

# TEST REPORT

**ACCORDING TO: FCC 47CFR part 15 subpart C §15.247 (DTS)  
RSS-247 issue 2, RSS-Gen issue 5**

FOR:

**Airthings AS**

**1) HUB model 2810**

**2) HUB Cellular model 2820**

**FCC ID:2APPT-2820**

**IC:23900-2820**

This report is in conformity with ISO/ IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested. This test report shall not be reproduced in any form except in full with the written approval of Hermon Laboratories Ltd.

## Table of contents

|      |   |    |
|------|---|----|
| 1    | Applicant information.....  | 3  |
| 2    | Equipment under test attributes .....   | 3  |
| 3    | Manufacturer information .....  | 3  |
| 4    | Test details.....   | 3  |
| 5    | Tests summary.....  | 4  |
| 6    | EUT description.....  | 5  |
| 6.1  | General information.....  | 5  |
| 6.2  | Ports and lines .....   | 5  |
| 6.3  | Changes made in EUT .....   | 5  |
| 6.4  | Test configuration.....   | 6  |
| 6.5  | Transmitter characteristics .....   | 7  |
| 7    | Transmitter tests according to 47CFR part 15 subpart C and RSS-247 requirements ..... | 8  |
| 7.1  | Minimum 6 dB bandwidth and 99% occupied bandwidth .....                               | 8  |
| 7.2  | Maximum peak output power .....   | 12 |
| 7.3  | Maximum peak output power .....   | 15 |
| 7.4  | Field strength of spurious emissions .....  | 18 |
| 7.5  | Field strength of spurious emissions .....  | 34 |
| 7.6  | Band edge radiated emissions .....  | 48 |
| 7.7  | Band edge radiated emissions .....  | 51 |
| 7.8  | Maximum power spectral density (PSD) .....  | 54 |
| 7.9  | Antenna requirements .....  | 58 |
| 7.10 | Conducted emissions .....   | 59 |
| 8    | APPENDIX A Test equipment and ancillaries used for tests.....                         | 62 |
| 9    | APPENDIX B Measurement uncertainties.....   | 63 |
| 10   | APPENDIX C Test laboratory description .....  | 64 |
| 11   | APPENDIX D Specification references .....   | 64 |
| 12   | APPENDIX E Test equipment correction factors.....                                     | 65 |
| 13   | APPENDIX F Abbreviations and acronyms.....  | 72 |

## 1 Applicant information

**Client name:** Airthings AS  
**Address:** Wergelandsveien 7, Oslo 0167, Norway  
**Telephone:** +47 909 686 23  
**E-mail:** eivind.fremstad@airthings.com  
**Contact name:** Mr. Eivind Fremstad

## 2 Equipment under test attributes

**Product name:** HUB  
**Product type:** Transceiver  
**Model:** HUB 2810  
**Hardware version:** 2  
**Software release:** 1.0.0  
**Model:** HUB Cellular 2820  
**Hardware version:** 2  
**Software release:** 1.0.0  
**Receipt date** 22-Aug-18

## 3 Manufacturer information

**Manufacturer name:** Crow Electronic Engineering Ltd.  
**Address:** 12 Kineret street, P.O.Box 293, Ben Gurion Airport, Airport City, 7010000, Israel  
**Telephone:** +972 3972 6049  
**Fax:** +972 3972 6001  
**E-Mail:** igal@crow.co.il  
**Contact name:** Mr. Igal Bromberg

## 4 Test details

**Project ID:** 31178  
**Location:** Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel  
**Test started:** 22-Aug-18  
**Test completed:** 17-Mar-19  
**Test specification(s):** FCC 47CFR part 15, subpart C, §15.247(DTS);  
RSS-247 issue 2, RSS-Gen issue 5



## 5 Tests summary

| Test   | Status  |
|--|---|
| <b>Transmitter characteristics</b>   |   |
| FCC section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth and RSS-Gen section 6.7, 99% occupied bandwidth | Pass  |
| FCC section 15.247(b)3/ RSS-247 section 5.4(d), Maximum peak output power                                      | Pass  |
| FCC section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions                                       | Pass  |
| FCC section 15.247(d) / RSS-247 section 5.5, Emissions at band edges   | Pass  |
| FCC section 15.247(e) / RSS-247 section 5.2(b), Maximum power spectral density                                 | Pass  |
| FCC section 15.247(i)5/ RSS-102 section 2.5, RF exposure   | Pass, the exhibit to the application of certification is provided |
| FCC section 15.203/ RSS-Gen section 6.8, Antenna requirements  | Pass  |
| FCC section 15.207(a) / RSS-Gen section 8.8, Conducted emission  | Pass  |

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.

The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

|              | Name and Title                              | Date             | Signature |
|--------------|---|------------------|-----------|
| Tested by:   | Mr. K. Zushchyk, test engineer              | November 6, 2018 |           |
|              | Mr. A. Morozov, test engineer               |                  |           |
|              | Mr. S. Samokha, test engineer               |                  |           |
| Reviewed by: | Mrs. M. Cherniavsky, certification engineer | March 20, 2019   |           |
| Approved by: | Mr. M. Nikishin, EMC and radio group leader | March 25, 2019   |           |



## 6 EUT description

### 6.1 General information

The Hub is the heart of the Airthings Ecosystem. It brings one or more supported devices online, providing on-demand access to Indoor Air Quality (IAQ) data at anytime, from anywhere. Continuous monitoring of your Indoor Air Quality levels is necessary to minimize potential health effects in all populated spaces.

The HUB is provided in two configurations: with and without Cellular module.

The HUB, model 2810, has CC2640R2F BLE 2.4 GHz chip on the board. The BLE 2.4GHz chip is actively used in RF operation. There is one additional radio in the HUB. That is CC1310F128 operating in 902-928 MHz.

The HUB Cellular, model 2820, has CC2640R2F BLE 2.4GHz chip radio on the board. There are two additional radios in HUB Cellular. That is CC1310F128 operating in 902-928 MHz and BG96 Cellular Module, FCC ID XMR201707BG96, that operates at many cellular frequency bands.

The HUB is powered from AC mains via AC/DC adapter manufactured by Dongguan Yingna Electronic Technology Co., model YNQX12H050200HL.

This test report represents test results for 2.4 MHz radio.

### 6.2 Ports and lines

| Port type | Port description | Connected from | Connected to | Qty. | Cable type | Cable length, m |
|-----------|------------------|----------------|--------------|------|------------|-----------------|
| Power     | AC               | AC adapter     | AC mains     | 1    | NA         | NA              |
| Power     | DC               | AC adapter     | EUT HUB      | 1    | Unshielded | 1.5 m           |

\*may be up to 100 m

### 6.3 Changes made in EUT

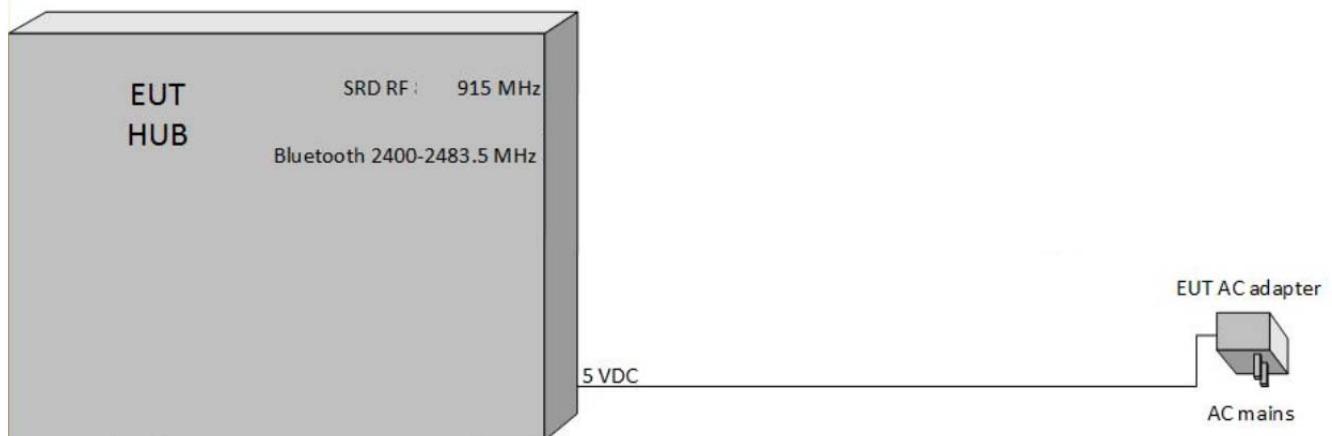
To withstand the standard requirements, the following changes were implemented in the EUT during testing: a power transient voltage suppressor (TVS) of 100V manufactured by CYG WAYON CIRCUIT PROTECTION CO., LTD., model SMAJ100CA-TR was soldered on top of C86 capacitor of 1nF/2KV placed on main PCB.

It is manufacturer responsibility to implement the change in the production version of the EUT. In any case the test report applies to the tested item only.

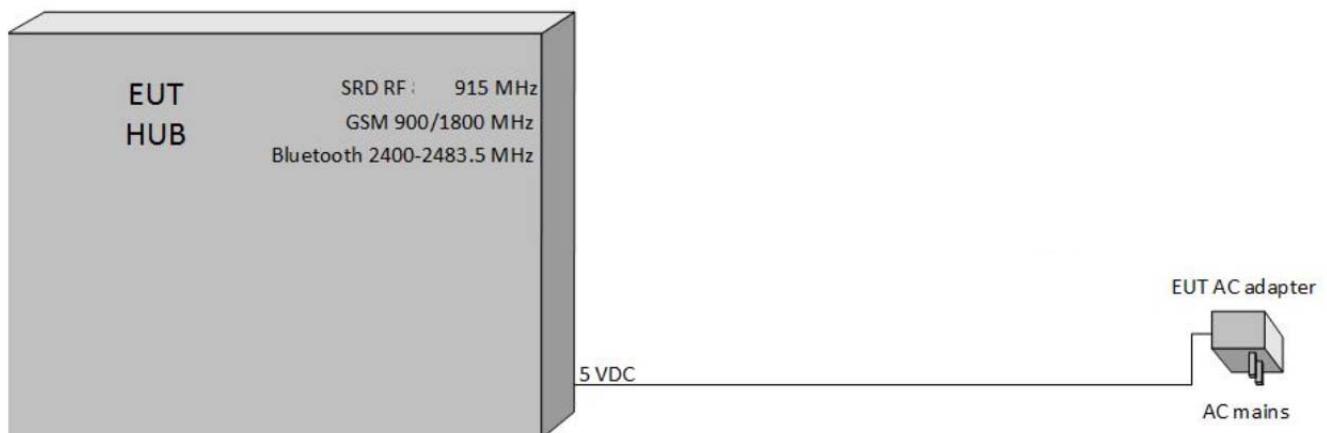


## 6.4 Test configuration

### 6.4.1 HUB model 2810 configuration



### 6.4.2 HUB Cellular model 2820 configuration





## 6.5 Transmitter characteristics

| Type of equipment                                |  |   |                                   |   |  |  |  |
|--|--|---|-----------------------------------|---|--|--|--|
| <input checked="" type="checkbox"/>              | Stand-alone (Equipment with or without its own control provisions)                                       |   |                                   |   |  |  |  |
|  | Combined equipment (Equipment where the radio part is fully integrated within another type of equipment) |   |                                   |   |  |  |  |
|  | Plug-in card (Equipment intended for a variety of host systems)  |   |                                   |   |  |  |  |
| Intended use                                     | Condition of use   |   |                                   |   |  |  |  |
|  | fixed  | Always at a distance more than 2 m from all people        |                                   |   |  |  |  |
| <input checked="" type="checkbox"/>              | mobile   | Always at a distance more than 20 cm from all people      |                                   |   |  |  |  |
|  | portable   | May operate at a distance closer than 20 cm to human body |                                   |   |  |  |  |
| Assigned frequency ranges                        | 2400-2483.5 MHz  |   |                                   |   |  |  |  |
| Operating frequencies                            | 2402-2480 MHz  |   |                                   |   |  |  |  |
| Maximum rated output power                       | At transmitter 50 Ω RF output connector  |   |                                   | dBm   |  |  |  |
|  | Peak output power  |   |                                   | -1.03 dBm (Hub 2820),<br>-0.12 dBm (Hub 2810)                 |  |  |  |
| Is transmitter output power variable?            | X  | No  |                                   |   |  |  |  |
|  | Yes  |   | continuous variable               |   |  |  |  |
|  |  |   | stepped variable with stepsize    | dB  |  |  |  |
|  |  |   | minimum RF power                  | dBm   |  |  |  |
|  |  |   | maximum RF power                  | dBm   |  |  |  |
| Antenna connection                               |  |   |                                   |   |  |  |  |
| unique coupling                                  | standard connector   | X integral  | X                                 | with temporary RF connector<br>without temporary RF connector |  |  |  |
| Antenna/s technical characteristics              |  |   |                                   |   |  |  |  |
| Type   | Manufacturer   | Model number  | Gain                              |   |  |  |  |
| Integral   | Crow   | Printed   | 2.5 dBi                           |   |  |  |  |
| Transmitter aggregate data rate/s                | 1 Mbps   |   |                                   |   |  |  |  |
| Type of modulation                               | GFSK   |   |                                   |   |  |  |  |
| Modulating test signal (baseband)                | PRBS   |   |                                   |   |  |  |  |
| Transmitter power source                         |  |   |                                   |   |  |  |  |
| Battery  | Nominal rated voltage  |   | Battery type                      |   |  |  |  |
| DC   | Nominal rated voltage  | 5   |                                   |   |  |  |  |
| X AC mains                                       | Nominal rated voltage  | Via 120 VAC/5 VDC adapter                                 | Frequency                         | 60 Hz   |  |  |  |
| Common power source for transmitter and receiver |  |   | X yes                             | no  |  |  |  |
| Spread spectrum technique used                   |  | Frequency hopping (FHSS)                                  |                                   |   |  |  |  |
|  |  | X   | Digital transmission system (DTS) |   |  |  |  |
|  |  |   | Hybrid                            |   |  |  |  |



HERMON LABORATORIES

Report ID: AIRRAD\_FCC.31178\_DTS.docx

Date of Issue: 25-Mar-19

|                                    |   |                        |                       |
|------------------------------------|---|------------------------|-----------------------|
| <b>Test specification:</b>         | Section 15.247(a)2 / RSS-247 section 5.2(a), 6 dB bandwidth and RSS-Gen section 6.7, 99% occupied bandwidth |                        |                       |
| <b>Test procedure:</b>             | ANSI C63.10 section 11.8.1  |                        |                       |
| <b>Test mode:</b>                  | Compliance  |                        |                       |
| <b>Date(s):</b>                    | 17-Mar-19   | <b>Verdict:</b>        | PASS                  |
| Temperature: 23 °C                 | Relative Humidity: 55 %   | Air Pressure: 1008 hPa | Power: 120 VAC, 60 Hz |
| <b>Remarks:</b> HUB 2810, HUB 2820 |   |                        |                       |

## 7 Transmitter tests according to 47CFR part 15 subpart C and RSS-247 requirements

### 7.1 Minimum 6 dB bandwidth and 99% occupied bandwidth

#### 7.1.1 General

This test was performed to measure the 6 dB bandwidth of the EUT carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 6 dB bandwidth limits

| Assigned frequency, MHz | Modulation envelope reference points*, dBc | Minimum bandwidth, kHz |
|-------------------------|--|------------------------|
| 2400.0 – 2483.5         | 6.0  | 500.0                  |

\* - Modulation envelope reference points provided in terms of attenuation below the peak of modulated carrier.

Table 7.1.2 The 99% bandwidth limits

| Assigned frequency, MHz | Modulation envelope reference points | Limit, kHz |
|-------------------------|--------------------------------------|------------|
| 2400.0 – 2483.5         | 99%                                  | NA         |

#### 7.1.2 Test procedure

- 7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.
- 7.1.2.2 The EUT was set to transmit modulated carrier at maximum data rate (low channel).
- 7.1.2.3 The transmitter minimum 6 dB bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.3 and the associated plots.
- 7.1.2.4 The test was repeated for mid and high carrier frequencies.
- 7.1.2.5 The transmitter 99% occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.4 and the associated plots.

Figure 7.1.1 The 6 dB bandwidth test setup





HERMON LABORATORIES

|                                    |   |                               |                              |
|------------------------------------|---|-------------------------------|------------------------------|
| <b>Test specification:</b>         | Section 15.247(a)2 / RSS-247 section 5.2(a), 6 dB bandwidth and RSS-Gen section 6.7, 99% occupied bandwidth |                               |                              |
| <b>Test procedure:</b>             | ANSI C63.10 section 11.8.1  |                               |                              |
| <b>Test mode:</b>                  | Compliance  |                               |                              |
| <b>Date(s):</b>                    | 17-Mar-19   | <b>Verdict:</b>               | PASS                         |
| <b>Temperature:</b> 23 °C          | <b>Relative Humidity:</b> 55 %  | <b>Air Pressure:</b> 1008 hPa | <b>Power:</b> 120 VAC, 60 Hz |
| <b>Remarks:</b> HUB 2810, HUB 2820 |   |                               |                              |

Table 7.1.3 The 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 2400 – 2483.5 MHz  
 DETECTOR USED: Peak  
 SWEEP TIME: Auto  
 RESOLUTION BANDWIDTH: 100 kHz  
 VIDEO BANDWIDTH: 300 kHz  
 MODULATION ENVELOPE REFERENCE POINTS: 6.0 dBc

| Carrier frequency, MHz | 6 dB bandwidth, kHz | Limit, kHz | Margin, kHz | Verdict |
|------------------------|---------------------|------------|-------------|---------|
| 2402                   | 744.0               | 500        | 244.0       | Pass    |
| 2440                   | 751.3               | 500        | 251.3       | Pass    |
| 2480                   | 762.9               | 500        | 262.9       | Pass    |

Table 7.1.4 The 99% bandwidth test results

ASSIGNED FREQUENCY BAND: 2400 – 2483.5 MHz  
 DETECTOR USED: Peak  
 SWEEP TIME: Auto  
 RESOLUTION BANDWIDTH: 100 kHz  
 VIDEO BANDWIDTH: 300 kHz  
 MODULATION ENVELOPE REFERENCE POINTS: 99% BW

| Carrier frequency, MHz | 99% bandwidth, kHz | Limit, kHz | Margin, kHz | Verdict |
|------------------------|--------------------|------------|-------------|---------|
| 2402                   | 1079.2             | NA         | NA          | Pass    |
| 2440                   | 1086.1             | NA         | NA          | Pass    |
| 2480                   | 1095.7             | NA         | NA          | Pass    |

**Reference numbers of test equipment used**

|         |         |  |  |  |  |  |  |
|---------|---------|--|--|--|--|--|--|
| HL 3440 | HL 5376 |  |  |  |  |  |  |
|---------|---------|--|--|--|--|--|--|

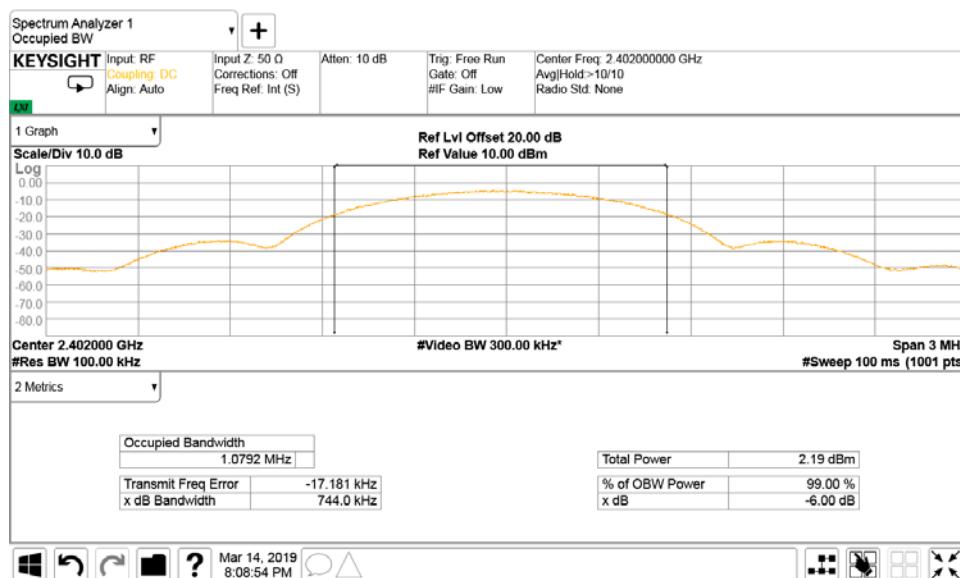
Full description is given in Appendix A.



HERMON LABORATORIES

|  |                         |                             |                       |
|--|-------------------------|-----------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(a)2 / RSS-247 section 5.2(a), 6 dB bandwidth and RSS-Gen section 6.7, 99% occupied bandwidth |                         |                             |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.8.1  |                         |                             |                       |
| <b>Test mode:</b> Compliance   |                         | <b>Verdict:</b> <b>PASS</b> |                       |
| Date(s):   | 17-Mar-19               |                             |                       |
| Temperature: 23 °C   | Relative Humidity: 55 % | Air Pressure: 1008 hPa      | Power: 120 VAC, 60 Hz |
| <b>Remarks:</b> HUB 2810, HUB 2820   |                         |                             |                       |

Plot 7.1.1 The 6 dB bandwidth test result at low frequency



Plot 7.1.2 The 6 dB bandwidth test result at mid frequency





HERMON LABORATORIES

|                                    |  |                               |                              |
|------------------------------------|--|-------------------------------|------------------------------|
| <b>Test specification:</b>         | <b>Section 15.247(a)2 / RSS-247 section 5.2(a), 6 dB bandwidth and RSS-Gen section 6.7, 99% occupied bandwidth</b> |                               |                              |
| <b>Test procedure:</b>             | <b>ANSI C63.10 section 11.8.1</b>  |                               |                              |
| <b>Test mode:</b>                  | <b>Compliance</b>  |                               |                              |
| <b>Date(s):</b>                    | <b>17-Mar-19</b>   |                               |                              |
| <b>Temperature: 23 °C</b>          | <b>Relative Humidity: 55 %</b>   | <b>Air Pressure: 1008 hPa</b> | <b>Power: 120 VAC, 60 Hz</b> |
| <b>Remarks: HUB 2810, HUB 2820</b> |  |                               |                              |

**Plot 7.1.3 The 6 dB bandwidth test result at high frequency**





HERMON LABORATORIES

Report ID: AIRRAD\_FCC.31178\_DTS.docx

Date of Issue: 25-Mar-19

|  |                                |                               |                              |
|--|--------------------------------|-------------------------------|------------------------------|
| <b>Test specification:</b> Section 15.247(b)3/ RSS-247 section 5.4(d), Maximum peak output power |                                |                               |                              |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1  |                                |                               |                              |
| <b>Test mode:</b> Compliance   |                                |                               | <b>Verdict:</b> PASS         |
| <b>Date(s):</b>  | 17-Oct-18 - 05-Nov-18          |                               |                              |
| <b>Temperature:</b> 22 °C  | <b>Relative Humidity:</b> 50 % | <b>Air Pressure:</b> 1013 hPa | <b>Power:</b> 120 VAC, 60 Hz |
| <b>Remarks:</b> HUB 2810   |                                |                               |                              |

## 7.2 Maximum peak output power

### 7.2.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Peak output power limits

| Assigned frequency range, MHz | Peak output power* |      | Equivalent field strength limit @ 3m, dB(µV/m)* | Maximum antenna gain, dBi |
|-------------------------------|--------------------|------|---|---------------------------|
|                               | W                  | dBm  |   |                           |
| 2400.0 – 2483.5               | 1.0                | 30.0 | 131.2   | 6.0*                      |

\*- Equivalent field strength limit was calculated from the peak output power as follows:  $E = \sqrt{30 \times P \times G} / r$ , where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

\*\*- The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band.

