Certification Test Report

FCC ID: 2AWTM-RTLS-OEM001
IC: 21847-RTLSOEM001

Radio Standard Specification: FCC 47 CFR Part 15.250 Subpart C
ISED Canada's Radio Standards Specification: RSS-220, Issue 1

TÜV SÜD Report Number: RD72160943.301

Manufacturer: Mirion Technologies
Model: UWB OEM Tag

Test Begin Date: June 17, 2020
Test End Date: July 7, 2020

Report Issue Date: October 8, 2020

A2LA Cert. No. 2955.18

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 2955.18

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, ANSI, or any agency of the Federal Government.

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This report contains 28 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with FCC 47 CFR 15.250 Subpart C and RSS-220, Issue 1.

1.2 Product Description

Ultra-Wideband Transceiver module with integrated planar antenna controlled via off-board microprocessor via serial interface.

Technical Information:

Detail	Description
Transmit Frequency / Carrier Wave	6178.9 MHz to 6731.4 MHz (Channel 5) / 6489.6 MHz
Receiver Frequency / Carrier Wave	6178.9 MHz to 6731.4 MHz (Channel 5) / 6489.6 MHz
Modulation Format	UWB using PRF16, PRF64
Operating Voltage	3.3Vdc
Antenna Type / Gain:	Planar PCB / 1.4dBi
Temperature Category	-20C to +60C
Type of equipment:	Mobile
Hardware version:	A
Software release:	5.6.4

Manufacturer Information:
Mirion Technologies (MGPI) SAS
174 Route d'Eyguiéres
13113 Lamanon
France

Contact:
David Jarrow
1-770-432-2744
DJarrow@Mirion.com

EUT Serial Numbers: 0B:00:01BA

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

The device is physically small and can be used in many orientations. Therefore, the EUT was evaluated in the X, Y, and Z planes. The worst-case plane was X-Plane. The data in the report represents worst case.

The EUT Power setting for PRF16 was:
Coarse Gain 0, Fine Gain 9

The EUT Power setting for PRF64 was:
Coarse Gain 1, Fine Gain 4

For testing, the client provided software to control and configure the EUT.

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

TÜV SÜD America Inc.
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. (Durham) is accredited to ISO/IEC 17025 by A2LA accreditation program, and has been issued certificate number 2955.18 in recognition of this accreditation. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC and Innovation, Science and Economic Development (ISED) Canada.

FCC Designation Number: US1245
FCC Test Firm Registration Number: 238628
ISED Canada Company Number: 20446

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using short #6 copper wire. The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the turntable. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

To comply with the requirements of the test methods given on page 4, RF absorbing foam was placed inside the chamber in a configuration that provided the best results. First, a 12ft X 12ft. patch of 10" tall absorber was placed on the floor between the turntable and the receiving antenna. This absorber meets the absorption requirements specified in ANSI C63.4:2009.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

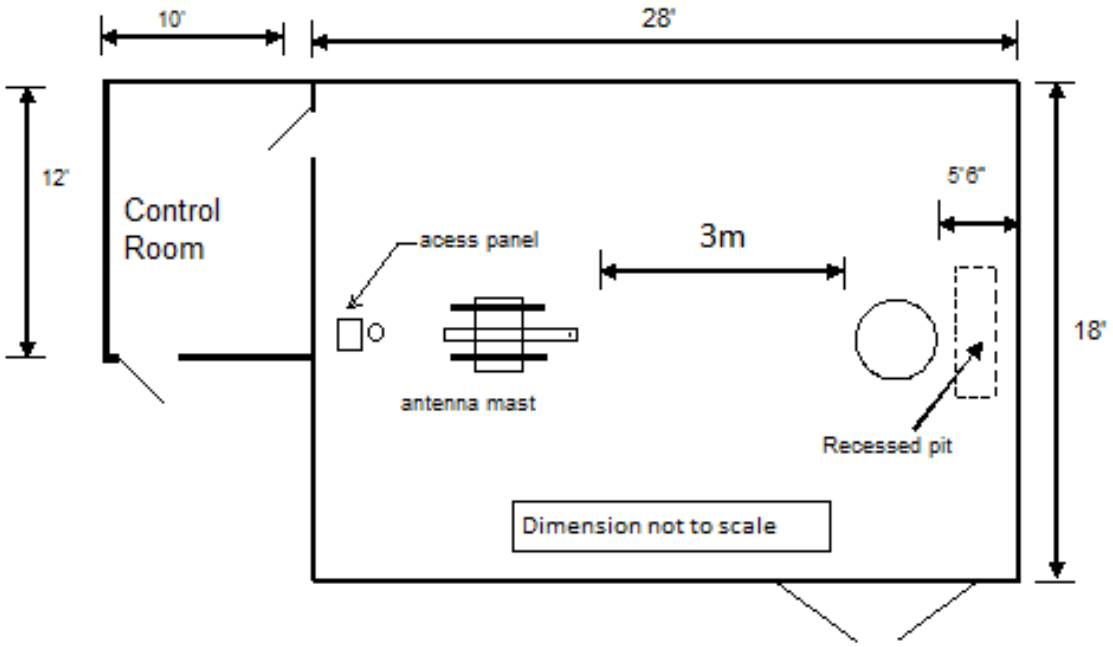

Figure 2.3-1: Semi-Anechoic Chamber Test Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- RSS-220, Issue 1 (March 2009) Amendment 1 (July 2018) — Devices Using Ultra-Wideband (UWB) Technology

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

Asset ID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
DEMC0426	Thermotron	S-8 Mini Max	Environmental Chamber	25-2888-10	1/23/2020	1/23/2021
DEMC3002	Rohde & Schwarz	ESU40	Receiver	100346	1/22/2020	1/22/2021
DEMC3006	Rohde & Schwarz	TS-PR18	Amplifier	122006	1/23/2020	1/23/2021
DEMC3007	Rohde & Schwarz	TS-PR26	Amplifier	100051	1/23/2020	1/23/2021
DEMC3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
DEMC3014	EMCO	3115	Antenna	9901-5653	4/12/2019	4/12/2021
DEMC3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antenna	2013120203	4/8/2020	4/8/2021
DEMC3032	Hasco, Inc.	HLL142-S1-S1-192/WA	Cable	3075	1/23/2020	1/23/2021
DEMC3033	Hasco, Inc.	HLL142-S1-S1-36	Cable	1435	1/23/2020	1/23/2021
DEMC3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/27/2020	1/27/2021
DEMC3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/27/2020	1/27/2021
DEMC3055	Rohde & Schwarz	3005	Cable	3055	1/23/2020	1/23/2021
DEMC3085	Rohde & Schwarz	FSW43	Spectrum Analyzer	103997	1/22/2020	1/22/2021
DEMC3161	TESEQ	CBL-6112D	Antenna	51323	2/18/2020	2/18/2021
332	Rohde & Schwarz	TS-PR40	Amplifier	100021	6/12/2020	6/12/2022
333	Rohde & Schwarz	3160-10	Antenna	49404	NCR	NCR
335	Suhner	SF-102A	Cable	882/2A	6/23/2020	6/23/2021

NCR = No Calibration Required
DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.
Asset DEMC3002: Firmware Version: ESU40 is 4.73 SP4
Asset DEMC3012: Software Version: EMC32-B is 10.50.00
Asset DEMC3020: Firmware Rev: 2.20.382.113
Asset DEMC3085: Instrument Firmware 2.90 SP1
All assets were only used within their current calibration cycle.

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Mirion Technologies	UWB OEM Tag	See Section 1.2

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

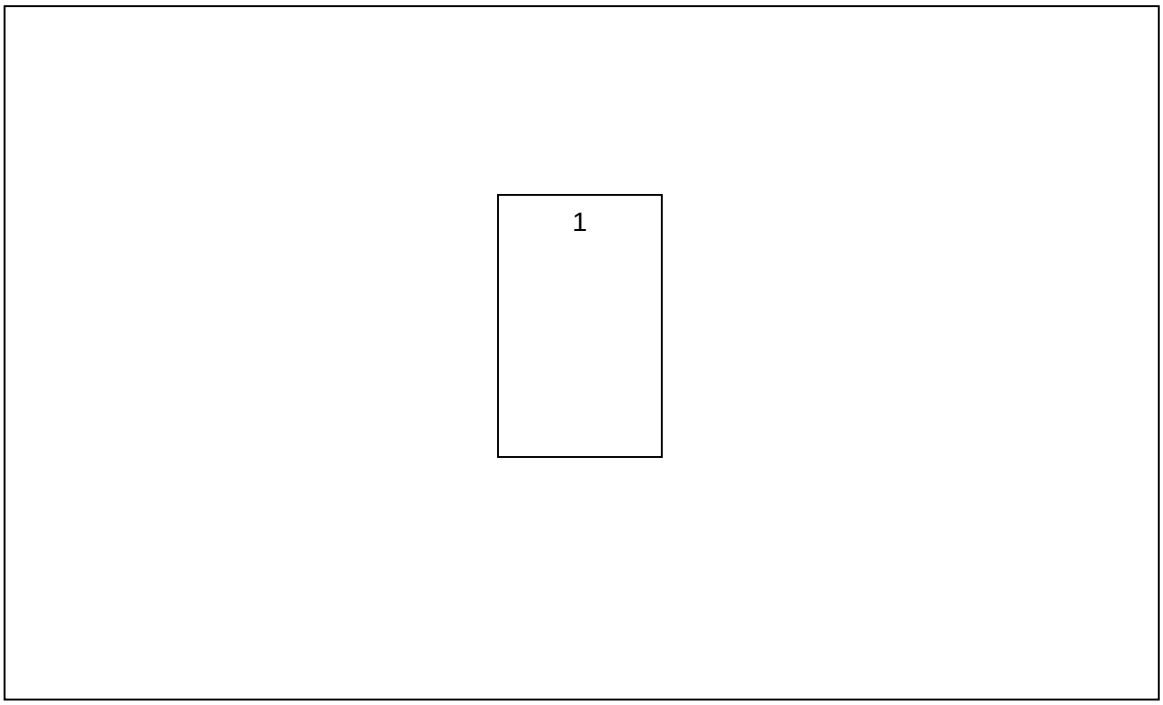

Figure 6-1: EUT Test Setup Block Diagram

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC: 15.203 and RSS-220, Issue 1, Section 5.1 (b) / 5.3.1(a)

The antennas are non-detachable PCB trace antennas.

