PCTEST
7185 Oakland Mills Road, Columbia, MD 21046 USA
Tel. 410.290.6652 / Fax 410.290.6654
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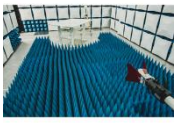


MEASUREMENT REPORT
LTE

Applicant Name:
Pivotal Commware
10801 120th Ave NE #200,
Kirkland, WA 98033
United States

Date of Testing:
6/29/2021-8/9/2021
Test Site/Location:
PCTEST Lab. Columbia, MD
Test Report Serial No.:
1M2106240071-01.2AUVU

FCC ID:	**2AUVU-UBR410M**
APPLICANT:	**Pivotal Commware**

Application Type:	Class II Permissive Change
Model:	UBR410M
EUT Type:	Multi-Band Cat. M1 LTE Module
FCC Classification:	PCS Licensed Transmitter (PCB)
FCC Rule Part(s):	2, 27
Test Procedure(s):	ANSI C63.26-2015, ANSI/TIA-603-E-2016, KDB 971168 D01 v03r01,
Class II Permissive Change:	Please see FCC change document
Original Grant Date:	12/16/2019

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in §2.947. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President

ACCREDITED
CERT #2041.01

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 PCTEST Test Location

These measurement tests were conducted at the PCTEST facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST located in Columbia, MD 21046, U.S.A.

- PCTEST is an ISO/IEC 17025:2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- PCTEST facility is a registered (2451B) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Pivotal Commware Multi-Band Cat. M1 LTE Module FCC ID: 2AUVU-UBR410M**. The test data contained in this report pertains to the emissions due to the integration of this LTE module into a host 5G mmWave device (FCC ID: 2AUVU-P28SUHMGA1) that also contains a previously certified WiFi module (FCC ID: Z64-WL18SBMOD).

Test Device Serial No.: 00057, 00010

2.2 Device Capabilities

This device contains the following capabilities: LTE Cat. M1

2.3 Test Configuration

The EUT was tested per the guidance of ANSI/TIA-603-E-2016 and KDB 971168 D01 v03r01. See Section 7.0 of this test report for a description of the radiated and antenna port conducted emissions tests.

The emissions below 1GHz and above 18GHz were tested with the highest transmitting power channel and the worst case configuration.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

2.4 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

3.0 DESCRIPTION OF TESTS

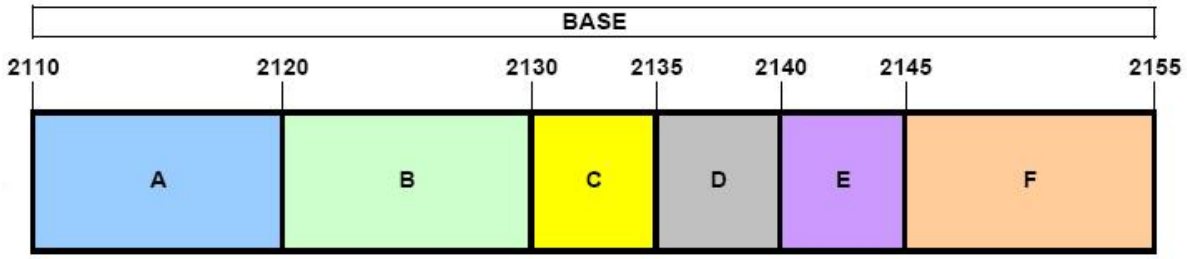
3.1 Measurement Procedure

The measurement procedures described in the document titled "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI/TIA-603-E-2016) and "Procedures for Compliance Measurement of the Fundamental Emission Power of Licensed Wideband (> 1 MHz) Digital Transmission Systems" (KDB 971168 D01 v03r01) were used in the measurement of the EUT.

