# Report on the Radio Testing of:

# SmartTAG

# Model(s): STG-875W(P1)

## In accordance with
## 47 CFR FCC Part 15C

PSB Singapore

Add value.
Inspire trust.

Cadi Scientific Pte Ltd
31 Ubi Road 1 #07-01A
Aztech Building
Singapore 408694

## COMMERCIAL-IN-CONFIDENCE

Document Number: 7191227398-EEC20/08 | Issue: 01
FCC ID: VPE-STG-875W

| RESPONSIBLE FOR | NAME | DATE | SIGNATURE |
|---|---|---|---|
| Project Management | Foo Kai Maun | 08 Apr 2020 | |
| Authorised Signatory | Quek Keng Huat | 07 Apr 2020 | |

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD PSB document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with the mentioned standard(s).

TÜV SÜD PSB

ilac-MRA

Accredited Laboratory SAC-SINGLAS

LA-2007-0380-A LA-2007-0385-E
LA-2007-0381-F LA-2007-0386-C
LA-2007-0382-B LA-2010-0464-D
LA-2007-0383-G LA-2018-0702-B
LA-2007-0384-G LA-2018-0703-G

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

Laboratory:
TÜV SÜD PSB Pte. Ltd.
No.1 Science Park Drive
Singapore 118221

Phone : +65-6885 1333
Fax : +65-6776 8670
E-mail: enquiries@tuv-sud-psb.sg
www.tuv-sud-psb.sg
Co. Reg : 199002667R

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
1 Science Park Drive, #02-01
Singapore 118221

PSB Singapore

# Contents

PSB Singapore

# 1 Report Summary

## 1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

| Issue | Description of Change | Date of Issue |
|---|---|---|
| 1 | First Issue | 08 Apr 2020 |
| | | |

PSB Singapore

## 1.2 Introduction

| | | |
|---|---|---|
| Applicant | : | Cadi Scientific Pte Ltd<br>31 Ubi Road 1 #07-01A<br>Aztech Building<br>Singapore 408694 |
| | | |
| Manufacturer | : | Same as applicant |
| | | |
| Factory | : | Same as applicant |
| | | |
| Model Number(s) | : | STG-875W(P1) |
| | | |
| Serial Number(s) | : | 94F55103611E |
| | | |
| Number of Samples Tested | : | 1 |
| | | |
| Test Sample(s) Condition | : | Good |
| | | |
| Quotation Reference | : | 5278517 |
| | | |
| Test Specification/Issue/Date | : | FCC 47 CFR 15C |
| | | |
| Test Sample(s) Received Date | : | 19 Feb 2020 |
| | | |
| Start of Test | : | 19 Feb 2020 |
| | | |
| Finish of Test | : | 17 Mar 2020 |

PSB Singapore

### 1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with specifications as shown below.

| Specification Clause | Test Description | Result | Comments/Base Standard |
|---|---|---|---|
| *47 CFR FCC Part 15* | | | |
| 15.107(a), 15.207 | Conducted Emissions | Not Applicable *See Note 3 | ANSI C63.4: 2014<br>ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2018 |
| 15.109(a), 15.205, 15.209 | Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) | Pass | ANSI C63.4: 2014<br>ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.247(a)(2) | Spectrum Bandwidth (6dB Bandwidth Measurement) | Not Tested *See Note 6 | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.247(b)(3) | Maximum Peak Power | Not Tested *See Note 6 | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.247(d) | RF Conducted Spurious Emissions (Non-Restricted Bands) | Not Tested *See Note 6 | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.247(d) | RF Conducted Spurious Emissions (Restricted Bands) | Not Tested *See Note 6 | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.247(d) | Band Edge Compliance (Conducted) | Not Tested *See Note 6 | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.247(d) | Band Edge Compliance (Radiated) | Pass | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.247(e) | Peak Power Spectral Density | Not Tested *See Note 6 | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 15.35(c) | Duty Cycle Factor Computation | Not Applicable *See Note 4 | ANSI C63.10: 2013<br>KDB 558074 D01 DTS Measurement Guidance V05R02: 2019 |
| 2.1091 | Maximum Permissible Exposure | Pass | |

PSB Singapore

**Notes**

1. All the measurements in section 15.247 were done based on conducted measurements except Band Edge Compliance (Radiated) test.

