



**DATE: 4 November 2020**

**I.T.L. (PRODUCT TESTING) LTD.  
FCC Radio Test Report  
for  
WaterIO LTD**

**Equipment under test:  
Smart VIP Data Logger**

**VIPDLOG**

Tested by:

M. Zohar

Approved by:

D. Shidlowsky

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## Measurement/Technical Report for WaterIO LTD

### Smart VIP Data Logger

## VIPDLOG

### FCC ID: 2AWPF-SMLOG

|                       |                                                          |
|-----------------------|----------------------------------------------------------|
| This report concerns: | Original Grant: X<br>Class I Change:<br>Class II Change: |
| Equipment type:       | FCC: (DTS) Digital Transmission System                   |
| Limits used:          | 47CFR15 Section 15.247                                   |

Measurement procedure used is KDB 558074 D01 v05r01, ANSI C63.10:2013 and RSS-Gen, Issue 5, April 2018

Application for Certification  
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# 1. General Information

## 1.1 Administrative Information

|                                |                                                                                                         |
|--------------------------------|---------------------------------------------------------------------------------------------------------|
| Manufacturer:                  | WaterIO LTD                                                                                             |
| Manufacturer's Address:        | 2 Bergman St. (Entrance A), 2nd floor.<br>Rehovot, Park Hamada 7670503, Israel.<br>Tel: +972-52-8333126 |
| Manufacturer's Representative: | Amir Salhuv                                                                                             |
| Equipment Under Test (E.U.T):  | Smart VIP Data Logger                                                                                   |
| Equipment PMN:                 | VIPDLOG                                                                                                 |
| Equipment Serial No.:          | Not designated                                                                                          |
| Date of Receipt of E.U.T:      | June 22, 2020                                                                                           |
| Start of Test:                 | June 22, 2020                                                                                           |
| End of Test:                   | June 29, 2020                                                                                           |
| Test Laboratory Location:      | I.T.L (Product Testing) Ltd.<br>1 Batsheva St.,<br>Lod<br>ISRAEL 7120101                                |
| Test Specifications:           | FCC Part 15, Subpart C                                                                                  |



## **1.2 List of Accreditations**

The EMC laboratory of I.T.L. is accredited by the following bodies:

1. The American Association for Laboratory Accreditation (A2LA) (U.S.A.), Certificate No. 1152.01.
2. The Federal Communications Commission (FCC) (U.S.A.), FCC Designation No. IL1005.
3. The Israel Ministry of the Environment (Israel), Registration No. 1104/01.
4. Department of Innovation, Science and Economic Development (ISED) Canada, CAB identifier: IL1002

I.T.L. Product Testing Ltd. is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this test report have been determined in accordance with I.T.L.'s terms of accreditation unless stated otherwise in the report.

### 1.3 **Product Description**

Smart Sensor logger is a smart, power consumption optimized logger for pressure, temperature and relative humidity.

It utilizes BLE technology for communicating the data to dedicated Application, which connect upon a user action.

The smart VIP data logger is a BLE powered logger encapsulating an accurate Temperature, relative humidity and pressure sensors.

The sensor measures every user-predefined time (defaults to one hour) these values, and save into a data log.

For log download, user can place a magnet to the sensor in a close proximity, which will start BLE advertise as a result. Once the user opens the dedicated Smartphone App, Log data will be downloaded to the Application, and the sensor will return to sleep.

|                           |                         |
|---------------------------|-------------------------|
| Working voltage           | 3.0VDC battery operated |
| Mode of operation         | BLE Transceiver         |
| Modulations               | GFSK                    |
| Assigned Frequency Range  | 2400.0-2483.5MHz        |
| Operating Frequency Range | 2402.0-2480.0MHz        |
| Transmit power(conducted) | ~3.0dBm                 |
| Antenna Gain              | +4.5dBi trace antenna   |
| Modulation BW             | 2MHz                    |
| Bit rate (Mbit/s)         | 1,2,3                   |

### 1.4 **Test Methodology**

Both conducted and radiated testing was performed according to the procedures in KDB 558074 D01 v05r01, ANSI C63.10: 2013. Radiated testing was performed at an antenna to EUT distance of 3 meters.

### 1.5 **Test Facility**

Emissions tests were performed at I.T.L.'s testing facility in Lod, Israel. I.T.L.'s EMC Laboratory is accredited by A2LA, certificate No. 1152.01 and its FCC Designation Number is IL1005.

### 1.6 **Measurement Uncertainty**

#### **Conducted Emission**

Conducted Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4)

0.15 – 30 MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 3.44 dB



### **Radiated Emission**

Radiated Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4)  
for open site:

30-1000MHz:

Expanded Uncertainty (95% Confidence, K=2):  
 $\pm 4.96$  dB

1 GHz to 6 GHz

Expanded Uncertainty (95% Confidence, K=2):  
 $\pm 5.19$  dB

>6 GHz

Expanded Uncertainty (95% Confidence, K=2):  
 $\pm 5.51$  dB

## 2. System Test Configuration

### 2.1 Justification

1. The E.U.T contains an IEEE 802.15.1 standard (BLE) transceiver.
2. The unit was evaluated while transmitting at the low channel (2402MHz), the mid channel (2440MHz) and the high channel (2480MHz).
3. Conducted emission tests were performed with the E.U.T. antenna terminal connected by a RF cable to the Spectrum Analyzer through a 20dB external attenuator.
4. Final radiated emission tests were performed after exploratory emission testing that was performed in 3 orthogonal polarities to determine the “worst case” radiation.
5. According to the below results, worst case was the Y-axis.

| Orientation | Frequency | 2 <sup>nd</sup> Harmonic | 3 <sup>rd</sup> Harmonic | Band Edge |
|-------------|-----------|--------------------------|--------------------------|-----------|
|             | (MHz)     | (dBuV/m)                 | (dBuV/m)                 | (dBuV/m)  |
| X axis      | 2402.0    | 52.1                     | 60.2                     | 65.3      |
|             | 2440.0    | 52.4                     | 56.5                     | -         |
|             | 2480.0    | 52.0                     | 58.0                     | 65.1      |
| Y axis      | 2402.0    | 52.9                     | 60.8                     | 66.1      |
|             | 2440.0    | 52.8                     | 57.3                     | -         |
|             | 2480.0    | 53.1                     | 58.7                     | 70.0      |
| Z axis      | 2402.0    | 51.9                     | 58.8                     | 63.3      |
|             | 2440.0    | 51.1                     | 55.6                     | -         |
|             | 2480.0    | 49.6                     | 56.2                     | 68.1      |

Figure 1. Screening Results

### 2.2 EUT Exercise Software

No special exercise software was used.

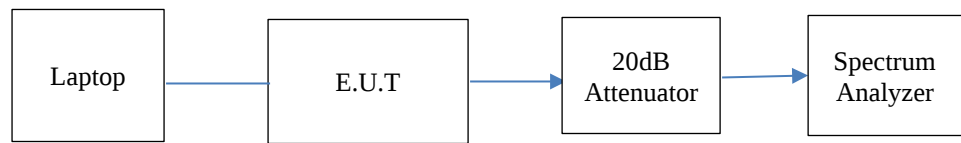
### 2.3 Special Accessories

No special accessories were used.

### 2.4 Equipment Modifications

No modifications were necessary in order to achieve compliance.

