

**Test Report No. 7191147393-EEC16/07**  
**dated 10 May 2018**



PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH  
47 CFR FCC Parts 15B & C  
OF A  
**Sirius Contactless Transit Reader**  
[ Model : SR272B ]  
[ FCC ID : 2AKLKS272B ]

**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)

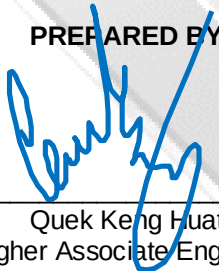
**PREPARED FOR** Land Transport Authority  
71 Chai Chee Street,  
Singapore 468981

**QUOTATION NUMBER** 2191045111

**JOB NUMBER** 7191147393

**TEST PERIOD** 19 Apr 2018 – 04 May 2018

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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

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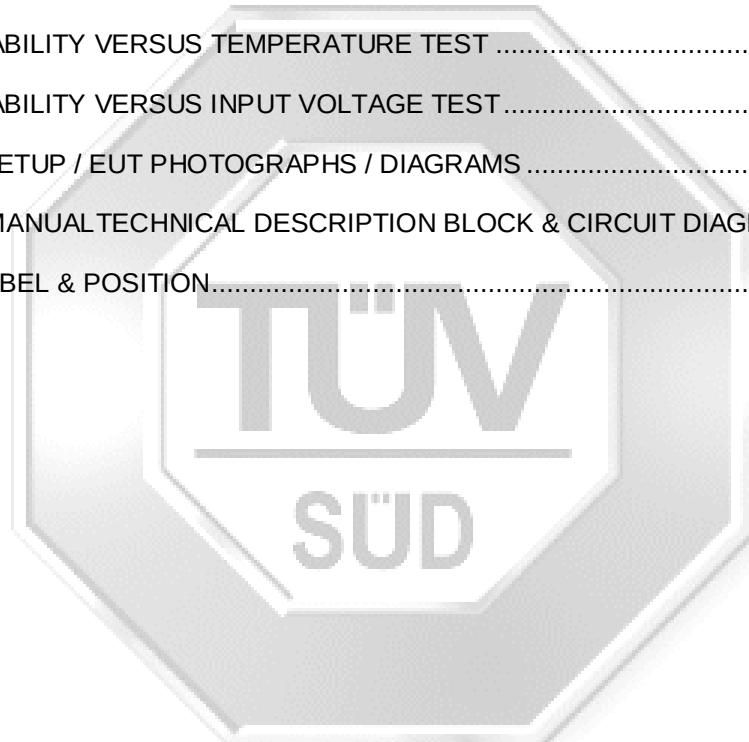
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## TEST SUMMARY

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                                                                                                | Not Applicable *See Note 4 |
| 15.109(a), 15.205, 15.209, 15.225(d) | Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)                                     | Pass                       |
| 15.225(a)                            | Radiated Emissions (Fundamental)<br>(applicable if EUT's carrier is in 13.553-13.567MHz)                           | Pass                       |
| 15.225(b)                            | Radiated Emissions (Fundamental)<br>(applicable if EUT's carrier is in 13.410-13.553MHz or / and 13.567-13.710MHz) | Not Applicable *See Note 1 |
| 15.225(c)                            | Radiated Emissions (Fundamental)<br>(applicable if EUT's carrier is in 13.110-13.410MHz or / and 13.710-14.010MHz) | Not Applicable *See Note 1 |
| 15.225(e)                            | Frequency Stability Versus Temperature                                                                             | Pass                       |
| 15.225(e)                            | Frequency Stability Versus Input Voltage                                                                           | Pass                       |

### Notes

1. The Equipment Under Test (EUT) was configured and tested to operate at 13.56MHz.
2. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.
3. All test measurement procedures are according to ANSI C63.4: 2014 and ANSI C63.10: 2013.
4. The Equipment Under Test (EUT) is a DC operated device and contains no provision for public utility connections.

### Modifications

No modifications were made.

