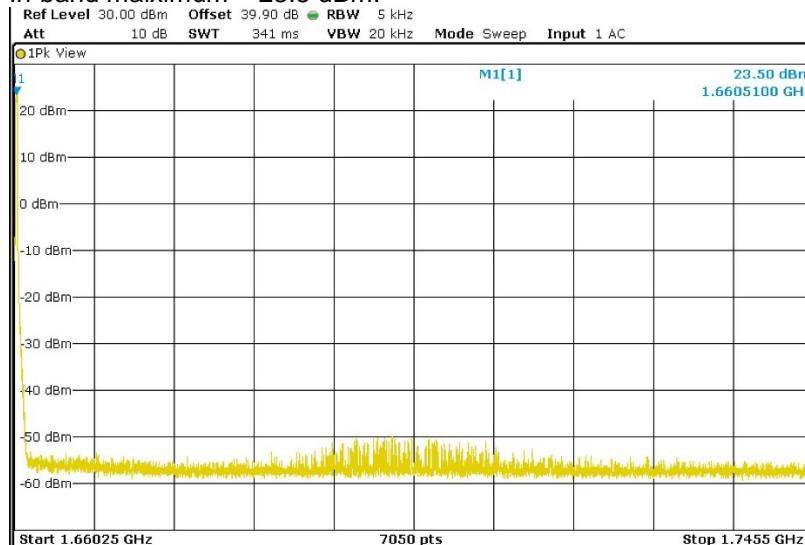
Ref Level 30.00 dBm Offset 39.90 dB RBW 5 kHz
 Att 10 dB SWT 341 ms VBW 20 kHz Mode Sweep Input 1 AC



No emissions were found near the limit.

Upper Band-edge, 25.202 (f)(1 and 2)

In-band maximum = 23.5 dBm:



No emissions were found near the limit.

Conducted spurious emissions 9 kHz to 18 GHz, 25.202 (f)(3)

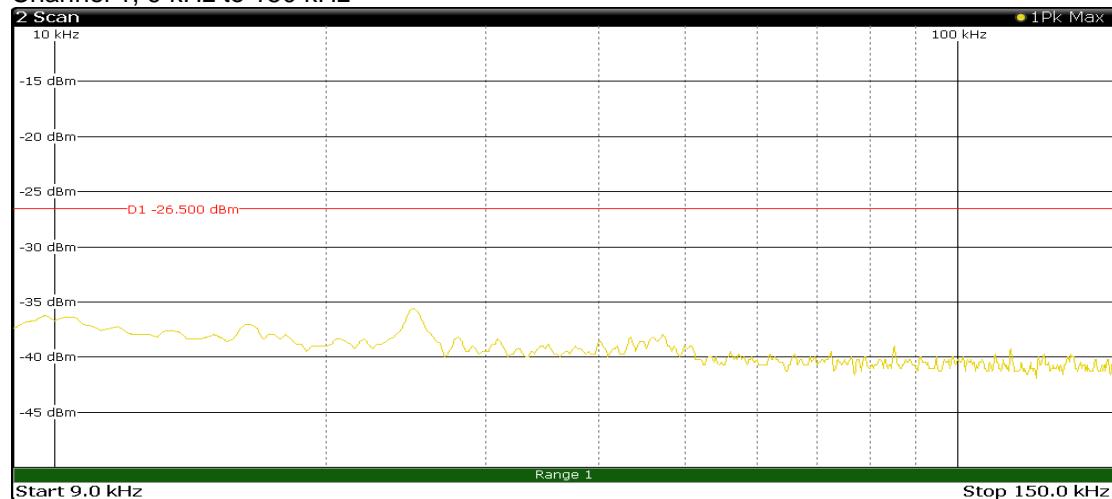
Receiver settings:

Parameter	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
Start	9 kHz	150 kHz	30 MHz	1 GHz	1.7455 GHz	8 GHz
Stop	150 kHz	30 MHz	1000 MHz	1.5415 GHz	8 GHz	18 GHz
Step	250 Hz	2.5 kHz	25 kHz	25 kHz	25 kHz	25 kHz
Detector	Peak	Peak	Peak	Peak	Peak	Peak
RBW	1 kHz	10 kHz	100 kHz	100 kHz	100 kHz	100 kHz
Meas Time	100 ms	100 ms	100 ms	100 ms	100 ms	100 ms
RF Att	40 dB	30 dB	20 dB	20 dB	20 dB	20 dB
Preamp	OFF	OFF	OFF	OFF	OFF	OFF

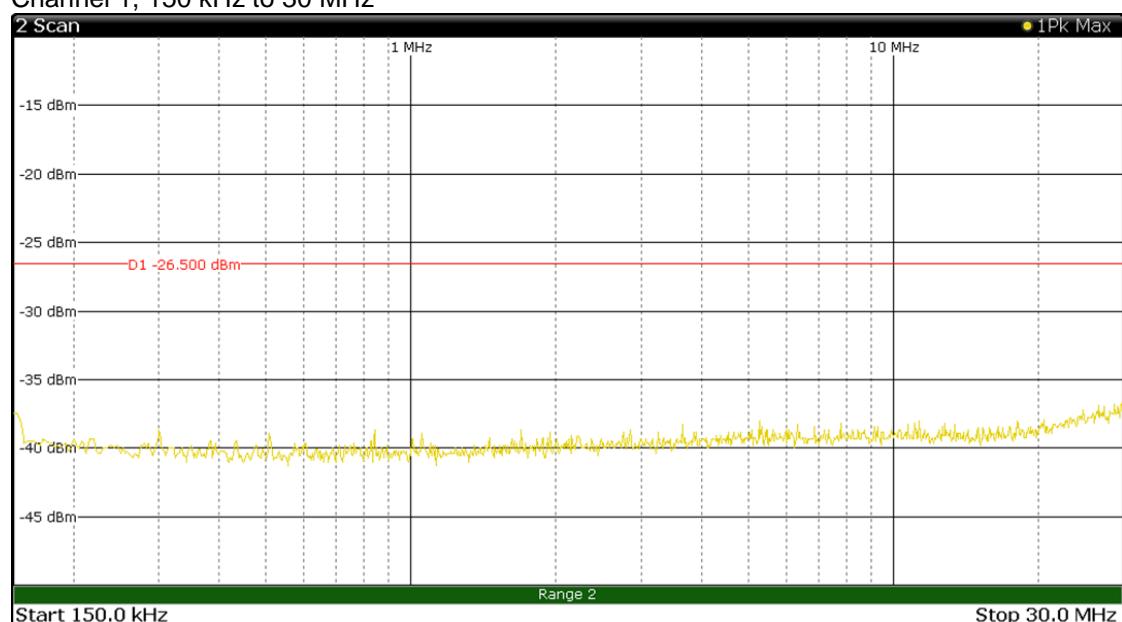
Results:

Channel	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]
1087	6,574	-27.6	-26.5	-1.1
1087	8,218	-29.6	-26.5	-3.1
1	17,100	-30.3	-26.5	-3.8
1087	12,850	-30.9	-26.5	-4.4
1	6,506	-31.2	-26.5	-4.7
1087	11,890	-31.2	-26.5	-4.7
1	4,880	-32.1	-26.5	-5.6
1	8,133	-32.2	-26.5	-5.7
1087	4,931	-33.3	-26.5	-6.8