## 2.5 Configuration of Tested System



**Figure 2. Configuration of Tested System Conducted**



**Figure 3. Configuration of Tested System Radiated**

### 3. Conducted & Radiated Measurement Test Set-Up Photos

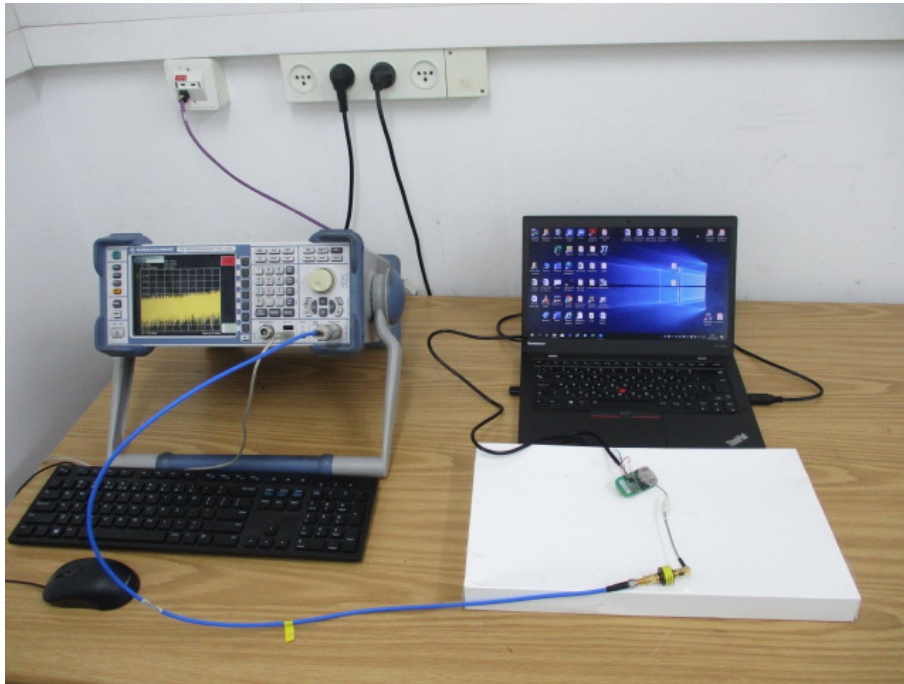


Figure 4. Conducted Test Set Up

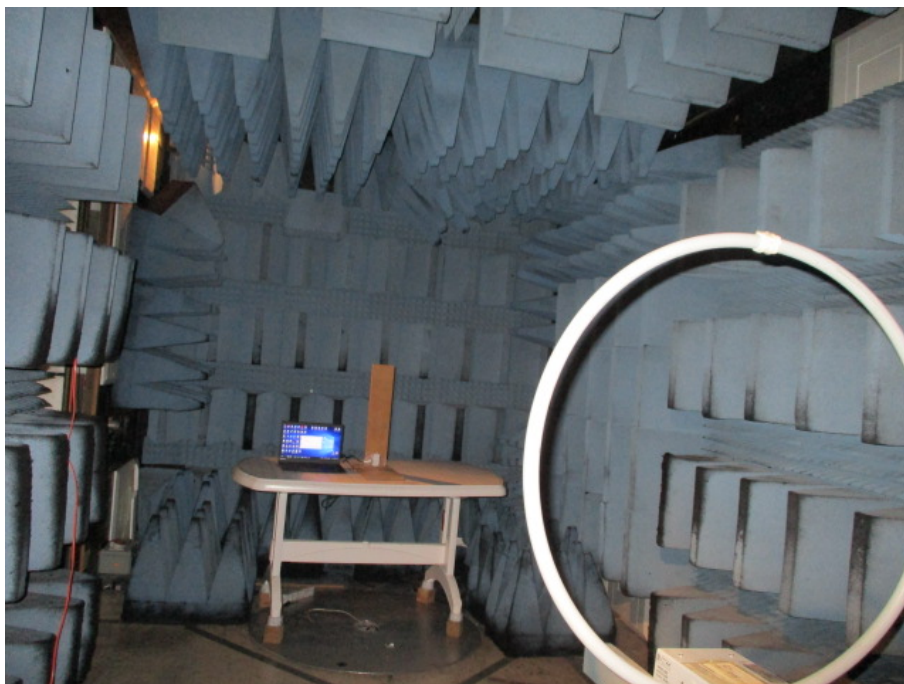


Figure 5. Radiated Emission Test, 0.009-30MHz



**Figure 6. Radiated Emission Test, 30-200MHz**



**Figure 7. Radiated Emission Test, 200-1000MHz**



**Figure 8. Radiated Emission Test, 1-18GHz**



**Figure 9. Radiated Emission Test, 18-25.0GHz**

## 4. 6 dB Minimum Bandwidth

### 4.1 Test Specification

FCC Part 15, Subpart C, Section 247(a)(2)

### 4.2 Test Procedure

(Temperature (22°C)/ Humidity (61%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss=22.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The spectrum bandwidth of the E.U.T. at the point of 6 dB below maximum peak power was measured and recorded. The RBW was set to 100 kHz.

### 4.3 Test Limit

Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 4.4 Test Results

| Protocol Type | Operation Frequency | Reading | Limit  |
|---------------|---------------------|---------|--------|
|               | (MHz)               | (kHz)   | (kHz)  |
| BLE           | 2402.0              | 709.0   | >500.0 |
|               | 2440.0              | 719.0   | >500.0 |
|               | 2480.0              | 709.0   | >500.0 |

Figure 10 6 dB Minimum Bandwidth

JUDGEMENT: Passed

For additional information, see *Figure 11* to *Figure 13*.