3.2 Block C Frequency Range

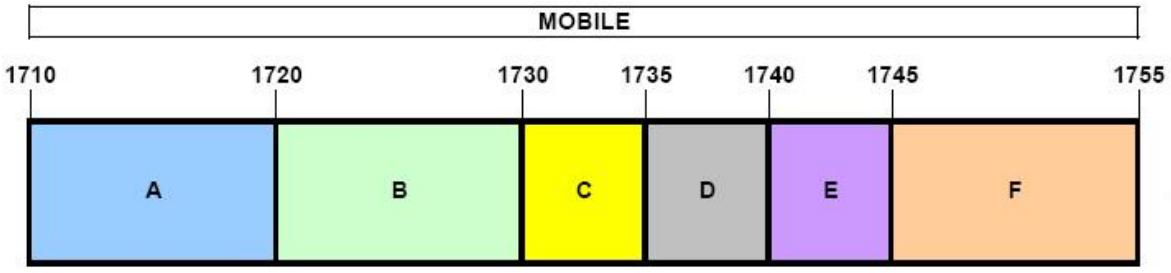
Two paired channels of 11 megahertz each are available for assignment in Block C in the 746-757 MHz and 776-787 MHz bands. In the event that no licenses for two channels in this Block C are assigned based on the results of the first auction in which such licenses were offered because the auction results do not satisfy the applicable reserve price, the spectrum in the 746-757 MHz and 776-787 MHz bands will instead be made available for assignment at a subsequent auction as follows: (i) Two paired channels of 6 megahertz each available for assignment in Block C1 in the 746-752 MHz and 776-782 MHz bands. (ii) Two paired channels of 5 megahertz each available for assignment in Block C2 in the 752-757 MHz and 782-787 MHz bands.

3.3 AWS - Base Frequency Blocks



BLOCK 1: 2110 – 2120 MHz (A)
BLOCK 2: 2120 – 2130 MHz (B)
BLOCK 3: 2130 – 2135 MHz (C)
BLOCK 4: 2135 – 2140 MHz (D)
BLOCK 5: 2140 – 2145 MHz (E)
BLOCK 6: 2145 – 2155 MHz (F)

3.4 AWS - Mobile Frequency Blocks



BLOCK 1: 1710 – 1720 MHz (A)
BLOCK 2: 1720 – 1730 MHz (B)
BLOCK 3: 1730 – 1735 MHz (C)
BLOCK 4: 1735 – 1740 MHz (D)
BLOCK 5: 1740 – 1745 MHz (E)
BLOCK 6: 1745 – 1755 MHz (F)

3.5 Radiated Power and Radiated Spurious Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. For measurements below 1GHz, the absorbers are removed. A raised turntable is used for radiated measurement. The turn table is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm tall test table made of Styrodur is placed on top of the turn table. A Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

The equipment under test was transmitting while connected to its integral antenna and is placed on a turntable 3 meters from the receive antenna. The receive antenna height is adjusted between 1 and 4 meter height, the turntable is rotated through 360 degrees, and the EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest reading on the receive spectrum analyzer. Radiated power levels are also investigated with the receive antenna horizontally and vertically polarized. The maximized power level is recorded using the spectrum analyzer “Channel Power” function with the integration band set to the emissions’ occupied bandwidth, a RMS detector, RBW = 100kHz, VBW = 300kHz, and a 1 second sweep time over a minimum of 10 sweeps, per the guidelines of KDB 971168 D01 v03r01.Per the guidelines of KDB 412172 D01 v01r01, radiated power levels are measured using the following formula:

Per the guidance of ANSI/TIA-603-E-2016, a half-wave dipole is then substituted in place of the EUT. For emissions above 1GHz, a horn antenna is substituted in place of the EUT. The substitute antenna is driven by a signal generator with the level of the signal generator being adjusted to obtain the same receive spectrum analyzer level previously recorded from the spurious emission from the EUT. The power of the emission is calculated using the following formula:

$$P_{d\ [dBm]} = P_{g\ [dBm]} - \text{cable loss}_{\ [dB]} + \text{antenna gain}_{\ [dBd/dBi]}$$

Where, P_d is the dipole equivalent power, P_g is the generator output into the substitution antenna, and the antenna gain is the gain of the substitute antenna used relative to either a half-wave dipole (dBd) or an isotropic source (dBi). The substitute level is equal to $P_{g\ [dBm]}$ – cable loss $_{[dB]}$.

The calculated P_d levels are then compared to the absolute spurious emission limit of -13dBm which is equivalent to the required minimum attenuation of 43 + 10 $\log_{10}$(Power $_{[Watts]}$).

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 474788 D01.

