

**Test Report No. 7191130600-EEC16/01**  
**dated 29 Mar 2016**



PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH  
47 CFR FCC Parts 15B & C  
OF A  
**RFID READER**  
[ Model : VS-2000 ]  
[ FCC ID : ZVUVS-2000 ]

**TEST FACILITY** TÜV SÜD PSB Pte Ltd  
Electrical & Electronics Centre (EEC), Product Services,  
No. 1 Science Park Drive, Singapore 118221  
  
TÜV SÜD PSB Pte Ltd  
Electrical & Electronics Centre (EEC), Product Services,  
13 International Business Park #01-01, Singapore 609932

**FCC REG. NO.** 99142 (3m and 10m Semi-Anechoic Chamber, Science Park) &  
160581 (3m and 10m Semi-Anechoic Chamber, International Business Park)

**IND. CANADA REG. NO.** 2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park) &  
2932N-1 (10m Semi-Anechoic Chamber, International Business Park)

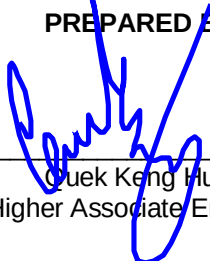
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434 Massachusetts Avenue  
Suite 406R  
Boston MA 02118  
USA  
  
Tel : 1 202 246 8349 Fax : 617 263 1270

**QUOTATION NUMBER** 2191032663

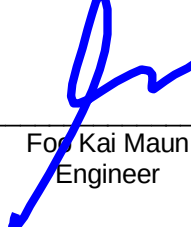
**JOB NUMBER** 7191030600

**TEST PERIOD** 01 Feb 2016 – 16 Mar 2016

**PREPARED BY**

  
Quek Keng Huat  
Higher Associate Engineer

**APPROVED BY**

  
For Kai Maun  
Engineer



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

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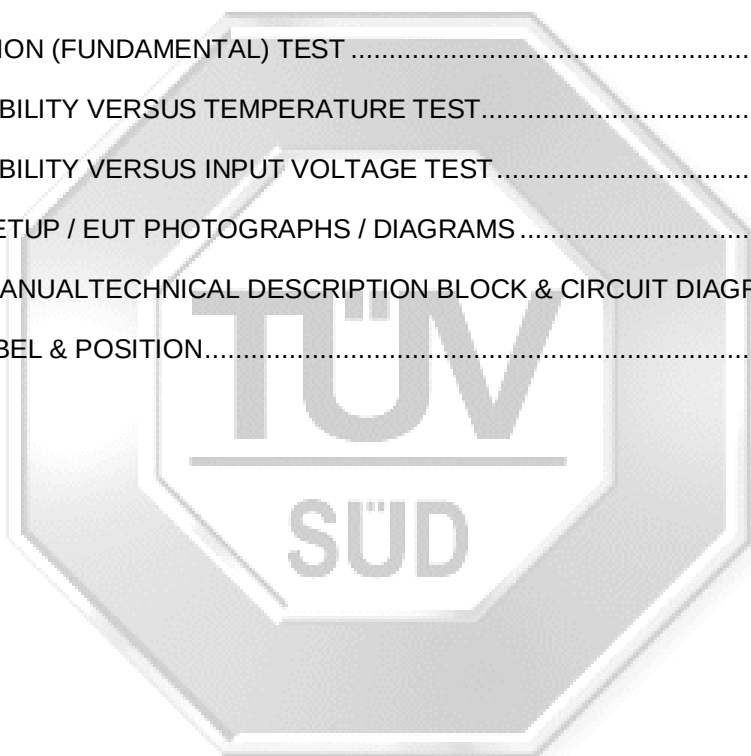
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## TEST SUMMARY

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

### Test Results Summary

| Test Standard                           | Description                                                                                                                | Pass / Fail                |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 47 CFR FCC Part 15                      |                                                                                                                            |                            |
| 15.107(a), 15.207                       | Conducted Emissions                                                                                                        | Pass *See Note 3           |
| 15.109(a), 15.205,<br>15.209, 15.225(d) | Radiated Emissions (Spurious<br>Emissions inclusive Restricted Bands<br>Requirement)                                       | Pass                       |
| 15.225(a)                               | Radiated Emissions (Fundamental)<br>(applicable if EUT's carrier is in 13.553<br>-13.567MHz)                               | Pass                       |
| 15.225(b)                               | Radiated Emissions (Fundamental)<br>(applicable if EUT's carrier is in 13.410<br>-13.553MHz or / and 13.567-<br>13.710MHz) | Not Applicable *See Note 4 |
| 15.225(c)                               | Radiated Emissions (Fundamental)<br>(applicable if EUT's carrier is in 13.110<br>-13.410MHz or / and 13.710-<br>14.010MHz) | Not Applicable *See Note 4 |
| 15.225(e)                               | Frequency Stability Versus<br>Temperature                                                                                  | Pass                       |
| 15.225(e)                               | Frequency Stability Versus Input<br>Voltage                                                                                | Pass                       |

### Notes

1. All test measurement procedures are according to ANSI C63.4: 2014 and ANSI C63.10: 2013.
2. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.
3. TJS USA INC declares that in line with the product's actual operational function, the 13.56MHz RFID transmitter will be disabled and scanning is not allowed during charging via 12Vdc input.
4. The Equipment Under Test (EUT) operates in 13.56MHz.

### Modifications

No modifications were made.



## PRODUCT DESCRIPTION

Description : The Equipment Under Test (EUT) is a **RFID READER**.

