

FCC 47 CFR PART 15 SUBPART F

TEST REPORT

FOR

ULTRA WIDEBAND ASSET SURVEILLANCE SENSOR

MODEL NUMBER: POLARIS

FCC ID: 2AK3W-POLARIS

REPORT NUMBER: R14672591-E1

ISSUE DATE: 2024-05-20

**Prepared for
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REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
1	2023-04-03	Initial Issue	Brian Kiewra
2	2024-02-28	Misc. editorial update	Mike Antola
3	2024-05-20	Removed horizontal data from Peak Power section (8.2); editorial update to Section 5.3	Mike Antola

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: PANERATECH, INC.
4125 Lafayette Drive, Suite 200
Chantilly, VA, 20151, USA

EUT DESCRIPTION: Ultra Wideband Asset Surveillance Sensor

MODEL: POLARIS

SERIAL NUMBER: 220001-A

SAMPLE RECEIPT DATE: 2023-03-13

DATE TESTED: 2023-03-13 to 2023-03-29

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart F	Complies

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

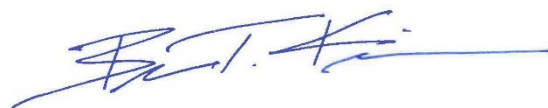
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Approved & Released
For UL LLC By:



Michael Antola
Staff Engineer
Consumer, Medical and IT Segment
UL LLC

Prepared By:



Brian Kiewra
Project Engineer
Consumer, Medical and IT Segment
UL LLC

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC KDB 393764, ANSI C63.10-2013.

This report contains data provided by the customer which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.

Below is a list of the data provided by the customer:

1. Antenna gain and type (see section 5.4)

3. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification # 0751.06, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
<input type="checkbox"/>	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
<input checked="" type="checkbox"/>	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A		27265	

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \text{Cable} \\ &\text{Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Final Voltage (dBuV)} &= \text{Measured Voltage (dBuV)} + \text{Cable Loss (dB)} + \text{Limiter Factor} \\ &\text{(dB)} + \text{LISN Insertion Loss.} \\ 36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} &= 46.6 \text{ dBuV} \end{aligned}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	3.4 dB
Radiated Disturbance, All ranges	6.0 dB
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is an Ultra Wideband Asset Surveillance Sensor.

5.2. OPERATING FREQUENCY RANGE

The UWB radio operates over a nominal frequency range of 2000 to 8000 MHz. The measured UWB bandwidths of all channels lie within this range.

5.3. MAXIMUM OUTPUT POWER

The UWB transmitter has a maximum radiated output power as follows:

Max Pk Field Strength (dBuV/m)	Peak Output Power (dBm/MHz EIRP)	Peak Output Power (uW/MHz EIRP)
61.09	-34.11	0.388

The peak power was derived from a maximum field strength of:

$$61.09 \text{ dBuV/m} - 95.2 \text{ (3M)} = -34.11 \text{ dBm/MHz}$$

5.4. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

Antenna option 1: "RTS": Single custom TEM horn antenna, Max Gain: 9.3 dBi
Antenna option 2: "INS": Single custom TEM horn antenna, Max Gain: 11.3 dBi

5.5. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was Ver. 6070
The test utility software used during testing was XProbeCommunication, Ver. 1.4.6

5.6. WORST-CASE CONFIGURATION

The EUT was positioned in its intended orientation of operation with the antenna towards the Rx antenna as worst-case. The EUT can be configured with or without a switch box installed between the main control box and antenna. All testing performed with and without the switch box, with the exception of spurious emissions. This testing was performed with the switch box installed only as this is representative of the worst-case configuration.

5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Dell	Precision 7530	7753258802	R-CMM-E2K-P74F001
Ethernet switch	Netgear	PR2000	3RB143BX00004	PY313200234

I/O CABLES

I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	1	2	SMA M	Coaxial	>3	Antenna to Switchbox
2	2	2	SMA M	Coaxial	>3	Switchbox to EUT
3	3	2	RJ-45	Cat6	>3	EUT to Switchbox
4	4	2	RJ-45	Cat6	>3	EUT to Laptop (removed before testing)
5	5	1	3 pin US plug, NEMA L6-20R	power	>3	Power to EUT

SETUP DIAGRAM FOR TESTS

Refer to Setup Photo Exhibit R14672951-EP1 for details.

6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 1)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
0.009-30MHz					
135144	Active Loop Antenna	ETS-Lindgren	6502	2023-01-17	2024-01-17
30-1000 MHz					
159203	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2023-01-23	2024-01-31
1-18 GHz					
89509	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2022-05-11	2023-05-11
135143	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2023-01-19	2024-01-19
18-40 GHz					
204704	Horn Antenna, 18-26.5GHz	Com-Power	AH-626	2022-07-11	2023-07-11
204705	Horn Antenna, 26-40GHz	Com-Power	AH-640	2022-07-11	2023-07-11
Gain-Loss Chains					
91974	Gain-loss string: 0.009-30MHz	Various	Various	2022-05-05	2023-05-05
91976	Gain-loss string: 25-1000MHz	Various	Various	2022-05-05	2023-05-05
91979	Gain-loss string: 1-18GHz	Various	Various	2022-12-02	2023-12-02
135999	Gain-loss string: 18-40GHz	Various	Various	2022-05-05	2023-05-05
Receiver & Software					
197955	Spectrum Analyzer	Rohde & Schwarz	ESW44	2022-03-08	2023-03-31
SA0026	Spectrum Analyzer	Keysight	N9030A	2022-08-02	2023-08-02
214284	Spectrum Analyzer	Rohde & Schwarz	FSW50	2023-01-24	2024-01-24
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
Additional Equipment used					
200539	Environmental Meter	Fisher Scientific	15-077-963 s/n 18474341	2022-10-05	2023-10-05

Test Equipment Used - Line-Conducted Emissions – Voltage (Morrisville – Conducted 1)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
CBL087	Coax cable, RG223, N-male to BNC-male, 20-ft.	Pasternack	PE3W06143-240	2022-04-05	2023-04-05
HI0091	Environmental Meter	Fisher Scientific	15-077-963	2022-07-20	2023-07-20
LISN003	LISN, 50-ohm/50-uH, 250uH 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50/250-25-2-01	2022-08-01	2023-08-01
75141	EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESCI 7	2022-08-03	2023-08-03
ATA222	Transient Limiter, 0.009-100MHz	Electro-Metrics	EM-7600	2022-04-05	2023-04-05
PS214	AC Power Source	Elgar	CW2501M (s/n 1523A02396)	NA	NA
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		

7. UWB TEST PROCEDURES

All RF characteristics of the EUT are made using radiated measurements.

For Occupied Bandwidth, in order to capture the waveform, the EUT was placed on a non-reflective surface and pointed directly toward the Receive antenna. Due to the low amplitude of the transmit signal, the Receive antenna was moved as close as necessary to obtain a measureable signal.

For Radiated Emissions testing, the EUT was placed 80 cm above the ground reference plane for testing below 1 GHz and 150 cm above the ground reference plane for testing above 1 GHz. The EUT is set to transmit in a continuous mode.

For measurements below 960 MHz the antenna is located 3 meters from the EUT. The resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements in the 30 to 960 MHz range, 9 kHz for peak and/or quasi-peak detection measurements in the 0.15 to 30 MHz range and 200 Hz for peak and/or quasi-peak detection measurements in the 9 kHz to 150kHz range. Peak detection is used unless otherwise noted as quasi-peak or average (9 kHz to 90 kHz and 110kHz to 490 kHz).

For 1 MHz RBW final measurements above 960 MHz the antenna is located no more than 3 meter from the EUT. The RBW and VBW are both set to 1 MHz. A R&S FSW signal analyzer with a true RMS detector is utilized.

A R&S FSW signal analyzer with a true RMS detector is utilized for measurements in the frequency ranges of 1164-1240 MHz and 1559-16160 MHz, the antenna is located 3 meters from the EUT. The RBW is set to 3 kHz and the VBW is set to 10 kHz.

The resulting 3 meter field strength is converted to EIRP using the equation $P \text{ (dBm EIRP)} = E \text{ (dBuV/m)} - 95.2$ per C63.10: 2013, Section 10.3.9.

Measurements used for calculating bandwidth, peak power, and the peak level of digital device emissions are made using peak detection.

8. LIMITS AND RESULTS

8.1. UWB BANDWIDTH, CENTER FREQUENCY, AND FRACTIONAL BW

DEFINITIONS AND LIMITS

§15.503 Definitions.

(a) UWB Bandwidth. For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L . The frequency at which the highest radiated emission occurs is designated f_M .

(b) Center frequency. The center frequency, f_C , equals $(f_H + f_L)/2$.

(c) Fractional bandwidth. The fractional bandwidth equals $2(f_H - f_L)/(f_H + f_L)$.

(d) Ultra-wideband (UWB) transmitter. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

§15.511 (a) The UWB bandwidth of an imaging system operating under the provisions of this section must be contained between 1990 MHz and 10,600 MHz.

TEST PROCEDURE

Radiated measurements are made using the procedures described above. The detection mode is set to peak detection, RBW/VBW = 1 MHz/3 MHz, the sweep time is AUTO, and the Max Hold trace function is utilized. The frequency range from 960 MHz to 10.6 GHz is measured.

The frequency at which the maximum EIRP is measured is designated as f_M . A major graticule line of the plot is adjusted to exactly equal the peak EIRP at f_M . The spectral envelope at the major graticule line that is 10 dB below the reference graticule is examined to determine the frequency band bounded by the points that are 10 dB below the highest radiated emission. The upper boundary is designated f_H and the lower boundary is designated f_L .

The center frequency, f_C , is calculated as $(f_H + f_L)/2$.

The RX antenna polarization that yields the highest EIRP at f_M is used to calculate the above parameters. In this case, the vertical polarity yielded the highest EIRP.

TESTED BY

Employee IDs: 23854

Test Dates: 2023-03-13

Test Location: Chamber 1

8.1.1. INS ANTENNA WITHOUT SWITCH BOX

f Max (GHz)	Reference EIRP at f Max (dBuV)	10 dB down from Reference EIRP (dBm)
3.456	36.0	26.0

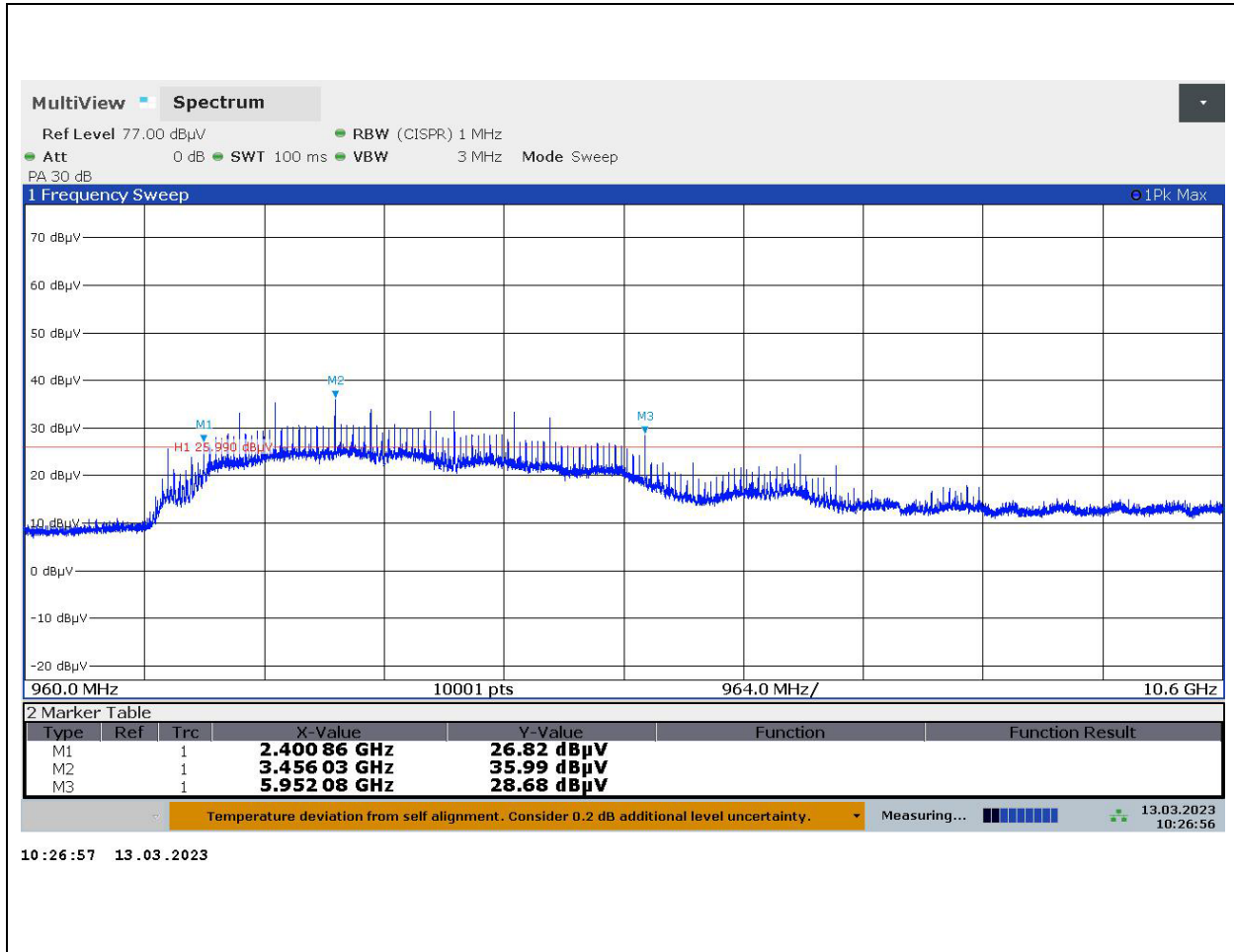
f Low (GHz)	f Low Limit (GHz)
2.400	1.99

f High (GHz)	f High Limit (GHz)
5.952	10.6

f Center (GHz)
4.176

UWB BW (MHz)	Minimum UWB BW (MHz)
3552	500

PLOT



8.1.2. INS ANTENNA WITH SWITCH BOX

f Max (GHz)	Reference EIRP at f Max (dBuV)	10 dB down from Reference EIRP (dBm)
3.744	30.8	20.8