7.2 Band of Operations – FCC 15.250(a) and RSS-220, Issue 1, Section 5.1 (a)

7.2.1 Measurement Procedure

The EUT was placed in an environmental chamber and the center frequency and 10dB bandwidth were measured in accordance with ANSI C63.10: 2013 Section 10.1. The resolution bandwidth (RBW) of the spectrum analyzer was set to 1MHz. The video bandwidth (VBW) was set to ≥ 1 to 3 times the RBW. The trace was set to max hold with a Peak detector active.

7.2.2 Measurement Results

Measurement performed by: Chris Gormley

Table 7.2.2-2: Frequency Stability over Temperature

Temperature °C	Measured Frequency (MHz)	-10dB Band Edges		15.250 Frequency Limits	
		Lower	Upper	Fmin (MHz)	Fmax (MHz)
-20	6490	6138.4	6827.7	5925	7250
-10	6488	6156.3	6833.7	5925	7250
0	6488	6188.3	6865.6	5925	7250
10	6476	6232.3	6855.6	5925	7250
20	6480	6236.3	6821.2	5925	7250
30	6490	6214.3	6825.7	5925	7250
40	6490	6322.2	6787.7	5925	7250
50	6400	6212.3	6807.7	5925	7250
60	6402	6238.3	6789.7	5925	7250

***Note - RSS-220 limits: The -10 dB bandwidth of the device shall be totally contained in the band 3.1-10.6 GHz**

7.3 10 dB Bandwidth – FCC 15.250(a) and RSS-220 5.1(a)

7.3.1 Measurement Procedure

The 10 dB bandwidth was measured in accordance with the ANSI C63.10: 2013 Section 10.1. The resolution bandwidth (RBW) of the spectrum analyzer was set to 1MHz. The video bandwidth (VBW) was set to ≥ 1 to 3 times the RBW. The trace was set to max hold with a Peak detector active.

7.3.2 Measurement Results

Measurement Performed By: Chris Gormley

Table 7.3.2-1: 10 dB Bandwidth

Modulation Format	Frequency fc [MHz]	10 dB Bandwidth [MHz]
PRF16	6544.5	613.3
PRF 64	6644.4	520.5

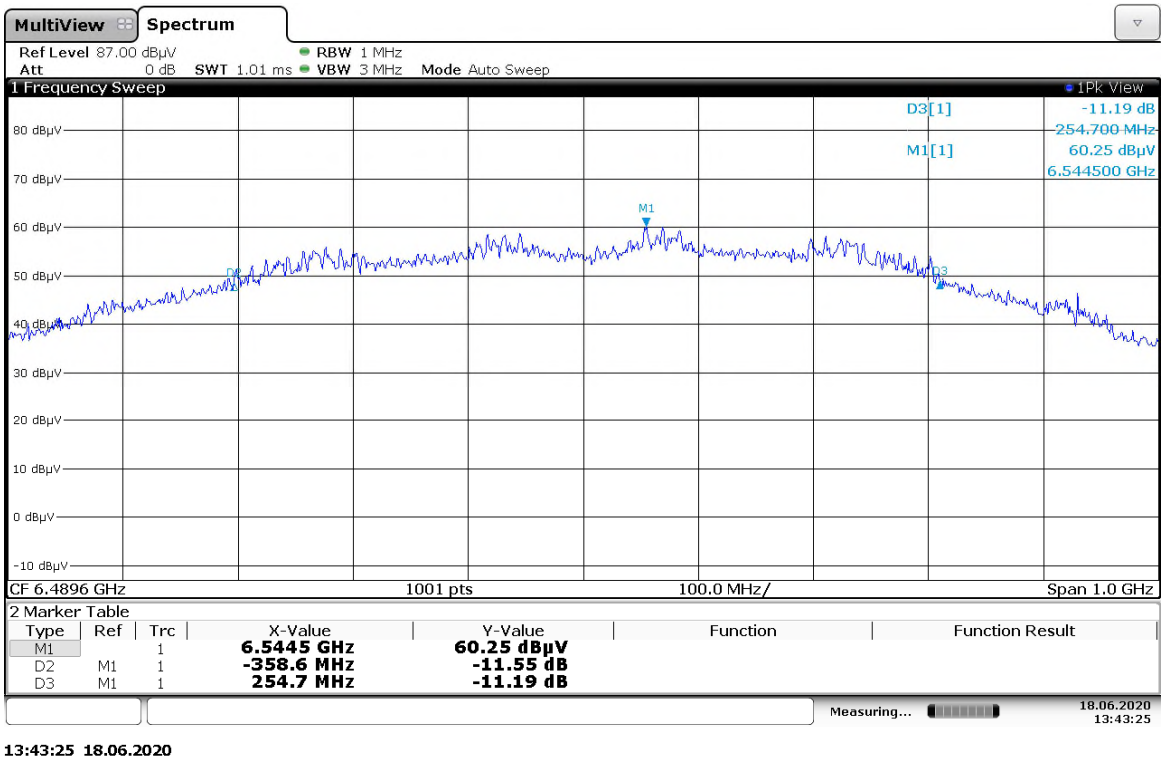

Figure 7.3.2-1: 10 dB Bandwidth – PRF16

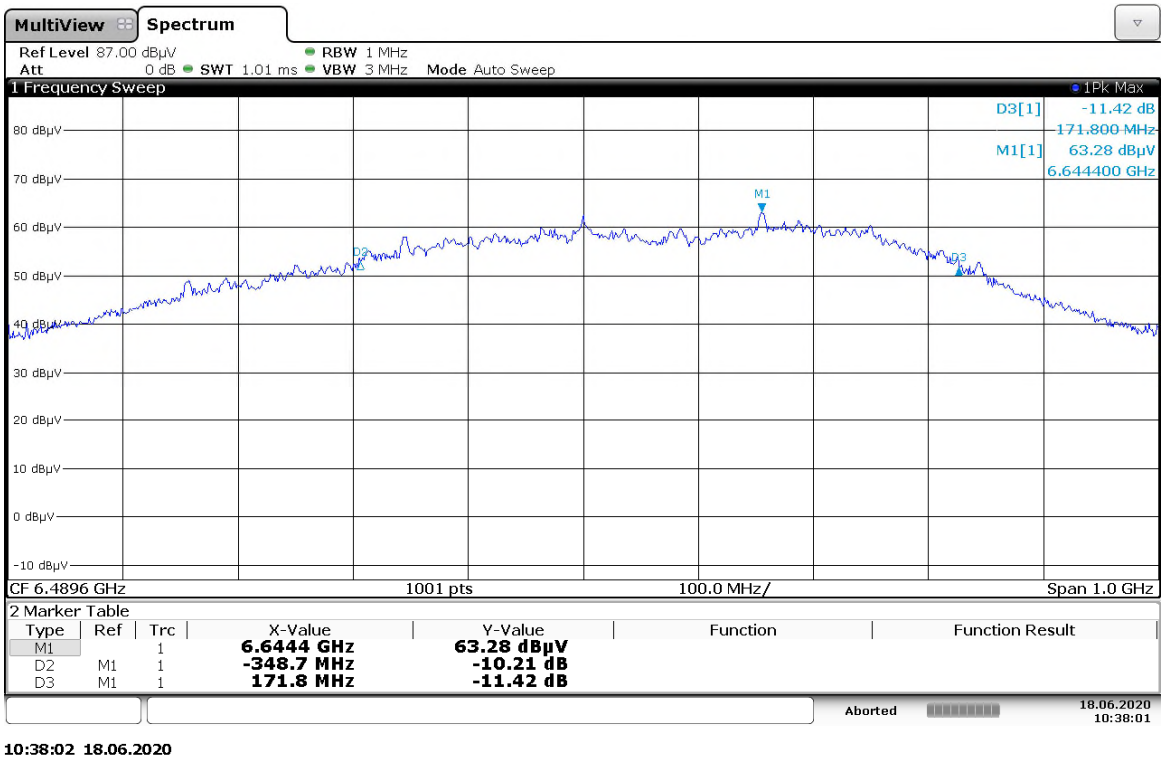

Figure 7.3.2-2: 10 dB Bandwidth – PRF64

7.4 Fundamental Emission Peak Power – FCC 15.250(d) and RSS-220, Issue 1, Section 5.3.1(g)

7.4.1 Measurement Procedure

The maximum peak radiated output power was measured in accordance with ANSI C63.10: 2013 Section 10.3.5. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 50MHz. The Video Bandwidth (VBW) was set to its maximum 80MHz. The trace was set to max hold with a peak detector active.

The RMS power was measured with RBW of the spectrum analyzer set to 1MHz and the VBW set to 3MHz. A longer sweep time was utilized a to ensure a 1ms integration period over each measurement bin.

7.4.2 Measurement Results

Measurement Performed By: Chris Gormley

Field Strength to EIRP (dBm): Corrected Field Strength – 95.2 = EIRP (dBm)

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA-PA)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
PA	=	Preamplifier Gain

Example Calculation:

89.13dBm + 5.79dB = 94.92dBuV
94.92dBuV – 95.2 = -0.28dBm EIRP

Per FCC 15.250(d) and RSS-220, Section 5.3.1(g) the peak limit on the fundamental is 0 dBm EIRP.