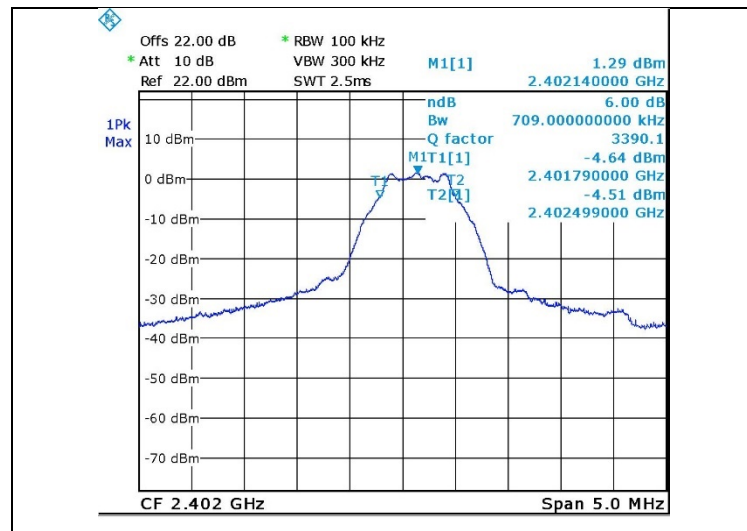


Figure 11. 2402.0 MHz, BLE

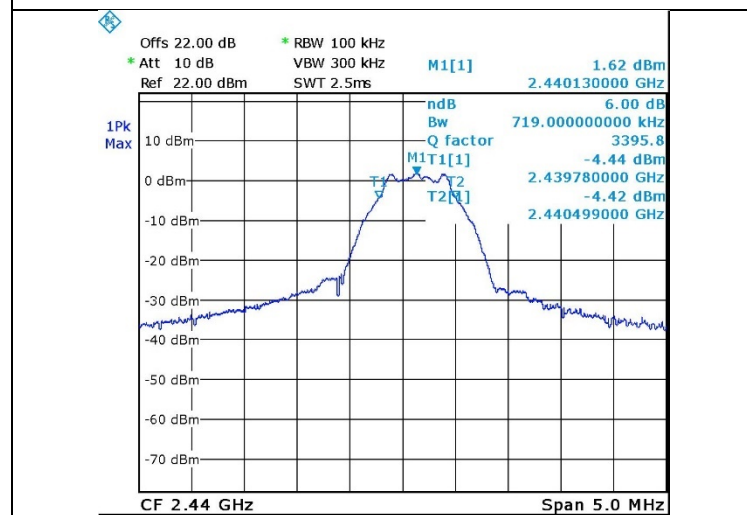


Figure 12. 2440.0 MHz, BLE

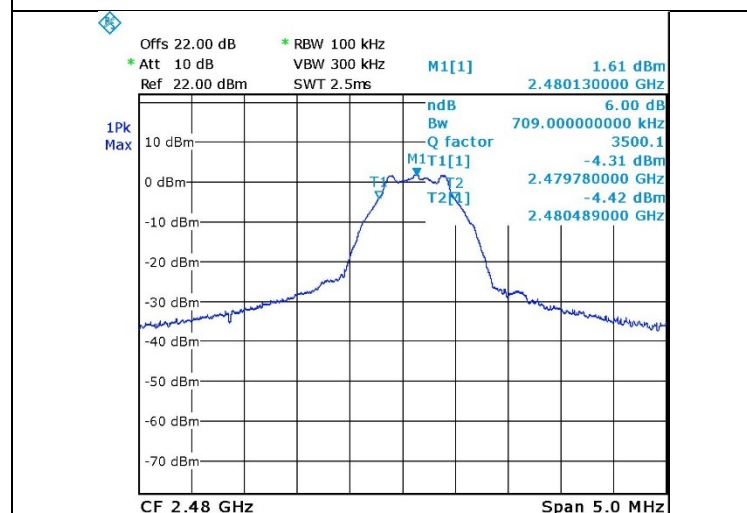


Figure 13. 2480.0 MHz, BLE



#### 4.5 Test Equipment Used; 6dB Bandwidth

| Instrument        | Manufacturer | Model         | Serial No. | Last Calibration Date | Next Calibration Due |
|-------------------|--------------|---------------|------------|-----------------------|----------------------|
| Spectrum Analyzer | R&S          | FSL6          | 100194     | March 10, 2020        | March 31, 2021       |
| 20dB Attenuator   | MCL          | VAT-20W2+     | 848        | December 24, 2018     | December 31, 2020    |
| RF Cable          | EIM          | 705A009301EIM | -          | June 1, 2020          | June 30, 2021        |

Figure 14 Test Equipment Used

## 5. Maximum Conducted Output Power

### 5.1 Test Specification

FCC, Part 15, Subpart C, Section 247(b)(3)

### 5.2 Test Procedure

(Temperature (22°C)/ Humidity (61%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss=22.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

### 5.3 Test Limit

The maximum peak conducted output power of the intentional radiator for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

### 5.4 Test Results

| Protocol Type | Operation Frequency | Power | Power | Limit  | Margin |
|---------------|---------------------|-------|-------|--------|--------|
|               | (MHz)               | (dBm) | (mW)  | (mW)   | (mW)   |
| BLE           | 2402.0              | 2.0   | 1.6   | 1000.0 | -998.4 |
|               | 2440.0              | 2.3   | 1.7   | 1000.0 | -998.3 |
|               | 2480.0              | 2.3   | 1.7   | 1000.0 | -998.3 |

Figure 15 Maximum Peak Power Output

JUDGEMENT: Passed by 998.3 mW

For additional information, see Figure 16 to Figure 18.

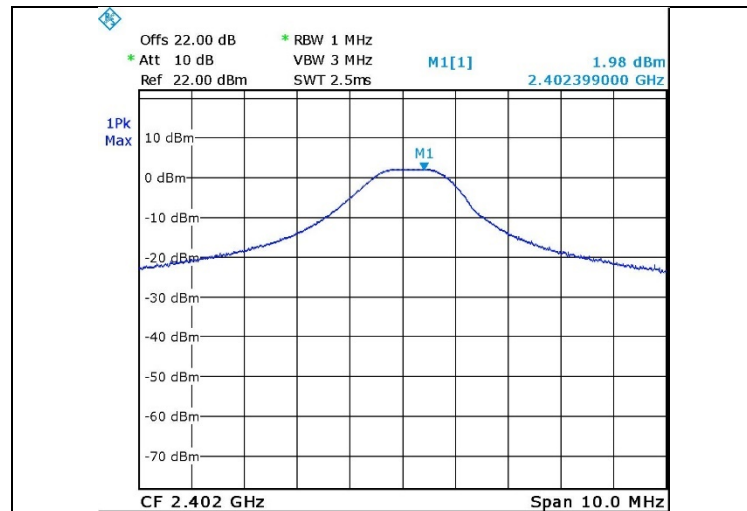


Figure 16. 2402.0 MHz, BLE

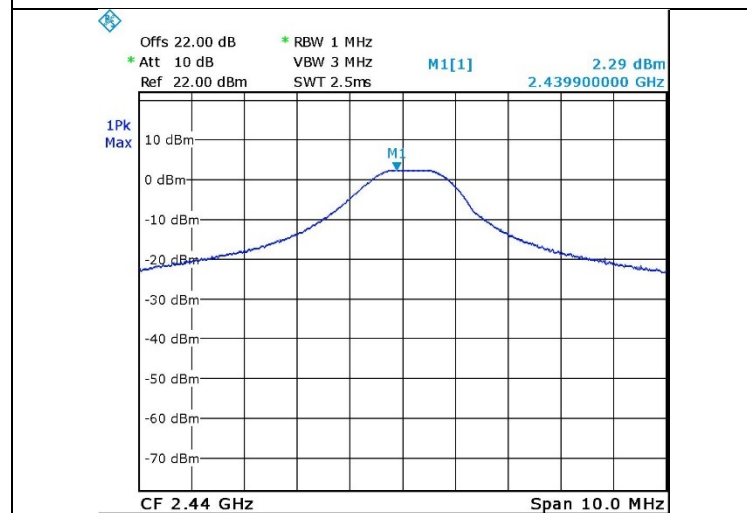


Figure 17. 2440.0 MHz, BLE

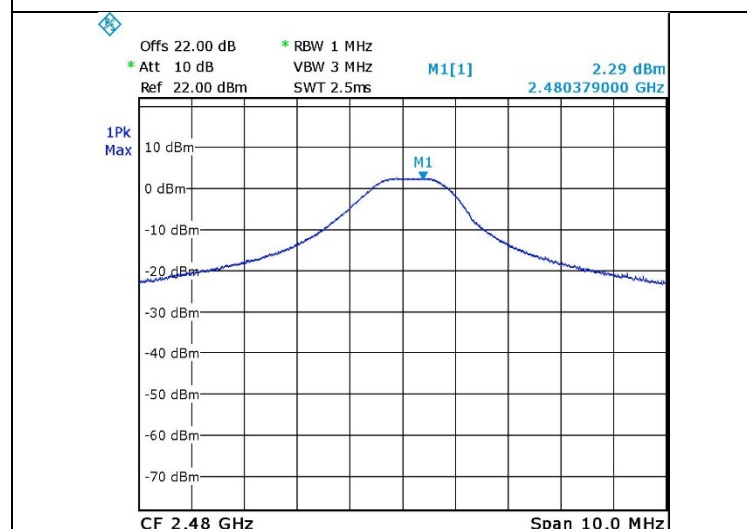


Figure 18. 2480.0 MHz, BLE



### 5.5 Test Equipment Used; Maximum Peak Power Output

| Instrument        | Manufacturer | Model         | Serial No. | Last Calibration Date | Next Calibration Due |
|-------------------|--------------|---------------|------------|-----------------------|----------------------|
| Spectrum Analyzer | R&S          | FSL6          | 100194     | March 10, 2020        | March 31, 2021       |
| 20dB Attenuator   | MCL          | VAT-20W2+     | 848        | December 24, 2018     | December 31, 2020    |
| RF Cable          | EIM          | 705A009301EIM | -          | June 1, 2020          | June 30, 2021        |

Figure 19 Test Equipment Used

## 6. Band Edge Spectrum

### 6.1 Test Specification

FCC, Part 15, Subpart C, Section 247(d)

### 6.2 Test Procedure

(Temperature (20°C)/ Humidity (59%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (loss=22.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The RBW was set to 100 kHz.