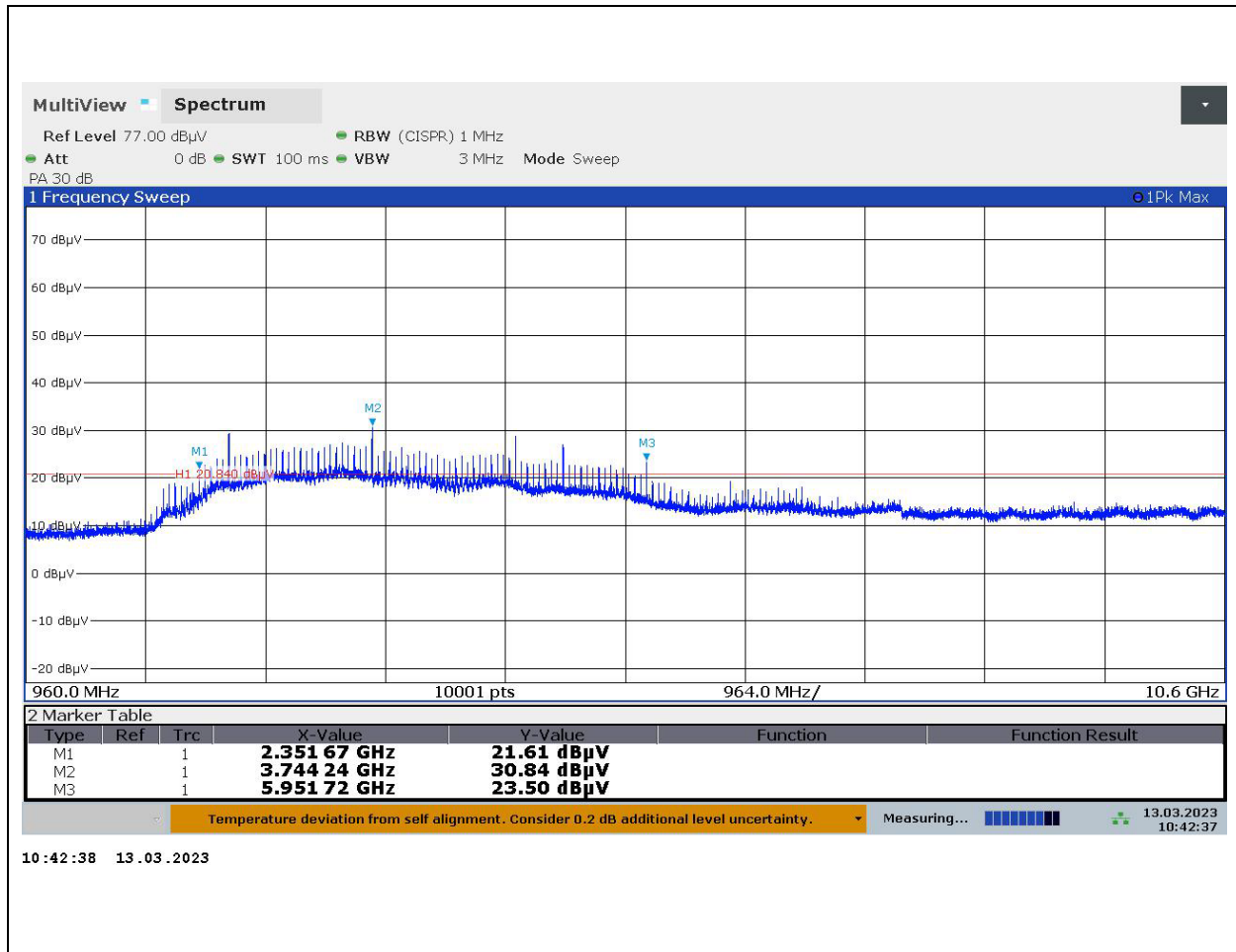
f Low (GHz)	f Low Limit (GHz)
2.352	1.99

f High (GHz)	f High Limit (GHz)
5.952	10.6

f Center (GHz)
4.152

UWB BW (MHz)	Minimum UWB BW (MHz)
3600	500

PLOT



8.1.3. RTS ANTENNA WITHOUT SWITCH BOX

f Max (GHz)	Reference EIRP at f Max (dBuV)	10 dB down from Reference EIRP (dBm)
2.592	36.3	26.3

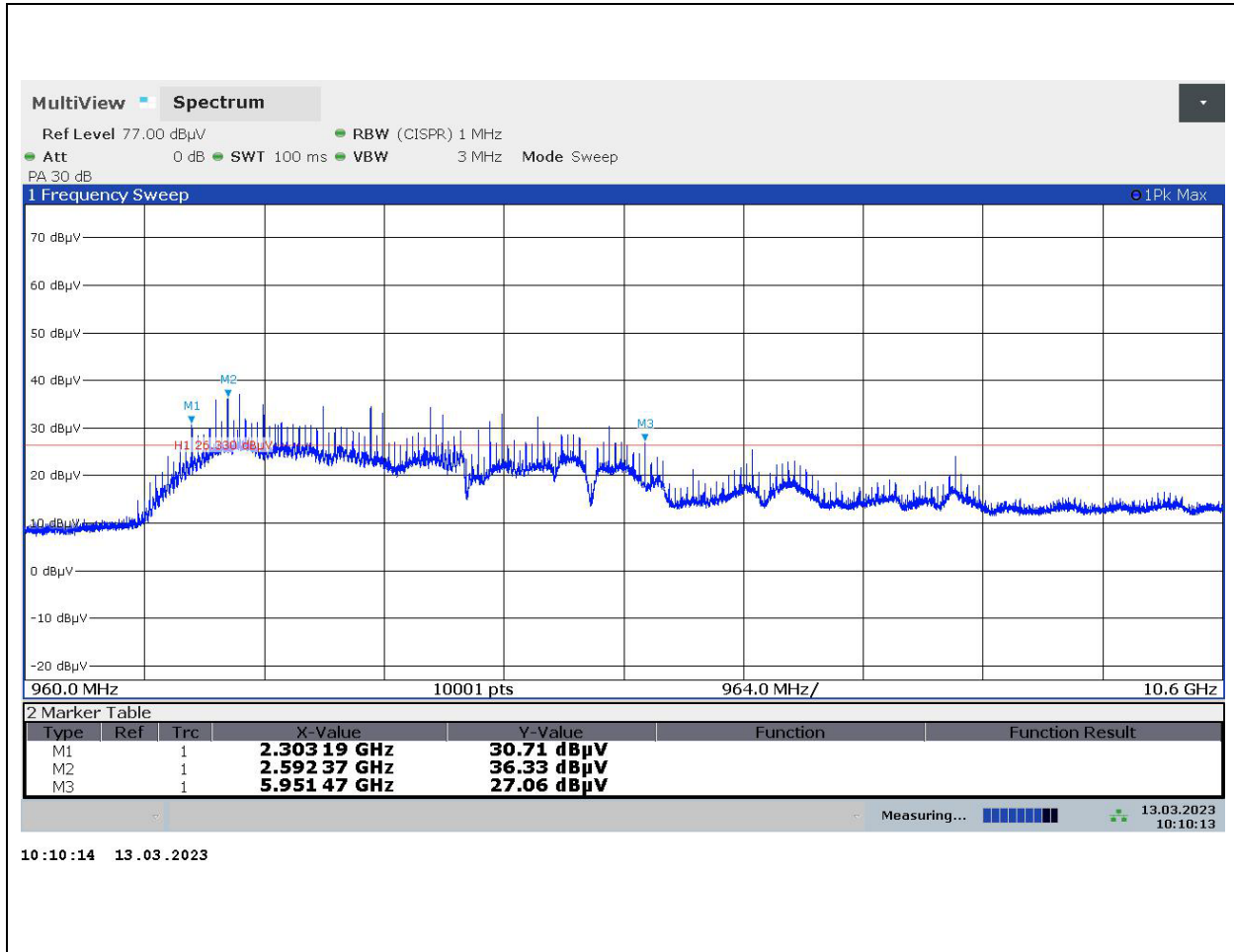
f Low (GHz)	f Low Limit
2.303	1.99

f High (GHz)	f High Limit (GHz)
5.951	10.6

f Center (GHz)
4.127

UWB BW (MHz)	Minimum UWB BW (MHz)
3648	500

PLOT



8.1.4. RTS ANTENNA WITH SWITCH BOX

f Max (GHz)	Reference EIRP at f Max (dBuV)	10 dB down from Reference EIRP (dBm)
2.496	28.1	18.1

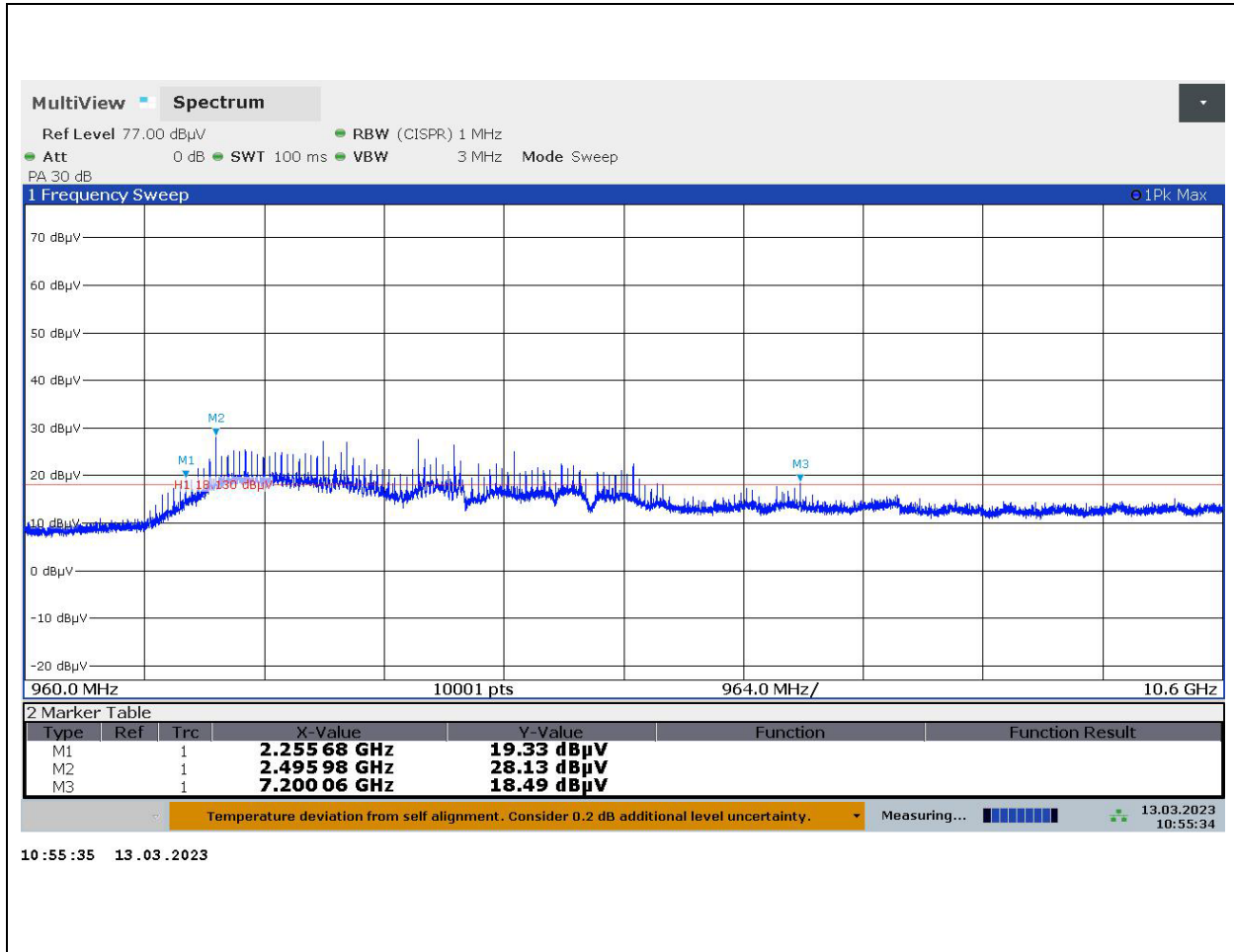
f Low (GHz)	f Low Limit (GHz)
2.256	1.99

f High (GHz)	f High Limit (GHz)
7.200	10.6

f Center (GHz)
4.728

UWB BW (MHz)	Minimum UWB BW (MHz)
4944	500

PLOT



8.2. PEAK POWER

LIMIT

§15.511 (e) There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in § 15.521.

§15.521 (e) The frequency at which the highest radiated emission occurs, f_M , must be contained within the UWB bandwidth.