Applicant : TJS USA INC  
434 Massachusetts Avenue  
Suite 406R  
Boston MA 02118  
USA

Manufacturer : TJS USA INC  
434 Massachusetts Avenue  
Suite 406R  
Boston MA 02118  
USA

Factory (ies) : Kenetics Innovations Pte Ltd  
2 Tannery Road #05-01  
Cencon Building  
Singapore 347720

Model Number : VS-2000

FCC ID : ZVUVS-2000

Serial Number : P0410150200011

Microprocessor : AT91SAM7

Operating / Transmitting Frequency : RFID  
13.56MHz, bandwidth is 500kHz

Bluetooth  
2.402GHz (lower channel) to 2.480GHz (upper channel),  
total 79 channels

WiFi  
2.412GHz (lower channel) to 2.484GHz (upper channel),  
total 14 channels

Clock / Oscillator Frequency : 27.12MHz (RFID)  
18.432MHz (Microprocessor)

Modulation : RFID  
Amplitude Shift Keying (RFID)

Bluetooth  
Gaussian Frequency Shift Keying (GFSK)  
 $\pi/4$  Differential-Quadrature Phase Shift Keying (DQPSK)  
8 Differential Phase-Shift Keying (DPSK)

WiFi  
11b - DBPSK, DQPSK, CCK for DSSS,  
11g - BPSK, QPSK, 16QAM, 64QAM for OFDM,  
11n - MCS0~7, OFDM



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**PRODUCT DESCRIPTION**

**Continued..**

Antenna Gain : -0.54dBi (Bluetooth)  
2.00dBi (WiFi)  
0.00dBi (RFID)

Port / Connectors : Refer to manufacturer's user manual / operating manual

Rated Input Power : 110V 60Hz

Accessories : Power Adapter Model TAP12-120S150U1  
Input 100V – 240V 50/60Hz 0.5A  
Output 12Vdc 1.5A

7.2Vdc 710mAh/5.1Wh Battery





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**SUPPORTING EQUIPMENT DESCRIPTION**

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The EUT was tested as a stand-alone unit without any supporting equipment.



## EUT OPERATING CONDITIONS

|                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>47 CFR FCC Part 15</b>                                                                                                                                                                                                                                                                                                                             |
| <ol style="list-style-type: none"><li><b>1. Conducted Emissions</b></li><li><b>2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)</b></li><li><b>3. Radiated Emissions (Fundamental)</b></li><li><b>4. Frequency Stability Versus Temperature</b></li><li><b>5. Frequency Stability Versus Input Voltage</b></li></ol> |
| <p>The EUT was exercised by operating in maximum continuous transmission in the following test modes</p> <ol style="list-style-type: none"><li>1. Transmitting RFID at 13.56MHz + Bluetooth continuously + Battery Charging.</li><li>2. Transmitting RFID at 13.56MHz + WiFi continuously + Battery Charging.</li></ol>                               |



## CONDUCTED EMISSION TEST

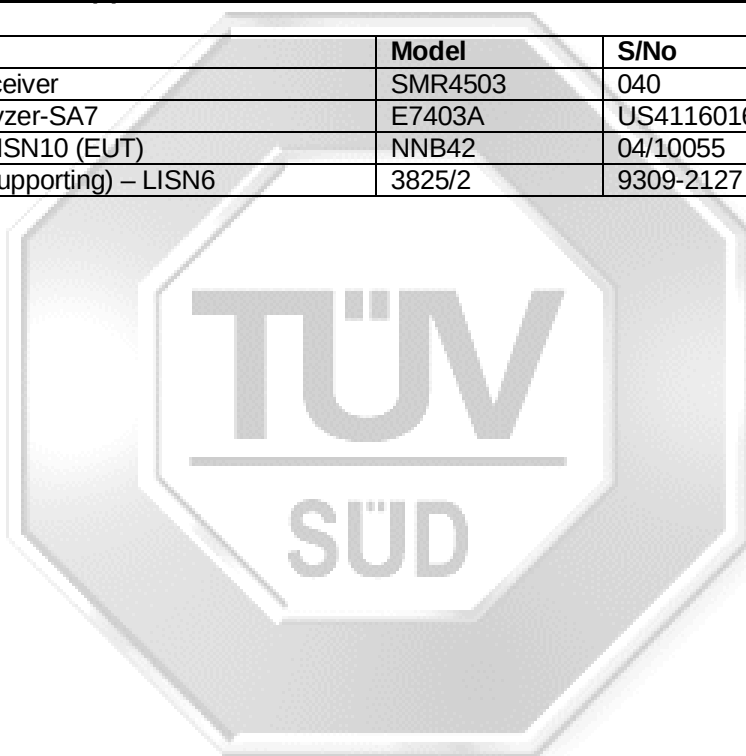
### 47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Limits

| Frequency Range<br>(MHz) | Limit Values (dBμV) |              |
|--------------------------|---------------------|--------------|
|                          | Quasi-peak (Q-P)    | Average (AV) |
| 0.15 - 0.5               | 66 – 56 *           | 56 – 46 *    |
| 0.5 - 5.0                | 56                  | 46           |
| 5.0 - 30.0               | 60                  | 50           |

\* Decreasing linearly with the logarithm of the frequency

### 47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

| Instrument                         | Model   | S/No       | Cal Due Date |
|------------------------------------|---------|------------|--------------|
| Schaffner EMI Receiver             | SMR4503 | 040        | 06 Mar 2017  |
| Agilent EMC Analyzer-SA7           | E7403A  | US41160167 | 28 May 2016  |
| Schaffner LISN –LISN10 (EUT)       | NNB42   | 04/10055   | 30 Oct 2016  |
| EMCO LISN (for supporting) – LISN6 | 3825/2  | 9309-2127  | 30 Oct 2016  |



## CONDUCTED EMISSION TEST

### 47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50 $\Omega$ /50 $\mu$ H EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

### 47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

### **Sample Calculation Example**

At 20 MHz

Q-P limit = 60.0 dB $\mu$ V

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dB $\mu$ V  
(Calibrated for system losses)