### 6.3 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

### 6.4 Test Results

| Protocol Type | Operation Frequency | Band Edge Frequency | Spectrum Level | Limit | Margin |
|---------------|---------------------|---------------------|----------------|-------|--------|
|               | (MHz)               | (MHz)               | (dBm)          | (dBm) | (dB)   |
| BLE           | 2402.0              | 2400.0              | -35.0          | -18.8 | -16.2  |
|               | 2480.0              | 2483.5              | -39.8          | -18.3 | -21.5  |

Figure 20 Band Edge Spectrum

JUDGEMENT: Passed by 16.2 dB

For additional information, see Figure 21 and Figure 22.

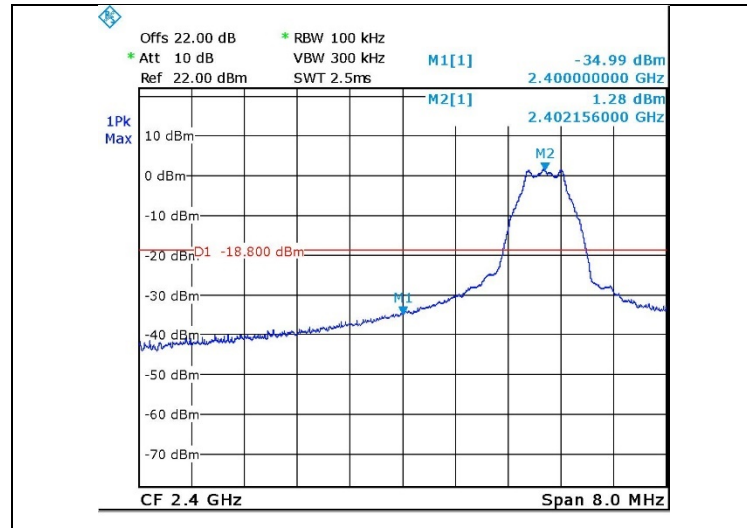


Figure 21. 2402.0 MHz, BLE

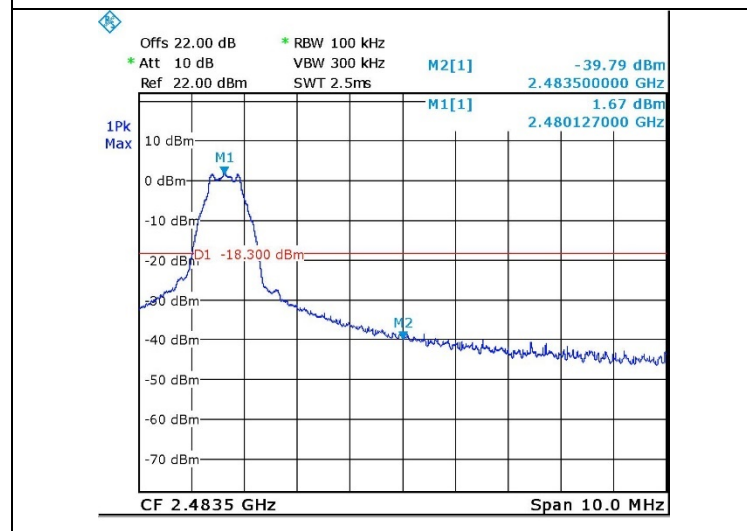


Figure 22. 2480.0 MHz, BLE



## 6.5 Test Equipment Used; Band Edge

| Instrument        | Manufacturer | Model         | Serial No. | Last Calibration Date | Next Calibration Due |
|-------------------|--------------|---------------|------------|-----------------------|----------------------|
| Spectrum Analyzer | R&S          | FSL6          | 100194     | March 10, 2020        | March 31, 2021       |
| 20dB Attenuator   | MCL          | VAT-20W2+     | 848        | December 24, 2018     | December 31, 2020    |
| RF Cable          | EIM          | 705A009301EIM | -          | June 1, 2020          | June 30, 2021        |

Figure 23 Test Equipment Used

## 7. Transmitted Power Density

### 7.1 Test Specification

FCC, Part 15, Subpart C, Section 247(e)

### 7.2 Test Procedure

(Temperature (22°C)/ Humidity (61%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss= 22.0dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The spectrum analyzer was set to 3 kHz RBW.

### 7.3 Test Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

#### 7.4 Test Results

| Protocol Type | Operation Frequency | PSD Reading | Limit | Margin |
|---------------|---------------------|-------------|-------|--------|
|               | (MHz)               | (dBm)       | (dBm) | (dB)   |
| BLE           | 2402.0              | -13.7       | 8.0   | -21.7  |
|               | 2440.0              | -13.6       | 8.0   | -21.6  |
|               | 2480.0              | -13.5       | 8.0   | -21.5  |

Figure 24 Test Results

JUDGEMENT: Passed by 21.5dB

For additional information, see Figure 25 to Figure 27.

