

TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C § 15.247 (FHSS),
RSS-247 issue 1

FOR:

Telematics Wireless Ltd.

Water meter

Model:SONATA

FCC ID:NTASONATA1

IC:4732A-SONATA1

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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 | Changes made in EUT | 5 |
| 6.3 | Test configuration | 5 |
| 6.4 | Transmitter characteristics | 6 |
| 7 | Transmitter tests according to 47CFR part 15 subpart C and RSS-247 requirements | 7 |
| 7.1 | 20 dB bandwidth | 7 |
| 7.2 | Carrier frequency separation | 15 |
| 7.3 | Number of hopping frequencies | 18 |
| 7.4 | Average time of occupancy | 26 |
| 7.5 | Peak output power | 30 |
| 7.6 | Field strength of spurious emissions | 40 |
| 7.7 | Band edge radiated emissions | 69 |
| 7.8 | Antenna requirements | 79 |
| 8 | APPENDIX A Test equipment and ancillaries used for tests | 80 |
| 9 | APPENDIX B Measurement uncertainties | 81 |
| 10 | APPENDIX C Test laboratory description | 82 |
| 11 | APPENDIX D Specification references | 82 |
| 12 | APPENDIX E Test equipment correction factors | 83 |
| 13 | APPENDIX F Abbreviations and acronyms | 93 |

1 Applicant information

Client name: Telematics Wireless Ltd.
Address: 26 Hamelaha street, POB 1911, Holon, 58117, Israel
Telephone: +972 3557 5767
Fax: +972 3557 5753
E-mail: itsikk@tlmw.com
Contact name: Mr. Itsik Kanner

2 Equipment under test attributes

Product name: Water meter
Product type: Transceiver
Model(s): SONATA
Serial number: 14192479
Hardware version: Rev D
Software release: AB01
Receipt date 31-Aug-16

3 Manufacturer information

Manufacturer name: Telematics Wireless Ltd.
Address: 26 Hamelaha street, POB 1911, Holon, 58117, Israel
Telephone: +972 3557 5767
Fax: +972 3557 5753
E-Mail: itsikk@tlmw.com
Contact name: Mr. Itsik Kanner

4 Test details

Project ID: 28785
Location: Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started: 31-Aug-16
Test completed: 22-Sep-16
Test specification(s): FCC 47CFR part 15 subpart C § 15.247 (FHSS);
RSS-247 issue 1




5 Tests summary

| Test | Status |
|---|---|
| Transmitter characteristics | |
| Section 15.247(a)1/ RSS-247 section 5.1(3), 20 dB bandwidth | Pass |
| Section 15.247(a)1/ RSS-247 section 5.1(2), Frequency separation | Pass |
| Section 15.247(a)1/ RSS-247 section 5.1(3), Number of hopping frequencies | Pass |
| Section 15.247(a)1/ RSS-247 section 5.1(3), Average time of occupancy | Pass |
| Section 15.247(b) / RSS-247 section 5.4(1), Peak output power | Pass |
| Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions | Pass |
| Section 15.247(d) / RSS-247 section 5.5, Emissions at band edges | Pass |
| Section 15.247(i)5/ RSS-102 section 2.5, RF exposure | Pass, the exhibit to the application of certification is provided |
| Section 15.203/ RSS-Gen section 8.3, Antenna requirements | Pass |
| Section 15.207(a) / RSS-Gen section 8.8, Conducted emission | Not required |

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.

This test report supersedes the previously issued test report identified by Doc ID: TELRAD_FCC.28785_FHSS.

| | Name and Title | Date | Signature |
|---------------------|---|--------------------|---|
| Tested by: | Mrs. E. Pitt, test engineer | September 22, 2016 |  |
| Reviewed by: | Mrs. M. Cherniavsky, certification engineer | October 31, 2016 |  |
| Approved by: | Mr. M. Nikishin, EMC and radio group leader | December 6, 2016 |  |

6 EUT description

6.1 General information

The EUT is a SONATA water meter, powered from two 3.6 VDC lithium internal batteries.

The EUT supports the following modes of operation:

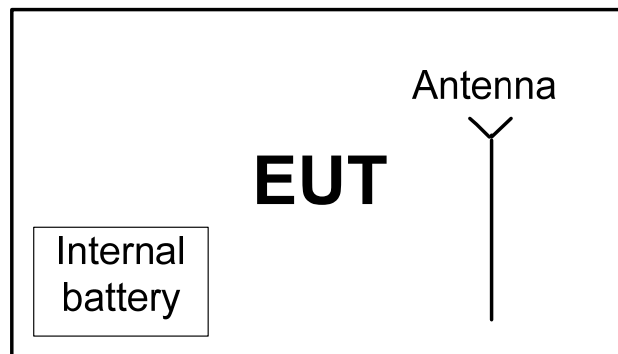
- 1) DTS- BPSK in 905.43 – 923.546 MHz
- 2) DTS- FSK at 916.3 MHz
- 3) FHSS- Wide channel in 902.3-927.8 MHz
- 4) FHSS- Narrow channel in 904-927.9 MHz

This test report represents the FHSS mode test results.

6.2 Changes made in EUT

No changes were implemented in the EUT during the testing.

6.3 Test configuration



6.4 Transmitter characteristics

| | | | | | |
|---|--|--|--|--|--------------------------------|
| Type of equipment | | | | | |
| | Stand-alone (Equipment with or without its own control provisions) | | | | |
| X | 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 | | | |
| X | 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 range | | 902 – 928 MHz | | | |
| Operating frequency range | | 902.3-927.8 MHz (FHSS wide channel) 904 – 927.9 MHz (FHSS narrow channel) | | | |
| Maximum rated output power | | At transmitter 50 Ω RF output connector | | NA | |
| | | Peak output power | | 21.50 dBm (FHSS wide channel) 21.68 dBm (FHSS narrow channel) | |
| 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 | without temporary RF connector |
| Antenna/s technical characteristics | | | | | |
| Type | Manufacturer | | Model number | | Gain |
| Integral | Telematics Wireless Ltd. | | Printed | | 0 dBi |
| Transmitter aggregate data rate/s | | 9.6, 19.2, 38.4, 115.2 kbps | | | |
| Transmitter aggregate symbol (baud) rate/s | | NA | | | |
| Modulating test signal (baseband) | | PRBS | | | |
| Modulation type | | FSK, GFSK | | | |
| Transmitter power source | | | | | |
| X | Battery | Nominal rated voltage | 3.6 VDC | Battery type | Lithium |
| | DC | Nominal rated voltage | VDC | | |
| | AC mains | Nominal rated voltage | VAC | Frequency | |
| Spread spectrum parameters for transmitters tested per FCC 15.247 only | | | | | |
| FHSS | Total number of hops | | 86 wide channels, 240 narrow channels | | |
| | Bandwidth per hop | | 212.7 kHz (for 86 channels); 86.5 kHz (for 240 channels) | | |
| | Max. separation of hops | | 300.7 kHz (for 86 channels); 99.6 kHz (for 240 channels) | | |

| | | | |
|---|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

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

7.1 20 dB bandwidth

7.1.1 General

This test was performed to measure 20 dB bandwidth of the transmitter hopping channel. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 20 dB bandwidth limits

| Assigned frequency, MHz | Maximum bandwidth, kHz | Modulation envelope reference points*, dBc |
|-------------------------|------------------------|--|
| 902.0 – 928.0 | 250 | 20 |
| 2400.0 – 2483.5 | NA | |
| 5725.0 – 5850.0 | 1000 | |

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

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.

7.1.2.3 The transmitter bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in **Error! Reference source not found.** and associated plot.

7.1.2.4 The test was repeated for each data rate and each modulation format.

Figure 7.1.1 The 20 dB bandwidth test setup





| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Table 7.1.2 The 20 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902 – 928 MHz
 DETECTOR USED: Peak
 SWEEP TIME: Auto
 VIDEO BANDWIDTH: ≥ RBW
 MODULATION ENVELOPE REFERENCE POINTS: 20.0 dBc
 MODULATION: GFSK
 MODE: 86 channels

| Carrier frequency, MHz | Baud Rate, bps | 20 dB bandwidth, kHz | Limit, kHz | Margin, kHz | Verdict |
|------------------------|----------------|----------------------|------------|-------------|---------|
| 902.3 | 115200 | 212.724 | 250 | -37.276 | Pass |
| 915.2 | 115200 | 210.566 | 250 | -39.434 | Pass |
| 927.8 | 115200 | 211.163 | 250 | -38.837 | Pass |

Table 7.1.3 The 20 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902 – 928 MHz
 DETECTOR USED: Peak
 SWEEP TIME: Auto
 VIDEO BANDWIDTH: ≥ RBW
 MODULATION ENVELOPE REFERENCE POINTS: 20.0 dBc
 FREQUENCY HOPPING: Disabled
 MODULATION: FSK
 MODE: 240 channels

| Carrier frequency, MHz | Baud Rate, bps | 20 dB bandwidth, kHz | Limit, kHz | Margin, kHz | Verdict |
|------------------------|----------------|----------------------|------------|-------------|---------|
| 904.0 | 9600 | 24.278 | 250 | -225.722 | Pass |
| | 19200 | 44.630 | 250 | -205.37 | Pass |
| | 38400 | 86.500 | 250 | -163.500 | Pass |
| 915.1 | 9600 | 24.998 | 250 | -225.002 | Pass |
| | 19200 | 45.991 | 250 | -204.009 | Pass |
| | 38400 | 84.836 | 250 | -165.164 | Pass |
| 927.9 | 9600 | 24.956 | 250 | -225.044 | Pass |
| | 19200 | 46.512 | 250 | -203.488 | Pass |
| | 38400 | 86.431 | 250 | -163.569 | Pass |

Reference numbers of test equipment used

| | | | | | | | | |
|---------|--|--|--|--|--|--|--|--|
| HL 3818 | | | | | | | | |
|---------|--|--|--|--|--|--|--|--|

Full description is given in Appendix A.

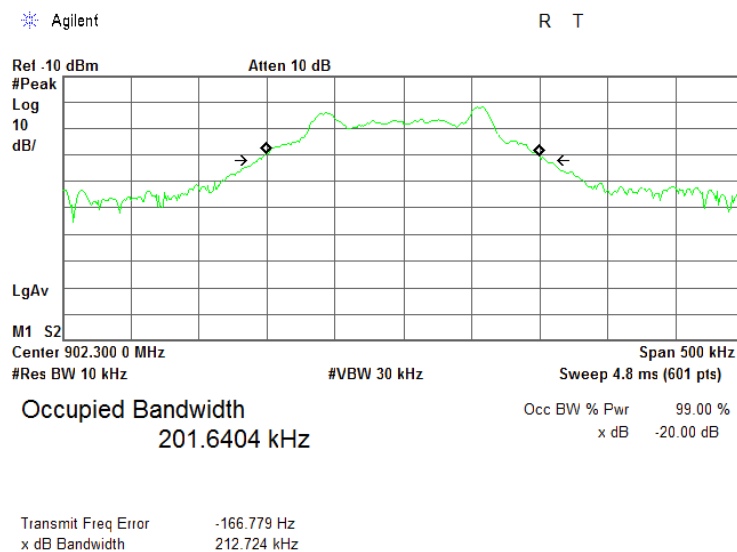


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| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

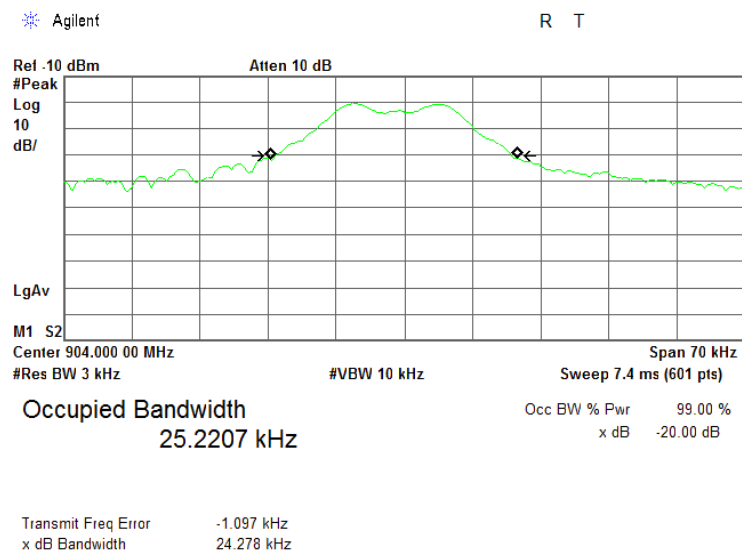
Plot 7.1.1 The 20 dB bandwidth test result at low frequency

CONFIGURATION: FHSS 86 channels
BAUD RATE: 11520 bps



Plot 7.1.2 The 20 dB bandwidth test result at low frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 9600 bps



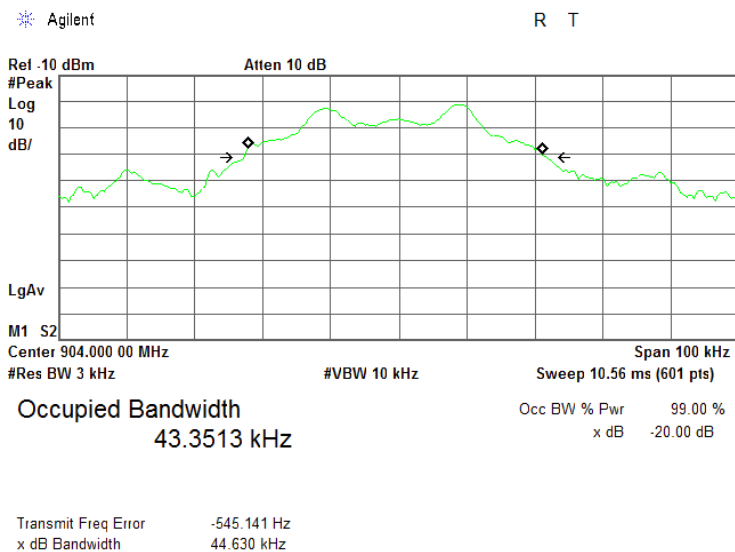


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| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

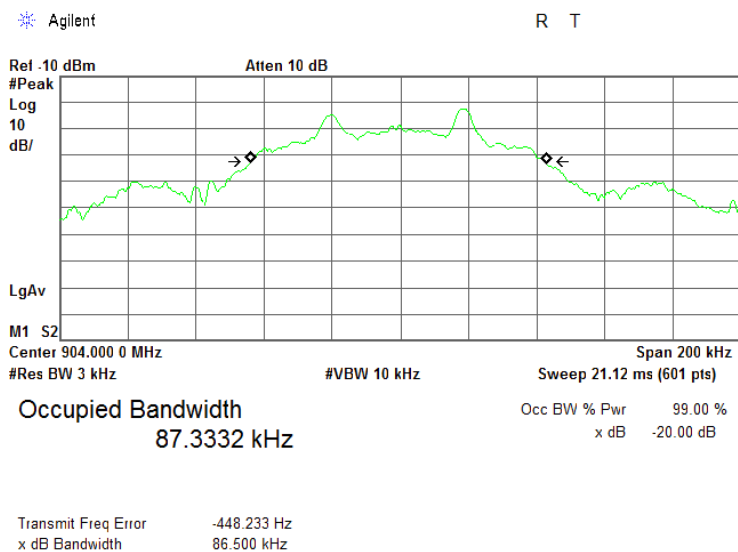
Plot 7.1.3 The 20 dB bandwidth test result at low frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 19200 bps