### 7.2.2 Test procedure

7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.

7.2.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.2.2.3 The frequency span of spectrum analyzer was set approximately 5 times wider than 20 dB bandwidth of the EUT and the resolution bandwidth was set wider than 20 dB bandwidth of the EUT. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.2.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.2.2 and associated plots.

7.2.2.5 The maximum peak output power was calculated from the field strength of carrier as follows:

$$P = (E \times d)^2 / (30 \times G),$$

where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.

The above equation was converted in logarithmic units for 3 m test distance:

$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V}/\text{m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

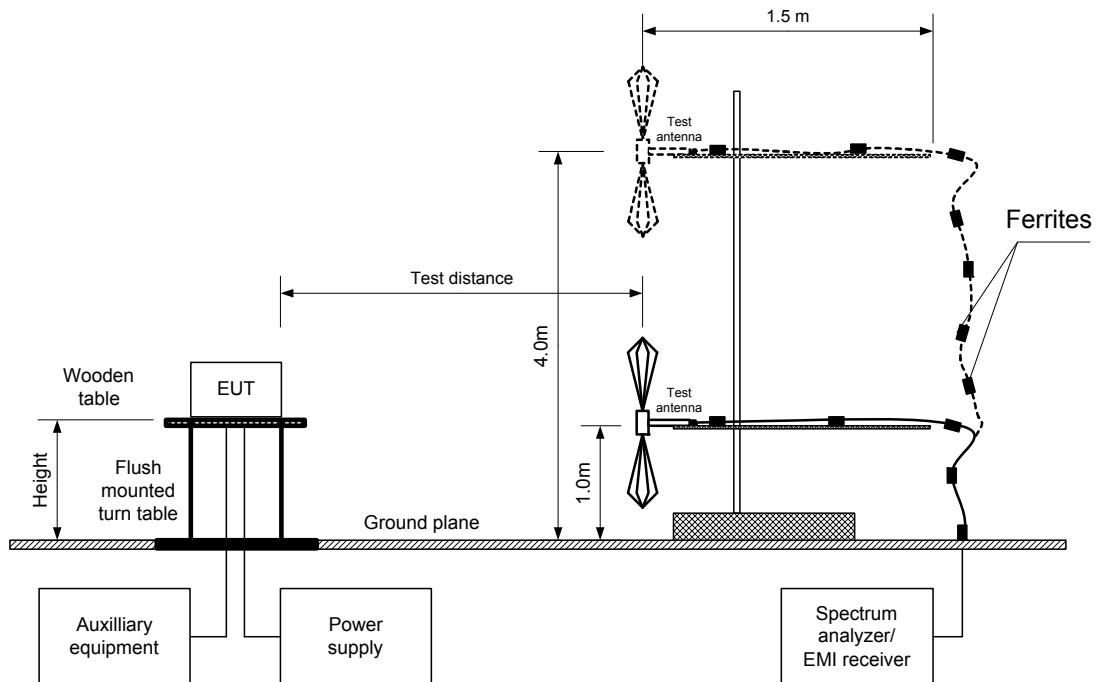
7.2.2.6 The worst test results (the lowest margins) were recorded in Table 7.2.2.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(b)3/ RSS-247 section 5.4(d), Maximum peak output power |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1  |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>17-Oct-18 - 05-Nov-18   |                                |                               |
| <b>Temperature:</b> 22 °C  | <b>Relative Humidity:</b> 50 % | <b>Air Pressure:</b> 1013 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

Figure 7.2.1 Setup for carrier field strength measurements





HERMON LABORATORIES

|  |  |
|--|--|
| <b>Test specification:</b> Section 15.247(b)3/ RSS-247 section 5.4(d), Maximum peak output power |  |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1  |  |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> <b>PASS</b>                                |
| <b>Date(s):</b> 17-Oct-18 - 05-Nov-18  |  |
| <b>Temperature:</b> 22 °C  | <b>Relative Humidity:</b> 50 %                             |
| <b>Remarks:</b> HUB 2810   | <b>Air Pressure:</b> 1013 hPa <b>Power:</b> 120 VAC, 60 Hz |

**Table 7.2.2 Peak output power test results**

|                                    |                                      |
|------------------------------------|--------------------------------------|
| ASSIGNED FREQUENCY:                | 2400-2483.5 MHz                      |
| TEST DISTANCE:                     | 3 m                                  |
| TEST SITE:                         | Semi anechoic chamber                |
| DETECTOR USED:                     | Peak                                 |
| TEST ANTENNA TYPE:                 | Double ridged guide (above 1000 MHz) |
| MODULATION:                        | GFSK                                 |
| MODULATING SIGNAL:                 | PRBS                                 |
| BIT RATE:                          | 1 Mbps                               |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum                              |
| RESOLUTION BANDWIDTH:              | 3 MHz                                |
| VIDEO BANDWIDTH:                   | 10 MHz                               |
| FREQUENCY HOPPING:                 | Disabled                             |

| Frequency, MHz | Field strength, dB(µV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | EUT antenna gain, dBi | Peak output power, dBm** | Limit, dBm | Margin, dB*** | Verdict |
|----------------|--------------------------|----------------------|-------------------|-------------------|-----------------------|--------------------------|------------|---------------|---------|
| 2401.9806      | 97.54                    | V                    | 1.03              | -112.0            | 2.5                   | -0.16                    | 30.0       | -30.16        | Pass    |
| 2439.7333      | 95.88                    | V                    | 1.00              | 26.0              | 2.5                   | -1.82                    | 30.0       | -31.82        | Pass    |
| 2479.6995      | 97.58                    | V                    | 1.12              | -36.0             | 2.5                   | -0.12                    | 30.0       | -30.12        | Pass    |

\*- EUT front panel refer to 0 degrees position of turntable.

\*\*- Peak output power was calculated from the field strength of carrier as follows:  $P = (E \times d)^2 / (30 \times G)$ , where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance: *Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi - 95.2 dB*

\*\*\*- Margin = Peak output power – specification limit.

**Reference numbers of test equipment used**

|         |        |         |         |  |  |  |  |
|---------|--------|---------|---------|--|--|--|--|
| HL 3903 | HL4360 | HL 4933 | HL 5405 |  |  |  |  |
|---------|--------|---------|---------|--|--|--|--|

Full description is given in Appendix A.



HERMON LABORATORIES

|  |                                |                               |                              |
|--|--------------------------------|-------------------------------|------------------------------|
| <b>Test specification:</b> Section 15.247(b)3/ RSS-247 section 5.4(d), Maximum peak output power |                                |                               |                              |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1  |                                |                               |                              |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |                              |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |                              |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 49 % | <b>Air Pressure:</b> 1008 hPa | <b>Power:</b> 120 VAC, 60 Hz |
| <b>Remarks:</b> HUB 2820   |                                |                               |                              |

## 7.3 Maximum peak output power

### 7.3.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Peak output power limits

| Assigned frequency range, MHz | Peak output power* |      | Equivalent field strength limit @ 3m, dB(µV/m)* | Maximum antenna gain, dBi |
|-------------------------------|--------------------|------|---|---------------------------|
|                               | W                  | dBm  |   |                           |
| 2400.0 – 2483.5               | 1.0                | 30.0 | 131.2   | 6.0*                      |

\*- Equivalent field strength limit was calculated from the peak output power as follows:  $E = \sqrt{30 \times P \times G} / r$ , where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

\*\*- The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band.

### 7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and its proper operation was checked.

7.3.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.3.2.3 The frequency span of spectrum analyzer was set approximately 5 times wider than 20 dB bandwidth of the EUT and the resolution bandwidth was set wider than 20 dB bandwidth of the EUT. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.3.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.6.2 and associated plots.

7.3.2.5 The maximum peak output power was calculated from the field strength of carrier as follows:

$$P = (E \times d)^2 / (30 \times G),$$

where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.

The above equation was converted in logarithmic units for 3 m test distance:

$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

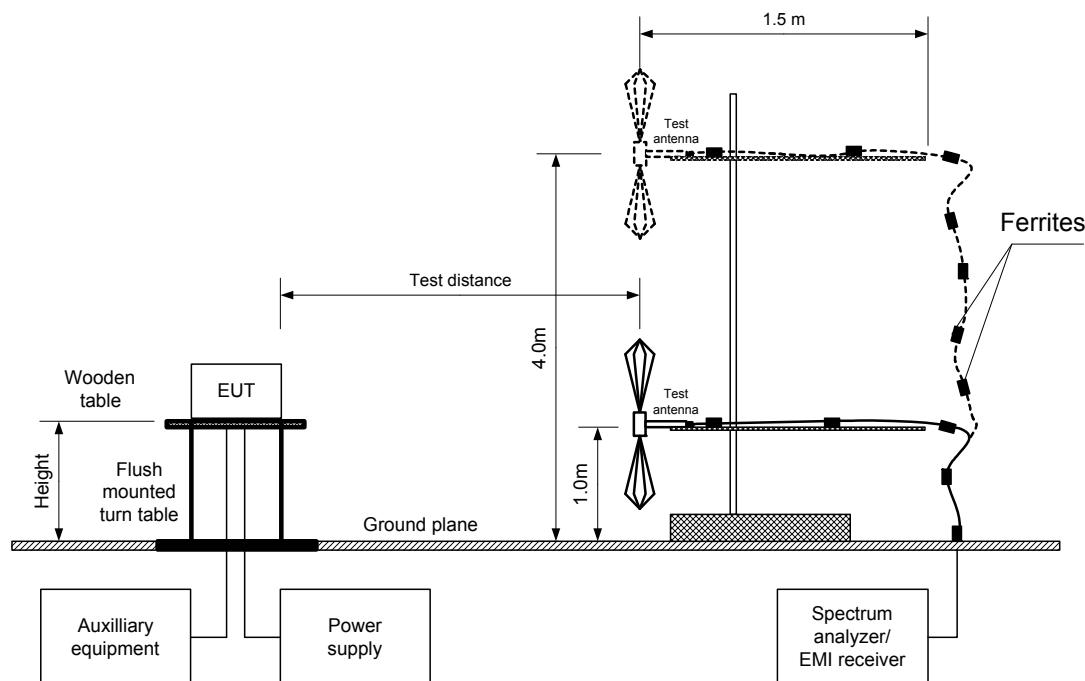
7.3.2.6 The worst test results (the lowest margins) were recorded in Table 7.3.2.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(b)3/ RSS-247 section 5.4(d), Maximum peak output power |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1  |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 49 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

Figure 7.3.1 Setup for carrier field strength measurements





HERMON LABORATORIES

Report ID: AIRRAD\_FCC.31178\_DTS.docx

Date of Issue: 25-Mar-19

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(b)3/ RSS-247 section 5.4(d), Maximum peak output power |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1  |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 49 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                |                               |

**Table 7.3.2 Peak output power test results**

ASSIGNED FREQUENCY: 2400 – 2483.5 MHz  
 TEST DISTANCE: 3 m  
 TEST SITE: Semi anechoic chamber  
 DETECTOR USED: Peak  
 TEST ANTENNA TYPE: Double ridged guide (above 1000 MHz)  
 MODULATION: GFSK  
 MODULATING SIGNAL: PRBS  
 BIT RATE: 1 Mbps  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 3 MHz  
 VIDEO BANDWIDTH: 10 MHz  
 FREQUENCY HOPPING: Disabled

| Frequency, MHz | Field strength, dB(µV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | EUT antenna gain, dBi | Peak output power, dBm** | Limit, dBm | Margin, dB*** | Verdict |
|----------------|--------------------------|----------------------|-------------------|-------------------|-----------------------|--------------------------|------------|---------------|---------|
| 2401.8915      | 96.67                    | Vertical             | 1.52              | 97.0              | 2.5                   | -1.03                    | 30.00      | -31.03        | Pass    |
| 2440.1365      | 96.10                    | Vertical             | 1.78              | 112.0             | 2.5                   | -1.60                    | 30.00      | -31.60        | Pass    |
| 2480.2370      | 95.44                    | Vertical             | 1.01              | 101.0             | 2.5                   | -2.06                    | 30.00      | -32.06        | Pass    |

\*- EUT front panel refer to 0 degrees position of turntable.

\*\*- Peak output power was calculated from the field strength of carrier as follows:  $P = (E \times d)^2 / (30 \times G)$ , where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance: *Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi - 95.2 dB*

\*\*\*- Margin = Peak output power – specification limit.

**Reference numbers of test equipment used**

|         |         |         |         |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|
| HL 3903 | HL 4360 | HL 4933 | HL 5405 |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|

Full description is given in Appendix A.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                |                               |

## 7.4 Field strength of spurious emissions

### 7.4.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Radiated spurious emissions limits

| Frequency, MHz                   | Field strength at 3 m within restricted bands, dB(µV/m)*** |                 |                 | Attenuation of field strength of spurious versus carrier outside restricted bands, dBc*** |
|----------------------------------|--|-----------------|-----------------|---|
|                                  | Peak   | Quasi Peak      | Average         |   |
| 0.009 – 0.090                    | 148.5 – 128.5  | NA              | 128.5 – 108.5** | 20.0  |
| 0.090 – 0.110                    | NA   | 108.5 – 106.8** | NA              |   |
| 0.110 – 0.490                    | 126.8 – 113.8  | NA              | 106.8 – 93.8**  |   |
| 0.490 – 1.705                    |  | 73.8 – 63.0**   |                 |   |
| 1.705 – 30.0*                    |  | 69.5            |                 |   |
| 30 – 88                          | NA   | 40.0            | NA              |   |
| 88 – 216                         |  | 43.5            |                 |   |
| 216 – 960                        |  | 46.0            |                 |   |
| 960 – 1000                       |  | 54.0            |                 |   |
| 1000 – 10 <sup>th</sup> harmonic | 74.0   | NA              | 54.0            |   |

\*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$\text{Lim}_{S_2} = \text{Lim}_{S_1} + 40 \log (S_1/S_2),$$

where  $S_1$  and  $S_2$  – standard defined and test distance respectively in meters.

\*\*- The limit decreases linearly with the logarithm of frequency.

\*\*\* - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

### 7.4.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and the performance check was conducted.

7.4.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.4.2.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.

### 7.4.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.4.3.1 The EUT was set up as shown in Figure 7.4.2, Figure 7.4.3, energized and the performance check was conducted.

7.4.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

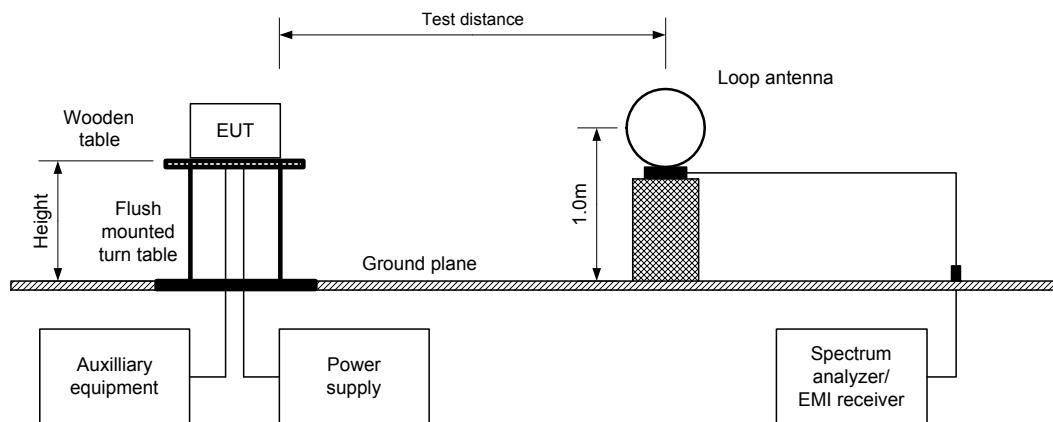
7.4.3.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

Figure 7.4.1 Setup for spurious emission field strength measurements below 30 MHz





HERMON LABORATORIES

| <b>Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions</b> |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

Figure 7.4.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz

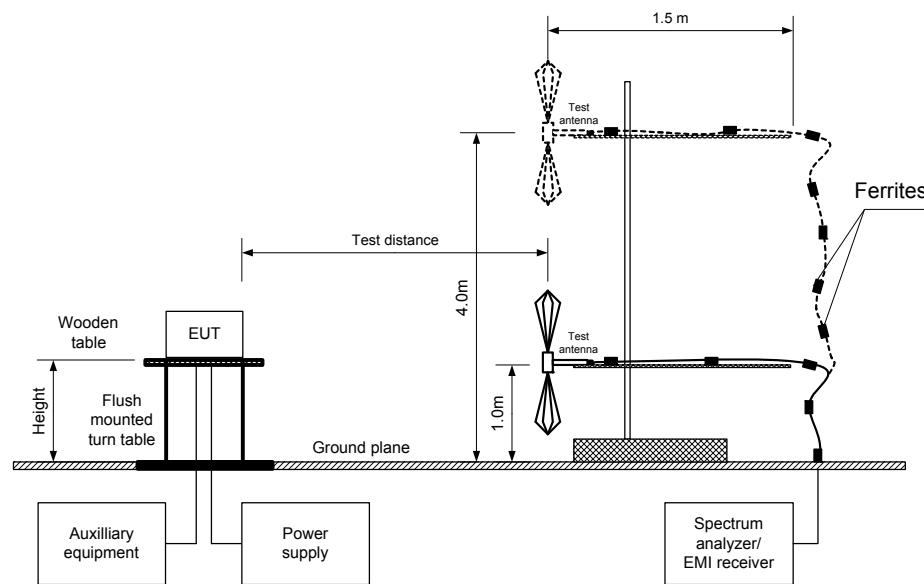
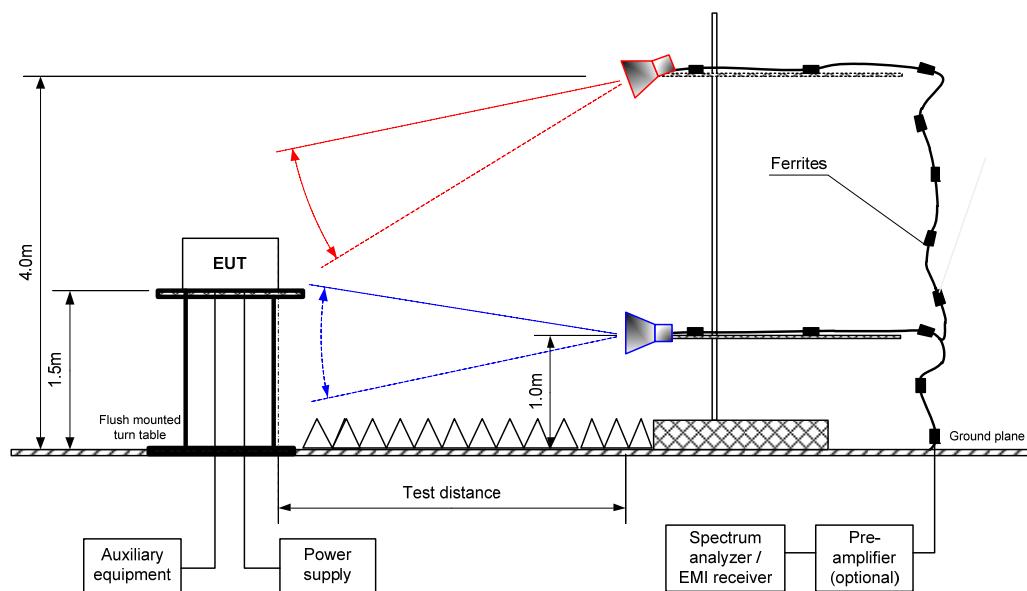


Figure 7.4.3 Setup for spurious emission field strength measurements above 1000 MHz





HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b>  | 23-Aug-18                      |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                |                               |

**Table 7.4.2 Field strength of emissions outside restricted bands**

|                                    |   |
|------------------------------------|---|
| ASSIGNED FREQUENCY:                | 2400.0 – 2483.5 MHz   |
| INVESTIGATED FREQUENCY RANGE:      | 0.009 – 25 000 MHz  |
| TEST DISTANCE:                     | 3 m   |
| MODULATION:                        | GFSK  |
| MODULATING SIGNAL:                 | PRBS  |
| BIT RATE:                          | 1 Mbps  |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum   |
| DETECTOR USED:                     | Peak  |
| RESOLUTION BANDWIDTH:              | 100 kHz   |
| VIDEO BANDWIDTH:                   | 300 kHz   |
| TEST ANTENNA TYPE:                 | Active loop (9 kHz – 30 MHz)<br>Biconilog (30 MHz – 1000 MHz)<br>Double ridged guide (above 1000 MHz) |
| FREQUENCY HOPPING:                 | Disabled  |

| Frequency, MHz                | Field strength of spurious, dB(µV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | Field strength of carrier, dB(µV/m) | Attenuation below carrier, dBc | Limit, dBc | Margin, dB** | Verdict |
|-------------------------------|--------------------------------------|----------------------|-------------------|-------------------|-------------------------------------|--------------------------------|------------|--------------|---------|
| <b>Low carrier frequency</b>  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 33.8043                       | 35.17                                | Vertical             | 1.01              | 180.0             | 96.77                               | 61.60                          | 20.0       | 41.60        | Pass    |
| 55.8976                       | 37.29                                | Vertical             | 1.00              | 99.0              |                                     | 59.48                          |            | 39.48        |         |
| 69.1060                       | 30.68                                | Vertical             | 1.54              | -46.0             |                                     | 66.09                          |            | 46.09        |         |
| 175.0240                      | 39.89                                | Vertical             | 1.00              | -46.0             |                                     | 56.88                          |            | 36.88        |         |
| 629.4770                      | 37.92                                | Vertical             | 1.00              | -46.0             |                                     | 58.85                          |            | 38.85        |         |
| <b>Mid carrier frequency</b>  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 33.7516                       | 36.91                                | Vertical             | 1.00              | 180.0             | 94.84                               | 57.93                          | 20.0       | 37.93        | Pass    |
| 57.0510                       | 39.55                                | Vertical             | 1.00              | 99.0              |                                     | 55.29                          |            | 35.29        |         |
| 70.8091                       | 28.63                                | Vertical             | 3.14              | -98.0             |                                     | 66.21                          |            | 36.21        |         |
| 174.9936                      | 39.69                                | Vertical             | 1.00              | -46.0             |                                     | 55.15                          |            | 35.15        |         |
| 629.9506                      | 36.91                                | Horizontal           | 1.23              | -46.0             |                                     | 57.93                          |            | 37.93        |         |
| <b>High carrier frequency</b> |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 34.0796                       | 34.72                                | Vertical             | 1.01              | 180.0             | 96.63                               | 61.91                          | 20.0       | 41.91        | Pass    |
| 56.9830                       | 38.31                                | Vertical             | 1.02              | 129.0             |                                     | 58.32                          |            | 38.32        |         |
| 64.6728                       | 34.13                                | Vertical             | 1.54              | -17.0             |                                     | 62.50                          |            | 42.50        |         |
| 174.9937                      | 36.82                                | Vertical             | 1.00              | -27.0             |                                     | 59.81                          |            | 39.81        |         |
| 623.9453                      | 45.38                                | Horizontal           | 1.01              | -134.0            |                                     | 51.25                          |            | 31.25        |         |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\*- Margin = Attenuation below carrier – specification limit.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b>  | 23-Aug-18                      |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                |                               |