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

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

4. The EUT was operated in continuous transmission, ie 100% duty cycle.

5. The EUT was tested using fully charged batteries with DC voltage of 3.6V.

6. The Wi-Fi module of the Equipment Under Test (EUT) is a FCC certified module bearing FCC ID: YOPGS2200M. The module was integrated into the EUT without any modifications to the hardware or firmware. Refer to Bay Area Compliance Labs Corp, issued test report, R1606202-247 dated 17 Aug 2016 for more details.

PSB Singapore

## 1.4 Product Information

### 1.4.1 Technical Description

| | | |
|---|---|---|
| Description | : | The Equipment Under Test(s) (EUT(s)) is a **SmartTAG**. It is a location tracking tag. |
| | | |
| Microprocessor | : | PIC18LF46K22 |
| | | |
| Operating Frequency | : | 125kHz (LF Receiver)<br>38kHz (IR Receiver)<br>2.4GHz (Wi-Fi) |
| | | |
| Clock / Oscillator Frequency | : | 32.768kHz external crystal oscillator<br>16MHz internal RC oscillator |
| | | |
| Modulation | : | Direct Sequence Spread Spectrum (Wi-Fi 802.11b)<br>Orthogonal Frequency Division Multiplexing (Wi-Fi 802.11g/n)<br>Amplitude Shift Keying (RFID) |
| | | |
| Antenna Gain | : | 3.35dBi |
| | | |
| Port / Connectors | : | Nil |
| | | |
| Rated Power | : | 3.6Vdc battery operated |
| | | |
| Accessories | : | Nil |

PSB Singapore

### 1.4.2 Test Configuration and Modes of Operation

| Mode(s) | Description |
|---|---|
| Maximum RF power transmission | The EUT was exercised in the mode, transmitting at lower, middle and upper channels as shown below one at a time with all supported modulation schemes were evaluated. For Band Edge Compliance, only lower and upper channels were evaluated. |

| Transmit Channel | Frequency (GHz) |
|---|---|
| Channel 1 (Lower Channel) | 2.412 |
| Channel 6 (Middle Channel) | 2.437 |
| Channel 11 (upper Channel) | 2.462 |

## 1.5 Deviations from the Standard

Nil.

## 1.6 EUT Modification Record

No modifications were made.

PSB Singapore

### 1.7 Test Location(s)

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,
15 International Business Park #01-01, Singapore 609937

### 1.8 Test Facilities Registrations

| Requirements | Registration Numbers |
|---|---|
| FCC | 994109 (Test Firm Registration Number)<br>SG0002 (Designation Number) |
| ISED | SGAP01 (CAB Identifier)<br><br>Science Park<br>2932I-1 (3m and 10m Semi-Anechoic Chamber)<br><br>International Business Park<br>2932N-1 (10m Semi-Anechoic Chamber) |
| VCCI | Science Park<br>R-1335 (10m ANC)<br>C-2306 (C.E @ Lab 3)<br>T-1471 (Telecom Ports @ Lab 3)<br><br>International Business Park<br>R-3324 (10m ANC), G-10203 (10mANC)<br>C-4933 (C.E @ CEIBP)<br>T-2403 (Telecom Ports @ CEIBP) |
| BSMI | SL2-IS-E-6001R *[CNS-13803 (ISM Equipment)]*<br>SL2-IN-E-6001R *[CNS-13438 (IT Equipment)]*<br>SL2-R1/R2-E-6001R *[CNS-13439 (Broadcast Receivers)]*<br>SL2-A1-E-6001R *[CNS-13783-1 (Household Appliances)]*<br>SL2-L1-E-6001R *[CNS-14115 (Lighting Equipment)]* |
| SABS | SABS/A-LAB/0029/2018 |

PSB Singapore

## 1.9 Supporting Equipment

| Equipment Description (Including Brand Name) | Model, Serial & FCC ID Number | Cable Description (List Length, Type & Purpose) |
|---|---|---|
| GW Laboratory DC Power Supply | M/N: GPS-3030D<br>S/N: 8120428<br>FCC ID: Nil | 1.80 m unshielded power cable |

PSB Singapore

# 2 Test Details

## 2.1 Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)

### 2.1.1 Test 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. | |

**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 | | | | | | | | | |

PSB Singapore

### 2.1.2 Test Setup

2.1.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.1.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

2.1.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

### 2.1.3 Test Method

2.1.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.1.3.2 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.