Plot 7.1.4 The 20 dB bandwidth test result at low frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 38400 bps



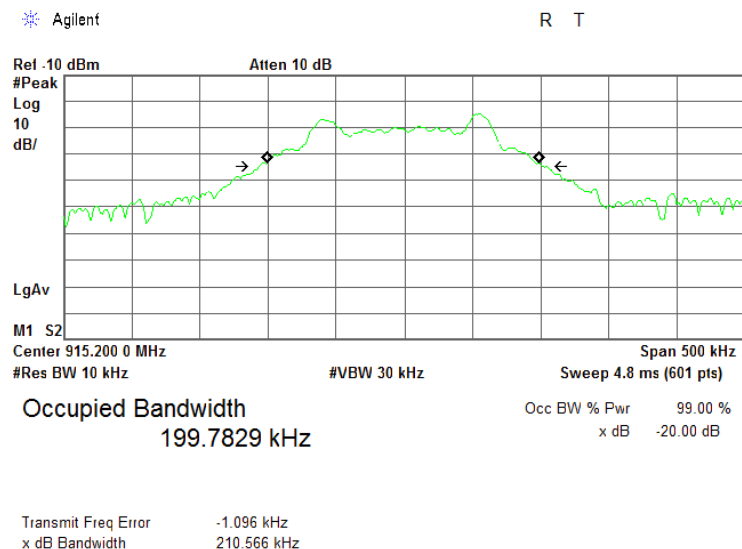


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| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

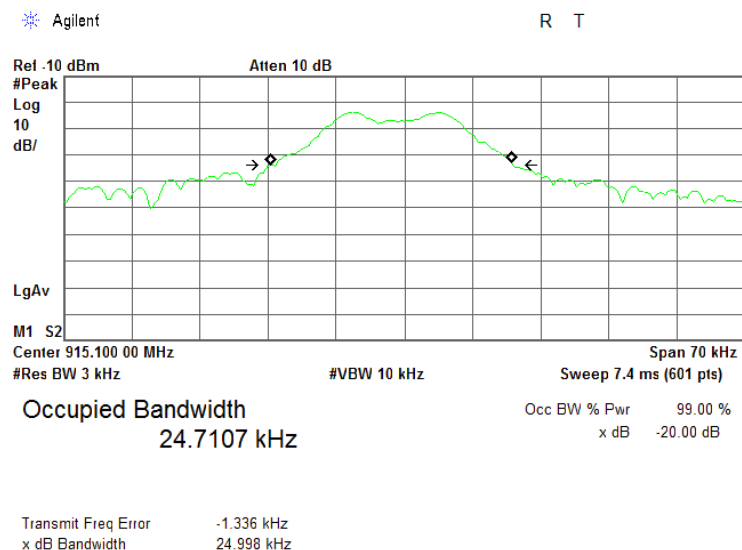
Plot 7.1.5 20 The 20 dB bandwidth test result at mid frequency

CONFIGURATION: FHSS 86 channels
BAUD RATE: 115200 bps



Plot 7.1.6 The 20 dB bandwidth test result at mid frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 9600 bps



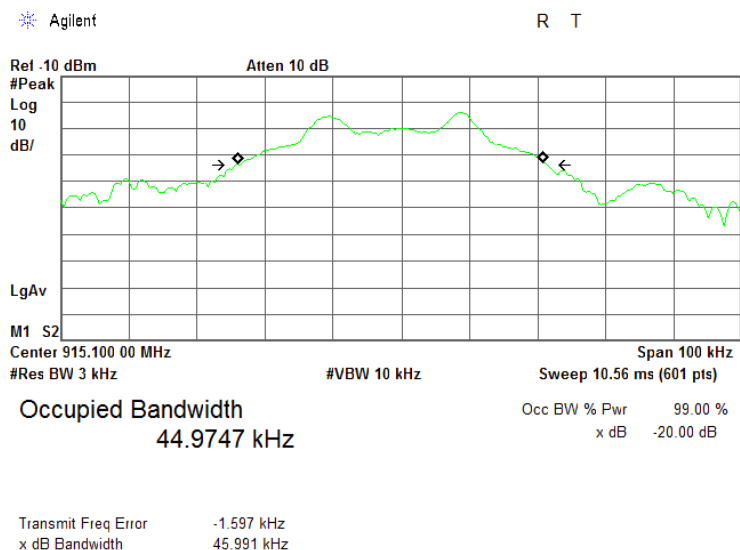


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| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

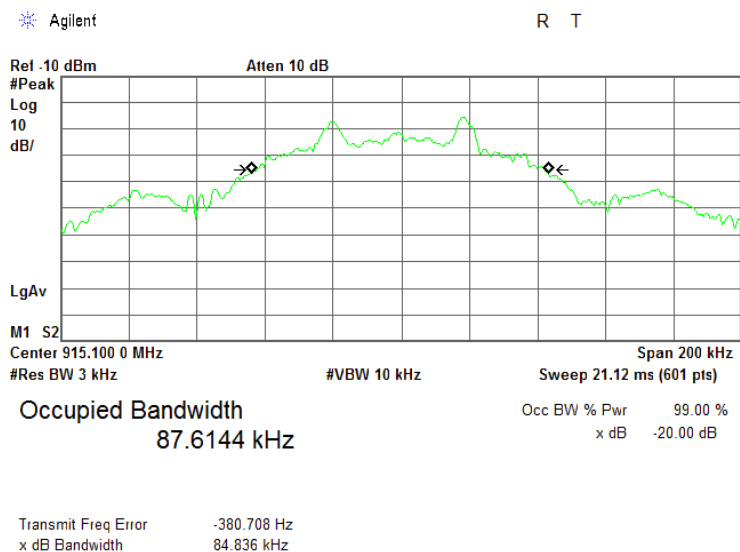
Plot 7.1.7 The 20 dB bandwidth test result at mid frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 19200 bps



Plot 7.1.8 The 20 dB bandwidth test result at mid frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 38400 bps



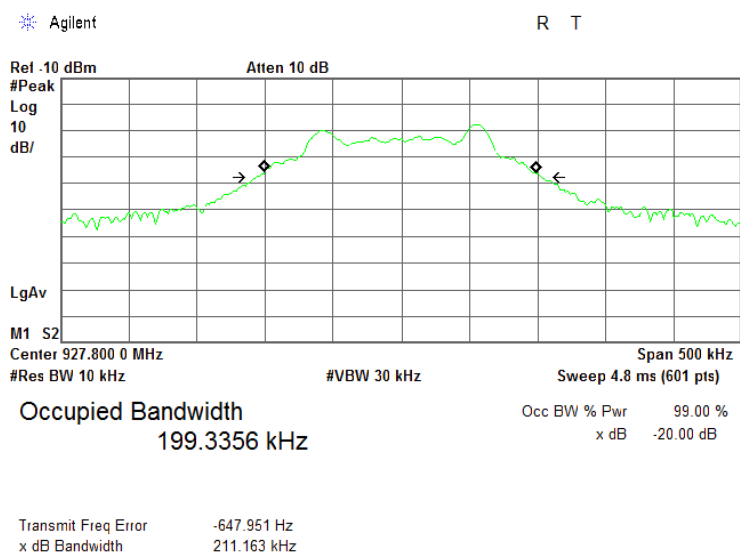


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| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

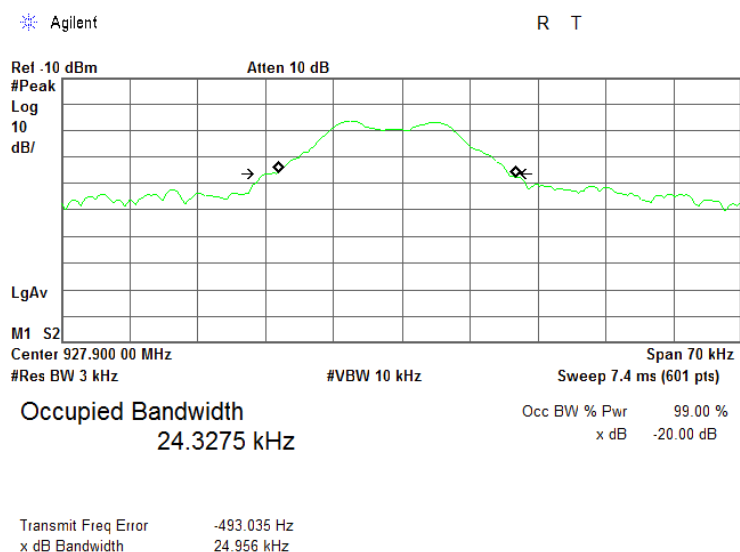
Plot 7.1.9 The 20 dB bandwidth test result at high frequency

CONFIGURATION: FHSS 86 channels
BAUD RATE: 115200 bps



Plot 7.1.10 The 20 dB bandwidth test result at high frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 9600 bps



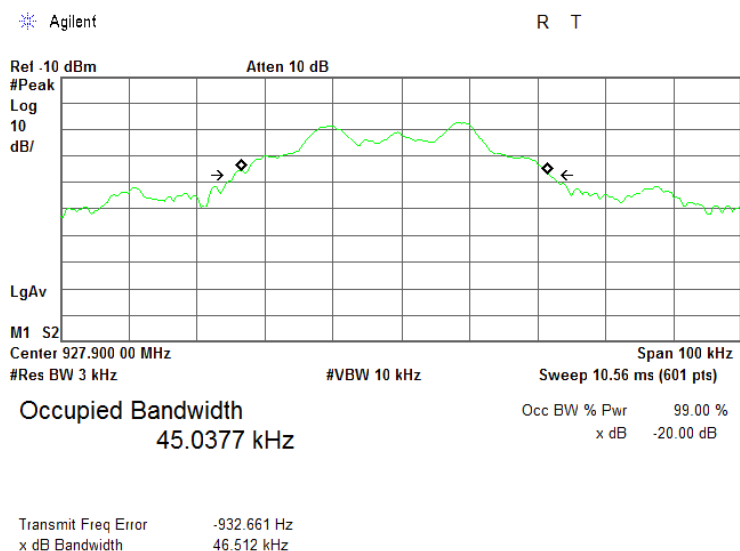


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| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth | | | |
| Test procedure: ANSI C63.10, section 7.8.7 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 31-Aug-16 | | | |
| Temperature: 23 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

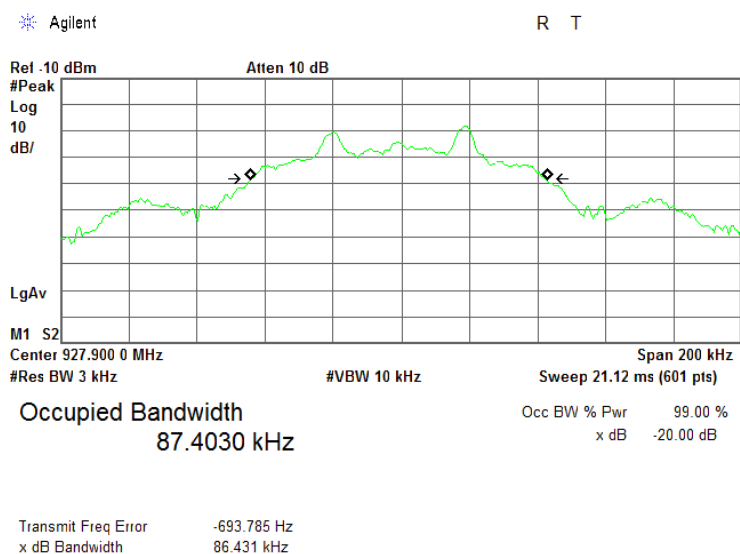
Plot 7.1.11 The 20 dB bandwidth test result at high frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 19200 bps



Plot 7.1.12 The 20 dB bandwidth test result at high frequency

CONFIGURATION: FHSS 240 channels
BAUD RATE: 38400 bps



| | | | |
|--|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(2), Frequency separation | | | |
| Test procedure: ANSI C63.10, section 7.8.2 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

7.2 Carrier frequency separation

7.2.1 General

This test was performed to measure frequency separation between the peaks of adjacent channels. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Carrier frequency separation limits

| Assigned frequency range, MHz | Carrier frequency separation |
|-------------------------------|--|
| 902.0 – 928.0 | 25 kHz or 20 dB bandwidth of the hopping channel, whichever is greater |
| 2400.0 – 2483.5 | |
| 5725.0 – 5850.0 | |

7.2.2 Test procedure

- 7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized with frequency hopping function enabled and its proper operation was checked.
- 7.2.2.2 The spectrum analyzer span was set to capture the carrier frequency and both of adjacent channels, the lower and the higher. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.2.2.3 The spectrum analyzer was set in max hold mode and allowed trace to stabilize.
- 7.2.2.4 The frequency separation between the peaks of adjacent channels was measured as provided in Table 7.2.2 and the associated plots.

Figure 7.2.1 Carrier frequency separation test setup





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| | | | |
|---|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(2), Frequency separation | | | |
| Test procedure: ANSI C63.10, section 7.8.2 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Table 7.2.2 Carrier frequency separation test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
DETECTOR USED: Peak
FREQUENCY HOPPING: Enabled

MODULATION: GFSK
MODE: 86 channels
20 dB BANDWIDTH: 212.7 kHz

| Carrier frequency separation, kHz | Limit, kHz | Margin, kHz* | Verdict |
|-----------------------------------|------------|--------------|---------|
| 300.7 | 212.7 | 88.0 | Pass |

MODULATION: FSK
MODE: 240 channels
20 dB BANDWIDTH: 86.5 kHz

| Carrier frequency separation, kHz | Limit, kHz | Margin, kHz* | Verdict |
|-----------------------------------|------------|--------------|---------|
| 99.6 | 86.5 | 13.1 | Pass |

* - Margin = Carrier frequency separation – specification limit.