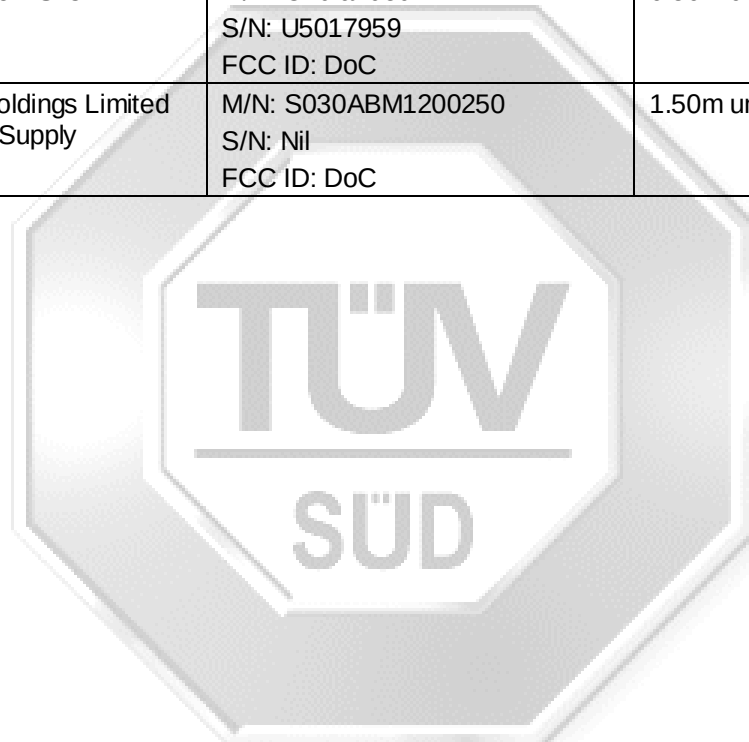
## PRODUCT DESCRIPTION

|                              |                                                                                                                                             |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Description                  | : The Equipment Under Test (EUT) is a <b>Sirius Contactless Transit Reader.</b>                                                             |
| Applicant                    | : Land Transport Authority<br>71 Chai Chee Street,<br>Singapore 468981                                                                      |
| Manufacturer                 | : STYL Solutions Pte Ltd, 81 Ubi Avenue 4 #05-07,<br>Singapore 408830                                                                       |
| Factory                      | : EASTOOL INDUSTRIES SDN. BHD.<br>No 6, 7 & 8, Jalan Gangsa 3,<br>Desa Perindustrian Kulai 2,<br>Kelapa Sawit, 81030 Kulai, Johor, Malaysia |
| FCC ID                       | : 2AKLKSR272B                                                                                                                               |
| Model Number(s)              | : SR72B                                                                                                                                     |
| Serial Number(s)             | : Nil                                                                                                                                       |
| Microprocessor(s)            | : Freescale iMX6D, Maxim MAX32550, NXP PN5180                                                                                               |
| Operating Frequency          | : 13.56MHz                                                                                                                                  |
| Clock / Oscillator Frequency | : 24MHz, 12MHz, 27.12MHz                                                                                                                    |
| Modulation                   | : Amplitude Shift Keying (ASK)                                                                                                              |
| Antenna Gain                 | : Refer to manufacturer's user manual / operating manual                                                                                    |
| Port / Connectors            | : Refer to manufacturer's user manual / operating manual                                                                                    |
| Rated Input Power            | : 12Vdc                                                                                                                                     |
| Accessories                  | : Refer to manufacturer's user manual / operating manual                                                                                    |



**SUPPORTING EQUIPMENT DESCRIPTION**

| Equipment Description<br>(Including Brand Name)       | Model, Serial & FCC ID Number                                  | Cable Description<br>(List Length, Type & Purpose) |
|-------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------|
| Lenovo Ideapad 310-15IKB Laptop                       | M/N: 80TV<br>S/N: PF0P8DLD<br>FCC ID: DoC                      |                                                    |
| Lenovo AC Adapter                                     | M/N: ADLX65CCGK2A<br>S/N: 8SSA10M42735C1SG6A807<br>FCC ID: DoC | 1.80m unshielded power cable                       |
| Unbranded USB to RS232 Converter                      | M/N: Unbranded<br>S/N: U5017959<br>FCC ID: DoC                 | 0.50m unshielded USB cable                         |
| Ten Pao Group Holdings Limited Switching Power Supply | M/N: S030ABM1200250<br>S/N: Nil<br>FCC ID: DoC                 | 1.50m unshielded power cable                       |





**EUT OPERATING CONDITIONS**

**47 CFR FCC Part 15**

- 1. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)**
- 2. Radiated Emissions (Fundamental)**
- 3. Frequency Stability Versus Temperature**
- 4. Frequency Stability Versus Input Voltage**

The EUT was exercised by operating in maximum continuous transmission in test mode, i.e transmitting at 13.56MHz continuously.