2.1.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. 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

2.1.3.4 A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz.For frequency point in range of 9kHz – 90kHz, 110kHz – 49k0kHz and above 1GHz, both Peak and Average measurements were carried out.

2.1.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

2.1.3.6 The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10$^{th}$ 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 dBμV/m |
| Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB<br>Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/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 |

PSB Singapore

### 2.2.5 Test Results

| | | | |
|---|---|---|---|
| Test Input Power | 3.6Vdc | Temperature | 23ºC |
| Test Distance | 3m (30MHz – 25GHz) | Relative Humidity | 55% |
| Data Rate | 802.11g @ 6Mbps (Worst) | Atmospheric Pressure | 1029mbar |
| | | Tested By | Chelmin Li<br>Dylan Lin |
| | | Test Date | 23 Feb 2020 |

Spurious Emissions ranging from 30MHz – 1GHz

| Frequency (MHz) | Q-P Value (dBµV/m) | Q-P Limit (dBµV/m) | Q-P Margin (dB) | Height (cm) | Azimuth (Degrees) | Pol (H/V) | Channel |
|---|---|---|---|---|---|---|---|
| 32.2150 | 20.3 | 40.0 | 19.7 | 100 | 301 | V | 11 |
| 38.6840 | 17.8 | 40.0 | 22.2 | 400 | 38 | V | 11 |
| 43.6690 | 11.3 | 40.0 | 28.7 | 193 | 49 | V | 11 |
| 49.3740 | 9.9 | 40.0 | 30.1 | 100 | 151 | V | 11 |
| 49.5220 | 10.4 | 40.0 | 29.6 | 100 | 40 | V | 11 |
| 94.9920 | 19.7 | 43.5 | 23.8 | 100 | 157 | H | 11 |

Spurious Emissions above 1GHz – 25GHz

| Freq (GHz) | Peak Value (dBµV/m) | Peak Limit (dBµV/m) | Peak Margin (dB) | AV Value (dBµV/m) | AV Limit (dBµV/m) | AV Margin (dB) | Height (cm) | Azimuth (Degrees) | Pol (H/V) | Ch |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.9122 | 48.0 | 74.0 | 26.0 | -- | 54.0 | 6.0 | 101 | 216 | V | 1 |
| 2.1078 | 48.2 | 74.0 | 25.8 | -- | 54.0 | 5.8 | 101 | 157 | V | 1 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

PSB Singapore

Spurious Emissions above 1GHz – 25GHz

| Freq (GHz) | Peak Value (dBµV/m) | Peak Limit (dBµV/m) | Peak Margin (dB) | AV Value (dBµV/m) | AV Limit (dBµV/m) | AV Margin (dB) | Height (cm) | Azimuth (Degrees) | Pol (H/V) | Ch |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.0745 | 48.3 | 74.0 | 25.7 | -- | 54.0 | 5.7 | 101 | 5 | H | 6 |
| 2.0916 | 48.3 | 74.0 | 25.7 | -- | 54.0 | 5.7 | 101 | 50 | H | 6 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

Spurious Emissions above 1GHz – 25GHz

| Freq (GHz) | Peak Value (dBµV/m) | Peak Limit (dBµV/m) | Peak Margin (dB) | AV Value (dBµV/m) | AV Limit (dBµV/m) | AV Margin (dB) | Height (cm) | Azimuth (Degrees) | Pol (H/V) | Ch |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.9550 | 48.5 | 74.0 | 25.5 | -- | 54.0 | 5.5 | 101 | 59 | H | 11 |
| 2.1034 | 48.0 | 74.0 | 26.0 | -- | 54.0 | 6.0 | 101 | 84 | V | 11 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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. | As the measured peak shows compliance to the average limit, as such no average measurement was required. |
| 3. | The average margin indicates the margin of the measured peak value below the average limit. |
| 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:<br>30MHz - 1GHz<br>RBW: 120kHz VBW: 1MHz<br>>1GHz<br>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. |

PSB Singapore

## 2.2 Band Edge Compliance (Radiated)

### 2.2.1 Test Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands shall comply to the radiated emission limits specified in 15.209.