Reference numbers of test equipment used

| | | | | | | | |
|---------|--|--|--|--|--|--|--|
| HL 3818 | | | | | | | |
|---------|--|--|--|--|--|--|--|

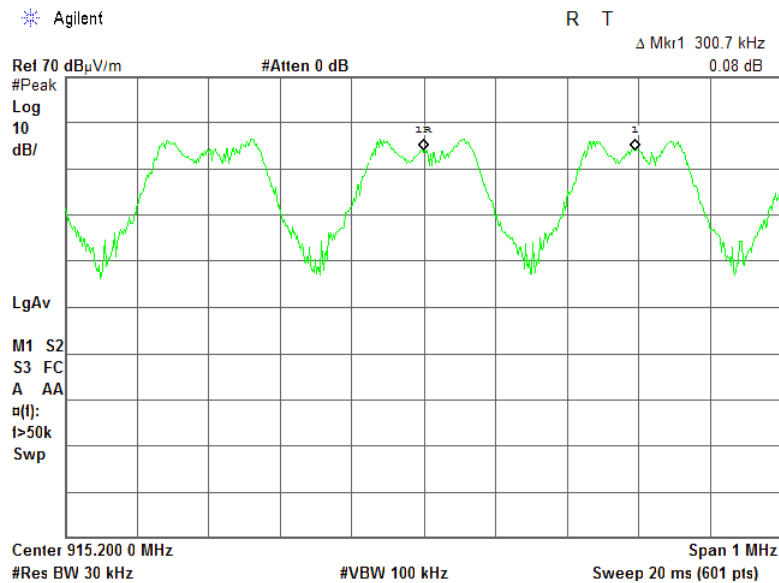
Full description is given in Appendix A.



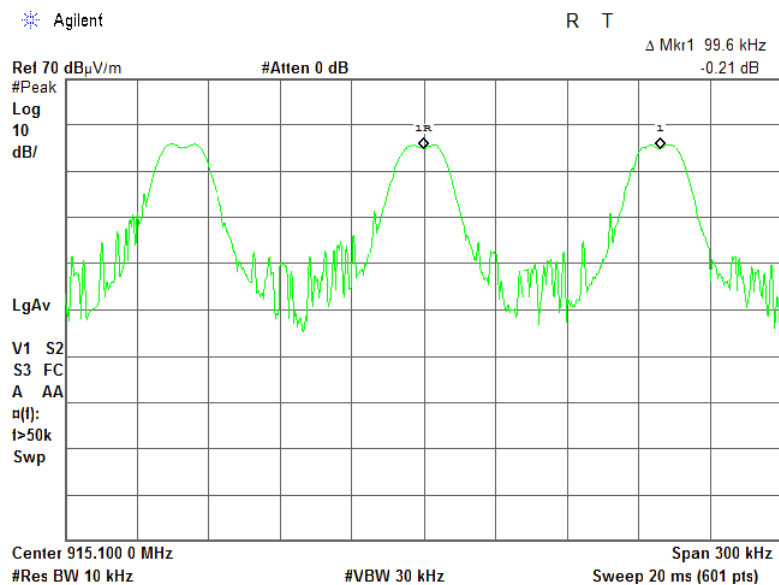
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| | | | |
|--|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(2), Frequency separation | | | |
| Test procedure: ANSI C63.10, section 7.8.2 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.2.1 Carrier frequency separation, 86 channels mode



Plot 7.2.2 Carrier frequency separation, 240 channels mode



| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

7.3 Number of hopping frequencies

7.3.1 General

This test was performed to calculate the number of hopping frequencies used by the EUT. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Minimum number of hopping frequencies

| Assigned frequency range, MHz | Number of hopping frequencies |
|-------------------------------|---|
| 902.0 – 928.0 | 50 (if the 20 dB bandwidth is less than 250 kHz) 25 (if the 20 dB bandwidth is 250 kHz or greater) |
| 2400.0 – 2483.5 | 15 |
| 5725.0 – 5850.0 | 75 |

7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized with frequency hopping function enabled and its proper operation was checked.

7.3.2.2 Initially the spectrum analyzer span was set equal to frequency band of operation and the resolution bandwidth was set wider than 1 % of the frequency span. If the separate hopping channels were not clearly resolved the frequency band of operation was broken to sections and the resolution bandwidth was set wider than 1 % of the frequency span of each section.

7.3.2.3 The spectrum analyzer was set in max hold mode and allowed trace to stabilize.

7.3.2.4 The number of frequency hopping channels was calculated as provided in Table 7.3.2 and the associated plots.

Figure 7.3.1 Hopping frequencies test setup





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| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Table 7.3.2 Hopping frequencies test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: $\geq 1\%$ of the span
 VIDEO BANDWIDTH: \geq RBW
 FREQUENCY HOPPING: Enabled

MODULATION: GFSK
 OPERATING MODE: Wide channel

| Number of hopping frequencies | Minimum number of hopping frequencies | Margin* | Verdict |
|-------------------------------|---------------------------------------|---------|---------|
| 86 | 50 | 36 | Pass |

MODULATION: FSK
 OPERATING MODE: Narrow channel

| Number of hopping frequencies | Minimum number of hopping frequencies | Margin* | Verdict |
|-------------------------------|---------------------------------------|---------|---------|
| 240 | 50 | 190 | Pass |

* - Margin = Number of hopping frequencies – Minimum number of hopping frequencies.

Reference numbers of test equipment used

| | | | | | | | |
|---------|--|--|--|--|--|--|--|
| HL 3818 | | | | | | | |
|---------|--|--|--|--|--|--|--|

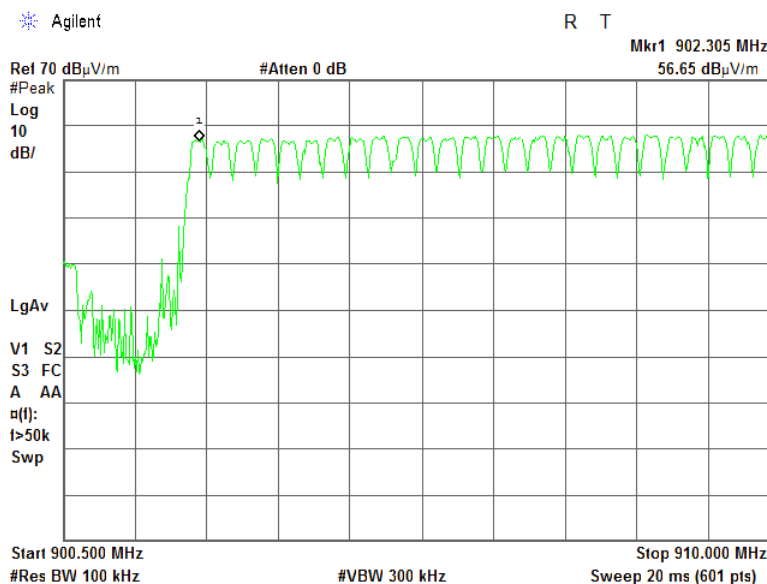
Full description is given in Appendix A.



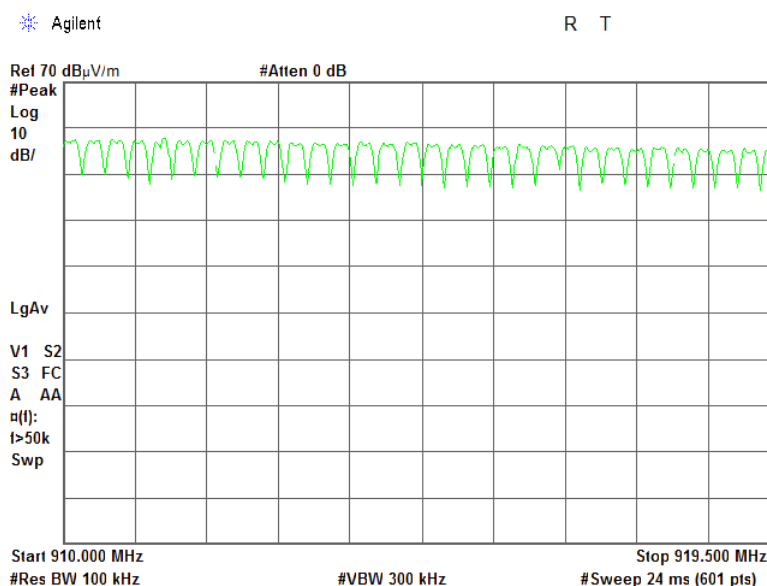
HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.3.1 Number of hopping frequencies in wide channel mode (26 channels)

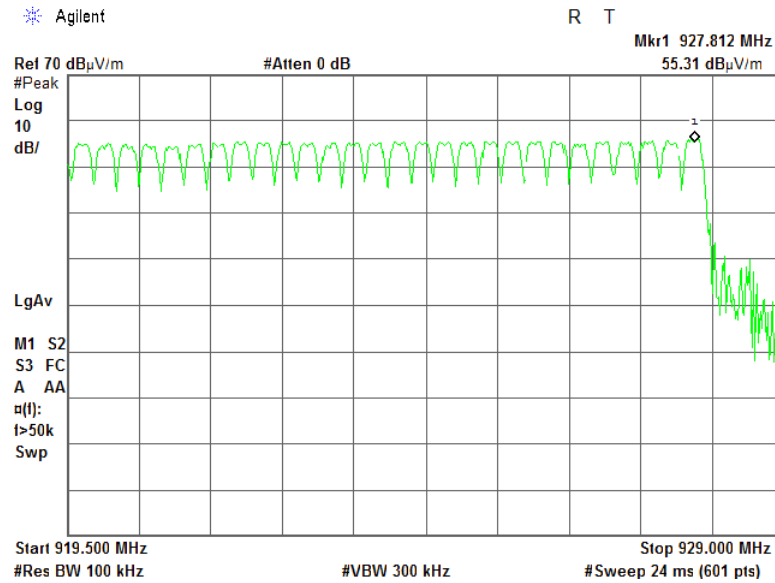


Plot 7.3.2 Number of hopping frequencies in wide channel mode (32 channels)



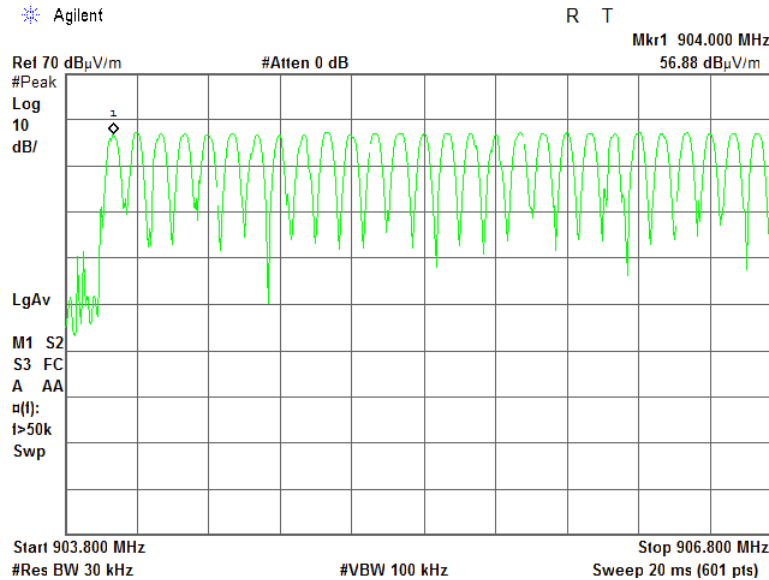
| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.3.3 Number of hopping frequencies in wide channel mode (28 channels)

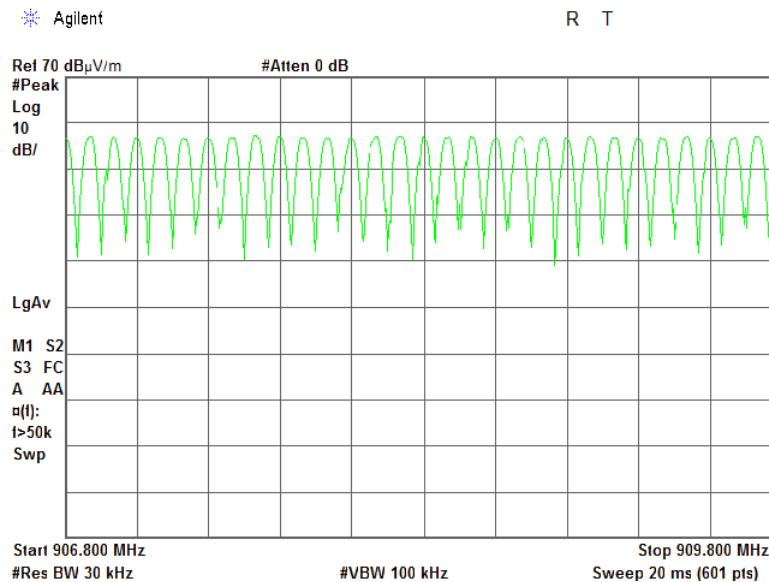


| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.3.4 Number of hopping frequencies in narrow channel mode (28 channels)



Plot 7.3.5 Number of hopping frequencies in narrow channel mode (30 channels)

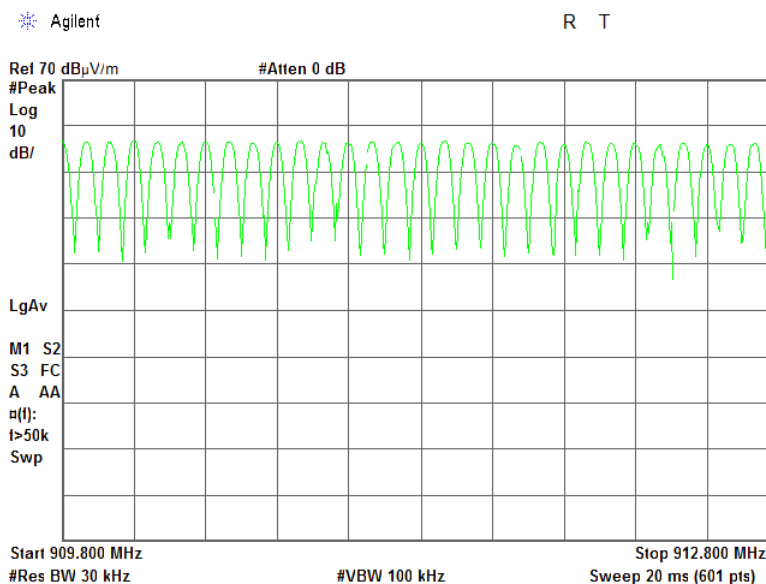




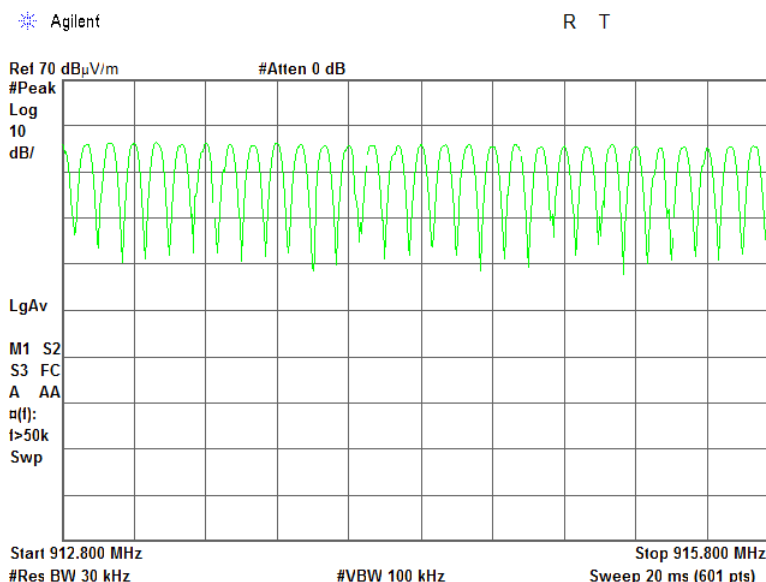
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| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.3.6 Number of hopping frequencies in narrow channel mode (30 channels)