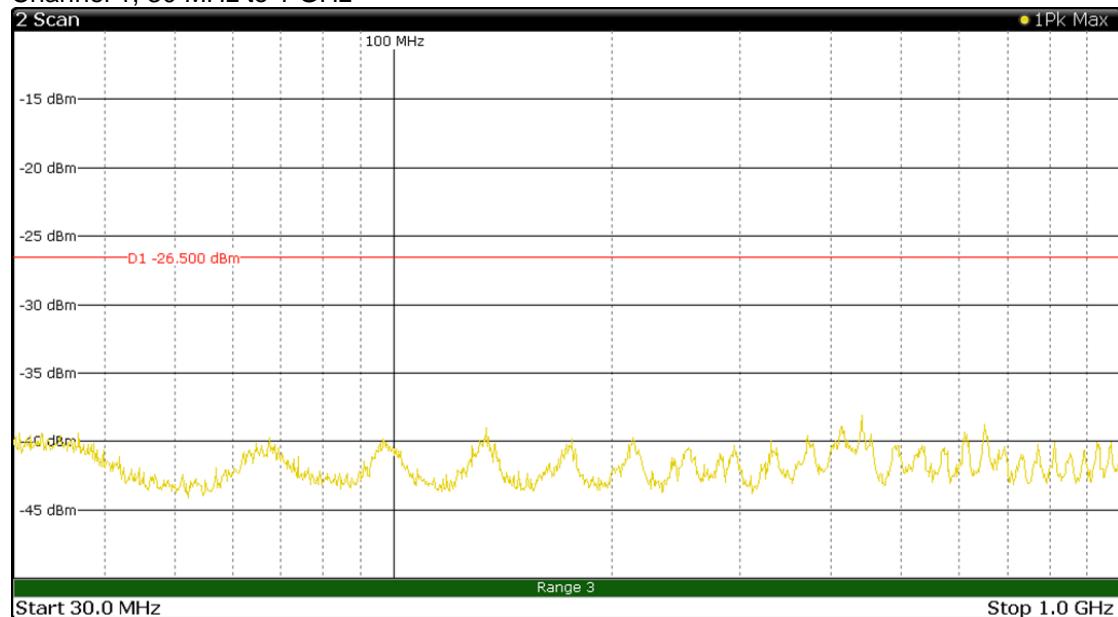
Channel 1, 9 kHz to 150 kHz



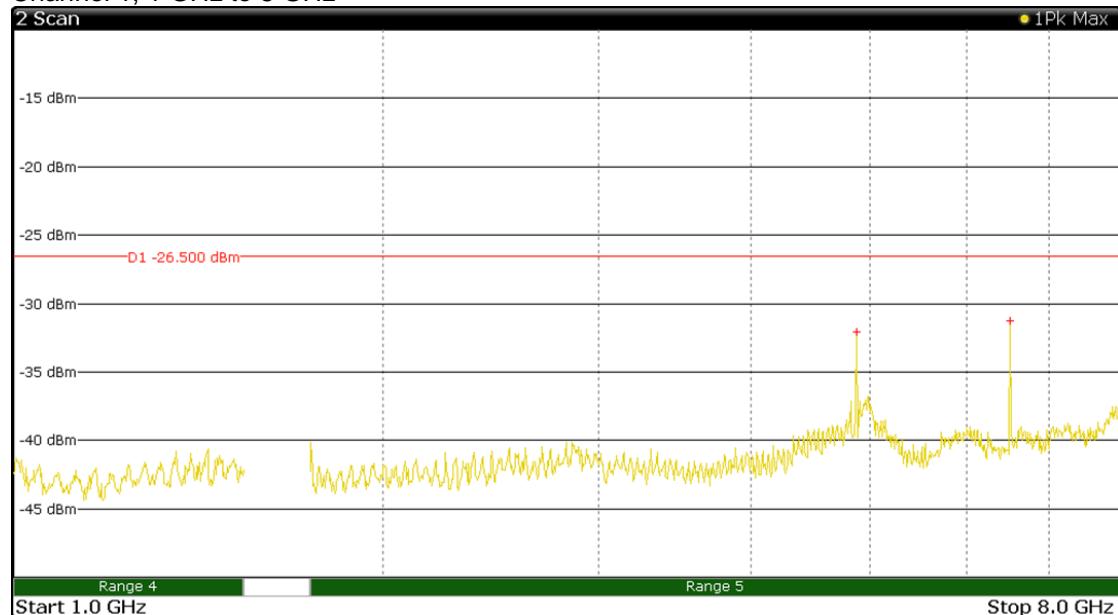
Channel 1, 150 kHz to 30 MHz



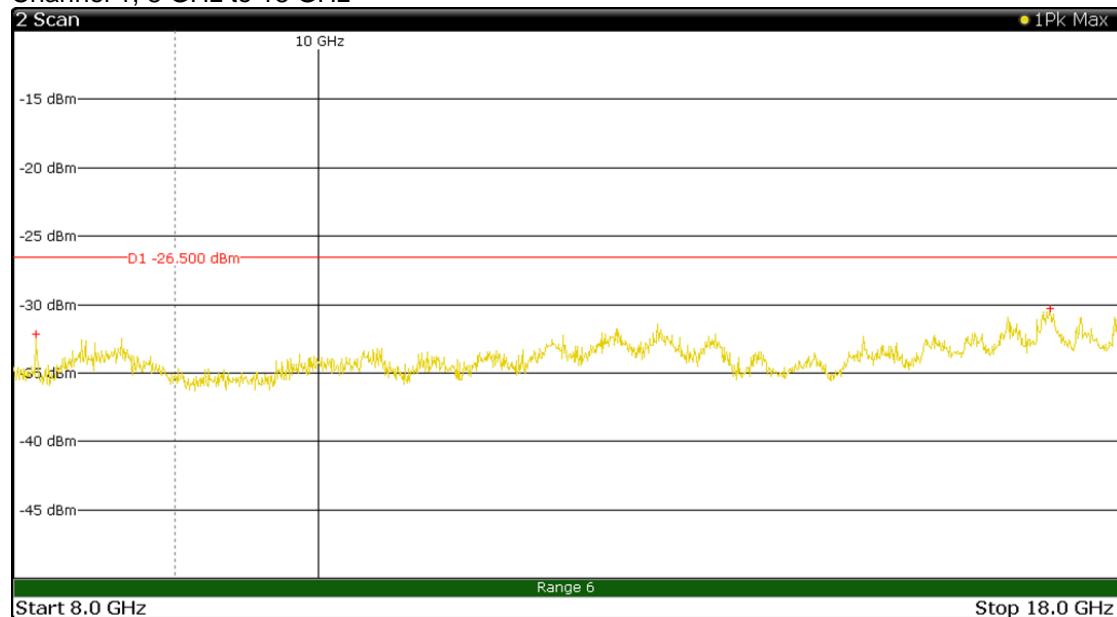
Channel 1, 30 MHz to 1 GHz



Channel 1, 1 GHz to 8 GHz



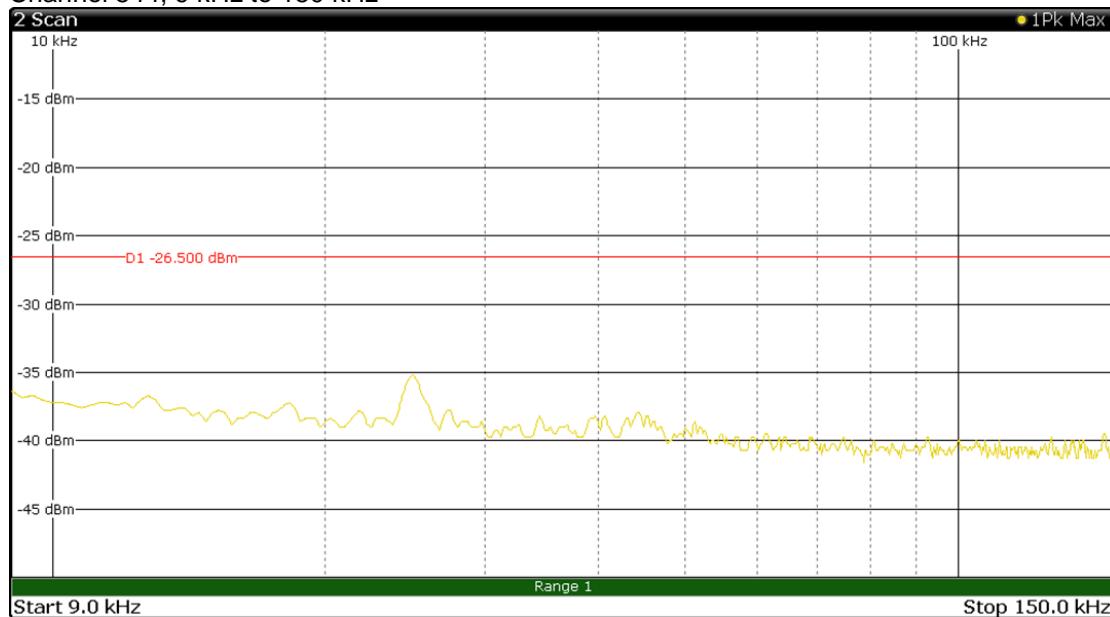
Channel 1, 8 GHz to 18 GHz



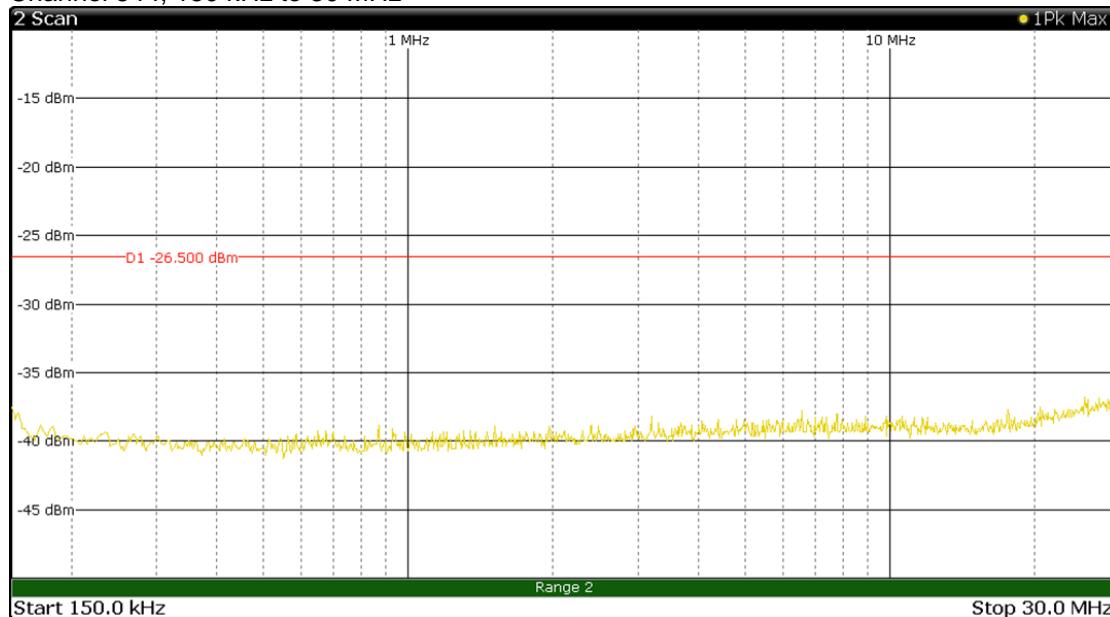
Results:

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]
4,880	-32.1	-26.5	-5.6
6,506	-31.2	-26.5	-4.7
8,133	-32.2	-26.5	-5.7
17,100	-30.3	-26.5	-3.8

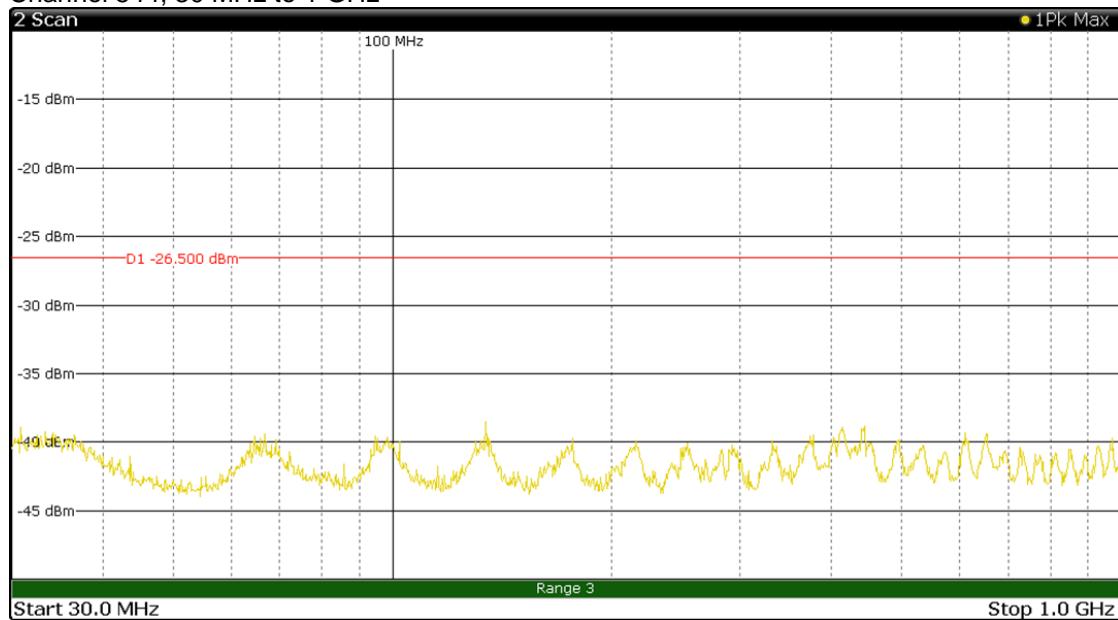
Channel 544, 9 kHz to 150 kHz



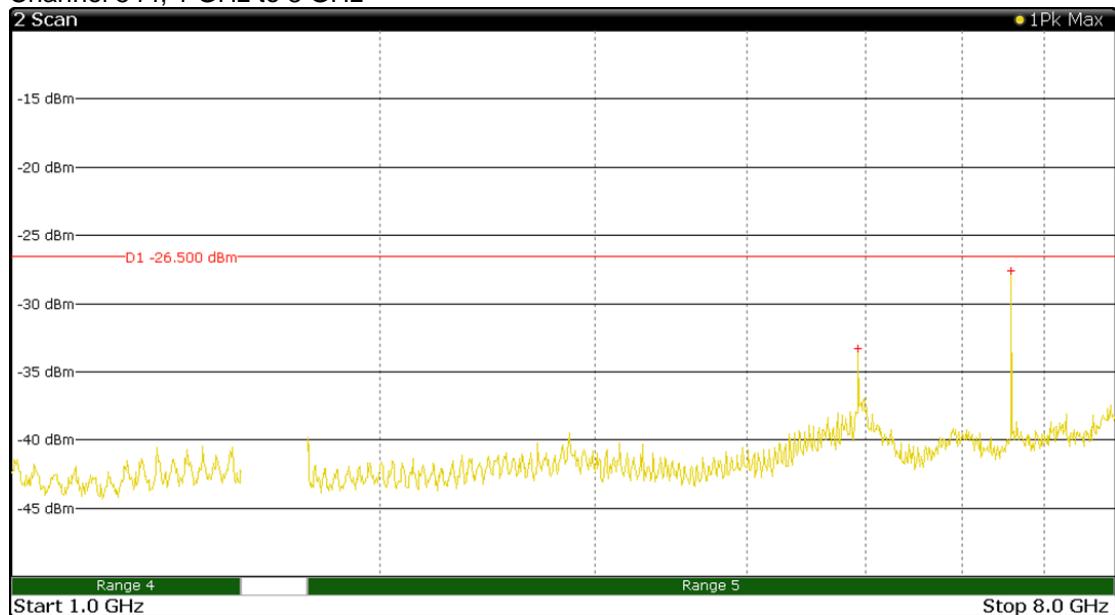
Channel 544, 150 kHz to 30 MHz



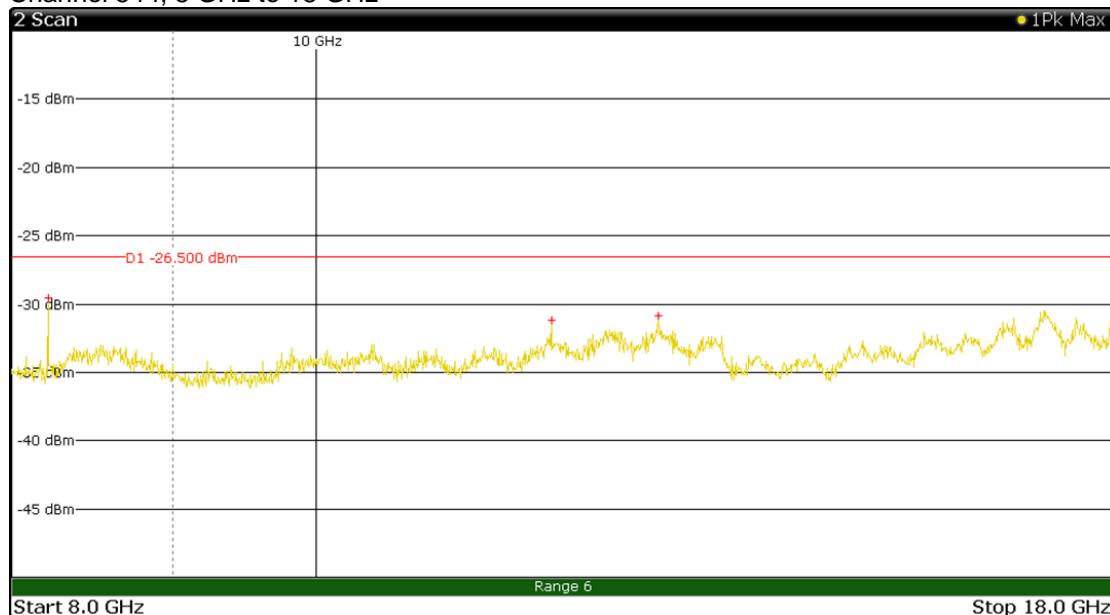
Channel 544, 30 MHz to 1 GHz



Channel 544, 1 GHz to 8 GHz



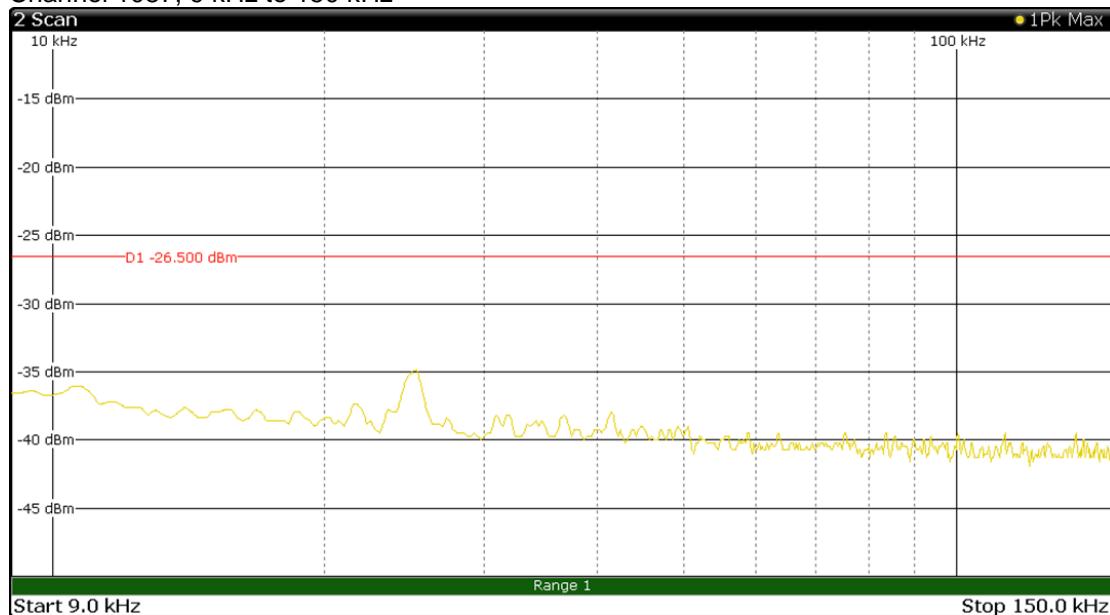
Channel 544, 8 GHz to 18 GHz



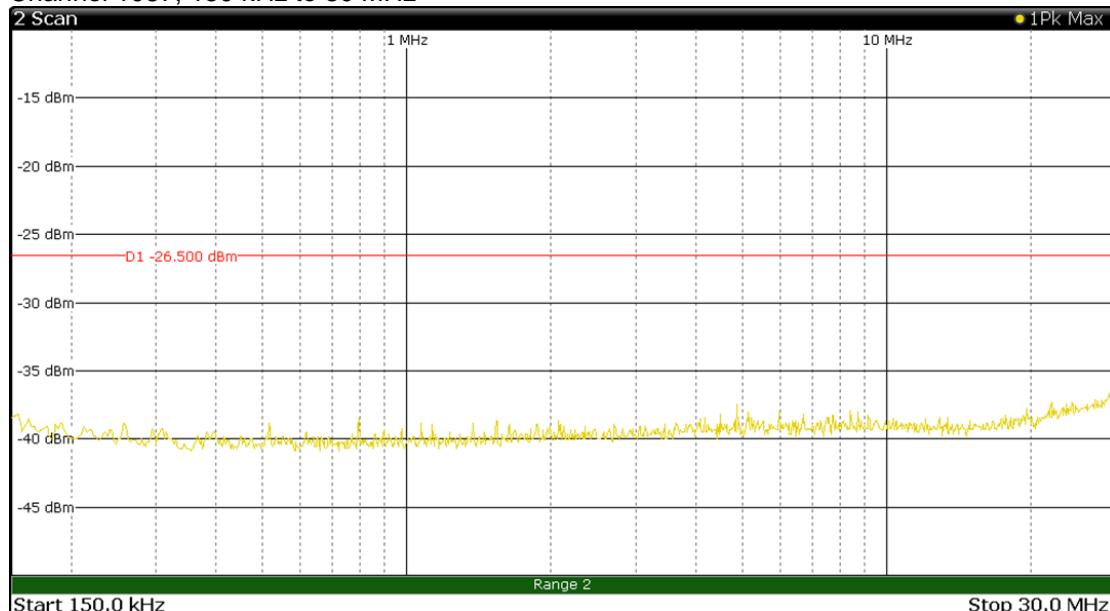
Results:

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]
4,931	-33.3	-26.5	-6.8
6,574	-27.6	-26.5	-1.1
8,218	-29.6	-26.5	-3.1
11,890	-31.2	-26.5	-4.7
12,850	-30.9	-26.5	-4.4

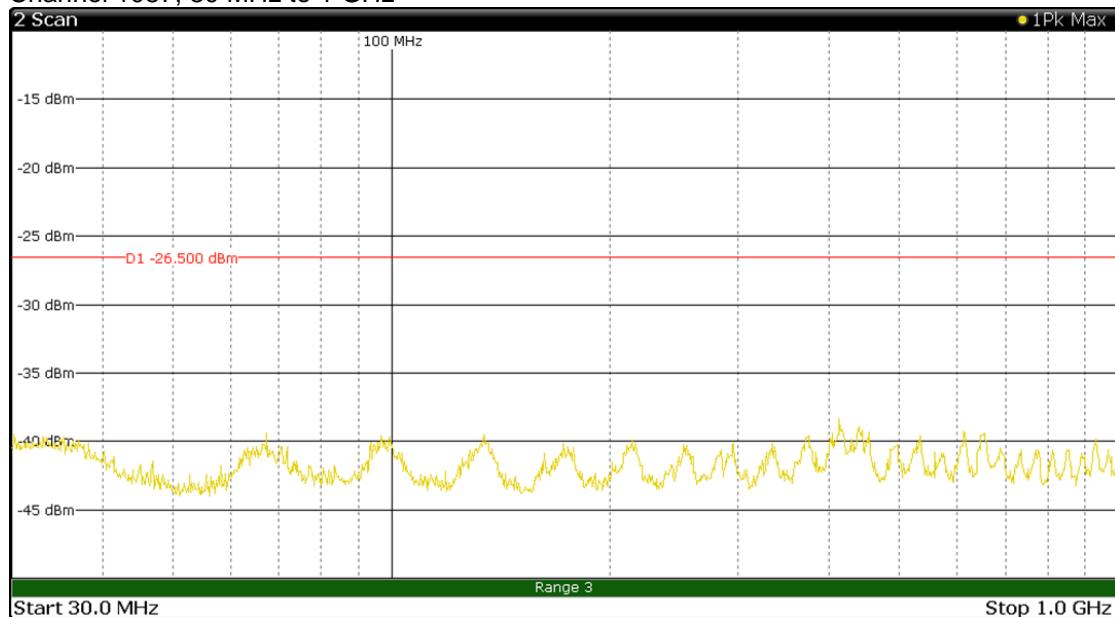
Channel 1087, 9 kHz to 150 kHz



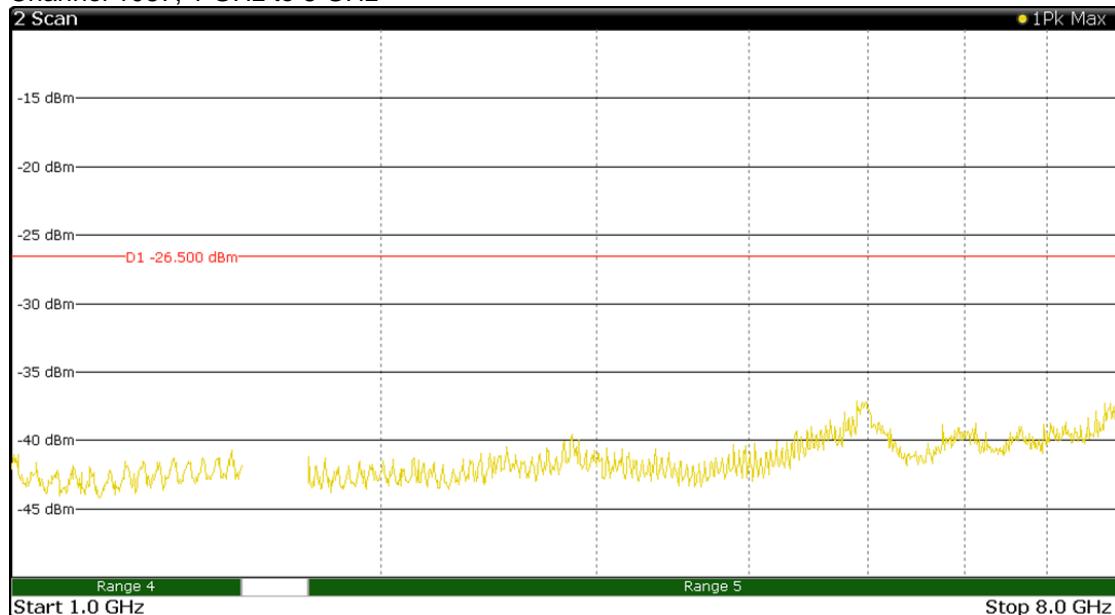
Channel 1087, 150 kHz to 30 MHz



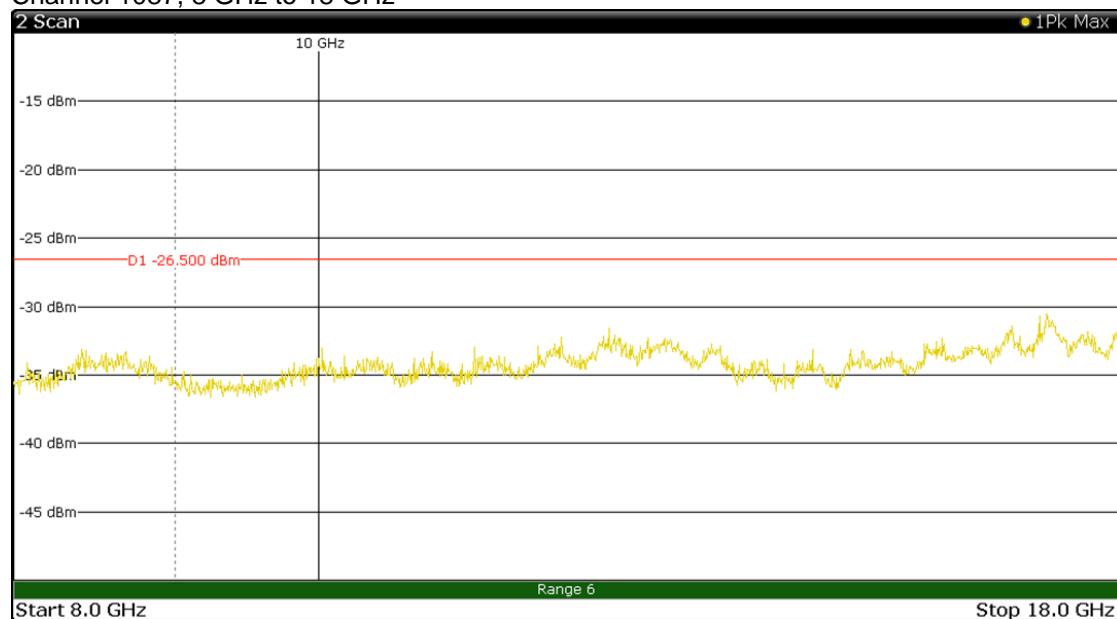
Channel 1087, 30 MHz to 1 GHz



Channel 1087, 1 GHz to 8 GHz



Channel 1087, 8 GHz to 18 GHz



Results:

No spurious emissions were recorded above the measurement system noise floor.

3.1.4 Emission Limitations - Radiated

Radiated spurious emission measurements were performed in a semi-anechoic chamber compliant with ANSI C63.4: 2014.

The test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of emissions.

Frequency range [MHz]	Measurement Bandwidth [kHz]	Measurement Distance [m]	Antenna
0.009 to 0.150	0.2	10	0.6 metre loop antenna
0.150 to 30	9	10	
30 to 1000	120	10	
1000 to 18 000	1000	3	Biconilog hybrid Standard gain or broad band horns
18 000 to 40 000	1000	1	

The sample was slowly rotated with the measurement receiver set to Max-Hold. This was performed for at least two antenna heights. When an emission was located, it was positively identified and its maximum level found by rotating the automated turntable and by varying the antenna height. Devices design for a fixed position were tested in that position, portable devices were tested in three orthogonal orientations.

The measurement data for each frequency range was corrected for cable losses, antenna factors and preamplifier gain. This process was performed for both horizontal and vertical antenna polarisations.

Calculation of field strength

The field strength was calculated automatically by software using pre-stored calibration data. The method of calculation is shown below:

$$E = V + AF - G + L$$

Where:

- E** = Radiated Field Strength in dB μ V/m.
- V** = EMI Receiver Voltage in dB μ V. (measured value)
- AF** = Antenna Factor in dB. (stored as a data array)
- G** = Preamplifier Gain in dB. (stored as a data array)
- L** = Cable loss in dB. (stored as a data array of Insertion Loss versus frequency)

Calculation of radiated power

For limits given in terms of power the following calculation was used to convert a measurement from electric field:

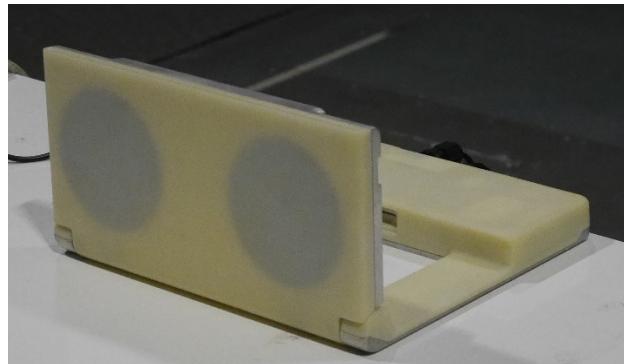
$$E = 20 \cdot \log \left(\frac{\sqrt{30 \cdot P}}{d} \right) + 120$$

$$P = \frac{(d \cdot 10^{(E/20)} \cdot 10^{-6})^2}{30}$$

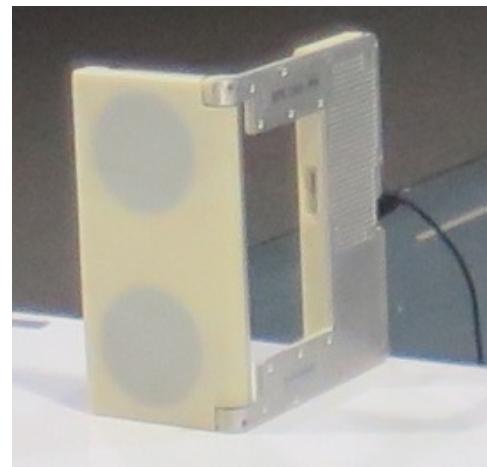
Where

- E** = Electric field strength in dB μ V/m
- d** = Measurement distance in metres
- P** = E.I.R.P in watts

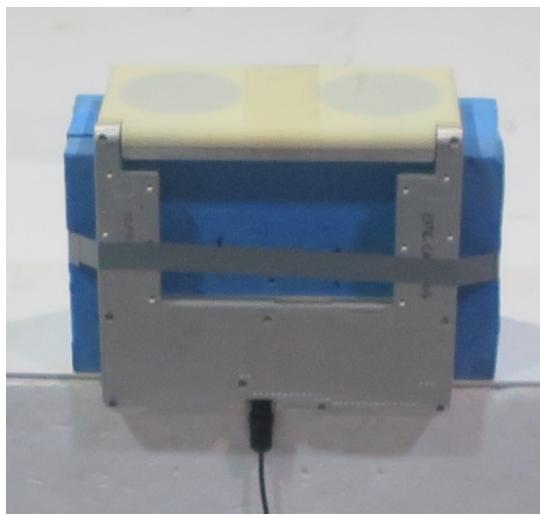
3.1.4.1 Sample Orientations



Position 1



Position 2



Position

3.1.4.2 Limit

The radiated spurious limit was calculated from the conducted emission measurements.