## 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 (dBuV/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 | 25 Oct 2018  |
| Com-Power Preamplifier(1MHz-1GHz)     | PAM-103  | 441158 | 22 Sep 2018  |
| Schaffner Bilog Antenna –(30MHz-2GHz) | CBL6112B | 2597   | 20 Feb 2019  |
| EMCO Loop Ant (ext) red 00134413      | 6502     | 134413 | 28 Oct 2018  |



## 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<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 TEST**

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

|                  |                                    |                      |           |
|------------------|------------------------------------|----------------------|-----------|
| Test Input Power | 12Vdc                              | Temperature          | 24°C      |
| Test Distance    | 10m (<30MHz)<br>3m (≥30MHz – 1GHz) | Relative Humidity    | 55%       |
|                  |                                    | Atmospheric Pressure | 1030mbar  |
|                  |                                    | Tested By            | Dylan Lin |

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) \*See Note 2 & 3

| 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) |
|------------|---------------------|---------------------|------------------|-------------------|-------------------|----------------|-------------|-------------------|
| 0.0240     | 57.7                | 147.4               | 89.7             | 46.4              | 127.4             | 81.0           | 120         | 141               |
| 0.0400     | 51.8                | 146.3               | 94.5             | 42.2              | 126.3             | 84.1           | 120         | 80                |
| 0.0600     | 48.2                | 144.8               | 96.6             | 38.5              | 124.8             | 86.3           | 120         | 142               |
| 0.0850     | 45.8                | 143.1               | 97.3             | 35.7              | 123.1             | 87.4           | 120         | 124               |
| 0.4530     | 50.6                | 116.5               | 65.9             | 39.6              | 96.5              | 56.9           | 120         | 136               |
| -          | -                   | -                   | -                | -                 | -                 | -              | -           | -                 |

Spurious Emissions ranging from 9kHz – 30MHz \*See Note 2 & 3

| Frequency (MHz) | Q-P Value (dBμV/m) | Q-P Limit (dBμV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|
| 0.0940          | 38.3               | 122.4              | 84.1            | 120         | 124               |
| 0.5090          | 42.5               | 73.6               | 31.1            | 120         | 123               |
| 6.4370          | 18.6               | 70.0               | 51.4            | 120         | 12                |
| 7.1550          | 17.6               | 70.0               | 52.4            | 120         | 231               |
| 22.6260         | 17.5               | 70.0               | 52.5            | 120         | 70                |
| -               | -                  | -                  | -               | -           | -                 |

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) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|-----------|
| 40.7690         | 29.8               | 40.0               | 10.2            | 100         | 352               | V         |
| 49.5830         | 34.7               | 40.0               | 5.3             | 114         | 62                | V         |
| 85.3720         | 34.5               | 40.0               | 5.5             | 100         | 226               | V         |
| 94.2230         | 35.4               | 43.5               | 8.1             | 100         | 113               | V         |
| 384.0300        | 35.1               | 46.0               | 10.9            | 100         | 146               | H         |
| 408.0500        | 39.6               | 46.0               | 6.4             | 101         | 15                | H         |

## 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 10m 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. The measurement was done at 10m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
4. “-” indicates no emissions were found and shows compliance to the limits.
5. 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.
6. 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.
7. 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: 3MHz  |
8. 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.
9. The channel in the table refers to the transmit channel of the EUT.
10. 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 – 1GHz is  $\pm 3.8\text{dB}$  and  $>1\text{GHz} - 40\text{GHz}$  is  $\pm 4.5\text{dB}$ .



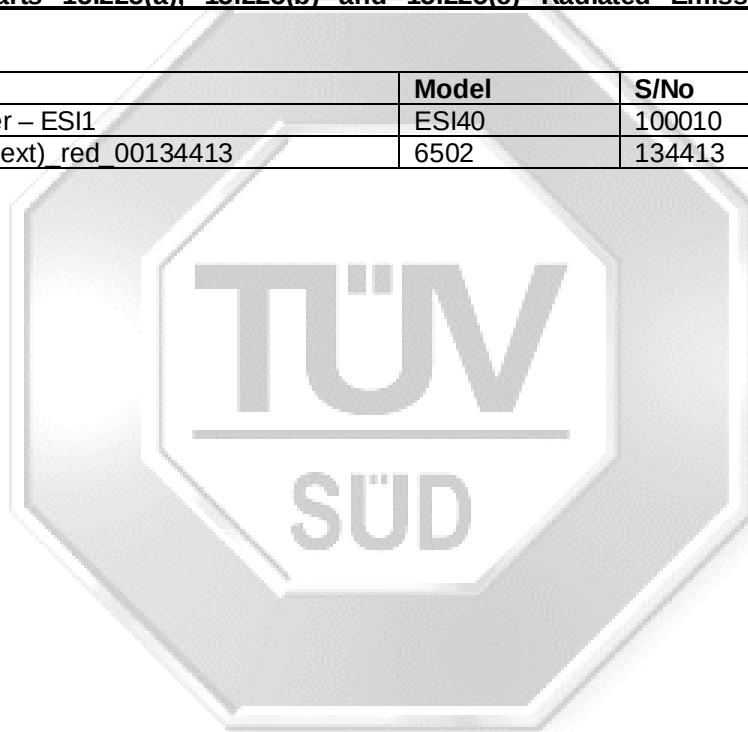
**RADIATED EMISSION (FUNDAMENTAL) TEST**