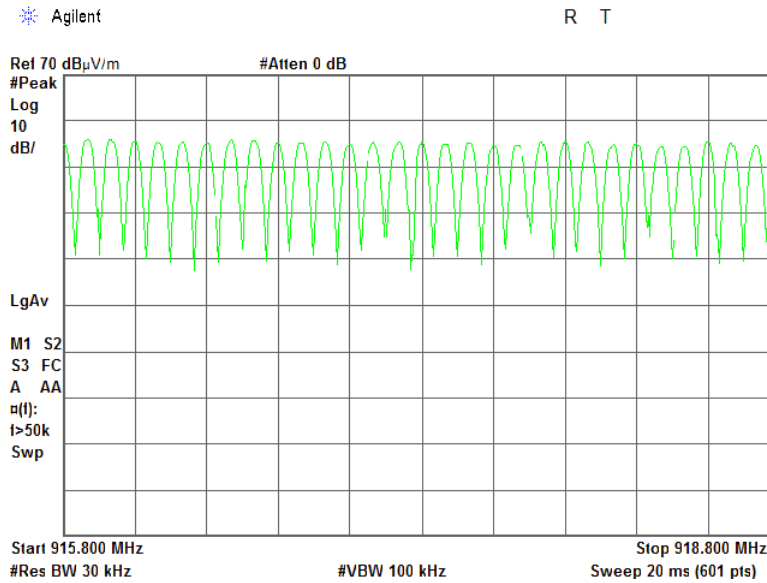


Plot 7.3.7 Number of hopping frequencies in narrow channel mode (30 channels)

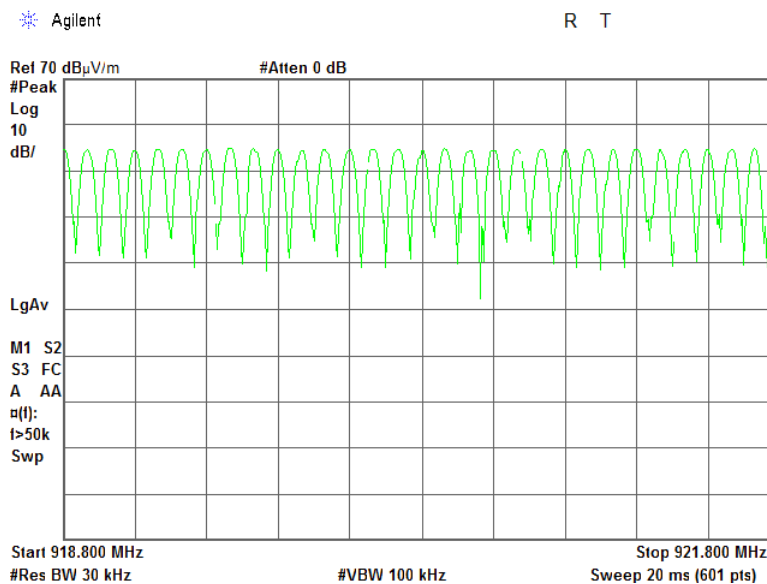


| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.3.8 Number of hopping frequencies in narrow channel mode (30 channels)

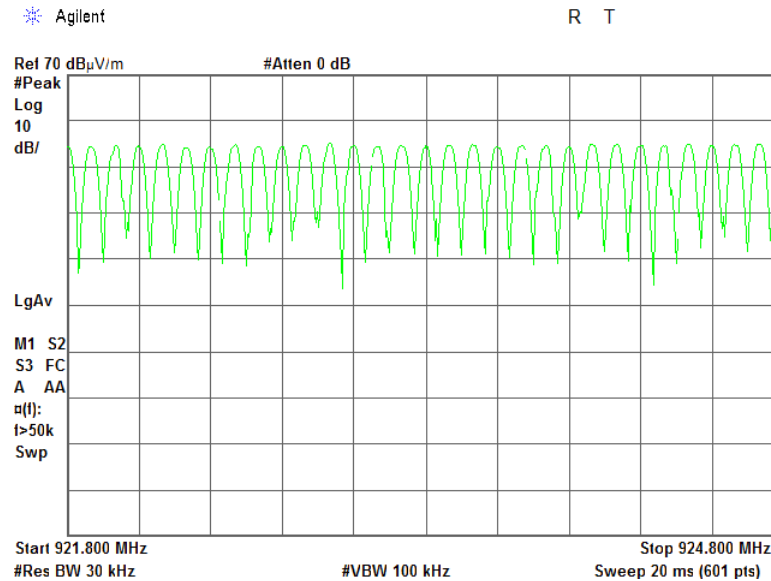


Plot 7.3.9 Number of hopping frequencies in narrow channel mode (30 channels)

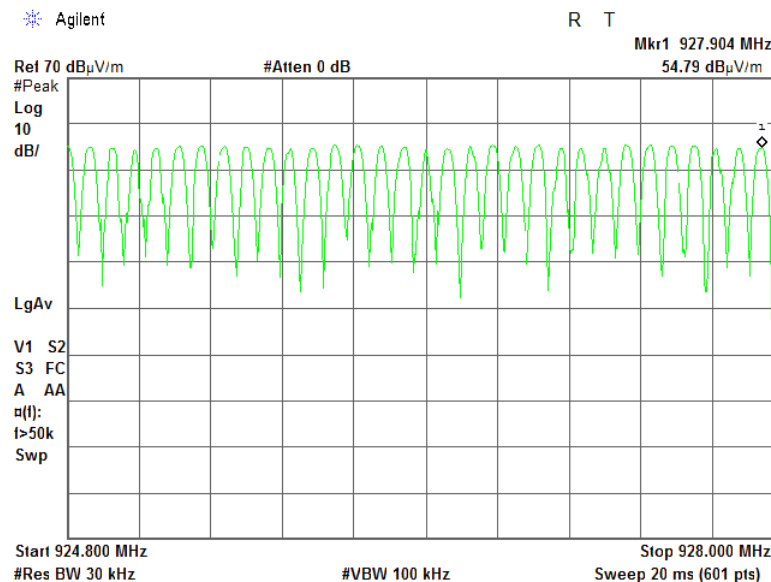


| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies | | | |
| Test procedure: ANSI C63.10, section 7.8.3 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.3.10 Number of hopping frequencies in narrow channel mode (30 channels)



Plot 7.3.11 Number of hopping frequencies in narrow channel mode (32 channels)



| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy | | | |
| Test procedure: ANSI C63.10, section 7.8.4 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

7.4 Average time of occupancy

7.4.1 General

This test was performed to calculate the average time of occupancy (dwell time) on any frequency channel of the EUT. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Average time of occupancy limits

| Assigned frequency range, MHz | Maximum average time of occupancy, s | Investigated period, s | Number of hopping frequencies |
|-------------------------------|--------------------------------------|------------------------|-------------------------------|
| 902.0 – 928.0 | 0.4 | 20.0 | ≥ 50 |
| 902.0 – 928.0 | 0.4 | 10.0 | < 50 |
| 2400.0 – 2483.5 | 0.4 | 0.4 × N | N (≥ 15) |
| 5725.0 – 5850.0 | 0.4 | 30.0 | ≥ 75 |

7.4.2 Test procedure

7.4.2.1 The EUT was set up as shown in **Error! Reference source not found.**, energized with frequency hopping function enabled and its proper operation was checked.

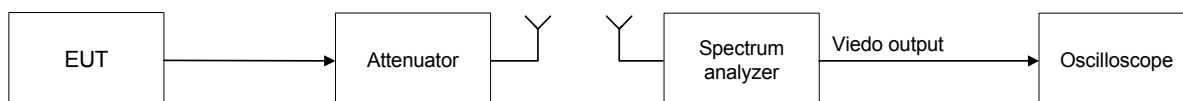
7.4.2.2 The spectrum analyzer span was set to zero centered on a hopping channel.

7.4.2.3 The single transmission duration and period were measured with oscilloscope.

7.4.2.4 The average time of occupancy was calculated as the single transmission time multiplied by the investigated period and divided by the single transmission period.

7.4.2.5 The test was repeated at each data rate and modulation type as provided in Table 7.4.2 and the associated plots.

Figure 7.4.1 Average time of occupancy test setup





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| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy | | | |
| Test procedure: ANSI C63.10, section 7.8.4 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Table 7.4.2 Average time of occupancy test results

ASSIGNED FREQUENCY BAND: 902-928 MHz

DETECTOR USED: Peak

FREQUENCY HOPPING: Enabled

MODULATION: GFSK

NUMBER OF HOPPING FREQUENCIES: 86

| Carrier frequency, MHz | Single transmission duration, ms | Single transmission period, s | Average time of occupancy*, s | Bit rate, bps | Limit, s | Margin, s** | Verdict |
|------------------------|----------------------------------|-------------------------------|-------------------------------|---------------|----------|-------------|---------|
| 915.2 | 1.27 | 1 | 0.0254 | 115200 | 0.4 | -0.3746 | Pass |

MODULATION: FSK

NUMBER OF HOPPING FREQUENCIES: 240

| Carrier frequency, MHz | Single transmission duration, ms | Single transmission period, s | Average time of occupancy*, s | Bit rate, bps | Limit, s | Margin, s** | Verdict |
|------------------------|----------------------------------|-------------------------------|-------------------------------|---------------|----------|-------------|---------|
| 915.1 | 4.235 | 2 | 0.04235 | 9600 | 0.4 | -0.35765 | Pass |

* - Average time of occupancy = (Single transmission duration × Investigated period) / (Single transmission period × number of hopping channels).

** - Margin = Average time of occupancy – specification limit.

Reference numbers of test equipment used

| | | | | | | | |
|---------|--|--|--|--|--|--|--|
| HL 3818 | | | | | | | |
|---------|--|--|--|--|--|--|--|

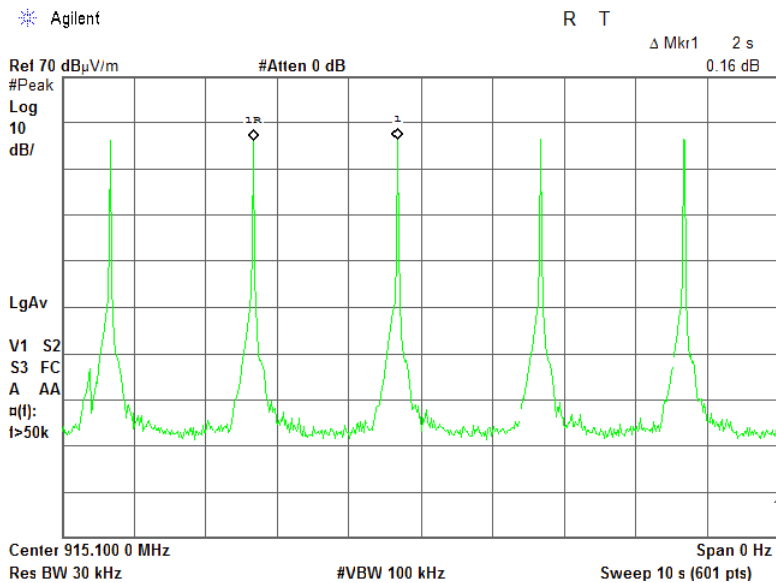
Full description is given in Appendix A.



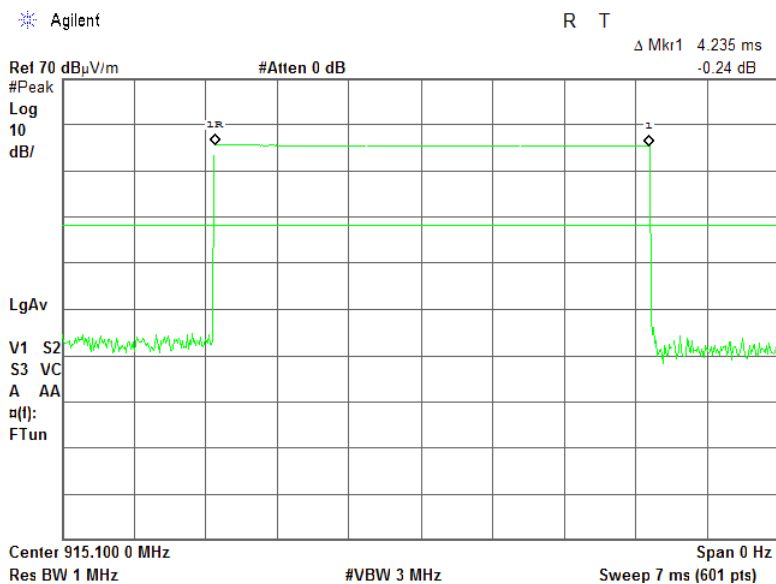
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| | | | |
|---------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy | |
| Test procedure: | | ANSI C63.10, section 7.8.4 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.4.1 Single transmission period in narrow channel mode (240 channels)



Plot 7.4.2 Single transmission duration in narrow channel mode (240 channels)

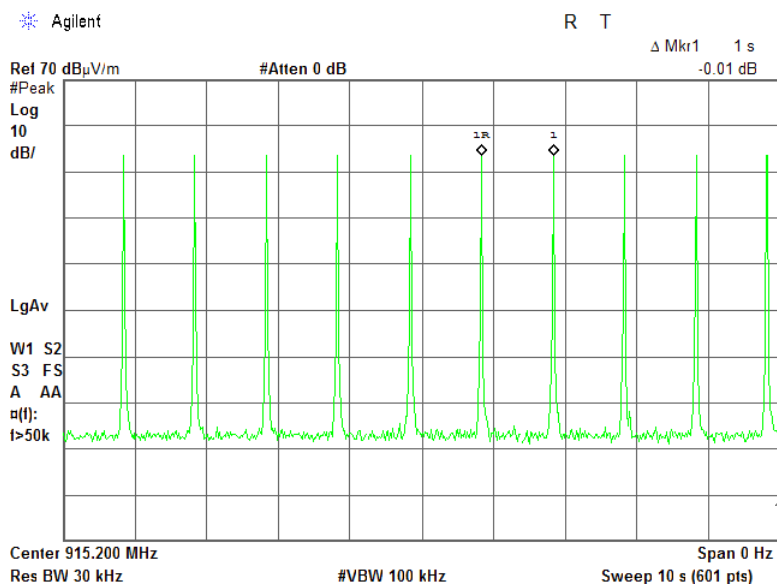




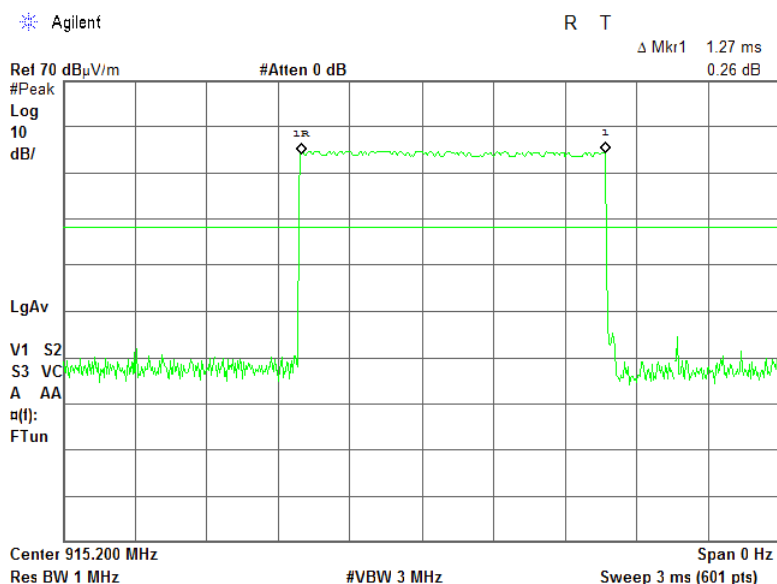
HERMON LABORATORIES

| | | | |
|---------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy | |
| Test procedure: | | ANSI C63.10, section 7.8.4 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 13-Sep-16 | | | |
| Temperature: 25 °C | Relative Humidity: 56 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.4.3 Single transmission period in wide channel mode (86 channels)



Plot 7.4.4 Single transmission duration in wide channel mode (86 channels)





| | | | |
|---|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power | | | |
| Test procedure: ANSI C63.10, section 7.8.5 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

7.5 Peak output power

7.5.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.5.1.

