



TEST REPORT

Report Number. : R13274094-E3

Applicant : Raspberry Pi Limited
Maurice Wilkes Building
St. Johns Innovation Park, Crowley Road
Cambridge, CB4 0DS
United Kingdom

Model : Pi Zero 2

FCC ID : 2ABCB-RPIZ2

IC : 20953-RPIZ2

EUT Description : Radio Module

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C
ISED RSS-247 ISSUE 2
ISED RSS-GEN ISSUE 5 + Amendment 2

Date Of Issue:
2021-08-19

Prepared by:
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REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
v.1	2021-03-26	Initial Issue	Haley Ackun
v2	2021-07-16	Editorial revisions	Brian T. Kiewra
V3	2021-08-19	Further editorial revisions	Brian T. Kiewra

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Raspberry Pi Limited
Maurice Wilkes Building
St. Johns Innovation Park, Crowley Road
Cambridge, CB4 0DS
United Kingdom

EUT DESCRIPTION: Radio Module

MODEL: Pi Zero 2

SERIAL NUMBER: DVT2 #72, DVT2 #42

SAMPLE RECEIPT DATE: 2020-11-09

DATE TESTED: 2020-12-01 TO 2021-01-22

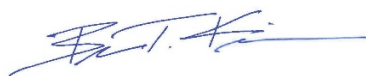
APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5 + Amendment 2	Complies

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.

This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document.

Approved & Released For
UL LLC:



Brian T. Kiewra
Project Engineer
Consumer Technology Division
UL LLC

Prepared By:



Haley Ackun
Laboratory Engineer
Consumer Technology Division
UL LLC

2. TEST RESULTS SUMMARY

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.

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	ANSI C63.10 Section 11.6.
-	RSS-GEN 6.7	99% OBW	Reporting purposes only	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	RSS-247 5.2 (a)	6dB BW	Complies	None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power	Complies	None.
See Comment		Average power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	RSS-247 5.2 (b)	PSD	Complies	None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions	Complies	None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Complies	None.

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site V01r01, RSS-GEN Issue 5 + Amendment 2, and RSS-247 Issue 2.

4. 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
☐	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	703469
☒	Building: 2800 Perimeter Park Dr Morrisville, NC 27560, U.S.A		27265	

5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
RF output power, radiated (SAC)	4.52 dB
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	2.26°C
Humidity	6.79%
DC Supply voltages	1.70%
Time	3.39%

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

5.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

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

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) +
LISN Insertion Loss.

36.5 dBuV + 0 dB + 10.1 dB + 0 dB = 46.6 dBuV

6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a BT/BLE/2.4GHz WLAN radio module. This report covers BLE only. The PMN is Raspberry Pi Zero 2 and HVIN is 1.0.

6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	BLE	6.27	4.24

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain, as provided by the manufacturer are as follows:
The radio utilizes an antenna, with a maximum gain of 2.5 dBi.

6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v1.0.

The test utility software used during testing was v1.0.

6.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that Z orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Z orientation.

The EUT only supports 1 data rate; therefore all final scans were performed with the EUT transmitting at 1 Mbps.

6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Monitor	Viewsonic	VX2452MH	TVT171081663	N/A
Power Supply	Stontronics	DSA-12CA-05	4314HB	V100236

I/O CABLES

I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Micro USB	1	USB	Power Supply	< 3m	Connected to AC mains.

TEST SETUP

Test software exercised the radio card.

SETUP DIAGRAMS

Refer to R13274094-EP1 for setup diagrams

7. MEASUREMENT METHOD

Duty Cycle: ANSI C63.10 Subclause -11.6

6 dB BW: ANSI C63.10 Subclause -11.8.1 RBW $\geq$ DTS BW

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter

Output Power: ANSI C63.10 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

Emissions non-restricted frequency bands: ANSI C63.10 Subclause -11.11 and 6.10.4

Emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1 and 6.10.5

General Radiated Spurious Emissions ANSI C63.10-2013 Section 6.3-6.6

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2

8. TEST AND MEASUREMENT EQUIPMENT

Test Equipment Used - Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
72822	Spectrum Analyzer	Agilent Technologies	E4446A	2020-01-02	2021-01-21
PWM005	RF Power Meter	Keysight Technologies	N1912A	2020-07-14	2021-07-14
PWS005	Peak and Avg Power Sensor, 50MHz to 6GHz	Keysight Technologies	E9323A	2020-05-26	2021-05-26
HI0090	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26
SOFTEMI	Antenna Port Software	UL	Version 2020-12-03		
	Additional Equipment used				
MM0167	True RMS Multimeter	Agilent	U1232A	2020-08-05	2021-08-05

Test Equipment Used - Conducted Disturbance Emissions – Voltage

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
85496	EMI Test Receiver 9kHz-3.6GHz	Rohde & Schwarz	ESR3	2020-08-18	2021-08-18
CBL004	Coaxial cable, 20 ft., BNC - male to BNC-male	UL	RG-223	2020-07-23	2021-07-23
HI0085	Temp/Humid/Pressure Meter	Extech	SD700	2020-04-20	2021-04-30
SOFTEMI	EMI Software	UL	Version 9.5 (2020-08-18)		
	Transient Limiter				
ATA508	Transient Limiter, 0.009 to 100 MHz	Electro-Metrics	EM 7600	2020-07-21	2021-07-21
	LISN (FCC & CISPR testing)				
LISN002	LISN, 50-ohm/50-uH, 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50-25-2-01-550V	2020-08-17	2021-08-17

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - North Chamber)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	18-40 GHz				
AT0063 (In @ 0800 11/04/2020)	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2020-10-30	2021-10-30
	Gain-Loss Chains				
N-SAC04	Gain-loss string: 18-40GHz	Various	Various	2020-07-31	2021-07-31
	Receiver & Software				
SA0026	Spectrum Analyzer	Agilent	N9030A	2020-07-16	2021-07-16
SA0027	Spectrum Analyzer	Agilent	N9030A	2020-06-10	2021-06-10
SOFTEMI	EMI Software	UL	Version 9.5 (2020-08-18)		
	Additional Equipment used				
s/n 200037610	Environmental Meter	Fisher Scientific	06-662-4	2020-01-22	2022-01-22
PS215	AC Power Source	Elgar	CW2501M (s/n 1523A02397)	NA	NA

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - South Chamber)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	0.009-30MHz	(Loop Ant.)			
AT0079 (In @ 0800 09/02/2020)	Active Loop Antenna	ETS-Lindgren	6502	2020-08-20	2021-08-20
	30-1000 MHz				
AT0075 (In @ 093011/19/2020)	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2020-10-27	2021-10-27
	1-18 GHz				
AT0067	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-28	2021-04-28
	Gain-Loss Chains				
S-SAC01	Gain-loss string: 0.009-30MHz	Various	Various	2020-07-10	2021-07-10
S-SAC02	Gain-loss string: 25-1000MHz	Various	Various	2020-07-10	2021-07-10
S-SAC03	Gain-loss string: 1-18GHz	Various	Various	2020-07-06	2021-07-06
	Receiver & Software				
SA0025	Spectrum Analyzer	Agilent	N9030A	2020-03-17	2021-03-17
SOFTEMI	EMI Software	UL	Version 9.5 (2020-08-18)		
	Additional Equipment used				
s/n 200037635	Environmental Meter	Fisher Scientific	06-662-4	2020-01-22	2022-01-22

9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

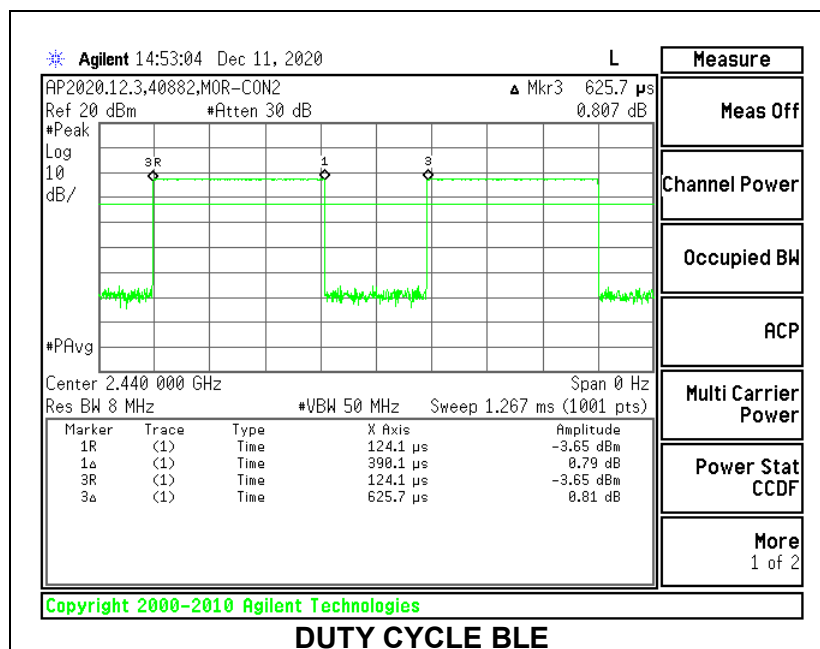
None; for reporting purposes only.

PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
BLE	0.390	0.626	0.623	62.35%	4.10	2.563



9.2. 99% BANDWIDTH

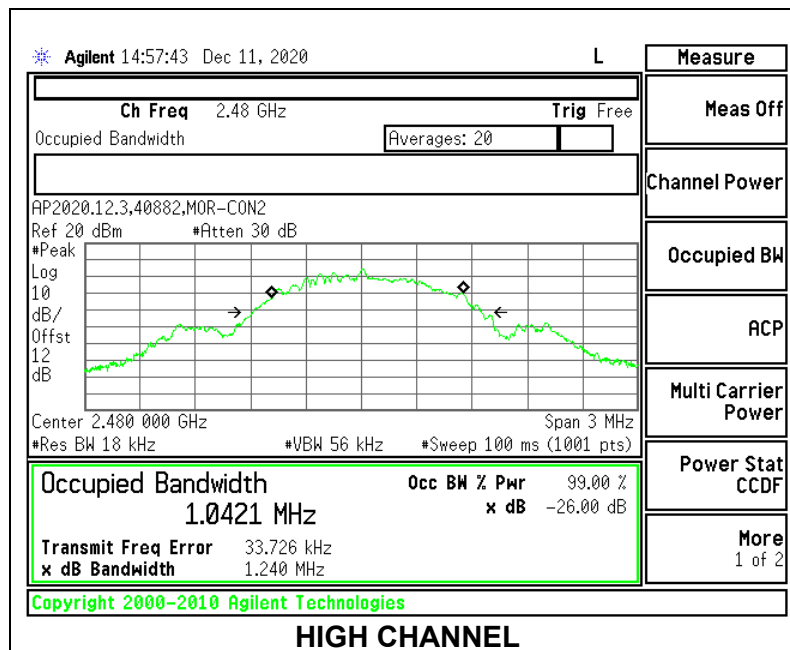
LIMITS

None; for reporting purposes only.

