Test Report No. 7191185564-EEC18/04
dated 11 Jul 2018

PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 2, 15, 22, 24 and 27
OF AN
INTELLIGENT VEHICLE GATEWAY
[Model : WP7504 (Host: IVG LTE)]
[FCC ID : 2AE8ZIVG02]

TEST FACILITY	TÜV SÜD PSB Pte Ltd Electrical & Electronics Centre (EEC), Product Services, No. 1 Science Park Drive, Singapore 118221
FCC REG. NO.	994109 (Test Firm Registration Number) SG0002 (Designation Number)
IND. CANADA REG. NO.	2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park) 2932N-1 (10m Semi-Anechoic Chamber, International Business Park)
PREPARED FOR	Omnitracs, LLC 9276 Scranton Road, Suite 200, San Diego, California, USA 92121
QUOTATION NUMBER	2191083345
JOB NUMBER	7191185564
TEST PERIOD	24 May 2018 – 30 May 2018

PREPARED BY	**APPROVED BY**
Quek Keng Huat	Foo Kai Maun
Higher Associate Engineer	Assistant Manager

TÜV SÜD PSB

ilac-MRA

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LA-2007-0380-A, LA-2007-0381-F, LA-2007-0382-B, LA-2007-0383-G, LA-2007-0384-G, LA-2007-0385-E, LA-2007-0386-C, LA-2010-0464-D

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council. Inspections/Calibrations/Tests marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our inspection body/laboratory.

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TABLE OF CONTENTS

The product was tested in accordance with the customer's specifications.

Test Results Summary

Test Standard	Description	Pass / Fail
47 CFR FCC Parts 2 and 22 (PCS 850)		
22.913(a)(2), 2.1046	RF Power Output	Not Tested *See Note 7
22.917(b), 2.1049	Occupied Bandwidth	Not Tested *See Note 7
22.917(a), 22.917(b), 2.1053	Band Edge Compliance (Radiated)	Not Tested *See Note 7
22.917(a), 22.917(b), 2.1051	Out of Band Emissions (Conducted)	Not Tested *See Note 7
22.917(a), 22.917(b), 2.1053	Out of Band Emissions (Radiated)	Pass
47 CFR FCC Parts 2 and 24 (PCS 1900)		
24.232(c), 2.1046	RF Power Output	Not Tested *See Note 7
24.238(b), 2.1049	Occupied Bandwidth	Not Tested *See Note 7
24.238(a), 24.238(b), 2.1053	Band Edge Compliance (Radiated)	Not Tested *See Note 7
24.238(a), 24.238(b), 2.1051	Out of Band Emissions (Conducted)	Not Tested *See Note 7
24.238(a), 24.238(b), 2.1053	Out of Band Emissions (Radiated)	Pass

TEST SUMMARY

The product was tested in accordance with the customer's specifications.

Test Results Summary

Test Standard	Description	Pass / Fail
47 CFR FCC Parts 2 and 27		
2.1046	RF Power Output	Not Tested *See Note 7
2.1049	Occupied Bandwidth	Not Tested *See Note 7
27.53(c)(2)(4), 27.53(g), 27.53(h), 2.1053	Band Edge Compliance (Radiated)	Not Tested *See Note 7
27.53(c)(2), 27.53(f), 27.53(g), 27.53(h), 2.1051	Out of Band Emissions (Conducted)	Not Tested *See Note 7
27.53(c)(2), 27.53(f), 27.53(g), 27.53(h), 2.1051	Out of Band Emissions (Radiated)	Pass
47 CFR FCC Parts 1 and 15		
15.107	Conducted Emissions	Not Applicable *See Note 5
15.109	Receiver Spurious Emissions	Pass
1.1310	Maximum Permissible Exposure	Not Tested *See Note 8

Notes

1. Three channels as listed below, which respectively represent the lower, middle and upper channels of the Equipment Under Test (EUT) when it was configured to operate in the test mode.