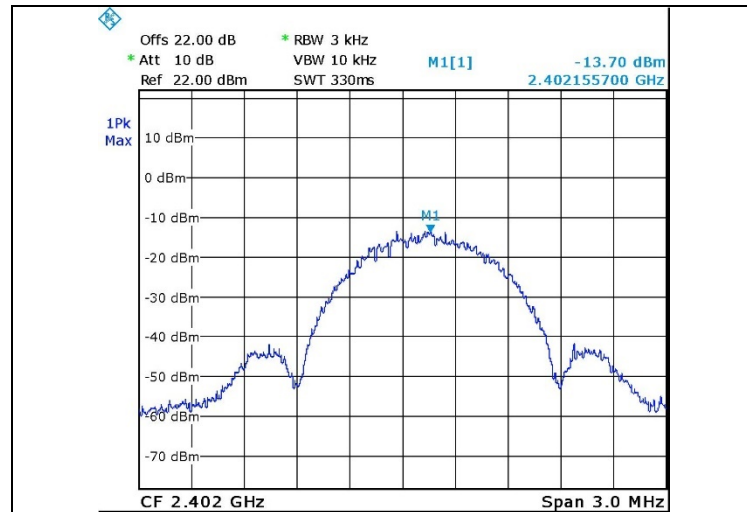


Figure 25. 2402.0 MHz, BLE

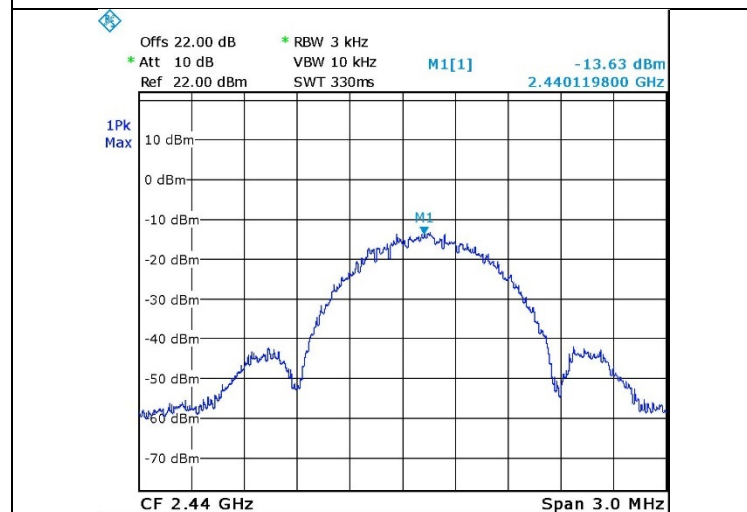


Figure 26. 2440.0 MHz, BLE

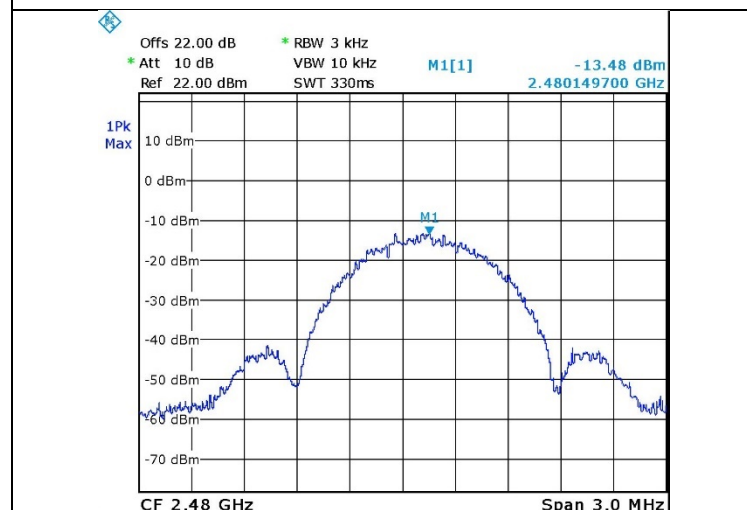


Figure 27. 2480.0 MHz, BLE



## 7.5 Test Equipment Used; Transmitted Power Density

| Instrument        | Manufacturer | Model         | Serial No. | Last Calibration Date | Next Calibration Due |
|-------------------|--------------|---------------|------------|-----------------------|----------------------|
| Spectrum Analyzer | R&S          | FSL6          | 100194     | March 10, 2020        | March 31, 2021       |
| 20dB Attenuator   | MCL          | VAT-20W2+     | 848        | December 24, 2018     | December 31, 2020    |
| RF Cable          | EIM          | 705A009301EIM | -          | June 1, 2020          | June 30, 2021        |

Figure 28 Test Equipment Used

## 8. Occupied Bandwidth

### 8.1 Test Specification

FCC, Part 2, Sub part J, Section 2.1049

### 8.2 Test Procedure

(Temperature (22°C)/ Humidity (61%RH))

The E.U.T. operation mode and test set-up are as described in Section 2 of this report.

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss= 22.0dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The RBW set to the range of 1% to 5% of the OBW.

The span was set between 1.5 to 5 times of the OBW.

99% occupied bandwidth function was set on.

### 8.3 Test Limit

N/A

### 8.4 Test Results

| Protocol Type | Operation Frequency | Reading |
|---------------|---------------------|---------|
|               | (MHz)               | (kHz)   |
| BLE           | 2402.0              | 1.05    |
|               | 2440.0              | 1.05    |
|               | 2480.0              | 1.06    |

Figure 29. Bandwidth Test Results

JUDGEMENT: N/A

See additional information in Figure 30 to Figure 32.

## Occupied Bandwidth

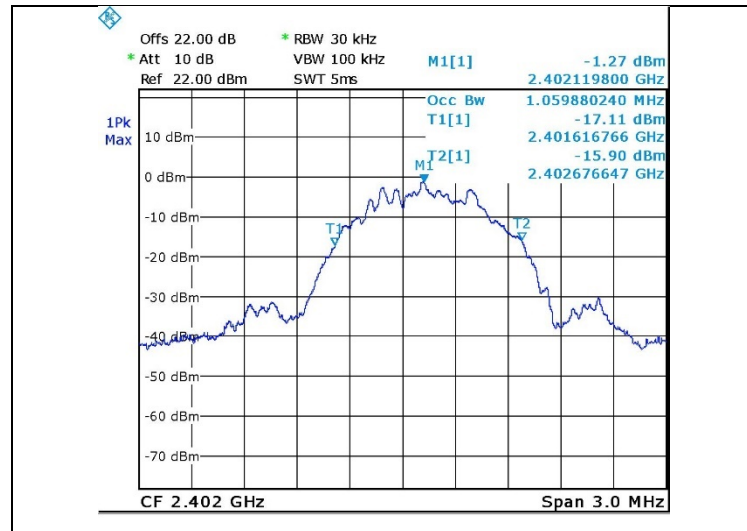


Figure 30. 2402.0 MHz, BLE

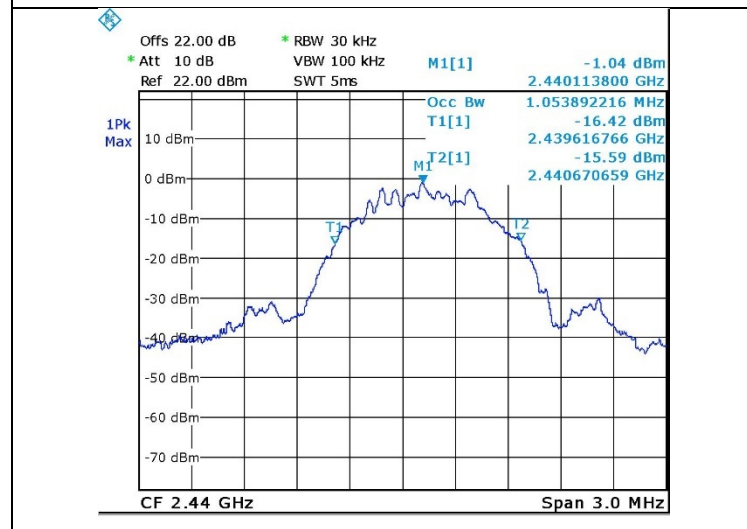


Figure 31. 2440.0 MHz, BLE

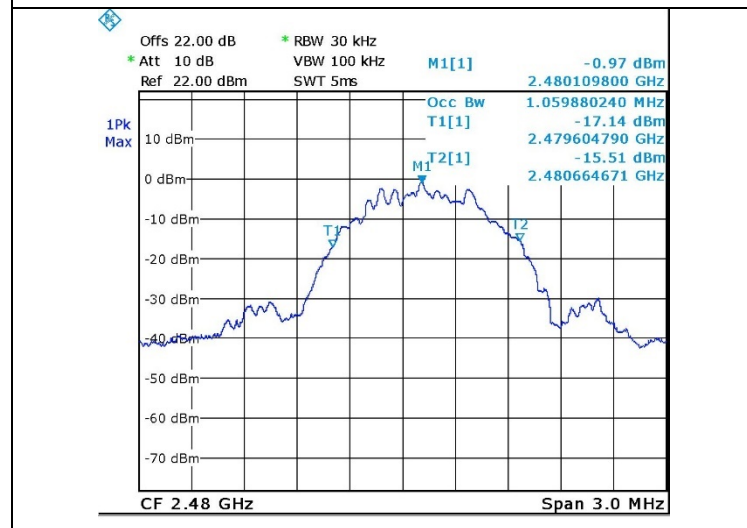


Figure 32. 2480.0 MHz, BLE



### 8.5 Test Equipment Used; Bandwidth

| Instrument        | Manufacturer | Model         | Serial No. | Last Calibration Date | Next Calibration Due |
|-------------------|--------------|---------------|------------|-----------------------|----------------------|
| Spectrum Analyzer | R&S          | FSL6          | 100194     | March 10, 2020        | March 31, 2021       |
| 20dB Attenuator   | MCL          | VAT-20W2+     | 848        | December 24, 2018     | December 31, 2020    |
| RF Cable          | EIM          | 705A009301EIM | -          | June 1, 2020          | June 30, 2021        |

**Figure 33 Test Equipment Used**

## 9. Emissions in Non-Restricted Frequency Bands

### 9.1 Test Specification

FCC, Part 15, Subpart C, Section 247(d)

### 9.2 Test Procedure

(Temperature (21°C)/ Humidity (60%RH))

The E.U.T. operation mode and test set-up are as described in Section 2 of this report.