RESULTS

9.2.1. BLE (1Mbps)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0423
Middle	2440	1.0422
High	2480	1.0421



9.3. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

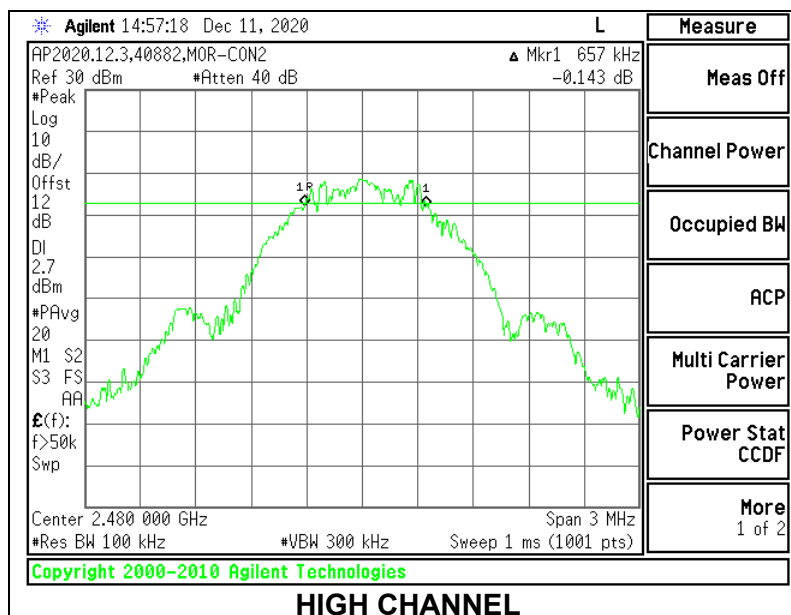
RSS-247 5.2 (a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

9.3.1. BLE (1Mbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.705	0.5
Middle	2440	0.690	0.5
High	2480	0.657	0.5



9.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.61 dB (including 10.13 dB pad and 1.48 dB cable) was entered as an offset in the power meter to allow for a peak reading of power.

RESULTS

9.4.1. BLE (1Mbps)

Tested By:	40882
Date:	2021-01-22

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	4.56	30	-25.440
Middle	2440	5.29	30	-24.710
High	2480	6.27	30	-23.730

9.5. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.61 dB (including 10.13 dB pad and 1.48 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

9.5.1. BLE (1Mbps)

Tested By:	40882
Date:	2020-12-01

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	4.26
Middle	2440	4.17
High	2480	6.04

9.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

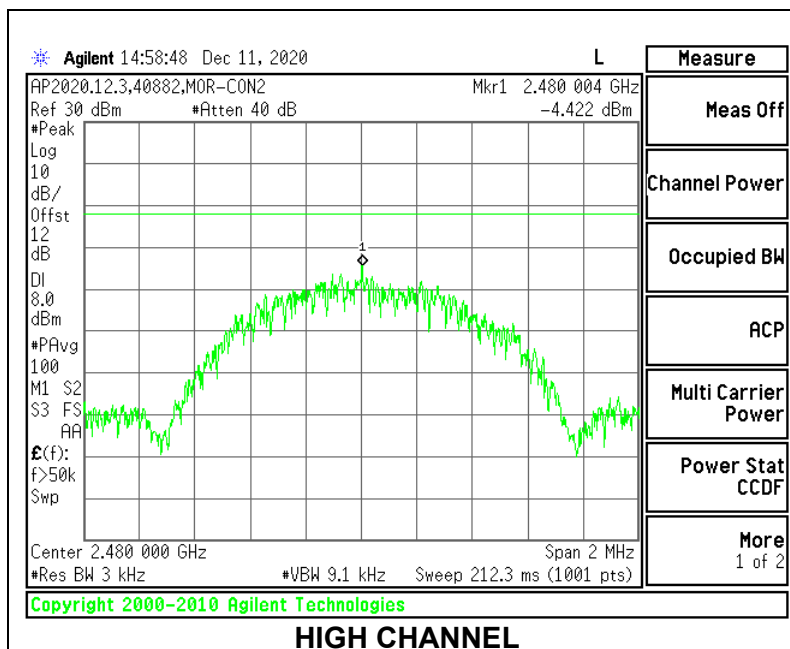
RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

9.6.1. BLE (1Mbps)

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-5.19	8	-13.19
Middle	2440	-4.79	8	-12.79
High	2480	-4.42	8	-12.42



9.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

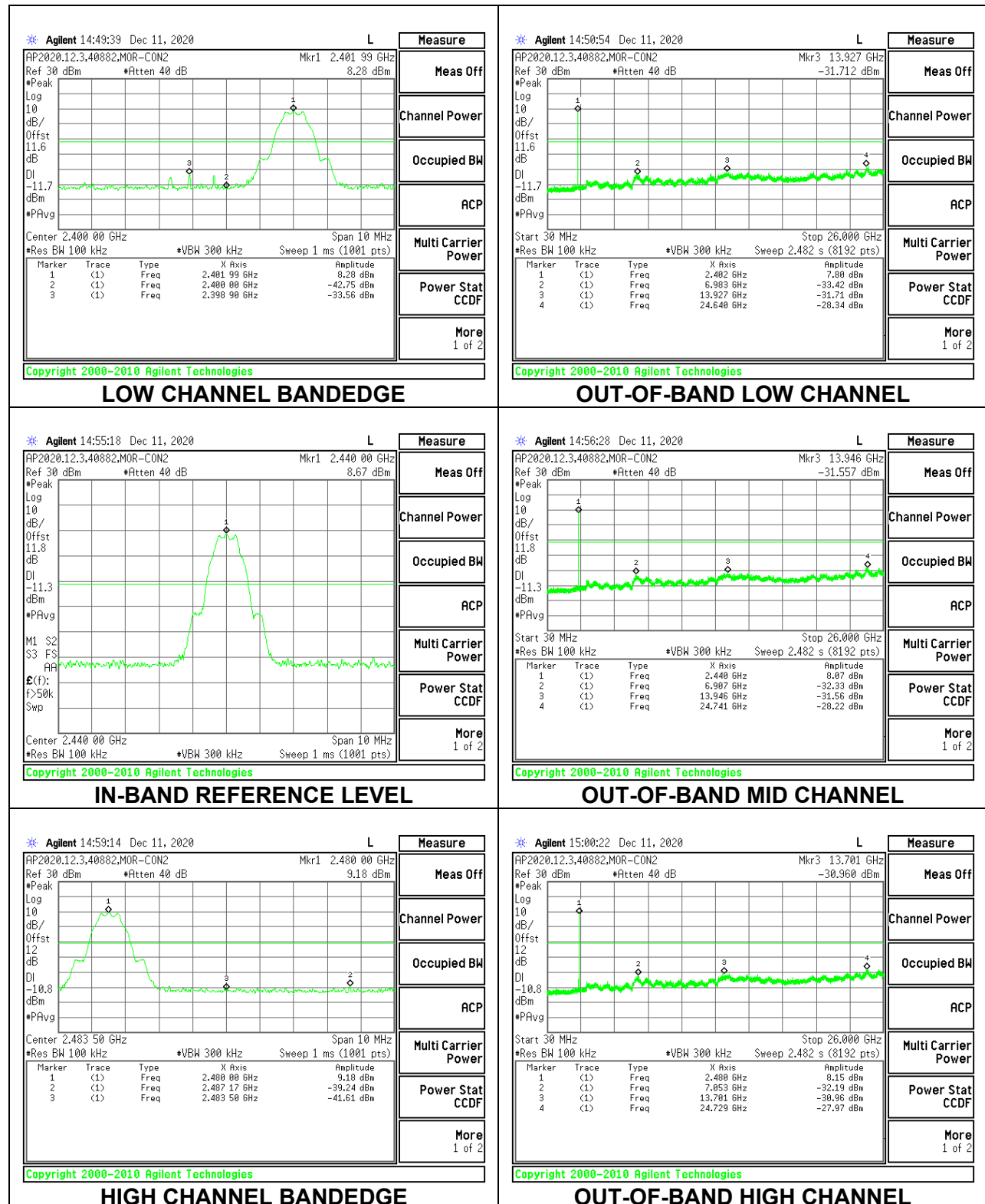
FCC §15.247 (d)

RSS-247 5.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

RESULTS

9.7.1. BLE (1Mbps)



10. RADIATED TEST RESULTS

10.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

RSS-GEN, Section 8.9 and 8.10.

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
0.009-0.490	2400/F(kHz) @ 300 m	-
0.490-1.705	24000/F(kHz) @ 30 m	-
1.705 - 30	30 @ 30m	-
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

The spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest output power was tested.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

3D antenna use - For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel).