Band 2	
Transmit Channel	Frequency (MHz)
Channel 18600	1850.0
Channel 18900	1880.0
Channel 19199	1909.9
Band 4	
Transmit Channel	Frequency (MHz)
Channel 19950	1710.0
Channel 20175	1732.5
Channel 20399	1754.9
Band 5	
Transmit Channel	Frequency (MHz)
Channel 20400	824.0
Channel 20525	836.5
Channel 20649	848.9
Band 17	
Transmit Channel	Frequency (MHz)
Channel 23730	704.0
Channel 23790	710.0
Channel 23849	715.9
Band 25	
Transmit Channel	Frequency (MHz)
Channel 26040	1850.0
Channel 26365	1882.5
Channel 26689	1914.9
Band 26	
Transmit Channel	Frequency (MHz)
Channel 26690	814.0
Channel 26865	831.5
Channel 27039	848.9

2. The Equipment Under Test (EUT) supports PCS 850 / PCS 1900 only.

3. 47 CFR FCC Parts 22 and 24 measurement procedures are according to ANSI TIA-603-D : 2010 while 47 CFR FCC Part 15 measurement procedures are according to ANSI C63.4 : 2014.

4. The EUT is a Class B device when in non-transmitting and receiving states and meets the 47 CFR FCC Part15B Class B requirements.

5. The Equipment Under Test (EUT) is a DC operated device and contains no provision for public utility connections.

Notes (continued)

6. The EUT was tested using fully charged batteries with DC voltage of 12.0V.

7. The RF module of the Equipment Under Test (EUT) is a FCC & IC certified module (FCC ID: N7NWP7, IC: 2417C-WP7). PCI Limited declares that the module was integrated into the main board without modifications in hardware nor firmware and the RF module used was tested and reported in Sporton International Inc. issued test reports, FG7D0540B dated 24th Apr 2018.

8. Please refer to the SAR report for more details.

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is an **INTELLIGENT VEHICLE GATEWAY.**
Applicant	:	Omnitracs, LLC 9276 Scranton Road, Suite 200, San Diego, California, USA 92121
Manufacturers	:	PCI Limited 35 Pioneer Road North Singapore 628475
Factor (ies)	:	PT PCI ELEKTRONIK INTERNASIONAL Panbil Industrial State Factory C Lot 2-3 Jalan Ahmad Yani Muka Kuning Indonesia 29433
FCC ID	:	2AE8ZIVG02
Model Number	:	WP7504 (Host: IVG LTE)
Serial Number	:	Nil
Microprocessor	:	NXP MCIMX6Q7CVT08AD
Operating / Transmitting Frequency	:	800MHz
Clock / Oscillator Frequency	:	24MHz
Modulation / Emissions Designator	:	Wifi: IEEE802.11a/b/g/n/ac Bluetooth 4.1 BR/EDR/LE
Antenna Gain	:	2.0dBi
Port / Connectors	:	1 x 20-pin port for 12VDC Input 2 x USB Type A ports 1 x micro SD port
Rated Input Power	:	Input 12Vdc 1A
Accessories	:	Plastic Holster

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Rohde & Schwarz Universal Radio Communication Tester	M/N: CMU200 S/N: 112123 FCC ID: Nil	2.00m unshielded power cable
Unbranded GSM Antenna	M/N: Nil S/N: Nil FCC ID: Nil	0.50m unshielded BNC cable
Lenovo ThinkPad R400	M/N: 7440 – C97 S/N: L3-ALB2G 09/03 FCC ID: DoC	
Lenovo AC Adapter	M/N: PA-1650-161 S/N: 11S92P1158Z1ZD2H9371JD FCC ID: DoC	1.80m unshielded power cable
TP-Link AC1750 Wireless Dual Band Gigabit Router	M/N: Archer C7 S/N: 2166545001077 FCC ID: DoC	1.50m unshielded RJ45 cable
TP-Link AC Adapter	M/N: T120200-2D1 S/N: 167351 FCC ID: DoC	1.80m unshielded power cable
Logitech Media Keyboard	M/N: K200 S/N: Nil FCC ID: DoC	1.50m unshielded signal cable
Dell Optical Mouse	M/N: MO56U0A S/N: G0N0419Z FCC ID: DoC	1.50m unshielded signal cable

47 CFR FCC Part 15
1. Receiver Spurious Emissions
The EUT was exercised by operating in continuous loopback mode with the reception level is above the receiver minimum sensitivity at lower, middle and upper channels one at a time. The R&S CMW500 was used as a simulated base station. At the same time, the EUT was exercised by operating in file transfer mode with maximum data transmission rate + Video Playback + LED Continuous ON.