Table 7.5.1 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 | | |
| 902.0 – 928.0 | 1.0 | 30.0 | 125.2 | 6.0* |
| 2400.0 – 2483.5 | 0.125 (<75 hopping channels) 1.0 (≥75 hopping channels) | 21.0(<75 hopping channels) 30.0 (≥75 hopping channels) | 122.2 (<75 hopping channels) 131.2 (≥75 hopping channels) | |
| 5725.0 – 5850.0 | 1.0 | 30.0 | 131.2 | |

*- 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;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

7.5.2 Test procedure

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

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

7.5.2.3 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.

7.5.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.5.2 and associated plots.

7.5.2.5 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.

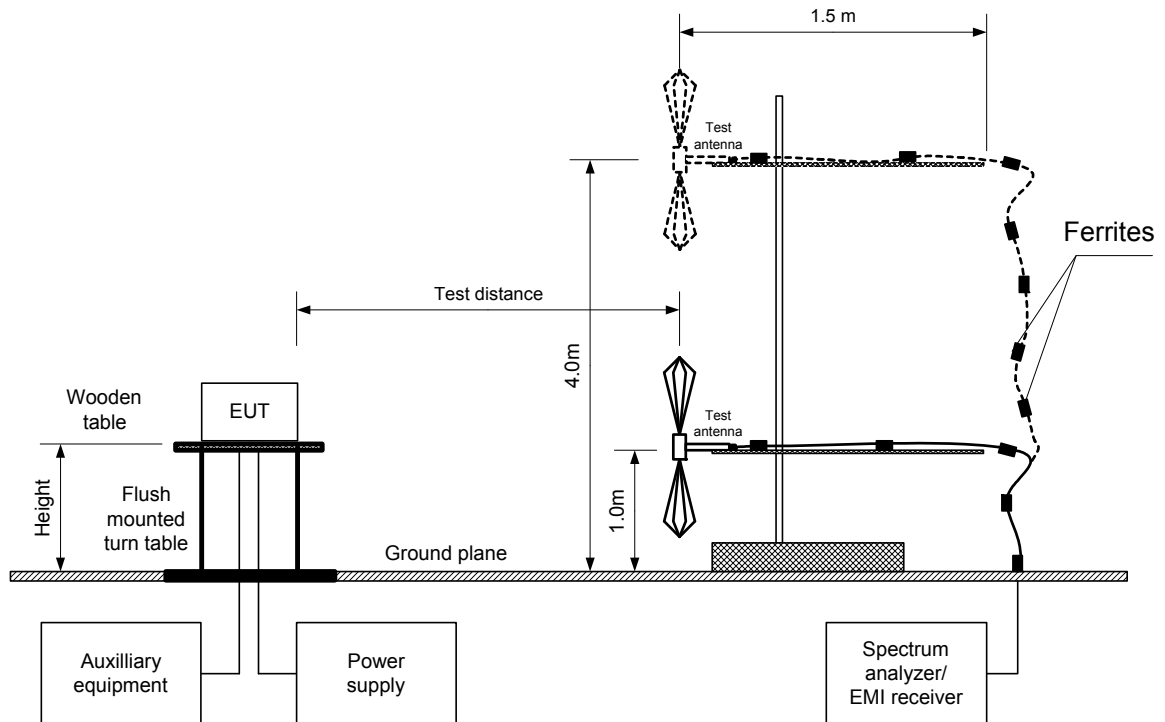
The above equation was converted in logarithmic units for 3 m test distance:

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

7.5.2.6 The worst test results (the lowest margins) were recorded in Table 7.5.2.

| | | | |
|---------------------|-------------------------|--|----------------|
| Test specification: | | Section 15.247(b), RSS-247 section 5.4(1), Peak output power | |
| Test procedure: | | ANSI C63.10, section 7.8.5 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Figure 7.5.1 Setup for carrier field strength measurements





| | |
|--------------------------|---|
| ASSIGNED FREQUENCY BAND: | 902-928 MHz |
| TEST DISTANCE: | 3 m |
| TEST SITE: | OATS |
| EUT HEIGHT: | 0.8 m |
| DETECTOR USED: | Peak |
| TEST ANTENNA TYPE | Log periodic |
| MODULATION: | FSK (for 9.6; 19.2.2; 38.4 kbps) GFSK (for 115.2 kbps) |
| DETECTOR USED: | Peak |
| RESOLUTION BANDWIDTH: | 1 MHz |
| VIDEO BANDWIDTH: | 3 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 |
|----------------------------|--------------------------|----------------------|-------------------|-------------------|-----------------------|--------------------------|------------|---------------|---------|
| Bit rate 115200 bps | | | | | | | | | |
| 902.3 | 116.7 | Vert | 1.3 | 20 | 0 | 21.5 | 30.0 | -8.5 | Pass |
| 915.2 | 116.2 | Vert | 1.3 | 20 | 0 | 21 | 30.0 | -9.0 | Pass |
| 927.8 | 114.2 | Vert | 1.3 | 20 | 0 | 19 | 30.0 | -11 | Pass |

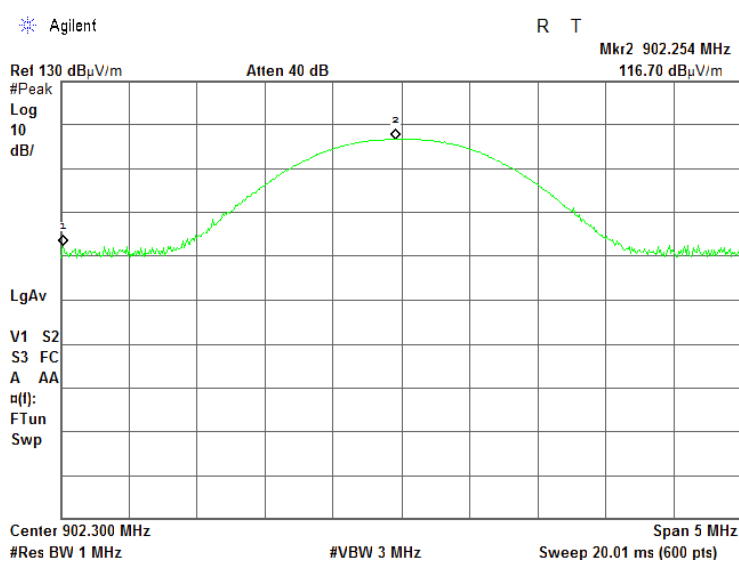
| Frequency, MHz | Field strength, dB(μV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | EUT antenna gain, dBi | Peak output power, dBm** | Limit, dBm | Margin, dB*** | Verdict |
|---------------------------|--------------------------|----------------------|-------------------|-------------------|-----------------------|--------------------------|------------|---------------|---------|
| Bit rate 9600 bps | | | | | | | | | |
| 904.0 | 116.88 | Vert | 1.3 | 20 | 0 | 21.68 | 30.0 | -8.32 | Pass |
| 915.1 | 116.29 | Vert | 1.3 | 20 | 0 | 21.09 | 30.0 | -8.91 | Pass |
| 927.9 | 114.13 | Vert | 1.3 | 20 | 0 | 18.93 | 30.0 | -11.07 | Pass |
| Bit rate 19200 bps | | | | | | | | | |
| 904.0 | 116.86 | Vert | 1.3 | 20 | 0 | 21.66 | 30.0 | -8.34 | Pass |
| 915.1 | 116.26 | Vert | 1.3 | 20 | 0 | 21.06 | 30.0 | -8.94 | Pass |
| 927.9 | 114.17 | Vert | 1.3 | 20 | 0 | 18.97 | 30.0 | -11.03 | Pass |
| Bit rate 38400 bps | | | | | | | | | |
| 904.0 | 116.76 | Vert | 1.3 | 20 | 0 | 21.56 | 30.0 | -8.44 | Pass |
| 915.1 | 116.31 | Vert | 1.3 | 20 | 0 | 21.11 | 30.0 | -8.89 | Pass |
| 927.9 | 114.17 | Vert | 1.3 | 20 | 0 | 18.97 | 30.0 | -11.03 | Pass |

| | | | | | | | |
|---------|---------|---------|---------|--|--|--|--|
| HL 0415 | HL 3818 | HL 4280 | HL 4294 | | | | |
|---------|---------|---------|---------|--|--|--|--|

| | | | |
|---|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power | | | |
| Test procedure: ANSI C63.10, section 7.8.5 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

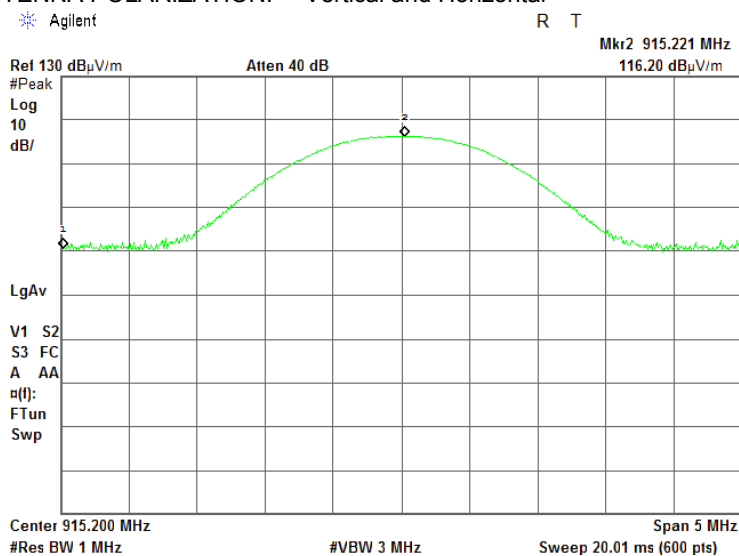
Plot 7.5.1 Field strength of carrier at low frequency

CONFIGURATION: FHSS 86 Channels
BIT RATE: 115.2 kbps
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.2 Field strength of carrier at mid frequency

CONFIGURATION: FHSS 86 Channels
BIT RATE: 115.2 kbps
ANTENNA POLARIZATION: Vertical and Horizontal



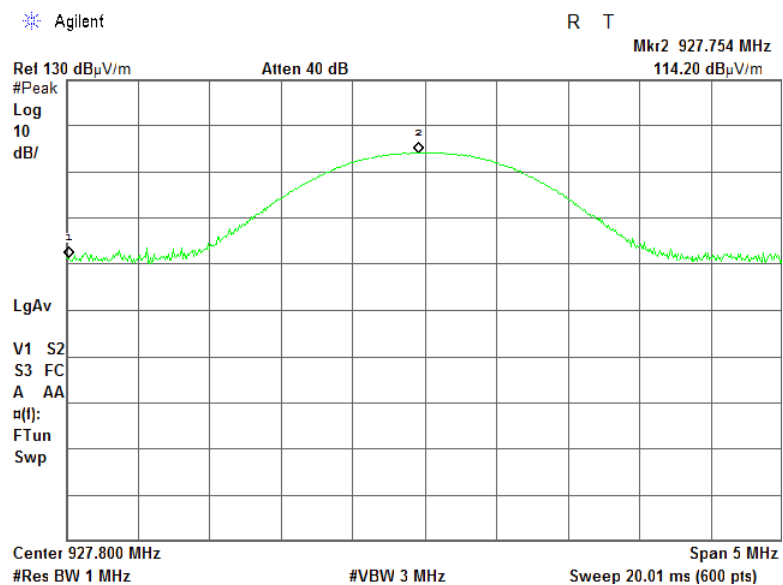


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| | | | |
|--|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power | | | |
| Test procedure: ANSI C63.10, section 7.8.5 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.5.3 Field strength of carrier at high frequency

CONFIGURATION: FHSS 86 Channels
BIT RATE: 115.2 kbps
ANTENNA POLARIZATION: Vertical and Horizontal



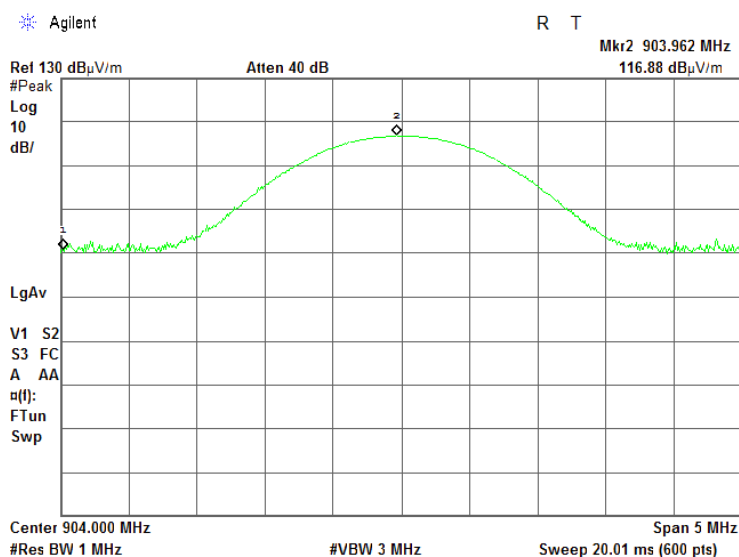


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| | | | |
|--|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power | | | |
| Test procedure: ANSI C63.10, section 7.8.5 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