**Table 7.4.3 Field strength of spurious emissions above 1 GHz within restricted bands**

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz  
 INVESTIGATED FREQUENCY RANGE: 1000 – 25000 MHz  
 TEST DISTANCE: 3 m  
 MODULATION: GFSK  
 MODULATING SIGNAL: PRBS  
 BIT RATE: 1 Mbps  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 1000 kHz  
 TEST ANTENNA TYPE: Double ridged guide  
 FREQUENCY HOPPING: Disabled

| Frequency, MHz                | Antenna      |           | Azimuth, degrees* | Peak field strength(VBW=3 MHz) |                 |              | Average field strength(VBW=10 Hz) |                      |                 | Verdict |      |
|-------------------------------|--------------|-----------|-------------------|--------------------------------|-----------------|--------------|-----------------------------------|----------------------|-----------------|---------|------|
|                               | Polarization | Height, m |                   | Measured, dB(µV/m)             | Limit, dB(µV/m) | Margin, dB** | Measured, dB(µV/m)                | Calculated, dB(µV/m) | Limit, dB(µV/m) |         |      |
| <b>Low carrier frequency</b>  |              |           |                   |                                |                 |              |                                   |                      |                 |         |      |
| 4804.4125                     | H            | 1.86      | 4.0               | 50.82                          | 74.00           | -23.18       | 43.66                             | NA                   | 54.00           | -10.34  | Pass |
| <b>Mid carrier frequency</b>  |              |           |                   |                                |                 |              |                                   |                      |                 |         | Pass |
| 4879.5000                     | H            | 1.60      | 4.0               | 52.11                          | 74.00           | -21.89       | 45.80                             | NA                   | 54.00           | -8.2    | Pass |
| <b>High carrier frequency</b> |              |           |                   |                                |                 |              |                                   |                      |                 |         | Pass |
| 4959.4875                     | H            | 1.78      | 3.0               | 49.60                          | 74.00           | -24.40       | 41.19                             | NA                   | 54.00           | -12.81  | Pass |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\*- Margin = Measured field strength - specification limit.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b>  | 23-Aug-18                      |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                |                               |

**Table 7.4.4 Field strength of spurious emissions below 1 GHz within restricted bands**

|                                    |  |
|------------------------------------|--|
| ASSIGNED FREQUENCY:                | 2400.0 – 2483.5 MHz  |
| INVESTIGATED FREQUENCY RANGE:      | 0.009 – 1000 MHz   |
| TEST DISTANCE:                     | 3 m  |
| MODULATION:                        | GFSK   |
| MODULATING SIGNAL:                 | PRBS   |
| BIT RATE:                          | 1 Mbps   |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum  |
| RESOLUTION BANDWIDTH:              | 0.2 kHz (9 kHz – 150 kHz)<br>9.0 kHz (150 kHz – 30 MHz)<br>120 kHz (30 MHz – 1000 MHz) |
| VIDEO BANDWIDTH:                   | > Resolution bandwidth   |
| TEST ANTENNA TYPE:                 | Active loop (9 kHz – 30 MHz)<br>Biconilog (30 MHz – 1000 MHz)                          |
| FREQUENCY HOPPING:                 | Disabled   |

| Frequency, MHz                | Peak emission, dB(µV/m) | Quasi-peak                  |                 |             | Antenna polarization | Antenna height, m | Turn-table position**, degrees | Verdict |
|-------------------------------|-------------------------|-----------------------------|-----------------|-------------|----------------------|-------------------|--------------------------------|---------|
|                               |                         | Measured emission, dB(µV/m) | Limit, dB(µV/m) | Margin, dB* |                      |                   |                                |         |
| <b>Low carrier frequency</b>  |                         |                             |                 |             |                      |                   |                                |         |
| 37.6748                       | 36.14                   | 32.88                       | 40.00           | -7.12       | Vertical             | 1.01              | 180.0                          | Pass    |
| 124.9740                      | 39.57                   | 34.75                       | 43.50           | -8.75       | Vertical             | 1.01              | -46.0                          |         |
| 130.9221                      | 35.82                   | 30.05                       | 43.50           | -13.45      | Vertical             | 1.23              | -39.0                          |         |
| <b>Mid carrier frequency</b>  |                         |                             |                 |             |                      |                   |                                |         |
| 37.6736                       | 36.79                   | 32.96                       | 40.00           | -7.04       | Vertical             | 1.01              | 180.0                          | Pass    |
| 123.9840                      | 32.82                   | 27.67                       | 43.50           | -15.83      | Vertical             | 2.45              | 176.0                          |         |
| 127.3801                      | 38.11                   | 32.40                       | 43.50           | -11.10      | Vertical             | 1.22              | -17.0                          |         |
| <b>High carrier frequency</b> |                         |                             |                 |             |                      |                   |                                |         |
| 37.5240                       | 35.67                   | 30.61                       | 40.00           | -9.39       | Vertical             | 1.02              | -180.0                         | Pass    |
| 123.4335                      | 39.83                   | 33.90                       | 43.50           | -9.60       | Vertical             | 1.01              | 180.0                          |         |
| 134.3763                      | 32.14                   | 24.96                       | 43.50           | -18.54      | Vertical             | 1.54              | -46.0                          |         |

\*- Margin = Measured emission - specification limit.

\*\*- EUT front panel refer to 0 degrees position of turntable.

**Reference numbers of test equipment used**

|         |         |         |         |         |         |  |  |
|---------|---------|---------|---------|---------|---------|--|--|
| HL 0446 | HL 3903 | HL 4360 | HL 4933 | HL 5288 | HL 5405 |  |  |
|---------|---------|---------|---------|---------|---------|--|--|

Full description is given in Appendix A.



HERMON LABORATORIES

|  |                                |  |                               |                              |  |
|--|--------------------------------|--|-------------------------------|------------------------------|--|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |  |                               |                              |  |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |  |                               |                              |  |
| <b>Test mode:</b> Compliance   |                                |  | <b>Verdict:</b> PASS          |                              |  |
| <b>Date(s):</b> 23-Aug-18  |                                |  |                               |                              |  |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % |  | <b>Air Pressure:</b> 1008 hPa | <b>Power:</b> 120 VAC, 60 Hz |  |
| <b>Remarks:</b> HUB 2820   |                                |  |                               |                              |  |

**Table 7.4.5 Restricted bands according to FCC section 15.205**

| MHz               | MHz                 | MHz                   | MHz             | MHz           | GHz           |
|-------------------|---------------------|-----------------------|-----------------|---------------|---------------|
| 0.09 - 0.11       | 8.37625 - 8.38675   | 73 - 74.6             | 399.9 - 410     | 2690 - 2900   | 10.6 - 12.7   |
| 0.495 - 0.505     | 8.41425 - 8.41475   | 74.8 - 75.2           | 608 - 614       | 3260 - 3267   | 13.25 - 13.4  |
| 2.1735 - 2.1905   | 12.29 - 12.293      | 108 - 121.94          | 960 - 1240      | 3332 - 3339   | 14.47 - 14.5  |
| 4.125 - 4.128     | 12.51975 - 12.52025 | 123 - 138             | 1300 - 1427     | 3345.8 - 3358 | 15.35 - 16.2  |
| 4.17725 - 4.17775 | 12.57675 - 12.57725 | 149.9 - 150.05        | 1435 - 1626.5   | 3600 - 4400   | 17.7 - 21.4   |
| 4.20725 - 4.20775 | 13.36 - 13.41       | 156.52475 - 156.52525 | 1645.5 - 1646.5 | 4500 - 5150   | 22.01 - 23.12 |
| 6.215 - 6.218     | 16.42 - 16.423      | 156.7 - 156.9         | 1660 - 1710     | 5350 - 5460   | 23.6 - 24     |
| 6.26775 - 6.26825 | 16.69475 - 16.69525 | 162.0125 - 167.17     | 1718.8 - 1722.2 | 7250 - 7750   | 31.2 - 31.8   |
| 6.31175 - 6.31225 | 16.80425 - 16.80475 | 167.72 - 173.2        | 2200 - 2300     | 8025 - 8500   | 36.43 - 36.5  |
| 8.291 - 8.294     | 25.5 - 25.67        | 240 - 285             | 2310 - 2390     | 9000 - 9200   |               |
| 8.362 - 8.366     | 37.5 - 38.25        | 322 - 335.4           | 2483.5 - 2500   | 9300 - 9500   | Above 38.6    |

**Table 7.4.6 Restricted bands according to RSS-Gen**

| MHz               | MHz                 | MHz                   | MHz             | MHz           | GHz           |
|-------------------|---------------------|-----------------------|-----------------|---------------|---------------|
| 0.09 - 0.11       | 8.291 - 8.294       | 16.80425 - 16.80475   | 399.9 - 410     | 3260 - 3267   | 10.6 - 12.7   |
| 2.1735 - 2.1905   | 8.362 - 8.366       | 25.5 - 25.67          | 608 - 614       | 3332 - 3339   | 13.25 - 13.4  |
| 3.020 - 3.026     | 8.37625 - 8.38675   | 37.5 - 38.25          | 960 - 1427      | 3345.8 - 3358 | 14.47 - 14.5  |
| 4.125 - 4.128     | 8.41425 - 8.41475   | 73 - 74.6             | 1435 - 1626.5   | 3500 - 4400   | 15.35 - 16.2  |
| 4.17725 - 4.17775 | 12.29 - 12.293      | 74.8 - 75.2           | 1645.5 - 1646.5 | 4500 - 5150   | 17.7 - 21.4   |
| 4.20725 - 4.20775 | 12.51975 - 12.52025 | 108 - 138             | 1660 - 1710     | 5350 - 5460   | 22.01 - 23.12 |
| 5.677 - 5.683     | 12.57675 - 12.57725 | 156.52475 - 156.52525 | 1718.8 - 1722.2 | 7250 - 7750   | 23.6 - 24     |
| 6.215 - 6.218     | 13.36 - 13.41       | 156.7 - 156.9         | 2200 - 2300     | 8025 - 8500   | 31.2 - 31.8   |
| 6.26775 - 6.26825 | 16.42 - 16.423      | 240 - 285             | 2310 - 2390     | 9000 - 9200   | 36.43 - 36.5  |
| 6.31175 - 6.31225 | 16.69475 - 16.69525 | 322 - 335.4           | 2655 - 2900     | 9300 - 9500   | Above 38.6    |

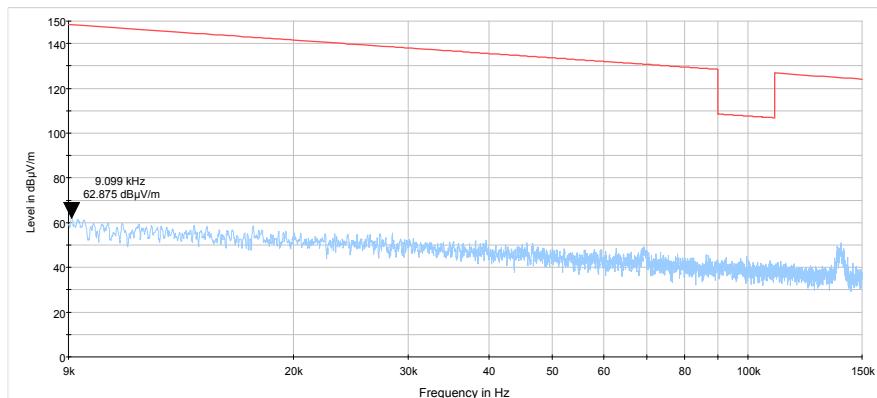


HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

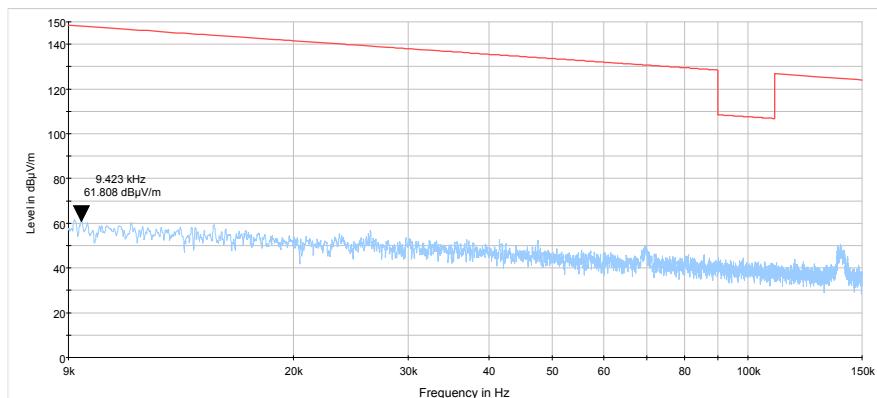
**Plot 7.4.1 Radiated emission measurements from 9 to 150 kHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & horizontal



**Plot 7.4.2 Radiated emission measurements from 9 to 150 kHz at the mid carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & horizontal



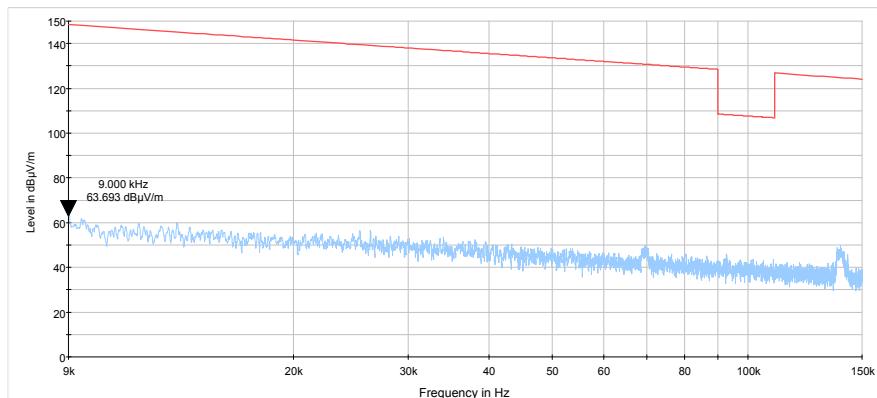


HERMON LABORATORIES

| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

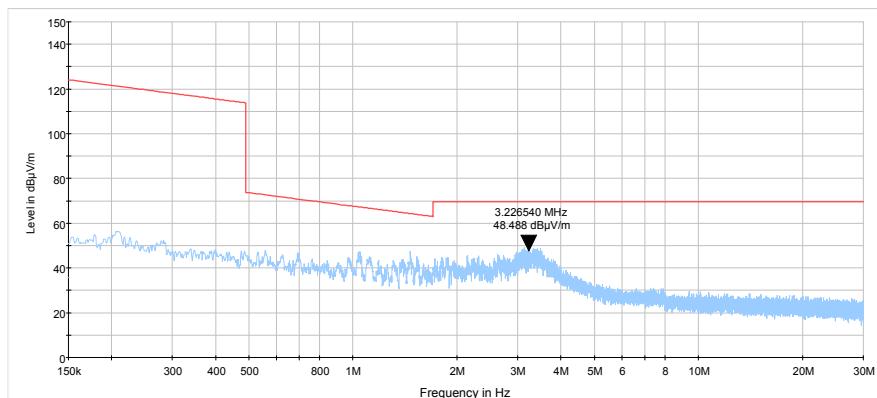
**Plot 7.4.3 Radiated emission measurements from 9 to 150 kHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & horizontal



**Plot 7.4.4 Radiated emission measurements from 0.15 to 30 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & horizontal



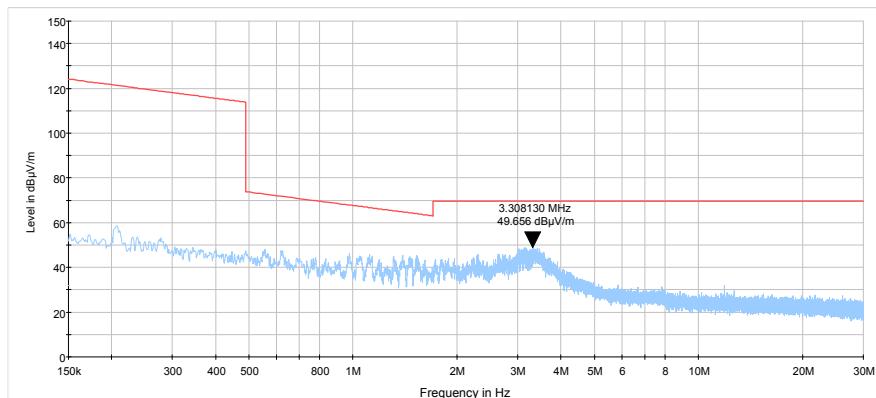


HERMON LABORATORIES

| <b>Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions</b> |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> <b>PASS</b>    |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

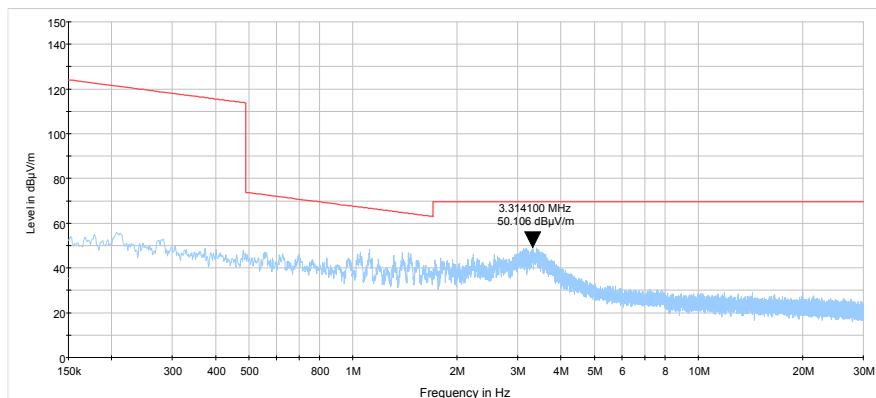
**Plot 7.4.5 Radiated emission measurements from 0.15 to 30 MHz at the mid carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & horizontal



**Plot 7.4.6 Radiated emission measurements from 0.15 to 30 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & horizontal



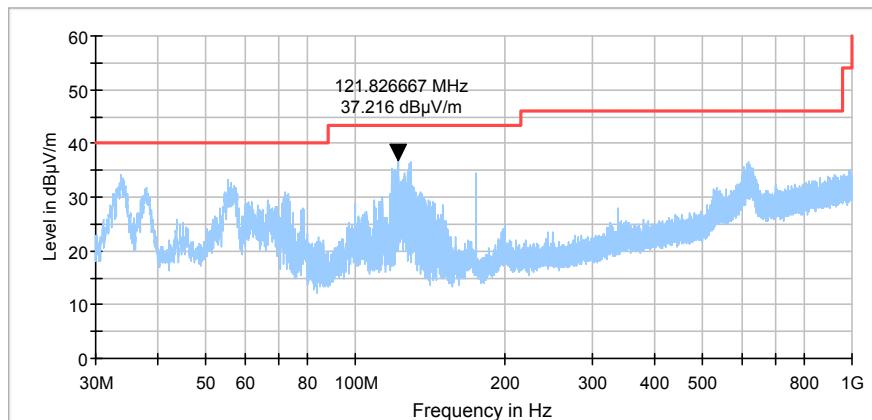


HERMON LABORATORIES

| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

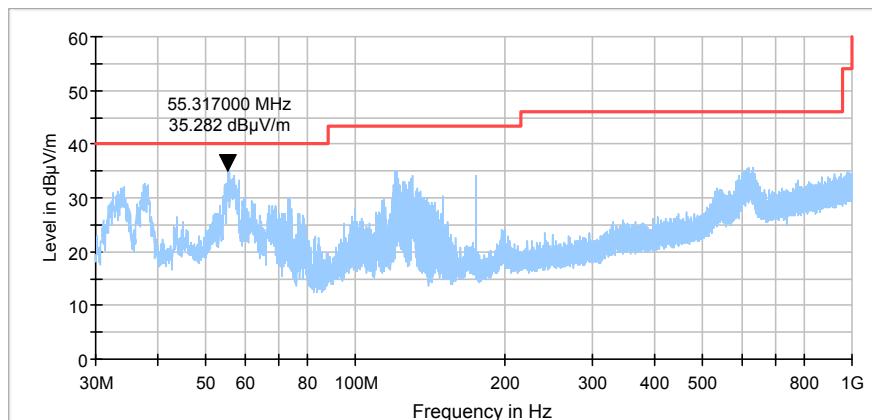
**Plot 7.4.7 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



**Plot 7.4.8 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



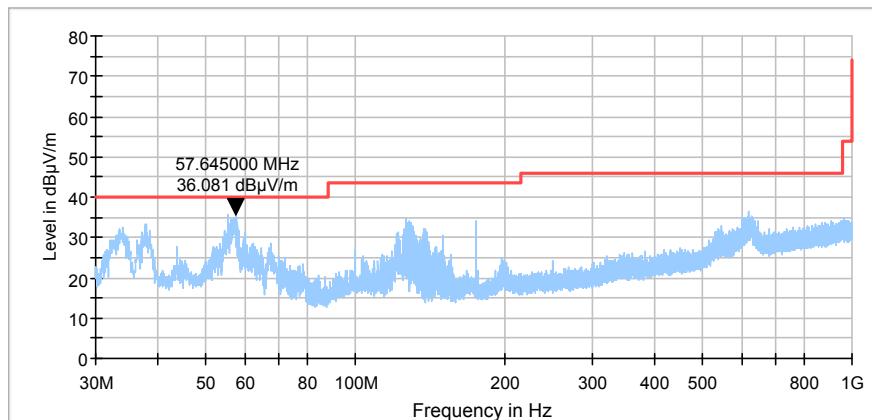


HERMON LABORATORIES

| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

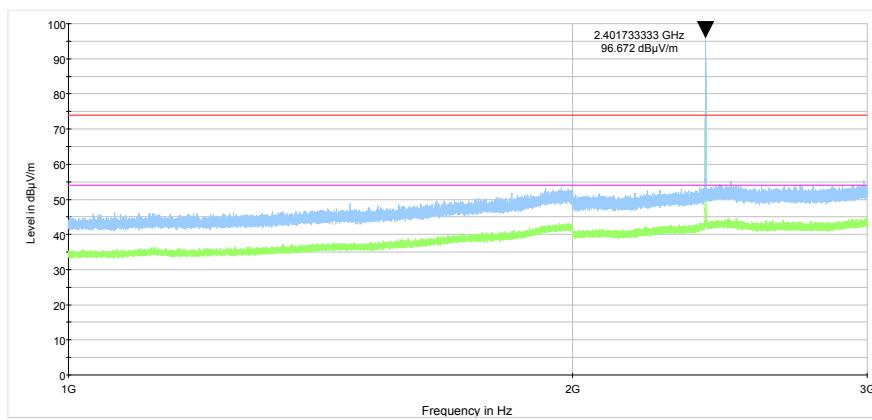
**Plot 7.4.9 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