47 CFR FCC Parts 22.917(a), 22.917(b) and 2.1053 Out of Band Emissions (Radiated) Limits

The EUT shows compliance to the requirements of this section, which states:

(a) The power of any emission outside the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

(b) Compliance with these rules is based on the use of measurement instrumentation employing resolution bandwidth of 100kHz or greater. In the 1MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attempted at least 26dB below the transmitter power.

47 CFR FCC Parts 22.917(a), 22.917(b) and 2.1053 Out of Band Emissions (Radiated) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E7405A	MY45106084	01 Aug 2018
R&S Test Receiver – ESI1	ESI40	100010	25 Oct 2018
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	13 Dec 2018
TDK-RF Horn Antenna	HRN-0118	130256	22 Feb 2019
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	15 Nov 2018
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	16 May 2019
Toyo Preamplifier	TPA0118036	00000005	16 Oct 2016
R&S Preamplifier (1GHz-18GHz)	SCU18	102191	09 Mar 2019
Agilent Preamplifier(1GHz-26.5GHz)	8449B	3008A01078	08 Jun 2019
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	15 Nov 2018
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2018
Micro-tronics Bandstop Filter (900MHz)	BRM14753	002	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-1000/2000-N/N	436	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-500/1000-N/N	396	13 Aug 2018

47 CFR FCC Parts 22.917(a), 22.917(b) and 2.1053 Out of Band Emissions (Radiated) Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant antenna was set at the required test distance away from the EUT and supporting equipment boundary.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1MHz.
5. All other supporting equipment were powered separately from another filtered mains.

47 CFR FCC Parts 22.917(a), 22.917(b) and 2.1053 Out of Band Emissions (Radiated) Test Method

1. The EUT was set to transmit at the maximum power at the lower channel with the modulation on at normal test condition.
2. The receiving antenna (test antenna) was set at vertical polarization with the height of 1m.
3. With the spectrum analyser was set to max hold enabled the emissions outside the operating frequency range (spurious emissions) were searched and recorded. For EUT which is a portable device, the spurious emission search was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces worst emissions.
4. For each spurious emission found, the test antenna was raised or lowered through the specified range of heights (1m – 4m) until a maximum signal level was detected on the test receiver.
5. The EUT was then rotated through 360º in the horizontal plane until the maximum signal was received. The maximum received signal level was recorded.
6. The steps 2 to 5 were repeated with the receiving antenna was set to horizontal polarization.
7. Comparison was made on both measured spurious emission results with vertical and horizontal polarizations. The highest value out of vertical and horizontal polarizations was recorded as A dBm.
8. A known reference path loss was then added to the A (measured level in step 7) to obtain the measured spurious emission power.
9. The steps 2 to 8 were repeated until all the spurious emissions (up to 10^{th} harmonics of the carrier frequency) were measured.
10. The steps 2 to 9 were repeated with the EUT was set to operate at the middle and upper channels respectively.

47 CFR FCC Parts 22.917(a), 22.917(b) and 2.1053 Out of Band Emissions (Radiated) Results

Operating Mode	Band 17 LTE Transmit (Worst) + Wi-Fi 802.11b CCK @ 11Mbps (Worst)	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Antenna Gain	2.0 dBi	Tested By	Chang Wai Kit

LOWER CHANNEL (CHANNEL 23730)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
45.3840	-66.5	-13.0
249.3480	-63.0	-13.0
1961.4230	-33.8	--
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MIDDLE CHANNEL (CHANNEL 23790)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
477.2380	-64.6	-13.0
955.2010	-56.7	-13.0
2123.3470	-45.0	--
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UPPER CHANNEL (CHANNEL 23849)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
374.6880	-62.4	-13.0
650.0100	-64.7	-13.0
2234.6690	-50.5	--
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Notes

1. Out of Band Emissions(Radiated) Measurement Uncertainty
All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 1GHz is ±3.8dB and >1GHz – 40GHz is ±4.5dB.

47 CFR FCC Parts 24.238(a), 24.238(b) and 2.1053 Out of Band Emissions (Radiated) Limits

The EUT shows compliance to the requirements of this section, which states:

(a) The power of any emission outside the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

(b) Compliance with these rules is based on the use of measurement instrumentation employing resolution bandwidth of 1MHz or greater. In the 1MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attempted at least 26dB below the transmitter power.