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (max total loss=24.0 dB).

Special attention was taken to prevent Spectrum Analyzer RF input overload.

RBW was set to 100 kHz, detector set to max peak and trace to “max hold”.

### 9.3 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

### 9.4 Test Results

JUDGEMENT: Passed

The EUT met the requirements of the F.C.C. Part 15, Subpart C, Section 247(d) specification.

For additional information, see *Figure 34* to *Figure 36*.

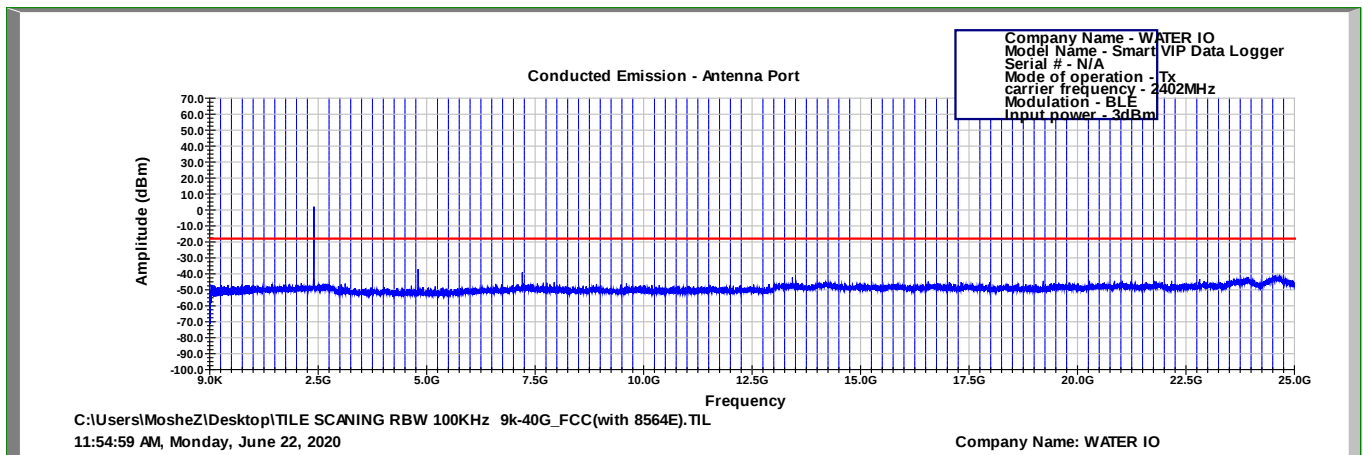


Figure 34 2402.0 MHz, BLE

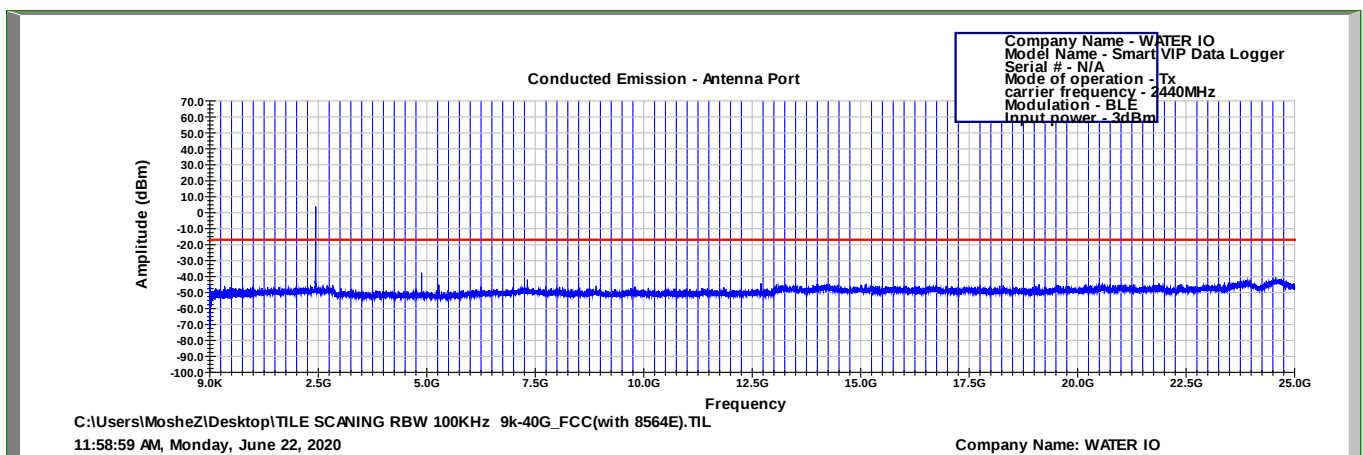


Figure 35 2440.0 MHz, BLE

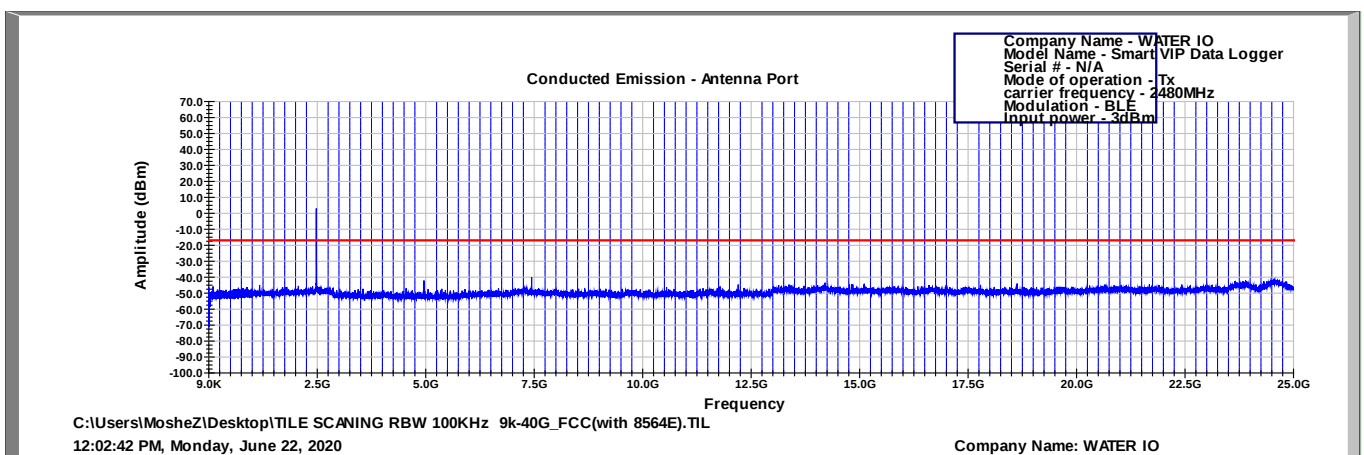


Figure 36 2480.0 MHz, BLE

Note: All peaks in plots are the fundamental transmission frequency.