Table 7.4.2-1: Maximum Radiated Output Power

Modulation Format	Detector	Frequency (MHz)	Measured Power (dBuV)	Correction (dB/m)	Output Power (EIRP) (dBm)	Limit (dBm)
PRF16	Peak	6550.5	89.13	5.79	-0.28	0
PRF16	RMS	6533.6	41.12	5.75	-48.33	-41.3
PRF64	Peak	6559.5	85.01	5.81	-4.38	0
PRF64	RMS	6616.5	47.15	5.94	-42.11	-41.3

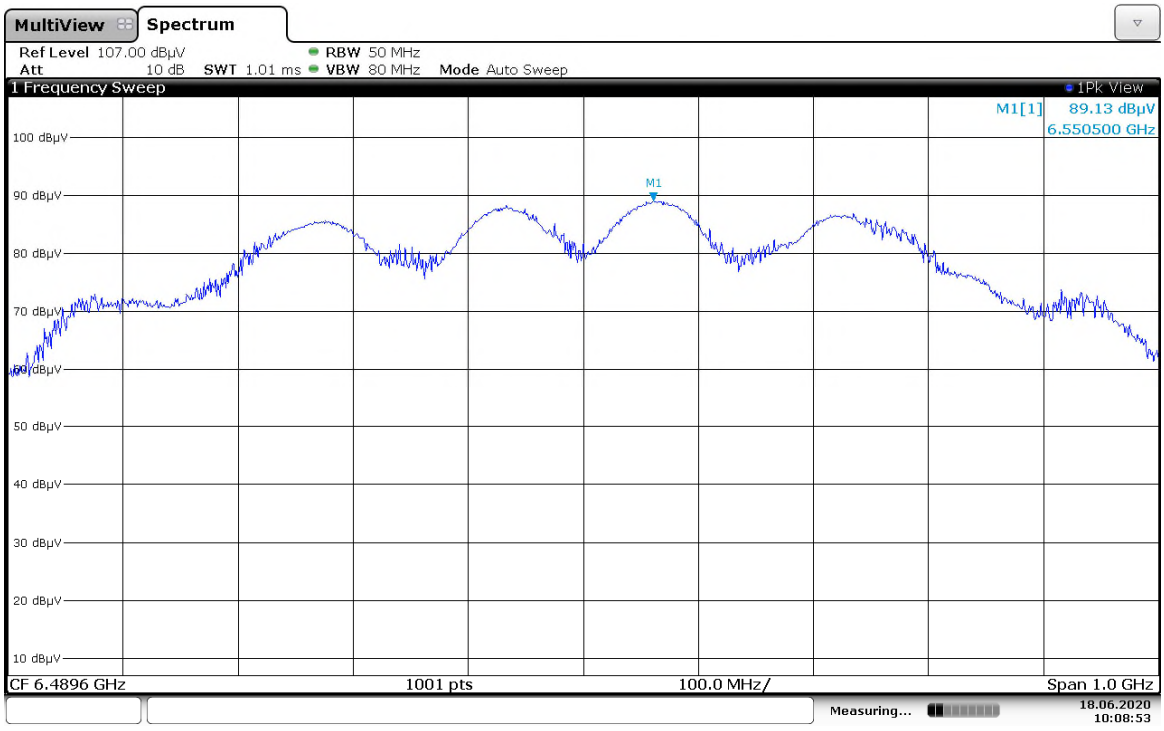

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Figure 7.4.2-1: Peak Power Plot – PRF16

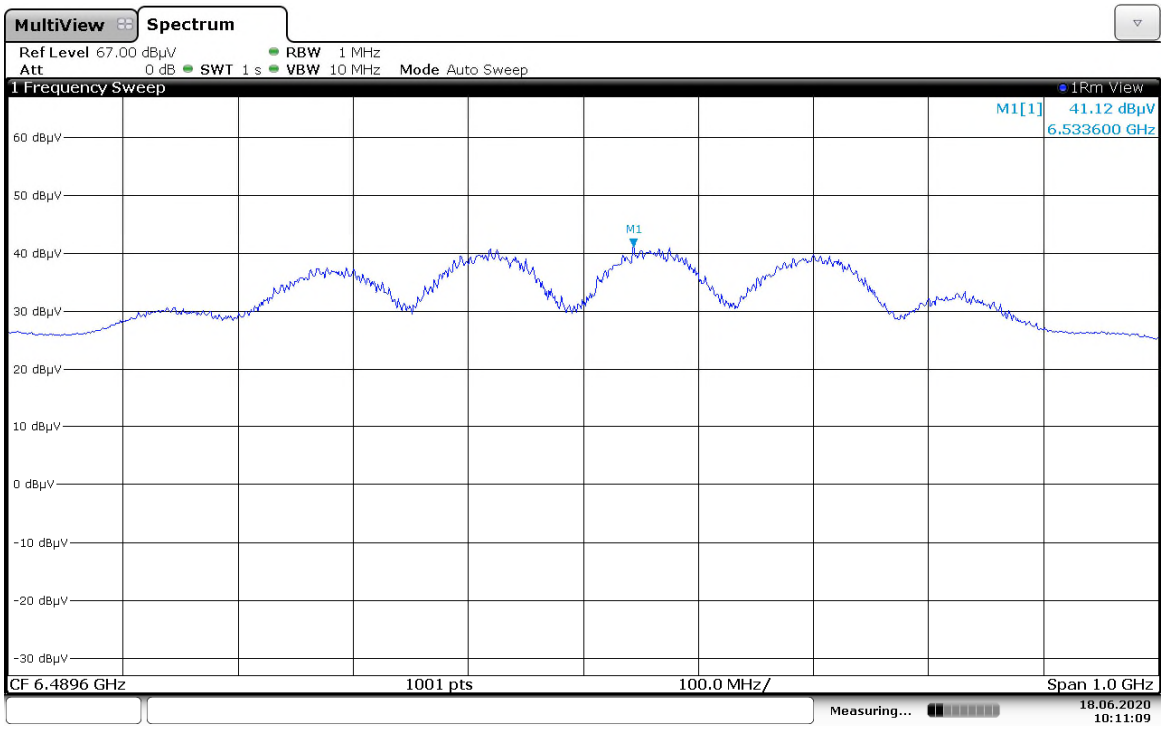

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Figure 7.4.2-2: RMS Power Plot – PRF16

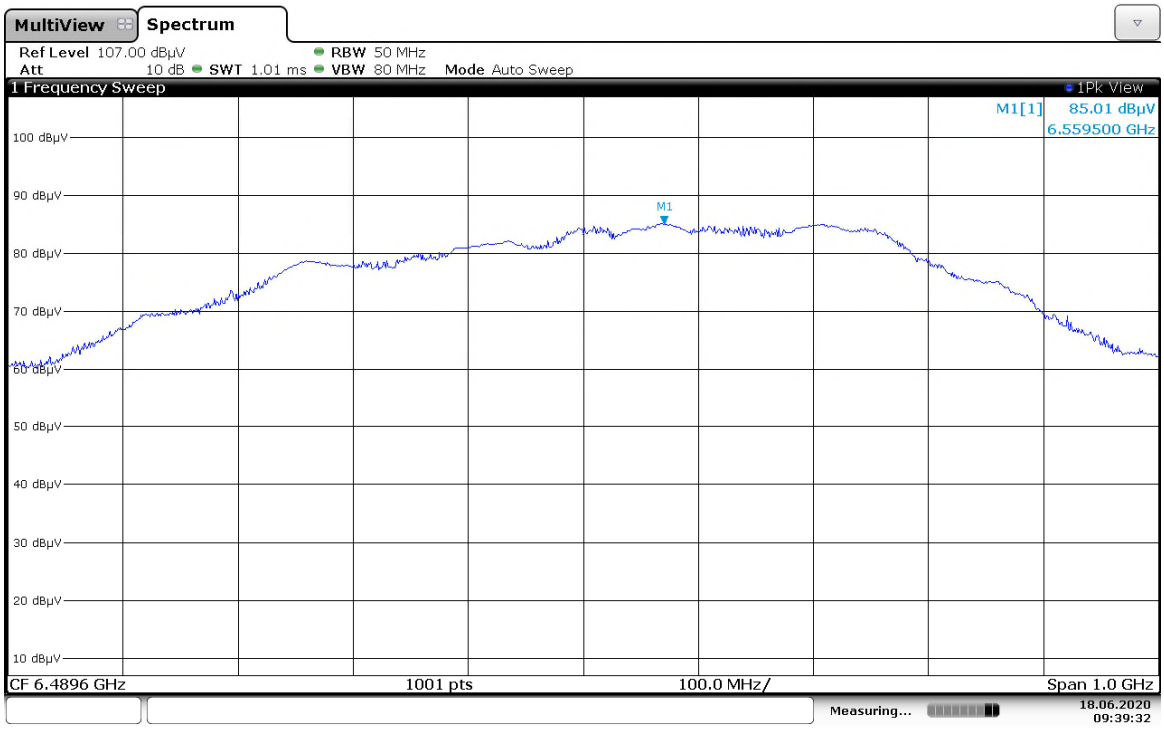

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Figure 7.4.2-3: Peak Power Plot – PRF64

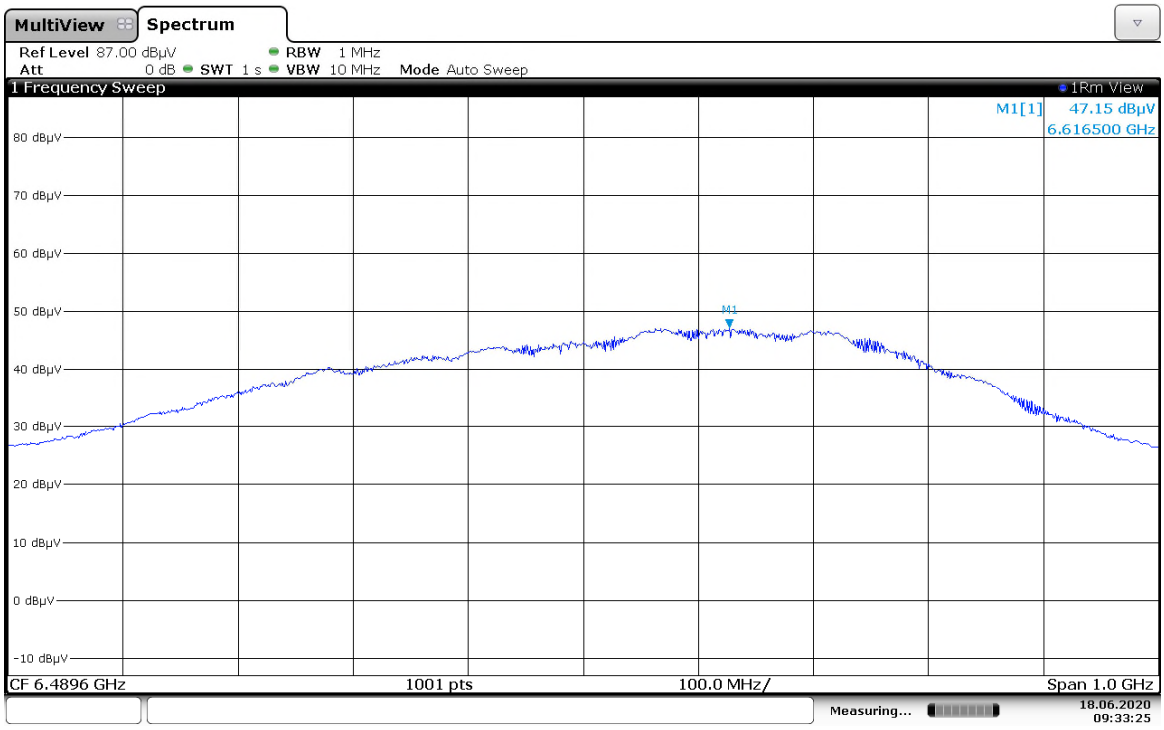

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Figure 7.4.2-4: RMS Power Plot – PRF64

7.5 Radiated emissions above 960 MHz – FCC 15.250(d)(1) and RSS-220, Issue 1, Section 5.3.1(d)

7.5.1 Measurement Procedure

The rms-average power spectral density was measured in accordance with the ANSI C63.10 Section 10.3.7. The equipment under test was tested radiated. The resolution bandwidth (RBW) of the spectrum analyzer was set to 1 MHz. The video bandwidth (VBW) was set to ≥1 MHz. Span was set to a convenient frequency segment. The trace was set to max hold with an RMS detector active. The sweep time did not exceed 1ms per bin.