### 2.2.2 Test Setup

2.2.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.2.2.2 The power supply for the EUT was connected to a filtered mains.

2.2.2.3 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz to show compliance of spurious at band edges are at least 20dB below the carriers. For restricted band spurious at band edges, peak and average measurement plots were taken using the following setting:

a. Peak Plot:
RBW = 1MHz, VBW = 3RBW
b. Average Plot
RBW = 1MHz, VBW = 10Hz

2.2.2.4 All other supporting equipment were powered separately from another filtered mains.

### 2.2.3 Test Method

2.2.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode.

2.2.3.2 The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge.

2.2.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

2.2.3.4 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.2.3.5 The measurements were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

PSB Singapore

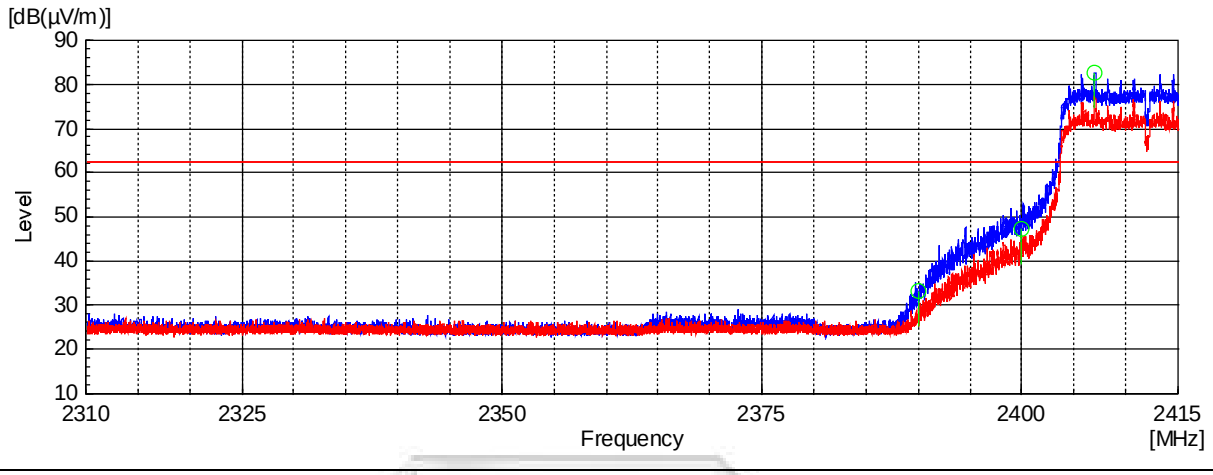
### 2.2.4 Test Results

| | | | |
|---|---|---|---|
| Test Input Power | 3.6Vdc | Temperature | 23°C |
| Attached Plots | 1 – 6 | Relative Humidity | 55% |
| | 802.11g @ 6Mbps (Worst) | Atmospheric Pressure | 1029mbar |
| | | Tested By | Li Chaoming<br>Dylan Lin |
| | | Test Date | 23 Feb 2020 |