4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.13
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	AP2-002	EMC Cable and Switch System	3/4/2021	Annual	3/4/2022	AP2-002
-	ETS-001	EMC Cable and Switch System	3/2/2021	Annual	3/2/2022	ETS-001
-	LTx2	Licensed Transmitter Cable Set	3/12/2021	Annual	3/12/2022	LTx2
Anritsu	MT8821C	Radio Communication Analyzer	4/30/2021	Annual	4/30/2022	6201524620
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	5/25/2021	Annual	5/25/2022	100348
Rohde & Schwarz	ESW44	EMI Test Receiver 2Hz to 44 GHz	1/21/2021	Annual	1/21/2022	101716
Rohde & Schwarz	TC-TA18	Cross Polarized Vivaldi Test Antenna	8/13/2020	Biennial	8/13/2022	101073
Sunol Science	JB5	Bi-Log Antenna (30M - 5GHz)	7/27/2020	Biennial	7/27/2022	A051107

Table 5-1. Test Equipment

Notes:

Equipment with a calibration date of “N/A” shown in this list was not used to make direct calibrated measurements.

6.0 SAMPLE CALCULATIONS

Spurious Radiated Emission – LTE Band

Example: Middle Channel LTE Mode 2nd Harmonic (1564 MHz)

The average spectrum analyzer reading at 3 meters with the EUT on the turntable was –81.0 dBm. The gain of the substituted antenna is 8.1 dBi. The signal generator connected to the substituted antenna terminals is adjusted to produce a reading of –81.0 dBm on the spectrum analzyer. The loss of the cable between the signal generator and the terminals of the substituted antenna is 2.0 dB at 1564 MHz. So 6.1 dB is added to the signal generator reading of –30.9 dBm yielding –24.80 dBm. The fundamental EIRP was 25.501 dBm so this harmonic was 25.501 dBm – (-24.80).

7.0 TEST RESULTS

7.1 Summary

Company Name: Pivotal Commware

FCC ID: 2AUVU-UBR410M

FCC Classification: PCS Licensed Transmitter (PCB)

Mode(s): LTE Cat. M1

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
2.1046	Transmitter Conducted Output Power	N/A	CONDUCTED	PASS	Section 7.2
2.1053 27.53(c) 27.53(f) 27.53(h) 15.247 30.203	Simultaneous Transmission	≤ -70 dBW/MHz (for wideband signals) for all emissions in the band 1559-1610 MHz. ≥ 43 + 10 log10 (P[Watts]) dB of attenuation for all other out-of-band emissions	RADIATED	PASS	Section 7.3

Table 7-1. Summary of Conducted Test Results

Notes:

1) All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables, attenuators, and couplers.
3) Conducted powers were spot checked to make sure that they were less than or equal to the powers on the Grant of the original module (FCC ID: 2AUVU-UBR410M).

7.2 Conducted Power

Test Overview

Conducted Power measurements are performed using a simulated base station and analyzer. The base station created a connection with a device to bring into a call and the analyzer is attached to the output port of the EUT. The power conduction from the antenna port is then measured.

Test Settings

1. Radiated power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation. For signals with burst transmission, the signal analyzer's "time domain power" measurement capability is used
2. RBW = 1 – 5% of the expected OBW, not to exceed 1MHz
3. VBW ≥ 3 x RBW
4. Span = 1.5 times the OBW
5. No. of sweep points ≥ 2 x span / RBW
6. Detector = RMS
7. For signals with continuous operation, Triggering was set to "free run" and the sweep time was set to "auto". For pulsed signals, triggering was set to enable measurements only during full power bursts with the sweep time set less than or equal to the transmission burst duration.
8. The integration bandwidth was roughly set equal to the measured OBW of the signal for signals with continuous operation. For signals with burst transmission, the "gating" function was enabled to ensure that measurements are performed during times in which the transmitter is operating at its maximum power
9. Trace mode = trace averaging (RMS) over 100 sweeps
10. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-1. Conducted Power Measurement Setup

Test Notes

1) Conducted Power measurements were tested while powered by a DC power source providing 14V.

2) The Level (dBm) readings in the table were taken with a correction table loaded into the base station simulator. The correction table was used to account for the signal attenuation in the connecting cable between the transmitter and antenna.