7.5.1.1 Sample Calculation:

Field Strength to EIRP (dBm): Field Strength – 95.2_{3m} (104.7_{1m}) = EIRP (dBm) (Applied using amplitude offset in plots)

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA-PA)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
PA	=	Preamplifier Gain

Example Calculation: RMS
Corrected Level: 28.38 + 5.11 = 33.49dBuV/m
Convert from dBuV to dBm: 33.49 - 104.7 = -71.21dBm/MHz

Table 7.5.1.1-1 Limits from 15.250(d)(1):

Frequency MHz	EIRP dBm
960 to 1610	-75.3
1610 to 1990	-63.3
1990 to 3100	-61.3
3100 to 5925	-51.3
5925 to 7250	-41.3
7250 to 10600	-51.3
Above 10600	-61.3

Table 7.5.1.1-2 Limits from RSS-220 Section 5.3.1(d):

Frequency MHz	EIRP dBm
960 to 1610	-75.3
1610 to 4750	-70.0
4750 to 10600	-41.3
Above 10600	-61.3

7.5.2 Measurement Results

Measurement Performed By: Chris Gormley

Table 7.5.2-1: Radiated Emissions above 960MHz – PRF16

Emission Frequency MHz	Reading From plot dBµV	Antenna Polarity	Measurement Distance m	Correction Factors dB/m	Corrected EIRP dBm	Limit dBm
1151.96	18.83	V	1	-7.05	-92.92	-75.3
1247.39	18.32	H	1	-7.00	-93.38	-75.3
6297.65	33.49	V	1	5.11	-66.10	-41.3
6297.65	28.38	H	1	5.11	-71.21	-41.3
6563.94	32.87	V	1	5.82	-66.01	-41.3
6564.9	43.86	H	1	5.82	-55.02	-41.3
8753	16.38	V	1	10.84	-77.48	-51.3
8568.7	16.04	H	1	11.04	-77.62	-51.3

Table 7.5.2-2: Radiated Emissions above 960MHz – PRF64

Emission Frequency MHz	Reading From plot dBµV	Antenna Polarity	Measurement Distance m	Correction Factors dB/m	Corrected EIRP dBm	Limit dBm
1267.39	18.63	H	1	-6.99	-93.06	-75.3
1227.09	18.61	V	1	-7.01	-93.1	-75.3
6292.01	28.06	H	1	5.09	-71.55	-41.3
6299.53	35.02	V	1	5.11	-64.57	-41.3
6663.78	34.59	H	1	6.04	-64.07	-41.3
6618.54	42.18	V	1	5.94	-56.58	-41.3
8741.9	16.53	H	1	10.85	-77.32	-51.3
8747.6	16.51	V	1	10.85	-77.34	-51.3

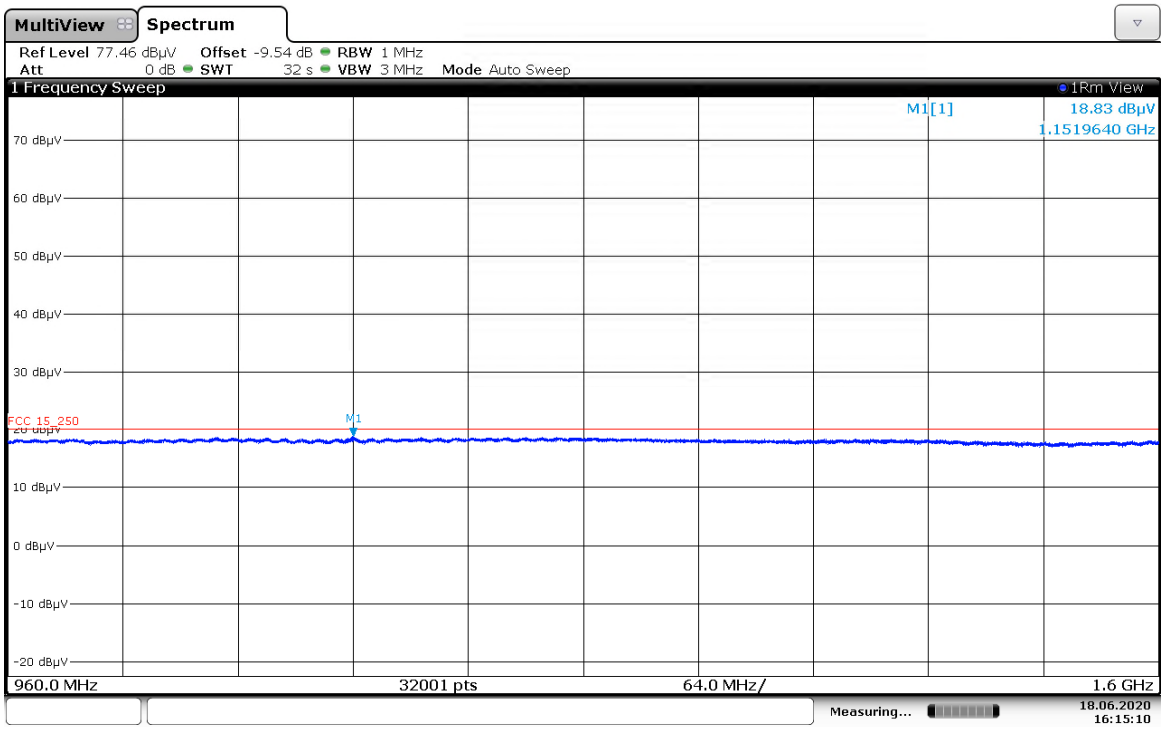

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Figure 7.5.2-1: 960 MHz – 1.61 GHz – PRF16 – 1m

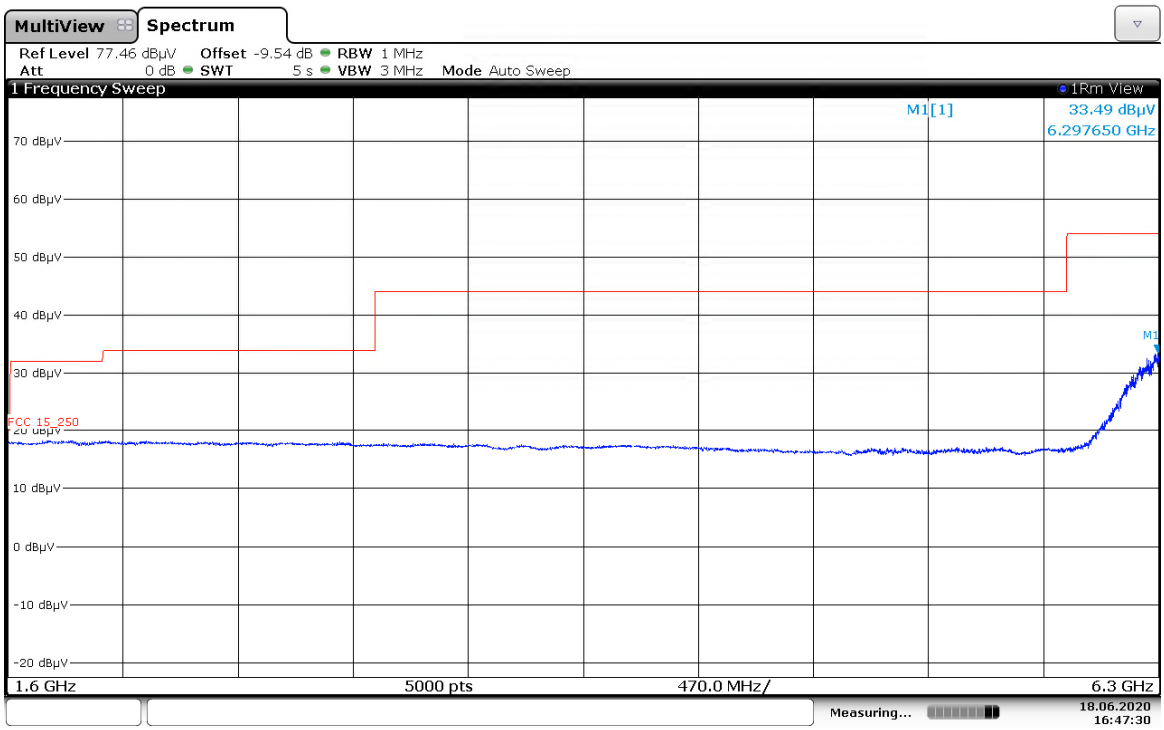

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Figure 7.5.2-2: 1.61 GHz – 6.3 GHz – PRF16 – 1m