47 CFR FCC Parts 24.238(a), 24.238(b) and 2.1053 Out of Band Emissions (Radiated) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E7405A	MY45106084	01 Aug 2018
R&S Test Receiver – ESI1	ESI40	100010	25 Oct 2018
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	13 Dec 2018
TDK-RF Horn Antenna	HRN-0118	130256	22 Feb 2019
ETS Horn Antenna(18GHz-40GHz) (Ref)	3116	0004-2474	15 Nov 2018
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	16 May 2019
Toyo Preamplifier	TPA0118036	00000005	16 Oct 2016
R&S Preamplifier (1GHz-18GHz)	SCU18	102191	09 Mar 2019
Agilent Preamplifier(1GHz-26.5GHz)	8449B	3008A01078	08 Jun 2019
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	15 Nov 2018
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2018
Micro-tronics Bandstop Filter (900MHz)	BRM14753	002	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-1000/2000-N/N	436	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-500/1000-N/N	396	13 Aug 2018

47 CFR FCC Parts 24.238(a), 24.238(b) and 2.1053 Out of Band Emissions (Radiated) Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant antenna was set at the required test distance away from the EUT and supporting equipment boundary.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1MHz.
5. All other supporting equipment were powered separately from another filtered mains.

47 CFR FCC Parts 24.238(a), 24.238(b) and 2.1053 Out of Band Emissions (Radiated) Test Method

1. The EUT was set to transmit at the maximum power at the lower channel with the modulation on at normal test condition.
2. The receiving antenna (test antenna) was set at vertical polarization with the height of 1m.
3. With the spectrum analyser was set to max hold enabled the emissions outside the operating frequency range (spurious emissions) were searched and recorded. For EUT which is a portable device, the spurious emission search was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces worst emissions.
4. For each spurious emission found, the test antenna was raised or lowered through the specified range of heights (1m – 4m) until a maximum signal level was detected on the test receiver.
5. The EUT was then rotated through 360º in the horizontal plane until the maximum signal was received. The maximum received signal level was recorded.
6. The steps 2 to 5 were repeated with the receiving antenna was set to horizontal polarization.
7. Comparison was made on both measured spurious emission results with vertical and horizontal polarizations. The highest value out of vertical and horizontal polarizations was recorded as A dBm.
8. A known reference path loss was then added to the A (measured level in step 7) to obtain the measured spurious emission power.
9. The steps 2 to 8 were repeated until all the spurious emissions (up to 10^{th} harmonics of the carrier frequency) were measured.
10. The steps 2 to 9 were repeated with the EUT was set to operate at the middle and upper channels respectively.

47 CFR FCC Parts 24.238(a), 24.238(b) and 2.1053 Out of Band Emissions (Radiated) Results

Operating Mode	Band 25 LTE Transmit (Worst) + Wi-Fi UNII 802.11n (HT20) @ MCS0	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Antenna Gain	2.0 dBi	Tested By	Chang Wai Kit

LOWER CHANNEL (CHANNEL 26040)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
45.7070	-63.1	-13.0
1435.1700	-53.4	-13.0
2497.7960	-50.5	-13.0
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MIDDLE CHANNEL (CHANNEL 26365)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
249.8930	-55.0	-13.0
1597.0940	-51.1	-13.0
3762.8260	-46.3	-13.0
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UPPER CHANNEL (CHANNEL 26689)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
233.0010	-54.3	-13.0
1890.5810	-25.9	-13.0
5007.6150	-48.8	-13.0
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Notes

1. Out of Band Emissions (Radiated) Measurement Uncertainty
All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 1GHz is ±3.8dB and >1GHz – 40GHz is ±4.5dB.

47 CFR FCC Parts 24.238(a), 24.238(b) and 2.1053 Out of Band Emissions (Radiated) Limits

The EUT shows compliance to the requirements of this section, which states:

(a) The power of any emission outside the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

(b) Compliance with these rules is based on the use of measurement instrumentation employing resolution bandwidth of 1MHz or greater. In the 1MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attempted at least 26dB below the transmitter power.