**Plot 7.4.10 Radiated emission measurements from 1000 to 3000 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



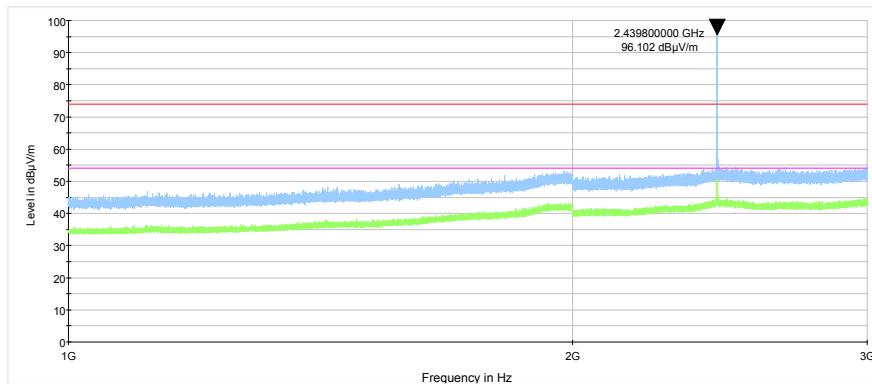


HERMON LABORATORIES

| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

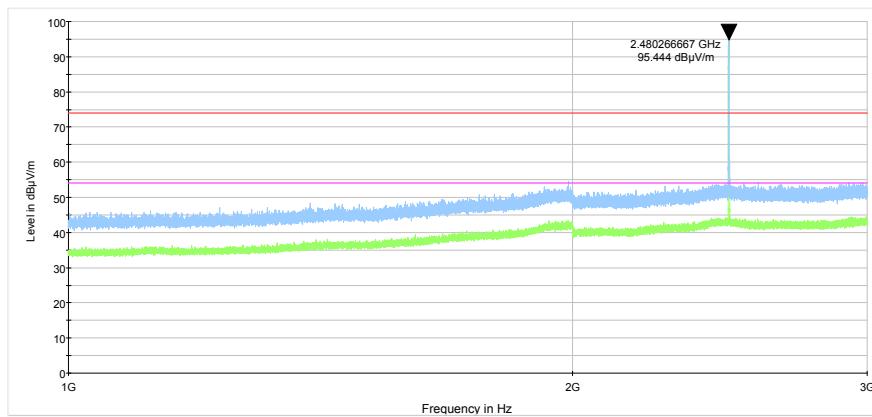
**Plot 7.4.11 Radiated emission measurements from 1000 to 3000 MHz at the mid carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



**Plot 7.4.12 Radiated emission measurements from 1000 to 3000 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



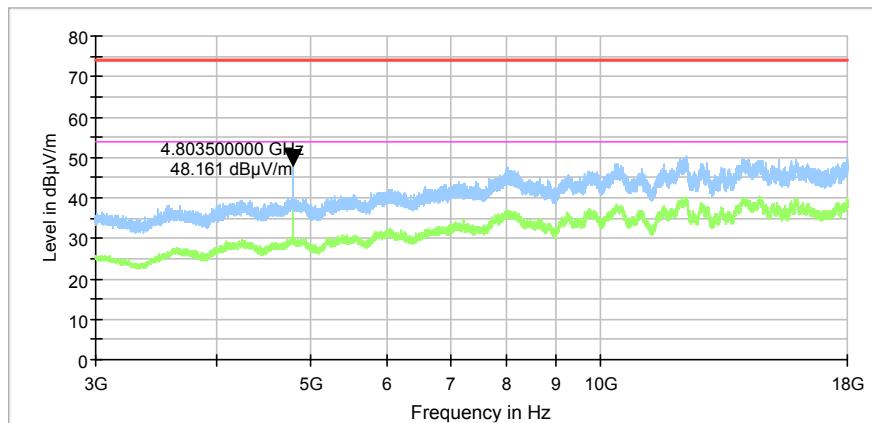


HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

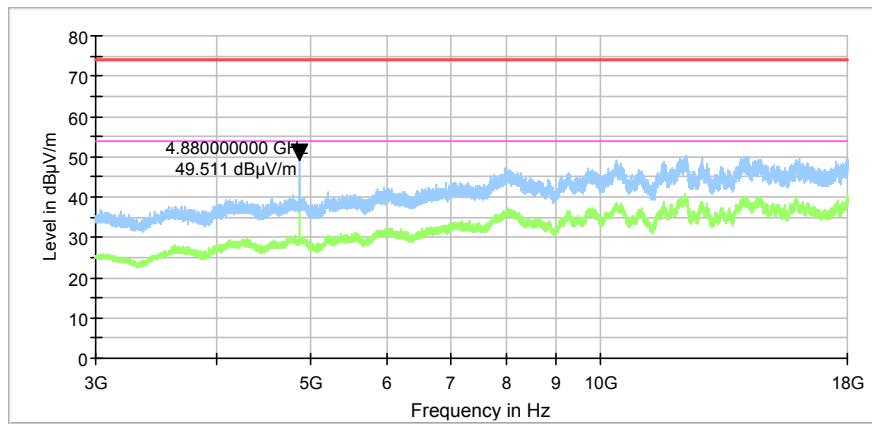
Plot 7.4.13 Radiated emission measurements from 3000 to 18000 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.4.14 Radiated emission measurements from 3000 to 18000 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



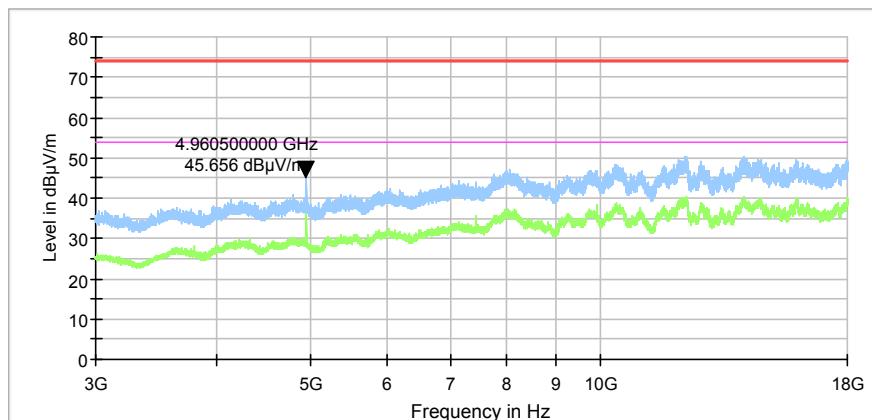


HERMON LABORATORIES

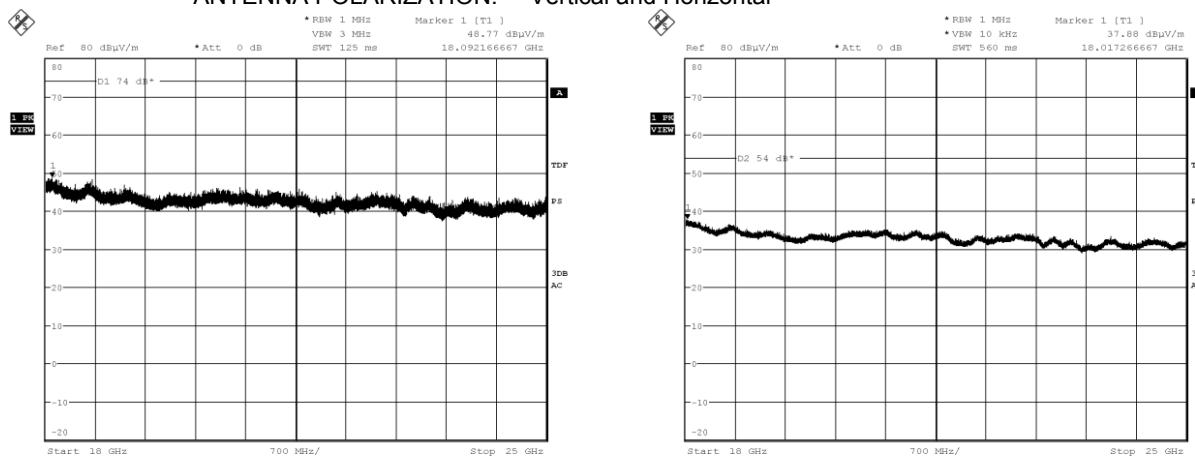
|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                |                               |

**Plot 7.4.15 Radiated emission measurements from 3000 to 18000 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical and Horizontal

**Plot 7.4.16 Radiated emission measurements from 18000 to 25000 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical and Horizontal



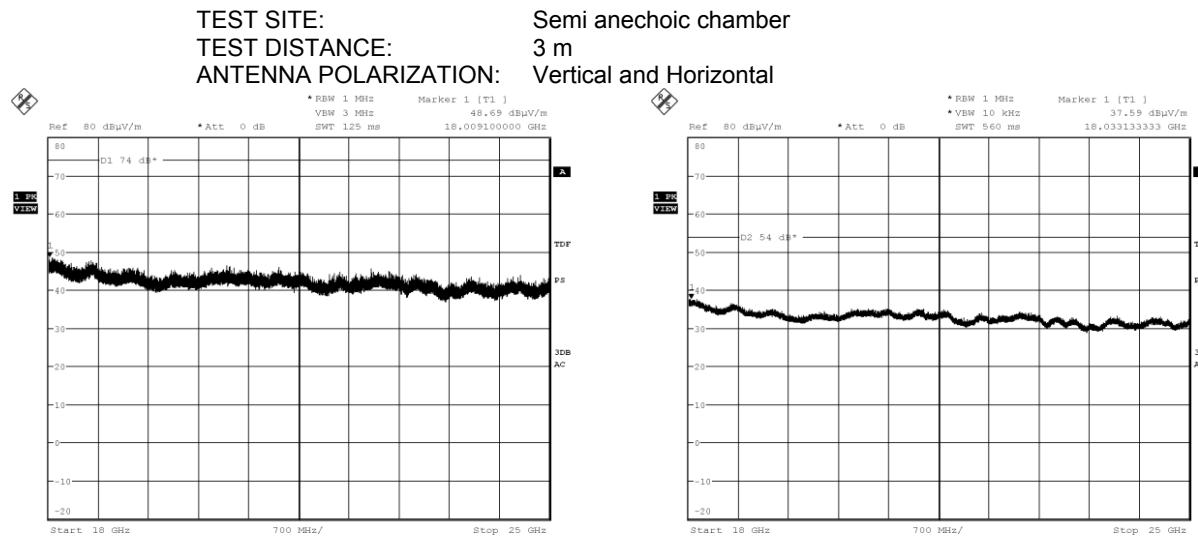
Date: 23.AUG.2018 11:04:04

Date: 23.AUG.2018 11:08:04



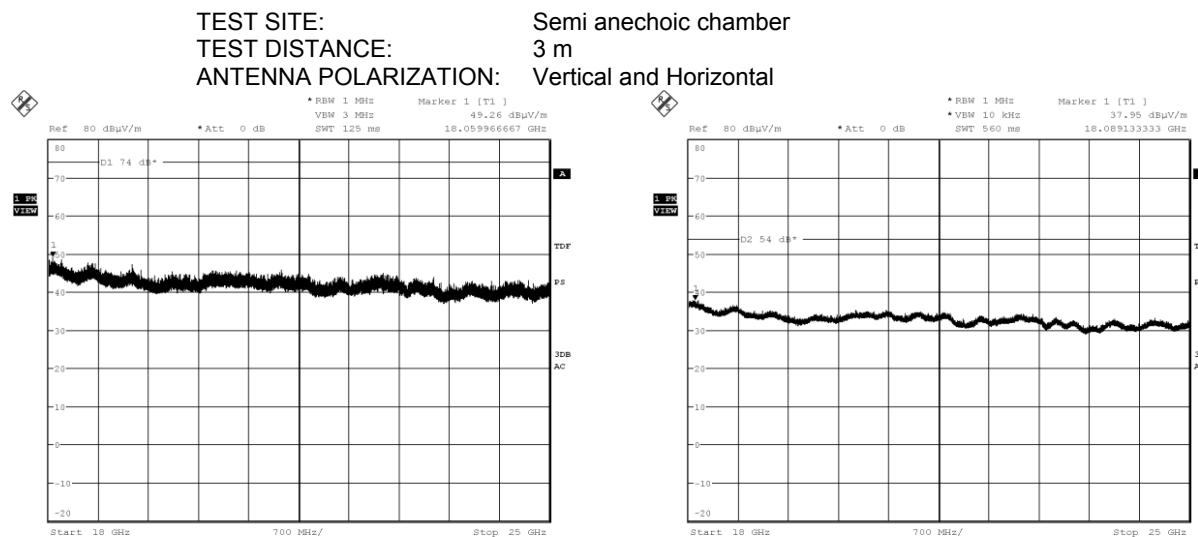
HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2820   |                                |                               |

**Plot 7.4.17 Radiated emission measurements from 18000 to 25000 MHz at the mid carrier frequency**

Date: 23.AUG.2018 11:05:25

Date: 23.AUG.2018 11:09:14

**Plot 7.4.18 Radiated emission measurements from 18000 to 25000 MHz at the high carrier frequency**

Date: 23.AUG.2018 11:06:42

Date: 23.AUG.2018 11:10:10



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                |                               |

## 7.5 Field strength of spurious emissions

### 7.5.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Radiated spurious emissions limits

| Frequency, MHz                   | Field strength at 3 m within restricted bands, dB(µV/m)*** |                 |                 | Attenuation of field strength of spurious versus carrier outside restricted bands, dBc*** |
|----------------------------------|--|-----------------|-----------------|---|
|                                  | Peak   | Quasi Peak      | Average         |   |
| 0.009 – 0.090                    | 148.5 – 128.5  | NA              | 128.5 – 108.5** | 20.0  |
| 0.090 – 0.110                    | NA   | 108.5 – 106.8** | NA              |   |
| 0.110 – 0.490                    | 126.8 – 113.8  | NA              | 106.8 – 93.8**  |   |
| 0.490 – 1.705                    |  | 73.8 – 63.0**   |                 |   |
| 1.705 – 30.0*                    |  | 69.5            |                 |   |
| 30 – 88                          | NA   | 40.0            | NA              |   |
| 88 – 216                         |  | 43.5            |                 |   |
| 216 – 960                        |  | 46.0            |                 |   |
| 960 – 1000                       |  | 54.0            |                 |   |
| 1000 – 10 <sup>th</sup> harmonic | 74.0   | NA              | 54.0            |   |

\*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$L_{m2} = L_{m1} + 40 \log (S_1/S_2),$$

where  $S_1$  and  $S_2$  – standard defined and test distance respectively in meters.

\*\*- The limit decreases linearly with the logarithm of frequency.

\*\*\* - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

### 7.5.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and the performance check was conducted.

7.5.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.5.2.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.

### 7.5.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.5.3.1 The EUT was set up as shown in Figure 7.5.2, Figure 7.5.3, energized and the performance check was conducted.

7.5.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

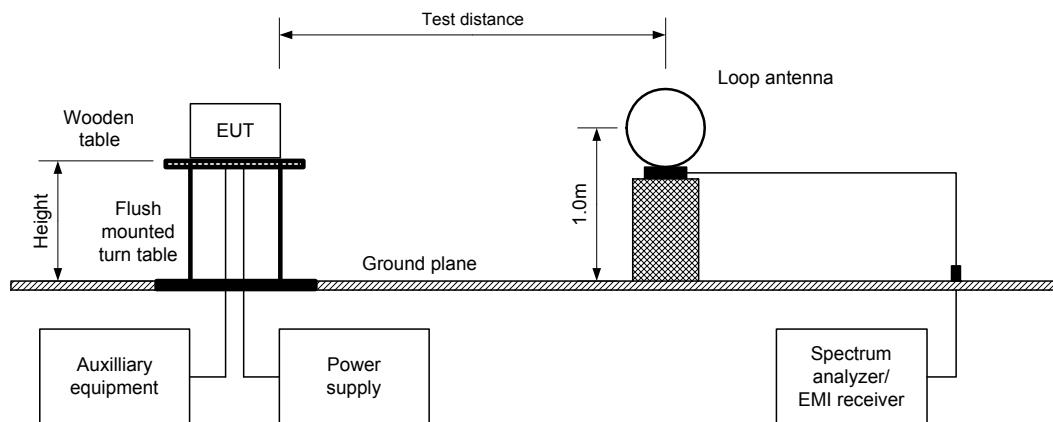
7.5.3.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

Figure 7.5.1 Setup for spurious emission field strength measurements below 30 MHz





HERMON LABORATORIES

| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                             |                        |
|---|-----------------------------|------------------------|
| Test procedure:   | ANSI C63.10 section 11.12.1 |                        |
| Test mode:  | Compliance                  |                        |
| Date(s):  | 23-Aug-18                   |                        |
| Temperature: 25 °C  | Relative Humidity: 48 %     | Air Pressure: 1008 hPa |
| Remarks: HUB 2810   |                             | Power: 120 VAC, 60 Hz  |

Figure 7.5.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz

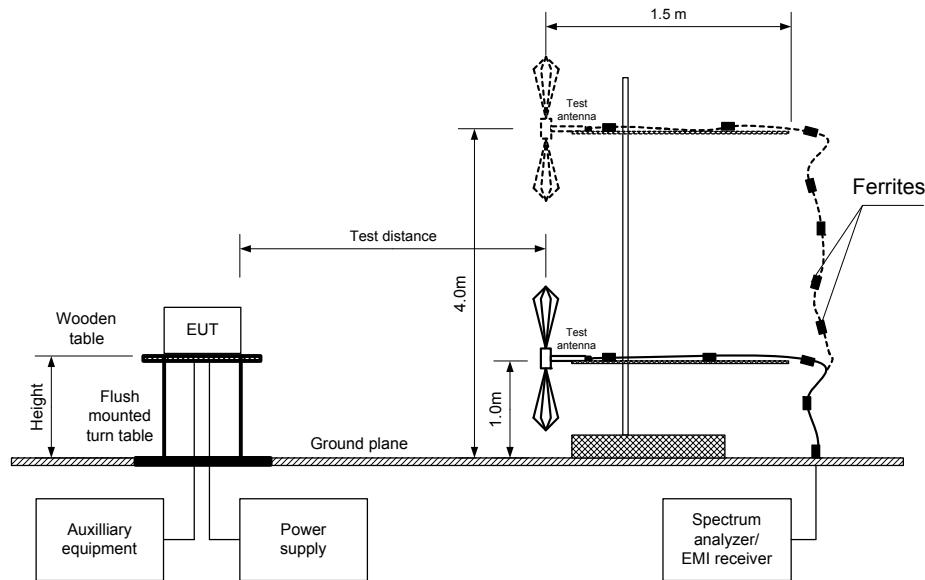
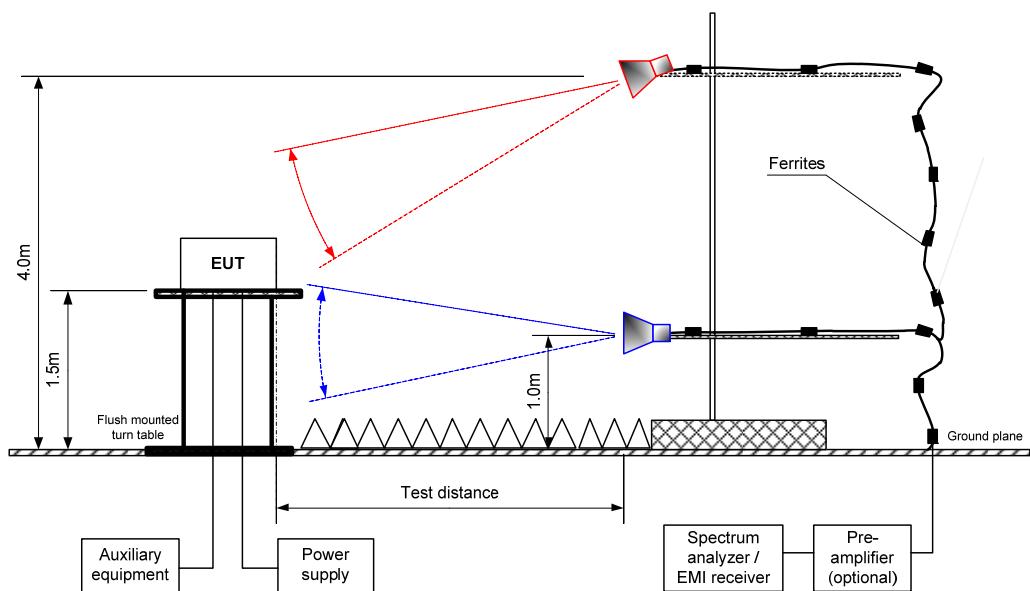


Figure 7.5.3 Setup for spurious emission field strength measurements above 1000 MHz





HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b>  | 23-Aug-18                      |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

**Table 7.5.2 Field strength of emissions outside restricted bands**

|                                    |   |
|------------------------------------|---|
| ASSIGNED FREQUENCY:                | 2400-2483.5 MHz   |
| INVESTIGATED FREQUENCY RANGE:      | 0.009 – 25000 MHz   |
| TEST DISTANCE:                     | 3 m   |
| MODULATION:                        | GFSK  |
| BIT RATE:                          | 1 Mbps  |
| DUTY CYCLE:                        | 100 %   |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum   |
| TRANSMITTER OUTPUT POWER:          | -0.92 dBm at low carrier frequency<br>-1.45 dBm at mid carrier frequency<br>-5.33 dBm at high carrier frequency |
| DETECTOR USED:                     | Peak  |
| RESOLUTION BANDWIDTH:              | 100 kHz   |
| VIDEO BANDWIDTH:                   | 300 kHz   |
| TEST ANTENNA TYPE:                 | Active loop (9 kHz – 30 MHz)<br>Biconilog (30 MHz – 1000 MHz)<br>Double ridged guide (above 1000 MHz)           |
| FREQUENCY HOPPING:                 | Disabled  |

| Frequency, MHz                | Field strength of spurious, dB(µV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | Field strength of carrier, dB(µV/m) | Attenuation below carrier, dBc | Limit, dBc | Margin, dB** | Verdict |
|-------------------------------|--------------------------------------|----------------------|-------------------|-------------------|-------------------------------------|--------------------------------|------------|--------------|---------|
| <b>Low carrier frequency</b>  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 7205.3750                     | 59.89                                | V                    | 1.79              | -80.0             | 96.78                               | 36.89                          | 20.0       | 16.89        | Pass    |
| 14389.4125                    | 52.34                                | H                    | 2.32              | 59.0              |                                     | 44.44                          |            | 24.44        |         |
| <b>Mid carrier frequency</b>  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 14430.6375                    | 52.58                                | V                    | 1.00              | 96.0              | 96.25                               | 43.67                          | 20.0       | 23.67        | Pass    |
| <b>High carrier frequency</b> |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 14411.2625                    | 52.40                                | V                    | 1.00              | 130.0             | 92.37                               | 39.97                          | 20.0       | 19.97        | Pass    |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\*- Margin = Attenuation below carrier – specification limit.