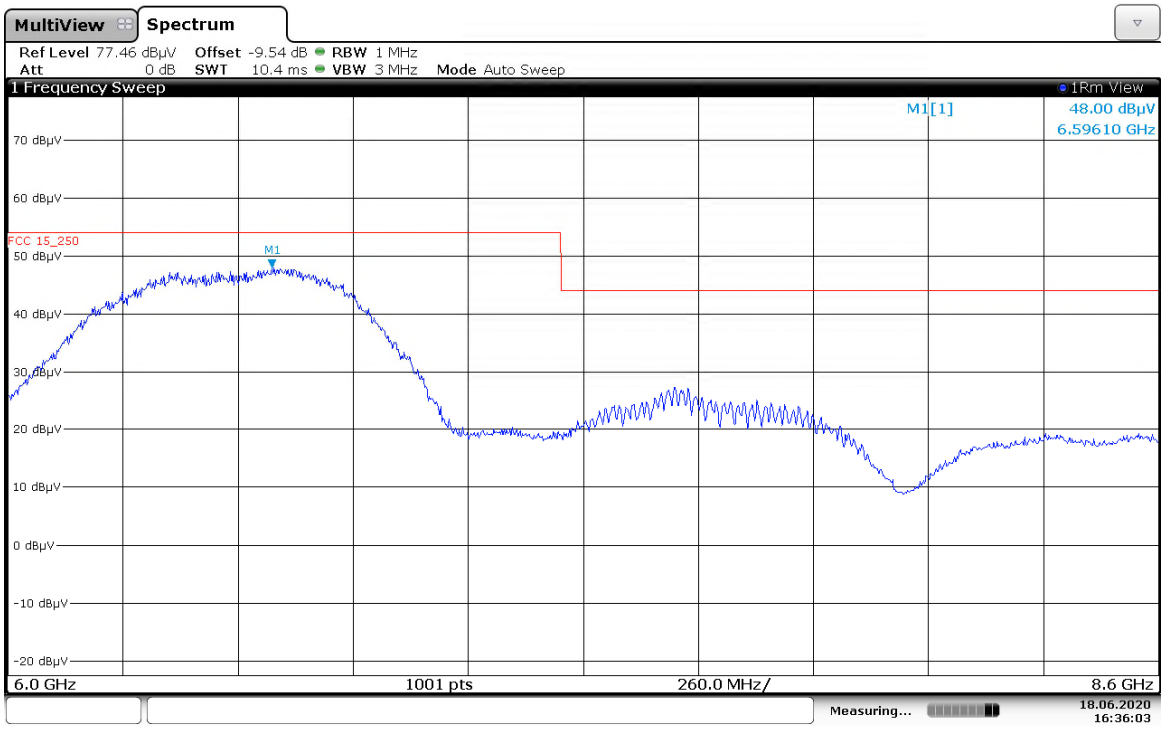

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Figure 7.5.2-3: 6 GHz – 8.6 GHz – PRF16 – 1m

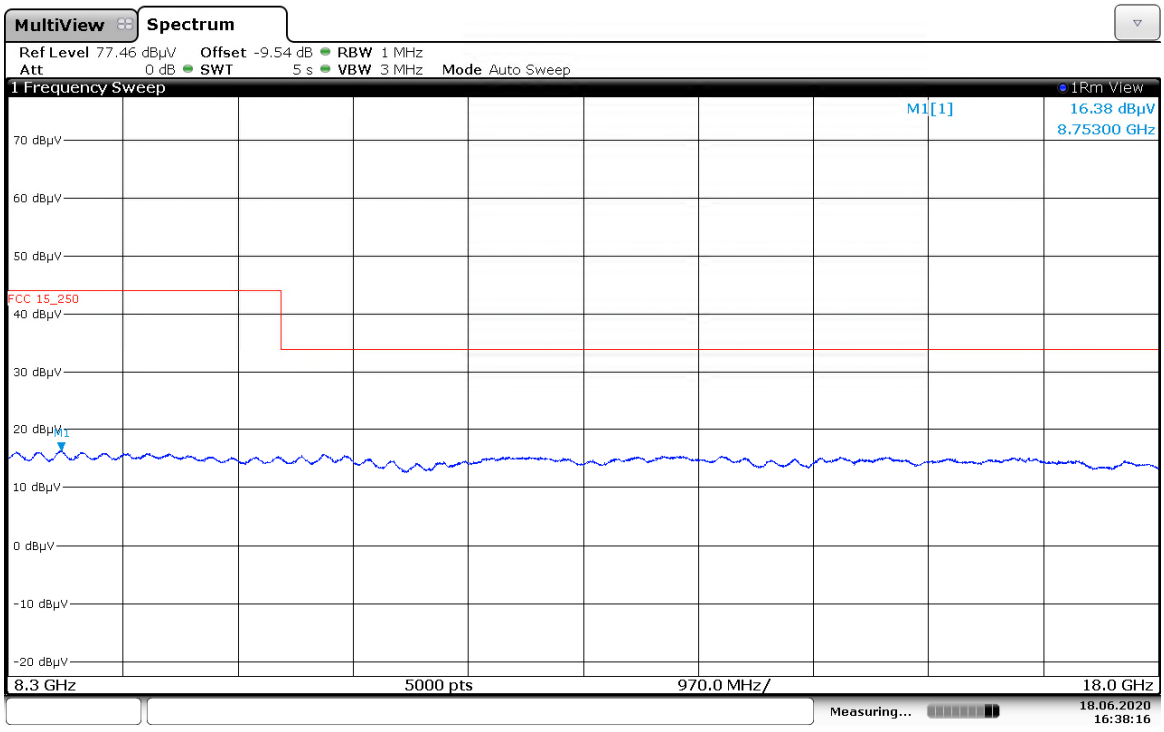

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Figure 7.5.2-4: 8.3 GHz – 18 GHz – PRF16 – 1m

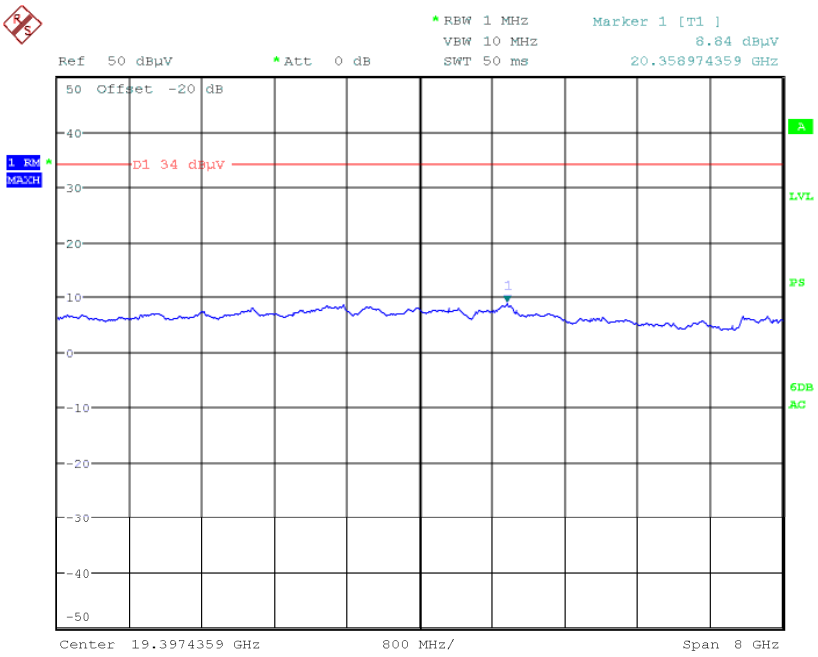

Figure 7.5.2-5: 18-26 GHz – PRF16 – 30cm

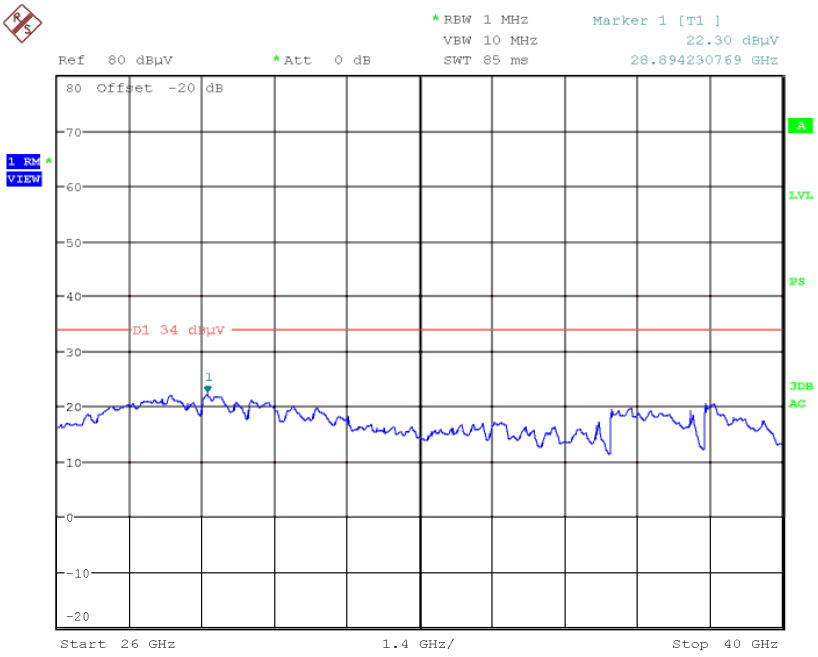

Figure 7.5.2-6: 26-40 GHz – PRF16 – 30cm

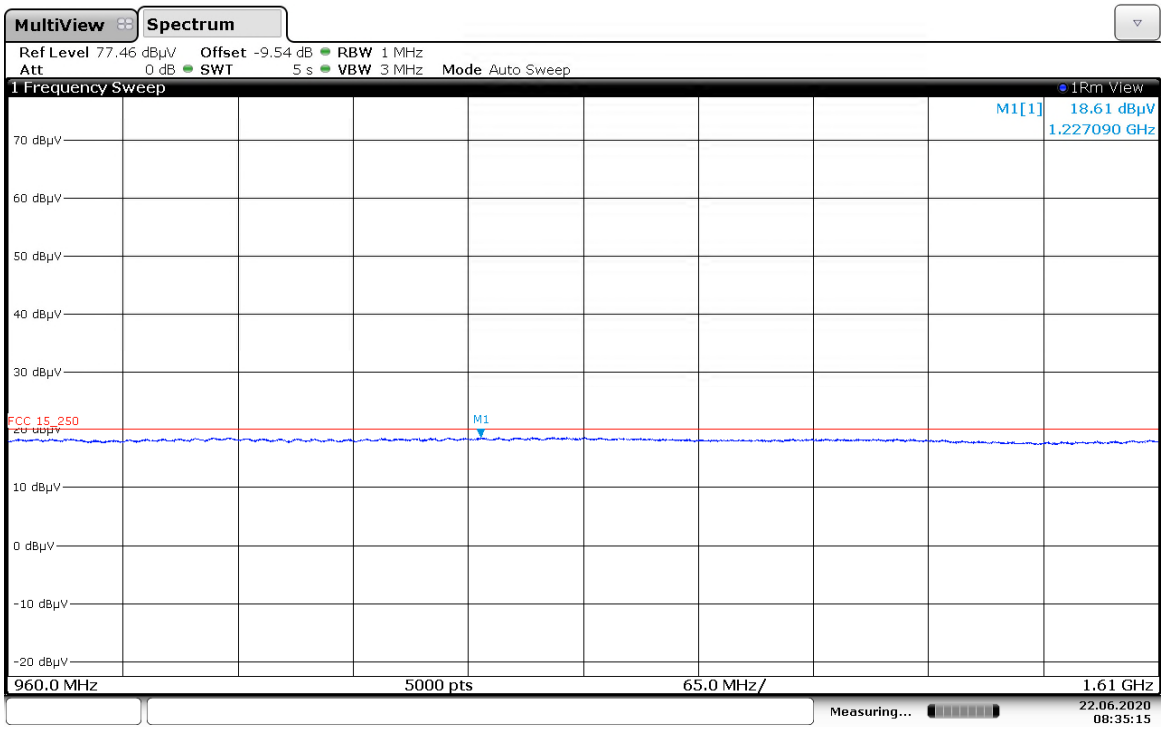

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Figure 7.5.2-7: 960 MHz – 1.61 GHz – PRF64 – 1m