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

KDB 414788 Open Field Site(OFS) and Chamber Correlation Justification

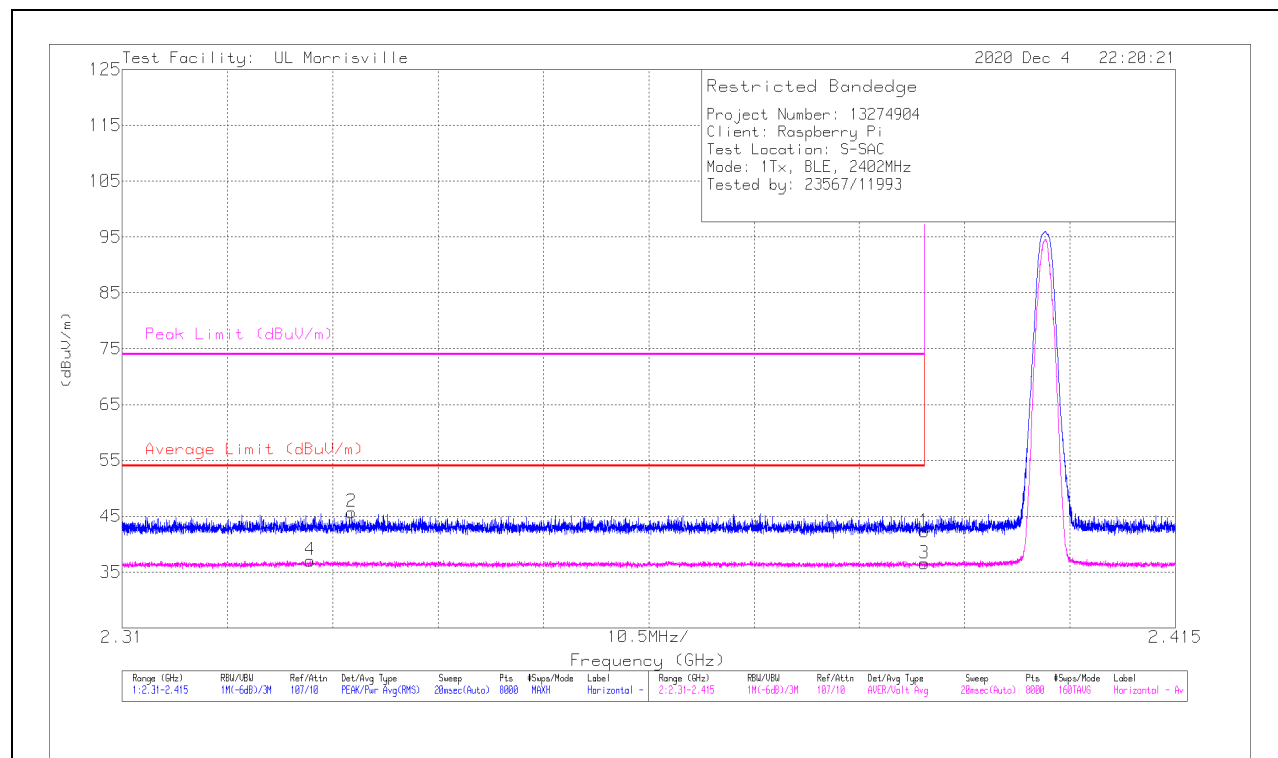
OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

10.2. TRANSMITTER ABOVE 1 GHz

10.2.1. BLE (1Mbps)

BANDEDGE (LOW CHANNEL)

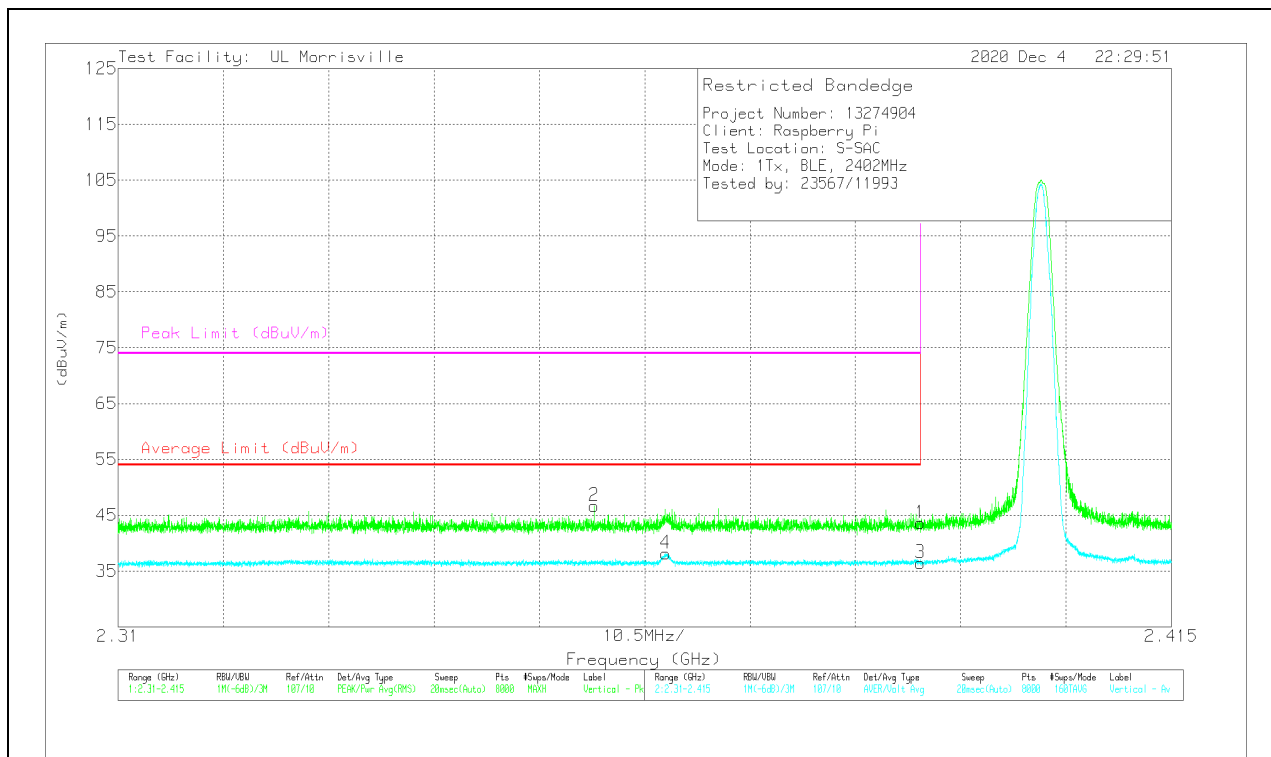
HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.39	34.17	Pk	32.1	-24	0	42.27	-	-	74	-31.73	178	181	H
2	* ** 2.33287	37.34	Pk	32.1	-23.7	0	45.74	-	-	74	-28.26	178	181	H
3	* ** 2.39	24.31	ADV	32.1	-24	4.13	36.54	54	-17.46	-	-	178	181	H
4	* ** 2.32876	24.56	ADV	32.1	-23.7	4.13	37	54	-17	-	-	178	181	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 ** - indicates frequency in Taiwan NCC LP0002 Restricted Band
 Pk - Peak detector
 ADV - Linear Voltage Average

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.39	35.52	Pk	32.1	-24	0	43.62	-	-	74	-30.38	233	180	V
2	* ** 2.35745	38.27	Pk	32.2	-23.8	0	46.67	-	-	74	-27.33	233	180	V
3	* ** 2.39	24.2	ADV	32.1	-24	4.13	36.43	54	-17.57	-	-	233	180	V
4	* ** 2.36458	25.72	ADV	32.2	-23.9	4.13	38.15	54	-15.85	-	-	233	180	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

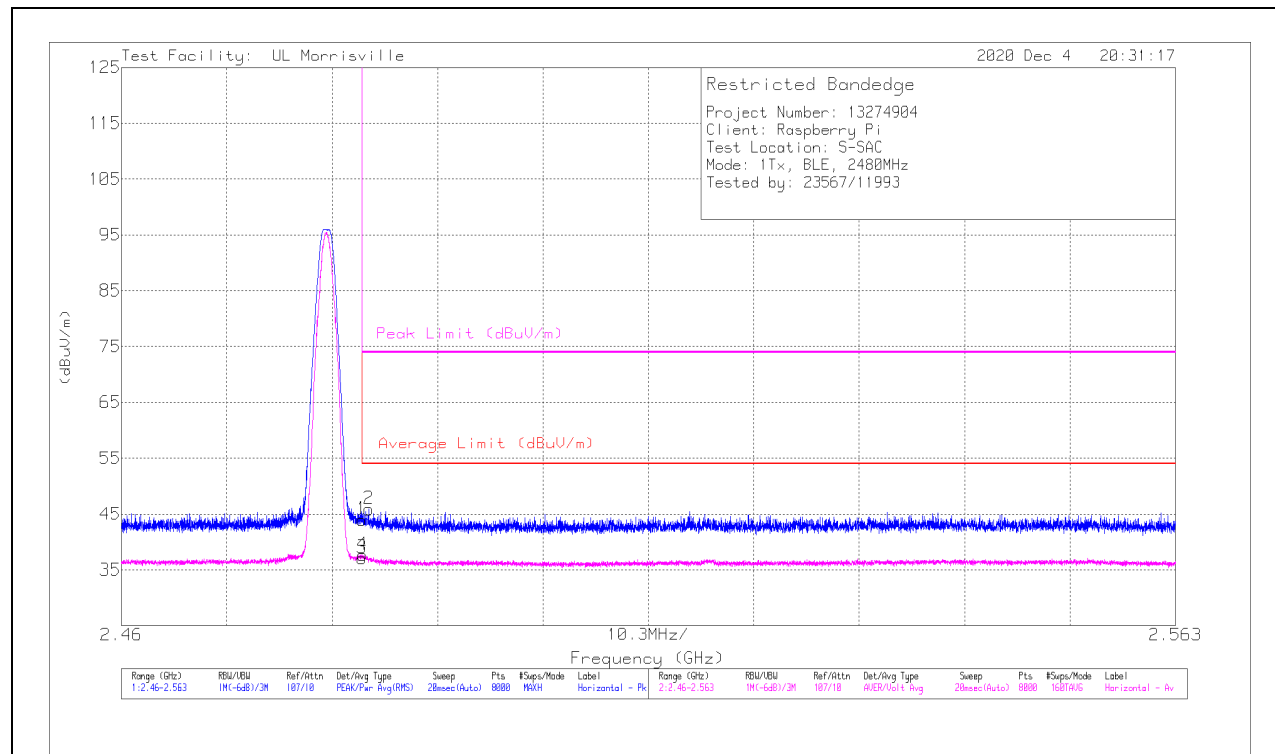
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.4835	36.01	Pk	32.4	-24.4	0	44.01	-	-	74	-29.99	191	164	H
2	* ** 2.48417	37.87	Pk	32.4	-24.4	0	45.87	-	-	74	-28.13	191	164	H
3	* ** 2.4835	24.97	ADV	32.4	-24.4	4.13	37.1	54	-16.9	-	-	191	164	H
4	* ** 2.48358	25.51	ADV	32.4	-24.4	4.13	37.64	54	-16.36	-	-	191	164	H