§15.521 (g) When a peak measurement is required, it is acceptable to use a resolution bandwidth other than the 50 MHz specified in this subpart. This resolution bandwidth shall not be lower than 1 MHz or greater than 50 MHz, and the measurement shall be centered on the frequency at which the highest radiated emission occurs, f_M . If a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be $20 \log (RBW/50)$ dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 meters using $E(\text{dBuV/m}) = P(\text{dBm EIRP}) + 95.2$. If RBW is greater than 3 MHz, the application for certification filed with the Commission must contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

TEST PROCEDURE

Radiated measurements are made using the procedures described above.

The spectrum analyzer center frequency is set to f_M . The RBW and VBW are both set to 50 MHz. The detector function is set to peak.

The instrumentation used is a R&S signal analyzer, model FSW50, which includes a standard RBW of 50 MHz. Thus, no correction to the limit is required and the E-field equivalent limit is defined as follows:

$$\text{Peak E-field (3m) } E(\text{dBuV/m}) = P(\text{dBm EIRP}) + 95.2 = 0 + 95.2 = 95.2 \text{ dBuV/m}$$

TESTED BY

Employee IDs: 23854
Test Dates: 2023-03-29
Test Location: Chamber 1

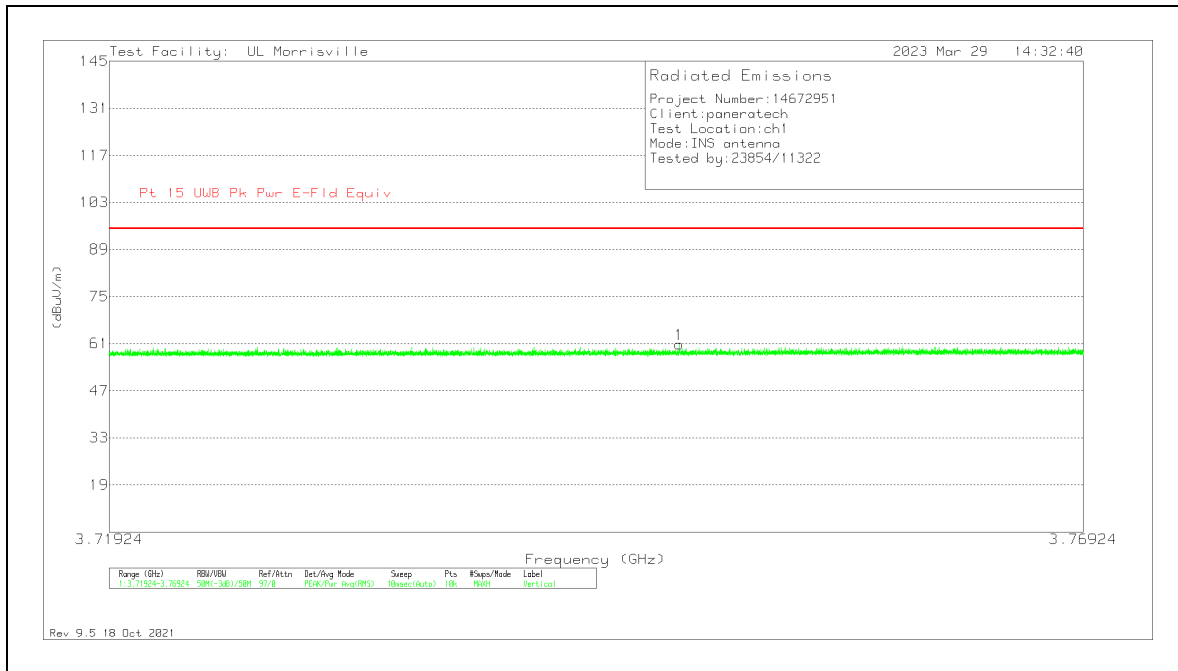
8.2.1. INS ANTENNA WITHOUT SWITCH BOX



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	89509 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	Pt 15 UWB Pk Pwr E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	3.44487	63.59	Pk	32.8	-35.3	61.09	95.2	-34.11	319	144	V

Pk - Peak detector

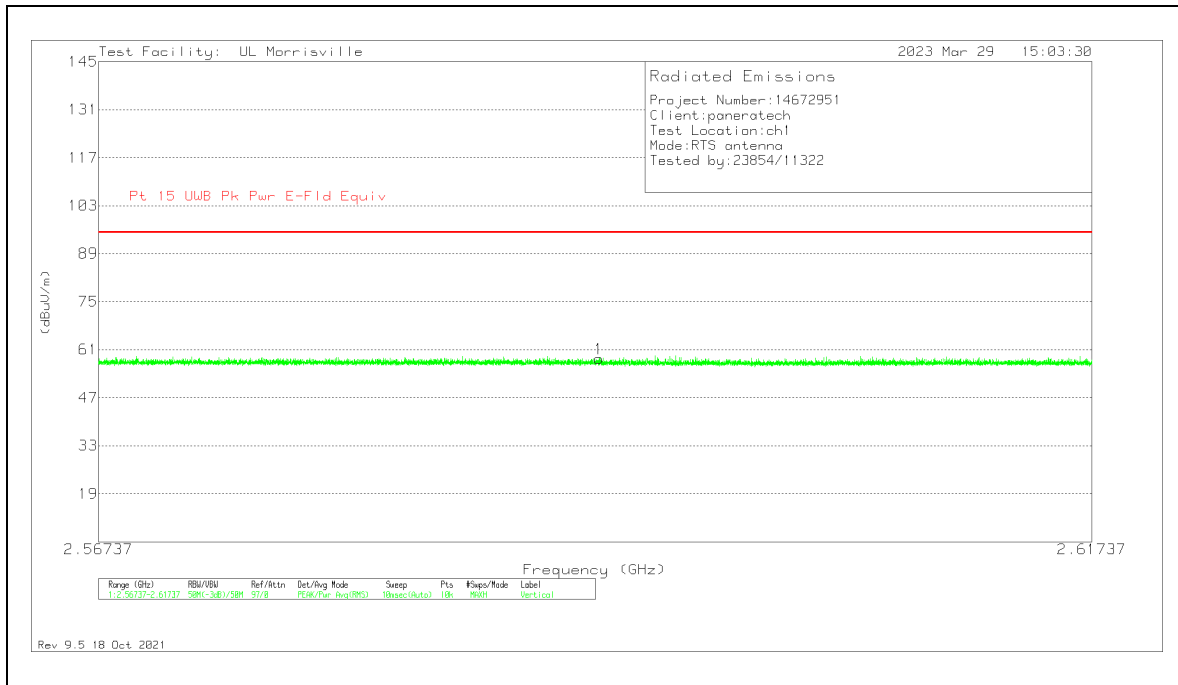
8.2.2. INS ANTENNA WITH SWITCH BOX



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	89509 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	Pt 15 UWB Pk Pwr E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	3.74842	62.41	Pk	33.4	-35	60.81	95.2	-34.39	274	361	V

Pk - Peak detector

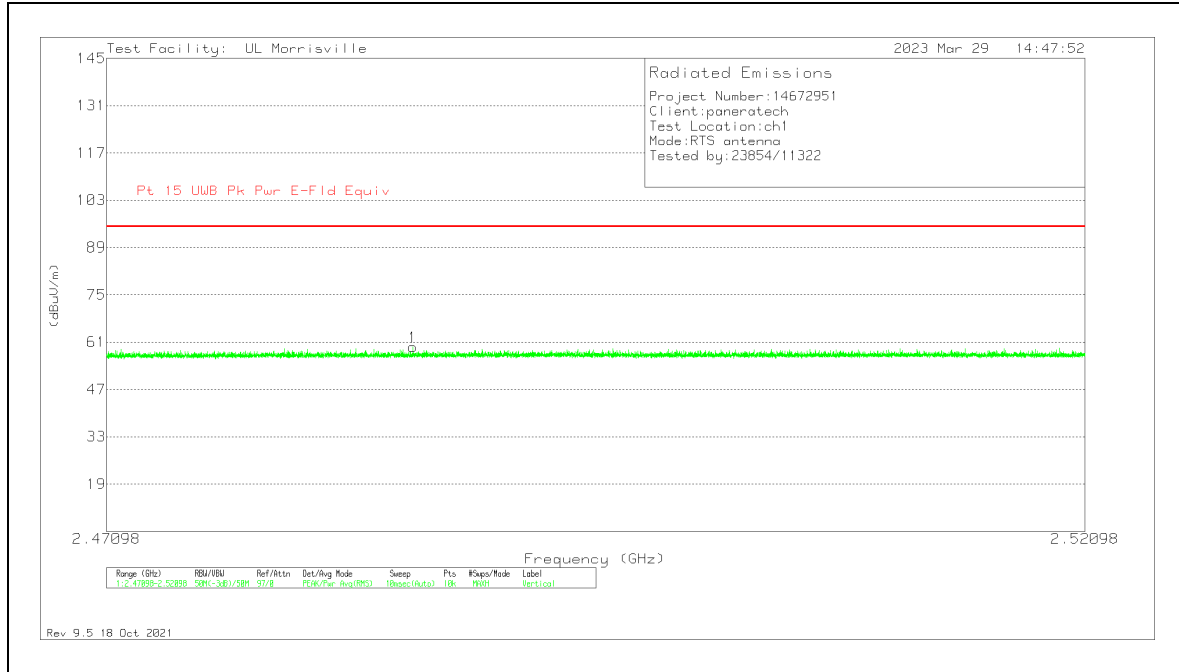
8.2.3. RTS ANTENNA WITHOUT SWITCH BOX



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	89509 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	Pt 15 UWB Pk Pwr E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	2.59243	61.89	Pk	32.6	-36.1	58.39	95.2	-36.81	354	333	V

Pk - Peak detector

8.2.4. RTS ANTENNA WITH SWITCH BOX



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	89509 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	Pt 15 UWB Pk Pwr E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	2.48652	63	PK	32.4	-35.8	59.6	95.2	-35.6	110	152	V

Pk - Peak detector

8.3. RADIATED EMISSIONS ABOVE 960 MHz

LIMITS

§15.511 (c) The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in § 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency in MHz	EIRP in dBm
960-1610	-53.3
1610-1990	-51.3
1990-10600	-41.3
Above 10600	-51.3

15.511 (d) In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164-1240	-63.3
1559-1610	-63.3

§15.521 (d) Within the tables in §§15.509, 15.511, 15.513, 15.515, 15.517, and 15.519, the tighter emission limit applies at the band edges. Radiated emission levels above 960 MHz are based on RMS average measurements over a 1 MHz resolution bandwidth. The RMS average measurement is based on the use of a spectrum analyzer with a resolution bandwidth of 1 MHz, an RMS detector, and a 1 millisecond or less averaging time.

§15.521 (e) The frequency at which the highest radiated emission occurs, f_m , must be contained within the UWB bandwidth.

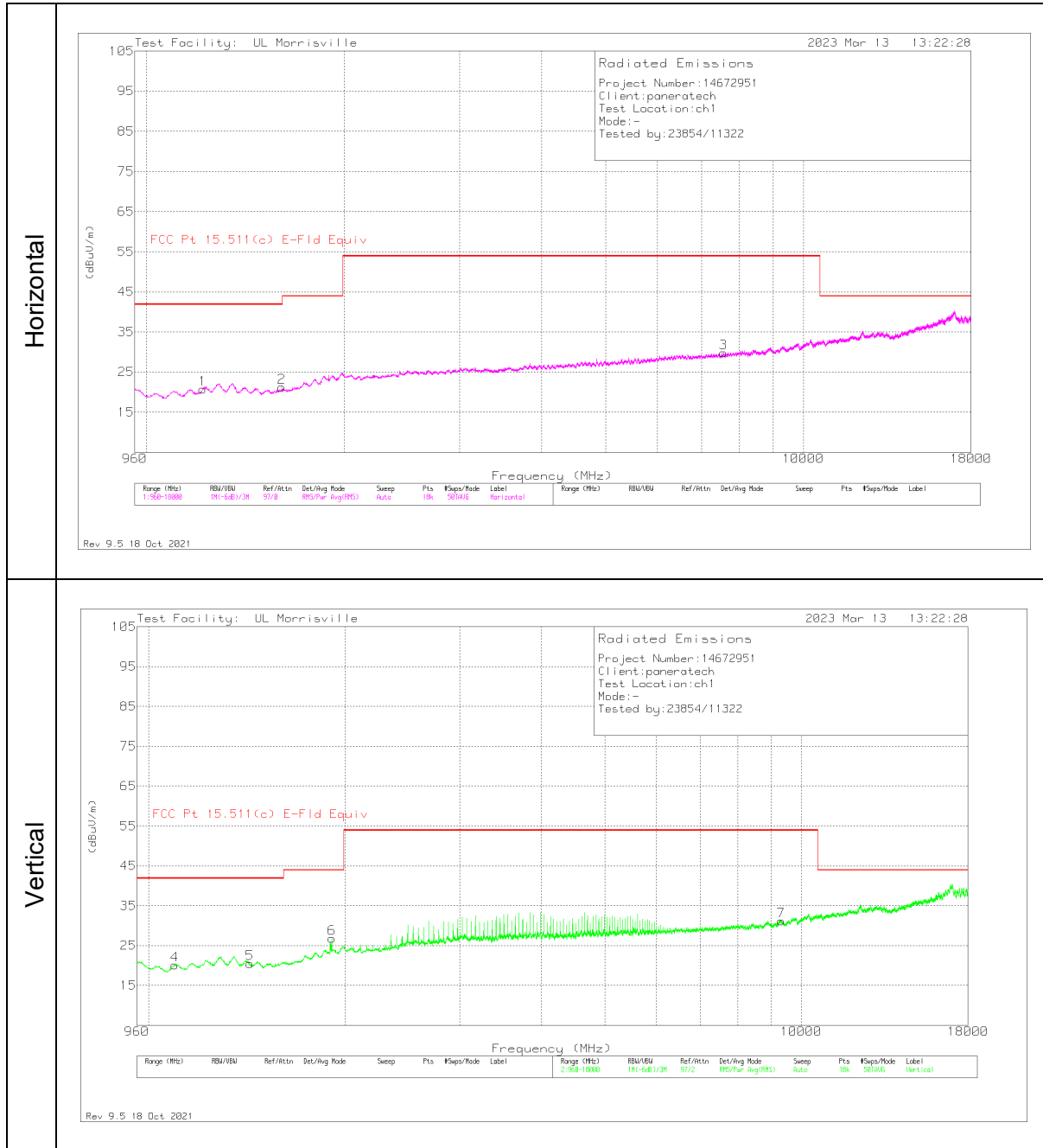
TEST PROCEDURE

Radiated measurements are made using the procedures described in ANSI C63.10: 2013 Section 10.3. The RBW/VBW = 1MHz/3MHz, the sweep time is set to 1mS/MHz, and the detector function is set to RMS average.