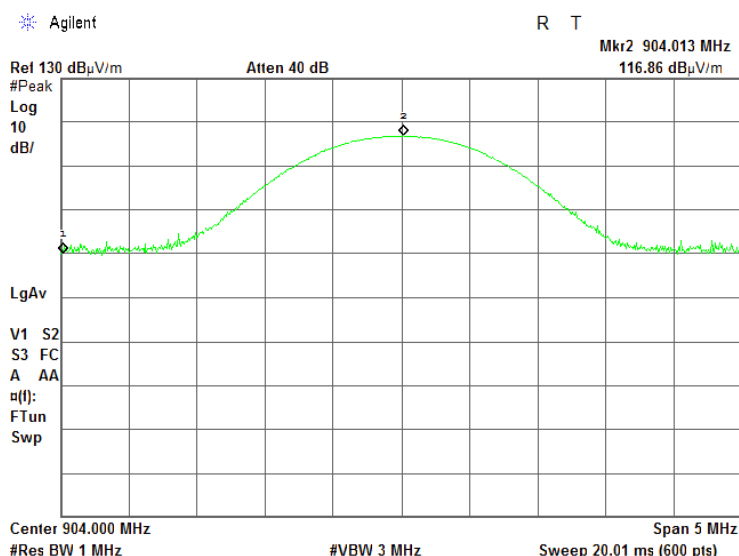
Plot 7.5.4 Field strength of carrier at low frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 9600 bps
ANTENNA POLARIZATION: Vertical & Horizontal



Plot 7.5.5 Field strength of carrier at low frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 19200 bps
ANTENNA POLARIZATION: Vertical and Horizontal



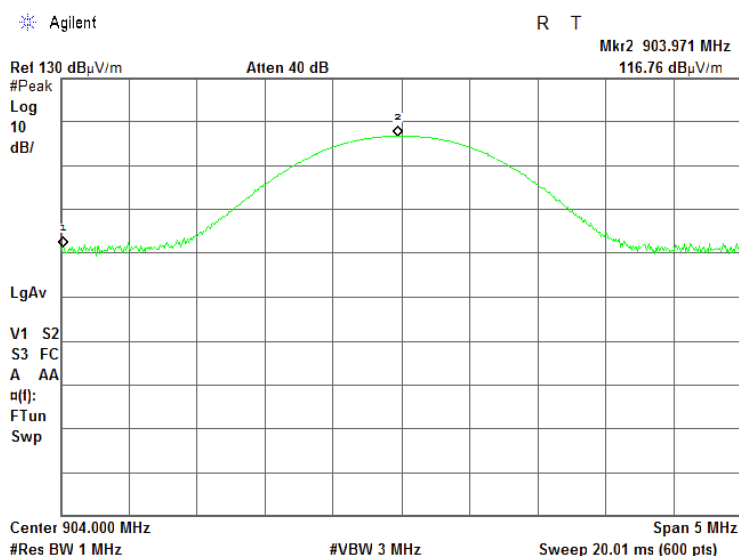


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| | | | |
|--|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power | | | |
| Test procedure: ANSI C63.10, section 7.8.5 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

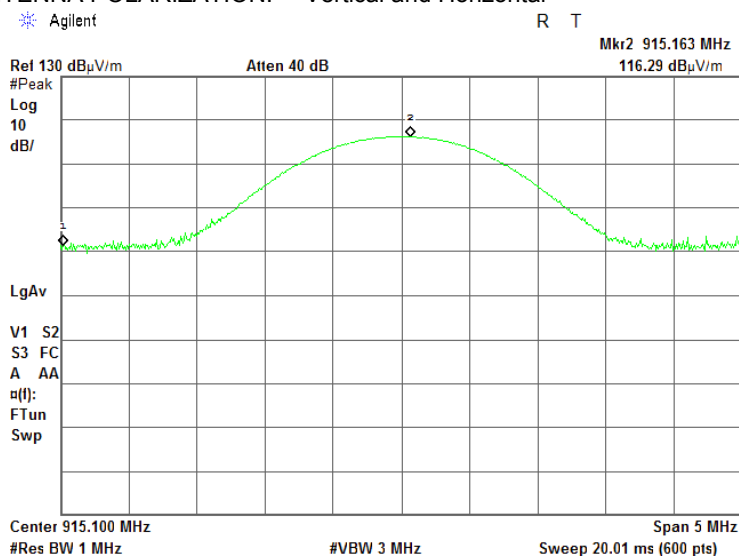
Plot 7.5.6 Field strength of carrier at low frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 38400 bps
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.7 Field strength of carrier at mid frequency

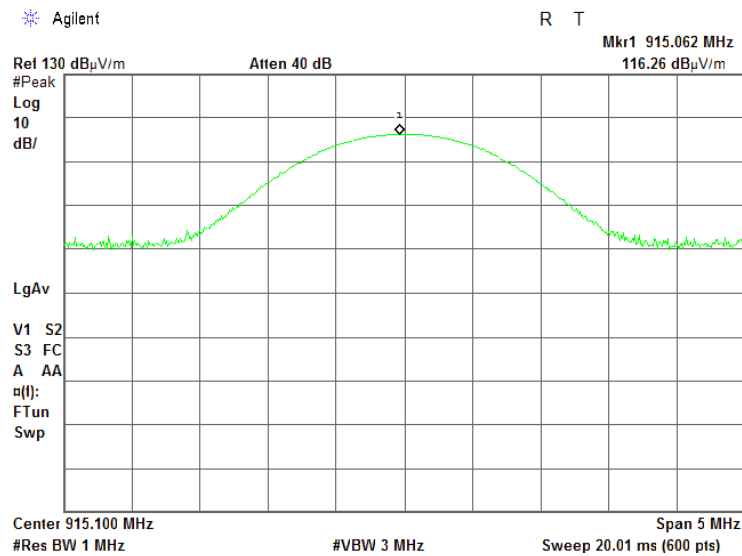
CONFIGURATION: FHSS 240 Channels
BIT RATE: 9600 bps
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|---------------------|-------------------------|--|----------------|
| Test specification: | | Section 15.247(b), RSS-247 section 5.4(1), Peak output power | |
| Test procedure: | | ANSI C63.10, section 7.8.5 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

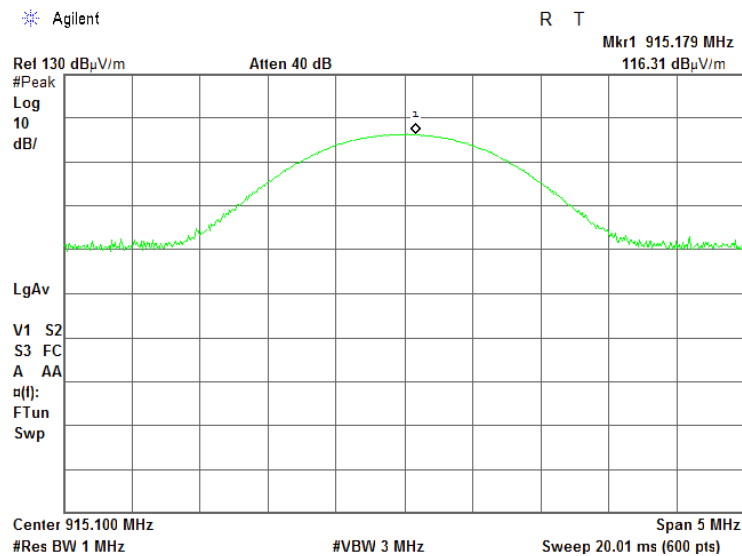
Plot 7.5.8 Field strength of carrier at mid frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 19200 bps
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.9 Field strength of carrier at mid frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 38400 bps
ANTENNA POLARIZATION: Vertical and Horizontal



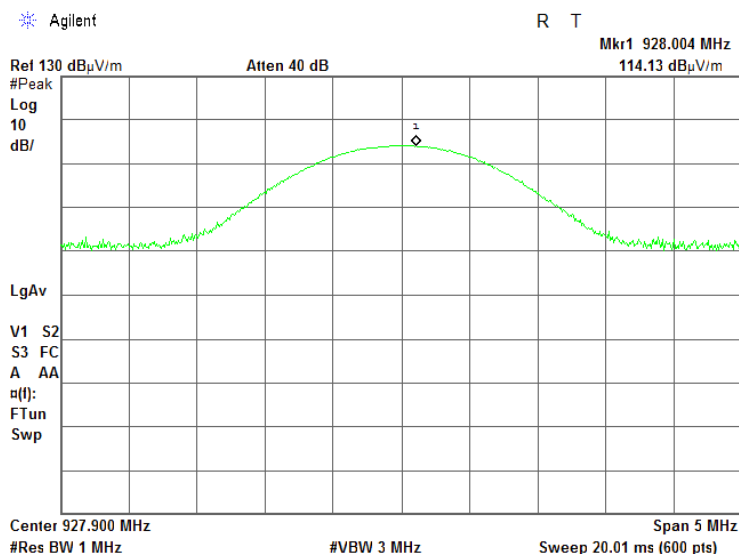


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| | | | |
|--|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power | | | |
| Test procedure: ANSI C63.10, section 7.8.5 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

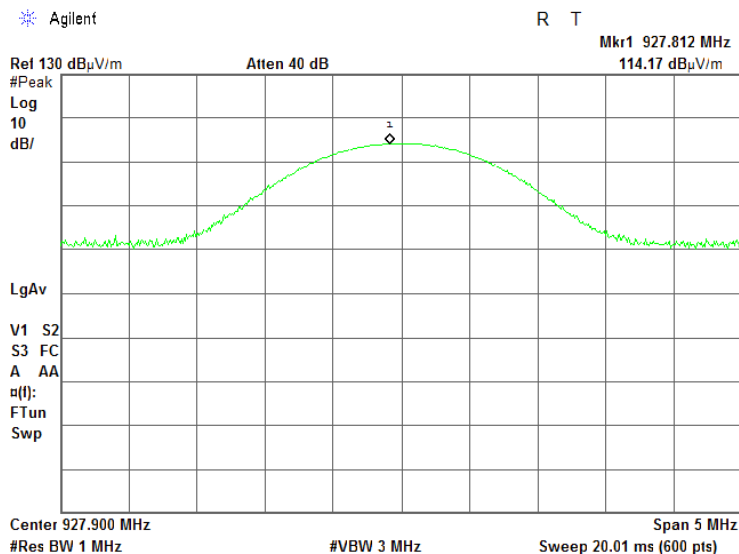
Plot 7.5.10 Field strength of carrier at high frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 9600 bps
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.11 Field strength of carrier at high frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 19200 bps
ANTENNA POLARIZATION: Vertical and Horizontal



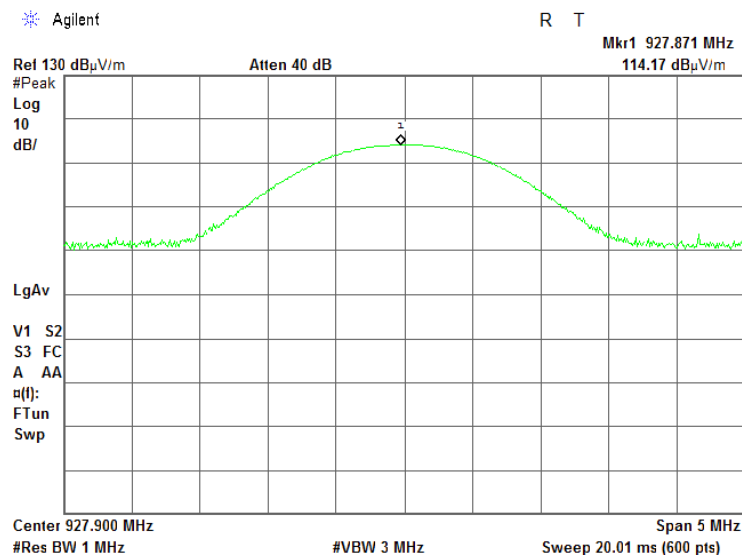


HERMON LABORATORIES

| | | | |
|---------------------|-------------------------|--|----------------|
| Test specification: | | Section 15.247(b), RSS-247 section 5.4(1), Peak output power | |
| Test procedure: | | ANSI C63.10, section 7.8.5 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 04-Sep-16 | | | |
| Temperature: 24 °C | Relative Humidity: 57 % | Air Pressure: 1008 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.5.12 Field strength of carrier at high frequency

CONFIGURATION: FHSS 240 Channels
BIT RATE: 38400 bps
ANTENNA POLARIZATION: Vertical and Horizontal





| | | | |
|---|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

7.6 Field strength of spurious emissions

7.6.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.6.1.

Table 7.6.1 Radiated spurious emissions limits

| Frequency, MHz | Field strength at 3 m within restricted bands, dB(□V/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 | NA | 73.8 – 63.0** | NA | |
| 1.705 – 30.0* | | 69.5 | | |
| 30 – 88 | | 40.0 | | |
| 88 – 216 | | 43.5 | | |
| 216 – 960 | | 46.0 | | |
| 960 - 1000 | | 54.0 | | |
| 1000 – 10 th harmonic | 74.0 | NA | 54.0 | |

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

$$\text{Lim}_{S2} = \text{Lim}_{S1} + 40 \log (S_1/S_2),$$

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.

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

7.6.2.1 The EUT was set up as shown in Figure 7.6.1, energized and the performance check was conducted.

7.6.2.2 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.

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

7.6.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.6.3.1 The EUT was set up as shown in Figure 7.6.2, Figure 7.6.3, energized and the performance check was conducted.

7.6.3.2 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.