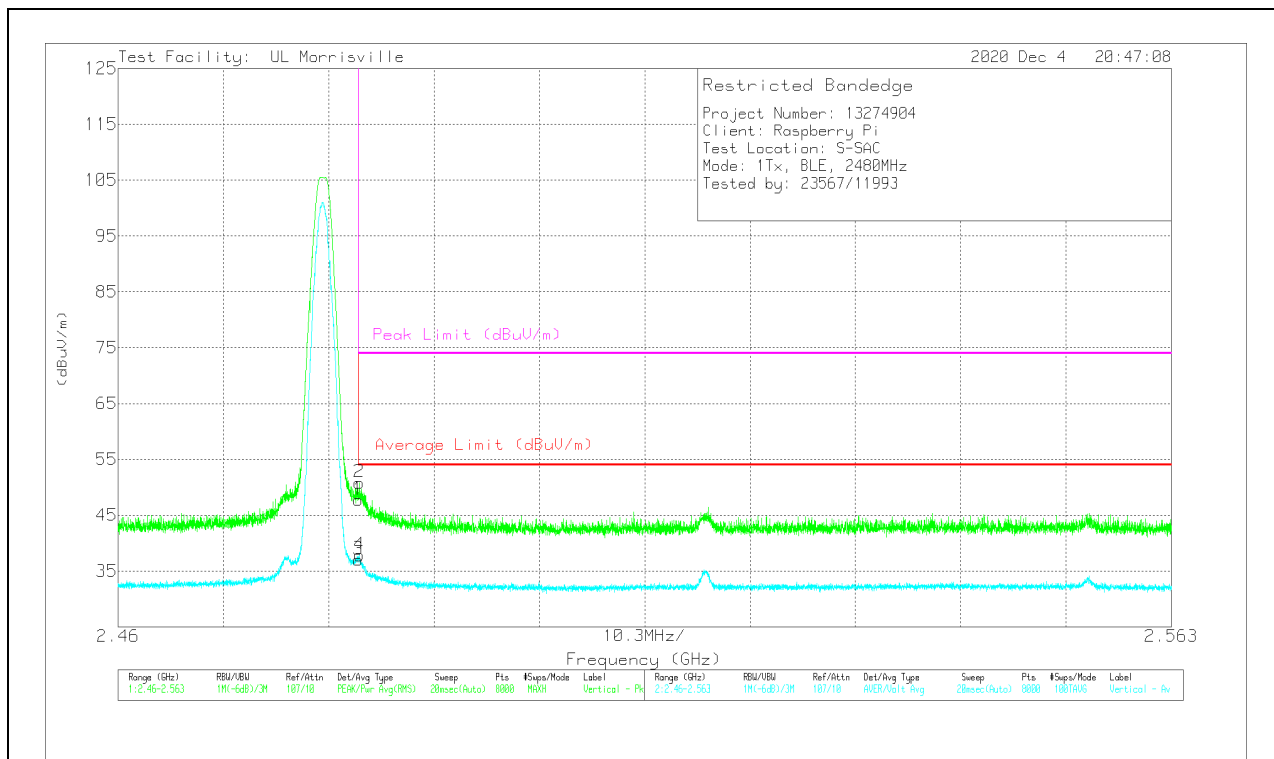
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 2.4835	39.79	Pk	32.4	-24.4	0	47.79	-	-	74	-26.21	233	169	V
2	*** 2.48358	42.86	Pk	32.4	-24.4	0	50.86	-	-	74	-23.14	233	169	V
3	*** 2.4835	24.91	ADV	32.4	-24.4	4.13	37.04	54	-16.96	-	-	233	169	V
4	*** 2.4836	25.72	ADV	32.4	-24.4	4.13	37.85	54	-16.15	-	-	233	169	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

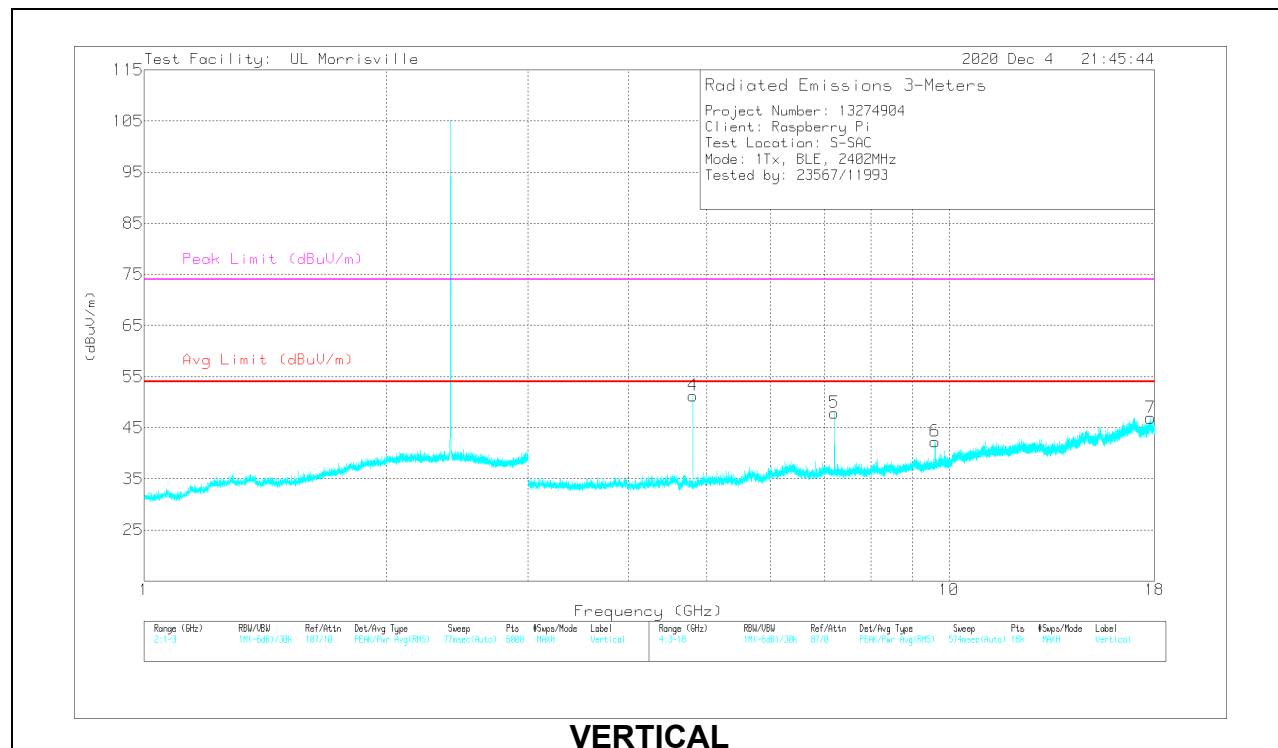
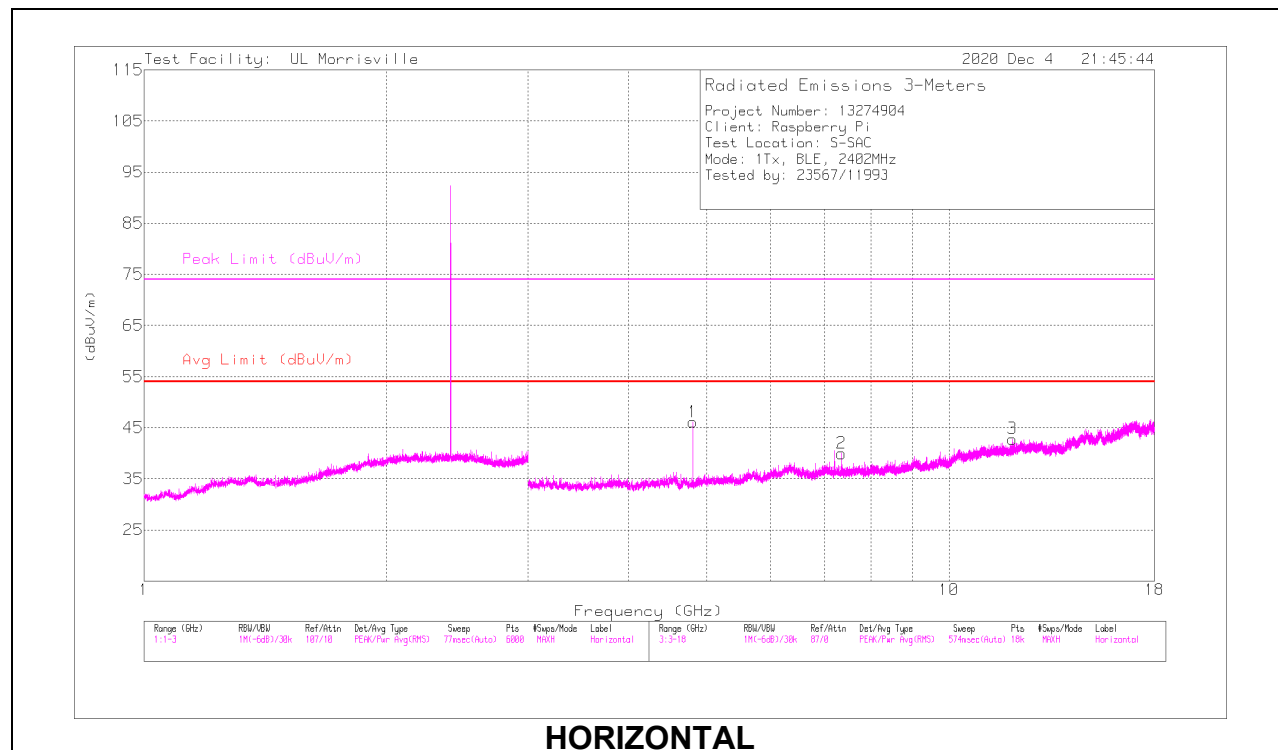
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 4.80399	46.92	PK2	34	-30.9	0	50.02	-	-	74	-23.98	32	102	H
	*** 4.80387	36.66	ADV	34	-30.9	4.13	43.89	54	-10.11	-	-	32	102	H
2	*** 7.35561	36.08	PK2	35.6	-27.5	0	44.18	-	-	74	-29.82	271	325	H
	*** 7.35532	22.56	ADV	35.6	-27.5	4.13	34.79	54	-19.21	-	-	271	325	H
3	*** 11.99245	33.93	PK2	38.7	-24.2	0	48.43	-	-	74	-25.57	226	202	H
	*** 11.99258	20.69	ADV	38.7	-24.2	4.13	39.32	54	-14.68	-	-	226	202	H
4	*** 4.80396	51.63	PK2	34	-30.9	0	54.73	-	-	74	-19.27	225	111	V
	*** 4.80397	42.03	ADV	34	-30.9	4.13	49.26	54	-4.74	-	-	225	111	V
7	*** 17.79951	34.01	PK2	41.1	-21.8	0	53.31	-	-	74	-20.69	17	166	V
	*** 17.80064	21.11	ADV	41.1	-21.8	4.13	44.54	54	-9.46	-	-	17	166	V
5	7.20524	40.23	Pk	35.6	-27.9	0	47.93	-	-	-	-	0-360	101	V
6	9.60704	32.02	Pk	36.6	-26.3	0	42.32	-	-	-	-	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