For the requirements of §15.511 (d), an RBW of 3 kHz is utilized in the 1164 to 1240 MHz and 1559-1610 MHz frequency range.

8.3.1. INS ANTENNA

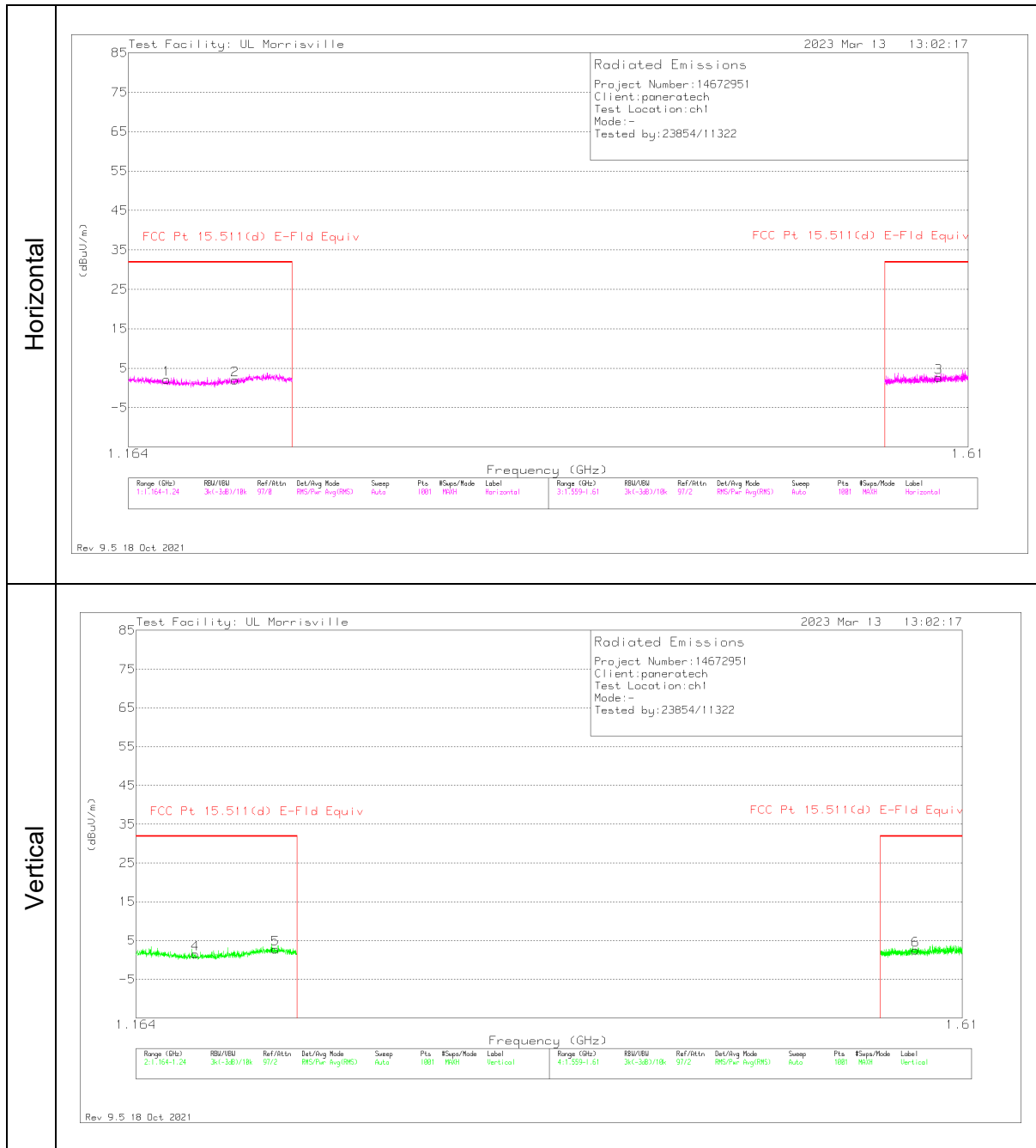
EIRP 0.960 TO 18 GHz, 1 MHz BW



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DCF (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(c) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	1097.2667	34.12	RMS	28	-38.5	-3.5	20.12	41.9	-21.78	185	200	V
1	1218.4401	33.54	RMS	28.9	-38.2	-3.5	20.74	41.9	-21.16	44	101	H
5	1429.5468	33.04	RMS	28.7	-37.8	-3.5	20.44	41.9	-21.46	330	101	V
2	1608.4669	33.64	RMS	28.4	-37.3	-3.5	21.24	41.9	-20.66	52	200	H
6	1908.5603	35.88	RMS	31.2	-36.8	-3.5	26.78	43.9	-17.12	86	101	V
3	7563.949	29.64	RMS	35.7	-32.1	-3.5	29.74	53.9	-24.16	44	101	H
7	9310.5496	30.21	RMS	36.5	-32	-3.5	31.21	53.9	-22.69	251	200	V

RMS - RMS detection

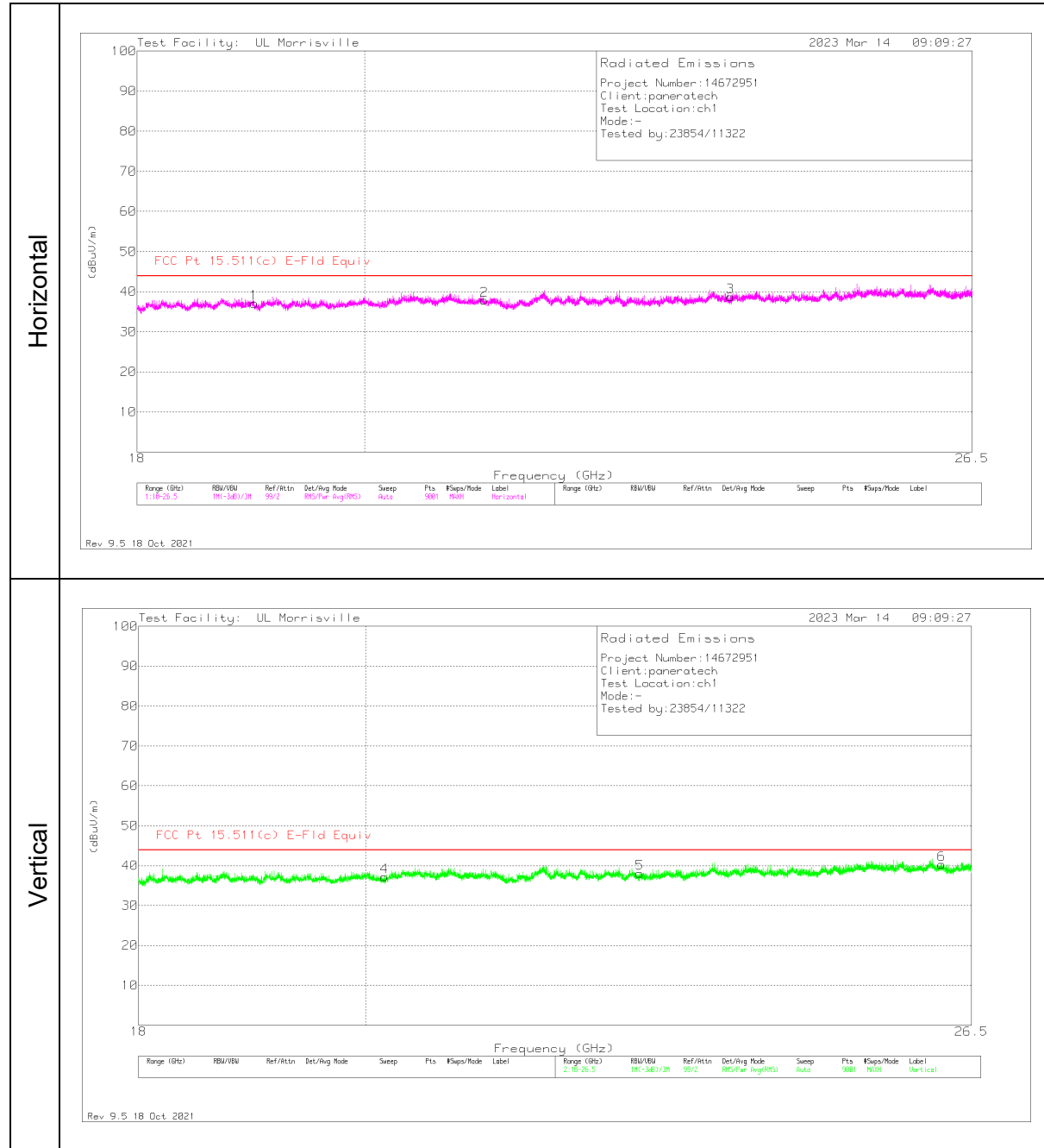
EIRP 1.164 TO 1.240 GHz & 1.559 TO 1.610 GHz, 3 kHz BW



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	89509 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(d) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1.1814	11.89	RMS	28.6	-38.3	2.19	31.9	-29.71	0-360	199	H
2	1.21294	11.42	RMS	28.8	-38.2	2.02	31.9	-29.88	0-360	101	H
4	1.19136	11	RMS	28.7	-38.2	1.5	31.9	-30.4	0-360	101	V
5	1.22951	11.86	RMS	29	-38.1	2.76	31.9	-29.14	0-360	200	V
3	1.59184	11.87	RMS	28.4	-37.6	2.67	31.9	-29.23	0-360	200	H
6	1.58068	11.83	RMS	28.3	-37.6	2.53	31.9	-29.37	0-360	101	V

RMS - RMS detection

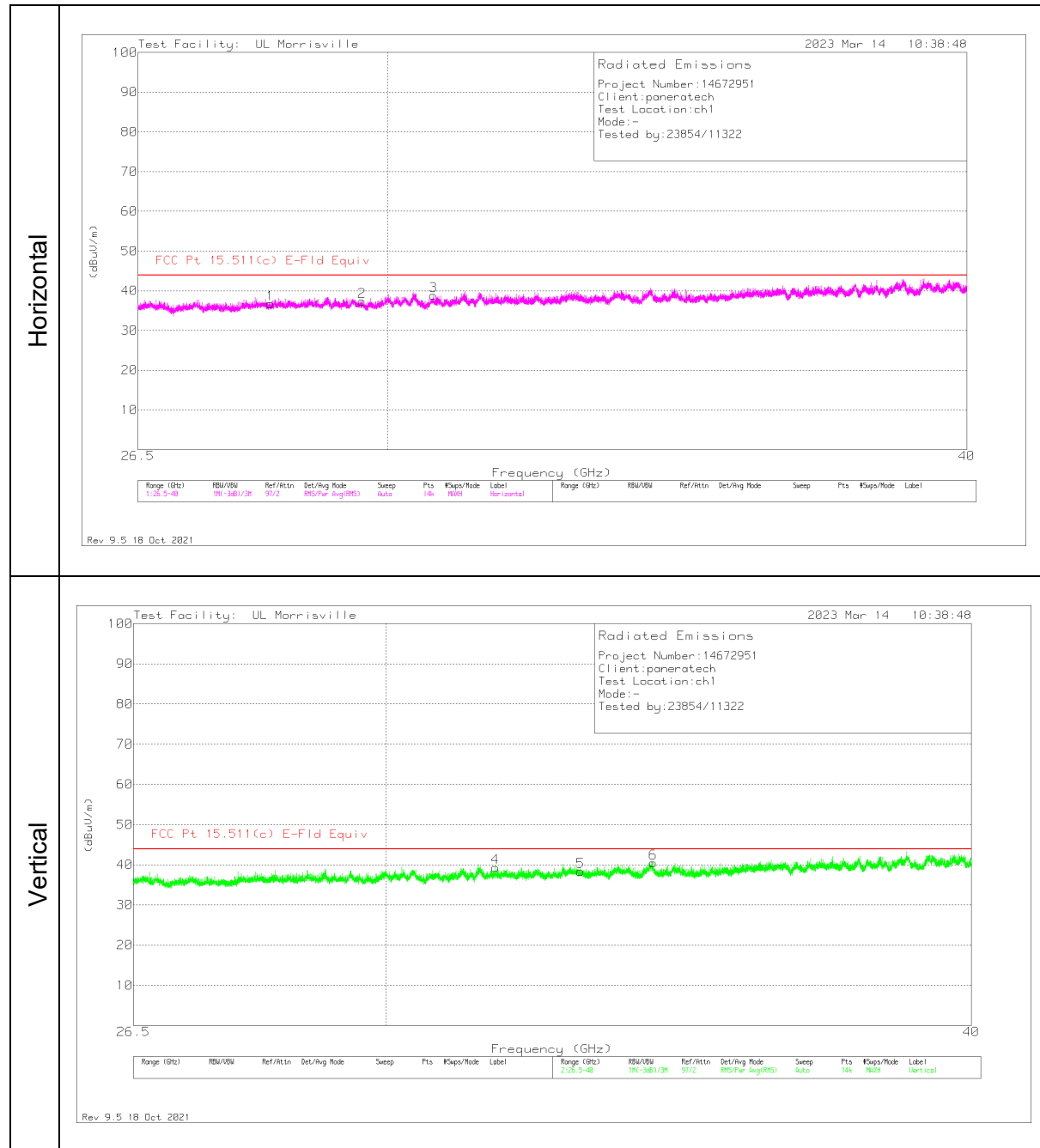
EIRP 18 TO 26.5 GHz, 1 MHz BW



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	204704 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(c) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	19.00489	42.79	RMS	33.8	-39.5	37.09	43.9	-6.81	0-360	101	H
4	20.176	42.87	RMS	33.7	-39.4	37.17	43.9	-6.73	0-360	201	V
2	21.14217	43.01	RMS	34	-39.2	37.81	43.9	-6.09	0-360	300	H
5	22.71561	43.05	RMS	34.3	-39.3	38.05	43.9	-5.85	0-360	101	V
3	23.69122	42.8	RMS	35.2	-39.3	38.7	43.9	-5.2	0-360	300	H
6	26.13922	42.15	RMS	36	-37.8	40.35	43.9	-3.55	0-360	300	V