Conducted Power

Frequency [MHz]	Channel Bandwidth [MHz]	Mod.	RB Size/Offset	Conducted Power [dBm]	Conducted Power [Watts]
782.00	10	QPSK	1 / 0	**22.43**	**0.175**

Table 7-2. Conducted Power Data (Band 13)

Frequency [MHz]	Channel Bandwidth [MHz]	Mod.	RB Size/Offset	Conducted Power [dBm]	Conducted Power [Watts]
1720.00	20	QPSK	1 / 0	22.18	0.165
1732.50	20	QPSK	1 / 0	22.09	0.162
1745.00	20	QPSK	1 / 0	**22.20**	**0.166**

Table 7-3. Conducted Power (Band 4)

Note:
In the original grant for this module (FCC ID: 2AUVU-UBR410M), the highest reported power was 24.4dBm for LTE Band 13 and 23.9dBm for LTE Band 4.

7.3 Simultaneous Transmission

Test Overview

To cover the simultaneous transmissions arising from integrating this module into the host device (FCC ID: 2AUVU-P28SUHMGA1), both the LTE and WLAN modules are set to transmit at the same time as the mmWave functionality of the host. EUT is transmitting WLAN at 2437MHz in 802.11b mode simultaneously with the LTE Cat M1 signal. Radiated spurious emissions measurements are performed using the substitution method described in ANSI/TIA-603-E-2016 with the EUT transmitting into an integral antenna. Measurements on signals operating below 1GHz are performed using vertically and horizontally polarized tuned dipole antennas. Measurements on signals operating above 1GHz are performed using vertically and horizontally polarized broadband horn antennas.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.8
ANSI C63.26-2015 Sections: 5.2.4.4.1 or 5.2.4.4.3
ANSI/TIA-603-E-2016 – Section 2.2.12

Test Settings

1. RBW = 100kHz for emissions below 1GHz and 1MHz for emissions above 1GHz
2. VBW ≥ 3 x RBW
3. Span = 1.5 times the OBW
4. No. of sweep points ≥ 2 x span / RBW
5. Trace / Detector =
    a. Average / RMS – for all emissions
    b. Max Hold / Peak – for emissions solely due to unlicensed transmitters (in addition to settings in 5a.)
6. For measurements made with Trace Averaging:
    a. These measurements were averaged over at least 100 traces.
    b. For signals with continuous operation, triggering was set to “free run” and the sweep time was set to “auto”. For pulsed signals, triggering was set to enable measurements only during full power bursts with the sweep time set less than or equal to the transmission burst duration.
7. Measurements performed with the trace in Max Hold mode were made after the trace had stabilized.

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

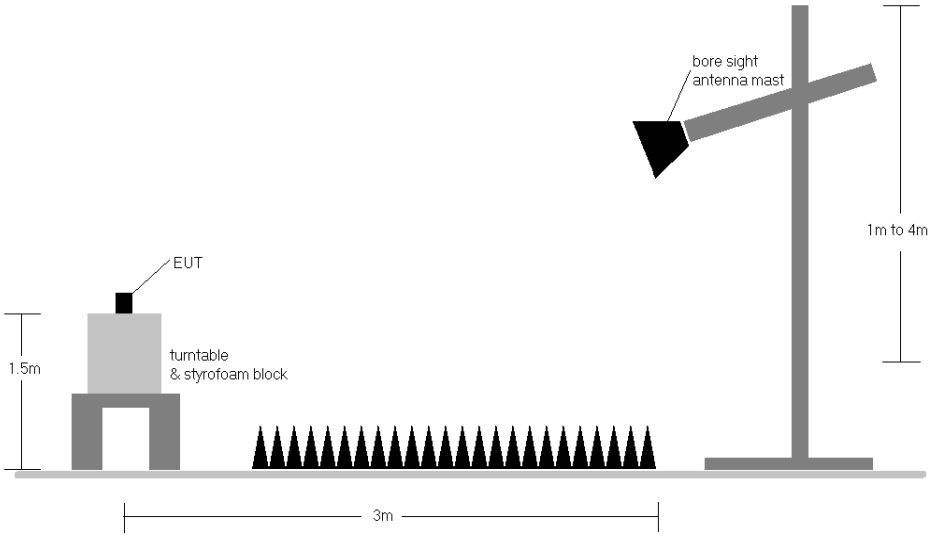


Figure 7-2. Test Instrument & Measurement Setup

Test Notes

1) The EUT was tested in three orthogonal planes and in all possible test configurations and positioning. The worst case emissions are reported with the EUT positioning, modulations, RB sizes and offsets, and channel bandwidth configurations shown in the tables below.

2) The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter. The worst-case emissions are reported.

3) Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.

4) The "-" shown in the following RSE tables are used to denote a noise floor measurement.

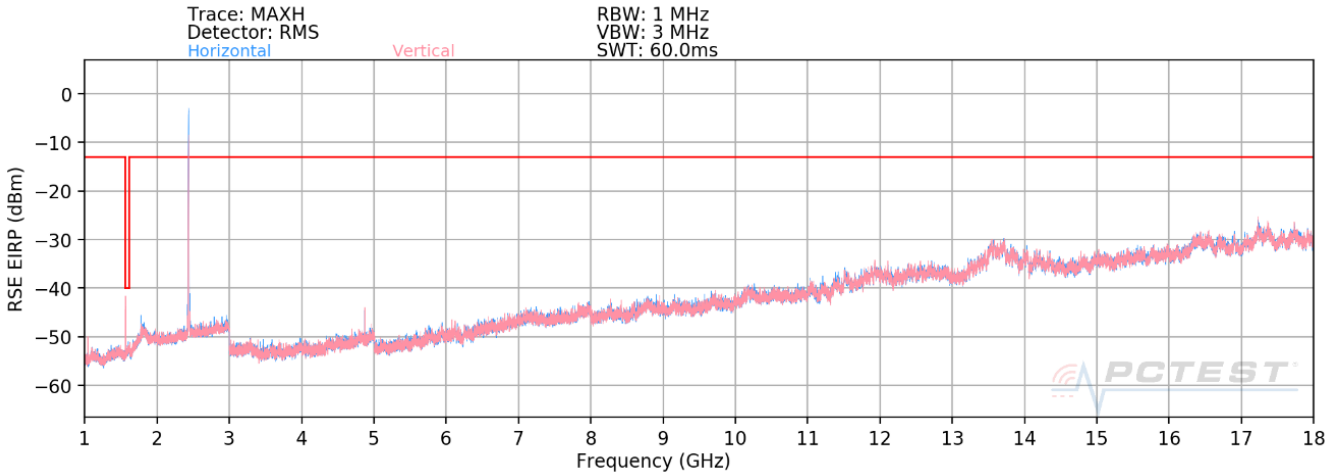
5) The spectrum scan plots on the following pages are used for the purpose of signal identification. Each emission is subject to a unique limit based on the rule under which the transmitter operates. For instances where an emission is the product of two co-located transmitters (i.e. an intermodulation product), the limit on that emission is the least stringent between the rule parts under which each transmitter operates.

6) For emissions subject to limits given in field strength, the limits are converted to EIRP levels for display in the following RSE tables. Per section 5.2.7 of ANSI C63.26-2015, this conversion is given by: $\mathbf{EIRP}_{[dBm]} = \mathbf{E}_{[dB\mu V/m]} + 20 \log(\mathbf{d}_{[m]}) - 104.8$; where E is the measured field strength (in the far-field) and d is the distance from the EUT to the measurement antenna.

7) The fundamental emissions from multiple co-located transmitters may appear on spectrum scan plots. These are not investigated as spurious emissions.

8) Aside from the fundamental mmW transmitter at 28GHz, no significant spurious emissions were found in the 18 – 100GHz range.

Simultaneous Transmission Results



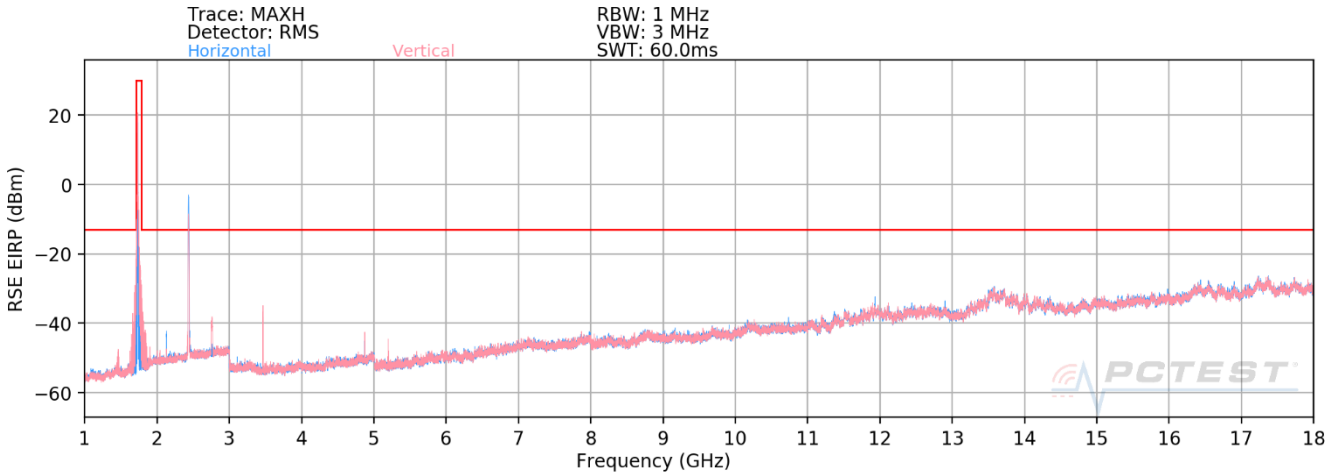
Plot 7-1. Band 13 - Radiated Spurious Emissions Plot <18GHz