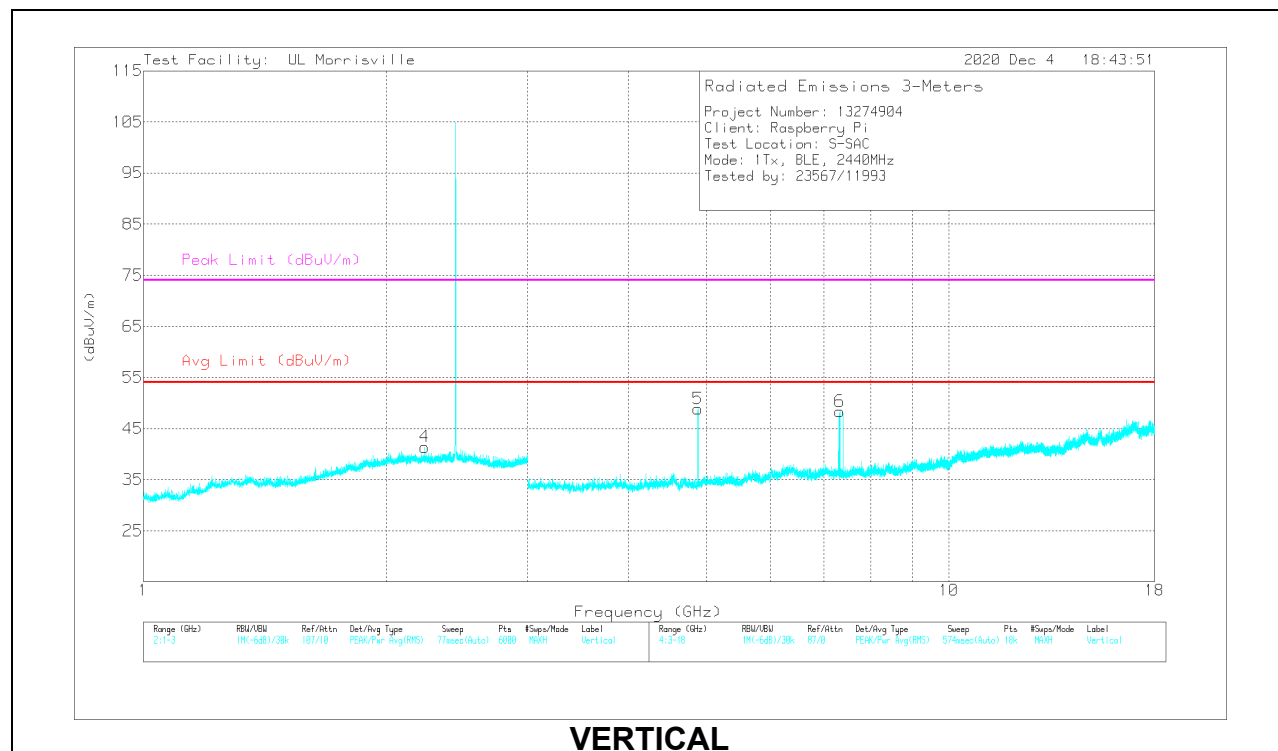
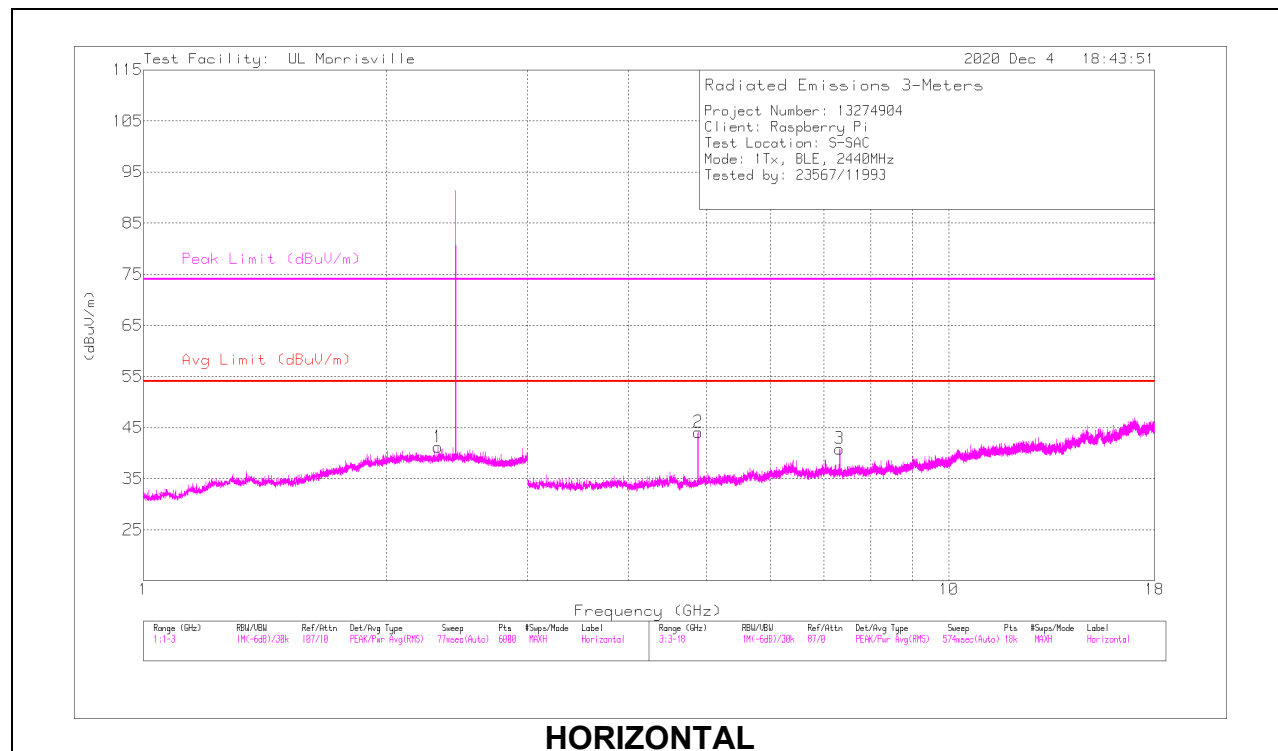
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

PK2 - Maximum Peak

ADV - Linear Voltage Average

Pk - Peak detector

MID CHANNEL RESULTS



RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.32192	37.3	PK2	32.1	-23.7	0	45.7	-	-	74	-28.3	287	130	H
	* ** 2.3238	24.05	ADV	32.1	-23.7	4.13	36.58	54	-17.42	-	-	287	130	H
4	* ** 2.23641	37.03	PK2	32	-23.3	0	45.73	-	-	74	-28.27	210	323	V
	* ** 2.23692	23.75	ADV	32	-23.3	4.13	36.58	54	-17.42	-	-	210	323	V
2	* ** 4.88056	46.1	PK2	34	-30.8	0	49.3	-	-	74	-24.7	31	101	H
	* ** 4.88	36.41	ADV	34	-30.8	4.13	43.74	54	-10.26	-	-	31	101	H
3	* ** 7.31918	39.55	PK2	35.6	-27.4	0	47.75	-	-	74	-26.25	252	278	H
	* ** 7.3195	27.55	ADV	35.6	-27.4	4.13	39.88	54	-14.12	-	-	252	278	H
5	* ** 4.87949	48.67	PK2	34	-30.8	0	51.87	-	-	74	-22.13	233	105	V
	* ** 4.87994	39.62	ADV	34	-30.8	4.13	46.95	54	-7.05	-	-	233	105	V
6	* ** 7.31931	44.84	PK2	35.6	-27.4	0	53.04	-	-	74	-20.96	213	102	V
	* ** 7.3195	34.2	ADV	35.6	-27.4	4.13	46.53	54	-7.47	-	-	213	102	V

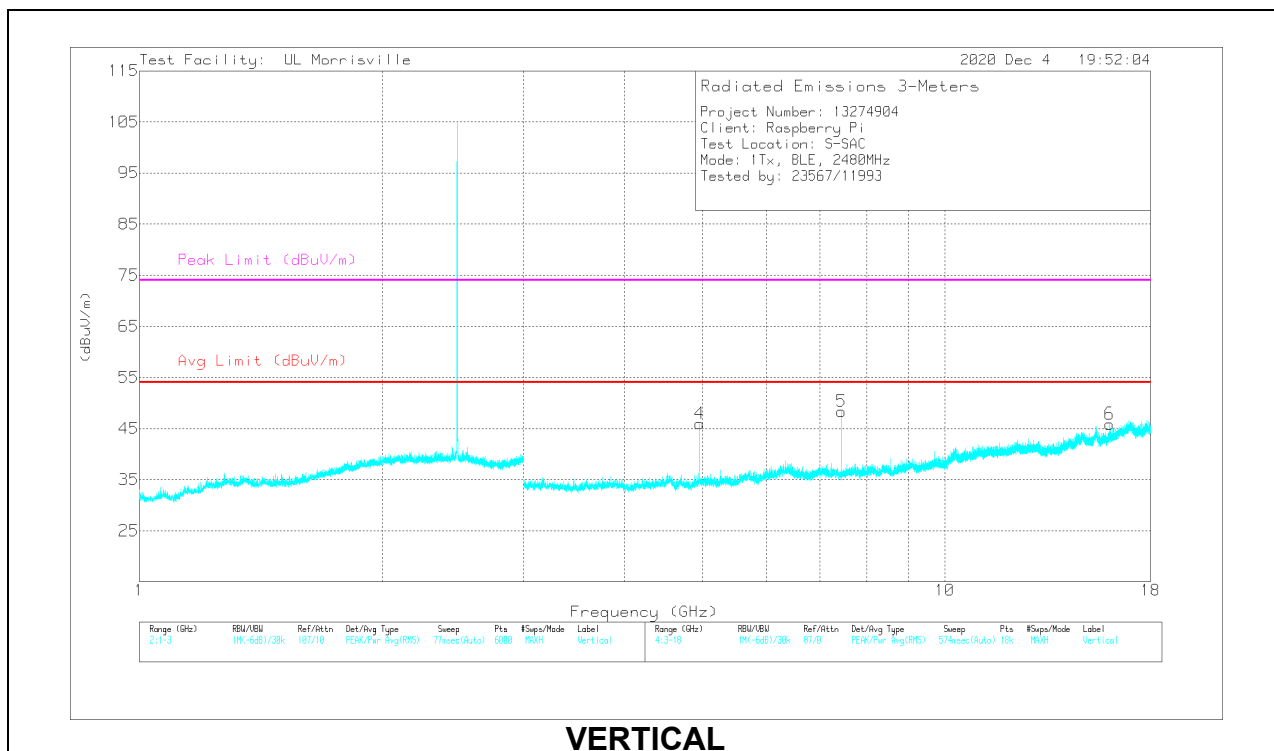
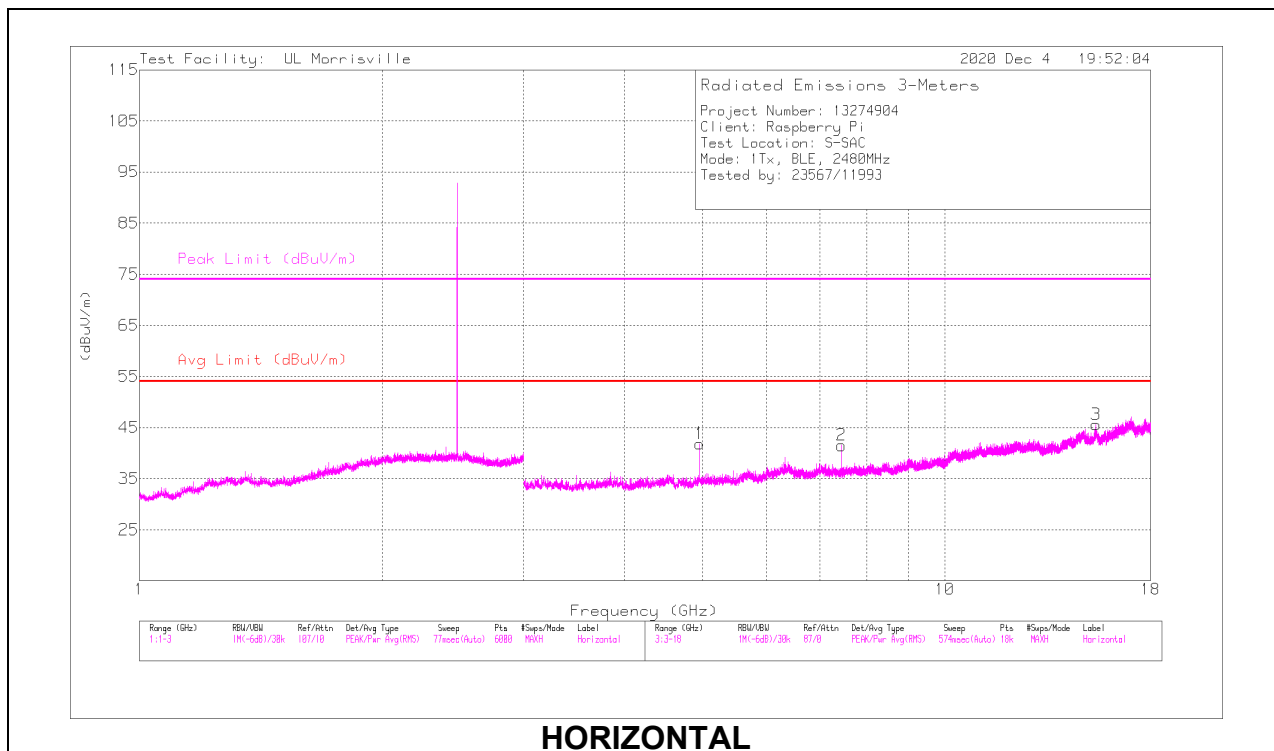
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