RMS - RMS detection

EIRP 26.5 TO 40 GHz, 1 MHz BW

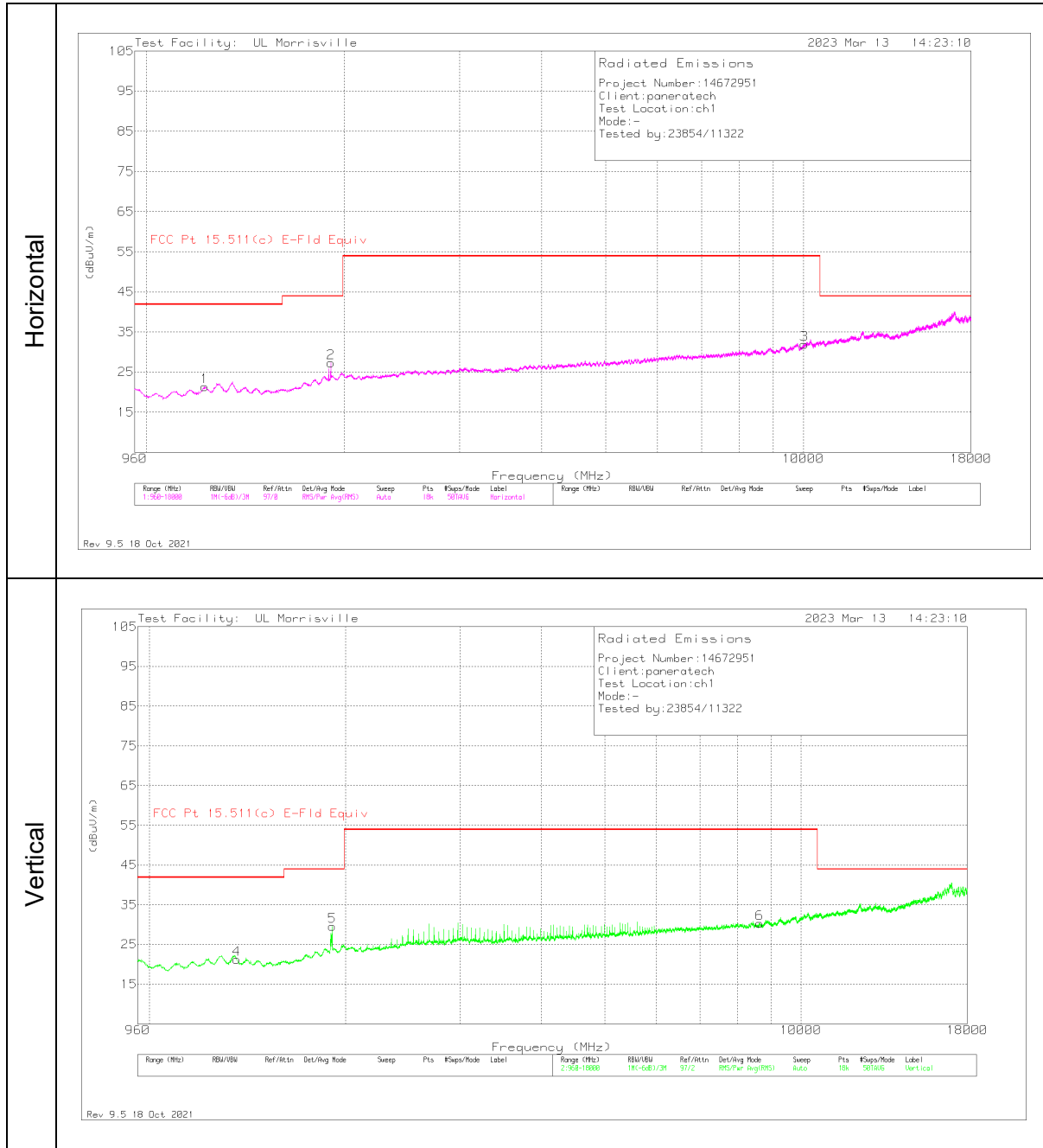


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	204705 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(c) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	28.30129	40.86	RMS	36.5	-40.6	36.76	43.9	-7.14	0-360	299	H
2	29.61947	41.09	RMS	36.5	-40.2	37.39	43.9	-6.51	0-360	101	H
3	30.69175	41.65	RMS	37	-39.8	38.85	43.9	-5.05	0-360	101	H
4	31.66086	41.73	RMS	37.2	-39.6	39.33	43.9	-4.57	0-360	201	V
5	33.01279	40.18	RMS	37.5	-39.3	38.38	43.9	-5.52	0-360	300	V
6	34.2114	42.29	RMS	37.7	-39.5	40.49	43.9	-3.41	0-360	201	V

RMS - RMS detection

8.3.2. RTS ANTENNA

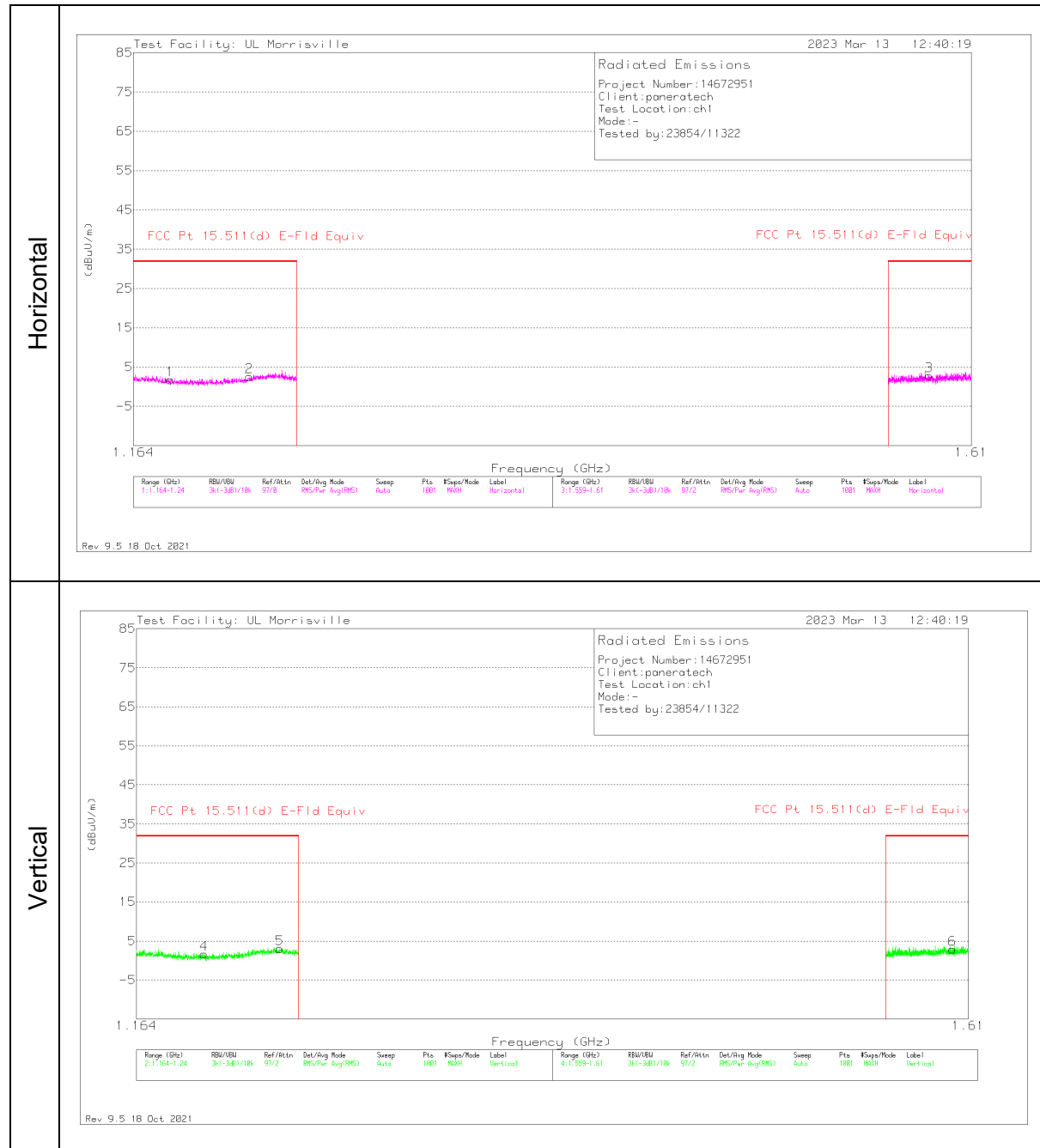
EIRP 0.960 TO 18 GHz, 1 MHz BW



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DCF (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(c) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1226.9601	33.93	RMS	29	-38.1	-3.5	21.33	41.9	-20.57	338	200	H
4	1363.2801	32.98	RMS	29.5	-37.8	-3.5	21.18	41.9	-20.72	340	200	V
2	1908.5603	36.41	RMS	31.2	-36.8	-3.5	27.31	43.9	-16.59	140	200	H
5	1908.5603	38.63	RMS	31.2	-36.8	-3.5	29.53	43.9	-14.37	30	200	V
6	8647.8827	30.14	RMS	35.8	-32.1	-3.5	30.34	53.9	-23.56	76	200	V
3	10033.8032	28.71	RMS	37.2	-30.5	-3.5	31.91	53.9	-21.99	176	101	H

RMS - RMS detection

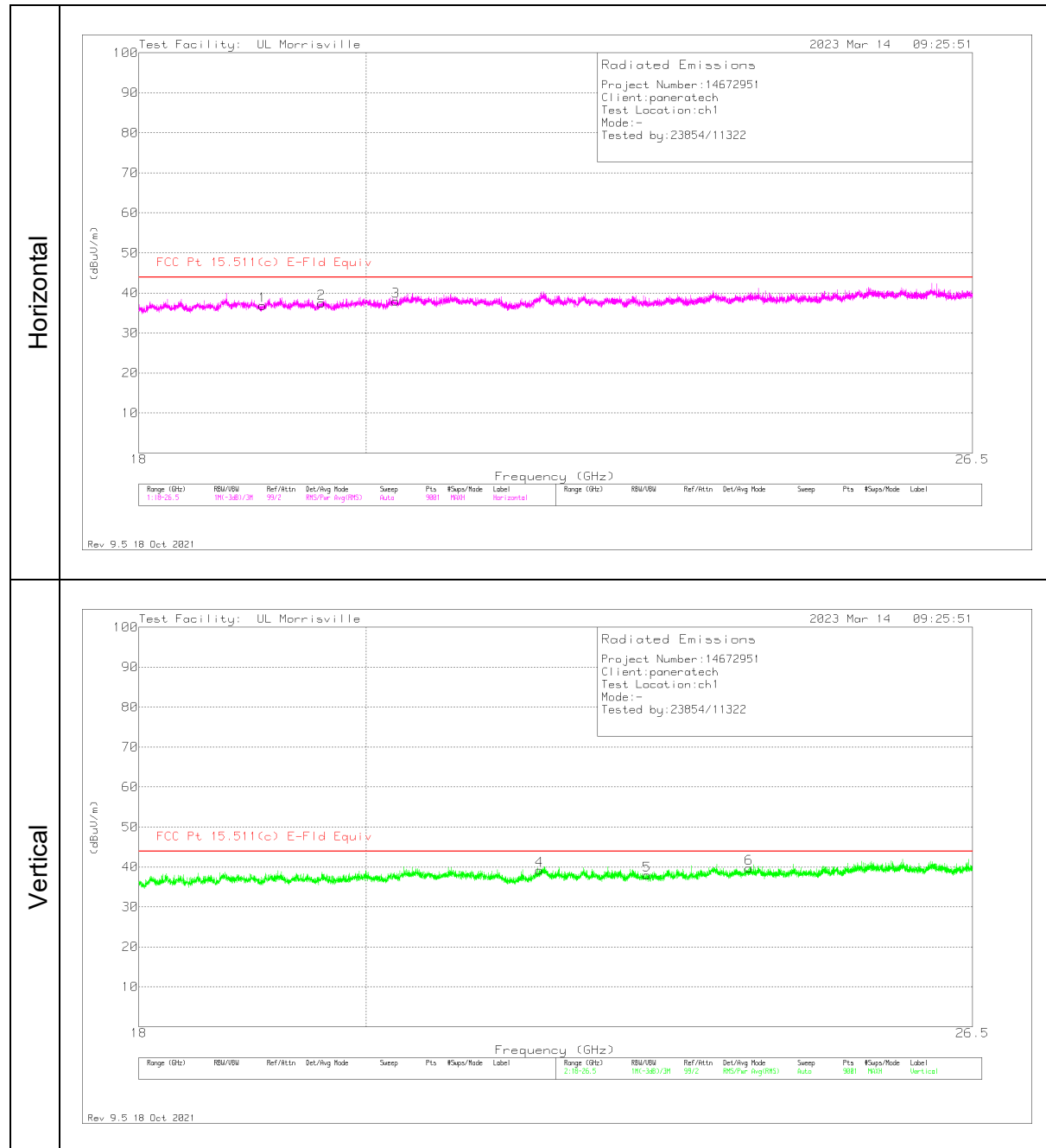
EIRP 1.164 TO 1.240 GHz & 1.559 TO 1.610 GHz, 3 kHz BW