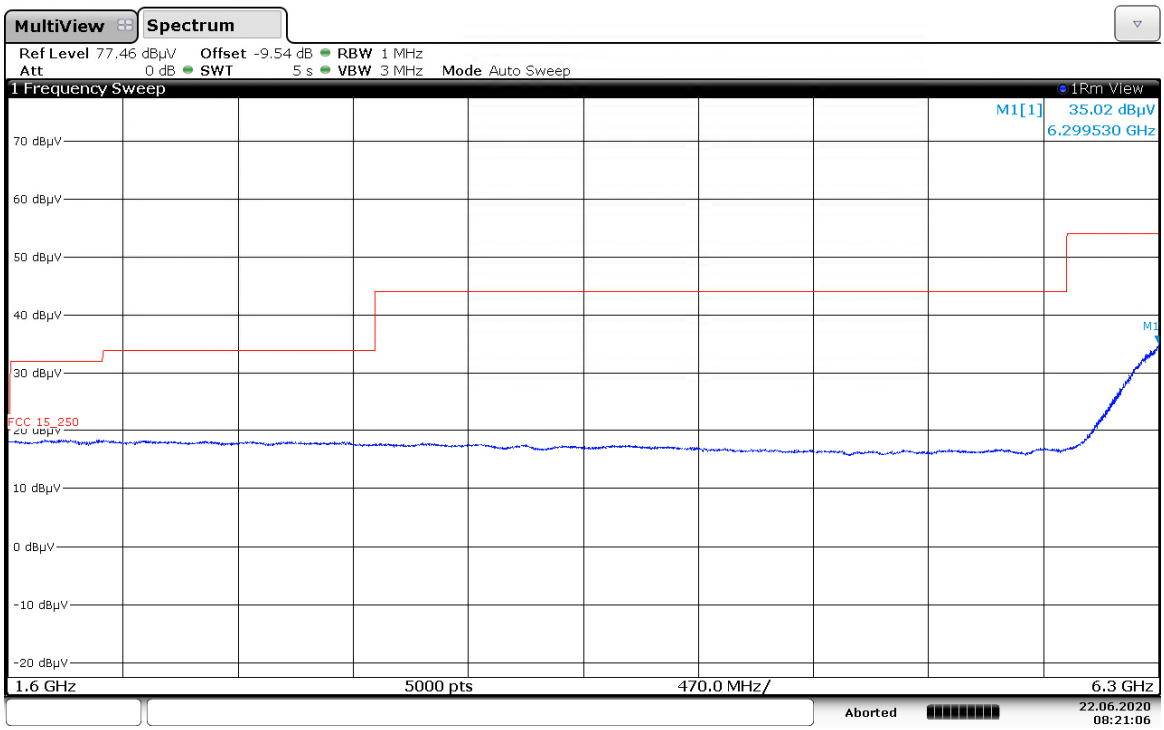

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Figure 7.5.2-8: 1.61 GHz – 6.3 GHz – PRF64 – 1m

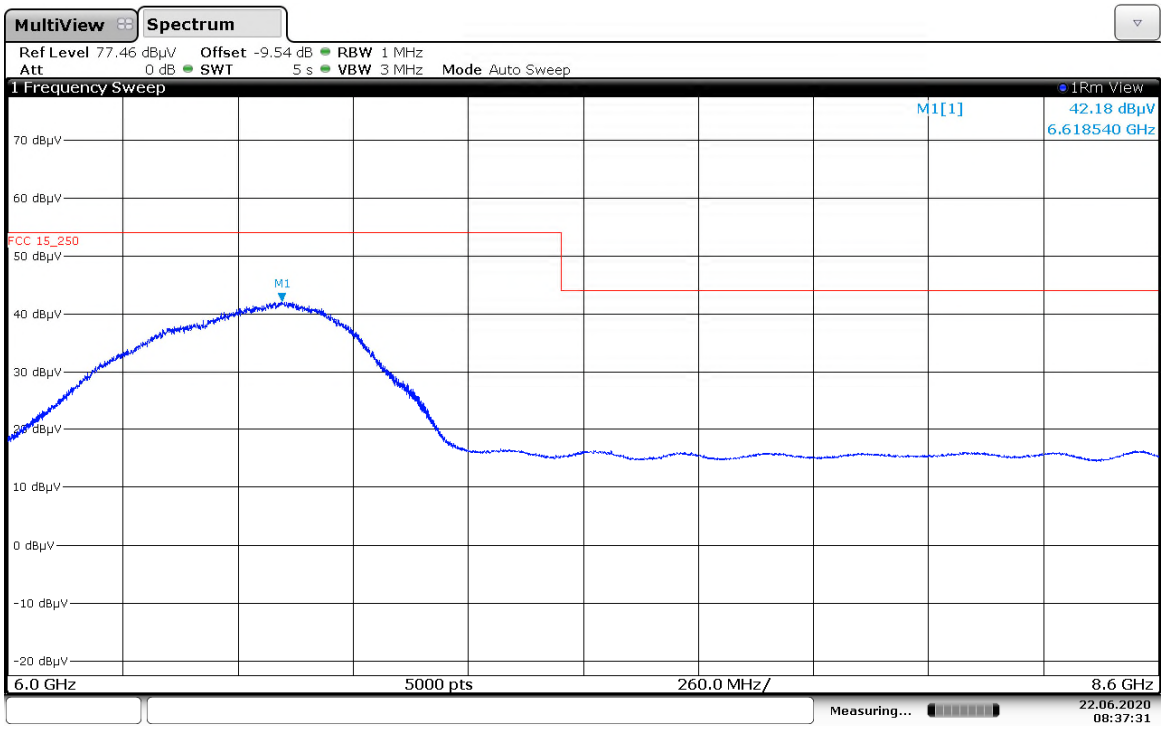

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Figure 7.5.2-9: 6 GHz – 8.6 GHz – PRF64 – 1m

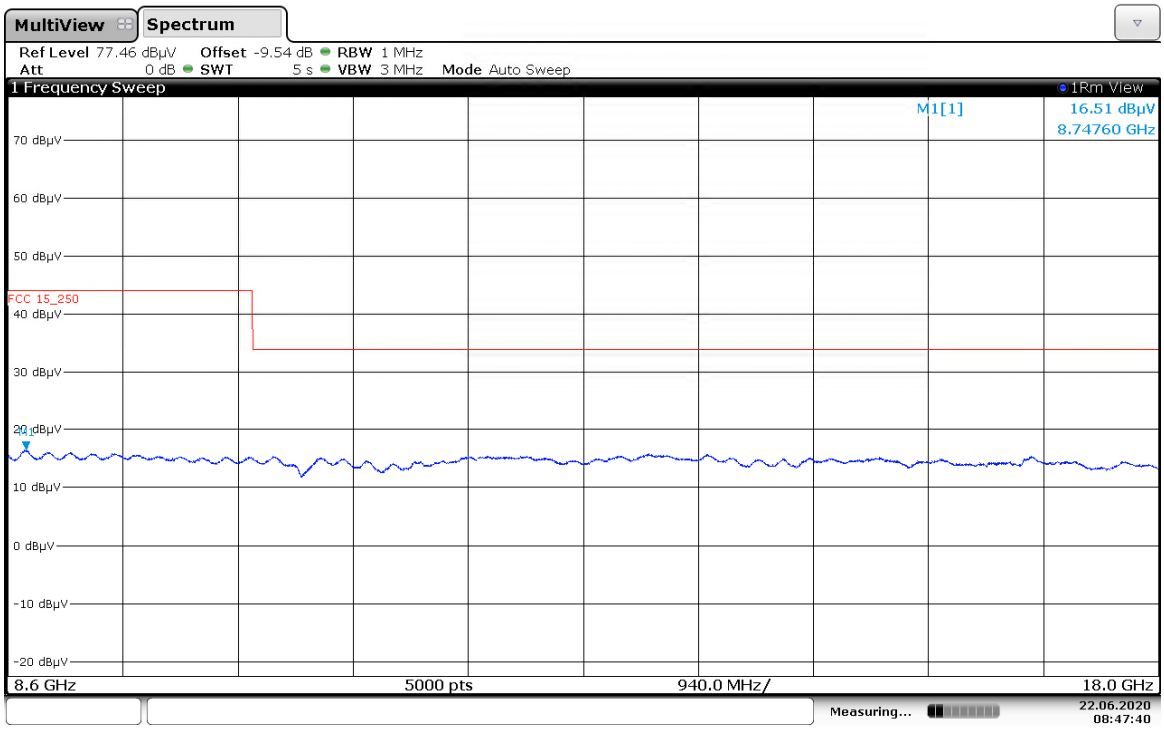

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Figure 7.5.2-10: 8.3 GHz – 18 GHz – PRF64 – 1m