Therefore, Q-P margin = 60.0 - 40.0 = 20.0

i.e. 20.0 dB below Q-P limit

CONDUCTED EMISSION TEST

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Results

|                  |                      |                      |              |
|------------------|----------------------|----------------------|--------------|
| Test Input Power | 120V 60Hz            | Temperature          | 23°C         |
| Line Under Test  | AC Mains             | Relative Humidity    | 59%          |
| Mode             | Bluetooth + Charging | Atmospheric Pressure | 1030mbar     |
|                  |                      | Tested By            | Lim Poh Huat |

| Frequency (MHz) | Q-P Value (dBμV) | Q-P Limit (dBμV) | Q-P Margin (dB) | AV Value (dBμV) | AV Limit (dBμV) | AV Margin (dB) | Line    |
|-----------------|------------------|------------------|-----------------|-----------------|-----------------|----------------|---------|
| 0.4023          | 49.1             | 57.8             | 8.7             | 36.1            | 47.8            | 11.7           | Live    |
| 0.4539          | 44.3             | 56.8             | 12.5            | 31.9            | 46.8            | 14.9           | Neutral |
| 0.7176          | 46.4             | 56.0             | 9.6             | 29.6            | 46.0            | 16.4           | Live    |
| 1.1014          | 43.9             | 56.0             | 12.1            | 32.0            | 46.0            | 14.0           | Neutral |
| 1.9861          | 40.3             | 56.0             | 15.7            | 28.2            | 46.0            | 17.8           | Neutral |
| 27.1212         | 56.2             | 60.0             | 3.8             | 34.2            | 50.0            | 15.8           | Live    |

|                  |                 |                      |              |
|------------------|-----------------|----------------------|--------------|
| Test Input Power | 120V 60Hz       | Temperature          | 23°C         |
| Line Under Test  | AC Mains        | Relative Humidity    | 59%          |
| Mode             | WiFi + Charging | Atmospheric Pressure | 1030mbar     |
|                  |                 | Tested By            | Lim Poh Huat |

| Frequency (MHz) | Q-P Value (dBμV) | Q-P Limit (dBμV) | Q-P Margin (dB) | AV Value (dBμV) | AV Limit (dBμV) | AV Margin (dB) | Line    |
|-----------------|------------------|------------------|-----------------|-----------------|-----------------|----------------|---------|
| 0.4169          | 35.5             | 57.5             | 22.0            | 14.7            | 47.5            | 32.8           | Neutral |
| 0.4169          | 35.5             | 57.5             | 22.0            | 14.7            | 47.5            | 32.8           | Neutral |
| 0.5131          | 32.6             | 56.0             | 23.4            | 11.6            | 46.0            | 34.4           | Neutral |
| 0.6066          | 32.1             | 56.0             | 23.9            | 10.7            | 46.0            | 35.3           | Neutral |
| 0.9688          | 23.3             | 56.0             | 32.7            | 2.6             | 46.0            | 43.4           | Live    |
| 1.3802          | 27.7             | 56.0             | 28.3            | 6.6             | 46.0            | 39.4           | Neutral |

Notes

- All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
- 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.
- EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:  
9kHz - 30MHz  
RBW: 9kHz VBW: 30kHz
- Conducted 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 9kHz – 30MHz is ±2.2dB.

**RADIATED EMISSION TEST**

**47 CFR FCC Part 15.205 Restricted Bands**

| MHz                 | MHz                   | MHz             | GHz           |
|---------------------|-----------------------|-----------------|---------------|
| 0.090 - 0.110       | 16.42 - 16.423        | 399.9 - 410     | 4.5 - 5.15    |
| 0.495 - 0.505       | 16.69475 - 16.69525   | 608 - 614       | 5.35 - 5.46   |
| 2.1735 - 2.1905     | 16.80425 - 16.80475   | 960 - 1240      | 7.25 - 7.75   |
| 4.125 - 4.128       | 25.5 - 25.67          | 1300 - 1427     | 8.025 - 8.5   |
| 4.17725 - 4.17775   | 37.5 - 38.25          | 1435 - 1626.5   | 9.0 - 9.2     |
| 4.20725 - 4.20775   | 73 - 74.6             | 1645.5 - 1646.5 | 9.3 - 9.5     |
| 6.215 - 6.218       | 74.8 - 75.2           | 1660 - 1710     | 10.6 - 12.7   |
| 6.26775 - 6.26825   | 108 - 121.94          | 1718.8 - 1722.2 | 13.25 - 13.4  |
| 6.31175 - 6.31225   | 123 - 138             | 2200 - 2300     | 14.47 - 14.5  |
| 8.291 - 8.294       | 149.9 - 150.05        | 2310 - 2390     | 15.35 - 16.2  |
| 8.362 - 8.366       | 156.52475 - 156.52525 | 2483.5 - 2500   | 17.7 - 21.4   |
| 8.37625 - 8.38675   | 156.7 - 156.9         | 2690 - 2900     | 22.01 - 23.12 |
| 8.41425 - 8.41475   | 162.0125 - 167.17     | 3260 - 3267     | 23.6 - 24.0   |
| 12.29 - 12.293      | 167.72 - 173.2        | 3332 - 3339     | 31.2 - 31.8   |
| 12.51975 - 12.52025 | 240 - 285             | 3345.8 - 3358   | 36.43 - 36.5  |
| 12.57675 - 12.57725 | 322 - 335.4           | 3600 - 4400     | Above 38.6    |
| 13.36 - 13.41       |                       |                 |               |

**47 CFR FCC Parts 15.109(a), 15.209 and 15.225(d) Radiated Emission Limits**

| Frequency Range (MHz) | Quasi-Peak Limit Values (dBμV/m) |
|-----------------------|----------------------------------|
| 0.009 - 0.490         | 20 log [2400 / F (kHz)] @ 300m   |
| 0.490 - 1.705         | 20 log [24000 / F (kHz)] @ 30m   |
| 1.705 - 30.0          | 30.0 @ 30m                       |
| 30 - 88               | 40.0 @ 3m                        |
| 88 - 216              | 43.5 @ 3m                        |
| 216 - 960             | 46.0 @ 3m                        |
| Above 960             | 54.0* @ 3m                       |

\* For frequency bands 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.