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

| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Figure 7.6.1 Setup for spurious emission field strength measurements below 30 MHz

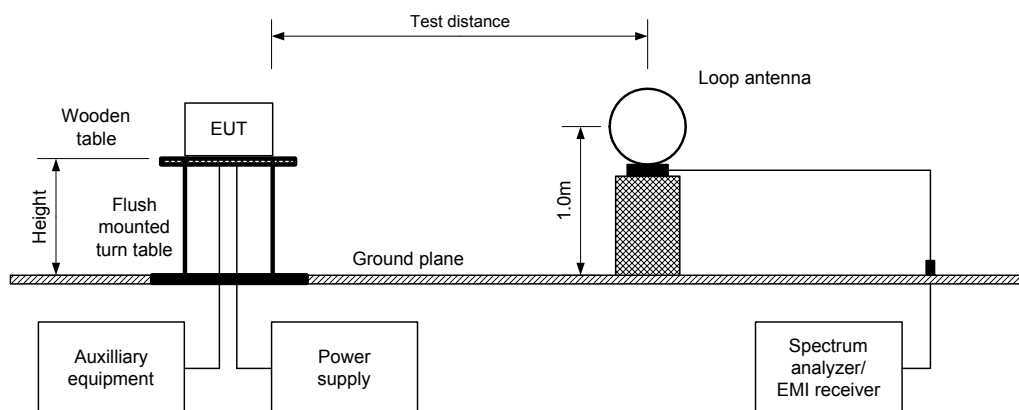
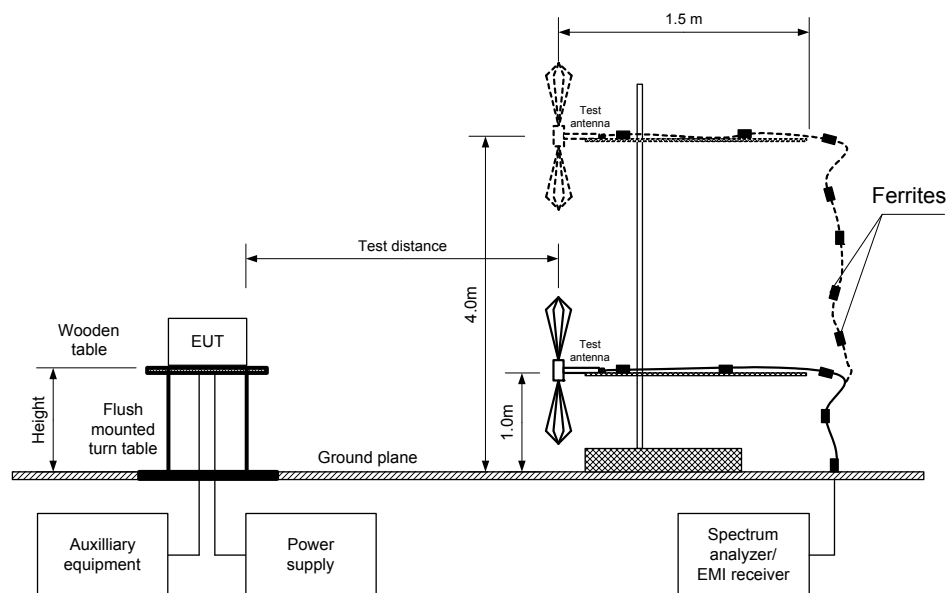


Figure 7.6.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz

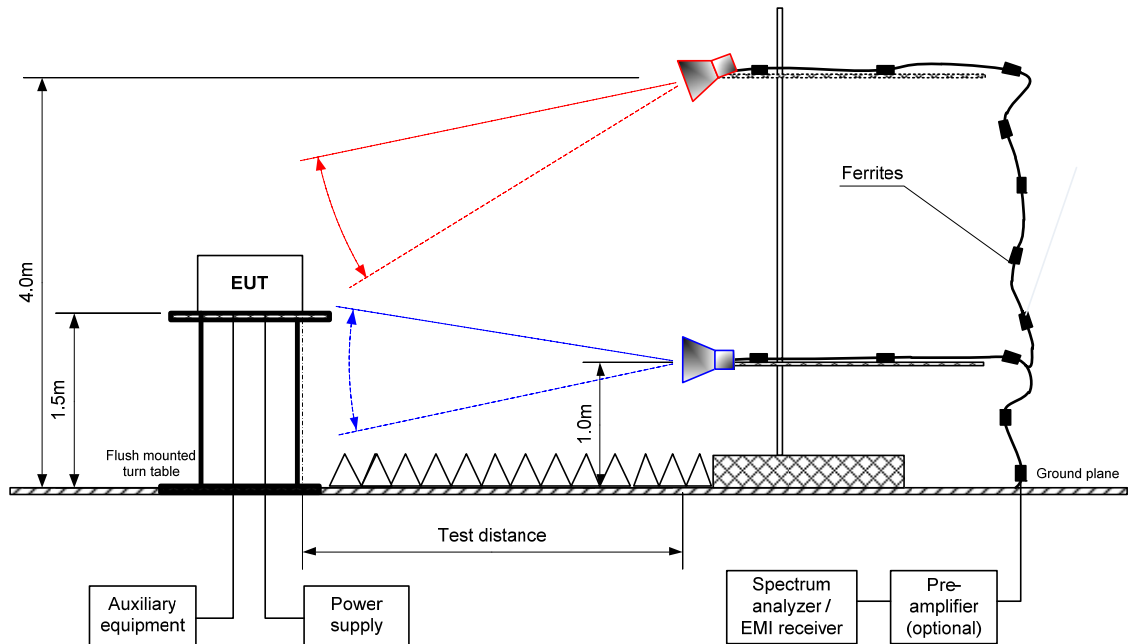




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| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Figure 7.6.3 Setup for spurious emission field strength measurements above 1000 MHz





HERMON LABORATORIES

| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Table 7.6.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY BAND: 902 - 928 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 - 9300 MHz
 TEST DISTANCE: 3 m
 MODULATION: GFSK
 BIT RATE: 115200 bps
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 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 |
|----------------------------------|--------------------------------------|----------------------|-------------------|-------------------|-------------------------------------|--------------------------------|------------|--------------|---------|
| Low carrier frequency 902.3 MHz | | | | | | | | | |
| 1804.6 | 54.38 | Horizontal | 1.7 | 110 | 114.76 | 60.38 | 20 | 40.38 | Pass |
| 6316.1 | 44.28 | Vertica | 1.5 | 20 | | 70.48 | | 50.48 | |
| Mid carrier frequency 915.2 MHz | | | | | | | | | |
| 1830.4 | 52.52 | Horizontal | 1.6 | 90 | 114.99 | 62.47 | 20 | 42.47 | Pass |
| 5491.2 | 37.32 | Vertical | 1.5 | 80 | | 62.47 | | 42.47 | |
| High carrier frequency 927.8 MHz | | | | | | | | | |
| 1855.6 | 53.61 | Vertica | 1.5 | 100 | 114.30 | 60.69 | 20 | 40.69 | Pass |
| 5566.8 | 36.67 | Vertical | 1.7 | 90 | | 77.63 | | 57.63 | |
| 9278.0 | 47.91 | Vertical | 1.6 | 90 | | 66.39 | | 46.39 | |

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

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



HERMON LABORATORIES

| | | | |
|----------------------------|--------------------------------|--|-----------------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Table 7.6.3 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY BAND: 902 – 928 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 - 10000 MHz
 TEST DISTANCE: 3 m
 MODULATION: GFSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 115200 bps
 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*** | |
| carrier frequency 902.3 MHz | | | | | | | | | | | |
| 2706.9 | Vertical | 1.7 | 75 | 47.22 | 74.0 | -26.78 | 47.22 | 18.42 | 54.0 | -35.58 | Pass |
| 3609.2 | Vertical | 1.6 | 88 | 46.66 | 74.0 | -27.34 | 46.66 | 17.86 | 54.0 | -36.14 | |
| 4511.5 | Vertical | 1.5 | 92 | 49.39 | 74.0 | -24.61 | 49.39 | 20.59 | 54.0 | -33.41 | |
| 5413.8 | Vertical | 1.5 | 75 | 47.12 | 74.0 | -26.88 | 47.12 | 18.32 | 54.0 | -35.68 | |
| 9023.0 | Vertical | 1.6 | 90 | 56.55 | 74.0 | -17.45 | 56.55 | 27.75 | 54.0 | -26.25 | |
| carrier frequency 915.2 MHz | | | | | | | | | | | |
| 2745.6 | Vertical | 1.6 | 88 | 47.40 | 74.0 | -26.6 | 47.40 | 18.60 | 54.0 | -35.4 | Pass |
| 3660.8. | Vertical | 1.6 | 92 | 52.28 | 74.0 | -21.72 | 52.28 | 23.48 | 54.0 | -30.52 | |
| 4576.0 | Vertical | 1.8 | 80 | 47.99 | 74.0 | -26.01 | 47.99 | 19.19 | 54.0 | -34.81 | |
| 9152.0 | Vertical | 1.5 | 90 | 54.71 | 74.0 | -19.29 | 54.71 | 25.91 | 54.0 | -28.09 | |
| High carrier frequency 927.8 MHz | | | | | | | | | | | |
| 2783.40 | Vertical | 1.6 | 120 | 57.32 | 74.0 | -16.68 | 57.32 | 28.52 | 54.0 | -25.48 | Pass |
| 3711.20 | Vertical | 1.8 | 20 | 47.08 | 74.0 | -26.92 | 47.08 | 18.28 | 54.0 | -35.72 | |
| 4639.00 | Vertical | 1.6 | 0 | 40.82 | 74.0 | -33.18 | 40.82 | 12.02 | 54.0 | -41.98 | |

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

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

*** - Margin = Calculated field strength - specification limit,

where Calculated field strength = Measured field strength + average factor.

Table 7.6.4 Average factor calculation

| Transmission pulse | | Transmission burst | | Transmission train duration, ms | Average factor, dB |
|--------------------|------------|--------------------|------------|---------------------------------|--------------------|
| Duration, ms | Period, ms | Duration, ms | Period, ms | | |
| 3.633 | 1000 | NA | NA | NA | -28.8 |

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{\text{Train duration}} \times \text{Number of bursts within pulse train} \right)$$

for pulse train longer than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{100 \text{ ms}} \times \text{Number of bursts within 100 ms} \right)$$



HERMON LABORATORIES

| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Table 7.6.5 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY BAND: 902 – 928 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: GFSK
 BIT RATE: 115200 bps
 RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)
 9.0 kHz (150 kHz – 30 MHz)
 120 kHz (30 MHz – 1000 MHz)
 VIDEO BANDWIDTH: > Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 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* | | | | | |
| Low carrier frequency 902.3 MHz | | | | | | | | | |
| 960.3 | 51.3 | 48.6 | 54 | -6.4 | Vert | 1.1 | 110 | Pass | |
| 974.7 | 49.7 | 46.5 | 54 | -7.5 | Vert | 1.1 | 110 | Pass | |
| Mid carrier frequency 915.2 MHz | | | | | | | | | |
| 973.1 | 48.5 | 45.7 | 54 | -8.3 | Vert | 1.1 | 100 | Pass | |
| 979.3 | 46.2 | 43.3 | 54 | -10.7 | Vert | 1.1 | 100 | Pass | |
| High carrier frequency 927.8 MHz | | | | | | | | | |
| 972.4 | 52.6 | 49.5 | 54 | -4.5 | Vert | 1.1 | 110 | Pass | |

*- Margin = Measured emission - specification limit.

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



HERMON LABORATORIES

| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Table 7.6.6 Restricted bands

| 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 | Above 38.6 |
| 8.362 - 8.366 | 37.5 - 38.25 | 322 - 335.4 | 2483.5 - 2500 | 9300 - 9500 | |

Harmonic distribution:

| Harmonic # | Low carrier, MHz | Mid carrier, MHz | High carrier, MHz |
|------------|------------------|------------------|-------------------|
| 1 | 902.3000 | 915.2000 | 927.8000 |
| 2 | 1,804.6000 | 1,830.4000 | 1,855.6000 |
| 3 | 2,706.9000 | 2,745.6000 | 2,783.4000 |
| 4 | 3,609.2000 | 3,660.8000 | 3,711.2000 |
| 5 | 4,511.5000 | 4,576.0000 | 4,639.0000 |
| 6 | 5,413.8000 | 5,491.2000 | 5,566.8000 |
| 7 | 6,316.1000 | 6,406.4000 | 6,494.6000 |
| 8 | 7,218.4000 | 7,321.6000 | 7,422.4000 |
| 9 | 8,120.7000 | 8,236.8000 | 8,350.2000 |
| 10 | 9,023.0000 | 9,152.0000 | 9,278.0000 |

Legend:

| |
|----------------------------------|
| Outside restricted band harmonic |
| Within restricted band harmonic |

Reference numbers of test equipment used

| | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| HL 0446 | HL 0521 | HL 0604 | HL 2909 | HL 3341 | HL 3342 | HL 3347 | HL 3354 |
| HL 3531 | HL 3533 | HL 3901 | HL 4278 | HL 4353 | HL 4909 | HL 4933 | |

Full description is given in Appendix A.

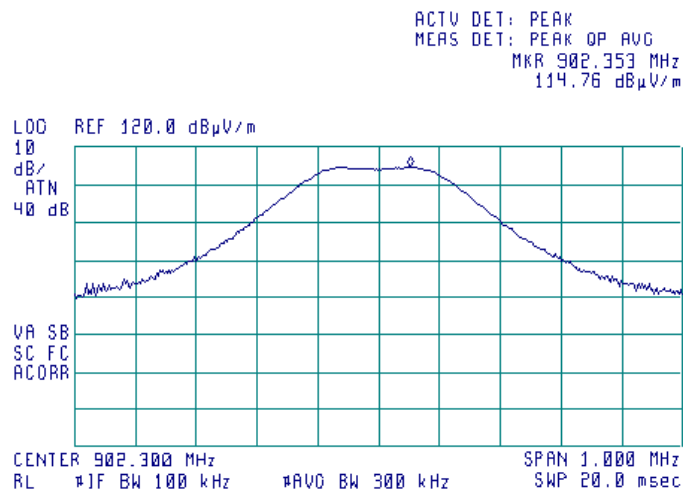


HERMON LABORATORIES

| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

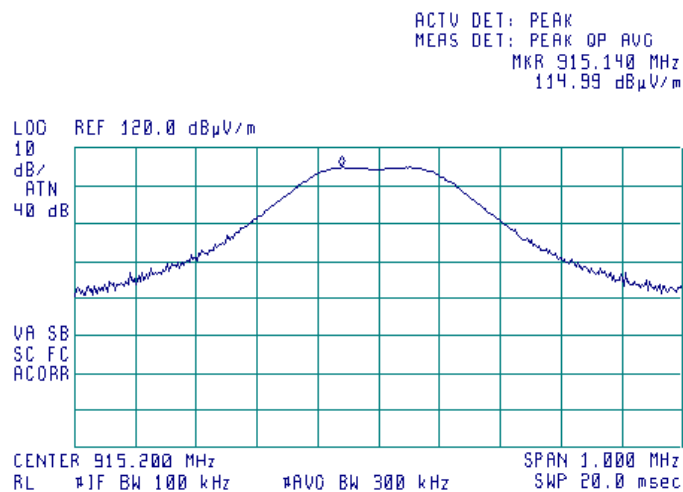
Plot 7.6.1 Radiated emission measurements at carrier frequency 902.3 MHz

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



Plot 7.6.2 Radiated emission measurements at carrier frequency 915.2 MHz

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



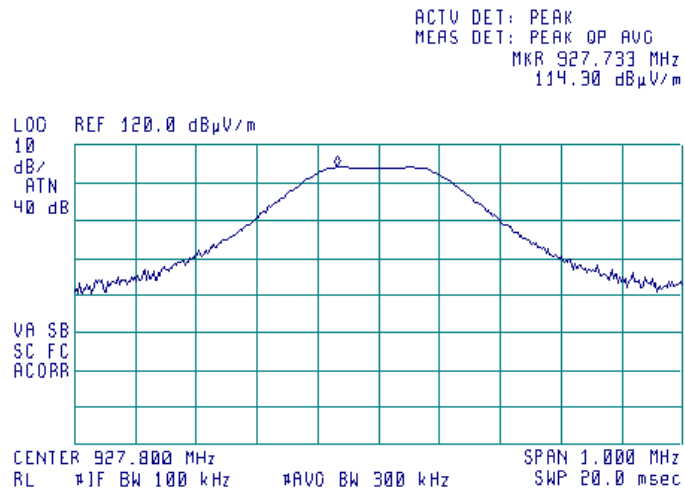


HERMON LABORATORIES

| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.6.3 Radiated emission measurements at carrier frequency 927.8 MHz