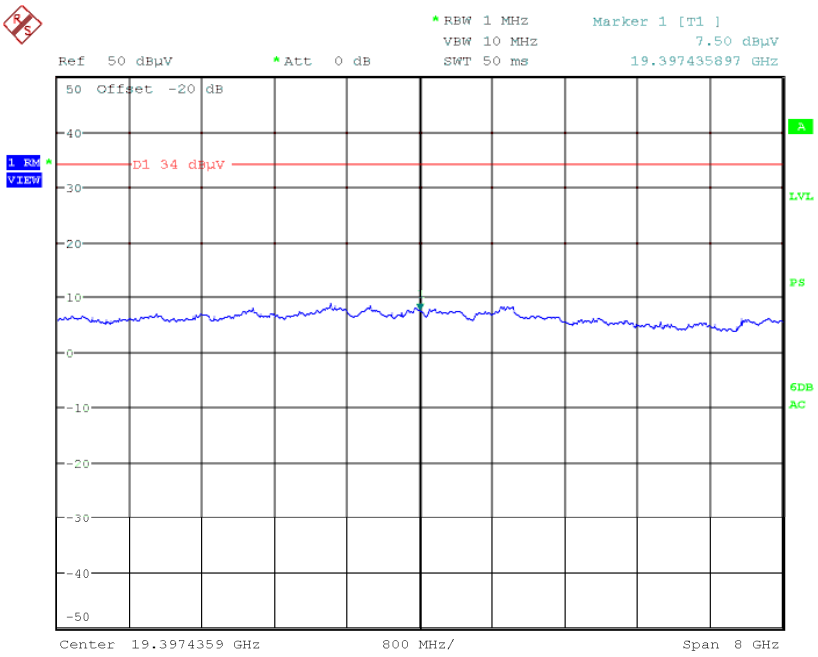

Figure 7.5.2-11: 18-26 GHz – PRF64 – 30cm

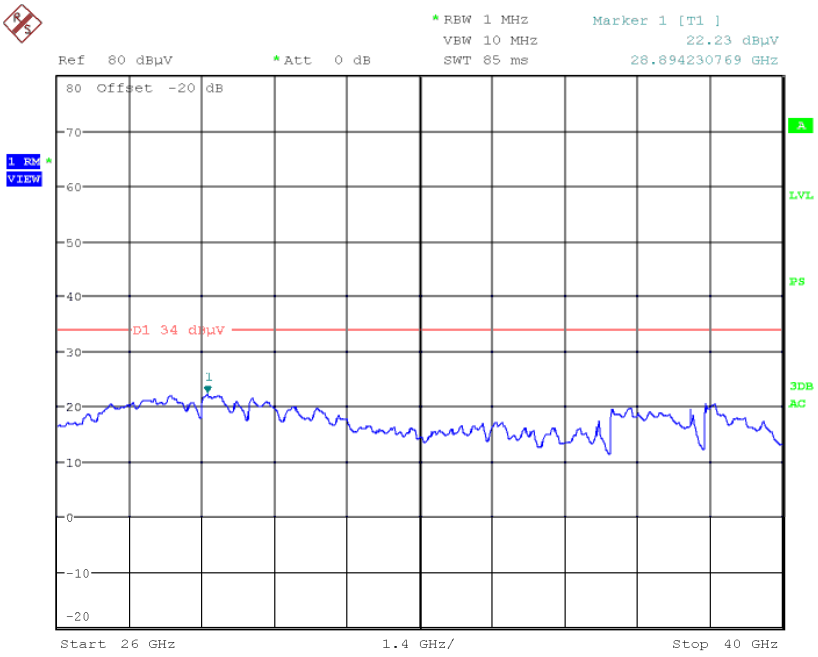

Figure 7.5.2-12: 26-40 GHz – PRF64 – 30cm

7.6 Radiated emissions at or below 960 MHz, FCC 15.250(d)(4) and RSS-220, Issue 1, Section 5.3.1(c) / 3.4

7.6.1 Measurement Procedure

The unwanted emissions from the lowest frequency generated or 9 kHz to 960 MHz in accordance with ANSI 63.10: 2013 Section 10.2. For peak prescans of the frequency range 30MHz to 960MHz, the Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz, and the Video Bandwidth (VBW) was set to 300 kHz. For final measurements, the receiver function of the analyzer was employed, and the resolution bandwidth was 120kHz.

The correction factor is a combination of measurement cable(s) loss, preamplifier gain, antenna factor, and a distance correction factor (if needed).

Table 7.6.2.1-1 Limits from FCC 15.209 and RSS-220, Section 3.4:

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (m)
0.009-0.490	2,400/F (F in kHz)	300
0.490-1.705	24,000/F (F in kHz)	30
1.705-30	30	30
30.0 to 88.0	100	3
88.0 to 216.0	150	3
216.0 to 960.0	200	3

7.6.2 Measurement Results

Measurement Performed By: Chris Gormley

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Turntable Position	Antenna Height	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(o)	(cm)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
30.01	4.10	-2.30	H	0	100	23.19	---------	20.89	--------	40.0	---------	19.11
76.28	3.40	-3.10	H	0	100	11.33	---------	8.23	--------	40.0	---------	31.77
195.83	4.50	-1.60	H	0	100	13.93	---------	12.33	--------	43.5	---------	31.17
357.05	4.10	-2.40	H	0	100	19.65	---------	17.25	--------	46.0	---------	28.75
617.23	6.00	-0.40	H	0	100	24.03	---------	23.63	--------	46.0	---------	22.37
976.67	5.80	-0.50	H	0	100	26.97	---------	26.47	--------	54.0	---------	27.53

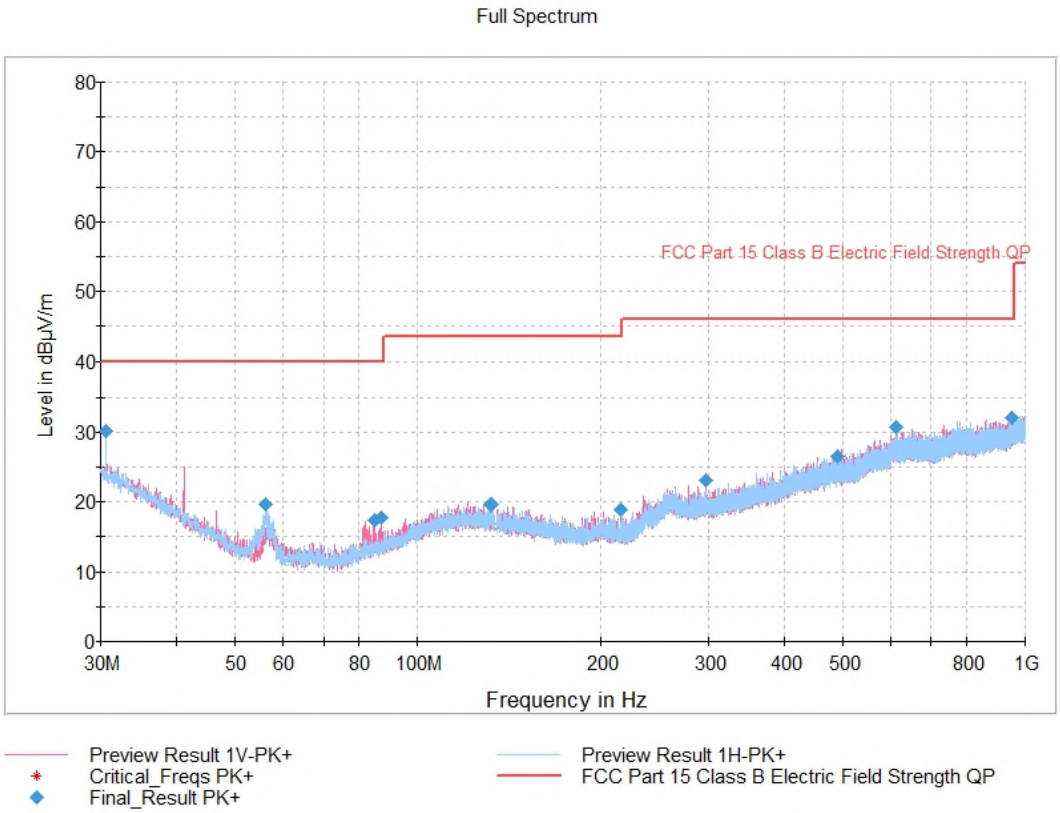

Figure 7.6.2.-1: Emission Profile 30MHz-1GHz

7.7 Radiated Emissions in the GPS bands FCC 15.250(d)(2) and RSS-220, Issue 1, Section 5.3.1(e)

7.7.1 Measurement Procedure

Unwanted emissions in the above bands were measured radiated in accordance with ANSI 63.10: 2013 Section 10.3.10. The resolution bandwidth (RBW) of the spectrum analyzer was set to 1 kHz. The ratio of the RBW to Video Bandwidth (VBW) was set to ≥ 3 where possible. The trace was set to max hold with the RMS detector active. The sweep time did not exceed 1ms per bin.

7.7.2 Sample Calculation:

Field Strength to EIRP (dBm): Field Strength – 95.2 = EIRP (dBm)
$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA-PA)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
PA	=	Preamplifier Gain

-78.41dBm + -7.29dB = --85.7dBm EIRP

The frequency bands to be investigated and the associated limits are:

Table 7.7.2-1 Frequency Bands

Frequency MHz	EIRP dBm
1164 to 1240	-85.3
1559 to 1610	-85.3

7.7.3 Measurement Results:

Measurement Performed By: Chris Gormley

There were no emissions above the noise floor of the analyzer for either PRF16 or PRF64 modulation formats. See plots on the following pages.

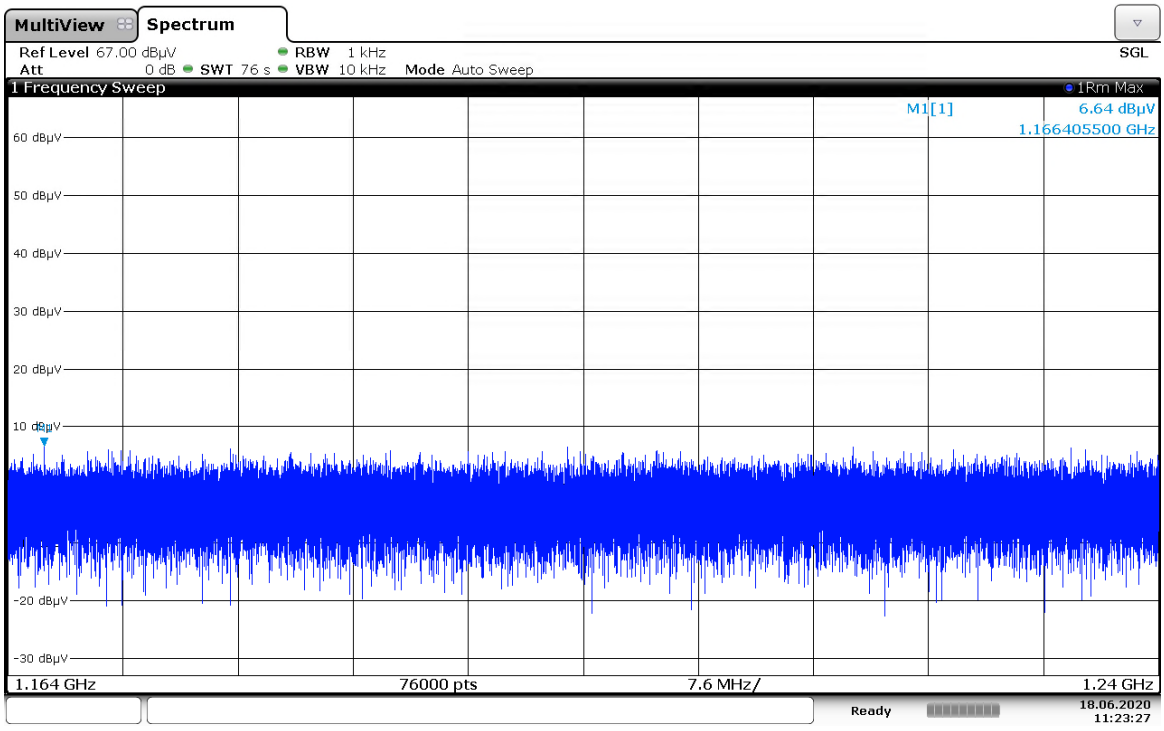

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Figure 7.7.3-1: 1.164 GHz – 1.24 GHz – 16PRF – 3m