Conducted power measured with a 4 kHz bandwidth = 23.5 dBm

Calculated radiated power = 23.5 dBm + 11.1 dBi (antenna gain) = 34.6 dBm

Spurious limit removed from the assigned frequency by more than 250% of the authorised bandwidth
= Power - [43xlog(Power, watts)]
= 34.6 dBm - [43 + 10log(40.7 Watts)]
= 7.7 dBm

Conversion of spurious power limit to electric field:

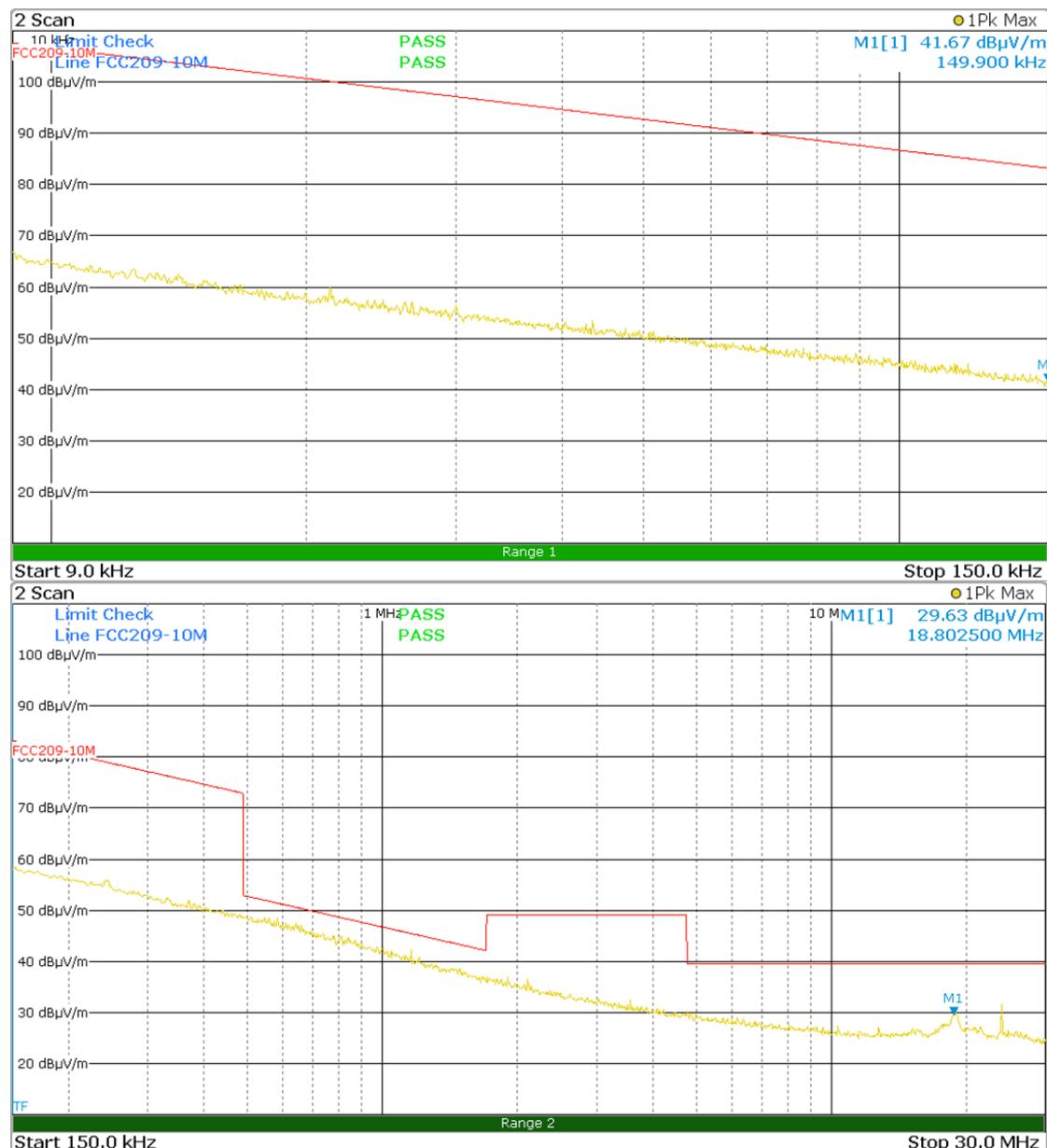
7.7 dBm = 102.9 dB μ V/m at 3 metres

7.7 dBm = 92.5 dB μ V/m at 10 metres

3.1.4.3 Frequency Band: 9 kHz - 30 MHz

Measurements were made at a distance of 10 metres using a peak detector. The measurement of emissions between 9 - 150 kHz were made with a resolution bandwidth (RBW) of 200 Hz and between 9 - 150 kHz were made with a resolution bandwidth (RBW) of 9 kHz. The lowest, middle and highest channels were investigated, the maximum emissions are reported.

Loop Antenna Perpendicular



Result:

No emissions were detected near the 102.9 dB μ V/m limit.

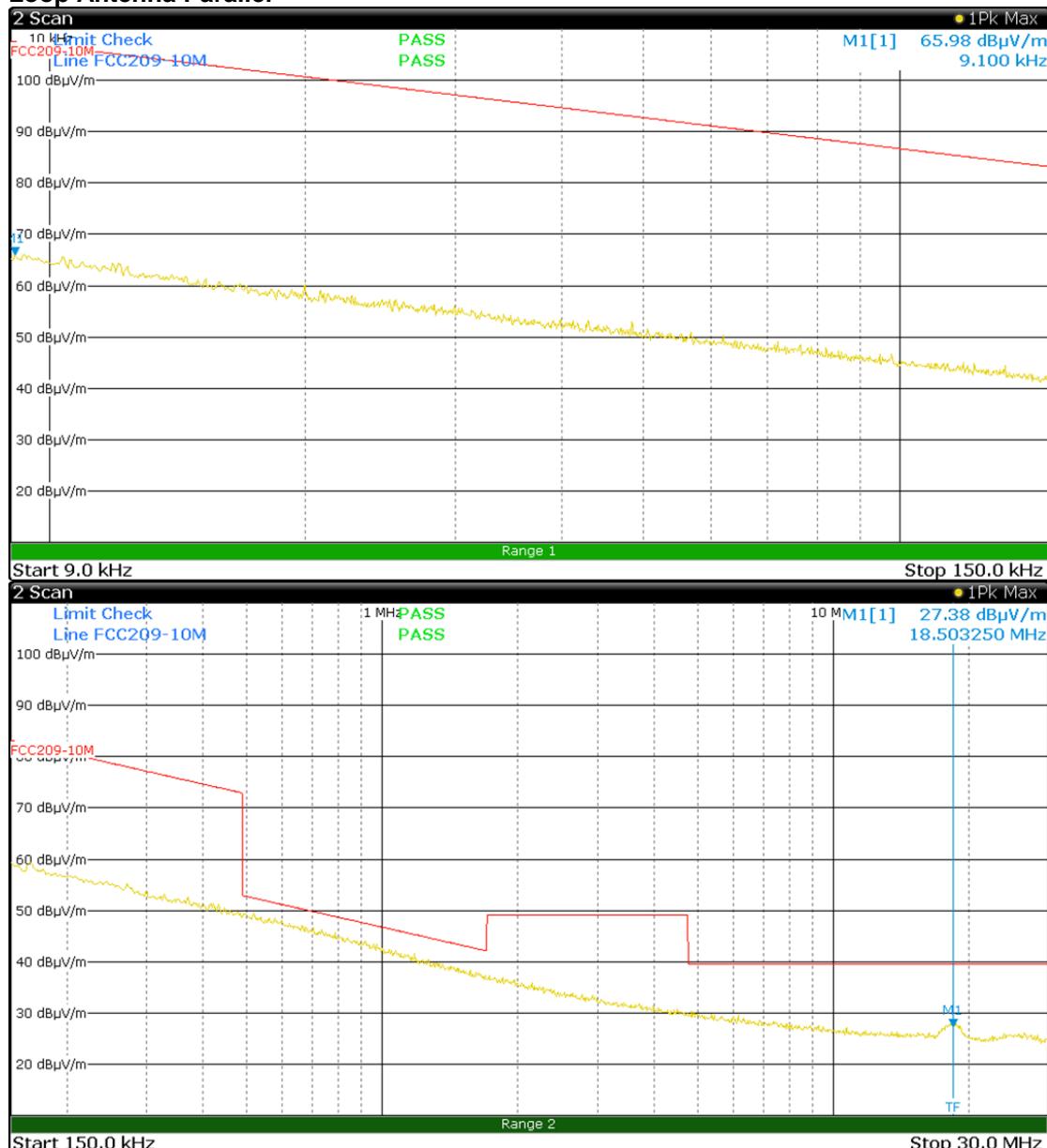
Loop antenna Ground-Parallel



Result

Ne emissions were detected near the 102.9 dB_{uV}/m limit.

Loop Antenna Parallel



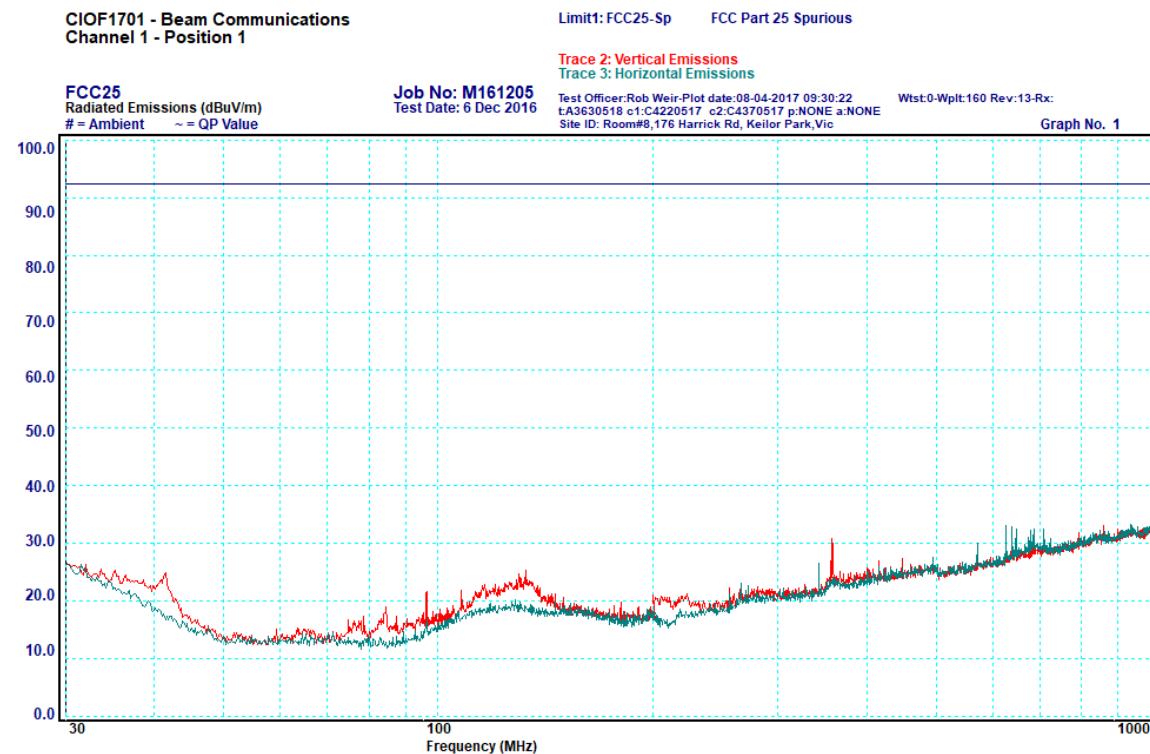
Result:

Ne emissions were detected near the 102.9 dB μ V/m limit.

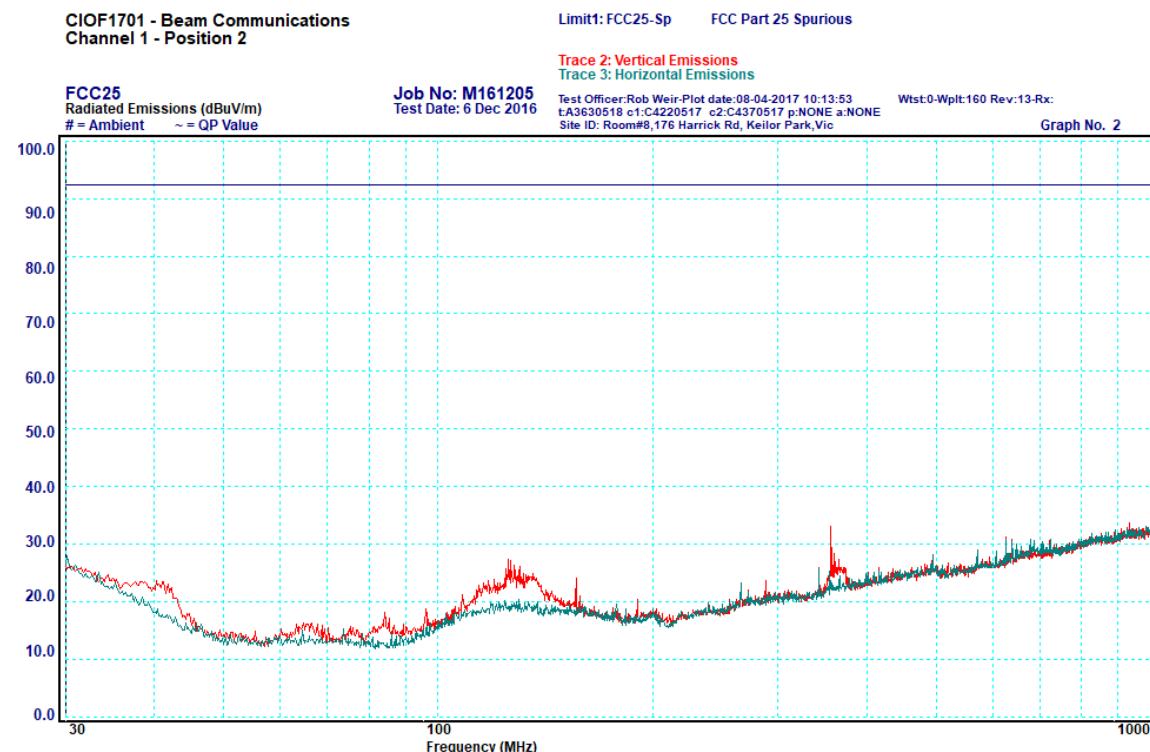
3.1.4.4 Frequency Band: 30 - 1000 MHz

Measurements were made at a distance of 10 metres using a peak detector. The measurement of emissions between 30 - 1000 MHz were made with a resolution bandwidth (RBW) of 120 kHz and the video bandwidth (VBW) of 300 kHz. The lowest, middle and highest channels were investigated, the maximum emissions are reported.