**47 CFR FCC Parts 15.109(a), 15.209 and 15.225(d) Radiated Emission Test Instrumentation**

| Instrument                                | Model       | S/No       | Cal Due Date |
|-------------------------------------------|-------------|------------|--------------|
| R&S Test Receiver – ESI1                  | ESI40       | 100010     | 14 Jul 2016  |
| Schaffner Bilog Antenna –(30MHz-2GHz) BL4 | CBL6112B    | 2593       | 15 Dec 2016  |
| EMCO Horn Antenna(1GHz-18GHz)             | 3115        | 0003-6088  | 20 Apr 2016  |
| ETS Horn Antenna(18GHz-40GHz)(Ref)        | 3116        | 0004-2474  | 14 Oct 2016  |
| Toyo Preamplifier (26.5GHz-40GHz)         | HAP26-40W   | 00000005   | 14 Oct 2016  |
| R&S Preamplifier (1GHz -18GHz)            | SCU18       | 102191     | 13 Mar 2017  |
| Agilent Preamplifier(1GHz-26.5GHz) (PA18) | 8449D       | 3008A02305 | 06 Oct 2016  |
| Com-Power Preamplifier (1MHz-1GHz)        | PAM-103     | 441096     | 09 Oct 2016  |
| EMCO Loop Antenna (9kHz – 30MHz)          | 6502        | 134413     | 01 Oct 2016  |
| Micro-tronics Bandstop Filter (2.4GHz)    | BRM50701-02 | 007        | 13 Aug 2016  |

**RADIATED EMISSION TEST**

**47 CFR FCC Parts 15.109(a), 15.209 and 15.225(d) Radiated Emission Test Setup**

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table for measurement up to 1GHz. For measurement above 1GHz, 1.5m height table was used.
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 Parts 15.109(a), 15.209 and 5.225(d) Radiated Emission 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 in the range of 9kHz – 90kHz, 110kHz – 490kHz and 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 the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10<sup>th</sup> harmonics of the EUT fundamental frequency, using the loop antenna for frequency below 30MHz, Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

**Sample Calculation Example**

At 300 MHz

Q-P limit = 46.0 dB $\mu$ V/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dB $\mu$ V/m  
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 46.0 - 40.0 = 6.0

i.e. 6.0 dB below Q-P limit

**RADIATED EMISSION TEST**

**47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results**

|                  |                                    |                      |                    |
|------------------|------------------------------------|----------------------|--------------------|
| Test Input Power | 120V 60Hz                          | Temperature          | 23°C               |
| Test Distance    | 3m (<30MHz)<br>3m (≥30MHz – 25GHz) | Relative Humidity    | 59%                |
| Mode             | RFID + Bluetooth + Charging        | Atmospheric Pressure | 1030mbar           |
|                  |                                    | Tested By            | Jason Lai Sze Hian |

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) \*See Note 3

| Freq (GHz) | Peak Value (dBμV/m) | Peak Limit (dBμV/m) | Peak Margin (dB) | AV Value (dBμV/m)<br>*See Note 5 | AV Limit (dBμV/m) | AV Margin (dB) | Height (cm) | Azimuth (Degrees) |
|------------|---------------------|---------------------|------------------|----------------------------------|-------------------|----------------|-------------|-------------------|
| 0.1570     | 60.0                | 123.7               | 63.7             | --                               | 103.7             | 43.7           | 120         | 282               |
| 0.1910     | 57.3                | 122.0               | 64.7             | --                               | 102.0             | 44.7           | 120         | 323               |
| 0.2240     | 56.5                | 120.6               | 64.1             | --                               | 100.6             | 44.1           | 120         | 356               |
| 0.2580     | 55.1                | 119.4               | 64.3             | --                               | 99.4              | 44.3           | 120         | 176               |
| 0.2910     | 53.5                | 118.3               | 64.8             | --                               | 98.3              | 44.8           | 120         | 282               |

Spurious Emissions ranging from 9kHz – 30MHz \*See Note 4

| Frequency (MHz) | Q-P Value (dBμV/m) | Q-P Limit (dBμV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|
| 17.1912         | 22.3               | 69.5               | 47.2            | 120         | 174               |

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) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|-----------|
| 44.7390         | 30.5               | 40.0               | 9.5             | 100         | 237               | V         |
| 161.6890        | 31.9               | 43.5               | 11.6            | 100         | 187               | V         |
| 215.7040        | 34.0               | 43.5               | 9.5             | 100         | 159               | V         |
| 270.5180        | 34.9               | 46.0               | 11.1            | 100         | 81                | V         |
| 378.9890        | 44.6               | 46.0               | 1.4             | 100         | 160               | V         |
| 798.2400        | 41.9               | 46.0               | 4.1             | 100         | 173               | V         |

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) |
|------------|---------------------|---------------------|------------------|-------------------|-------------------|----------------|-------------|-------------------|-----------|
| 1.6565     | 29.2                | 74.0                | 44.8             | 15.3              | 54.0              | 38.7           | 101         | 341               | H         |
| 3.5643     | 40.2                | 74.0                | 33.8             | 26.7              | 54.0              | 27.3           | 101         | 216               | V         |
| 4.9727     | 49.0                | 74.0                | 25.0             | 35.6              | 54.0              | 18.4           | 218         | 162               | H         |
| 5.6965     | 48.1                | 74.0                | 25.9             | 34.3              | 54.0              | 19.7           | 399         | 216               | H         |
| 15.1708    | 48.6                | 74.0                | 25.4             | 35.5              | 54.0              | 18.5           | 100         | 271               | H         |
| 17.5140    | 50.0                | 74.0                | 24.0             | 36.7              | 54.0              | 17.3           | 100         | 151               | V         |

**RADIATED EMISSION TEST**

**47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results**

|                  |                                    |                      |              |
|------------------|------------------------------------|----------------------|--------------|
| Test Input Power | 120V 60Hz                          | Temperature          | 23°C         |
| Test Distance    | 3m (<30MHz)<br>3m (≥30MHz – 25GHz) | Relative Humidity    | 59%          |
| Mode             | RFID + 802.11b + Charging          | Atmospheric Pressure | 1030mbar     |
|                  |                                    | Tested By            | Lim Poh Huat |