Bandwidth (MHz):	10
Frequency (MHz):	782.0
RB / Offset:	1/0

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Trace / Detector	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1564.0	V	218	163	Avg / RMS	50.91	-44.35	-40.00	-4.35
2346.0	V	260	207	Avg / RMS	41.42	-53.84	-13.00	-40.84
3128.0	V	-	-	Avg / RMS	34.59	-60.67	-13.00	-47.67
3910.0	V	-	-	Avg / RMS	33.58	-61.68	-13.00	-48.68
4874.0**	V	199	185	Avg / RMS	49.51	-45.75	-41.28	-4.47
4874.0**	V	199	185	Max / Peak	52.96	-42.30	-21.28	-21.02
7311.0**	V	-	-	Avg / RMS	38.81	-56.45	-41.28	-15.17
7311.0**	V	-	-	Max / Peak	48.75	-46.51	-21.28	-25.23

Table 7-4. Radiated Spurious Data (Band 13 – Mid Channel)

**These emissions are due solely to the WLAN transmitter. As such, they are subject to the spurious emission limits for unlicensed transmitters from FCC Part 15 Subpart C (§15.247). These limits have been converted from the given field strength values to an EIRP level for display in Table 7-4.



Plot 7-2. Band 4 - Radiated Spurious Emissions Plot <18GHz

Note: The emission at 2132.5 MHz is due to the downlink signal from the radio communication tester used to establish an LTE Cat M1 connection. As it did not originate from the EUT, it was not investigated as a spurious emission.

Bandwidth (MHz):	20
Frequency (MHz):	1732.5
RB / Offset:	1/0

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Trace / Detector	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1443.7	V	130	120	Avg / RMS	35.75	-59.51	-13.00	-46.51
2759.0	V	147	180	Avg / RMS	52.92	-42.34	-13.00	-29.34
3465.0	V	294	141	Avg / RMS	56.87	-38.39	-13.00	-25.39
4874.0**	V	199	184	Avg / RMS	49.38	-45.88	-41.28	-4.60
4874.0**	V	499	184	Max / Peak	52.57	-42.69	-21.28	-21.41
5197.5	V	114	227	Avg / RMS	47.79	-47.47	-13.00	-34.47
6930.0	V	158	236	Avg / RMS	44.37	-50.89	-13.00	-37.89
7311.0**	V	-	-	Avg / RMS	38.38	-56.88	-41.28	-15.60
7311.0**	V	-	-	Max / Peak	49.30	-45.96	-21.28	-24.68
8662.5	V	-	-	Avg / RMS	39.38	-55.88	-13.00	-42.88
10395.0	V	-	-	Avg / RMS	42.64	-52.62	-13.00	-39.62

Table 7-5. Radiated Spurious Data (Band 4 – Mid Channel)

**These emissions are due solely to the WLAN transmitter. As such, they are subject to the spurious emission limits for unlicensed transmitters from FCC Part 15 Subpart C (§15.247). These limits have been converted from the given field strength values to an EIRP level for display in Table 7-5.

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Pivotal Commware Multi-Band Cat. M1 LTE Module FCC ID: 2AUVU-UBR410M** complies with all of the technical requirements when integrated into the host device (FCC ID: 2AUVU-P28SUHMGA1) and while transmitting simultaneously with the WiFi module (FCC ID: Z64-WL18SBMOD).