HERMON LABORATORIES

|  |                                |  |  |                               |  |  |                              |             |  |  |  |
|--|--------------------------------|--|--|-------------------------------|--|--|------------------------------|-------------|--|--|--|
| <b>Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions</b> |                                |  |  |                               |  |  |                              |             |  |  |  |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |  |  |                               |  |  |                              |             |  |  |  |
| <b>Test mode:</b> Compliance   |                                |  |  |                               |  |  | <b>Verdict:</b>              | <b>PASS</b> |  |  |  |
| <b>Date(s):</b> 23-Aug-18  |                                |  |  |                               |  |  |                              |             |  |  |  |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % |  |  | <b>Air Pressure:</b> 1008 hPa |  |  | <b>Power:</b> 120 VAC, 60 Hz |             |  |  |  |
| <b>Remarks:</b> HUB 2810   |                                |  |  |                               |  |  |                              |             |  |  |  |

**Table 7.5.3 Field strength of spurious emissions above 1 GHz within restricted bands**

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz  
 INVESTIGATED FREQUENCY RANGE: 1000 – 25000 MHz  
 TEST DISTANCE: 3 m  
 MODULATION: GFSK  
 MODULATING SIGNAL: PRBS  
 BIT RATE: 1 Mbps  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 1000 kHz  
 TEST ANTENNA TYPE: Double ridged guide  
 FREQUENCY HOPPING: Disabled

| Frequency, MHz                | Antenna      |           | Azimuth, degrees* | Peak field strength(VBW=3 MHz) |                 |              | Average field strength |                      |                 |              | Verdict |
|-------------------------------|--------------|-----------|-------------------|--------------------------------|-----------------|--------------|------------------------|----------------------|-----------------|--------------|---------|
|                               | Polarization | Height, m |                   | Measured, dB(µV/m)             | Limit, dB(µV/m) | Margin, dB** | Measured, dB(µV/m)     | Calculated, dB(µV/m) | Limit, dB(µV/m) | Margin, dB** |         |
| <b>Low carrier frequency</b>  |              |           |                   |                                |                 |              |                        |                      |                 |              |         |
| 4804.4000                     | V            | 1.50      | -80.0             | 58.94                          | 74.00           | -15.06       | 53.17                  | N/A                  | 54.00           | -0.83        | Pass    |
| 12257.8375                    | H            | 1.50      | -92.0             | 52.10                          | 74.00           | -21.90       | 38.32                  | N/A                  | 54.00           | -15.68       |         |
| 15943.1000                    | V            | 3.91      | 80.0              | 52.86                          | 74.00           | -21.14       | 38.39                  | N/A                  | 54.00           | -15.61       |         |
| <b>Mid carrier frequency</b>  |              |           |                   |                                |                 |              |                        |                      |                 |              |         |
| 4880.4875                     | V            | 1.53      | -81.0             | 63.80                          | 74.00           | -10.20       | 52.24                  | N/A                  | 54.00           | -1.76        | Pass    |
| 7319.0250                     | V            | 1.00      | -80.0             | 55.81                          | 74.00           | -18.19       | 47.00                  | N/A                  | 54.00           | -7.00        |         |
| 12237.7375                    | V            | 1.00      | 98.0              | 52.19                          | 74.00           | -21.81       | 38.12                  | N/A                  | 54.00           | -15.88       |         |
| 15948.0000                    | H            | 1.00      | -105.0            | 52.71                          | 74.00           | -21.29       | 38.53                  | N/A                  | 54.00           | -15.47       |         |
| <b>High carrier frequency</b> |              |           |                   |                                |                 |              |                        |                      |                 |              |         |
| 4960.5000                     | V            | 1.53      | -93.0             | 63.64                          | 74.00           | -10.36       | 53.18                  | N/A                  | 54.00           | -0.82        | Pass    |
| 7438.9875                     | V            | 1.00      | -93.0             | 56.79                          | 74.00           | -17.21       | 48.22                  | N/A                  | 54.00           | -5.78        |         |
| 12277.7125                    | V            | 1.00      | -32.0             | 52.21                          | 74.00           | -21.79       | 38.21                  | N/A                  | 54.00           | -15.79       |         |
| 15936.3500                    | V            | 1.00      | 43.0              | 52.10                          | 74.00           | -21.90       | 38.16                  | N/A                  | 54.00           | -15.84       |         |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\*- Margin = Measured field strength - specification limit.



HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b>  | 23-Aug-18                      |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

**Table 7.5.4 Field strength of spurious emissions below 1 GHz within restricted bands**

|                                    |  |
|------------------------------------|--|
| ASSIGNED FREQUENCY:                | 2400.0 – 2483.5 MHz  |
| INVESTIGATED FREQUENCY RANGE:      | 0.009 – 1000 MHz   |
| TEST DISTANCE:                     | 3 m  |
| MODULATION:                        | GFSK   |
| MODULATING SIGNAL:                 | PRBS   |
| BIT RATE:                          | 1 Mbps   |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum  |
| RESOLUTION BANDWIDTH:              | 0.2 kHz (9 kHz – 150 kHz)<br>9.0 kHz (150 kHz – 30 MHz)<br>120 kHz (30 MHz – 1000 MHz) |
| VIDEO BANDWIDTH:                   | > Resolution bandwidth   |
| TEST ANTENNA TYPE:                 | Active loop (9 kHz – 30 MHz)<br>Biconilog (30 MHz – 1000 MHz)                          |
| FREQUENCY HOPPING:                 | Disabled   |

| Frequency, MHz                | Peak emission, dB(µV/m) | Quasi-peak                  |                 |             | Antenna polarization | Antenna height, m | Turn-table position**, degrees | Verdict |
|-------------------------------|-------------------------|-----------------------------|-----------------|-------------|----------------------|-------------------|--------------------------------|---------|
|                               |                         | Measured emission, dB(µV/m) | Limit, dB(µV/m) | Margin, dB* |                      |                   |                                |         |
| <b>Low carrier frequency</b>  |                         |                             |                 |             |                      |                   |                                |         |
| 37.5187                       | 35.09                   | 33.18                       | 40.00           | -6.82       | Vertical             | 1.11              | -180.0                         | Pass    |
| 123.1965                      | 38.98                   | 35.91                       | 43.50           | -7.59       | Vertical             | 1.06              | -65.0                          |         |
| 131.3674                      | 35.56                   | 31.14                       | 43.50           | -12.36      | Vertical             | 1.15              | -95.0                          |         |
| <b>Mid carrier frequency</b>  |                         |                             |                 |             |                      |                   |                                |         |
| 37.5487                       | 36.25                   | 33.87                       | 40.00           | -6.13       | Vertical             | 1.51              | -180.0                         | Pass    |
| 123.9652                      | 32.87                   | 28.65                       | 43.50           | -14.85      | Vertical             | 1.16              | 65.0                           |         |
| 127.1298                      | 38.65                   | 33.47                       | 43.50           | -10.03      | Vertical             | 1.12              | 171.0                          |         |
| <b>High carrier frequency</b> |                         |                             |                 |             |                      |                   |                                |         |
| 37.5847                       | 35.49                   | 32.61                       | 40.00           | -7.39       | Vertical             | 1.12              | 180.0                          | Pass    |
| 123.6835                      | 39.61                   | 35.95                       | 43.50           | -7.55       | Vertical             | 1.01              | 51.0                           |         |
| 134.5763                      | 32.85                   | 29.14                       | 43.50           | -14.36      | Vertical             | 1.04              | -1.0                           |         |

\*- Margin = Measured emission - specification limit.

\*\*- EUT front panel refer to 0 degrees position of turntable.

**Reference numbers of test equipment used**

|         |         |         |         |         |         |  |  |
|---------|---------|---------|---------|---------|---------|--|--|
| HL 0446 | HL 3903 | HL 4360 | HL 4933 | HL 5288 | HL 5405 |  |  |
|---------|---------|---------|---------|---------|---------|--|--|

Full description is given in Appendix A.



HERMON LABORATORIES

|  |                                |  |                               |                              |  |
|--|--------------------------------|--|-------------------------------|------------------------------|--|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |  |                               |                              |  |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |  |                               |                              |  |
| <b>Test mode:</b> Compliance   |                                |  | <b>Verdict:</b> PASS          |                              |  |
| <b>Date(s):</b> 23-Aug-18  |                                |  |                               |                              |  |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % |  | <b>Air Pressure:</b> 1008 hPa | <b>Power:</b> 120 VAC, 60 Hz |  |
| <b>Remarks:</b> HUB 2810   |                                |  |                               |                              |  |

**Table 7.5.5 Restricted bands according to FCC section 15.205**

| MHz               | MHz                 | MHz                   | MHz             | MHz           | GHz           |
|-------------------|---------------------|-----------------------|-----------------|---------------|---------------|
| 0.09 - 0.11       | 8.37625 - 8.38675   | 73 - 74.6             | 399.9 - 410     | 2690 - 2900   | 10.6 - 12.7   |
| 0.495 - 0.505     | 8.41425 - 8.41475   | 74.8 - 75.2           | 608 - 614       | 3260 - 3267   | 13.25 - 13.4  |
| 2.1735 - 2.1905   | 12.29 - 12.293      | 108 - 121.94          | 960 - 1240      | 3332 - 3339   | 14.47 - 14.5  |
| 4.125 - 4.128     | 12.51975 - 12.52025 | 123 - 138             | 1300 - 1427     | 3345.8 - 3358 | 15.35 - 16.2  |
| 4.17725 - 4.17775 | 12.57675 - 12.57725 | 149.9 - 150.05        | 1435 - 1626.5   | 3600 - 4400   | 17.7 - 21.4   |
| 4.20725 - 4.20775 | 13.36 - 13.41       | 156.52475 - 156.52525 | 1645.5 - 1646.5 | 4500 - 5150   | 22.01 - 23.12 |
| 6.215 - 6.218     | 16.42 - 16.423      | 156.7 - 156.9         | 1660 - 1710     | 5350 - 5460   | 23.6 - 24     |
| 6.26775 - 6.26825 | 16.69475 - 16.69525 | 162.0125 - 167.17     | 1718.8 - 1722.2 | 7250 - 7750   | 31.2 - 31.8   |
| 6.31175 - 6.31225 | 16.80425 - 16.80475 | 167.72 - 173.2        | 2200 - 2300     | 8025 - 8500   | 36.43 - 36.5  |
| 8.291 - 8.294     | 25.5 - 25.67        | 240 - 285             | 2310 - 2390     | 9000 - 9200   |               |
| 8.362 - 8.366     | 37.5 - 38.25        | 322 - 335.4           | 2483.5 - 2500   | 9300 - 9500   | Above 38.6    |

**Table 7.5.6 Restricted bands according to RSS-Gen**

| MHz               | MHz                 | MHz                   | MHz             | MHz           | GHz           |
|-------------------|---------------------|-----------------------|-----------------|---------------|---------------|
| 0.09 - 0.11       | 8.291 - 8.294       | 16.80425 - 16.80475   | 399.9 - 410     | 3260 - 3267   | 10.6 - 12.7   |
| 2.1735 - 2.1905   | 8.362 - 8.366       | 25.5 - 25.67          | 608 - 614       | 3332 - 3339   | 13.25 - 13.4  |
| 3.020 - 3.026     | 8.37625 - 8.38675   | 37.5 - 38.25          | 960 - 1427      | 3345.8 - 3358 | 14.47 - 14.5  |
| 4.125 - 4.128     | 8.41425 - 8.41475   | 73 - 74.6             | 1435 - 1626.5   | 3500 - 4400   | 15.35 - 16.2  |
| 4.17725 - 4.17775 | 12.29 - 12.293      | 74.8 - 75.2           | 1645.5 - 1646.5 | 4500 - 5150   | 17.7 - 21.4   |
| 4.20725 - 4.20775 | 12.51975 - 12.52025 | 108 - 138             | 1660 - 1710     | 5350 - 5460   | 22.01 - 23.12 |
| 5.677 - 5.683     | 12.57675 - 12.57725 | 156.52475 - 156.52525 | 1718.8 - 1722.2 | 7250 - 7750   | 23.6 - 24     |
| 6.215 - 6.218     | 13.36 - 13.41       | 156.7 - 156.9         | 2200 - 2300     | 8025 - 8500   | 31.2 - 31.8   |
| 6.26775 - 6.26825 | 16.42 - 16.423      | 240 - 285             | 2310 - 2390     | 9000 - 9200   | 36.43 - 36.5  |
| 6.31175 - 6.31225 | 16.69475 - 16.69525 | 322 - 335.4           | 2655 - 2900     | 9300 - 9500   | Above 38.6    |

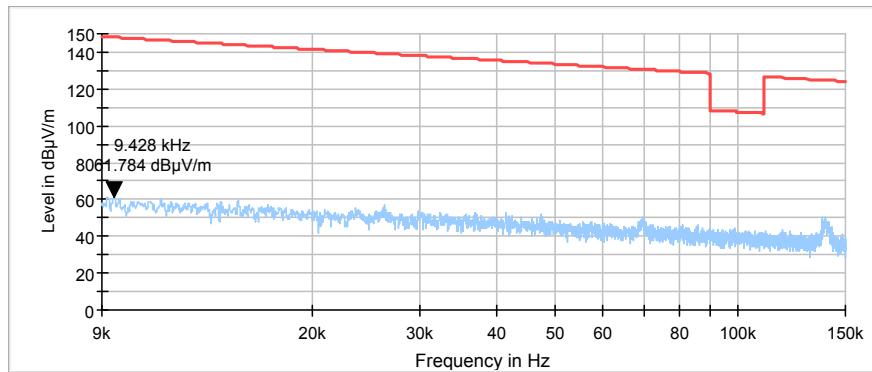


HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

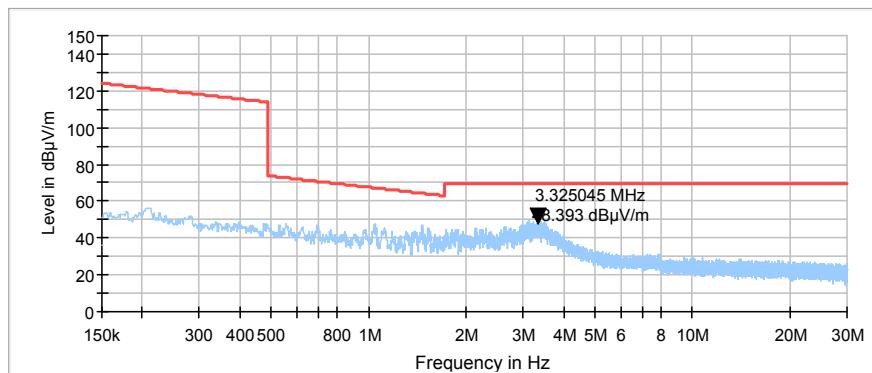
**Plot 7.5.1 Radiated emission measurements from 9 to 150 kHz at the low; mid; high carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical



**Plot 7.5.2 Radiated emission measurements from 0.150 to 30 MHz at the low; mid; high carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical



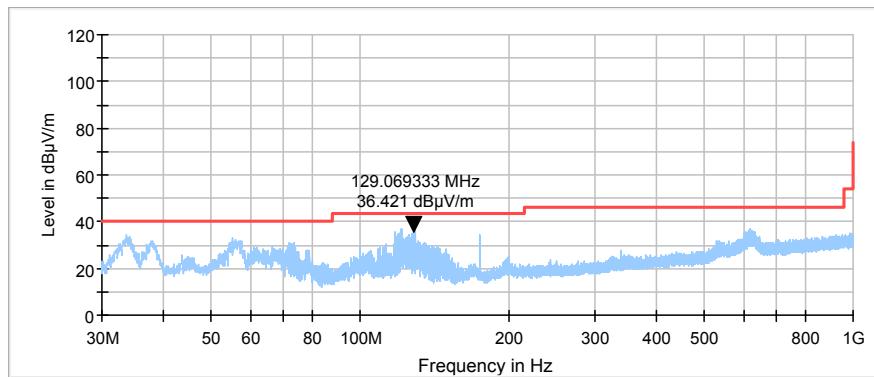


HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

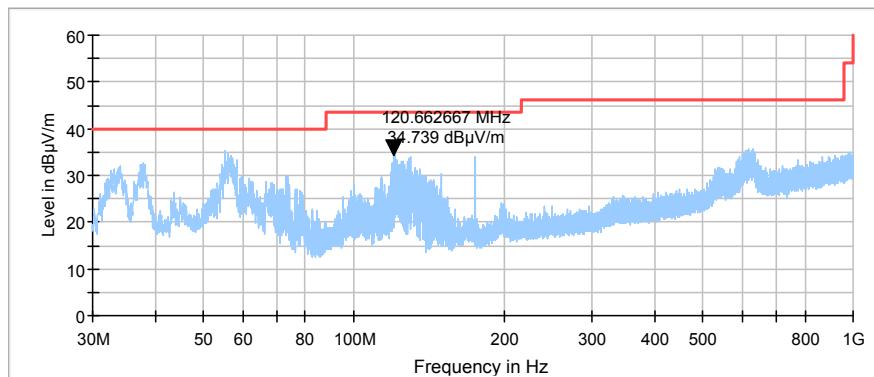
Plot 7.5.3 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.4 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



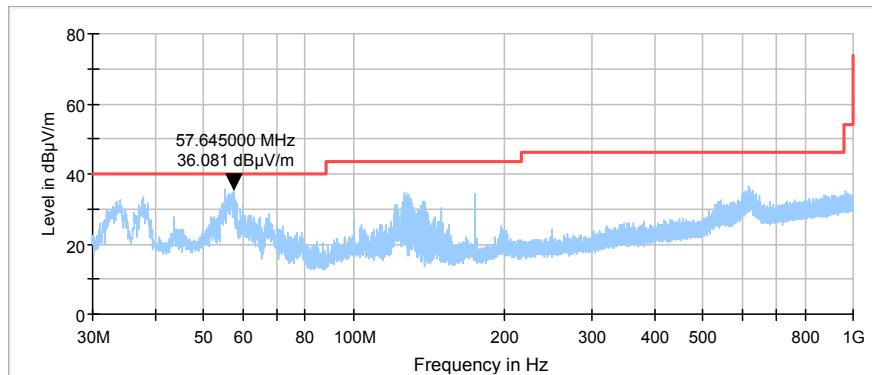


HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

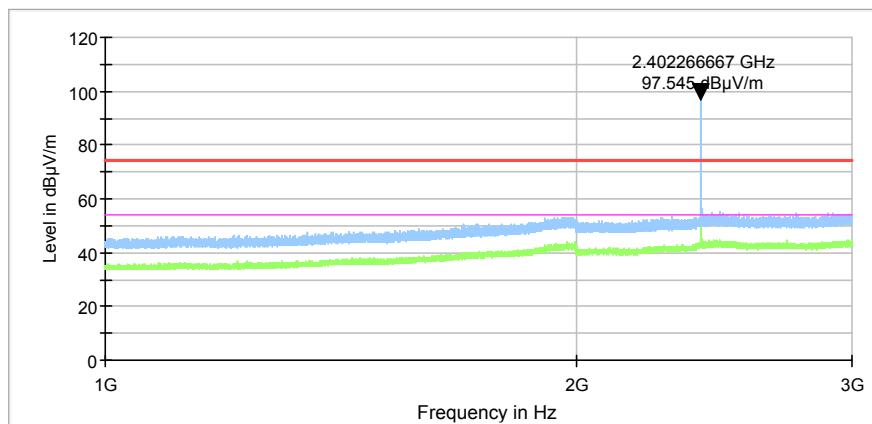
**Plot 7.5.5 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



**Plot 7.5.6 Radiated emission measurements from 1000 to 3000 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



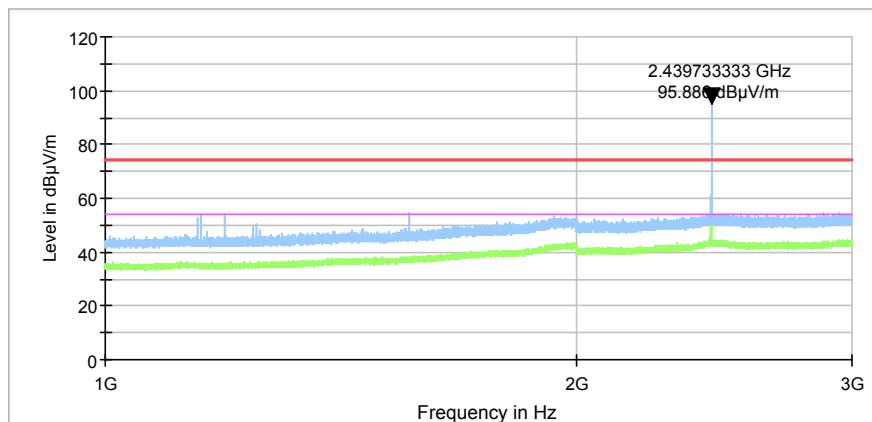


HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

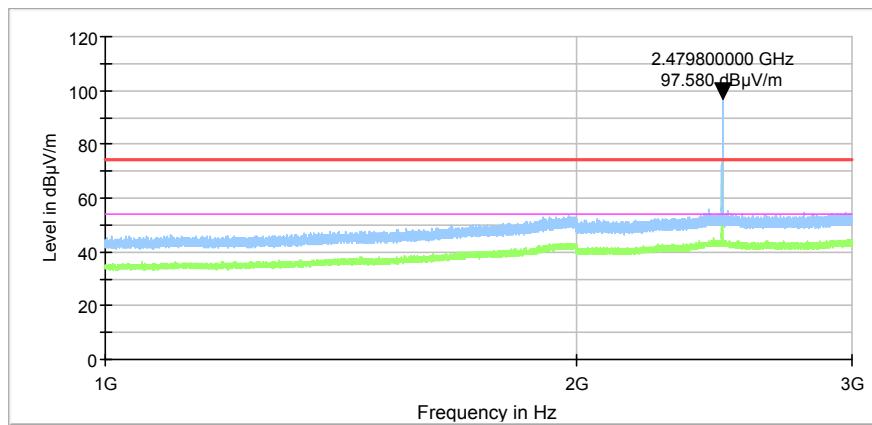
Plot 7.5.7 Radiated emission measurements from 1000 to 3000 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.8 Radiated emission measurements from 1000 to 3000 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



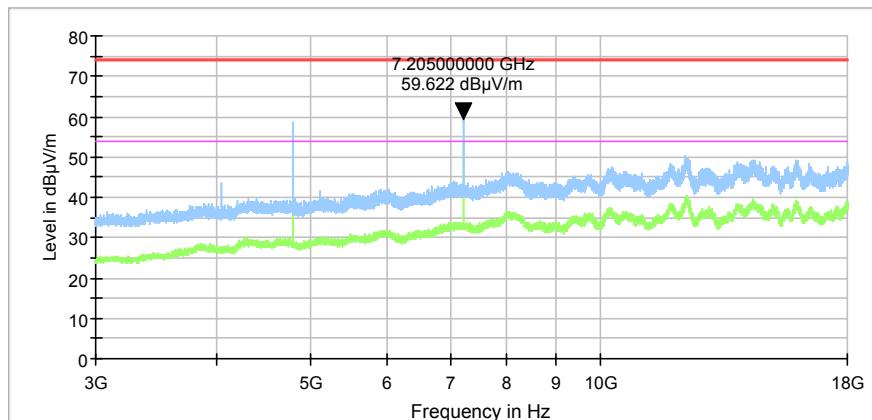


HERMON LABORATORIES

| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                | <b>Power:</b> 120 VAC, 60 Hz  |

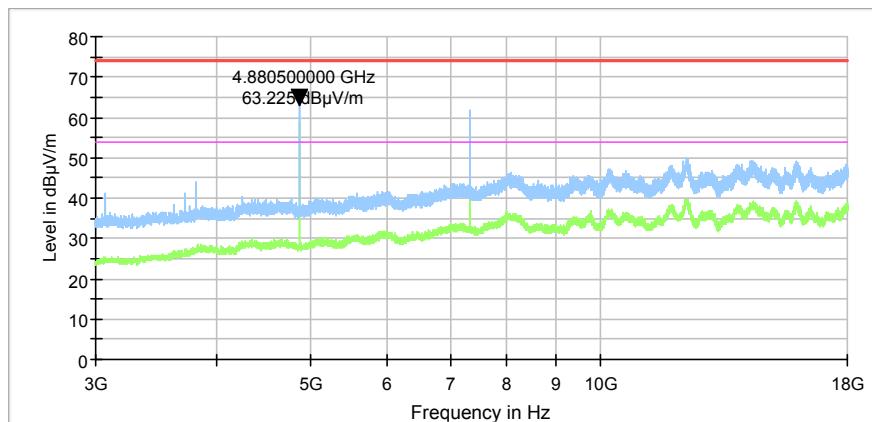
**Plot 7.5.9 Radiated emission measurements from 3000 to 18000 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



**Plot 7.5.10 Radiated emission measurements from 3000 to 18000 MHz at the mid carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