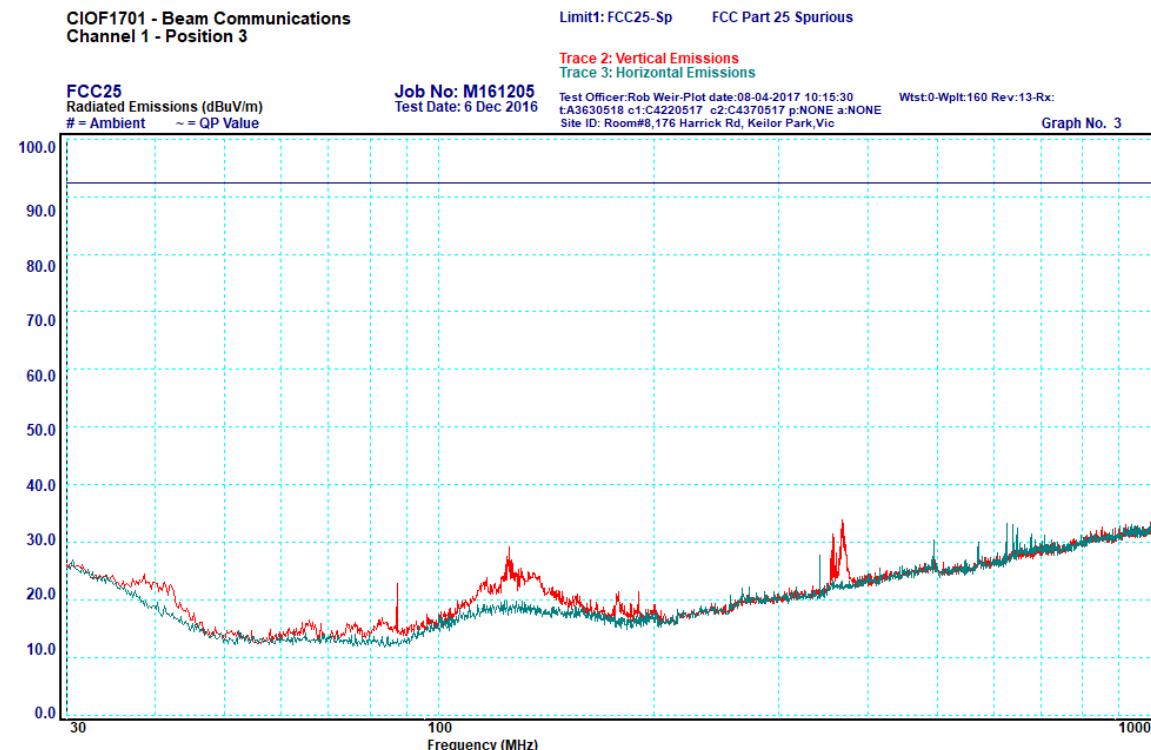
Position 1



Position 2



Position 3



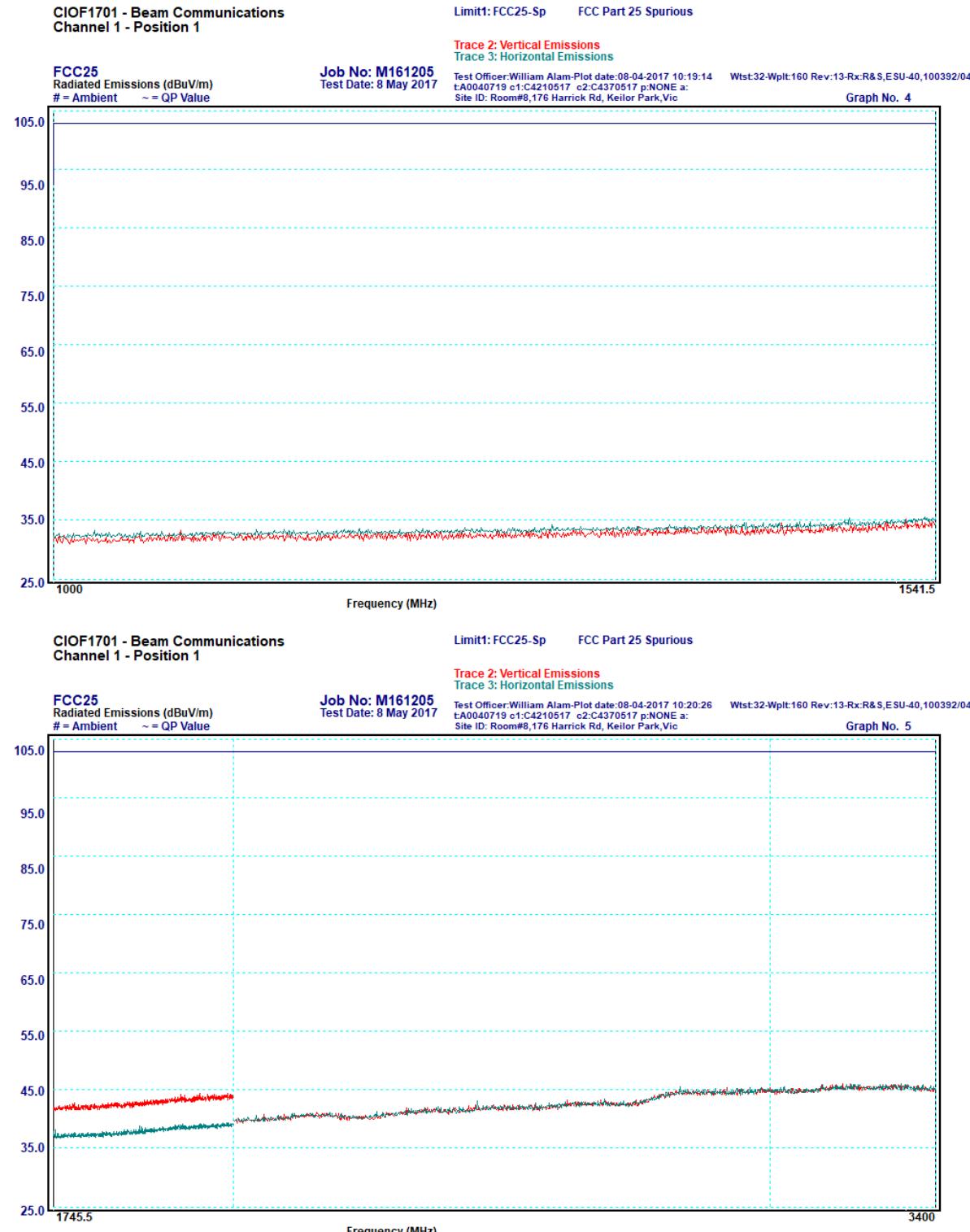
Result:

All emissions detected in the range 30 MHz to 1000 MHz were well below the 25.202 (f)(3) limit.

3.1.4.5 Frequency Band: 1 000 – 18 000 MHz

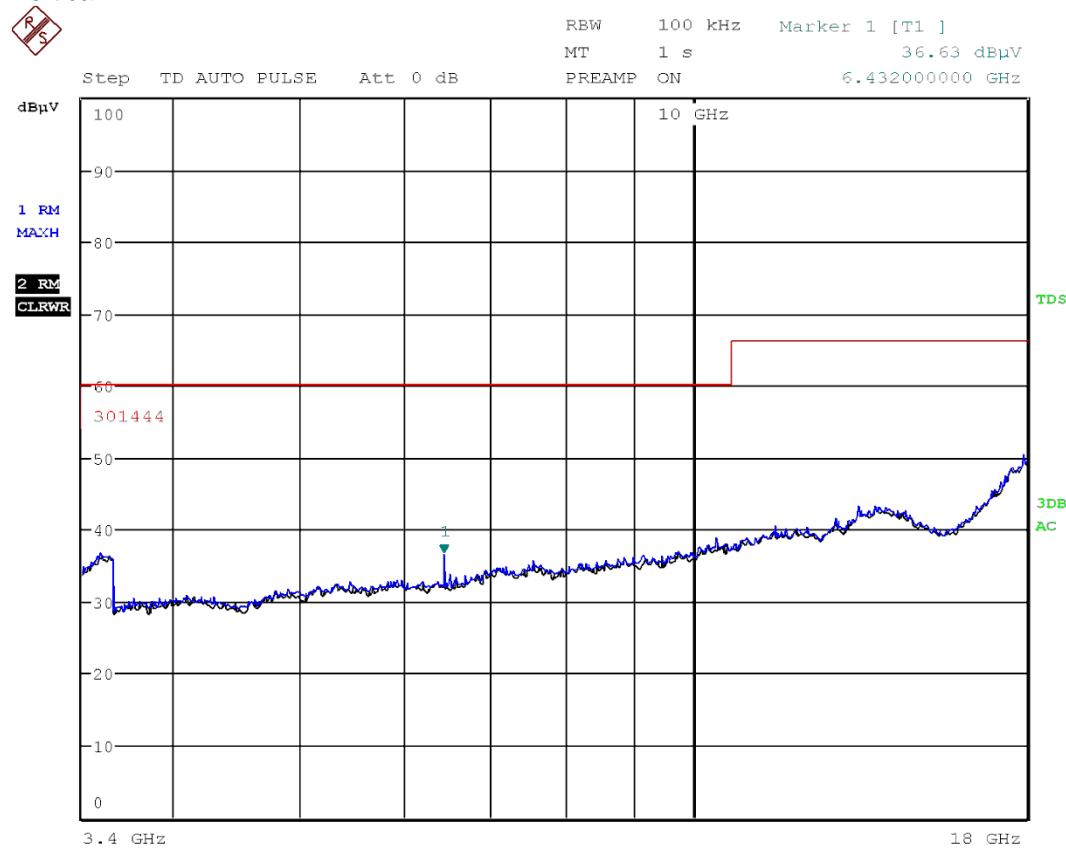
Measurements were made at a distance of 3 metres using a peak detector. The measurement of emissions between 1000 – 18 000 MHz were made with a resolution bandwidth (RBW) of 1000 kHz and the video bandwidth (VBW) of 1000 kHz. The lowest, middle and highest channels were investigated, the maximum emissions are reported.

Position 1 (1 to 3.4 GHz)

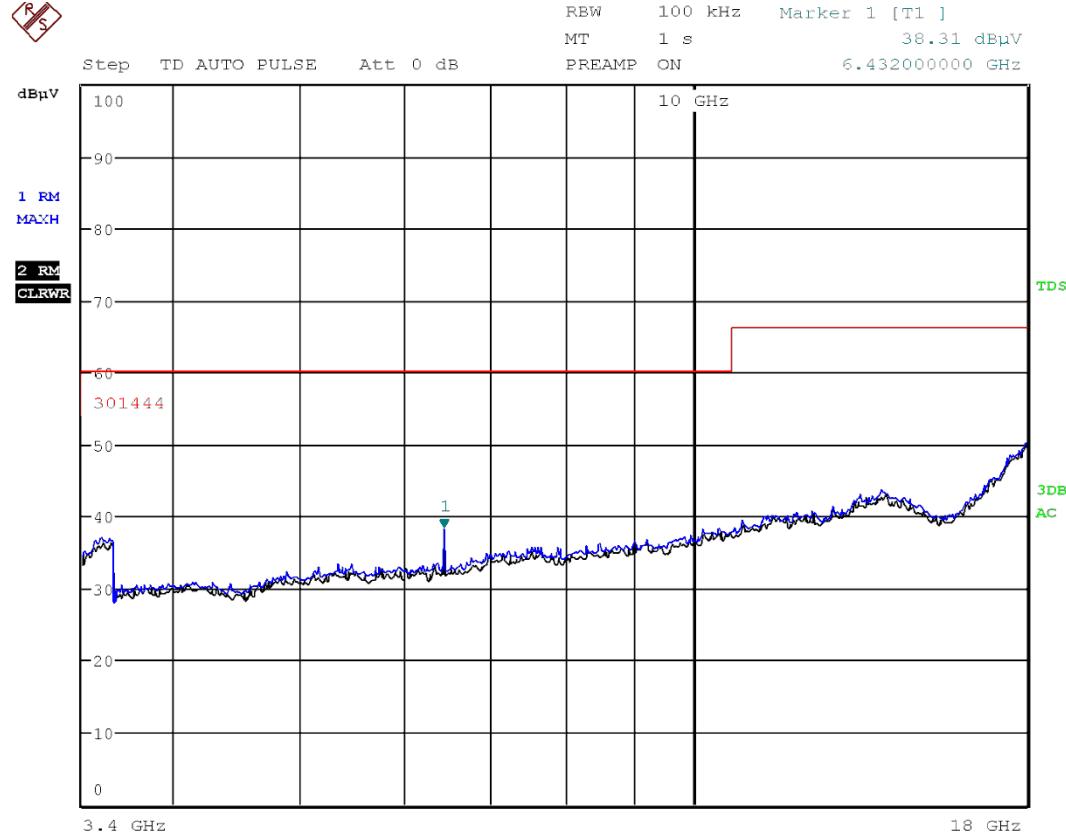


Position 1 (3.4 to 18 GHz)

Vertical:

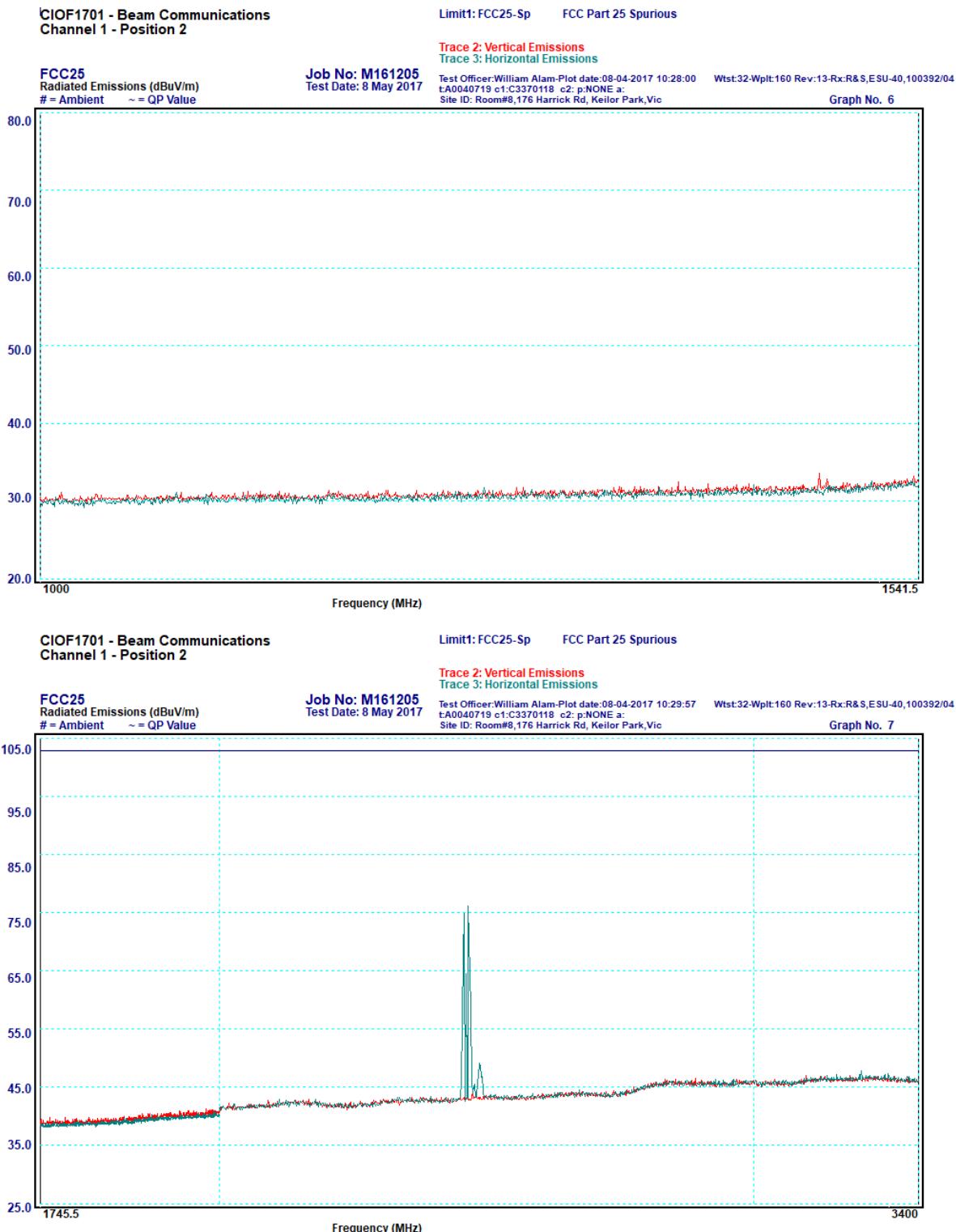


Horizontal:



Note: Correct limit is 102.9 dB μ V/m, no emissions detected near this limit.