47 CFR FCC Parts 24.238(a), 24.238(b) and 2.1053 Out of Band Emissions (Radiated) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E7405A	MY45106084	01 Aug 2018
R&S Test Receiver – ESI1	ESI40	100010	25 Oct 2018
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	13 Dec 2018
TDK-RF Horn Antenna	HRN-0118	130256	22 Feb 2019
ETS Horn Antenna(18GHz-40GHz) (Ref)	3116	0004-2474	15 Nov 2018
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	16 May 2019
Toyo Preamplifier	TPA0118036	00000005	16 Oct 2016
R&S Preamplifier (1GHz-18GHz)	SCU18	102191	09 Mar 2019
Agilent Preamplifier(1GHz-26.5GHz)	8449B	3008A01078	08 Jun 2019
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	15 Nov 2018
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2018
Micro-tronics Bandstop Filter (900MHz)	BRM14753	002	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-1000/2000-N/N	436	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-500/1000-N/N	396	13 Aug 2018

OUT OF BAND EMISSIONS (RADIATED) TEST

47 CFR FCC Parts 27.53(c)(2), 27.53(f), 27.53(g), 27.53(h), 2.1051 Out of Band Emissions (Radiated) Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant antenna was set at the required test distance away from the EUT and supporting equipment boundary.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1MHz.
5. All other supporting equipment were powered separately from another filtered mains.

47 CFR FCC Parts 27.53(c)(2), 27.53(f), 27.53(g), 27.53(h), 2.1051 Out of Band Emissions (Radiated) Test Method

1. The EUT was set to transmit at the maximum power at the lower channel with the modulation on at normal test condition.
2. The receiving antenna (test antenna) was set at vertical polarization with the height of 1m.
3. With the spectrum analyser was set to max hold enabled the emissions outside the operating frequency range (spurious emissions) were searched and recorded. For EUT which is a portable device, the spurious emission search was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces worst emissions.
4. For each spurious emission found, the test antenna was raised or lowered through the specified range of heights (1m – 4m) until a maximum signal level was detected on the test receiver.
5. The EUT was then rotated through 360º in the horizontal plane until the maximum signal was received. The maximum received signal level was recorded.
6. The steps 2 to 5 were repeated with the receiving antenna was set to horizontal polarization.
7. Comparison was made on both measured spurious emission results with vertical and horizontal polarizations. The highest value out of vertical and horizontal polarizations was recorded as A dBm.
8. A known reference path loss was then added to the A (measured level in step 7) to obtain the measured spurious emission power.
9. The steps 2 to 8 were repeated until all the spurious emissions (up to 10^{th} harmonics of the carrier frequency) were measured.
10. The steps 2 to 9 were repeated with the EUT was set to operate at the middle and upper channels respectively.

47 CFR FCC Parts 27.53(c)(2), 27.53(f), 27.53(g), 27.53(h), 2.1051 Out of Band Emissions (Radiated) Results

Operating Mode	Band 26 LTE Transmit (Worst) + Bluetooth @ GFSK	Temperature	24ºC
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Antenna Gain	2.0 dBi	Tested By	Chang Wai Kit

LOWER CHANNEL (CHANNEL 26690)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
47.7760	-71.2	-13.0
1445.2910	-51.8	-13.0
2133.4670	-44.0	-13.0
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MIDDLE CHANNEL (CHANNEL 26865)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
249.9980	-59.1	-13.0
1597.0940	-47.3	-13.0
2649.5990	-50.6	-13.0
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UPPER CHANNEL (CHANNEL 27039)

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
615.2010	-58.8	-13.0
1961.4230	-39.2	-13.0
5017.7350	-49.5	-13.0
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Notes

1. Out of Band Emissions (Radiated) Measurement Uncertainty
All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 1GHz is ±3.8dB and >1GHz – 40GHz is ±4.5dB.

47 CFR FCC Part 15.109 Receiver Spurious Emissions Limits (Class B)

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m) @ 3m
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
Above 960	54.0*
* Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

47 CFR FCC Part 15.109 Receiver Spurious Emissions Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver – ESI1	ESI40	100010	25 Oct 2018
EMCO Loop Ant (ext)_red_00134413	6502	134413	28 Oct 2018
Schaffner Bilog Antenna – (30MHz-2GHz)	CBL6112B	2597	20 Feb 2019
TDK-RF Horn Antenna	HRN-0118	130256	22 Feb 2019
ETS Horn Antenna(18GHz-40GHz) (Ref)	3116	0004-2474	15 Nov 2018
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	25 Sep 2018
R&S Preamplifier (1GHz-18GHz)	SCU18	102191	09 Mar 2019
Agilent Preamplifier(1GHz-26.5GHz)	8449B	3008A01078	08 Jun 2019
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	15 Nov 2018
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2018
Micro-tronics Bandstop Filter (900MHz)	BRM14753	002	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-1000/2000-N/N	436	13 Aug 2018
K&L Microwave Tunable Band Reject Filter	3TNF-500/1000-N/N	396	13 Aug 2018