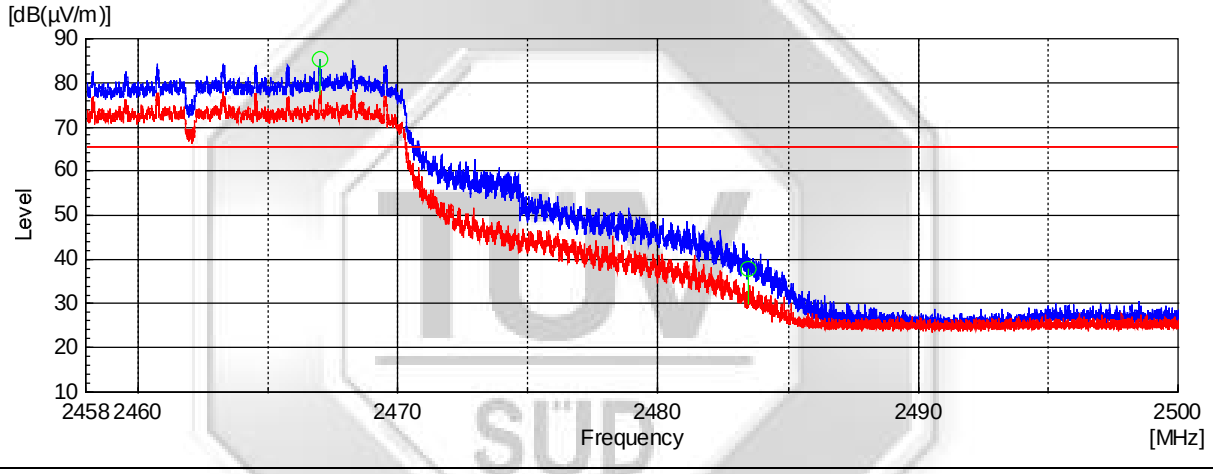
No significant signal was found and they were below the specified limit.