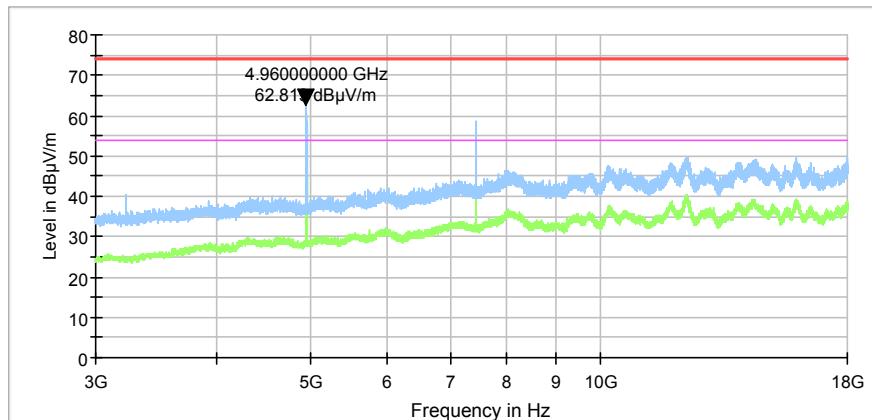


HERMON LABORATORIES

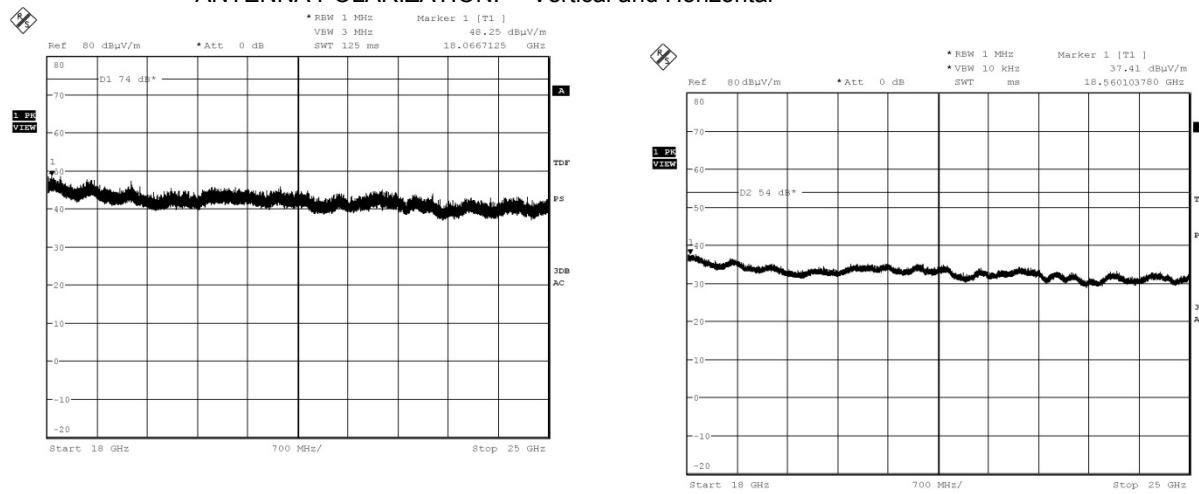
|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18   |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                |                               |

**Plot 7.5.11 Radiated emission measurements from 3000 to 18000 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical and Horizontal

**Plot 7.5.12 Radiated emission measurements from 18000 to 25000 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical and Horizontal



Date: 23.AUG.2018 18:23:25

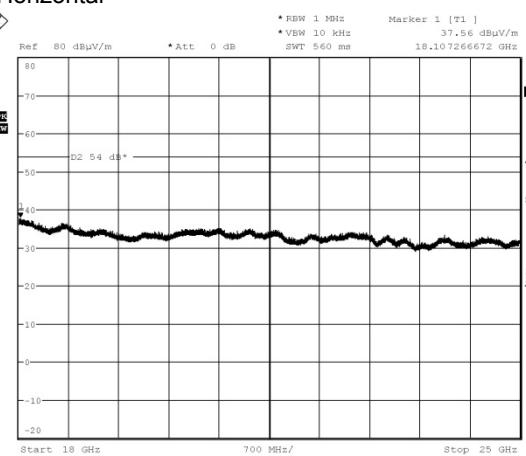
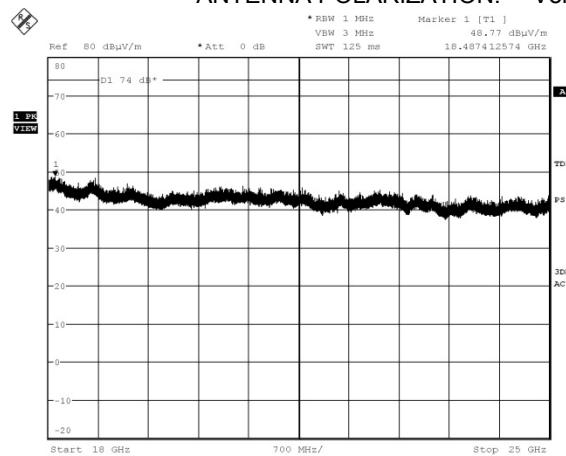


HERMON LABORATORIES

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 23-Aug-18  |                                |                               |
| <b>Temperature:</b> 25 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1008 hPa |
| <b>Remarks:</b> HUB 2810   |                                |                               |

**Plot 7.5.13 Radiated emission measurements from 18000 to 25000 MHz at the mid carrier frequency**

TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical and Horizontal

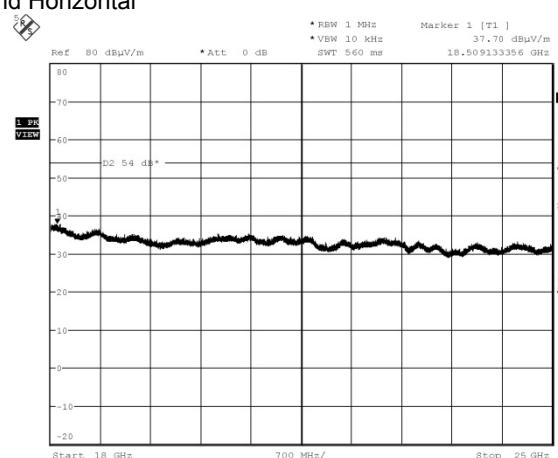
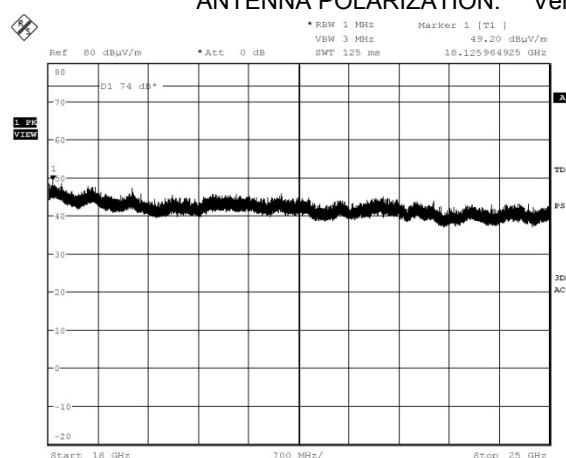


Date: 23.AUG.2018 11:18:23

Date: 23.AUG.2018 11:56:04

**Plot 7.5.14 Radiated emission measurements from 18000 to 25000 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical and Horizontal



Date: 23.AUG.2018 11:25:25

Date: 23.AUG.2018 11:17:25



HERMON LABORATORIES

|   |                                |                               |
|---|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d) / RSS-247 section 5.5, Band edge emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                                      |                                |                               |
| <b>Test mode:</b> Compliance  |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>17-Oct-18 - 06-Nov-18  |                                |                               |
| <b>Temperature:</b> 25 °C   | <b>Relative Humidity:</b> 51 % | <b>Air Pressure:</b> 1013 hPa |
| <b>Remarks:</b> HUB 2810  |                                | <b>Power:</b> 120 VAC, 60 Hz  |

## 7.6 Band edge radiated emissions

### 7.6.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.6.1.

Table 7.6.1 Band edge emission limits

| Assigned frequency, MHz | Attenuation below carrier*, dBc | Field strength at 3 m within restricted bands, dB(μV/m) |         |
|-------------------------|---------------------------------|---|---------|
|                         |                                 | Peak  | Average |
| 2400.0 – 2483.5         | 20.0                            | 74.0  | 54.0    |

\* - Band edge emission limit is provided in terms of attenuation below the peak of modulated carrier measured with the same resolution bandwidth.

### 7.6.2 Test procedure

- 7.6.2.1 The EUT was set up as shown in Figure 7.6.1, energized normally modulated at the maximum data rate with its hopping function disabled and its proper operation was checked.
- 7.6.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.6.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.6.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.6.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.6.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.6.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

Figure 7.6.1 Band edge emission test setup





HERMON LABORATORIES

|   |  |                                |                               |                              |  |  |
|---|--|--------------------------------|-------------------------------|------------------------------|--|--|
| <b>Test specification:</b> Section 15.247(d) / RSS-247 section 5.5, Band edge emissions |  |                                |                               |                              |  |  |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                                      |  |                                |                               |                              |  |  |
| <b>Test mode:</b> Compliance  |  | <b>Verdict:</b> <b>PASS</b>    |                               |                              |  |  |
| <b>Date(s):</b> 17-Oct-18 - 06-Nov-18   |  |                                |                               |                              |  |  |
| <b>Temperature:</b> 25 °C   |  | <b>Relative Humidity:</b> 51 % | <b>Air Pressure:</b> 1013 hPa | <b>Power:</b> 120 VAC, 60 Hz |  |  |
| <b>Remarks:</b> HUB 2810  |  |                                |                               |                              |  |  |

**Table 7.6.2 Band edge emission test results**

ASSIGNED FREQUENCY RANGE: 2400 – 2483.5 MHz  
 DETECTOR USED: Peak  
 MODULATION: GFSK  
 MODULATING SIGNAL: PRBS  
 BIT RATE: 1 Mbps  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum  
 TRANSMITTER OUTPUT POWER: -0.92 dBm at low carrier frequency  
 -5.33 dBm at high carrier frequency  
 RESOLUTION BANDWIDTH:  $\geq 1\%$  of the span  
 VIDEO BANDWIDTH:  $\geq$  RBW

| Frequency, MHz                        | Band edge emission, dBuV/m | Emission at carrier, dBuV/m | Attenuation below carrier, dBc | Limit, dBc | Margin, dB* | Verdict |
|---------------------------------------|----------------------------|-----------------------------|--------------------------------|------------|-------------|---------|
| <b>Low carrier frequency 2402 MHz</b> |                            |                             |                                |            |             |         |
| 2400.0                                | 55.44                      | 96.78                       | 41.34                          | 20.0       | 21.34       | Pass    |

\*- Margin = Attenuation below carrier – specification limit.

| Frequency, MHz                         | Peak field strength(VBW=3 MHz) |                       |              | Average field strength   |                       |              | Verdict |
|--|--------------------------------|-----------------------|--------------|--------------------------|-----------------------|--------------|---------|
|  | Measured, dB( $\mu$ V/m)       | Limit, dB( $\mu$ V/m) | Margin, dB** | Measured, dB( $\mu$ V/m) | Limit, dB( $\mu$ V/m) | Margin, dB** |         |
| <b>Low carrier frequency 2402 MHz</b>  |                                |                       |              |                          |                       |              |         |
| 2390.0                                 | 55.44                          | 74.0                  | -18.56       | 45.63                    | 54.0                  | -8.37        | Pass    |
| <b>High carrier frequency 2480 MHz</b> |                                |                       |              |                          |                       |              |         |
| 2483.5                                 | 51.04                          | 74.0                  | -22.96       | 42.97                    | 54.0                  | -11.03       | Pass    |

\*\*- Margin = Measured field strength - specification limit.

**Reference numbers of test equipment used**

|         |         |         |         |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|
| HL 3903 | HL 4360 | HL 4933 | HL 5405 |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|

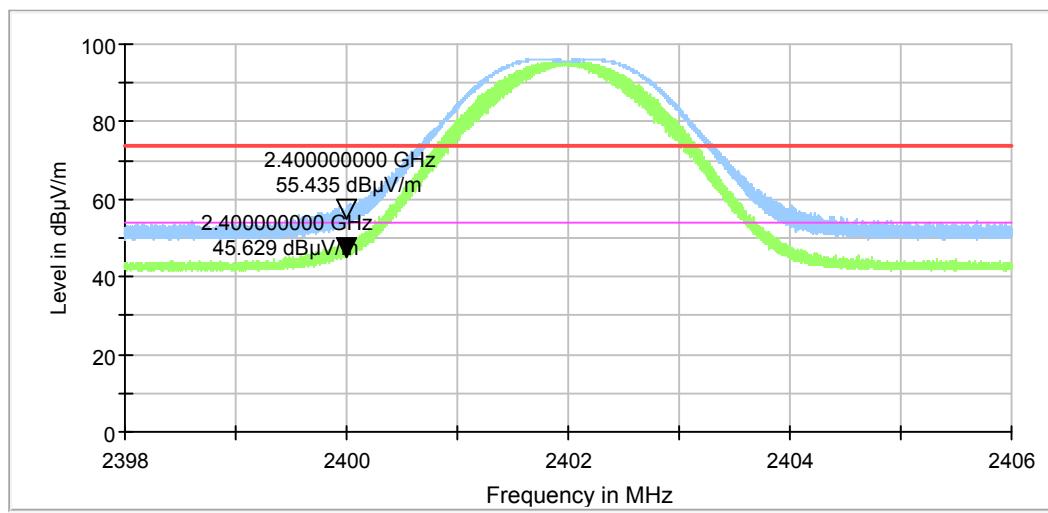
Full description is given in Appendix A.



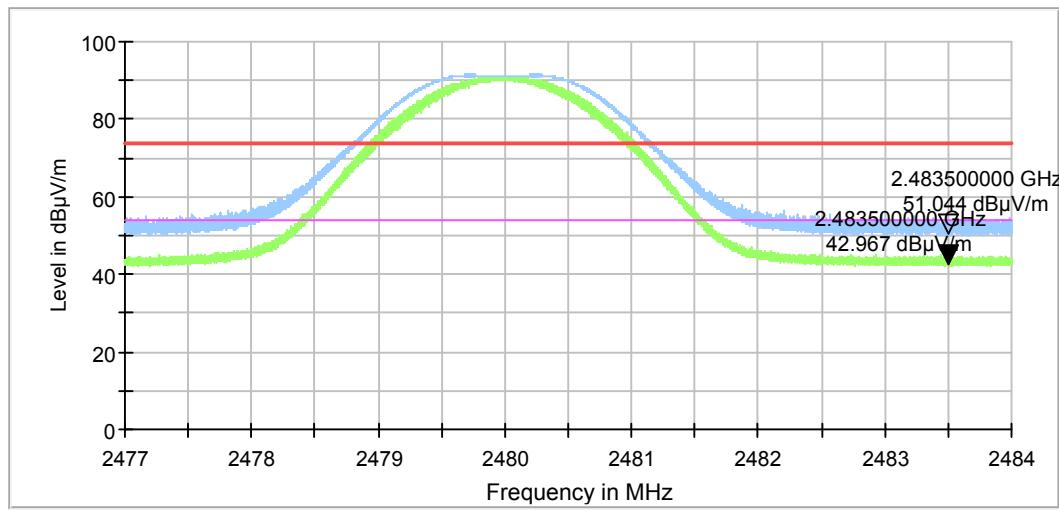
HERMON LABORATORIES

|   |                                |                               |
|---|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d) / RSS-247 section 5.5, Band edge emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                                      |                                |                               |
| <b>Test mode:</b> Compliance  | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 17-Oct-18 - 06-Nov-18   |                                |                               |
| <b>Temperature:</b> 25 °C   | <b>Relative Humidity:</b> 51 % | <b>Air Pressure:</b> 1013 hPa |
| <b>Remarks:</b> HUB 2810  |                                |                               |

Plot 7.6.1 The highest emission level within the assigned band at low carrier frequency



Plot 7.6.2 The highest emission level within the assigned band at high carrier frequency





HERMON LABORATORIES

|   |                                |                               |
|---|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d) / RSS-247 section 5.5, Band edge emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                                      |                                |                               |
| <b>Test mode:</b> Compliance  |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b><br>23-Aug-18 - 17-Oct-18  |                                |                               |
| <b>Temperature:</b> 23 °C   | <b>Relative Humidity:</b> 42 % | <b>Air Pressure:</b> 1009 hPa |
| <b>Remarks:</b> HUB 2820  |                                | <b>Power:</b> 120 VAC, 60 Hz  |

## 7.7 Band edge radiated emissions

### 7.7.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.7.1.

Table 7.7.1 Band edge emission limits

| Assigned frequency, MHz | Attenuation below carrier*, dBc | Field strength at 3 m within restricted bands, dB(μV/m) |         |
|-------------------------|---------------------------------|---|---------|
|                         |                                 | Peak  | Average |
| 2400.0 – 2483.5         | 20.0                            | 74.0  | 54.0    |

\* - Band edge emission limit is provided in terms of attenuation below the peak of modulated carrier measured with the same resolution bandwidth.

### 7.7.2 Test procedure

- 7.7.2.1 The EUT was set up as shown in Figure 7.7.1, energized normally modulated at the maximum data rate with its hopping function disabled and its proper operation was checked.
- 7.7.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.7.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.7.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.7.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.7.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.7.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

Figure 7.7.1 Band edge emission test setup





HERMON LABORATORIES

|   |  |                                |                               |                      |                              |  |
|---|--|--------------------------------|-------------------------------|----------------------|------------------------------|--|
| <b>Test specification:</b> Section 15.247(d) / RSS-247 section 5.5, Band edge emissions |  |                                |                               |                      |                              |  |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                                      |  |                                |                               |                      |                              |  |
| <b>Test mode:</b> Compliance  |  |                                |                               | <b>Verdict:</b> PASS |                              |  |
| <b>Date(s):</b> 23-Aug-18 - 17-Oct-18   |  |                                |                               |                      |                              |  |
| <b>Temperature:</b> 23 °C   |  | <b>Relative Humidity:</b> 42 % | <b>Air Pressure:</b> 1009 hPa |                      | <b>Power:</b> 120 VAC, 60 Hz |  |
| <b>Remarks:</b> HUB 2820  |  |                                |                               |                      |                              |  |

**Table 7.7.2 Band edge emission test results**

|                                    |   |
|------------------------------------|---|
| ASSIGNED FREQUENCY RANGE:          | 2400-2483.5 MHz   |
| DETECTOR USED:                     | Peak  |
| MODULATION:                        | GFSK  |
| MODULATING SIGNAL:                 | PRBS  |
| BIT RATE:                          | 1 Mbps  |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum   |
| TRANSMITTER OUTPUT POWER:          | -0.93 dBm at low carrier frequency<br>-1.07 dBm at high carrier frequency |
| RESOLUTION BANDWIDTH:              | ≥ 1% of the span  |
| VIDEO BANDWIDTH:                   | ≥ RBW   |

| Frequency,<br>MHz                     | Band edge emission,<br>dB <sub>UV</sub> /m | Emission at carrier,<br>dB <sub>UV</sub> /m | Attenuation below carrier,<br>dBc | Limit,<br>dBc | Margin,<br>dB* | Verdict |
|---------------------------------------|--|---|-----------------------------------|---------------|----------------|---------|
| <b>Low carrier frequency 2402 MHz</b> |  |   |                                   |               |                |         |
| 2400.0                                | 54.96                                      | 96.77                                       | 41.81                             | 20.0          | 21.81          | Pass    |

\*- Margin = Attenuation below carrier – specification limit.

| Frequency,<br>MHz                      | Peak field strength(VBW=3 MHz) |                    |                 | Average field strength |                    |                 | Verdict |
|--|--------------------------------|--------------------|-----------------|------------------------|--------------------|-----------------|---------|
|  | Measured,<br>dB(μV/m)          | Limit,<br>dB(μV/m) | Margin,<br>dB** | Measured,<br>dB(μV/m)  | Limit,<br>dB(μV/m) | Margin,<br>dB** |         |
| <b>Low carrier frequency 2402 MHz</b>  |                                |                    |                 |                        |                    |                 |         |
| 2390.0                                 | 54.94                          | 74.0               | -19.06          | 44.94                  | 54.0               | -9.06           | Pass    |
| <b>High carrier frequency 2480 MHz</b> |                                |                    |                 |                        |                    |                 |         |
| 2483.5                                 | 51.84                          | 74.0               | -22.16          | 43.67                  | 54.0               | -10.33          | Pass    |

\*\*- Margin = Measured field strength - specification limit.

**Reference numbers of test equipment used**

|         |         |         |         |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|
| HL 3903 | HL 4360 | HL 4933 | HL 5405 |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|

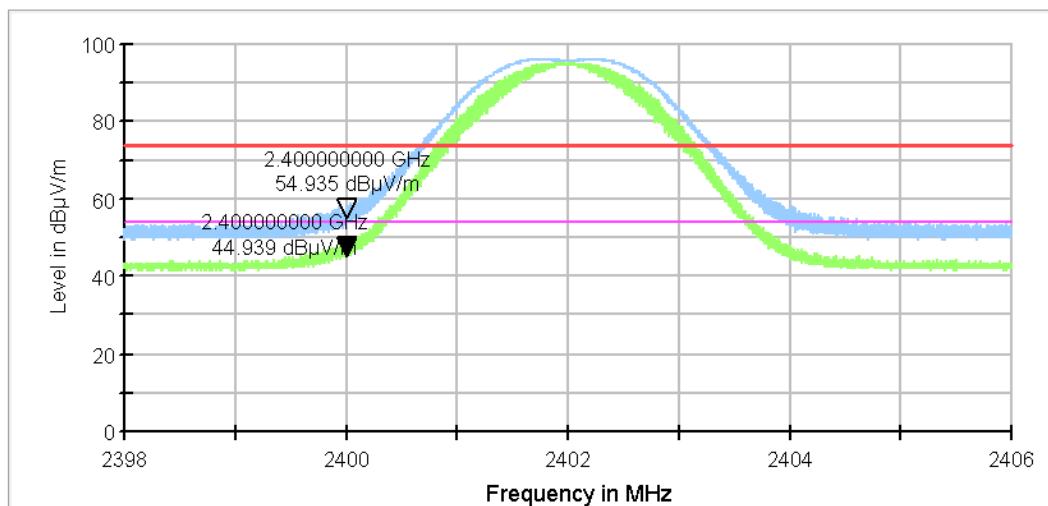
Full description is given in Appendix A.