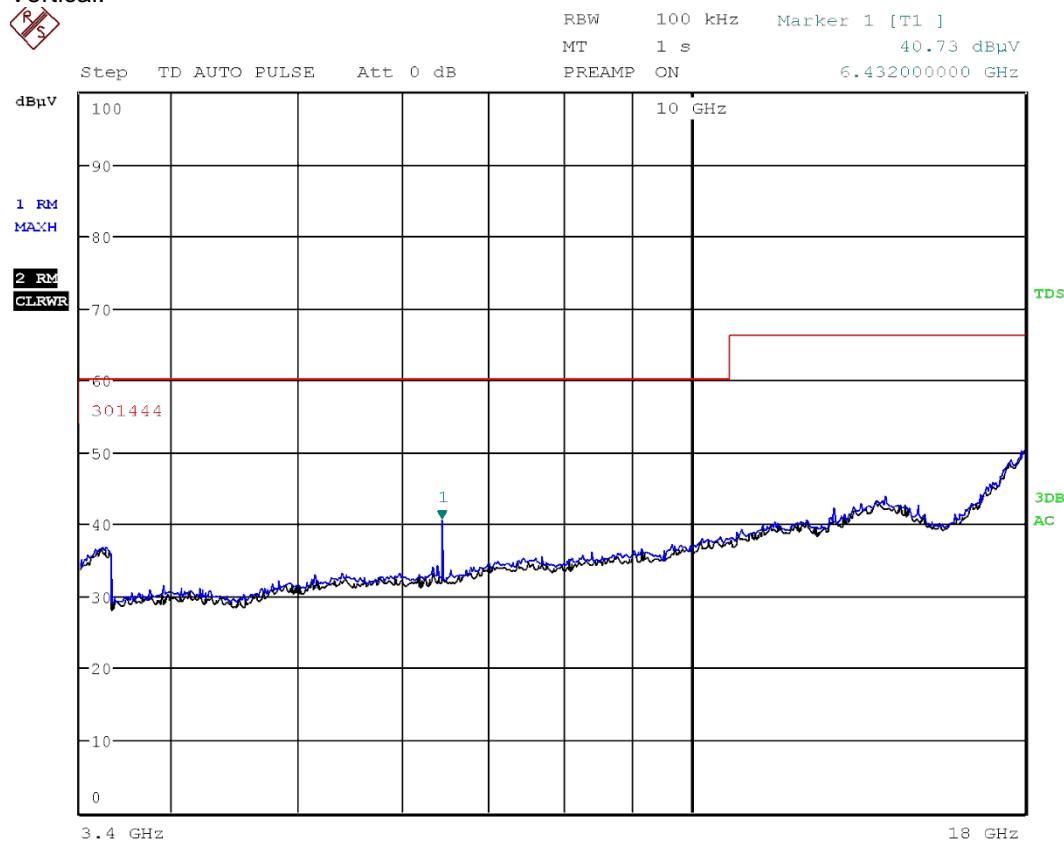
Position 2 (1 to 3.4 GHz)



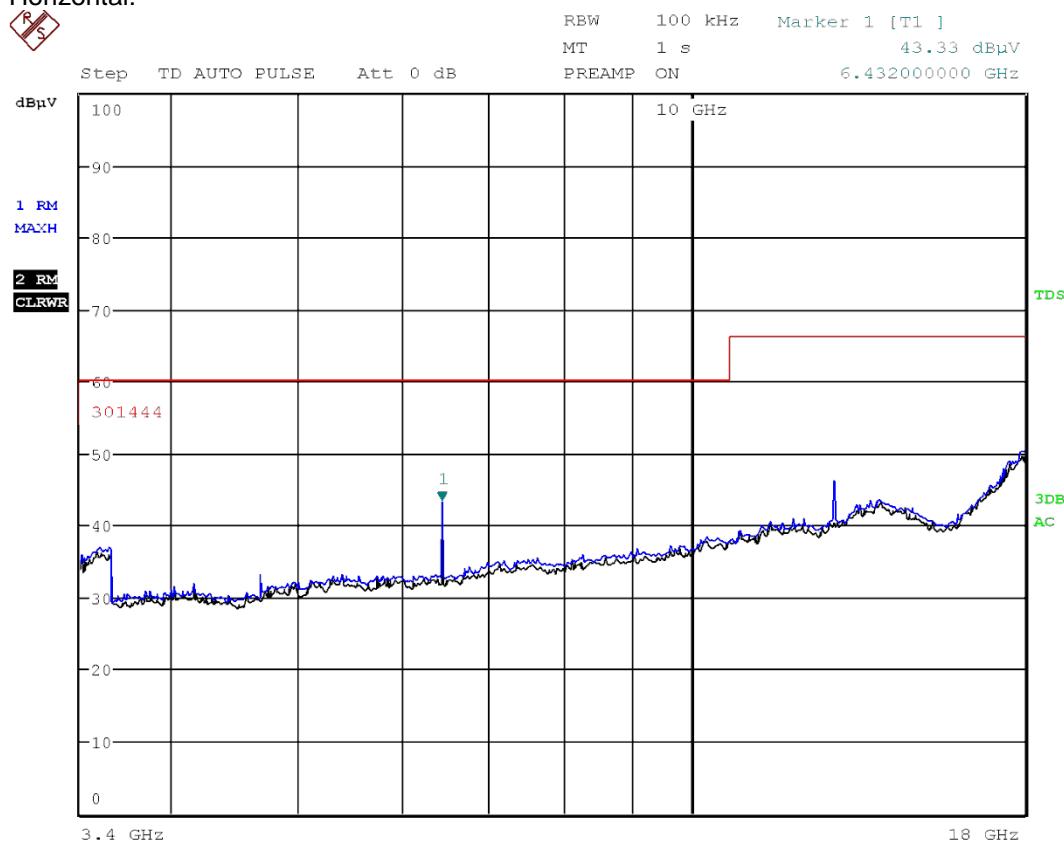
** Peaks at 2.4 GHz were from samples Wi Fi communications and not subject to FCC Part 25 limit.

Position 2 (3.4 to 18 GHz)

Vertical:

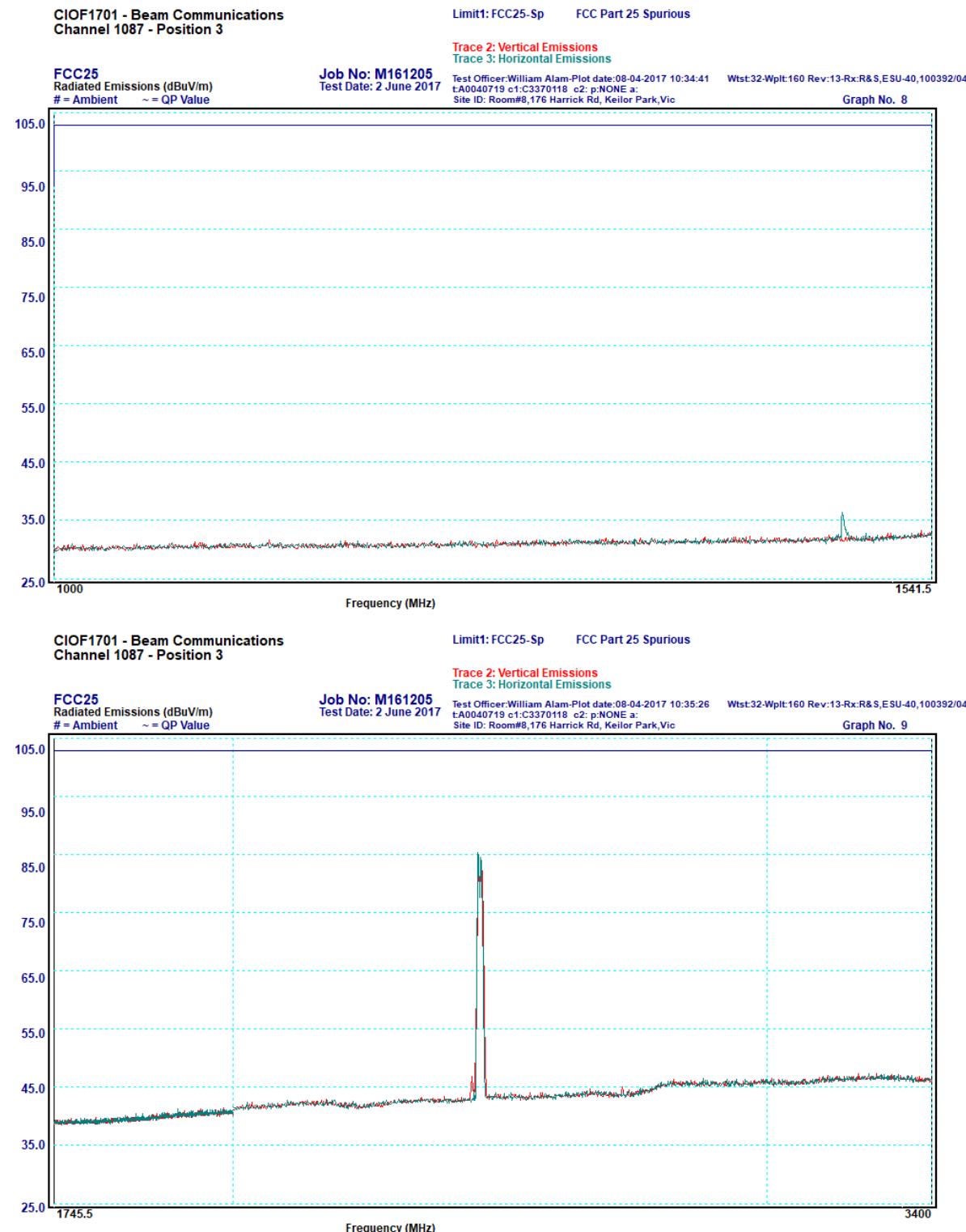


Horizontal:



Note: Correct limit is 102.9 dB μ V/m, no emissions detected near this limit.

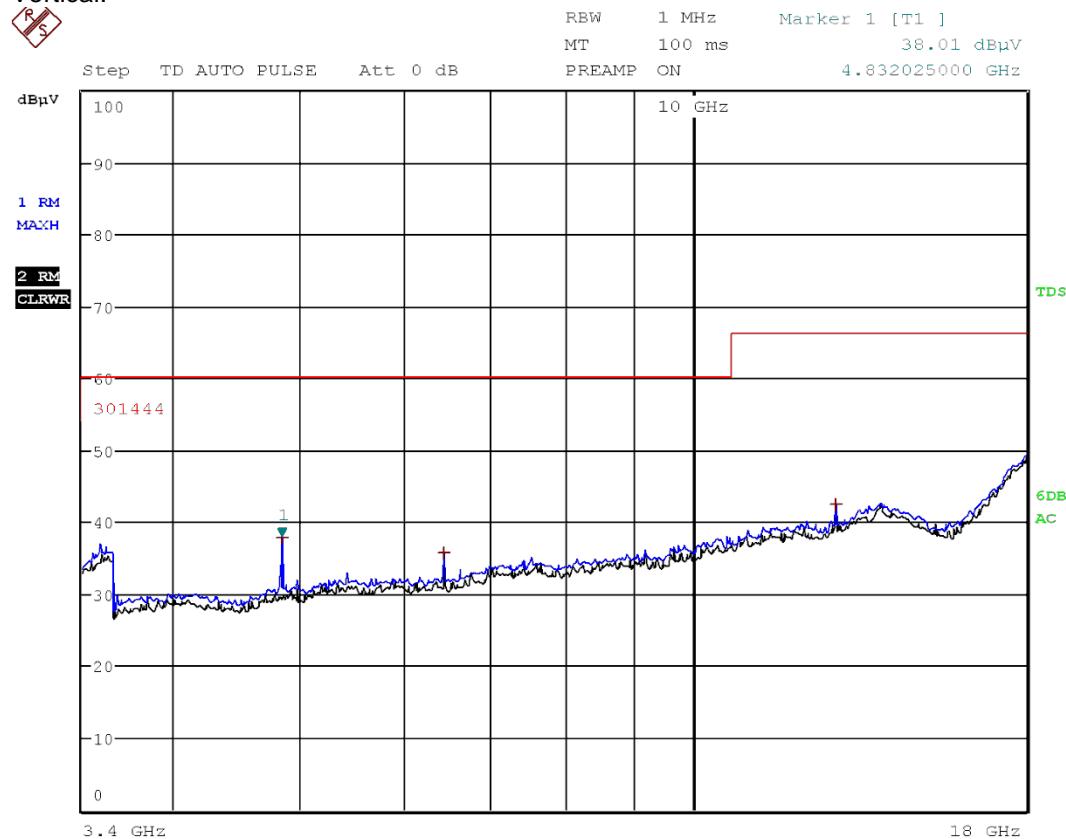
Position 3 (1 to 3.4 GHz)