PK2 - Maximum Peak

ADV - Linear Voltage Average

HIGH CHANNEL RESULTS



RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 4.95988	43.42	PK2	33.9	-31	0	46.32	-	-	74	-27.68	0	132	H
	*** 4.95987	32.07	ADV	33.9	-31	4.13	39.1	54	-14.9	-	-	0	132	H
2	*** 7.43931	39.76	PK2	35.6	-27.7	0	47.66	-	-	74	-26.34	218	161	H
	*** 7.43946	27.93	ADV	35.6	-27.7	4.13	39.96	54	-14.04	-	-	218	161	H
3	*** 15.40696	33.14	PK2	40.3	-22	0	51.44	-	-	74	-22.56	60	384	H
	*** 15.40641	20.04	ADV	40.3	-22	4.13	42.47	54	-11.53	-	-	60	384	H
4	*** 4.96067	47.4	PK2	33.9	-31	0	50.3	-	-	74	-23.7	247	144	V
	*** 4.95995	36.57	ADV	33.9	-31	4.13	43.6	54	-10.4	-	-	247	144	V
5	*** 7.43928	44.58	PK2	35.6	-27.7	0	52.48	-	-	74	-21.52	218	135	V
	*** 7.43944	33.78	ADV	35.6	-27.7	4.13	45.81	54	-8.19	-	-	218	135	V
6	*** 16.01862	35.04	PK2	40.5	-23.8	0	51.74	-	-	74	-22.26	325	312	V
	*** 16.01943	21.82	ADV	40.5	-23.9	4.13	42.55	54	-11.45	-	-	325	312	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

PK2 - Maximum Peak

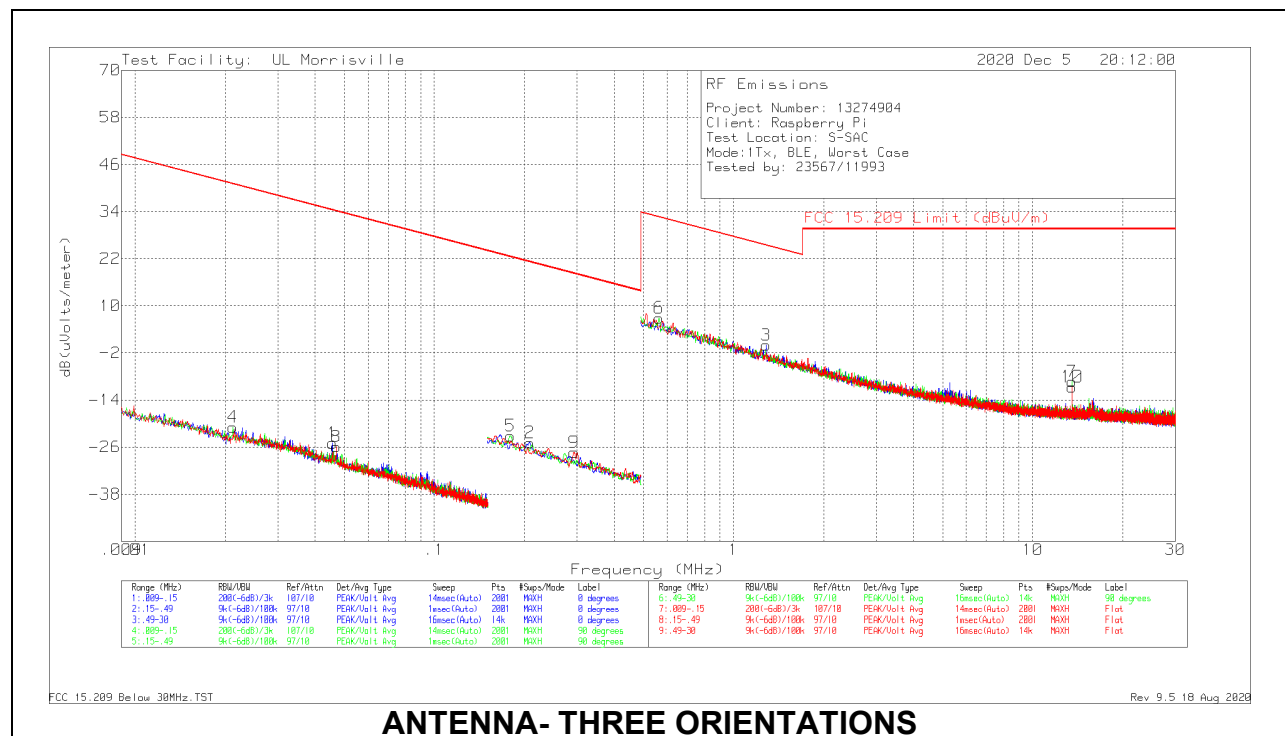
ADV - Linear Voltage Average

10.3. WORST CASE BELOW 30MHZ

Note for below 30 MHz scans: All measurements were made at a test distance of 3 m. The measured data was extrapolated from the test distance (3m) to the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) 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 $40 \cdot \log(\text{test distance} / \text{specification distance})$.

The below 30 MHz limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency 21.21 kHz resulted in a level of -20.89 dBuV/m, which is equivalent to $-20.89 - 51.5 = -72.39$ dBuA/m, which has the same margin, -61.96 dB, to the corresponding RSS-GEN Table 6 limit as it has to be 15.209(a) limit.

SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)