PSB Singapore

**Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge)**



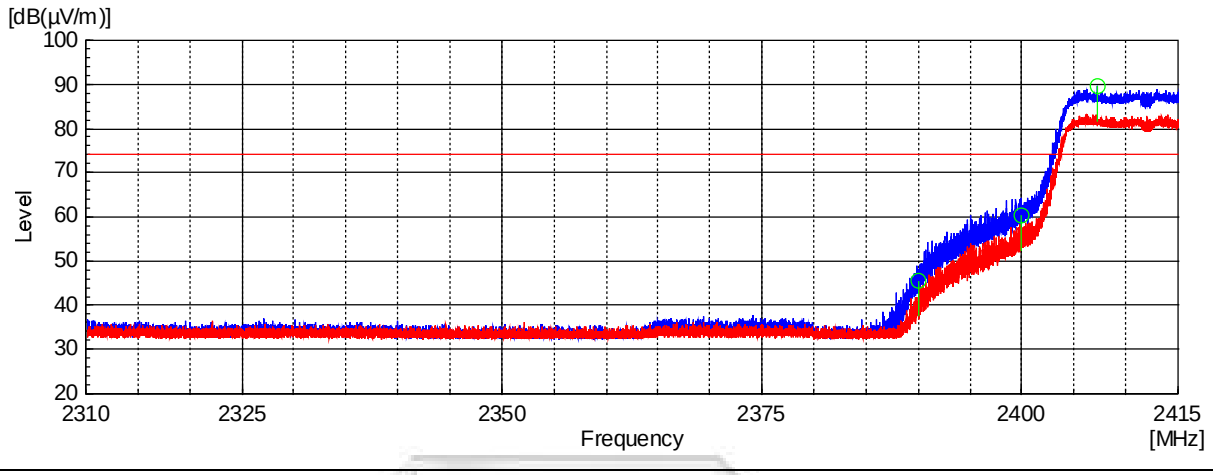

**Plot 1 – Lower Band Edge at 2.4000GHz**



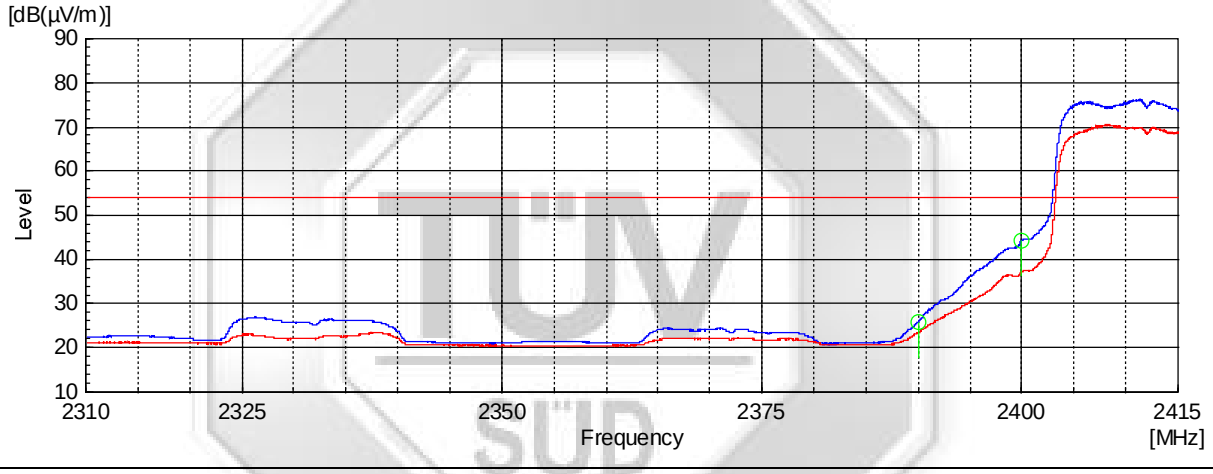

**Plot 2 – Upper Band Edge at 2.4835GHz**

PSB Singapore

**Band Edge Compliance (Radiated) Plots (Restricted Band)**



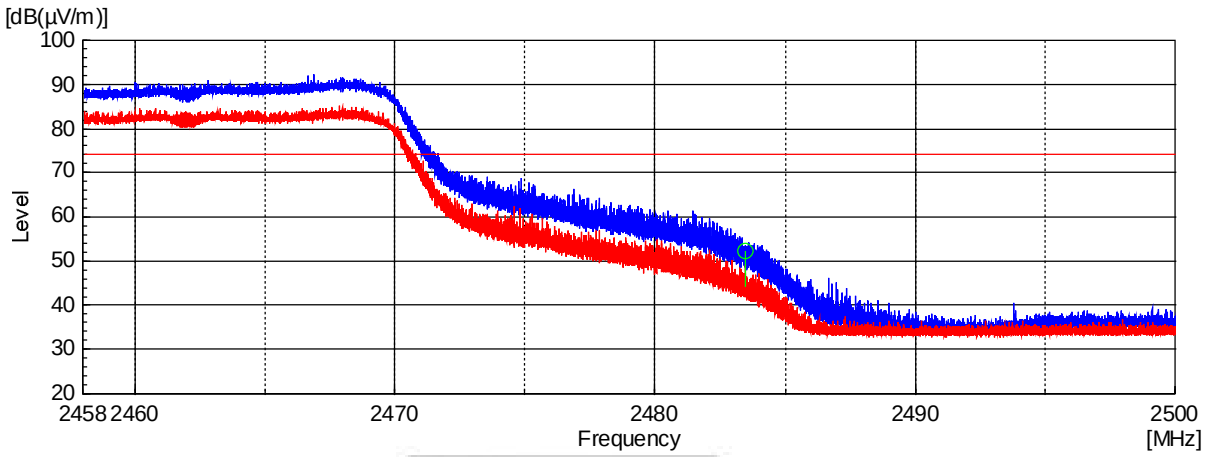

**Plot 3 – Peak Plot at Lower Band Edge at 2.4000GHz**



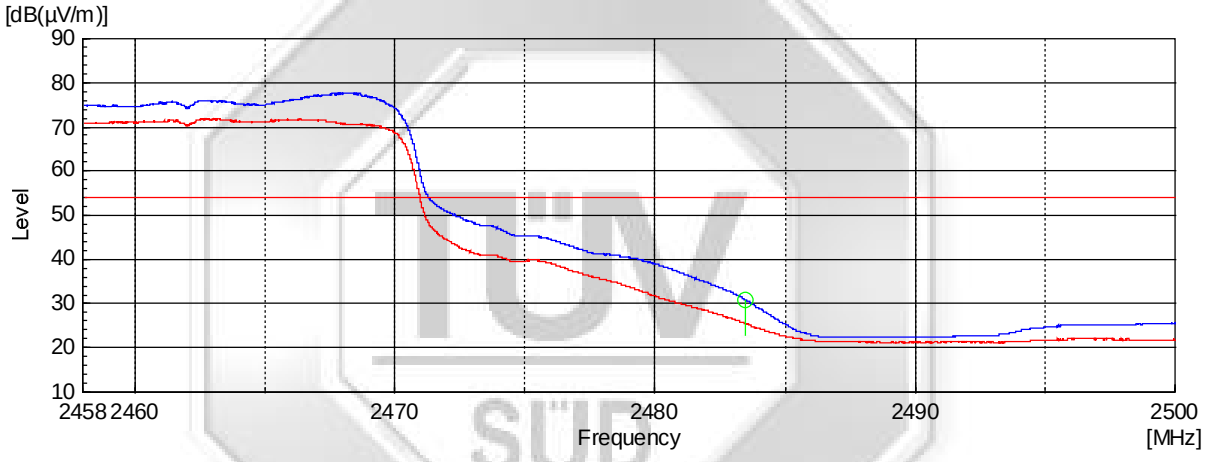

**Plot 4 – Average Plot at Lower Band Edge at 2.4000GHz**

PSB Singapore

**Band Edge Compliance (Radiated) Plots (Restricted Band)**




**Plot 5 – Peak Plot at Upper Band Edge at 2.4835GHz**




**Plot 6 – Average Plot at Upper Band Edge at 2.4835GHz**

PSB Singapore

## 2.3 Maximum Permissible Exposure (MPE)

### 2.3.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density ($mW/cm^2$) | Average Time (min) |
|---|---|---|---|---|
| 0.3 - 1.34 | 614 | 1.63 | 100 Note 2 | 30 |
| 1.34 - 30 | 824 / f | 2.19 / f | 180 / $f^2$ Note 2 | 30 |
| 30 - 300 | 27.5 | 0.073 | 0.2 | 30 |
| 300 - 1500 | - | - | f / 1500 | 30 |
| 1500 - 100000 | - | - | 1.0 | 30 |
| Notes | | | | |
| 1. f = frequency in MHz | | | | |
| 2. Plane wave equivalent power density | | | | |

PSB Singapore

### 2.3.2 Test Setup

2.3.2.1 The EUT and supporting equipment were set up as shown on the setup photo.

2.3.2.2 The relevant field probe was positioned at least 20cm away from the EUT and supporting equipment boundary.