**9.5 Test Instrumentation Used, Emission in Non Restricted Frequency Bands**

| <b>Instrument</b> | <b>Manufacturer</b> | <b>Model</b>  | <b>Serial No.</b> | <b>Last Calibration Date</b> | <b>Next Calibration Due</b> |
|-------------------|---------------------|---------------|-------------------|------------------------------|-----------------------------|
| Spectrum Analyzer | HP                  | 8564E         | 3442A00275        | March 11, 2020               | March 31, 2021              |
| 20dB Attenuator   | MCL                 | VAT-20W2+     | 848               | December 24, 2018            | December 31, 2020           |
| RF Cable          | EIM                 | 705A009301EIM | -                 | June 1, 2020                 | June 30, 2021               |

**Figure 37 Test Equipment Used**

## 10. Emissions in Restricted Frequency Bands

### 10.1 Test Specification

FCC Part 15, Subpart C, Sections 15.209, 15.205, 15.247(d)

### 10.2 Test Procedure

(Temperature (23°C)/ Humidity (65%RH))

The E.U.T. operation mode and test set-up are as described in Section 2 of this report.

#### **For measurements between 0.009-30MHz:**

The E.U.T was tested inside the shielded room and placed on a non-metallic table, 0.8 meters above the ground. The emissions were measured at a distance of 3 meters. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.

The frequency range 0.009MHz-30MHz was scanned.

#### **For measurements between 30-1000MHz:**

A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The emissions were measured at a distance of 3 meters. The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization. The frequency range 30MHz -1000MHz was scanned and the list of the highest emissions was verified and updated accordingly.

#### **For measurements between 1GHz-25GHz:**

The E.U.T was tested inside the shielded room and placed on a non-metallic table, 1.5 meters above the ground. The emissions were measured at a distance of 3 meters. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.

The frequency range 1GHz -25GHz was scanned.

. The highest radiation describes in the tables below

The levels of the emissions within the frequency ranges of the restricted bands (Section 15.205 of FCC Part 15) were compared to the limits of the table in Section 15.209 (a), General Requirements.

### 10.3 Test Limit

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement distance (meters) | Field Strength* (dBµV/m) | Field Strength* (dBµV/m)@3m |
|-----------------|-----------------------------------|-------------------------------|--------------------------|-----------------------------|
| 0.009-0.490     | 2400/F(kHz)                       | 300                           | 48.5-13.8                | 128.5-73.8                  |
| 0.490-1.705     | 24000/F(kHz)                      | 30                            | 33.8-23.0                | 73.8-63.0                   |
| 1.705-30.0      | 30                                | 30                            | 29.5                     | 69.5                        |
| 30-88           | 100                               | 3                             | 40.0                     | 40.0                        |
| 88-216          | 150                               | 3                             | 43.5                     | 43.5                        |
| 216-960         | 200                               | 3                             | 46.0                     | 46.0                        |
| Above 960       | 500                               | 3                             | 54.0                     | 54.0                        |

\*The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

**Figure 38 Table of Limits**

### 10.4 Test Results

JUDGEMENT: Passed by 2.0 dB

For the operation frequency of 2402 MHz, the margin between the emission level and the specification limit is in the worst case 6.4 dB at the frequency of 7206.0 MHz, vertical polarization.

For the operation frequency of 2440 MHz, the margin between the emission level and the specification limit is in the worst case 8.0 dB at the frequency of 7320.0 MHz, vertical polarization.

For the operation frequency of 2480 MHz, the margin between the emission level and the specification limit is in the worst case 2.0 dB at the frequency of 2483.5 MHz, vertical polarization.

The EUT met the requirements of the F.C.C. Part 15, Subpart C Sections 15.209, 15.205, 15.247(d) specifications.

The details of the highest emissions are given in *Figure 39*.



## Radiated Emission

E.U.T Description Smart VIP Data Logger  
Type VIPDLOG  
Serial Number: Not designated

Specifications: FCC, Part 15, Subpart C, Sections 15.209, 15.205, 15.247(d)

Antenna Polarization: Horizontal/Vertical Frequency Range: 9kHz to 25.0 GHz  
Protocol Type: BLE Detector: Peak, Average

| Operation Frequency | Freq.  | Pol   | Peak Reading | Peak Limit | Peak Margin | Average Reading | Average Limit | Average Margin |
|---------------------|--------|-------|--------------|------------|-------------|-----------------|---------------|----------------|
| (MHz)               | (MHz)  | (H/V) | (dBμV/m)     | (dBμV/m)   | (dB)        | (dBμV/m)        | (dBμV/m)      | (dB)           |
| 2402.0              | 2390.0 | V     | 66.1         | 74.0       | -7.9        | 44.2            | 54.0          | -9.8           |
|                     | 2390.0 | H     | 60.4         | 74.0       | -13.6       | 41.4            | 54.0          | -12.6          |
|                     | 7206.0 | V     | 60.2         | 74.0       | -13.8       | 47.6            | 54.0          | -6.4           |
|                     | 7206.0 | H     | 59.2         | 74.0       | -14.8       | 46.8            | 54.0          | -7.2           |
| 2440.0              | 4880.0 | V     | 52.3         | 74.0       | -21.7       | -               | 54.0          | -              |
|                     | 4880.0 | H     | 50.2         | 74.0       | -23.8       | -               | 54.0          | -              |
|                     | 7320.0 | V     | 58.3         | 74.0       | -15.7       | 46.0            | 54.0          | -8.0           |
|                     | 7320.0 | H     | 57.6         | 74.0       | -16.4       | 45.1            | 54.0          | -8.9           |
| 2480.0              | 7440.0 | V     | 60.0         | 74.0       | -14.0       | 46.6            | 54.0          | -7.4           |
|                     | 7440.0 | H     | 59.8         | 74.0       | -14.2       | 46.2            | 54.0          | -7.8           |
|                     | 2483.5 | V     | 70.0         | 74.0       | -4.0        | 52.0            | 54.0          | -2.0           |
|                     | 2483.5 | H     | 66.1         | 74.0       | -7.9        | 45.3            | 54.0          | -8.7           |

**Figure 39. Radiated Emission Results**

Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

“Peak Amp” includes correction factor.

\* “Correction Factor” = Antenna Factor + Cable Loss- Low Noise Amplifier Gain



### 10.5 Test Instrumentation Used; Emissions in Restricted Frequency Bands

| Instrument                     | Manufacturer  | Model                | Serial No. | Last Calibration Date | Next Calibration Due |
|--------------------------------|---------------|----------------------|------------|-----------------------|----------------------|
| EMI Receiver                   | R&S           | ESCI7                | 100724     | March 09 2020         | March 31, 2021       |
| EMI Receiver                   | HP            | 8542E                | 3906A00276 | March 11 2020         | March 31, 2021       |
| RF Filter Section              | HP            | 85420E               | 3705A00248 | March 11 2020         | March 31, 2021       |
| Spectrum Analyzer              | HP            | 8593EM               | 3826A00265 | March 9, 2020         | March 31, 2021       |
| Active Loop Antenna            | EMCO          | 6502                 | 9506-2950  | February 5, 2019      | February 29, 2021    |
| Biconical Antenna              | EMCO          | 3110B                | 9912-3337  | May 21, 2019          | October 31, 2020     |
| Log Periodic Antenna           | EMCO          | 3146                 | 9505-4081  | May 31, 2018          | May 31, 2021         |
| Horn Antenna                   | ETS           | 3115                 | 29845      | May 31, 2018          | May 31, 2021         |
| Horn Antenna                   | ARA           | SWH-28               | 1007       | December 13, 2017     | December 31, 2020    |
| MicroWave System Amplifier     | HP            | 83006A               | 3104A00589 | December 24, 2018     | December 31, 2020    |
| Low Noise Amplifier 1GHz-18GHz | Miteq         | AFSX4-02001800-50-8P | -          | December 24, 2018     | December 31, 2020    |
| RF Cable Chamber               | Commscope ORS | 0623 WBC-400         | G020132    | December 24, 2018     | December 31, 2020    |
| RF Cable Oats                  | EIM           | RG214-11N(X2)        |            | May 26, 2019          | May 31, 2021         |
| Filter Band Pass 4-20 GHz      | Meuro         | MFL040120H50         | 902252     | December 24, 2018     | December 31, 2020    |
| Semi Anechoic Civil Chamber    | ETS           | S81                  | SL 11643   | NCR                   | NCR                  |
| Antenna Mast                   | ETS           | 2070-2               | 9608-1497  | NCR                   | NCR                  |
| Turntable                      | ETS           | 2087                 | -          | NCR                   | NCR                  |
| Mast & Table Controller        | ETS/EMCO      | 2090                 | 9608-1456  | NCR                   | NCR                  |

Figure 40 Test Equipment Used



## 11. Antenna Gain/Information

The antenna gain is +4.5dBi trace antenna, type: integral.