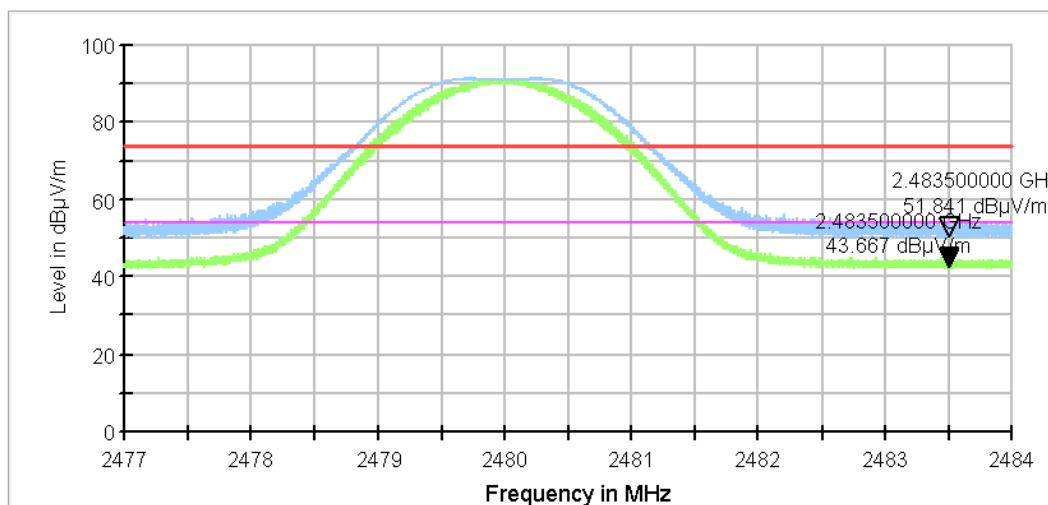
HERMON LABORATORIES

|   |                                |                               |
|---|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(d) / RSS-247 section 5.5, Band edge emissions |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                                      |                                |                               |
| <b>Test mode:</b> Compliance  | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 23-Aug-18 - 17-Oct-18   |                                |                               |
| <b>Temperature:</b> 23 °C   | <b>Relative Humidity:</b> 42 % | <b>Air Pressure:</b> 1009 hPa |
| <b>Remarks:</b> HUB 2820  |                                |                               |

Plot 7.7.1 The highest emission level within the assigned band at low carrier frequency



Plot 7.7.2 The highest emission level within the assigned band at high carrier frequency





HERMON LABORATORIES

|  |                                |                               |                              |
|--|--------------------------------|-------------------------------|------------------------------|
| <b>Test specification:</b> Section 15.247(e) / RSS-247 section 5.2(b), Maximum power density |                                |                               |                              |
| <b>Test procedure:</b>   | ANSI C63.10 section 11.10.2    |                               |                              |
| <b>Test mode:</b>  | Compliance                     |                               |                              |
| <b>Date(s):</b>  | 17-Mar-19                      |                               | <b>Verdict:</b> PASS         |
| Temperature: 23 °C   | <b>Relative Humidity:</b> 55 % | <b>Air Pressure:</b> 1009 hPa | <b>Power:</b> 120 VAC, 60 Hz |
| <b>Remarks:</b>  |                                |                               |                              |

## 7.8 Maximum power spectral density (PSD)

### 7.8.1 General

This test was performed to measure the peak power spectral density radiated by the transmitter RF antenna. Specification test limits are given in Table 7.8.1.

Table 7.8.1 Peak spectral power density limits

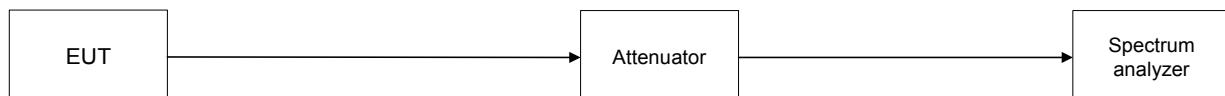
| Assigned frequency range, MHz | Measurement bandwidth, kHz | Peak spectral power density, dBm | Equivalent field strength limit @ 3m, dB( $\mu$ V/m)* |
|-------------------------------|----------------------------|----------------------------------|---|
| 2400.0 – 2483.5               | 3.0                        | 8.0                              | 103.2   |

\* - Equivalent field strength limit was calculated from the peak spectral power density as follows:  $E = \sqrt{30 \times P \times G} / r$ , where P is peak spectral power density and r is antenna to EUT distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator.

### 7.8.2 Test procedure

- 7.8.2.1 The EUT was set up as shown in Figure 7.8.1, energized and its proper operation was checked.
- 7.8.2.2 The EUT was adjusted to produce maximum available to end user RF output power.
- 7.8.2.3 The peak power spectral density was measured in peak hold mode with resolution bandwidth set to 100 kHz, video bandwidth  $\geq$  300 kHz, auto sweep time and sufficient number of sweeps was allowed for trace stabilization. The maximum power level was determined in any 100 kHz band within the fundamental EBW.
- 7.8.2.4 The peak spectral power density was measured as provided in Table 7.8.2 and the associated plots.

Figure 7.8.1 Peak spectral power density test setup





HERMON LABORATORIES

|  |                                |
|--|--------------------------------|
| <b>Test specification:</b> Section 15.247(e) / RSS-247 section 5.2(b), Maximum power density |                                |
| <b>Test procedure:</b>   | ANSI C63.10 section 11.10.2    |
| <b>Test mode:</b>  | Compliance                     |
| <b>Date(s):</b>  | 17-Mar-19                      |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 55 % |
|  | <b>Air Pressure:</b> 1009 hPa  |
|  | <b>Power:</b> 120 VAC, 60 Hz   |
| <b>Remarks:</b>  |                                |

**Table 7.8.2 Peak spectral power density test results**

ASSIGNED FREQUENCY: 2400-2483.5 MHz  
 TEST DISTANCE: 3 m  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 100 kHz  
 VIDEO BANDWIDTH: 300 kHz  
 MODULATION: GFSK  
 BIT RATE: 1 Mbps  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

| Frequency, MHz | PSD at antenna connector, dBm | EUT antenna gain, dBi | PSD, dBm | Limit, dBm | Margin, dB* | Verdict |
|----------------|-------------------------------|-----------------------|----------|------------|-------------|---------|
| 2402           | 1.78                          | 2.5                   | 4.28     | 8          | -3.72       | Pass    |
| 2440           | 2.00                          | 2.5                   | 4.50     | 8          | -3.50       | Pass    |
| 2480           | 2.14                          | 2.5                   | 4.64     | 8          | -3.36       | Pass    |

\*- Margin, dB = PSD, dBm – Limit, dBm.

**Reference numbers of test equipment used**

|         |         |         |  |  |  |  |
|---------|---------|---------|--|--|--|--|
| HL 3440 | HL 3903 | HL 5376 |  |  |  |  |
|---------|---------|---------|--|--|--|--|

Full description is given in Appendix A.



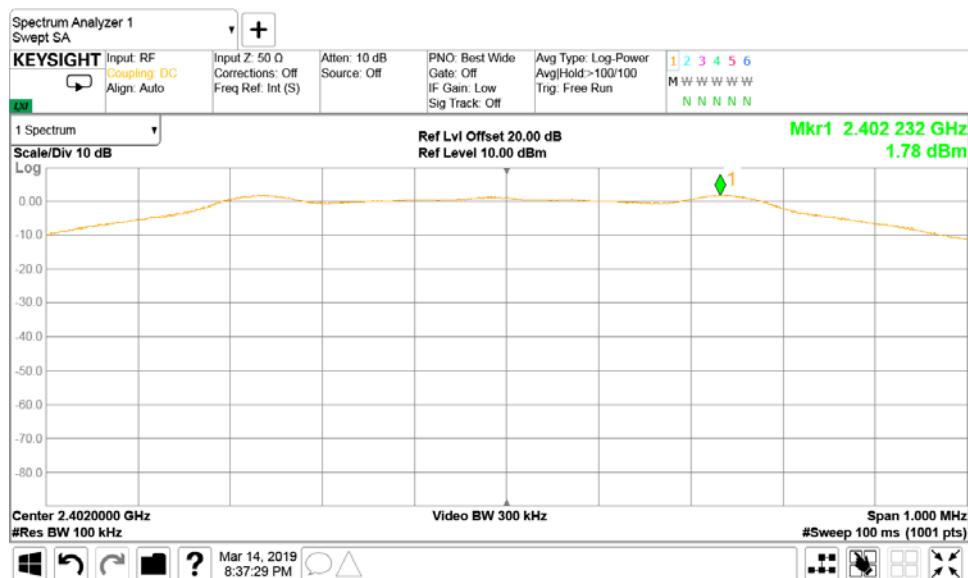
HERMON LABORATORIES

Report ID: AIRRAD\_FCC.31178\_DTS.docx

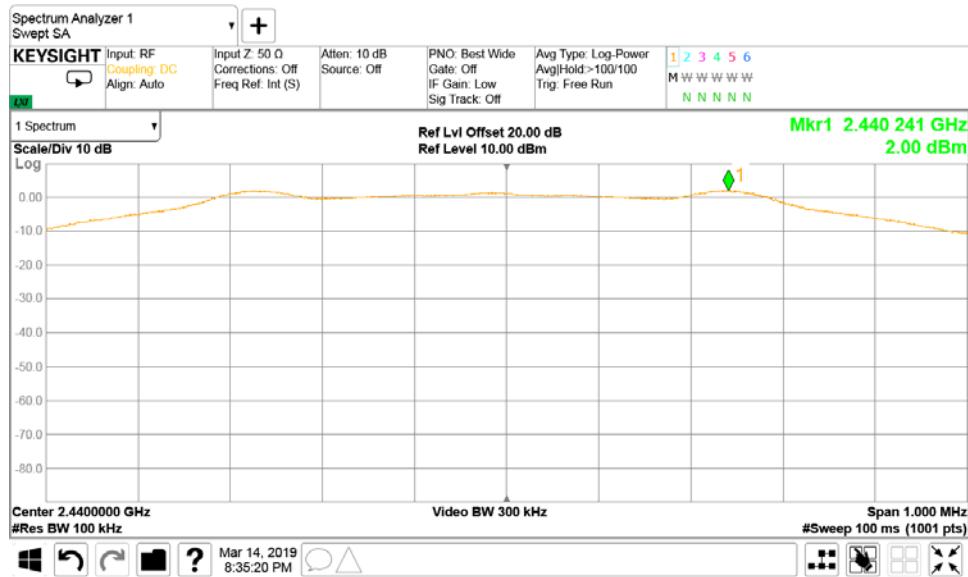
Date of Issue: 25-Mar-19

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(e) / RSS-247 section 5.2(b), Maximum power density |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.10.2   |                                |                               |
| <b>Test mode:</b> Compliance   | <b>Verdict:</b> PASS           |                               |
| <b>Date(s):</b> 17-Mar-19  |                                |                               |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 55 % | <b>Air Pressure:</b> 1009 hPa |
| <b>Remarks:</b>  |                                |                               |

Plot 7.8.1 Peak spectral power density at low frequency



Plot 7.8.2 Peak spectral power density at mid frequency





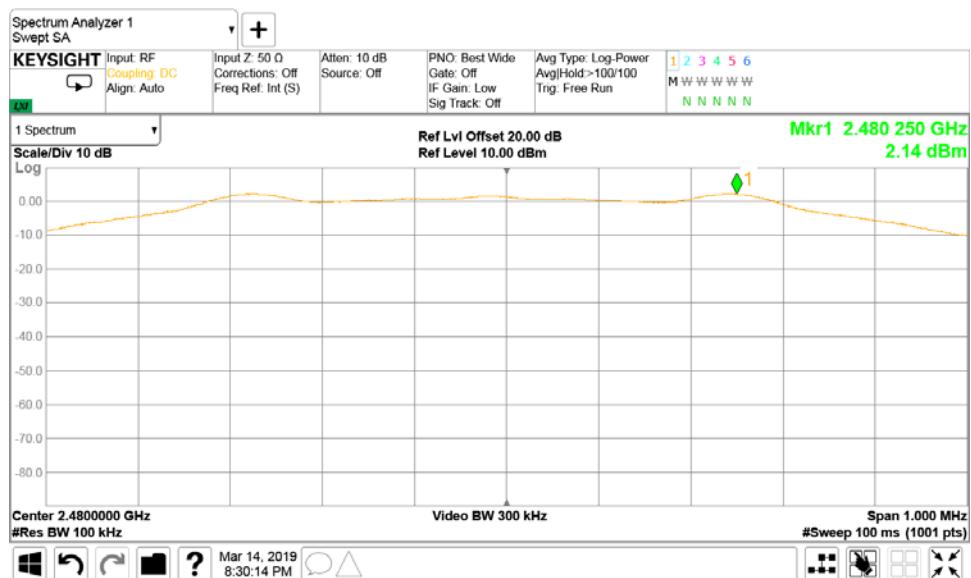
HERMON LABORATORIES

Report ID: AIRRAD\_FCC.31178\_DTS.docx

Date of Issue: 25-Mar-19

|  |                                |                               |
|--|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.247(e) / RSS-247 section 5.2(b), Maximum power density |                                |                               |
| <b>Test procedure:</b> ANSI C63.10 section 11.10.2   |                                |                               |
| <b>Test mode:</b> Compliance   |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 17-Mar-19  |                                |                               |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 55 % | <b>Air Pressure:</b> 1009 hPa |
| <b>Remarks:</b>  |                                |                               |

#### Plot 7.8.3 Peak spectral power density at high frequency





HERMON LABORATORIES

|                                    |   |                               |                              |
|------------------------------------|---|-------------------------------|------------------------------|
| <b>Test specification:</b>         | <b>FCC Part 15, Section 15.203, RSS-Gen section 6.8, Antenna requirements</b> |                               |                              |
| <b>Test procedure:</b>             | Visual inspection   |                               |                              |
| <b>Test mode:</b>                  | Compliance  |                               |                              |
| <b>Date(s):</b>                    | 15-Oct-18   | <b>Verdict:</b>               | PASS                         |
| <b>Temperature:</b> 24.3 °C        | <b>Relative Humidity:</b> 48 %  | <b>Air Pressure:</b> 1009 hPa | <b>Power:</b> 120 VAC, 60 Hz |
| <b>Remarks:</b> HUB 2810, HUB 2820 |   |                               |                              |

## 7.9 Antenna requirements

The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.9.1.

**Table 7.9.1 Antenna requirements**

| Requirement  | Rationale         | Verdict |
|--|-------------------|---------|
| The transmitter antenna is permanently attached    | Visual inspection | Comply  |
| The transmitter employs a unique antenna connector | NA                |         |
| The transmitter requires professional installation | NA                |         |



HERMON LABORATORIES

|   |                                |                               |
|---|--------------------------------|-------------------------------|
| <b>Test specification:</b> Section 15.207(a), RSS-Gen section 8.8, Conducted emission |                                |                               |
| <b>Test procedure:</b> ANSI C63.10, section 6.2                                       |                                |                               |
| <b>Test mode:</b> Compliance  |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 15-Oct-18   |                                |                               |
| Temperature: 24.3 °C  | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1009 hPa |
| <b>Remarks:</b> HUB 2810, HUB 2820  |                                | <b>Power:</b> 120 VAC, 60 Hz  |

## 7.10 Conducted emissions

### 7.10.1 General

This test was performed to measure common mode conducted emissions at the mains power port. Specification test limits are given in Table 7.10.1.

Table 7.10.1 Limits for conducted emissions

| Frequency,<br>MHz | Class B limit, dB(µV) |          | Class A limit, dB(µV) |      |
|-------------------|-----------------------|----------|-----------------------|------|
|                   | QP                    | AVRG     | QP                    | AVRG |
| 0.15 - 0.5        | 66 - 56*              | 56 - 46* | 79                    | 66   |
| 0.5 - 5.0         | 56                    | 46       | 73                    | 60   |
| 5.0 - 30          | 60                    | 50       | 73                    | 60   |

\* The limit decreases linearly with the logarithm of frequency.

### 7.10.2 Test procedure

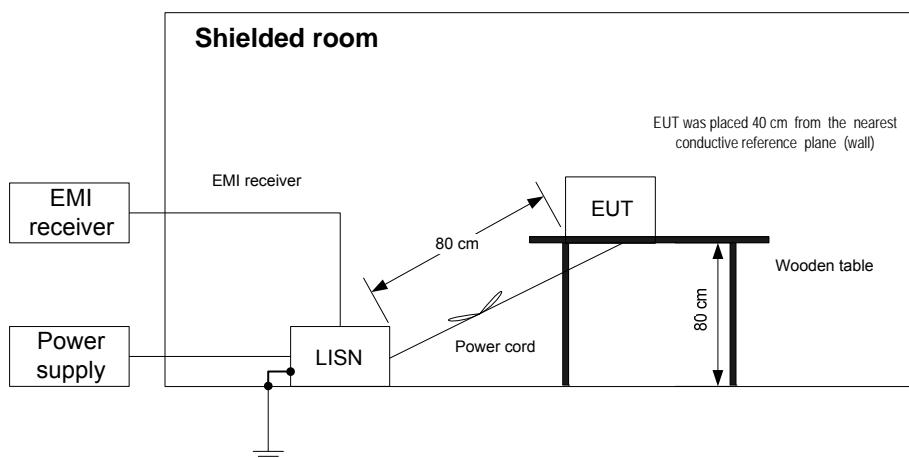
7.10.2.1 The EUT was set up as shown in Figure 7.10.1 and associated photographs, energized and the performance check was conducted.

7.10.2.2 The measurements were performed at power terminals with the LISN, connected to a spectrum analyzer in the frequency range referred to in Table 7.10.2. Unused coaxial connector of the LISN was terminated with 50 Ohm. Quasi-peak and average detectors were used throughout the testing.

7.10.2.3 The position of the device cables was varied to determine maximum emission level.

7.10.2.4 The worst test results (the lowest margins) were recorded in Table 7.10.2 and shown in the associated plots.

Figure 7.10.1 Setup for conducted emission measurements, table-top equipment





HERMON LABORATORIES

|   |                          |
|---|--------------------------|
| <b>Test specification:</b> Section 15.207(a), RSS-Gen section 8.8, Conducted emission |                          |
| Test procedure:   | ANSI C63.10, section 6.2 |
| Test mode:  | Compliance               |
| Date(s):  | 15-Oct-18                |
| Temperature: 24.3 °C  | Relative Humidity: 48 %  |
| Air Pressure: 1009 hPa  |                          |
| Power: 120 VAC, 60 Hz   |                          |
| Remarks: HUB 2810, HUB 2820   |                          |

Table 7.10.2 Conducted emission test results

LINE: AC mains  
 LIMIT: Class B  
 EUT OPERATING MODE: Transmit  
 EUT SET UP: TABLE-TOP  
 TEST SITE: SHIELDED ROOM  
 DETECTORS USED: PEAK / QUASI-PEAK / AVERAGE  
 FREQUENCY RANGE: 150 kHz - 30 MHz  
 RESOLUTION BANDWIDTH: 9 kHz

| Frequency, MHz | Peak emission, dB(µV) | Quasi-peak                |               |             | Average                   |               |             | Line ID | Verdict |
|----------------|-----------------------|---------------------------|---------------|-------------|---------------------------|---------------|-------------|---------|---------|
|                |                       | Measured emission, dB(µV) | Limit, dB(µV) | Margin, dB* | Measured emission, dB(µV) | Limit, dB(µV) | Margin, dB* |         |         |
| 0.556475       | 51.9                  | 50.8                      | 56.0          | -5.20       | 35.8                      | 46.0          | -10.20      | L1      | Pass    |
| 2.782638       | 40.5                  | 38.6                      | 56.0          | -17.40      | 23.4                      | 46.0          | -22.60      |         |         |
| 10.065250      | 39.8                  | 35.9                      | 60.0          | -24.10      | 27.0                      | 50.0          | -23.00      |         |         |
| 15.199400      | 43.0                  | 36.5                      | 60.0          | -23.50      | 27.5                      | 50.0          | -22.50      |         |         |
| 0.278661       | 35.2                  | 31.2                      | 60.9          | -29.66      | 15.4                      | 50.86         | -35.46      |         |         |
| 0.486590       | 37.1                  | 27.2                      | 56.2          | -29.03      | 14.9                      | 46.23         | -31.33      |         |         |
| 0.556260       | 52.2                  | 50.5                      | 56.0          | -5.50       | 34.0                      | 46.0          | -12.00      |         |         |
| 2.780588       | 41.0                  | 38.7                      | 56.0          | -17.30      | 21.2                      | 46.0          | -24.80      |         |         |
| 10.066280      | 39.0                  | 33.0                      | 60.0          | -27.00      | 21.0                      | 50.0          | -29.00      |         |         |
| 15.194888      | 41.2                  | 34.9                      | 60.0          | -25.10      | 26.5                      | 50.0          | -23.50      |         |         |

\*- Margin = Measured emission - specification limit.

## Reference numbers of test equipment used

|         |         |         |         |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|
| HL 0787 | HL 3016 | HL 4280 | HL 4778 |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|

Full description is given in Appendix A.



HERMON LABORATORIES

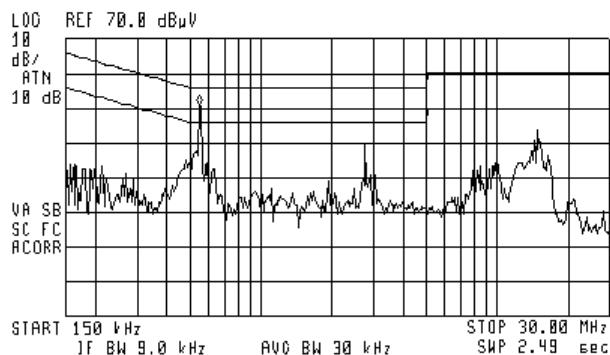
| <b>Test specification:</b> Section 15.207(a), RSS-Gen section 8.8, Conducted emission |                                |                               |
|---|--------------------------------|-------------------------------|
| <b>Test procedure:</b> ANSI C63.10, section 6.2                                       |                                |                               |
| <b>Test mode:</b> Compliance  |                                | <b>Verdict:</b> PASS          |
| <b>Date(s):</b> 15-Oct-18   |                                |                               |
| <b>Temperature:</b> 24.3 °C   | <b>Relative Humidity:</b> 48 % | <b>Air Pressure:</b> 1009 hPa |
| <b>Remarks:</b> HUB 2810, HUB 2820  |                                | <b>Power:</b> 120 VAC, 60 Hz  |

**Plot 7.10.1 Conducted emission measurements**

LINE: L1  
LIMIT: Class B  
EUT OPERATING MODE: Transmit  
LIMIT: QUASI-PEAK, AVERAGE  
PEAK  
DETECTOR:



ACTV DET: PEAK  
MERS DET: PEAK QP AVG  
MKR 550 kHz  
51.08 dB $\mu$ V

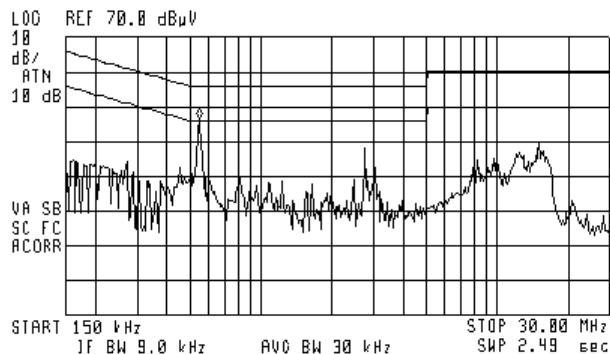


**Plot 7.10.2 Conducted emission measurements**

LINE: L2  
LIMIT: Class B  
EUT OPERATING MODE: Transmit  
LIMIT: QUASI-PEAK, AVERAGE  
PEAK  
DETECTOR:



ACTV DET: PEAK  
MERS DET: PEAK QP AVG  
MKR 550 kHz  
46.71 dB $\mu$ V





HERMON LABORATORIES

## 8 APPENDIX A Test equipment and ancillaries used for tests

| HL No | Description   | Manufacturer          | Model                                | Ser. No.                           | Last Cal./Check | Due Cal./Check |
|-------|---|-----------------------|--------------------------------------|------------------------------------|-----------------|----------------|
| 0446  | Antenna, Loop, Active, 10 kHz - 30 MHz  | EMCO                  | 6502                                 | 2857                               | 24-Feb-19       | 24-Feb-20      |
| 0787  | Transient Limiter 9 kHz-200 MHz   | Hewlett Packard       | 11947A                               | 3107A018<br>77                     | 08-Oct-18       | 08-Oct-19      |
| 3016  | LISN, Two-line V-network, 9 kHz to 30 MHz, (50 uH+5 Ohm), CISPR16-1, MIL-461E | Rohde & Schwarz       | ESH 3-Z5                             | 892239/00<br>2                     | 27-Jan-19       | 27-Jan-20      |
| 3440  | Precision Fixed Attenuator, 50 Ohm, 5 W, 20 dB, DC to 18 GHz                  | Mini-Circuits         | BW-S20W5+                            | NA                                 | 10-Dec-18       | 10-Dec-19      |
| 3903  | Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA                            | Huber-Suhner          | SUCOFLE X 102A                       | 1226/2A                            | 07-Feb-18       | 07-Mar-19      |
| 4280  | Test Cable , DC-18 GHz, 4.6 m, N/M - N/M                                      | Mini-Circuits         | APC-15FT-NMNM+                       | 0763A                              | 01-Aug-18       | 01-Aug-19      |
| 4355  | Signal and Spectrum Analyzer, 9 kHz to 7 GHz                                  | Rohde & Schwarz       | FSV 7                                | 101630                             | 01-Jan-19       | 01-Jan-20      |
| 4360  | EMI Test Receiver, 20 Hz to 40 GHz.   | Rohde & Schwarz       | ESU40                                | 100322                             | 31-Dec-18       | 31-Dec-19      |
| 4778  | EMI Receiver, 9 kHz - 2.9 GHz, System: HL1431, HL4777                         | Hewlett Packard       | 8542E                                | 30807A00<br>262,<br>3427A001<br>23 | 28-Oct-18       | 28-Oct-19      |
| 4933  | Active Horn Antenna, 1 GHz to 18 GHz  | Com-Power Corporation | AHA-118                              | 701046                             | 06-Jan-19       | 06-Jan-20      |
| 5288  | Trilog Antenna, 25 MHz - 8 GHz, 100W  | Frankonia             | ALX-8000E                            | 00809                              | 08-Feb-19       | 08-Feb-22      |
| 5376  | EXA Signal Analyzer, 10 Hz - 32 GHz   | Keysight Technologies | N9010B                               | MY574704<br>04                     | 18-Mar-19       | 18-Mar-20      |
| 5405  | RF cable, 18 GHz, N-N, 6 m  | Huber-Suhner          | SF118/11<br>N(x2)                    | 500023/11<br>8                     | 01-Aug-18       | 01-Aug-19      |
| 5409  | RF cable, 40 GHz, SMA-SMA, 2 m  | Huber-Suhner          | SF102EA/<br>11SK/11S<br>K/2000M<br>M | 503973/2E<br>A                     | 19-Aug-18       | 19-Aug-19      |



HERMON LABORATORIES

## 9 APPENDIX B Measurement uncertainties

### Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

| Test description  | Expanded uncertainty   |
|---|--|
| Conducted carrier power at RF antenna connector                         | Below 12.4 GHz: $\pm 1.7$ dB<br>12.4 GHz to 40 GHz: $\pm 2.3$ dB   |
| Conducted emissions at RF antenna connector                             | 9 kHz to 2.9 GHz: $\pm 2.6$ dB<br>2.9 GHz to 6.46 GHz: $\pm 3.5$ dB<br>6.46 GHz to 13.2 GHz: $\pm 4.3$ dB<br>13.2 GHz to 22.0 GHz: $\pm 5.0$ dB<br>22.0 GHz to 26.8 GHz: $\pm 5.5$ dB<br>26.8 GHz to 40.0 GHz: $\pm 4.8$ dB  |
| Occupied bandwidth  | $\pm 8.0$ %  |
| Duty cycle, timing (Tx ON / OFF) and average factor measurements        | $\pm 1.0$ %  |
| Conducted emissions with LISN   | 9 kHz to 150 kHz: $\pm 3.9$ dB<br>150 kHz to 30 MHz: $\pm 3.8$ dB  |
| Radiated emissions at 3 m measuring distance<br>Horizontal polarization | Biconilog antenna: $\pm 5.3$ dB<br>Biconical antenna: $\pm 5.0$ dB<br>Log periodic antenna: $\pm 5.3$ dB<br>Double ridged horn antenna: $\pm 5.3$ dB<br>Biconilog antenna: $\pm 6.0$ dB<br>Biconical antenna: $\pm 5.7$ dB<br>Log periodic antenna: $\pm 6.0$ dB<br>Double ridged horn antenna: $\pm 6.0$ dB |
| Vertical polarization   |  |

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.

Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.

In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.



HERMON LABORATORIES

## 10 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.

Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-1082 for anechoic chamber, G-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 for conducted emissions at telecommunication ports).

The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

Address: P.O. Box 23, Binyamina 3055001, Israel.  
Telephone: +972 4628 8001  
Fax: +972 4628 8277  
e-mail: mail@hermonlabs.com  
website: www.hermonlabs.com

Person for contact: Mr. Michael Nikishin, EMC&Radio group manager

## 11 APPENDIX D Specification references

|  |  |
|--|--|
| FCC 47CFR part 15: 2017                      | Radio Frequency Devices  |
| ANSI C63.10: 2013                            | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices   |
| KDB 558074 D01 15.247 Meas Guidance v05:2018 | Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules |
| ANSI C63.2: 1996                             | American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications   |
| ANSI C63.4: 2014                             | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz                      |
| RSS-247 Issue 2: 2017                        | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence- Exempt Local Area Network (LE-LAN) Devices  |
| RSS-Gen Issue 5: 2018                        | General Requirements for Compliance of Radio Apparatus   |



HERMON LABORATORIES

## 12 APPENDIX E Test equipment correction factors

Antenna factor  
Active loop antenna  
Model 6502, S/N 2857, HL 0446

| Frequency,<br>MHz | Magnetic antenna factor,<br>dB | Electric antenna factor,<br>dB |
|-------------------|--------------------------------|--------------------------------|
| 0.009             | -32.8                          | 18.7                           |
| 0.010             | -33.8                          | 17.7                           |
| 0.020             | -38.3                          | 13.2                           |
| 0.050             | -41.1                          | 10.4                           |
| 0.075             | -41.3                          | 10.2                           |
| 0.100             | -41.6                          | 9.9                            |
| 0.150             | -41.7                          | 9.8                            |
| 0.250             | -41.6                          | 9.9                            |
| 0.500             | -41.8                          | 9.8                            |
| 0.750             | -41.9                          | 9.7                            |
| 1.000             | -41.4                          | 10.1                           |
| 2.000             | -41.5                          | 10.0                           |
| 3.000             | -41.4                          | 10.2                           |
| 4.000             | -41.4                          | 10.1                           |
| 5.000             | -41.5                          | 10.1                           |
| 10.000            | -41.9                          | 9.6                            |
| 15.000            | -41.9                          | 9.6                            |
| 20.000            | -42.2                          | 9.3                            |
| 25.000            | -42.8                          | 8.7                            |
| 30.000            | -44.0                          | 7.5                            |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB( $\mu$ V) to convert it into field strength in dB( $\mu$ V/m).



HERMON LABORATORIES

**Antenna factor**

**Trilog antenna**

**Model ALX-8000E, Frankonia, S/N 00809, HL 5288, 30-1000 MHz**

| Frequency, MHz | Antenna factor, dB/m |
|----------------|----------------------|
| 30             | 14.96                |
| 35             | 15.33                |
| 40             | 16.37                |
| 45             | 17.56                |
| 50             | 17.95                |
| 60             | 16.87                |
| 70             | 13.22                |
| 80             | 10.56                |
| 90             | 13.61                |
| 100            | 15.46                |
| 120            | 14.03                |
| 140            | 12.23                |
| 160            | 12.67                |
| 180            | 13.34                |
| 200            | 15.40                |
| 250            | 16.42                |
| 300            | 17.28                |
| 400            | 19.98                |
| 500            | 21.11                |
| 600            | 22.90                |
| 700            | 24.13                |
| 800            | 25.25                |
| 900            | 26.35                |
| 1000           | 27.18                |

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



HERMON LABORATORIES

**Antenna factor**  
**Active Horn Antenna,**  
**Com-Power Corporation, model: AHA-118, s/n 701046, HL 4933**

| Frequency, MHz | Measured antenna factor (with preamplifier), dB/m |
|----------------|---|
| 1000           | -16.1   |
| 1500           | -15.1   |
| 2000           | -10.9   |
| 2500           | -11.9   |
| 3000           | -11.1   |
| 3500           | -10.6   |
| 4000           | -8.6  |
| 4500           | -8.3  |
| 5000           | -5.9  |
| 5500           | -5.7  |
| 6000           | -3.3  |
| 6500           | -4.0  |
| 7000           | -2.2  |
| 7500           | -1.7  |
| 8000           | 1.1   |
| 8500           | -0.8  |
| 9000           | -1.5  |
| 9500           | -0.2  |

| Frequency, MHz | Measured antenna factor (with preamplifier), dB/m |
|----------------|---|
| 10000          | 1.8   |
| 10500          | 1.0   |
| 11000          | 0.3   |
| 11500          | -0.5  |
| 12000          | 3.1   |
| 12500          | 1.4   |
| 13000          | -0.3  |
| 13500          | -0.4  |
| 14000          | 2.5   |
| 14500          | 2.2   |
| 15000          | 1.9   |
| 15500          | 0.5   |
| 16000          | 2.1   |
| 16500          | 1.2   |
| 17000          | 0.6   |
| 17500          | 3.1   |
| 18000          | 4.2   |

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



HERMON LABORATORIES

**Cable loss**  
**Microwave Cable Assembly, Huber-Suhner, 40 GHz, 1.5 m, SMA-SMA, S/N 1226/2A**  
**HL 3903**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|----------------|----------------|----------------|----------------|----------------|----------------|
| 10             | -0.02          | 9500           | 1.84           | 21000          | 2.98           |
| 100            | 0.15           | 10000          | 1.86           | 22000          | 3.07           |
| 500            | 0.38           | 10500          | 1.93           | 23000          | 3.13           |
| 1000           | 0.56           | 11000          | 1.99           | 24000          | 3.21           |
| 1500           | 0.69           | 11500          | 2.04           | 25000          | 3.26           |
| 2000           | 0.82           | 12000          | 2.10           | 26000          | 3.48           |
| 2500           | 0.90           | 12500          | 2.15           | 27000          | 3.44           |
| 3000           | 0.98           | 13000          | 2.21           | 28000          | 3.53           |
| 3500           | 1.06           | 13500          | 2.25           | 29000          | 3.59           |
| 4000           | 1.11           | 14000          | 2.29           | 30000          | 3.66           |
| 4500           | 1.17           | 14500          | 2.34           | 31000          | 3.70           |
| 5000           | 1.24           | 15000          | 2.36           | 32000          | 3.79           |
| 5500           | 1.32           | 15500          | 2.40           | 33000          | 3.88           |
| 6000           | 1.40           | 16000          | 2.45           | 34000          | 3.94           |
| 6500           | 1.50           | 16500          | 2.48           | 35000          | 3.91           |
| 7000           | 1.56           | 17000          | 2.56           | 36000          | 4.05           |
| 7500           | 1.62           | 17500          | 2.58           | 37000          | 4.22           |
| 8000           | 1.68           | 18000          | 2.60           | 38000          | 4.25           |
| 8500           | 1.74           | 19000          | 2.84           | 39000          | 4.27           |
| 9000           | 1.78           | 20000          | 2.88           | 40000          | 4.33           |



HERMON LABORATORIES

**Cable loss**  
**Test cable, Mini-Circuits, S/N 0763A, 18 GHz, 4.6 m, N/M - N/M**  
**APC-15FT-NMNM+, HL 4280**

| Frequency, MHz | Cable loss, dB |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 10             | 0.21           | 5000           | 4.27           | 10200          | 6.50           | 15400          | 8.49           |
| 30             | 0.26           | 5100           | 4.32           | 10300          | 6.55           | 15500          | 8.50           |
| 50             | 0.34           | 5200           | 4.35           | 10400          | 6.59           | 15600          | 8.55           |
| 100            | 0.51           | 5300           | 4.41           | 10500          | 6.62           | 15700          | 8.58           |
| 200            | 0.63           | 5400           | 4.43           | 10600          | 6.65           | 15800          | 8.61           |
| 300            | 0.73           | 5500           | 4.49           | 10700          | 6.66           | 15900          | 8.64           |
| 400            | 0.91           | 5600           | 4.54           | 10800          | 6.68           | 16000          | 8.68           |
| 500            | 1.07           | 5700           | 4.58           | 10900          | 6.70           | 16100          | 8.72           |
| 600            | 1.21           | 5800           | 4.63           | 11000          | 6.71           | 16200          | 8.73           |
| 700            | 1.33           | 5900           | 4.67           | 11100          | 6.72           | 16300          | 8.75           |
| 800            | 1.45           | 6000           | 4.73           | 11200          | 6.74           | 16400          | 8.77           |
| 900            | 1.55           | 6100           | 4.76           | 11300          | 6.77           | 16500          | 8.80           |
| 1000           | 1.65           | 6200           | 4.81           | 11400          | 6.81           | 16600          | 8.80           |
| 1100           | 1.75           | 6300           | 4.86           | 11500          | 6.84           | 16700          | 8.82           |
| 1200           | 1.85           | 6400           | 4.89           | 11600          | 6.87           | 16800          | 8.83           |
| 1300           | 1.94           | 6500           | 4.94           | 11700          | 6.89           | 16900          | 8.87           |
| 1400           | 2.03           | 6600           | 4.95           | 11800          | 6.94           | 17000          | 8.92           |
| 1500           | 2.11           | 6700           | 4.99           | 11900          | 7.00           | 17100          | 8.96           |
| 1600           | 2.19           | 6800           | 5.04           | 12000          | 7.05           | 17200          | 9.01           |
| 1700           | 2.27           | 6900           | 5.04           | 12100          | 7.10           | 17300          | 9.07           |
| 1800           | 2.34           | 7000           | 5.09           | 12200          | 7.17           | 17400          | 9.09           |
| 1900           | 2.42           | 7100           | 5.15           | 12300          | 7.23           | 17500          | 9.14           |
| 2000           | 2.49           | 7200           | 5.19           | 12400          | 7.29           | 17600          | 9.17           |
| 2100           | 2.56           | 7300           | 5.25           | 12500          | 7.34           | 17700          | 9.21           |
| 2200           | 2.63           | 7400           | 5.33           | 12600          | 7.38           | 17800          | 9.24           |
| 2300           | 2.69           | 7500           | 5.39           | 12700          | 7.44           | 17900          | 9.28           |
| 2400           | 2.76           | 7600           | 5.42           | 12800          | 7.48           | 18000          | 9.31           |
| 2500           | 2.83           | 7700           | 5.51           | 12900          | 7.55           |                |                |
| 2600           | 2.89           | 7800           | 5.58           | 13000          | 7.58           |                |                |
| 2700           | 2.95           | 7900           | 5.62           | 13100          | 7.63           |                |                |
| 2800           | 3.02           | 8000           | 5.68           | 13200          | 7.67           |                |                |
| 2900           | 3.08           | 8100           | 5.73           | 13300          | 7.72           |                |                |
| 3000           | 3.15           | 8200           | 5.78           | 13400          | 7.76           |                |                |
| 3100           | 3.21           | 8300           | 5.83           | 13500          | 7.81           |                |                |
| 3200           | 3.27           | 8400           | 5.87           | 13600          | 7.85           |                |                |
| 3300           | 3.33           | 8500           | 5.92           | 13700          | 7.88           |                |                |
| 3400           | 3.38           | 8600           | 5.96           | 13800          | 7.93           |                |                |
| 3500           | 3.44           | 8700           | 6.00           | 13900          | 7.97           |                |                |
| 3600           | 3.49           | 8800           | 6.04           | 14000          | 8.01           |                |                |
| 3700           | 3.55           | 8900           | 6.10           | 14100          | 8.05           |                |                |
| 3800           | 3.60           | 9000           | 6.13           | 14200          | 8.09           |                |                |
| 3900           | 3.65           | 9100           | 6.17           | 14300          | 8.12           |                |                |
| 4000           | 3.71           | 9200           | 6.22           | 14400          | 8.15           |                |                |
| 4100           | 3.75           | 9300           | 6.25           | 14500          | 8.19           |                |                |
| 4200           | 3.81           | 9400           | 6.28           | 14600          | 8.22           |                |                |
| 4300           | 3.86           | 9500           | 6.32           | 14700          | 8.26           |                |                |
| 4400           | 3.93           | 9600           | 6.36           | 14800          | 8.29           |                |                |
| 4500           | 3.98           | 9700           | 6.37           | 14900          | 8.32           |                |                |
| 4600           | 4.03           | 9800           | 6.41           | 15000          | 8.36           |                |                |
| 4700           | 4.08           | 9900           | 6.42           | 15100          | 8.40           |                |                |
| 4800           | 4.13           | 10000          | 6.45           | 15200          | 8.43           |                |                |
| 4900           | 4.18           | 10100          | 6.48           | 15300          | 8.44           |                |                |



HERMON LABORATORIES

Report ID: AIRRAD\_FCC.31178\_DTS.docx  
Date of Issue: 25-Mar-19

**Cable loss**  
**RF Cable, Huber-Suhner, 18 GHz, 6 m,**  
**SF118/11N(x2), S/N 500023/118**  
**HL 5405**

5405

## Specific Test Report



| Frequency Range [GHz] | IL min S21 [dB] | IL min S12 [dB] | RL max S11 [dB] | RL max S22 [dB] | Type:         | SF118/11N/11N/6000MM         |
|-----------------------|-----------------|-----------------|-----------------|-----------------|---------------|------------------------------|
| 0.040 - 1.836         | -1.431          | -1.431          | -37.037         | -37.704         | Sales no.:    | 10497130                     |
| 1.836 - 3.632         | -2.062          | -2.066          | -33.573         | -32.848         | Serial no.:   | 500023/118                   |
| 3.632 - 5.428         | -2.576          | -2.576          | -28.548         | -29.602         | PA no.:       | 1956306                      |
| 5.428 - 7.224         | -3.013          | -3.014          | -30.738         | -32.523         | Ring no.:     |                              |
| 7.224 - 9.020         | -3.415          | -3.416          | -33.728         | -32.257         | Cable length: | 6 m                          |
| 9.020 - 10.816        | -3.772          | -3.772          | -29.302         | -30.735         | Test length:  |                              |
| 10.816 - 12.612       | -4.138          | -4.138          | -28.768         | -26.255         | Connector 1:  | SF_11_N-656                  |
| 12.612 - 14.408       | -4.456          | -4.462          | -27.109         | -26.151         | Connector 2:  | SF_11_N-656                  |
| 14.408 - 16.204       | -4.786          | -4.786          | -26.056         | -27.116         | Cable:        | SUCOFLEX_118                 |
| 16.204 - 18.000       | -5.113          | -5.111          | -27.762         | -28.508         | Meas. System: | N5230C,MY49001834,A.09.42.22 |
|                       |                 |                 |                 |                 | Time:         | 7:04:21 AM                   |
|                       |                 |                 |                 |                 | Date:         | 6/6/2018                     |
|                       |                 |                 |                 |                 | Inspected by: | AZ/111                       |
|                       |                 |                 |                 |                 | Start Freq.:  | 0.04000 GHz                  |
|                       |                 |                 |                 |                 | Stop Freq.:   | 18.00000 GHz                 |
|                       |                 |                 |                 |                 | Meas Points:  | 801                          |
|                       |                 |                 |                 |                 | Source Power: | -5 dBm                       |



HERMON LABORATORIES

**Cable loss**  
RF Cable, Huber-Suhner, 40 GHz, 2 m, ,  
SF102EA/11SK/11SK/2000MM, S/N 503973/2EA  
HL 5409

| Frequency,<br>MHz | Cable loss,<br>dB | Frequency,<br>MHz | Cable loss,<br>dB |
|-------------------|-------------------|-------------------|-------------------|
| 100               | 0.26              | 20500             | 3.75              |
| 200               | 0.36              | 21000             | 3.80              |
| 300               | 0.45              | 21500             | 3.85              |
| 500               | 0.58              | 22000             | 3.90              |
| 1000              | 0.82              | 22500             | 3.95              |
| 1500              | 0.99              | 23000             | 4.00              |
| 2000              | 1.15              | 23500             | 4.04              |
| 2500              | 1.28              | 24000             | 4.09              |
| 3000              | 1.40              | 24500             | 4.13              |
| 3500              | 1.51              | 25000             | 4.19              |
| 4000              | 1.61              | 25500             | 4.25              |
| 4500              | 1.71              | 26000             | 4.30              |
| 5000              | 1.80              | 26500             | 4.37              |
| 5500              | 1.89              | 27000             | 4.45              |
| 6000              | 1.98              | 27500             | 4.47              |
| 6500              | 2.06              | 28000             | 4.45              |
| 7000              | 2.14              | 28500             | 4.49              |
| 7500              | 2.22              | 29000             | 4.57              |
| 8000              | 2.29              | 29500             | 4.60              |
| 8500              | 2.36              | 30000             | 4.59              |
| 9000              | 2.43              | 30500             | 4.63              |
| 9500              | 2.50              | 31000             | 4.68              |
| 10000             | 2.58              | 31500             | 4.74              |
| 10500             | 2.63              | 32000             | 4.81              |
| 11000             | 2.70              | 32500             | 4.89              |
| 11500             | 2.76              | 33000             | 4.89              |
| 12000             | 2.82              | 33500             | 4.92              |
| 12500             | 2.87              | 34000             | 4.94              |
| 13000             | 2.94              | 34500             | 4.99              |
| 13500             | 3.00              | 35000             | 5.07              |
| 14000             | 3.06              | 35500             | 5.12              |
| 14500             | 3.11              | 36000             | 5.14              |
| 15000             | 3.17              | 36500             | 5.22              |
| 15500             | 3.23              | 37000             | 5.28              |
| 16000             | 3.29              | 37500             | 5.30              |
| 16500             | 3.35              | 38000             | 5.39              |
| 17000             | 3.41              | 38500             | 5.48              |
| 17500             | 3.47              | 39000             | 5.44              |
| 18000             | 3.51              | 39500             | 5.45              |
| 18500             | 3.56              | 40000             | 5.51              |
| 19000             | 3.60              |                   |                   |
| 19500             | 3.66              |                   |                   |
| 20000             | 3.71              |                   |                   |



HERMON LABORATORIES

## 13 APPENDIX F Abbreviations and acronyms

|          |   |
|----------|---|
| A        | ampere                                      |
| AC       | alternating current                         |
| AM       | amplitude modulation                        |
| AVRG     | average (detector)                          |
| cm       | centimeter                                  |
| dB       | decibel                                     |
| dBm      | decibel referred to one milliwatt           |
| dB(µV)   | decibel referred to one microvolt           |
| dB(µV/m) | decibel referred to one microvolt per meter |
| dB(µA)   | decibel referred to one microampere         |
| DC       | direct current                              |
| EIRP     | equivalent isotropically radiated power     |
| ERP      | effective radiated power                    |
| EUT      | equipment under test                        |
| F        | frequency                                   |
| GHz      | gigahertz                                   |
| GND      | ground                                      |
| H        | height                                      |
| HL       | Hermon laboratories                         |
| Hz       | hertz                                       |
| k        | kilo  |
| kHz      | kilohertz                                   |
| LO       | local oscillator                            |
| m        | meter                                       |
| MHz      | megahertz                                   |
| min      | minute                                      |
| mm       | millimeter                                  |
| ms       | millisecond                                 |
| µs       | microsecond                                 |
| NA       | not applicable                              |
| NB       | narrow band                                 |
| OATS     | open area test site                         |
| Ω        | Ohm   |
| PM       | pulse modulation                            |
| PS       | power supply                                |
| ppm      | part per million ( $10^{-6}$ )              |
| QP       | quasi-peak                                  |
| RE       | radiated emission                           |
| RF       | radio frequency                             |
| rms      | root mean square                            |
| Rx       | receive                                     |
| s        | second                                      |
| T        | temperature                                 |
| Tx       | transmit                                    |
| V        | volt  |
| WB       | wideband                                    |

END OF DOCUMENT