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) \*See Note 3

| Freq (GHz) | Peak Value (dBμV/m) | Peak Limit (dBμV/m) | Peak Margin (dB) | AV Value (dBμV/m)<br>*See Note 5 | AV Limit (dBμV/m) | AV Margin (dB) | Height (cm) | Azimuth (Degrees) |
|------------|---------------------|---------------------|------------------|----------------------------------|-------------------|----------------|-------------|-------------------|
| 0.1570     | 61.0                | 123.7               | 62.7             | --                               | 103.7             | 42.7           | 120         | 54                |
| 0.1910     | 59.0                | 122.0               | 63.0             | --                               | 102.0             | 43.0           | 120         | 41                |
| 0.2240     | 56.5                | 120.6               | 64.1             | --                               | 100.6             | 44.1           | 120         | 184               |
| 0.2580     | 54.4                | 119.4               | 65.0             | --                               | 99.4              | 45.0           | 120         | 9                 |
| 0.4260     | 51.4                | 115.0               | 63.6             | --                               | 95.0              | 43.6           | 120         | 63                |

Spurious Emissions ranging from 9kHz – 30MHz \*See Note 4

| Frequency (MHz) | Q-P Value (dBμV/m) | Q-P Limit (dBμV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|
| 27.1440         | 25.5               | 69.5               | 44.0            | 120         | 174.3             |

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) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|-----------|
| 44.7310         | 30.6               | 40.0               | 9.4             | 100         | 204               | V         |
| 119.9980        | 37.0               | 43.5               | 6.5             | 100         | 29                | V         |
| 162.3670        | 31.8               | 43.5               | 11.7            | 107         | 171               | V         |
| 215.6320        | 35.3               | 43.5               | 8.2             | 106         | 148               | V         |
| 270.6940        | 37.3               | 46.0               | 8.7             | 100         | 178               | V         |
| 311.8790        | 39.0               | 46.0               | 7.0             | 170         | 71                | V         |

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) |
|------------|---------------------|---------------------|------------------|-------------------|-------------------|----------------|-------------|-------------------|-----------|
| 3.2366     | 38.8                | 74.0                | 35.2             | 39.0              | 54.0              | 15.0           | 200         | 168               | V         |
| 3.2872     | 42.8                | 74.0                | 31.2             | 40.3              | 54.0              | 13.7           | 100         | 134               | H         |
| 4.8761     | 45.3                | 74.0                | 28.7             | 42.2              | 54.0              | 11.8           | 200         | 172               | H         |
| 4.9267     | 42.5                | 74.0                | 31.5             | 41.6              | 54.0              | 12.4           | 200         | 255               | H         |
| 4.9469     | 40.6                | 74.0                | 33.4             | 39.0              | 54.0              | 15.0           | 200         | 179               | V         |
| 5.6047     | 41.9                | 74.0                | 32.1             | 41.1              | 54.0              | 12.9           | 200         | 168               | V         |

**RADIATED EMISSION TEST**

**47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results**

|                  |                                    |                      |              |
|------------------|------------------------------------|----------------------|--------------|
| Test Input Power | 120V 60Hz                          | Temperature          | 23°C         |
| Test Distance    | 3m (<30MHz)<br>3m (≥30MHz – 25GHz) | Relative Humidity    | 59%          |
| Mode             | RFID + 802.11g + Charging          | Atmospheric Pressure | 1030mbar     |
|                  |                                    | Tested By            | Lim Poh Huat |

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) \*See Note 3

| Freq (GHz) | Peak Value (dBμV/m) | Peak Limit (dBμV/m) | Peak Margin (dB) | AV Value (dBμV/m)<br>*See Note 5 | AV Limit (dBμV/m) | AV Margin (dB) | Height (cm) | Azimuth (Degrees) |
|------------|---------------------|---------------------|------------------|----------------------------------|-------------------|----------------|-------------|-------------------|
| 0.0150     | 80.3                | 144.1               | 63.8             | --                               | 124.1             | 43.8           | 120         | 193               |

Spurious Emissions ranging from 9kHz – 30MHz \*See Note 4

| Frequency (MHz) | Q-P Value (dBμV/m) | Q-P Limit (dBμV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|
| 2.4430          | 39.5               | 69.5               | 30.0            | 120         | 340               |
| 26.4760         | 31.2               | 69.5               | 38.3            | 120         | 59                |
| 26.9620         | 34.3               | 69.5               | 35.2            | 120         | 119               |
| 27.5690         | 32.8               | 69.5               | 36.7            | 120         | 185               |
| 27.9330         | 28.8               | 69.5               | 40.7            | 120         | 185               |

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) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|-----------|
| 44.7350         | 32.4               | 40.0               | 7.6             | 100         | 201               | V         |
| 120.0020        | 36.4               | 43.5               | 7.1             | 100         | 48                | V         |
| 167.9880        | 35.8               | 43.5               | 7.7             | 100         | 149               | V         |
| 215.9690        | 34.1               | 43.5               | 9.4             | 107         | 173               | V         |
| 269.4400        | 33.7               | 46.0               | 12.3            | 100         | 93                | V         |
| 311.8870        | 38.1               | 46.0               | 7.9             | 170         | 115               | V         |

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) |
|------------|---------------------|---------------------|------------------|-------------------|-------------------|----------------|-------------|-------------------|-----------|
| 3.2872     | 43.1                | 74.0                | 30.9             | 40.8              | 54.0              | 13.2           | 200         | 156               | V         |
| 4.9267     | 43.7                | 74.0                | 30.3             | 39.6              | 54.0              | 14.4           | 300         | 266               | H         |
| 5.1999     | 42.2                | 74.0                | 31.8             | 40.6              | 54.0              | 13.4           | 200         | 186               | V         |
| 5.2404     | 44.3                | 74.0                | 29.7             | 41.1              | 54.0              | 12.9           | 200         | 197               | V         |
| 5.6857     | 43.1                | 74.0                | 30.9             | 42.9              | 54.0              | 11.1           | 200         | 174               | V         |
| 5.8071     | 42.0                | 74.0                | 32.0             | 39.8              | 54.0              | 14.2           | 400         | 266               | H         |