ANTENNA- THREE ORIENTATIONS

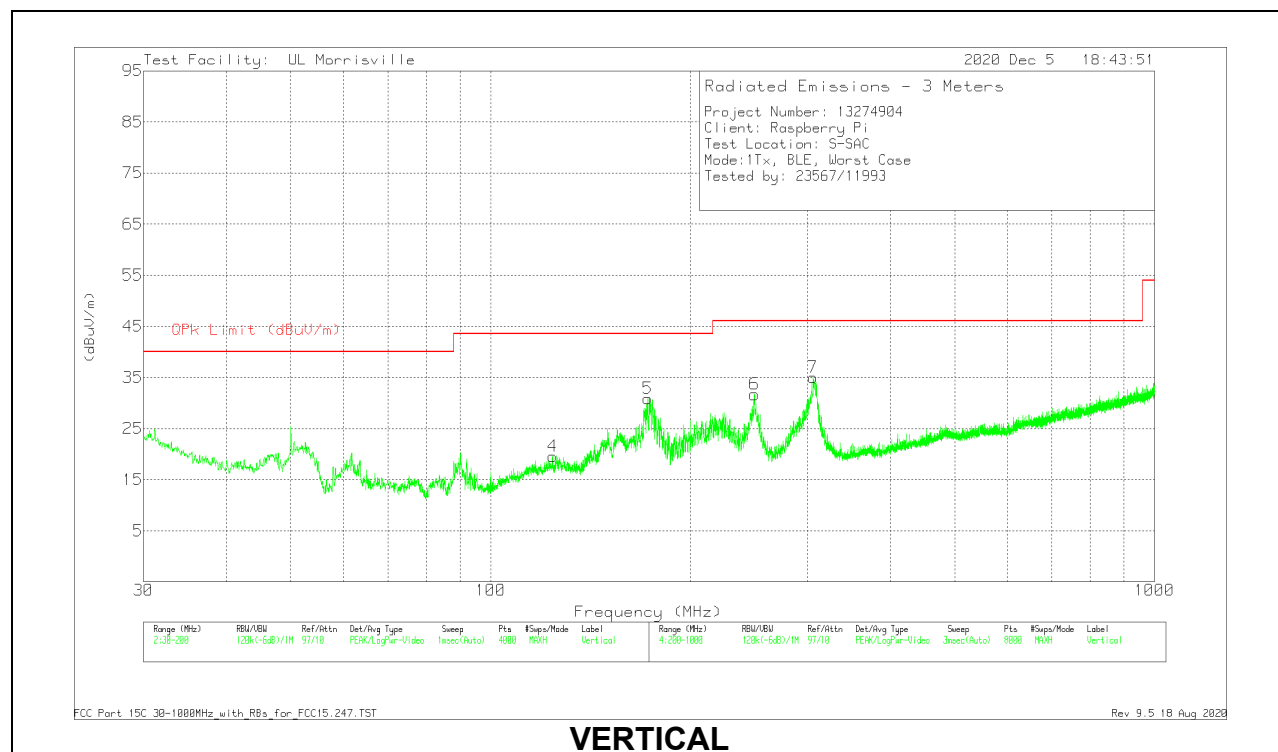
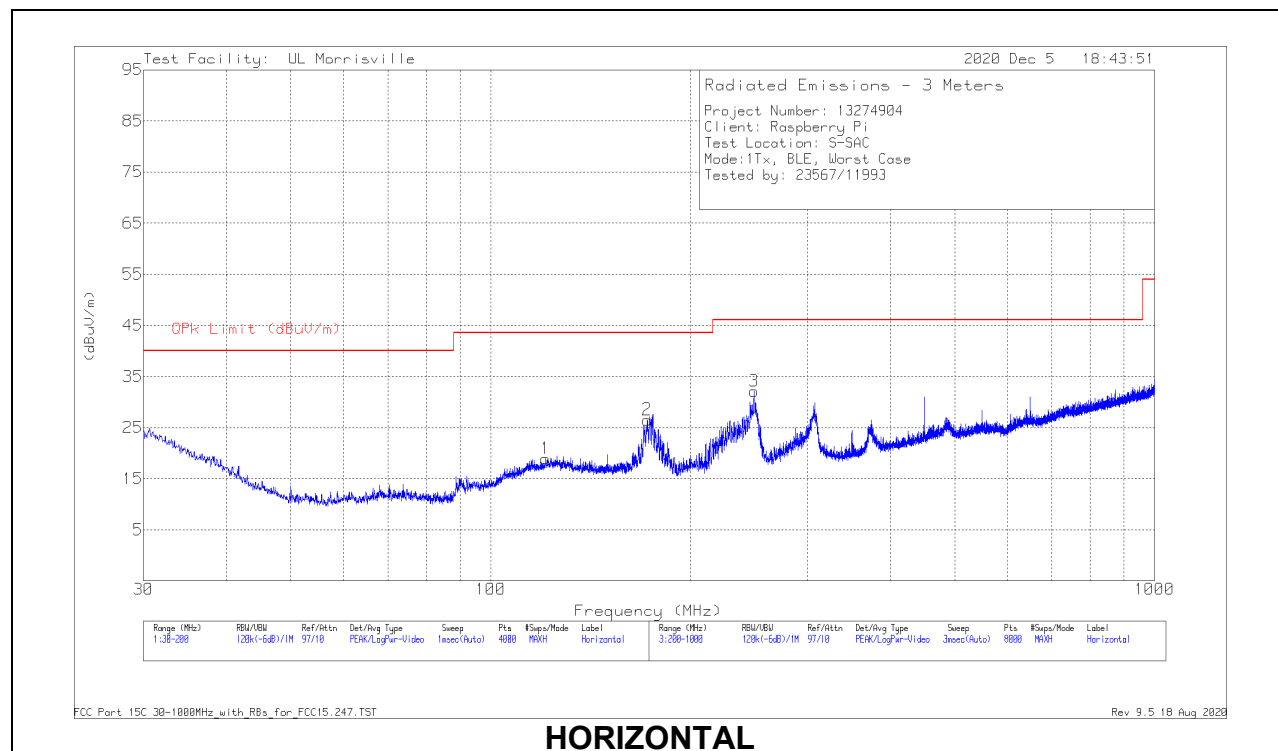
Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 (dB/m)	Cbl (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	FCC 15.209 Limit Avg/QP (dBuV/m)	FCC 15.209 Pk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
4	.02121	45.31	Pk	13.7	.1	-80	-20.89	41.07	61.07	-61.96	0-360
1	.04564	43.09	Pk	11.8	.1	-80	-25.01	34.42	54.42	-59.43	0-360
8	.04706	42.28	Pk	11.7	.1	-80	-25.92	34.15	54.15	-60.07	0-360
5	.17967	45.96	Pk	10.8	.1	-80	-23.14	22.51	42.51	-45.65	0-360
2	.20865	44.23	Pk	10.8	.1	-80	-24.87	21.22	41.22	-46.09	0-360
9	.29323	41.83	Pk	10.7	.1	-80	-27.37	18.26	38.26	-45.63	0-360
6	.56378	36.01	Pk	10.8	.1	-40	6.91	32.58	-	-25.67	0-360
3	1.28682	28.77	Pk	11	.2	-40	-.03	25.41	-	-25.44	0-360
7	13.5596	19.64	Pk	10.4	.7	-40	-9.26	29.54	-	-38.8	0-360
10	13.5596	18.23	Pk	10.4	.7	-40	-10.67	29.54	-	-40.21	0-360

Pk - Peak detector

10.4. WORST CASE BELOW 1 GHZ

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0075 AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 121.0586	29.2	Pk	20.1	-30.4	18.9	43.52	-24.62	0-360	200	H
2	* ** 172.1143	38.41	Pk	17.9	-29.8	26.51	43.52	-17.01	0-360	200	H
4	* ** 123.9493	29.74	Pk	20.1	-30.3	19.54	43.52	-23.98	0-360	101	V
5	* ** 172.4969	42.79	Pk	17.9	-29.8	30.89	43.52	-12.63	0-360	101	V
3	* ** 249.4064	43.58	Pk	17.6	-29.1	32.08	46.02	-13.94	0-360	101	H
6	* ** 249.7065	43.19	Pk	17.6	-29.1	31.69	46.02	-14.33	0-360	101	V
7	306.2138	43.97	Pk	19.7	-28.7	34.97	-	-	0-360	200	V

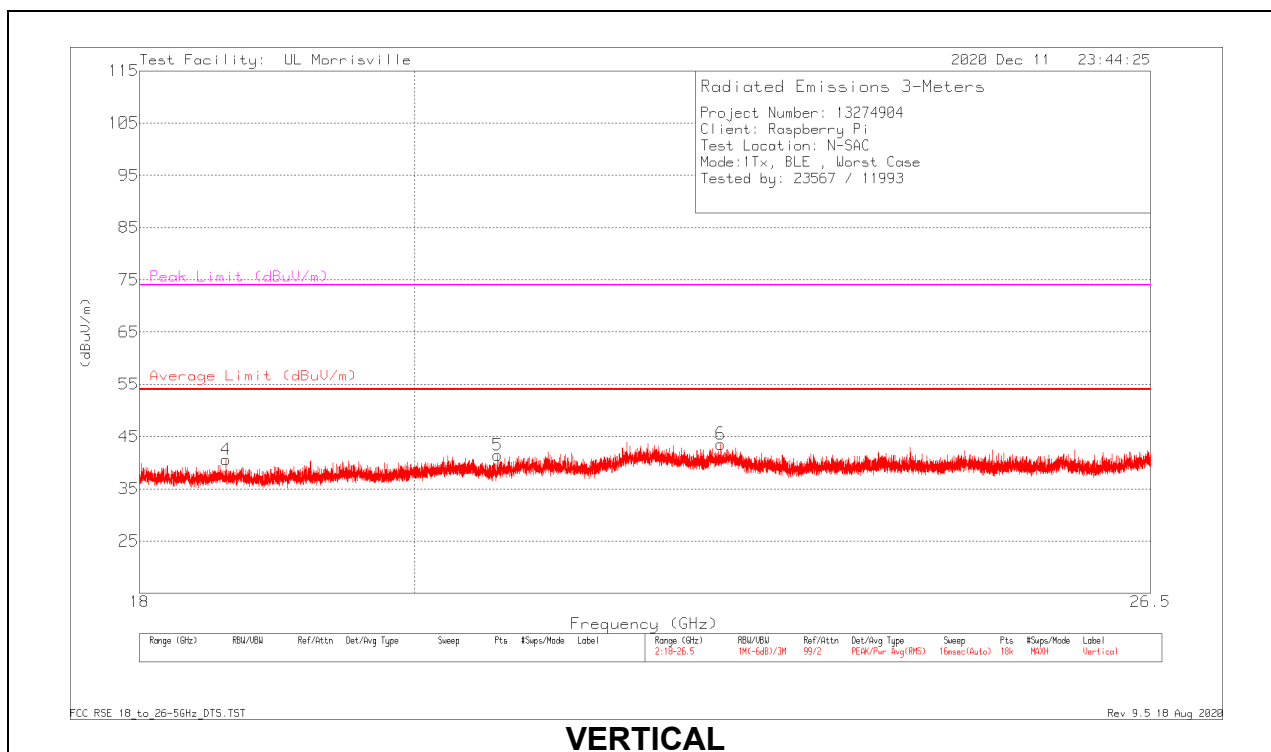
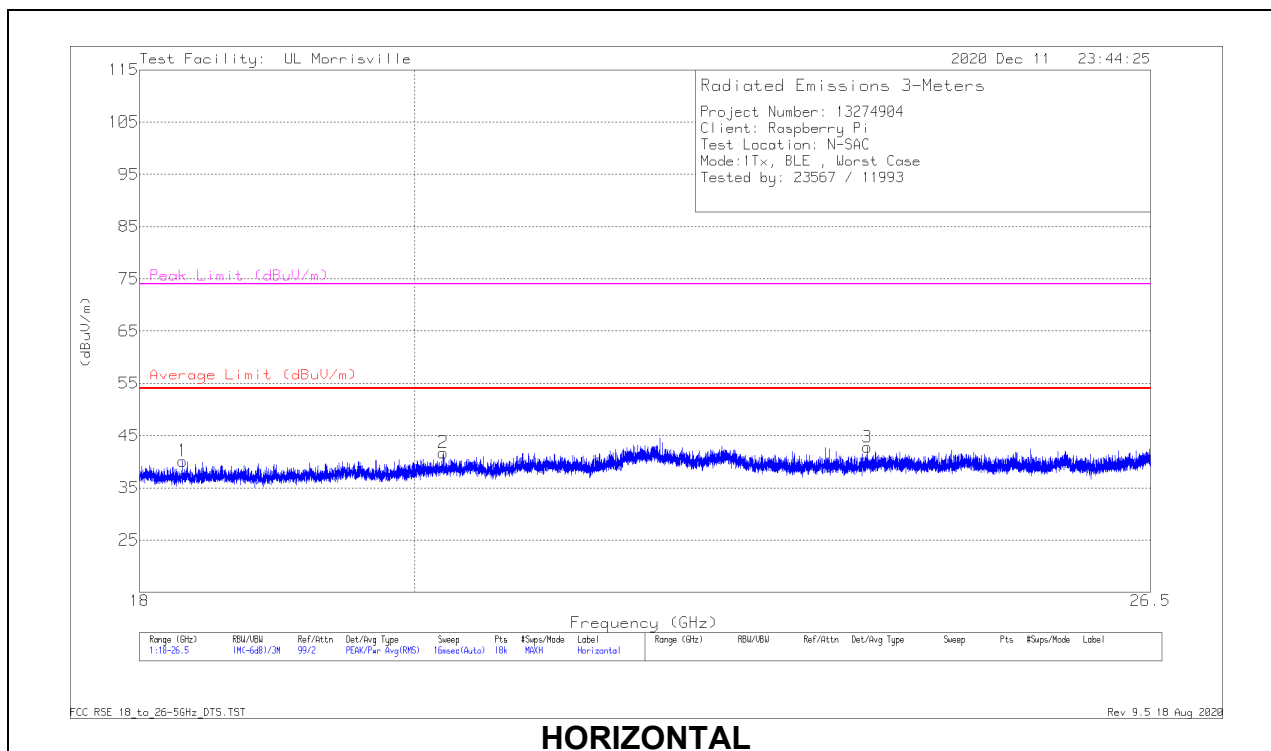
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