## 12. R.F Exposure/Safety

The typical placement of the E.U.T. is wall mounted.

The typical distance between the E.U.T. and the user is 1 cm=10 mm

SAR Testing Exclusion Based on Section 4.3.1 and Appendix A of KDB 447498 D01 V06 Requirements

### **For FCC**

Section 4.3.1 and Appendix A of KDB447498 D01 V06 was used as the guidance as follows:

Conducted power output = 2.3dBm

Antenna gain= 4.5dBi

EIRP = 2.3+4.5= 6.8dBm = 5mW

Operation frequency= 2.4GHz

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]$

$= [5/10] \cdot 1.55 = 0.78$  this value is less than 3.0 for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR.

The SAR measurement is not necessary.

## 13. APPENDIX A - CORRECTION FACTORS

### 13.1 Correction factors for RF OATS Cable 35m ITL #1911

| Frequency<br>(MHz) | loss<br>(dB) |
|--------------------|--------------|
| 30.0               | 1.3          |
| 50.0               | 1.7          |
| 100.0              | 2.6          |
| 200.0              | 3.7          |
| 300.0              | 4.7          |
| 400.0              | 5.5          |
| 500.0              | 6.3          |
| 600.0              | 7.0          |
| 700.0              | 7.6          |
| 800.0              | 8.4          |
| 900.0              | 9.0          |
| 1000.0             | 9.6          |

### 13.2 Correction Factors for RF Cable for Anechoic Chamber ITL #1840

| FREQ<br>(MHz) | LOSS<br>(dB) |
|---------------|--------------|
| 1000.0        | 1.5          |
| 2000.0        | 2.1          |
| 3000.0        | 2.7          |
| 4000.0        | 3.1          |
| 5000.0        | 3.5          |
| 6000.0        | 4.1          |
| 7000.0        | 4.6          |
| 8000.0        | 4.9          |
| 9000.0        | 5.7          |
| 10000.0       | 5.7          |
| 11000.0       | 6.1          |
| 12000.0       | 6.1          |
| 13000.0       | 6.2          |
| 14000.0       | 6.7          |
| 15000.0       | 7.4          |
| 16000.0       | 7.5          |
| 17000.0       | 7.9          |
| 18000.0       | 8.1          |
| 19000.0       | 8.8          |
| 20000.0       | 9.1          |

**NOTES:**

1. The cable is manufactured by Commscope
2. The cable type is 0623 WBC-400, serial # G020132 and 10m long

### 13.3 *Correction Factors for Active Loop Antenna* *ITL # 1075*

| F(MHz) | AF(dB/m) |
|--------|----------|
| 0.01   | 18.4     |
| 0.02   | 14.3     |
| 0.03   | 13.3     |
| 0.05   | 11.7     |
| 0.1    | 11.4     |
| 0.2    | 11.2     |
| 0.3    | 11.2     |
| 0.5    | 11.2     |
| 0.7    | 11.2     |
| 1      | 11.4     |
| 2      | 11.5     |
| 3      | 11.5     |
| 4      | 11.4     |
| 5      | 11.3     |
| 6      | 11.1     |
| 7      | 11.1     |
| 8      | 11.1     |
| 9      | 11       |
| 10     | 11       |
| 20     | 10       |
| 30     | 8        |



**13.4 Correction Factors for Biconical Antenna**  
**ITL #1356, EMCO 3110B 9912-3337**

| Frequency | AF     |
|-----------|--------|
| [MHz]     | [dB/m] |
| 30        | 13.00  |
| 35        | 10.89  |
| 40        | 10.59  |
| 45        | 10.63  |
| 50        | 10.12  |
| 60        | 9.26   |
| 70        | 7.74   |
| 80        | 6.63   |
| 90        | 8.23   |
| 100       | 11.12  |
| 120       | 13.16  |
| 140       | 13.07  |
| 160       | 14.80  |
| 180       | 16.95  |
| 200       | 17.17  |



**13.5      *Correction Factors for Log Periodic Antenna***  
***ITL # 1349, EMCO 3146 s/n 9505-4081***

| <b>Frequency</b> | <b>AF</b>     |
|------------------|---------------|
| <b>[MHz]</b>     | <b>[dB/m]</b> |
| 200              | 11.58         |
| 250              | 12.04         |
| 300              | 14.76         |
| 400              | 15.55         |
| 500              | 17.85         |
| 600              | 18.66         |
| 700              | 20.87         |
| 800              | 21.15         |
| 900              | 22.32         |
| 1000             | 24.22         |



**13.6 Correction Factors for Double – Ridged Waveguide Horn**  
**ANTENNA 3 meter range;**  
**ITL # 1352, ETS 3115 s/n 29845**

| FREQUENCY | AFE    | FREQUENCY | AFE    |
|-----------|--------|-----------|--------|
| (GHz)     | (dB/m) | (GHz)     | (dB/m) |
| 0.75      | 25.0   | 9.5       | 38.0   |
| 1.0       | 23.5   | 10.0      | 38.5   |
| 1.5       | 26.0   | 10.5      | 38.5   |
| 2.0       | 29.0   | 11.0      | 38.5   |
| 2.5       | 27.5   | 11.5      | 38.5   |
| 3.0       | 30.0   | 12.0      | 38.0   |
| 3.5       | 31.5   | 12.5      | 38.5   |
| 4.0       | 32.5   | 13.0      | 40.0   |
| 4.5       | 32.5   | 13.5      | 41.0   |
| 5.0       | 33.0   | 14.0      | 40.0   |
| 5.5       | 35.0   | 14.5      | 39.0   |
| 6.0       | 36.5   | 15.0      | 38.0   |
| 6.5       | 36.5   | 15.5      | 37.5   |
| 7.0       | 37.5   | 16.0      | 37.5   |
| 7.5       | 37.5   | 16.5      | 39.0   |
| 8.0       | 37.5   | 17.0      | 40.0   |
| 8.5       | 38.0   | 17.5      | 42.0   |
| 9.0       | 37.5   | 18.0      | 42.5   |



### 13.7 Correction Factors for Horn Antenna Model SWH-28 ITL # 1353

#### CALIBRATION DATA

3 m distance

| Frequency, MHz | Measured antenna factor, dB/m <sup>1)</sup> |
|----------------|---------------------------------------------|
| 18000          | 32.4                                        |
| 18500          | 32.0                                        |
| 19000          | 32.3                                        |
| 19500          | 32.4                                        |
| 20000          | 32.3                                        |
| 20500          | 32.8                                        |
| 21000          | 32.8                                        |
| 21500          | 32.7                                        |
| 22000          | 33.1                                        |
| 22500          | 33.0                                        |
| 23000          | 33.1                                        |
| 23500          | 33.8                                        |
| 24000          | 33.5                                        |
| 24500          | 33.5                                        |
| 25000          | 33.8                                        |
| 25500          | 33.9                                        |
| 26000          | 34.2                                        |
| 26500          | 34.7                                        |

<sup>1)</sup> The antenna factor shall be added to receiver reading in dB $\mu$ V to obtain field strength in dB $\mu$ V/m.