**RADIATED EMISSION TEST**

**47 CFR FCC Parts 15.109(a), 15.205, 15.209 and 15.225(d) Radiated Emission Results**

|                  |                                    |                      |              |
|------------------|------------------------------------|----------------------|--------------|
| Test Input Power | 120V 60Hz                          | Temperature          | 23°C         |
| Test Distance    | 3m (<30MHz)<br>3m (≥30MHz – 25GHz) | Relative Humidity    | 59%          |
| Mode             | RFID + 802.11n + Charging          | Atmospheric Pressure | 1030mbar     |
|                  |                                    | Tested By            | Lim Poh Huat |

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) \*See Note 3

| Freq (GHz) | Peak Value (dBμV/m) | Peak Limit (dBμV/m) | Peak Margin (dB) | AV Value (dBμV/m)<br>*See Note 5 | AV Limit (dBμV/m) | AV Margin (dB) | Height (cm) | Azimuth (Degrees) |
|------------|---------------------|---------------------|------------------|----------------------------------|-------------------|----------------|-------------|-------------------|
| 0.4400     | 51.0                | 114.7               | 63.7             | --                               | 94.7              | 43.7           | 120         | 322               |

Spurious Emissions ranging from 9kHz – 30MHz \*See Note 4

| Frequency (MHz) | Q-P Value (dBμV/m) | Q-P Limit (dBμV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|
| 1.6540          | 37.7               | 63.2               | 25.5            | 120         | 214               |
| 3.5350          | 31.2               | 69.5               | 38.3            | 120         | 243               |
| 9.0580          | 24.5               | 69.5               | 45.0            | 120         | 194               |
| 17.1910         | 22.3               | 69.5               | 47.2            | 120         | 95                |
| 27.1440         | 25.5               | 69.5               | 44.0            | 120         | 174               |

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) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|-----------|
| 48.0010         | 35.7               | 40.0               | 4.3             | 100         | 244               | V         |
| 120.0100        | 34.5               | 43.5               | 9.0             | 100         | 40                | V         |
| 162.1700        | 31.4               | 43.5               | 12.1            | 100         | 167               | V         |
| 167.9960        | 35.7               | 43.5               | 7.8             | 106         | 173               | V         |
| 270.2690        | 35.0               | 46.0               | 11.0            | 100         | 174               | V         |
| 324.8420        | 36.4               | 46.0               | 9.6             | 100         | 177               | V         |

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) |
|------------|---------------------|---------------------|------------------|-------------------|-------------------|----------------|-------------|-------------------|-----------|
| 3.2872     | 43.2                | 74.0                | 30.8             | 40.9              | 54.0              | 13.1           | 200         | 161               | V         |
| 4.8356     | 40.0                | 74.0                | 34.0             | 39.8              | 54.0              | 14.2           | 100         | 225               | V         |
| 4.9267     | 43.5                | 74.0                | 30.5             | 39.3              | 54.0              | 14.7           | 100         | 103               | V         |
| 5.2404     | 43.5                | 74.0                | 30.5             | 41.9              | 54.0              | 12.1           | 300         | 278               | H         |
| 5.6452     | 45.8                | 74.0                | 28.2             | 42.8              | 54.0              | 11.2           | 100         | 173               | V         |
| 5.6857     | 44.5                | 74.0                | 29.5             | 43.0              | 54.0              | 11.0           | 100         | 160               | V         |

## RADIATED EMISSION TEST

### 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 closer test distance of 3m was used for the measurement instead of 30m as the fundamental (carrier) electric field strength of the EUT at the 10m distance shows compliance to the limit of 30m test distance.
3. “-” indicates no emissions were found and shows compliance to the limits.
4. The measurement was done at 3m. The specified test limits were extrapolated to the measurement distance as specified in § 15.209 (a) based on 40dB/decade.
5. As the measured peak shows compliance to the average limit, as such no average measurement was required.
6. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
7. 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.
8. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:  

|                       |            |
|-----------------------|------------|
| <u>9kHz - 150kHz</u>  |            |
| RBW: 100Hz            | VBW: 300Hz |
| <u>150kHz - 30MHz</u> |            |
| RBW: 10kHz            | VBW: 30kHz |
| <u>30MHz - 1GHz</u>   |            |
| RBW: 120kHz           | VBW: 1MHz  |
| <u>&gt;1GHz</u>       |            |
| RBW: 1MHz             | VBW: 1MHz  |
9. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
10. The channel in the table refers to the transmit channel of the EUT.
11. Radiated 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 – 25GHz is  $\pm 4.0\text{dB}$ .

**RADIATED EMISSION (FUNDAMENTAL) TEST**

**47 CFR FCC Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) Limits**

| Fundamental Frequency (MHz) | Field Strength of Fundamental Limit Values @ 30m (dBµV/m) |
|-----------------------------|-----------------------------------------------------------|
| 13.553 - 13.567             | 84.0                                                      |
| 13.410 -13.553              | 50.5                                                      |
| 13.567 -13.710              | 50.5                                                      |
| 13.110 -13.410              | 40.5                                                      |
| 13.710 -14.010              | 40.5                                                      |