47 CFR FCC Part 15.109 Receiver Spurious Emissions Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

47 CFR FCC Part 15.109 Receiver Spurious Emissions Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from 30MHz to 5th harmonic of the highest frequency used or generated by the EUT, using the Bi-log antenna for frequencies from 30MHz up to 3GHz, and the Horn antenna above 3GHz.

Sample Calculation Example

At 300 MHz	Q-P limit = 37.0 dBµV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB	
Q-P reading obtained directly from EMI Receiver = 31.0 dBµV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 37.0 - 31.0 = 6.0	i.e. 6.0 dB below Q-P limit

47 CFR FCC Part 15.109 Receiver Spurious Emissions Results

Operating Mode	LTE Band 17 + Wi-Fi 802.11b CCK @ 11Mbps (Worst)	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Class	B	Tested By	Chang Wai Kit

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
105.3230	32.3	43.5	11.2	98	243	H	23849
224.3840	33.6	46.0	12.4	100	243	H	23849
247.3480	35.7	46.0	10.3	199	146	V	23849
307.3810	40.8	46.0	5.2	199	146	V	23849
473.2380	31.2	46.0	14.8	100	248	H	23849
615.2010	36.4	46.0	9.6	199	76	V	23849

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch (Worst)
1.3846	41.7	74.0	32.3	34.7	54.0	19.3	200	250	V	23849
1.4959	42.9	74.0	31.1	39.8	54.0	14.2	200	15	V	23849
1.9614	62.5	74.0	11.5	52.8	54.0	1.2	200	75	H	23849
3.0038	50.8	74.0	23.2	34.3	54.0	19.7	200	26	V	23849
3.7628	50.0	74.0	24.0	42.0	54.0	12.0	200	242	H	23849
5.0076	45.3	74.0	28.7	37.3	54.0	16.7	200	91	V	23849

47 CFR FCC Part 15.109 Receiver Spurious Emissions Results

Operating Mode	LTE Band 5 + Wi-Fi UNII 802.11n (HT20) @ MCS0	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Class	B	Tested By	Chang Wai Kit

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
45.7070	32.2	39.0	6.8	100	249	V	20649
47.7760	24.0	39.0	15.0	130	282	V	20649
249.8930	40.2	46.4	6.2	100	15	V	20649
249.9980	36.1	46.4	10.3	117	7	V	20649
273.4530	28.8	46.4	17.6	300	222	H	20649
375.5450	29.3	46.4	17.1	100	265	V	20649

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch (Worst)
1.1923	39.5	74.0	34.5	29.7	54.0	24.3	300	15	V	20649
5.8241	73.0	74.0	1.0	53.0	54.0	1.0	112	242	V	20649
6.6518	72.6	74.0	1.4	50.7	54.0	3.3	110	294	V	20649
7.4793	71.7	74.0	2.3	53.5	54.0	0.5	123	127	V	20649
9.1419	69.1	74.0	4.9	50.8	54.0	3.2	108	264	V	20649
14.1383	66.1	74.0	7.9	46.2	54.0	7.8	105	265	V	20649

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a “negative” margin indicates a FAIL.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 3MHz
4. Receiver Spurious Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 1GHz is ±3.8dB and >1GHz – 40GHz is ±4.5dB.

47 CFR FCC Part 15.109 Receiver Spurious Emissions Results

Operating Mode	LTE Band 4 + Wi-Fi 802.11b CCK @ 11Mbps (Worst Mode)	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Class	B	Tested By	Chang Wai Kit

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
224.3690	23.6	46.0	22.4	300	94	H	20399
249.8930	25.7	46.0	20.3	100	260	V	20399
479.6020	31.2	46.0	14.8	100	243	V	20399
617.0350	33.9	46.0	12.1	400	127	H	20399
624.8880	34.3	46.0	11.7	100	294	V	20399
929.2040	39.1	46.0	6.9	300	353	V	20399