**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 | 25 Oct 2018  |
| EMCO Loop Ant (ext) red 00134413 | 6502  | 134413 | 28 Oct 2018  |





## 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 | 12Vdc           | Temperature          | 24°C      |
| Test Distance    | 10m *see Note 2 | Relative Humidity    | 55%       |
|                  |                 | Atmospheric Pressure | 1030mbar  |
|                  |                 | Tested By            | Dylan Lin |

| Frequency (MHz) | Q-P Value (dBμV/m) | Q-P Limit (dBμV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) |
|-----------------|--------------------|--------------------|-----------------|-------------|-------------------|
| 13.3530         | 29.7               | 84.0               | 10.8            | 120         | 189               |

### 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 10m 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.
- 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: 3MHz
- 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 Oct 2018    |
| Agilent DC Power Supply                                           | E3620A        | MY40000448 | Output Monitor |
| Cincinnati Sub-Zero Products, INC. Temperature & Humidity Chamber | ZH-8-1-1-H/AC | ZF9722653  | 28 Dec 2018    |

### 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 until no further changes were observed. Four measurements were made in total.
4. The EUT was switched off. The environmental chamber temperature was lowered by  $10^{\circ}\text{C}$  and was allowed the temperature inside the chamber to stabilize.
5. The EUT was turned on and the step 3 was repeated.
6. The steps 3 and 4 were repeated until the lowest temperature was reached, 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 | 12Vdc | Temperature          | See table below |
|                  |       | Relative Humidity    | 60%             |
|                  |       | Atmospheric Pressure | 1030mbar        |
|                  |       | Tested By            | Win Min Htwe    |

| Channel Frequency (MHz) | Temperature (°C) | ± 0.01% Carrier Tolerance (kHz) | Measured Tolerance (kHz) | Measurement with respects to Start Up Time (Mins) |
|-------------------------|------------------|---------------------------------|--------------------------|---------------------------------------------------|
| 13.5600                 | 50.0             | ±1.3560                         | 0.1290                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.1180                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.1960                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.1046                   | 10                                                |
|                         | 40.0             | ±1.3560                         | 0.0900                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.0850                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.0490                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.0850                   | 10                                                |
|                         | 30.0             | ±1.3560                         | 0.0900                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.0880                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.0890                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.0900                   | 10                                                |
|                         | 20.0             | ±1.3560                         | 0.1000                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.1000                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.7000                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.1000                   | 10                                                |
|                         | 10.0             | ±1.3560                         | 0.2590                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.2591                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.2597                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.2600                   | 10                                                |
|                         | 0.0              | ±1.3560                         | 0.0200                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.0300                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.0400                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.0300                   | 10                                                |
|                         | -10.0            | ±1.3560                         | 0.0800                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.0700                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.0700                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.0700                   | 10                                                |
|                         | -20.0            | ±1.3560                         | 0.0020                   | 0                                                 |
|                         |                  | ±1.3560                         | 0.0200                   | 2                                                 |
|                         |                  | ±1.3560                         | 0.0200                   | 5                                                 |
|                         |                  | ±1.3560                         | 0.0300                   | 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 Oct 2018    |
| Agilent DC Power Supply                                           | E3620A        | MY40000448 | Output Monitor |
| Cincinnati Sub-Zero Products, INC. Temperature & Humidity Chamber | ZH-8-1-1-H/AC | ZF9722653  | 28 Dec 2018    |

### **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, the EUT was supplied using a variable power supply.
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 with the frequency counter 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.



**FREQUENCY STABILITY VERSUS INPUT VOLTAGE TEST**

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

|                  |                 |                      |              |
|------------------|-----------------|----------------------|--------------|
| Test Input Power | See table below | Temperature          | 20°C         |
|                  |                 | Relative Humidity    | 60%          |
|                  |                 | Atmospheric Pressure | 1030mbar     |
|                  |                 | Tested By            | Win Min Htwe |

| Channel Frequency (MHz) | Test Input Power (Vac / Vdc)               | ± 1% Carrier Tolerance (kHz) | Measured Tolerance (kHz) |
|-------------------------|--------------------------------------------|------------------------------|--------------------------|
| 13.5600                 | 12Vdc ( <i>nominal voltage</i> )           | ±1.3560                      | 0.1000                   |
|                         | 10.2Vdc ( <i>85% of nominal voltage</i> )  | ±1.3560                      | 0.1080                   |
|                         | 13.8Vdc ( <i>115% of nominal voltage</i> ) | ±1.3560                      | 0.1060                   |





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