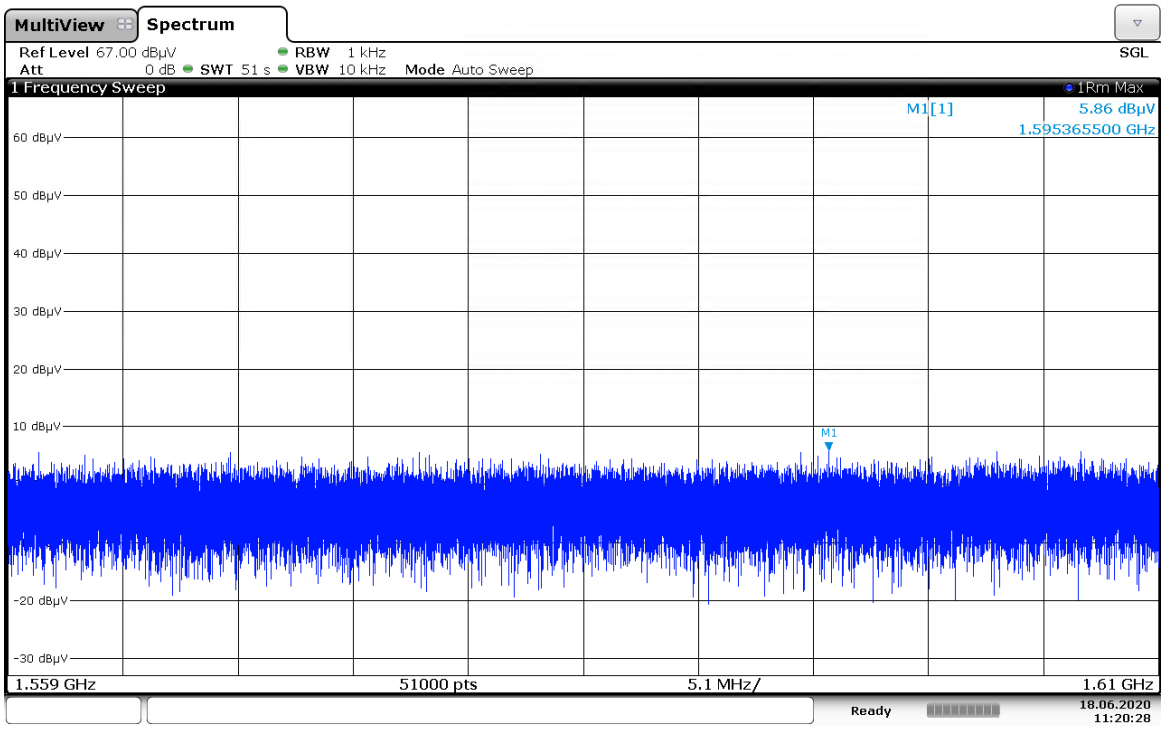

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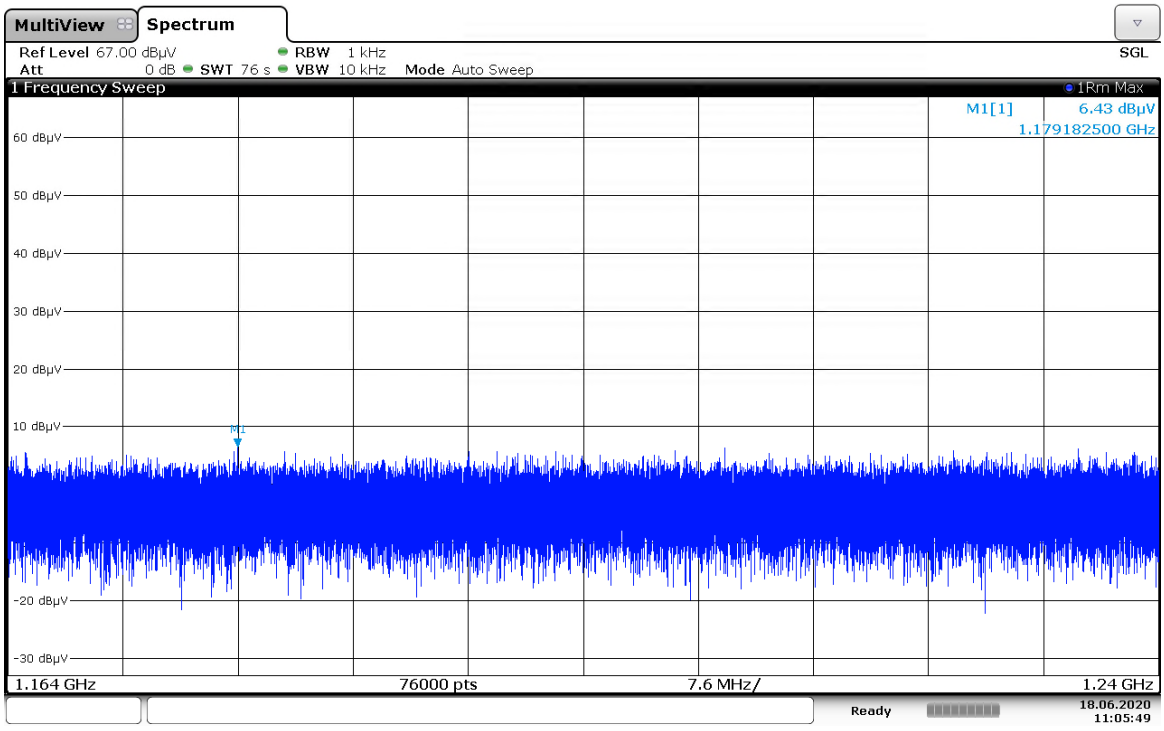
Figure 7.7.3-2: 1.559 GHz – 1.610 GHz – 16PRF – 3m



11:05:50 18.06.2020

Figure 7.7.3-1: 1.164 GHz – 1.24 GHz – 64PRF – 3m

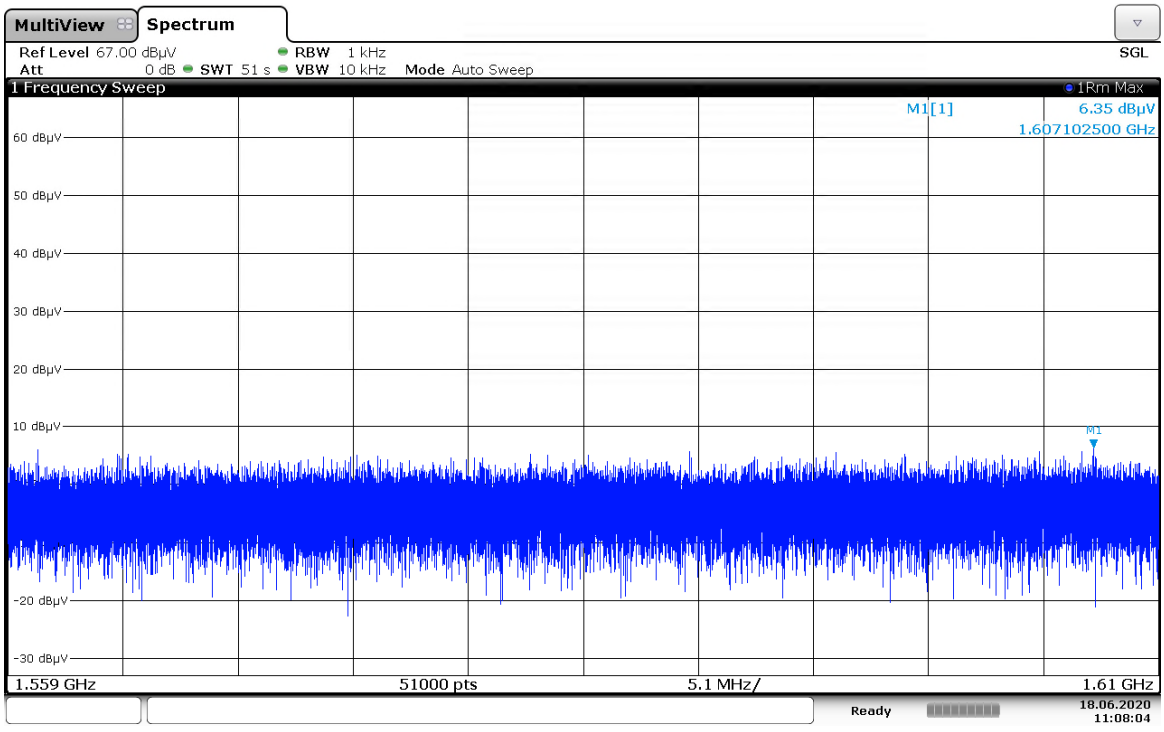


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Figure 7.7.3-2: 1.559 GHz – 1.610 GHz – 64PRF – 3m

7.8 Transmit On/Off Requirements – RSS-220, Issue 1, Section 5.3.1(b)

The device is to transmit only when it is sending information to an associated receiver. The device shall cease transmission of information within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB device at least every 10 seconds or the UWB device shall cease transmitting any information other than periodic signals used for the establishment or re-establishment of a communication link with an associated receiver.

The Theory of Operation, provided under a separate cover, contains detailed information supporting the transmission time of the device.

8 MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.004%
RF Conducted Output Power	± 0.689 dB
Power Spectral Density	±0.5 dB
Antenna Port Conducted Emissions	± 2.717 dB
Radiated Emissions	± 5.877 dB
Temperature	± 0.860 °C
Radio Frequency	±2.832 x 10-8
AC Power Line Conducted Emissions	±2.85 dB

9 CONCLUSION

In the opinion of TÜV SÜD America Inc. the UWB OEM Tag manufactured by Mirion Technologies meets the requirements of FCC 15.250 and RSS-220, Issue 1.

END REPORT