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch (worst)
1.3238	37.0	74.0	37.0	29.7	54.0	24.3	200	40	V	20399
2.3966	40.6	74.0	33.4	35.2	54.0	18.8	200	213	V	20399
3.1860	43.0	74.0	31.0	37.1	54.0	16.9	101	208	V	20399
3.8640	42.8	74.0	31.2	32.7	54.0	21.3	200	10	V	20399
4.1879	41.8	74.0	32.2	34.7	54.0	19.3	101	236	V	20399
4.2587	41.3	74.0	32.7	35.7	54.0	18.3	200	249	H	20399

47 CFR FCC Part 15.109 Receiver Spurious Emissions Results

Operating Mode	WCDMA Band 2 + Bluetooth @ GFSK	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Class	B	Tested By	Chang Wai Kit

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
222.4060	21.7	46.0	24.3	300	94	H	19199
249.8930	23.6	46.0	22.4	100	265	V	19199
269.5260	22.5	46.0	23.5	300	344	H	19199
499.2350	25.4	46.0	20.6	100	243	V	19199
624.8880	29.7	46.0	16.3	100	284	V	19199
876.1940	31.4	46.0	14.6	200	140	V	19199

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch (Worst)
1.4959	45.3	74.0	28.7	37.5	54.0	16.5	300	245	V	19199
1.8838	68.2	74.0	5.8	51.8	54.0	2.2	197	81	H	19199
1.9513	62.5	74.0	11.5	48.2	54.0	5.8	200	80	V	19199
2.1335	44.3	74.0	29.7	30.9	54.0	23.1	400	275	V	19199
3.7628	51.0	74.0	23.0	42.9	54.0	11.1	200	240	V	19199
5.0076	44.2	74.0	29.8	36.7	54.0	17.3	200	236	V	19199

47 CFR FCC Part 15.109 Receiver Spurious Emissions Results

Operating Mode	LTE Band 25 + Wi-Fi UNII 802.11n (HT20) @ MCS0	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Class	B	Tested By	Chang Wai Kit

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
216.5160	23.9	46.0	22.1	400	97	H	26689
534.5750	32.2	46.0	13.8	100	160	V	26689
644.5210	33.6	46.0	12.4	300	319	V	26689
707.3480	33.9	46.0	12.1	300	190	V	26689
825.1470	36.8	46.0	9.2	300	78	V	26689
923.3140	38.7	46.0	7.3	100	275	H	26689

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch (Worst)
1.4959	46.6	74.0	27.4	39.9	54.0	14.1	200	225	V	26689
1.5769	48.1	74.0	25.9	33.5	54.0	20.5	200	335	V	26689
1.8840	69.3	74.0	4.7	52.6	54.0	1.4	196	84	H	26689
1.9614	62.4	74.0	11.6	53.2	54.0	0.8	200	350	V	26689
3.3074	50.2	74.0	23.8	42.0	54.0	12.0	200	235	H	26689
5.0076	44.0	74.0	30.0	37.7	54.0	16.3	200	90	V	26689

47 CFR FCC Part 15.109 Receiver Spurious Emissions Results

Operating Mode	LTE Band 26 + Bluetooth @ GFSK	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Class	B	Tested By	Chang Wai Kit

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
45.8130	32.1	40.0	7.9	100	249	V	27039
222.4060	31.1	46.0	14.9	300	106	H	27039
249.8930	31.0	46.0	15.0	100	265	V	27039
249.9330	40.0	46.0	6.0	100	15	V	27039
479.6020	30.4	46.0	15.6	100	196	V	27039
624.8880	30.6	46.0	15.4	100	284	V	27039

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch (Worst)
1.0304	32.3	74.0	41.7	31.1	54.0	22.9	200	33	H	27039
1.1923	39.5	74.0	34.5	34.6	54.0	19.4	300	15	V	27039
1.2429	39.2	74.0	34.8	35.6	54.0	18.4	399	177	V	27039
1.3744	34.0	74.0	40.0	27.9	54.0	26.1	100	19	H	27039
1.4959	45.9	74.0	28.1	37.0	54.0	17.0	300	15	V	27039
2.7002	39.8	74.0	34.2	29.0	54.0	25.0	300	139	V	27039

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a “negative” margin indicates a FAIL.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
4. Receiver Spurious Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 1GHz is ±3.8dB and >1GHz – 40GHz is ±4.5dB.

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