### 2.3.3 Test Method

2.3.3.1 . The EUT was switched on and allowed to warm up to its normal operating condition.

2.3.3.2 The test was first carried out at one of the positions / sides of the EUT.

2.3.3.3 Power density measurement ($mW/cm^2$) was made using the field meter set to the required averaging time.

2.3.3.4 Measurements were repeated for the next position and its associate EUT operating mode, until all possible positions and modes were measured.

**Sample Calculation Example**

| |
|---|
| At 2400 MHz, limit = 1.0 $mW/cm^2$ |
| Power density reading obtained directly from field meter = 0.3 $mW/cm^2$ averaged over the required 30 minutes. |
| Therefore, margin = 0.3 – 1.0 = -0.7 $mW/cm^2$ i.e. 0.7 $mW/cm^2$ below limit |

PSB Singapore

### 2.3.4 Test Results

| | | | |
|---|---|---|---|
| Test Input Power | 3.6Vdc Battery Operated | Temperature | 20°C |
| Test Distance | 20cm | Relative Humidity | 55% |
| Data Rate | 802.11g @ 6Mbps (Worst) | Atmospheric Pressure | 1029mbar |
| | | Tested By | Chang Wai Kit |
| | | Test Date | 17 Mar 2020 |

| Channel | Channel Frequency (GHz) | Power Density Value ($mW/cm^2$) | Margin ($mW/cm^2$) | Averaging Time (min) | Limit ($mW/cm^2$) |
|---|---|---|---|---|---|
| Lower | 2.412 | 0.0064 | 0.9936 | 30 | 1.0 |
| Middle | 2.437 | 0.0061 | 0.9939 | 30 | 1.0 |
| Upper | 2.462 | 0.0063 | 0.9937 | 30 | 1.0 |