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	89509 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(d) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1.18064	11.54	RMS	28.5	-38.3	1.74	31.9	-30.16	0-360	200	H
2	1.2175	11.78	RMS	28.9	-38.2	2.48	31.9	-29.42	0-360	200	H
4	1.19516	11.08	RMS	28.7	-38.1	1.68	31.9	-30.22	0-360	101	V
5	1.2308	12.14	RMS	29	-38.1	3.04	31.9	-28.86	0-360	200	V
3	1.58384	12.05	RMS	28.3	-37.6	2.75	31.9	-29.15	0-360	101	H
6	1.59995	11.83	RMS	28.4	-37.3	2.93	31.9	-28.97	0-360	101	V

RMS - RMS detection

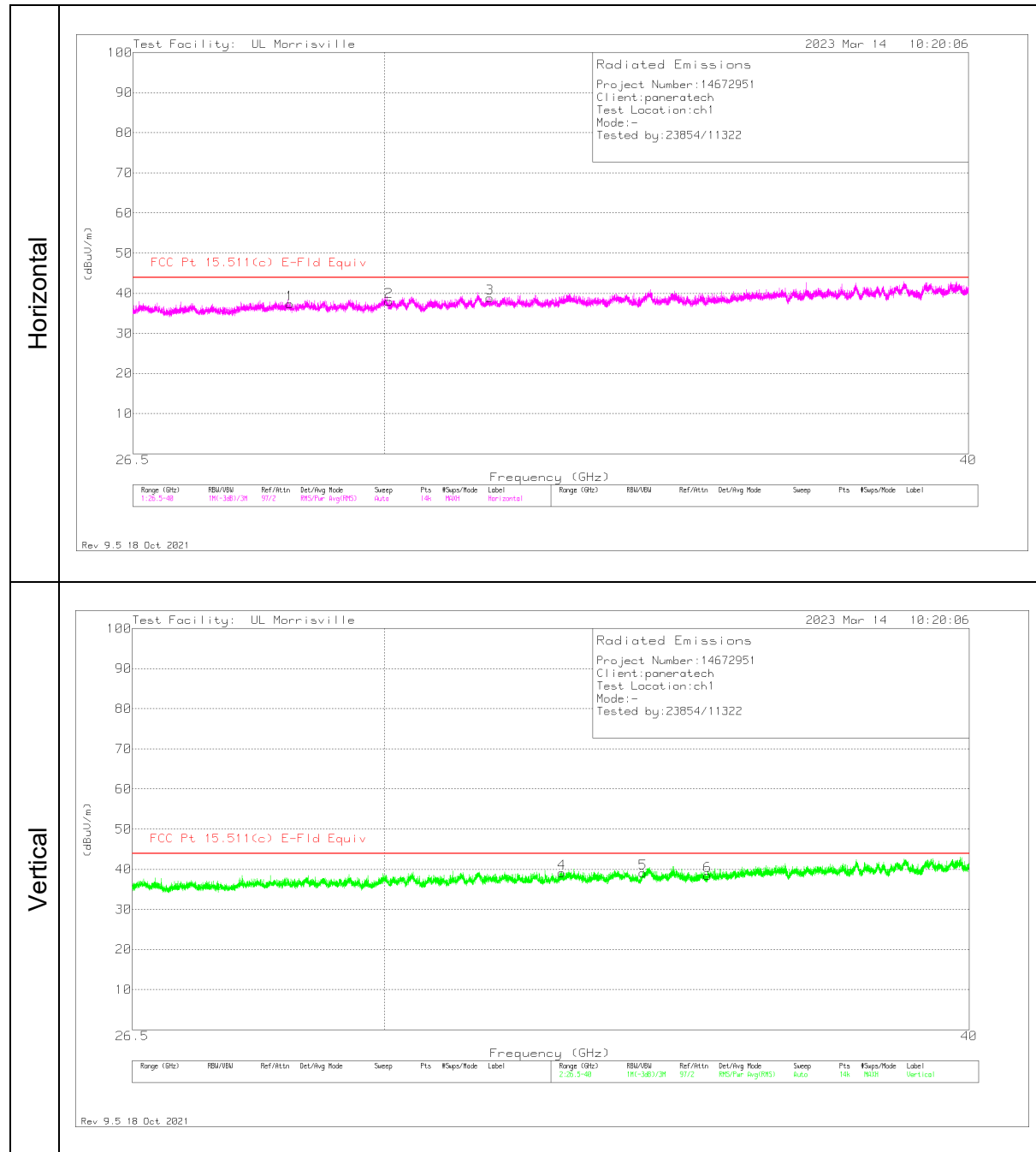
EIRP 18 TO 26.5 GHz, 1 MHz BW



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	204704 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(c) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	19.0625	42.51	RMS	33.8	-39.5	36.81	43.9	-7.09	0-360	101	H
2	19.59328	43.13	RMS	33.4	-39.1	37.43	43.9	-6.47	0-360	299	H
3	20.27894	43.15	RMS	34	-39.2	37.95	43.9	-5.95	0-360	299	H
4	21.67672	43.55	RMS	34.3	-38.6	39.25	43.9	-4.65	0-360	300	V
5	22.7855	42.93	RMS	34.4	-39.4	37.93	43.9	-5.97	0-360	300	V
6	23.88955	43.37	RMS	35	-38.7	39.67	43.9	-4.23	0-360	200	V

RMS - RMS detection

EIRP 26.5 TO 40 GHz, 1 MHz BW



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	204705 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	FCC Pt 15.511(c) E-Fld Equiv (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	28.63107	41.1	RMS	36.4	-40.2	37.3	43.9	-6.6	0-360	300	H
2	30.06111	40.74	RMS	36.9	-39.7	37.94	43.9	-5.96	0-360	101	H
3	31.59336	41.27	RMS	37.1	-39.6	38.77	43.9	-5.13	0-360	300	H
4	32.73411	40.85	RMS	37.5	-39.3	39.05	43.9	-4.85	0-360	300	V
5	34.06868	41.42	RMS	37.6	-39.9	39.12	43.9	-4.78	0-360	101	V
6	35.16893	41.41	RMS	37.7	-40.7	38.41	43.9	-5.49	0-360	101	V

RMS - RMS detection

8.4. RADIATED EMISSIONS AT OR BELOW 960 MHz

LIMITS

§15.511 (c) The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209 of this chapter.

§15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

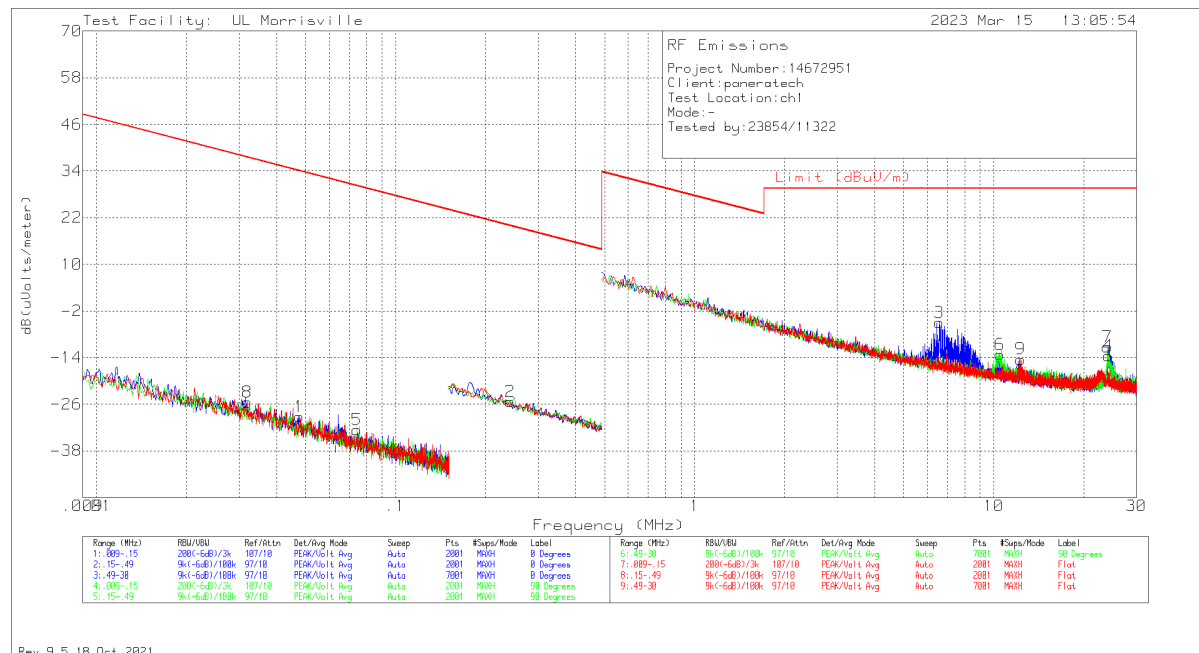
§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

8.4.1. INS ANTENNA

SPURIOUS EMISSIONS 0.009 TO 30 MHz

Note: All measurements were made at a test distance of 3 m. The limits in the plots and tabular data are the FCC/IC limits extrapolated from the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to the measurement distance to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were $40 \cdot \log$ (specification distance / test distance).

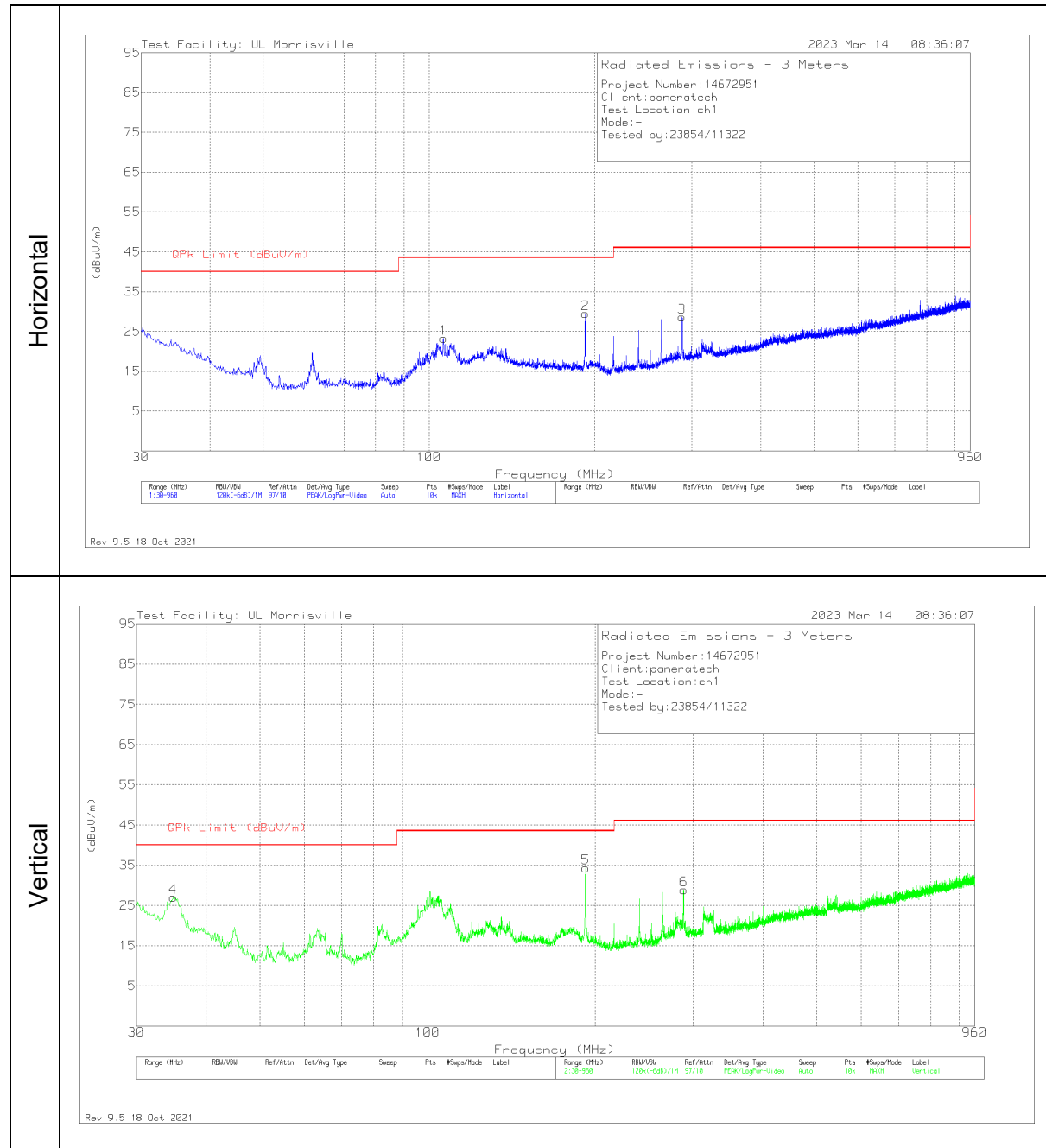
Although these tests were performed at a test site other than an open area test site, adequate comparison measurements were confirmed against an open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dB/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	QP/AV Limit (dBuV/m)	PK Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
8	.03193	40.36	Pk	14	.1	-80	-25.54	37.52	57.52	-63.06	0-360	Flat
1	.0477	37.94	Pk	12.8	.1	-80	-29.16	34.04	54.04	-63.2	0-360	0 degs
5	.07425	34.99	Pk	12.3	.1	-80	-32.61	30.19	50.19	-62.8	0-360	90 degs
2	.24172	42.43	Pk	12.2	.1	-80	-25.27	19.94	39.94	-45.21	0-360	0 degs
3	6.58634	22.96	Pk	11.5	.5	-40	-5.04	29.54	-	-34.58	0-360	0 degs
6	10.49035	15.19	Pk	10.9	.7	-40	-13.21	29.54	-	-42.75	0-360	90 degs
9	12.31588	14.18	Pk	10.7	.7	-40	-14.42	29.54	-	-43.96	0-360	Flat
7	23.97312	18.69	Pk	9.1	1	-40	-11.21	29.54	-	-40.75	0-360	90 degs
4	24.13333	16.31	Pk	9.1	1	-40	-13.59	29.54	-	-43.13	0-360	0 degs