**47 CFR FCC Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) Test Instrumentation**

| Instrument                                | Model     | S/No       | Cal Due Date |
|-------------------------------------------|-----------|------------|--------------|
| R&S Test Receiver – ESI1                  | ESI40     | 100010     | 14 Jul 2016  |
| Schaffner Bilog Antenna –(30MHz-2GHz) BL4 | CBL6112B  | 2593       | 15 Dec 2016  |
| EMCO Horn Antenna(1GHz-18GHz)             | 3115      | 0003-6088  | 20 Apr 2016  |
| ETS Horn Antenna(18GHz-40GHz)(Ref)        | 3116      | 0004-2474  | 14 Oct 2016  |
| Toyo Preamplifier (26.5GHz-40GHz)         | HAP26-40W | 00000005   | 14 Oct 2016  |
| R&S Preamplifier (1GHz -18GHz)            | SCU18     | 102191     | 13 Mar 2017  |
| Agilent Preamplifier(1GHz-26.5GHz) (PA18) | 8449D     | 3008A02305 | 06 Oct 2016  |
| Com-Power Preamplifier (1MHz-1GHz)        | PAM-103   | 441096     | 09 Oct 2016  |
| EMCO Loop Antenna (9kHz – 30MHz)          | 6502      | 134413     | 01 Oct 2016  |

## RADIATED EMISSION (FUNDAMENTAL) TEST

### 47 CFR FCC Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table for measurement up to 1GHz. For measurement above 1GHz, 1.5m height table was used.
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 Parts 15.225(a), 15.225(b) and 15.225(c) Radiated Emission (Fundamental) 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 fundamental frequency 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.

### Sample Calculation Example

|                                                                                                                                    |                               |
|------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| At 300 MHz                                                                                                                         | Q-P limit = 46.0 dB $\mu$ V/m |
| Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB                                                                      |                               |
| Q-P reading obtained directly from EMI Receiver = 40.0 dB $\mu$ V/m<br>(Calibrated level including antenna factors & cable losses) |                               |
| Therefore, Q-P margin = 46.0 - 40.0 = 6.0                                                                                          | i.e. 6.0 dB below Q-P limit   |



**RADIATED EMISSION (FUNDAMENTAL) TEST**

**47 CFR FCC Part 15.225(a / b / c) Radiated Emission (Fundamental) Results**

|                  |                |                      |              |
|------------------|----------------|----------------------|--------------|
| Test Input Power | 120V 60Hz      | Temperature          | 23°C         |
| Test Distance    | 3m *see Note 2 | Relative Humidity    | 59%          |
|                  |                | Atmospheric Pressure | 1030mbar     |
|                  |                | Tested By            | Lim Poh Huat |

| Frequency (MHz) | Peak Value (dBμV/m) | Q-P Limit (dBμV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) |
|-----------------|---------------------|--------------------|-----------------|-------------|-------------------|
| 13.5490         | 70.3                | 84.0               | 13.7            | 100         | 197               |

Notes

- All possible modes of operation were investigated. Only the worst case emissions measured, using the average and peak detectors, are reported. All other emissions were relatively insignificant.
- A closer test distance of 3m was used for the measurement instead of 30m as the fundamental (carrier) electric field strength of the EUT at the 3m distance shows compliance to the limit of 30m test distance.
- As the measured peak shows compliance to the Q-P limit, as such no Q-P measurement was required.
- 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.
- EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:  
150kHz - 30MHz  
RBW: 10kHz VBW: 30kHz  
30MHz - 1GHz  
RBW: 120kHz VBW: 1MHz  
>1GHz  
RBW: 1MHz VBW: 1MHz
- Radiated Emissions (Fundamental) 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 – 25GHz is ±4.0dB.

## FREQUENCY STABILITY VERSUS TEMPERATURE TEST

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Limits

The EUT shows compliance to the requirements of this section, which states that the frequency tolerance of the carrier frequency shall be  $\pm 0.01\%$  for a temperature variation of  $-20^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  at normal supply voltage.

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Test Instrumentation

| Instrument                      | Model  | S/No       | Cal Due Date   |
|---------------------------------|--------|------------|----------------|
| HP Universal Counter            | 53132A | 3736A06236 | 05 Apr 2016    |
| Hewlett Packard DC Power Supply | 6228B  | 2833A-0523 | Output Monitor |
| EMCO Near Field Probe Set       | 7405   | 9107-2063  | Output Monitor |

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo. The EUT was placed in an environmental temperature chamber with a nominal supply voltage. For the battery operated EUT, a new battery was used.
2. The RF antenna connector of the EUT was connected to the frequency counter via a low-loss coaxial cable.

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Test Method

1. The EUT was switched off and the environmental temperature was set to the highest temperature, i.e.,  $+50^{\circ}\text{C}$ .
2. Upon reaching the highest set temperature with 30 minutes of stabilisation period, the EUT was switched on and configured to operate in the test mode with transmitting frequency at 13.56MHz.
3. The EUT's transmitting frequency was then measured at start up, and two, five and ten minutes after start up with the frequency counter set to max hold to capture the transmitting frequency. For each measurement, the signal capturing was continuous until no further changes were observed. Four measurements were made in total.
4. Repeat steps 1 to 3 with the temperature set to the lowest temperature, i.e.,  $-20^{\circ}\text{C}$ .



**FREQUENCY STABILITY VERSUS TEMPERATURE TEST**

**47 CFR FCC Part 15.225(e) Frequency Stability Versus Temperature Results**

|                  |        |                      |              |
|------------------|--------|----------------------|--------------|
| Test Input Power | 7.2Vdc | Temperature          | +50°C        |
|                  |        | Relative Humidity    | 59%          |
|                  |        | Atmospheric Pressure | 1030mbar     |
|                  |        | Tested By            | Lim Poh Huat |

| Channel Frequency (MHz) | ± 0.01% Carrier Tolerance (MHz) | Measured Tolerance (Hz) | Measurement with respects to Start Up Time (Mins) |
|-------------------------|---------------------------------|-------------------------|---------------------------------------------------|
| 13.5600                 | ±1356.0000                      | 19.8200                 | 0                                                 |
| 13.5600                 | ±1356.0000                      | 113.8100                | 2                                                 |
| 13.5600                 | ±1356.0000                      | 99.8400                 | 5                                                 |
| 13.5600                 | ±1356.0000                      | 135.6200                | 10                                                |