10.5. WORST CASE 18-26 GHZ

SPURIOUS EMISSIONS 18-26 GHz (WORST-CASE CONFIGURATION)



18 – 26GHz DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0063 AF (dB/m)	Amp/CBL (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 18.29799	47.45	Pk	33.1	-40.4	40.15	54	-13.85	74	-33.85	0-360	250	H
2	* ** 20.21815	48.53	Pk	33.8	-40.6	41.73	54	-12.27	74	-32.27	0-360	200	H
3	* ** 23.77984	48.4	Pk	34.8	-40.4	42.8	54	-11.2	74	-31.2	0-360	101	H
4	* ** 18.60684	48.1	Pk	33.2	-40.7	40.6	54	-13.4	74	-33.4	0-360	300	V
5	* ** 20.64317	48.06	Pk	34	-40.6	41.46	54	-12.54	74	-32.54	0-360	250	V
6	* ** 22.48116	48.07	Pk	36.4	-40.9	43.57	54	-10.43	74	-30.43	0-360	250	V

Pk - Peak detector

11. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

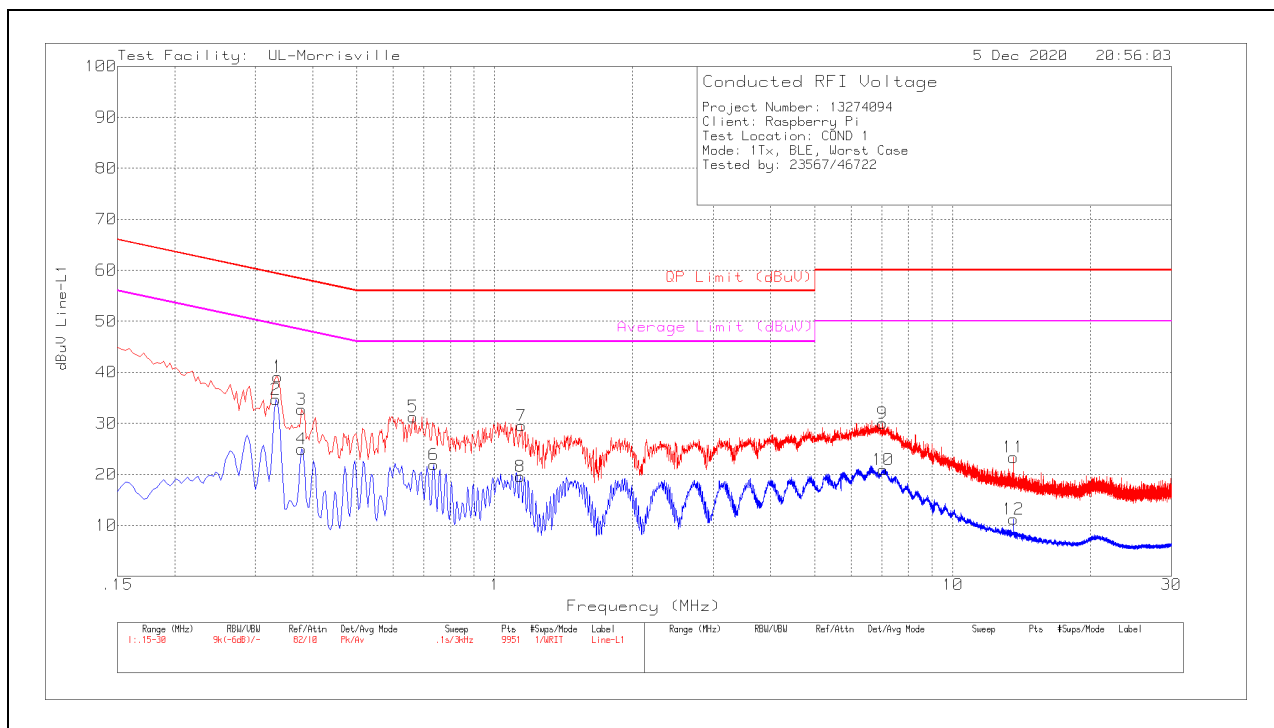
Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

RESULTS

11.1.1. AC Power Line Host

LINE 1 RESULTS

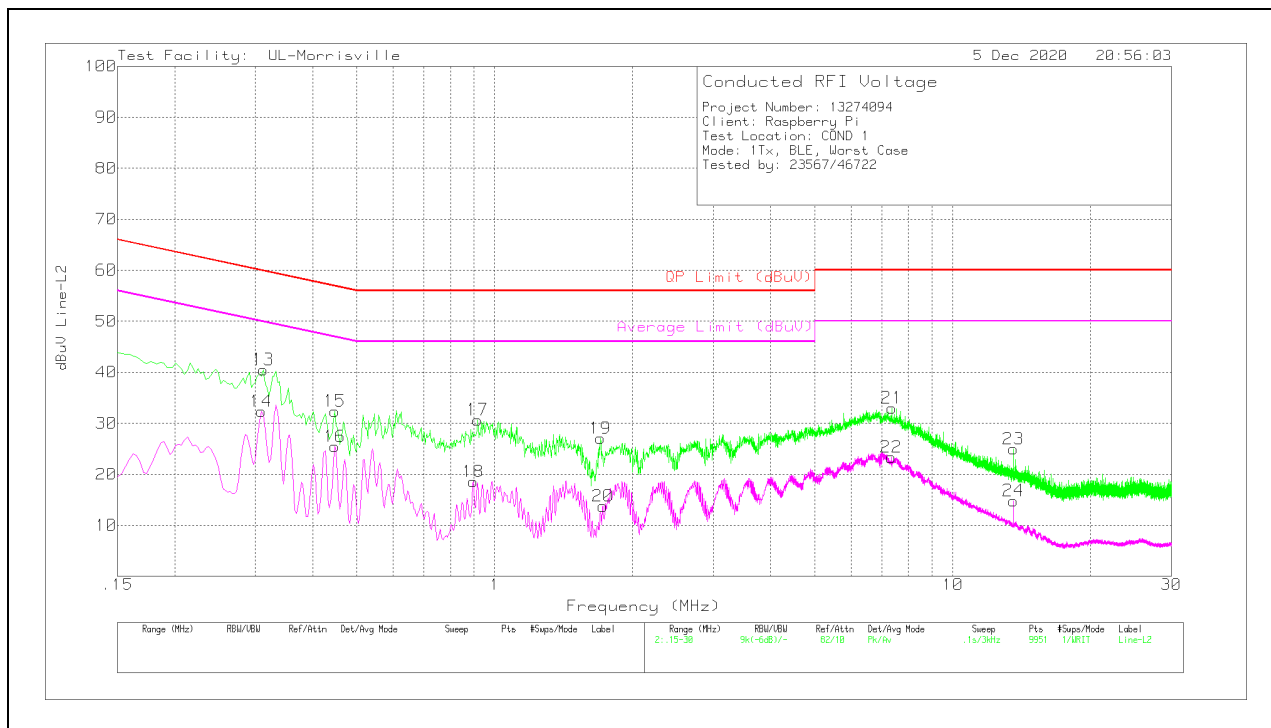


Range 1: Line-L1 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
1	.336	29.34	Pk	.1	9.7	39.14	59.3	-20.16	-	-
2	.333	24.85	Av	.1	9.7	34.65	-	-	49.38	-14.73
3	.378	22.81	Pk	.1	9.8	32.71	58.32	-25.61	-	-
4	.378	15.03	Av	.1	9.8	24.93	-	-	48.32	-23.39
5	.663	21.49	Pk	0	9.8	31.29	56	-24.71	-	-
6	.735	12.07	Av	0	9.8	21.87	-	-	46	-24.13
7	1.143	19.69	Pk	0	9.8	29.49	56	-26.51	-	-
8	1.137	9.75	Av	0	9.8	19.55	-	-	46	-26.45
9	7.017	19.98	Pk	.1	9.9	29.98	60	-30.02	-	-
10	7.047	10.92	Av	.1	9.9	20.92	-	-	50	-29.08
11	13.56	13.23	Pk	.1	10	23.33	60	-36.67	-	-
12	13.56	1.13	Av	.1	10	11.23	-	-	50	-38.77

Pk - Peak detector

Av - Average detection

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)
13	.312	30.71	Pk	.1	9.7	40.51	59.92	-19.41	-	-
14	.309	22.53	Av	.1	9.7	32.33	-	-	50	-17.67
15	.447	22.59	Pk	.1	9.7	32.39	56.93	-24.54	-	-
16	.447	15.67	Av	.1	9.7	25.47	-	-	46.93	-21.46
17	.918	20.88	Pk	0	9.8	30.68	56	-25.32	-	-
18	.897	8.81	Av	0	9.8	18.61	-	-	46	-27.39
19	1.701	17.27	Pk	0	9.8	27.07	56	-28.93	-	-
20	1.722	3.94	Av	0	9.8	13.74	-	-	46	-32.26
21	7.356	23.01	Pk	.1	9.9	33.01	60	-26.99	-	-
22	7.341	13.33	Av	.1	9.9	23.33	-	-	50	-26.67
23	13.56	14.89	Pk	.1	10	24.99	60	-35.01	-	-
24	13.56	4.73	Av	.1	10	14.83	-	-	50	-35.17

Pk - Peak detector
Av - Average detection

12. SETUP PHOTOS

Refer to R13274094-EP1 for setup photos

END OF TEST REPORT