Pk - Peak detector

SPURIOUS EMISSIONS 30 TO 960 MHz



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	159203 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	106.167	35.78	Pk	17.9	-30.4	23.28	43.52	-20.24	0-360	299	H
2	192.006	41.53	Pk	17.5	-29.6	29.43	43.52	-14.09	0-360	100	H
3	287.982	37.94	Pk	19.4	-28.7	28.64	46.02	-17.38	0-360	100	H
4	34.929	34.91	Pk	23.6	-31.5	27.01	40	-12.99	0-360	100	V
5	192.006	46.43	Pk	17.5	-29.6	34.33	43.52	-9.19	0-360	100	V
6	288.075	38.18	Pk	19.4	-28.7	28.88	46.02	-17.14	0-360	100	V

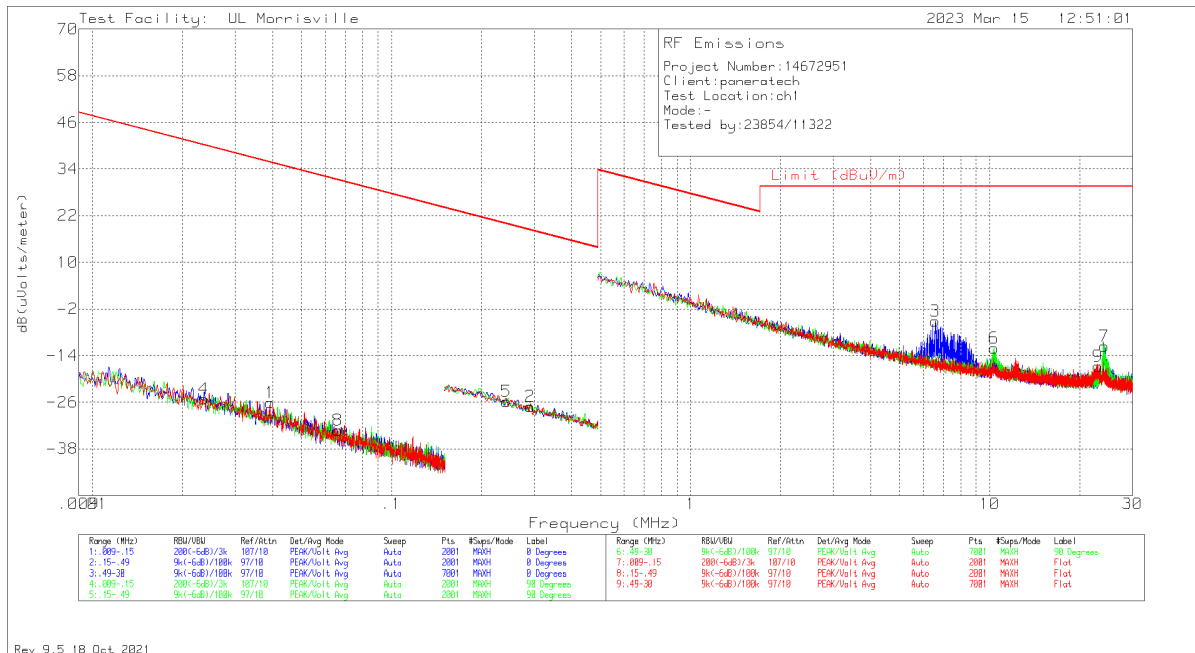
Pk - Peak detector

8.4.2. RTS ANTENNA

SPURIOUS EMISSIONS 0.009 TO 30 MHz

Note: All measurements were made at a test distance of 3 m. The limits in the plots and tabular data are the FCC/IC limits extrapolated from the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to the measurement distance to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were 40*Log (specification distance / test distance).

Although these tests were performed at a test site other than an open area test site, adequate comparison measurements were confirmed against an open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606

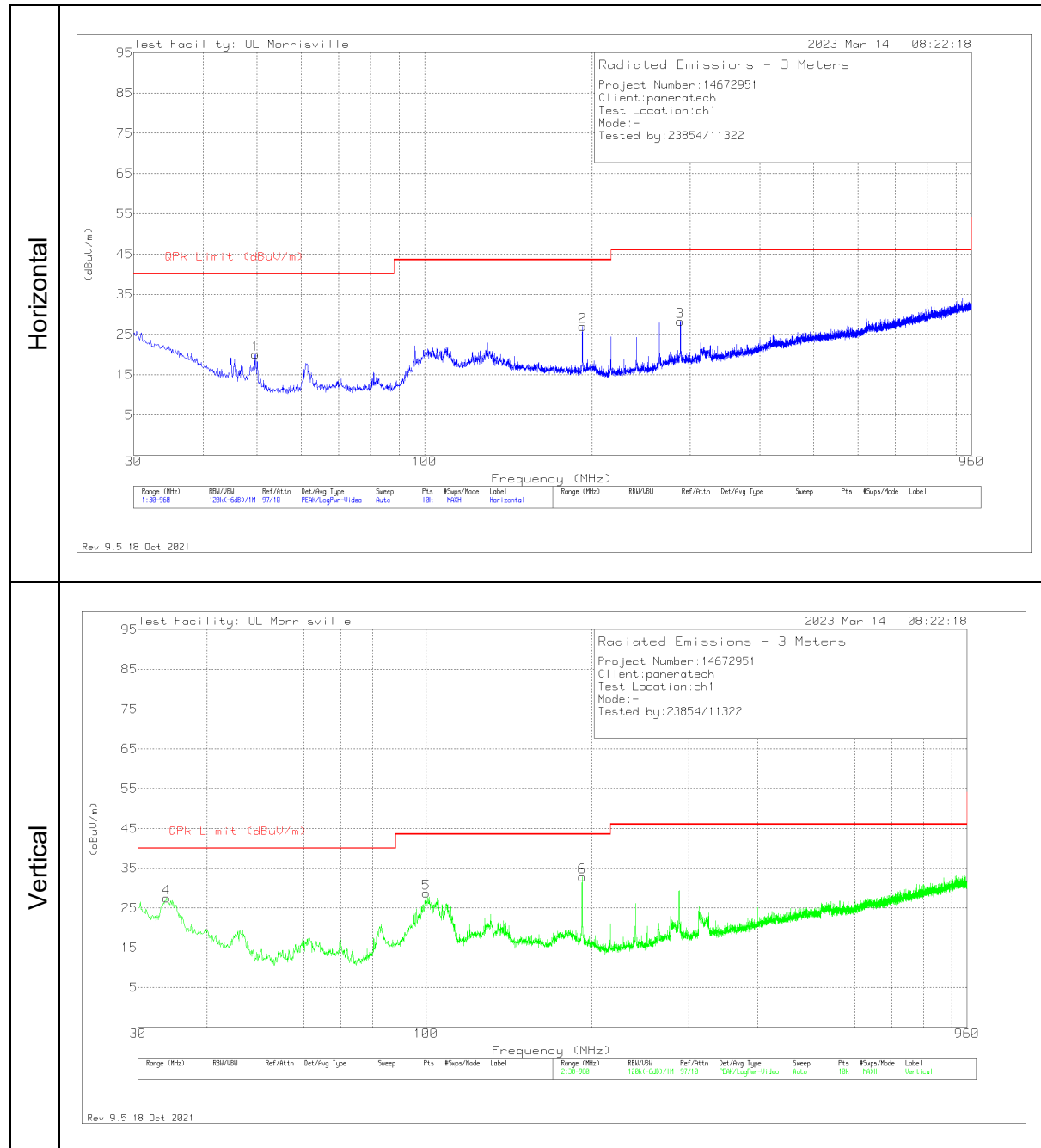


Rev 9.5 18 Oct 2021

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dB/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	QP/AV Limit (dBuV/m)	QP/AV Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
4	.02363	40.2	Pk	14.6	.1	-80	-25.1	40.14	60.14	-65.24	0-360	90 degs
1	.03932	40.31	Pk	13.4	.1	-80	-26.19	35.71	55.71	-61.9	0-360	0 degs
8	.06623	34.25	Pk	12.4	.1	-80	-33.25	31.18	51.18	-64.43	0-360	Flat
5	.24146	41.95	Pk	12.2	.1	-80	-25.75	19.95	39.95	-45.7	0-360	90 degs
2	.29093	40.61	Pk	12.2	.1	-80	-27.09	18.33	38.33	-45.42	0-360	0 degs
3	6.58634	22.86	Pk	11.5	.5	-40	-5.14	29.54	-	-34.68	0-360	0 degs
6	10.33858	16.19	Pk	11	.7	-40	-12.11	29.54	-	-41.65	0-360	90 degs
9	23.00344	12.96	Pk	9.3	1	-40	-16.74	29.54	-	-46.28	0-360	Flat
7	24.11646	18.34	Pk	9.1	1	-40	-11.56	29.54	-	-41.1	0-360	90 degs

Pk - Peak detector

SPURIOUS EMISSIONS 30 TO 960 MHz



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	159203 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	49.716	37.08	Pk	14.2	-31.2	20.08	40	-19.92	0-360	299	H
2	192.006	39.14	Pk	17.5	-29.6	27.04	43.52	-16.48	0-360	200	H
3	287.982	37.57	Pk	19.4	-28.7	28.27	46.02	-17.75	0-360	99	H
4	33.813	34.51	Pk	24.4	-31.4	27.51	40	-12.49	0-360	100	V
5	100.029	42.95	Pk	16.4	-30.6	28.75	43.52	-14.77	0-360	100	V
6	192.006	44.91	Pk	17.5	-29.6	32.81	43.52	-10.71	0-360	100	V

Pk - Peak detector

9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

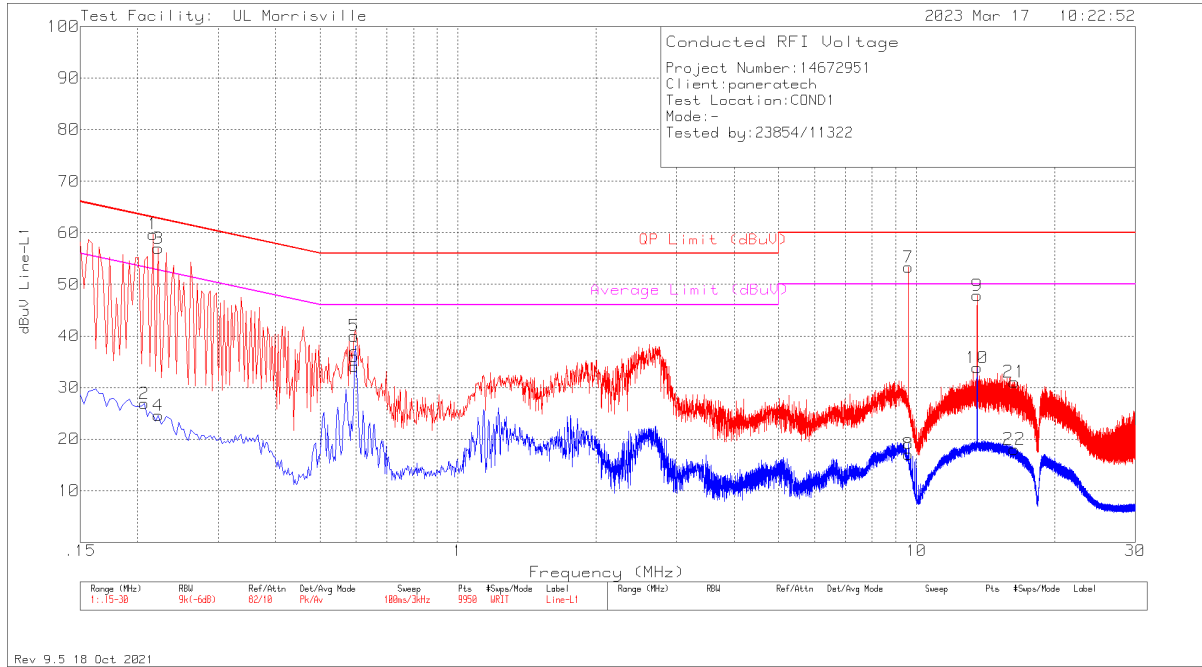
The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both lines.