|                  |        |                      |              |
|------------------|--------|----------------------|--------------|
| Test Input Power | 7.2Vdc | Temperature          | -20°C        |
|                  |        | Relative Humidity    | 59%          |
|                  |        | Atmospheric Pressure | 1030mbar     |
|                  |        | Tested By            | Lim Poh Huat |

| Channel Frequency (MHz) | ± 0.01% Carrier Tolerance (MHz) | Measured Tolerance (Hz) | Measurement with respects to Start Up Time (Mins) |
|-------------------------|---------------------------------|-------------------------|---------------------------------------------------|
| 13.5600                 | ±1356.0000                      | -27.4500                | 0                                                 |
| 13.5600                 | ±1356.0000                      | -50.9100                | 2                                                 |
| 13.5600                 | ±1356.0000                      | -76.0900                | 5                                                 |
| 13.5600                 | ±1356.0000                      | -76.0900                | 10                                                |

## FREQUENCY STABILITY VERSUS INPUT VOLTAGE TEST

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Limits

The EUT shows compliance to the requirements of this section, which states that the frequency tolerance of the carrier frequency shall be  $\pm 0.01\%$  for variation of a primary voltage from 85% to 115% of the rated supply voltage at a temperature of 20°C. For a battery operated equipment, the equipment tests shall be performed using a new battery.

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Test Instrumentation

| Instrument                      | Model  | S/No       | Cal Due Date   |
|---------------------------------|--------|------------|----------------|
| HP Universal Counter            | 53132A | 3736A06236 | 05 Apr 2016    |
| Hewlett Packard DC Power Supply | 6228B  | 2833A-0523 | Output Monitor |
| EMCO Near Field Probe Set       | 7405   | 9107-2063  | Output Monitor |

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo. The EUT was placed in an environmental temperature chamber with a nominal supply voltage. For the battery operated EUT, a new battery was used.
2. The RF antenna connector of the EUT was connected to the frequency counter via a low-loss coaxial cable.

### 47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Test Method

1. The EUT was switched off and the environmental temperature was set to 20°C.
2. Upon reaching the set temperature with 30 minutes of stabilisation period, the EUT was switched on and configured to operate in the test mode with transmitting frequency at 13.56MHz.
3. The EUT's transmitting frequency was then measured at start up, and two, five and ten minutes after start up with the frequency counter set to max hold to capture the transmitting frequency. For each measurement, the signal capturing was continuous until no further changes were observed. Four measurements were made in total.
4. Repeat steps 1 to 3 with the supply voltage set to 85% and 115% of the nominal voltage supply respectively. For the battery operated EUT, this step is not applicable.



**FREQUENCY STABILITY VERSUS INPUT VOLTAGE TEST**

**47 CFR FCC Part 15.225(e) Frequency Stability Versus Input Voltage Results**

|                  |                             |                      |              |
|------------------|-----------------------------|----------------------|--------------|
| Test Input Power | 7.2Vdc<br>(Nominal Voltage) | Temperature          | 20°C         |
|                  |                             | Relative Humidity    | 59%          |
|                  |                             | Atmospheric Pressure | 1030mbar     |
|                  |                             | Tested By            | Lim Poh Huat |

| Channel Frequency<br>(MHz) | ± 0.01% Carrier<br>Tolerance<br>(MHz) | Measured Tolerance<br>(Hz) | Measurement with<br>respects to Start Up<br>Time (Mins) |
|----------------------------|---------------------------------------|----------------------------|---------------------------------------------------------|
| 13.5600                    | ±1356.0000                            | 137.4607                   | 0                                                       |
| 13.5600                    | ±1356.0000                            | 130.8352                   | 2                                                       |
| 13.5600                    | ±1356.0000                            | 121.0373                   | 5                                                       |
| 13.5600                    | ±1356.0000                            | 105.6177                   | 10                                                      |

|                  |                                            |                      |              |
|------------------|--------------------------------------------|----------------------|--------------|
| Test Input Power | 6.80Vdc<br>(85% of the Nominal<br>voltage) | Temperature          | 20°C         |
|                  |                                            | Relative Humidity    | 59%          |
|                  |                                            | Atmospheric Pressure | 1030mbar     |
|                  |                                            | Tested By            | Lim Poh Huat |

| Channel Frequency<br>(MHz) | ± 0.01% Carrier<br>Tolerance<br>(MHz) | Measured Tolerance<br>(Hz) | Measurement with<br>respects to Start Up<br>Time (Mins) |
|----------------------------|---------------------------------------|----------------------------|---------------------------------------------------------|
| 13.5600                    | ±1356.0000                            | 19.1897                    | 0                                                       |
| 13.5600                    | ±1356.0000                            | 45.9341                    | 2                                                       |
| 13.5600                    | ±1356.0000                            | 49.4828                    | 5                                                       |
| 13.5600                    | ±1356.0000                            | 63.4036                    | 10                                                      |

|                  |                                             |                      |              |
|------------------|---------------------------------------------|----------------------|--------------|
| Test Input Power | 8.28Vdc<br>(115% of the Nominal<br>voltage) | Temperature          | 20°C         |
|                  |                                             | Relative Humidity    | 59%          |
|                  |                                             | Atmospheric Pressure | 1030mbar     |
|                  |                                             | Tested By            | Lim Poh Huat |

| Channel Frequency<br>(MHz) | ± 0.01% Carrier<br>Tolerance<br>(MHz) | Measured Tolerance<br>(Hz) | Measurement with<br>respects to Start Up<br>Time (Mins) |
|----------------------------|---------------------------------------|----------------------------|---------------------------------------------------------|
| 13.5600                    | ±1356.0000                            | -0.1630                    | 0                                                       |
| 13.5600                    | ±1356.0000                            | 90.5087                    | 2                                                       |
| 13.5600                    | ±1356.0000                            | 40.4963                    | 5                                                       |
| 13.5600                    | ±1356.0000                            | 79.6613                    | 10                                                      |



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July 2011