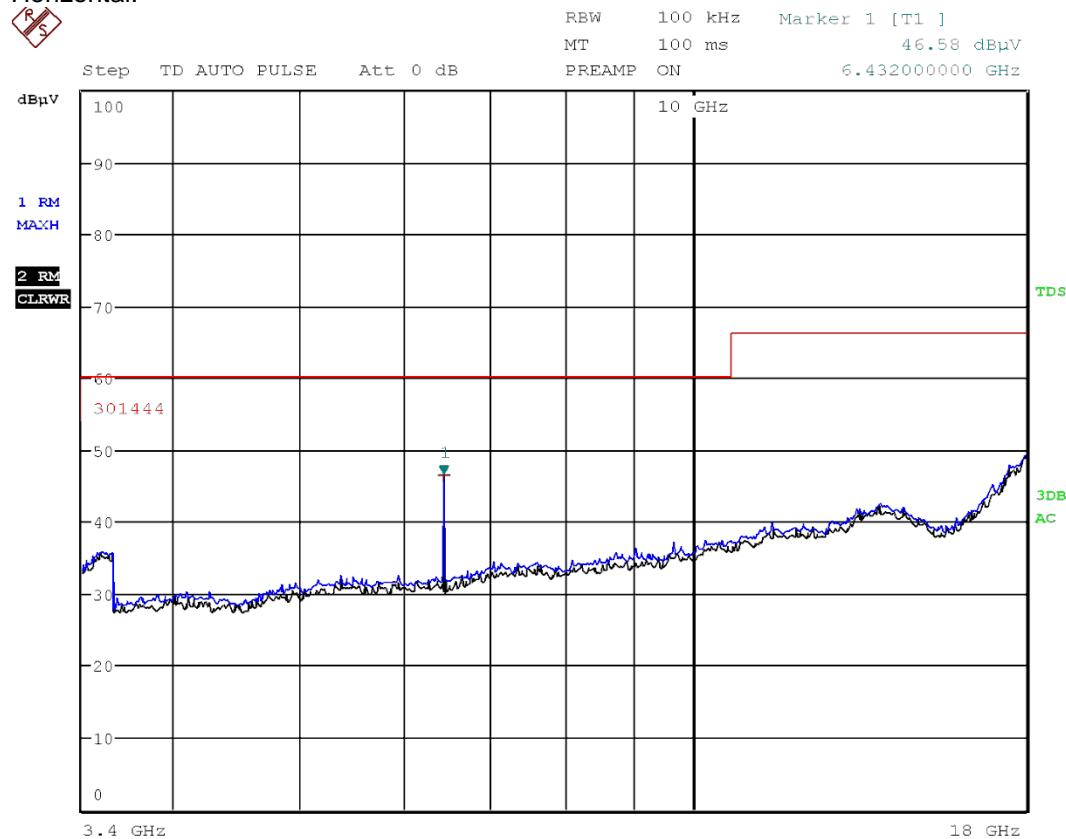
** Peaks at 2.4 GHz were from samples Wi Fi communications and not subject to FCC Part 25 limit.

Position 3 (3.4 to 18 GHz)

Vertical:



Horizontal:



Note: Correct limit is 102.9 dB μ V/m, no emissions detected near this limit.

3.2 §25.204 Power limits for Earth stations

The output power of the CIOF1071 was measured at the antenna port. The antenna gain of 11.1 dBi was added to calculate the Equivalent Isotropic Radiated Power (EIRP).

Attenuator and cable losses were accounted for by applying an amplitude offset allowing direct readings from the display. The peak detector was used.

Limit:

- + 40 dBW in any 4 kHz band for $\theta \leq 0^\circ$
- + 40 + 30 dBW in any 4 kHz band for $0^\circ < \theta \leq 5^\circ$

Where θ is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

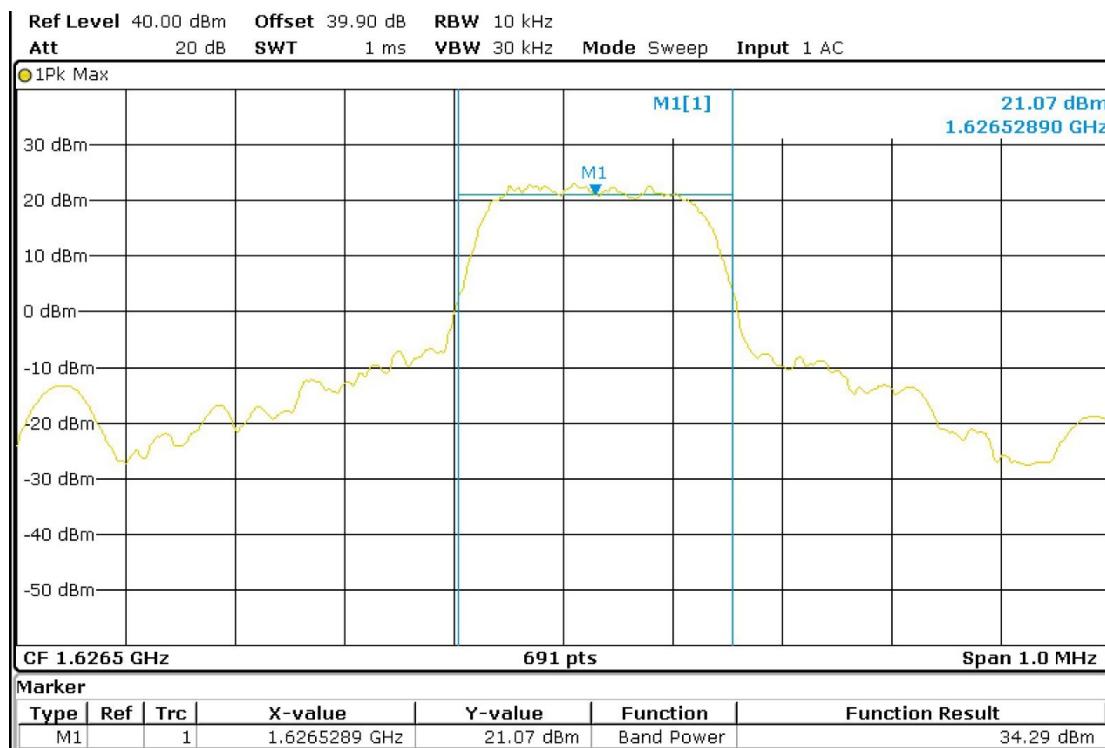
Results:

Channel	Conducted Power [dBm]	Antenna Gain [dBi]	EIRP [dBm]	EIRP [dBW]
1	34.3	11.1	45.4	15.4
544	34.6	11.1	45.7	15.7
1087	35.0	11.1	46.1	16.1

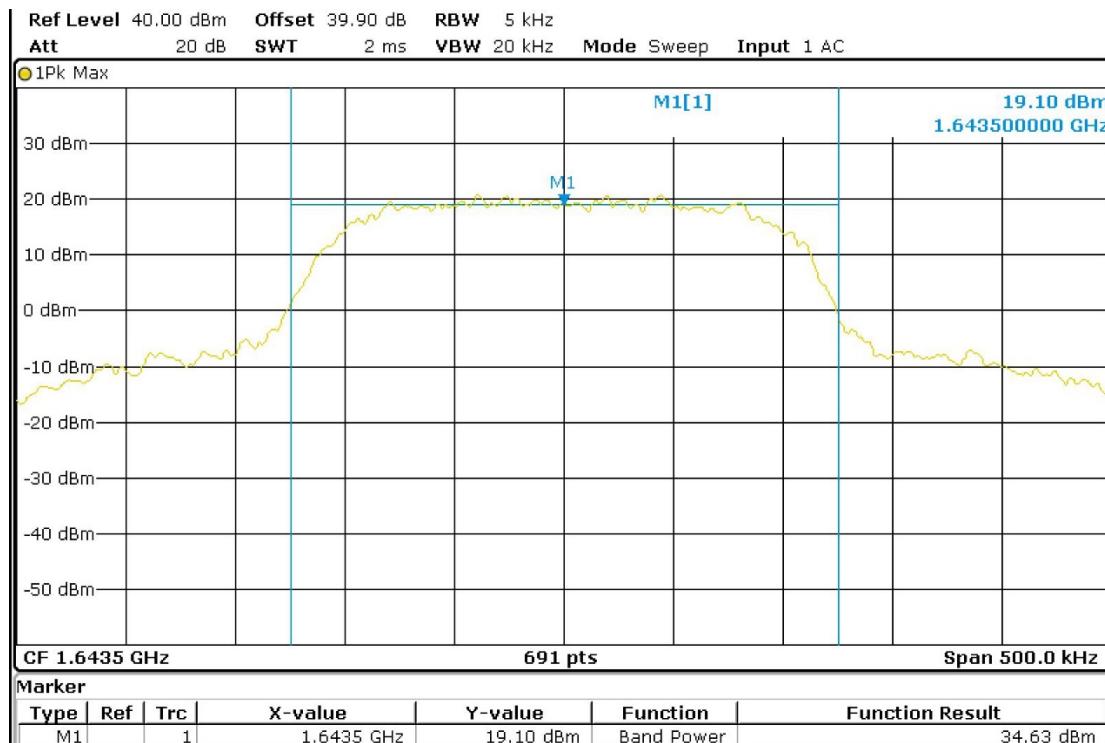
Conclusion:

The CIOF1071 did not exceed 40 dBW and therefore complied with the power requirements for any direction towards the horizontal plane.

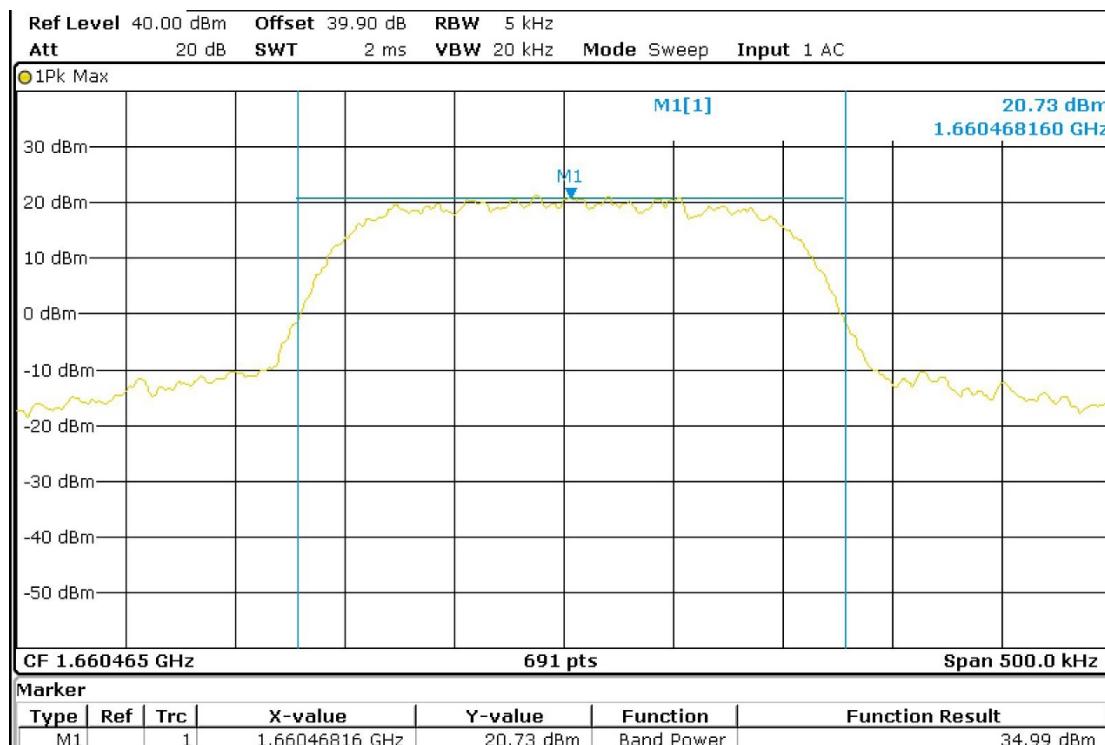
Channel 1 Power:



Channel 544 Power:



Channel 1087 Power:



3.3 §25.216 Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service

The emissions in the band 1559 MHz to 1605 MHz were measured at the antenna port of the sample. The measurements were repeated with the sample transmitting on the low, middle and high channels.

The measurements were calculated by including the attenuator loss, cable loss and antenna gain in a transducer factor loaded into the test instrument enabling direct readings from the display. A measurement bandwidth of 1 MHz using an average detector was applied.