RESULTS

9.1.1. INS ANTENNA

LINE 1 RESULTS

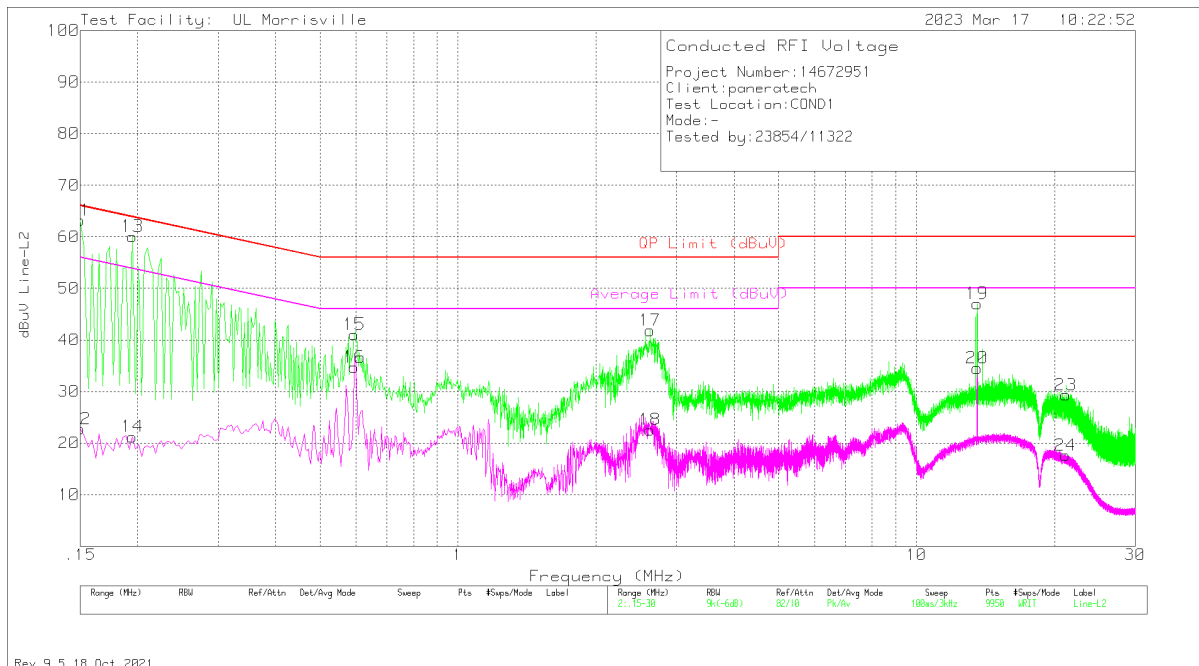


Range 1: Line-L1 .15 - 30MHz

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
2	.207	16.98	Av	.1	9.8	26.88	-	-	53.32	-26.44
1	.21539	24.82	Qp	.1	9.8	34.72	62.99	-28.27	-	-
3	.222	26.56	Qp	.1	9.8	36.46	62.74	-26.28	-	-
4	.222	14.68	Av	.1	9.8	24.58	-	-	52.74	-28.16
5	.594	30.21	Pk	0	9.8	40.01	56	-15.99	-	-
6	.594	24.31	Av	0	9.8	34.11	-	-	46	-11.89
7	9.588	43.23	Pk	.1	10	53.33	60	-6.67	-	-
8	9.588	7	Av	.1	10	17.1	-	-	50	-32.9
9	13.56	37.74	Pk	.1	10	47.84	60	-12.16	-	-
10	13.56	23.73	Av	.1	10	33.83	-	-	50	-16.17
21	16.335	20.88	Pk	.1	10.1	31.08	60	-28.92	-	-
22	16.335	7.84	Av	.1	10.1	18.04	-	-	50	-31.96

Pk - Peak detector
 Av - Average detection
 Qp - Quasi-Peak detector

LINE 2 RESULTS

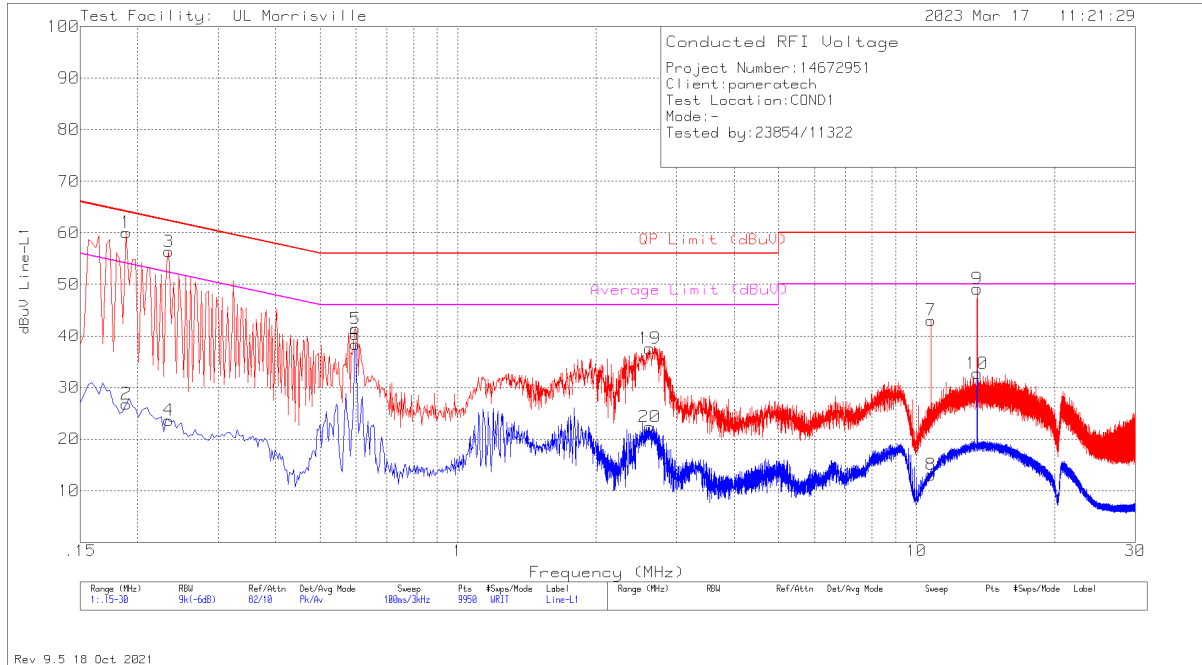


Range 2: Line-L2 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
11	.15014	33.86	Qp	.2	9.8	43.86	65.99	-22.13	-	-
12	.15	12.63	Av	.3	9.8	22.73	-	-	56	-33.27
13	.1792	31.74	Qp	.2	9.8	41.74	64.52	-22.78	-	-
14	.195	11.24	Av	.2	9.8	21.24	-	-	53.82	-32.58
15	.594	31.24	Pk	0	9.8	41.04	56	-14.96	-	-
16	.594	24.91	Av	0	9.8	34.71	-	-	46	-11.29
17	2.625	32.04	Pk	0	9.8	41.84	56	-14.16	-	-
18	2.625	12.78	Av	0	9.8	22.58	-	-	46	-23.42
19	13.56	36.93	Pk	.1	10	47.03	60	-12.97	-	-
20	13.56	24.42	Av	.1	10	34.52	-	-	50	-15.48
24	21.138	7.22	Av	.2	10.2	17.62	-	-	50	-32.38
23	21.159	18.92	Pk	.2	10.2	29.32	60	-30.68	-	-

Pk - Peak detector
 Av - Average detection
 Qp - Quasi-Peak detector

9.1.2. RTS ANTENNA

LINE 1 RESULTS

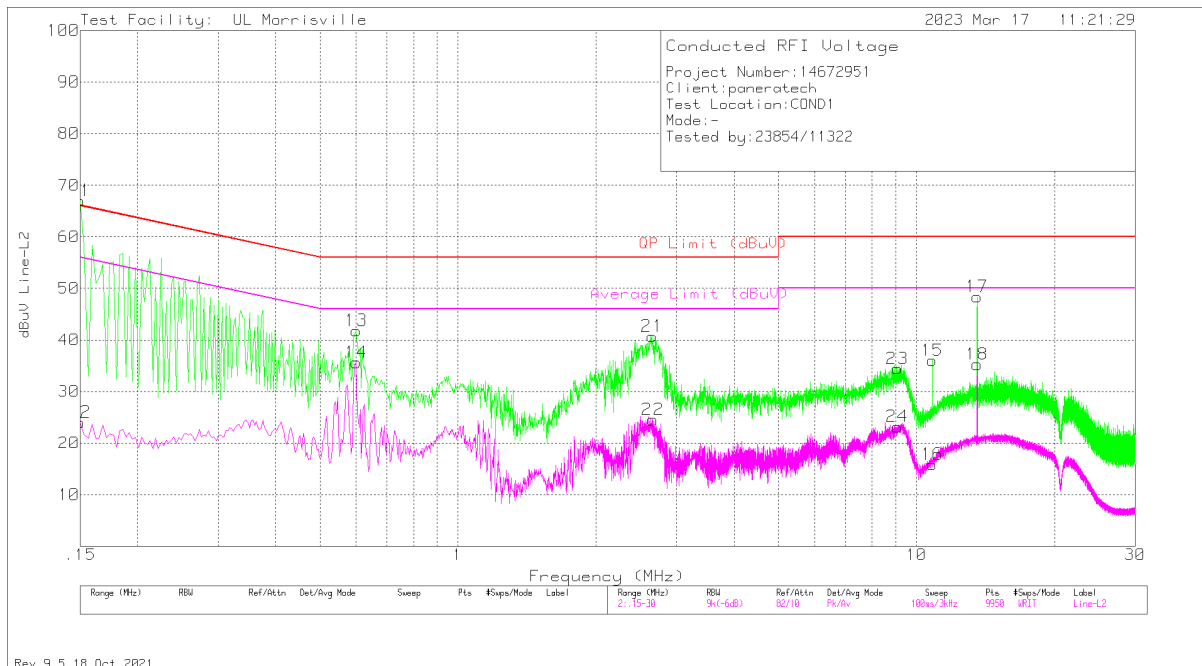


Range 1: Line-L1 .15 - 30MHz

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
1	.17633	30.88	Qp	.2	9.8	40.88	64.66	-23.78	-	-
2	.189	16.82	Av	.2	9.8	26.82	-	-	54.08	-27.26
3	.22176	25.44	Qp	.1	9.8	35.34	62.75	-27.41	-	-
4	.234	13.75	Av	.1	9.8	23.65	-	-	52.31	-28.66
5	.597	31.58	Pk	0	9.8	41.38	56	-14.62	-	-
6	.597	28.57	Av	0	9.8	38.37	-	-	46	-7.63
19	2.619	27.77	Pk	0	9.8	37.57	56	-18.43	-	-
20	2.619	12.58	Av	0	9.8	22.38	-	-	46	-23.62
7	10.749	32.94	Pk	.1	10	43.04	60	-16.96	-	-
8	10.749	2.99	Av	.1	10	13.09	-	-	50	-36.91
9	13.563	39.06	Pk	.1	10	49.16	60	-10.84	-	-
10	13.563	22.63	Av	.1	10	32.73	-	-	50	-17.27

Pk - Peak detector
 Av - Average detection
 Qp - Quasi-Peak detector

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
11	.15392	33.31	Qp	.2	9.8	43.31	65.79	-22.48	-	-
12	.15	13.92	Av	.3	9.8	24.02	-	-	56	-31.98
13	.6	32.01	Pk	0	9.8	41.81	56	-14.19	-	-
14	.6	25.84	Av	0	9.8	35.64	-	-	46	-10.36
21	2.652	30.9	Pk	0	9.8	40.7	56	-15.3	-	-
22	2.661	14.74	Av	0	9.8	24.54	-	-	46	-21.46
24	9.081	13.08	Av	.1	10	23.18	-	-	50	-26.82
23	9.084	24.34	Pk	.1	10	34.44	60	-25.56	-	-
15	10.824	25.91	Pk	.1	10	36.01	60	-23.99	-	-
16	10.824	5.75	Av	.1	10	15.85	-	-	50	-34.15
17	13.56	38.27	Pk	.1	10	48.37	60	-11.63	-	-
18	13.56	25.16	Av	.1	10	35.26	-	-	50	-14.74

Pk - Peak detector
 Av - Average detection
 Qp - Quasi-Peak detector

10. SETUP PHOTOS

Refer to Setup Photo Exhibit R14672951-EP1 for details.

END OF TEST REPORT