Notes

| | |
|---|---|
| 1. | All possible modes of operation were investigated. Only the worst case highest radiation levels were measured. Measurements were taken at the required averaging time. All other radiation levels were relatively insignificant. |
| 2. | A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL. |

PSB Singapore

# 4 Test Equipment

| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| *Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)* | | | |
| R&S EMI Test Receiver | ESW44 | 101661 | 30 May 2020 |
| Schaffner Bilog Antenna (30MHz-2GHz) | CBL6112B | 2597 | 27 Jun 2020 |
| Com-Power Preamplifier (1MHz-1GHz) | PAM-103 | 441056 | 07 May 2020 |
| Electro-Metrics Horn Antenna(1GHz-18GHz) | EM-6961 | 6553 | 18 Nov 2020 |
| R&S Preamplifier (1GHz -18GHz) | SCU18 | 102191 | 15 Jan 2021 |
| ETS Horn Antenna (18GHz-40GHz) | 3116 | 0004-2474 | 07 Jul 2020 |
| Agilent Preamplifier (1GHz-26.5GHz) | 8449D | 3008A02305 | 26 Sep 2020 |
| Toyo Preamplifier (26.5GHz-40GHz) | HAP26-40W | 00000005 | 07 Jul 2020 |
| Micro-tronics Bandstop Filter (2.4GHz) | BRM50701-02 | 007 | 13 Aug 2020 |
| | | | |
| *Band Edge Compliance (Radiated)* | | | |
| R&S EMI Test Receiver | ESW44 | 101661 | 30 May 2020 |
| Electro-Metrics Horn Antenna(1GHz-18GHz) | EM-6961 | 6553 | 18 Nov 2020 |
| R&S Preamplifier (1GHz -18GHz) | SCU18 | 102191 | 15 Jan 2021 |
| | | | |
| *Maximum Permissible Exposure* | | | |
| PMM 8053 Portable Field Meter | 8053 | 0220J10308 | 07 Mar 2021 |
| PMM Electric Field Probe | EP330 | 1010J10301 | 27 Mar 2021 |

PSB Singapore

# 5 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.

| Test Name | Measurement Uncertainty |
|---|---|
| Conducted Emissions | 9kHz to 30MHz, ±2.4dB |
| Radiated Emissions | 9kHz to 30MHz @ 10m, ±2.3dB<br>30MHz to 1GHz @ 10m, ±4.0dB<br>30MHz to 1GHz @ 3m, ±5.6dB<br>>1GHz to 40GHz @3m, ±5.0dB |
| Maximum Permissible Exposure | 0.1MHz – 3GHz is ±15.0% |

PSB Singapore

Please note that this Report is issued under the following terms :

1. This report applies to the sample of the specific product/equipment given at the time of its testing/calibration. The results are not used to indicate or imply that they are applicable to other similar items. In addition, such results must not be used to indicate or imply that TÜV SÜD PSB approves, recommends or endorses the manufacturer, supplier or user of such product/equipment, or that TÜV SÜD PSB in any way "guarantees" the later performance of the product/equipment. Unless otherwise stated in this report, no tests were conducted to determine long term effects of using the specific product/equipment.

2. The sample/s mentioned in this report is/are submitted/supplied/manufactured by the Client. TÜV SÜD PSB therefore assumes no responsibility for the accuracy of information on the brand name, model number, origin of manufacture, consignment or any information supplied.

3. Nothing in this report shall be interpreted to mean that TÜV SÜD PSB has verified or ascertained any endorsement or marks from any other testing authority or bodies that may be found on that sample.

4. This report shall not be reproduced wholly or in parts and no reference shall be made by the Client to TÜV SÜD PSB or to the report or results furnished by TÜV SÜD PSB in any advertisements or sales promotion.

5. Unless otherwise stated, the tests were carried out in TÜV SÜD PSB Pte Ltd, No.1 Science Park Drive Singapore 118221.

July 2011

PSB Singapore

**End of the Test Report**