Start Frequency 1.559 GHz
Stop Frequency 1.605 GHz
Step Size 400.000 kHz
Detector Average
RBW 1.0 MHz
Meas Time 2.0 ms
RF Atten 0.0 dB
Preamp Off

Limit:

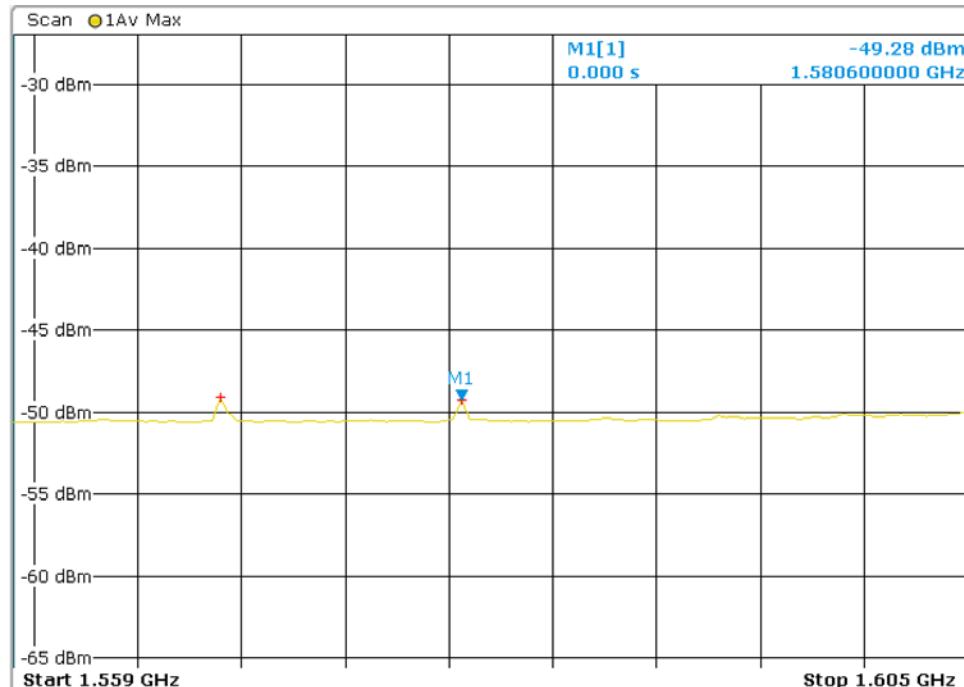
A limit of -70 dBW/MHz averaged over 2 ms applied. (-40 dBm/MHz)

Result:

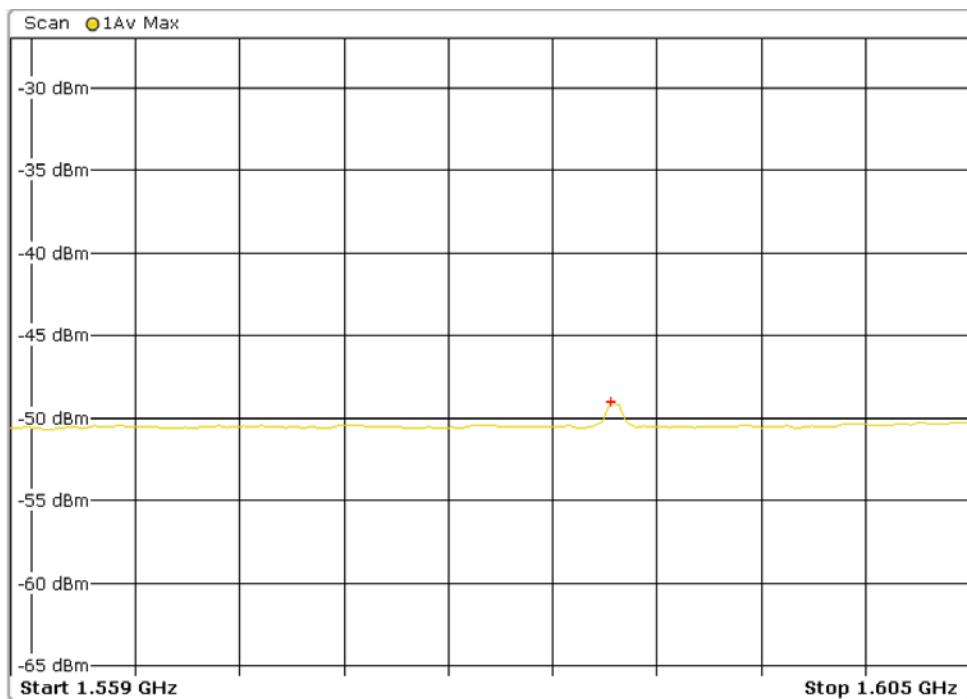
Channel	Frequency [GHz]	Level [dBm]	Margin [dB]
1	1.569	-49.1	-9.1
1	1.581	-49.3	-9.3
544	1.588	-49.0	-9.0

No emissions exceeded the limit.

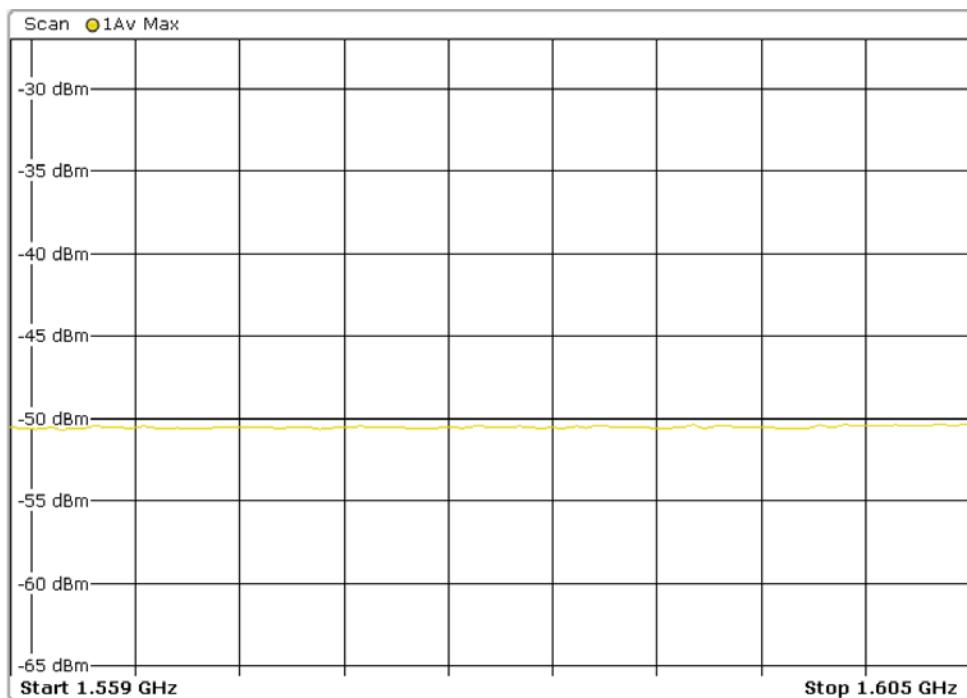
Channel 1



Channel 544



Channel 1087



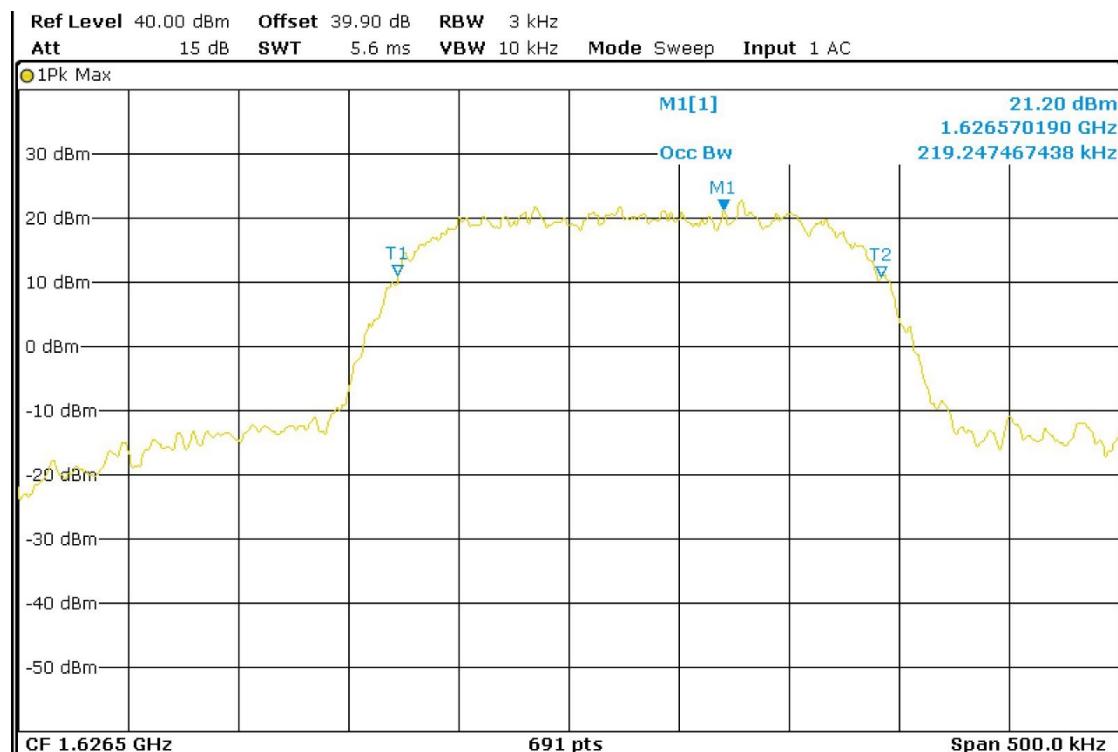
3.4 §2.1049 Occupied bandwidth – 99% power

The bandwidth containing 99% power of the transmitted signal was measured using the procedure from ANSI C63.26 section 5.4.4.

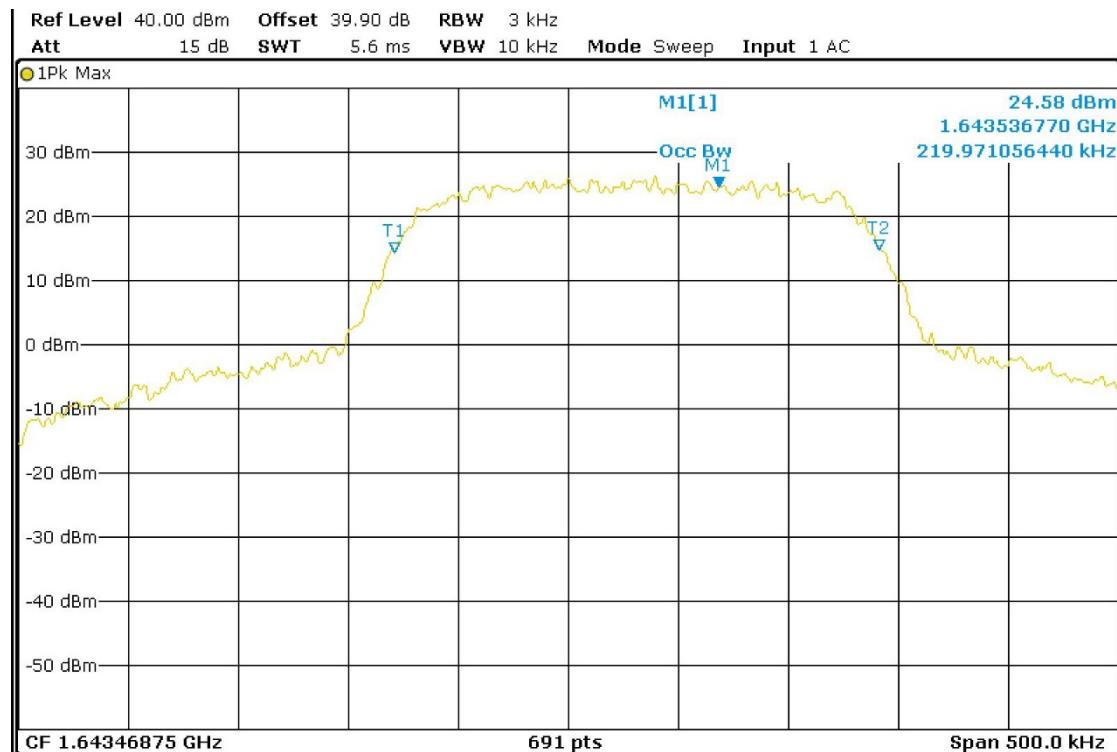
Result:

Channel	Occupied Bandwidth [kHz]
1	219
544	220
1087	220

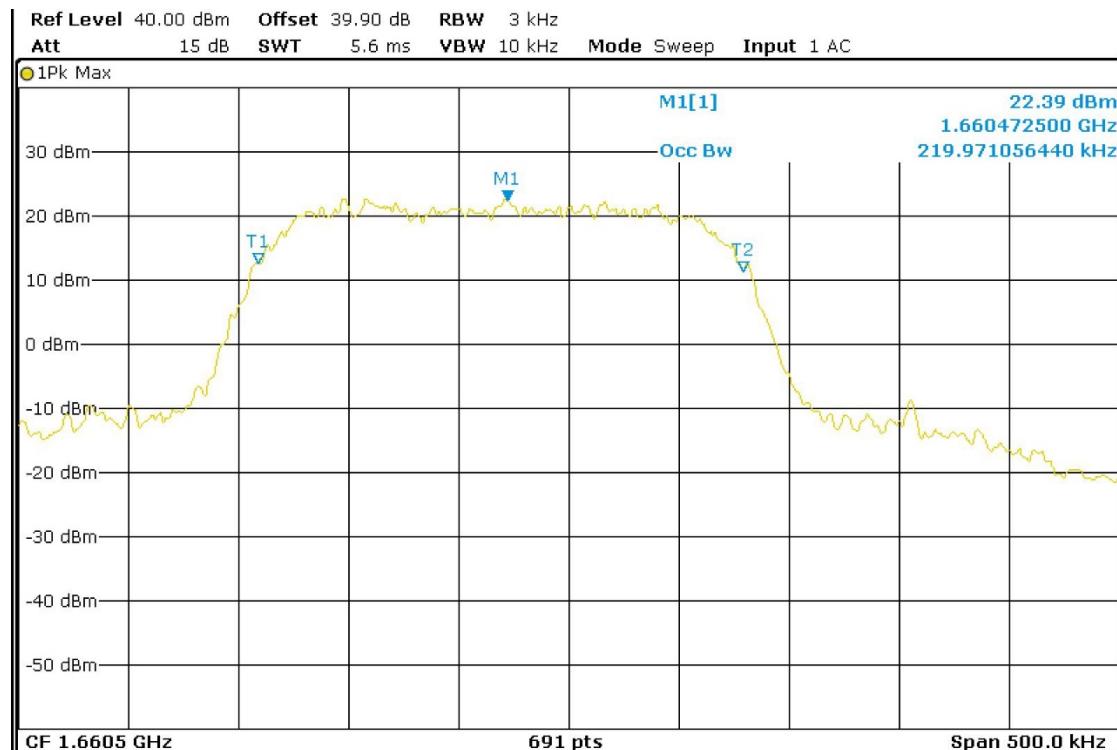
Channel 1



Channel 544



Channel 1087



4.0 COMPLIANCE STATEMENT

The CIOF1071 Thuraya WE tested on behalf of Beam Communications **complied** with the requirements of 47 CFR, Part 25 Subpart C - for a 1.5/1.6 GHz Mobile-Satellite Service.

5.0 MEASUREMENT UNCERTAINTY

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Level Uncertainty:

9 kHz to 18 GHz	±1.5 dB
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Radiated Emissions

9 kHz to 30 MHz	±4.1 dB
30 MHz to 300 MHz	±5.1 dB
300 MHz to 1000 MHz	±4.7 dB
1 GHz to 18 GHz	±4.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.