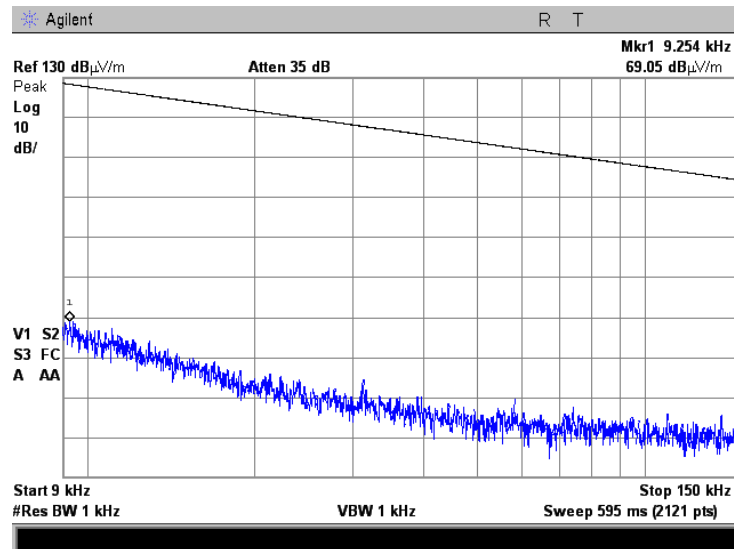
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

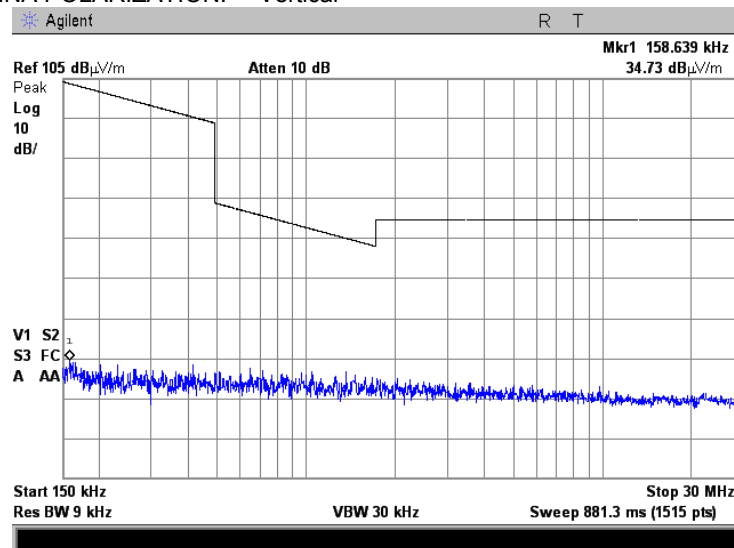
Plot 7.6.4 Radiated emission measurements from 9 to 150 kHz at the low, mid and high carrier frequency

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Plot 7.6.5 Radiated emission measurements from 0.15 to 30 MHz at the low, mid and high carrier frequency

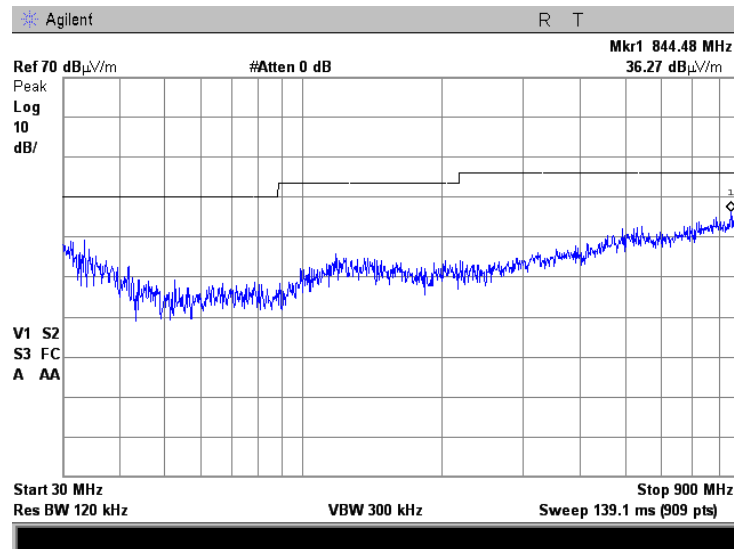
TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

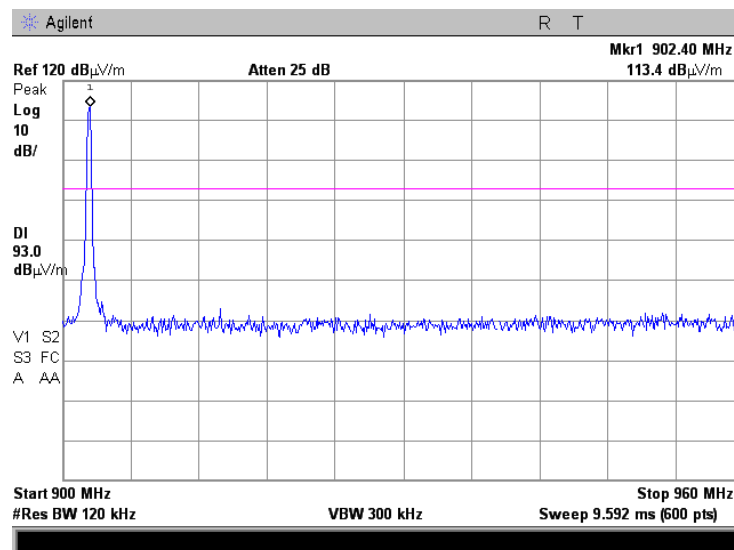
Plot 7.6.6 Radiated emission measurements from 30 to 900 MHz at the low carrier frequency

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



Plot 7.6.7 Radiated emission measurements from 900 to 960 MHz at the low carrier frequency

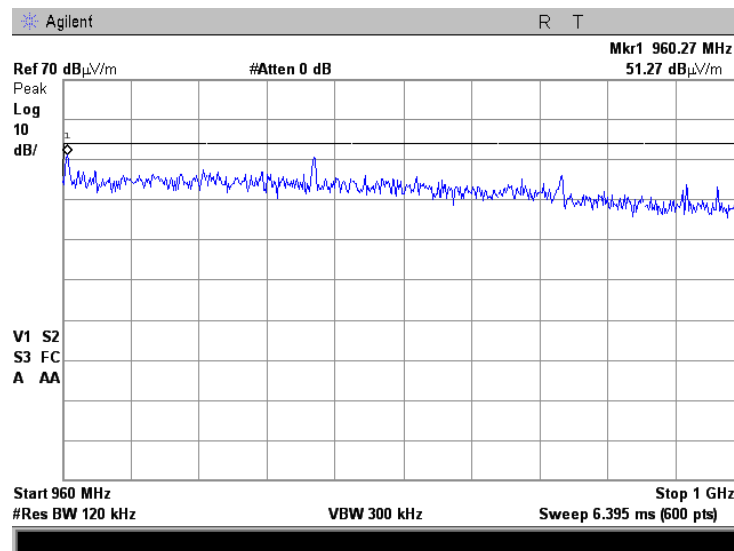
TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

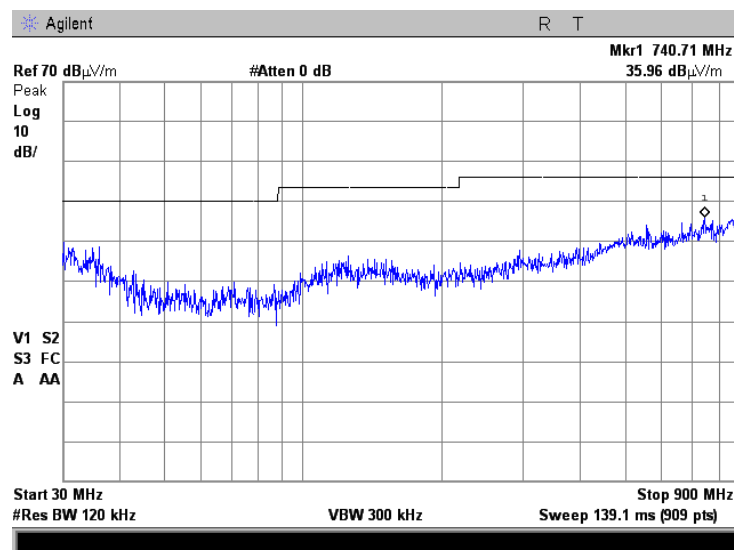
Plot 7.6.8 Radiated emission measurements from 960 to 1000 MHz at the low carrier frequency

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



Plot 7.6.9 Radiated emission measurements from 30 to 900 MHz at carrier frequency 915.2 MHz

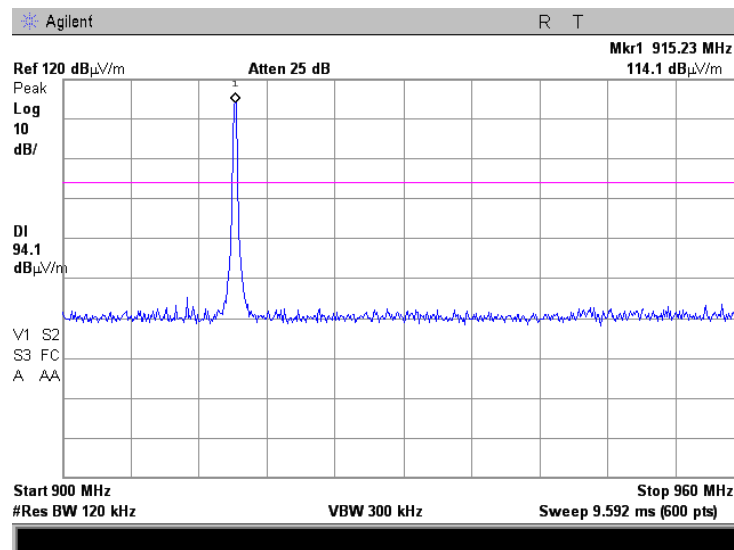
TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

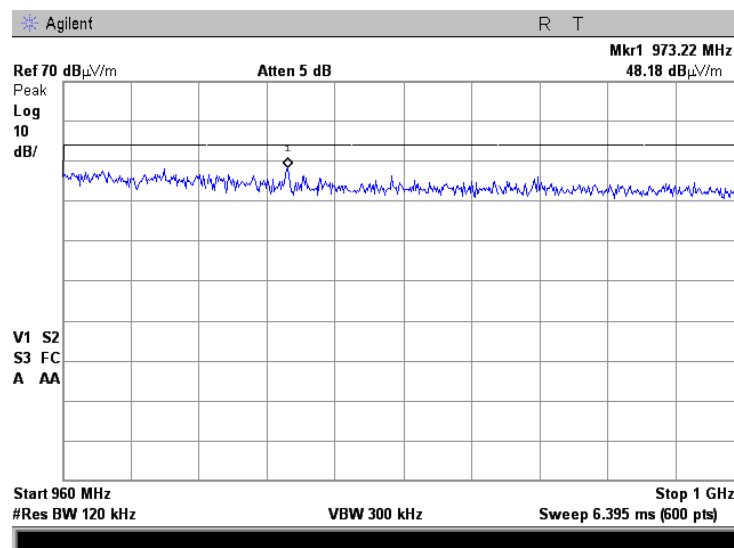
Plot 7.6.10 Radiated emission measurements from 900 to 960 MHz at carrier frequency 915.2 MHz

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



Plot 7.6.11 Radiated emission measurements from 960 to 1000 MHz at carrier frequency 915.2 MHz

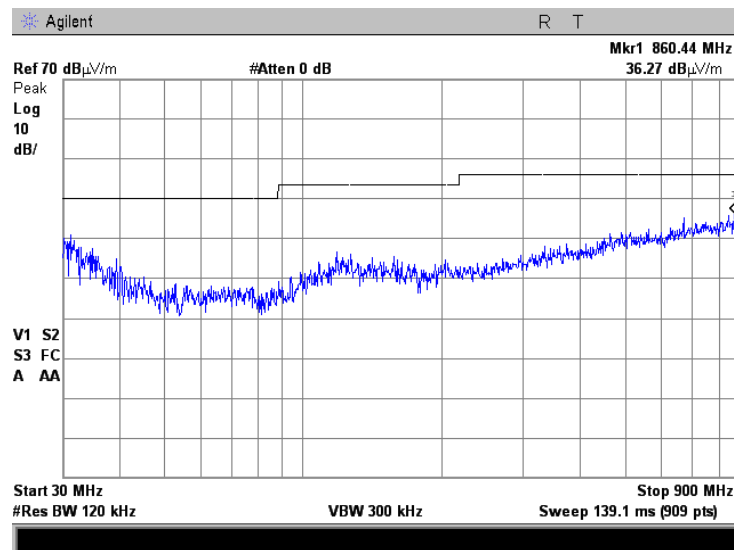
TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

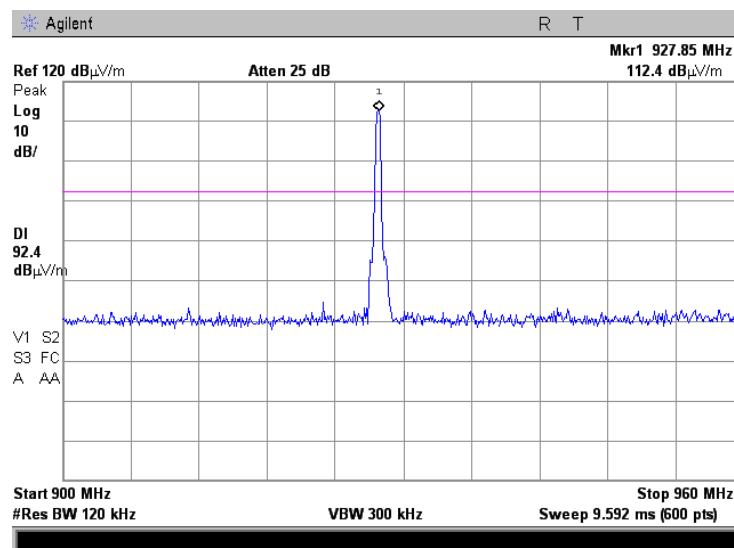
Plot 7.6.12 Radiated emission measurements from 30 to 900 MHz at carrier frequency 927.8 MHz

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



Plot 7.6.13 Radiated emission measurements from 900 to 960 MHz at carrier frequency 927.8 MHz

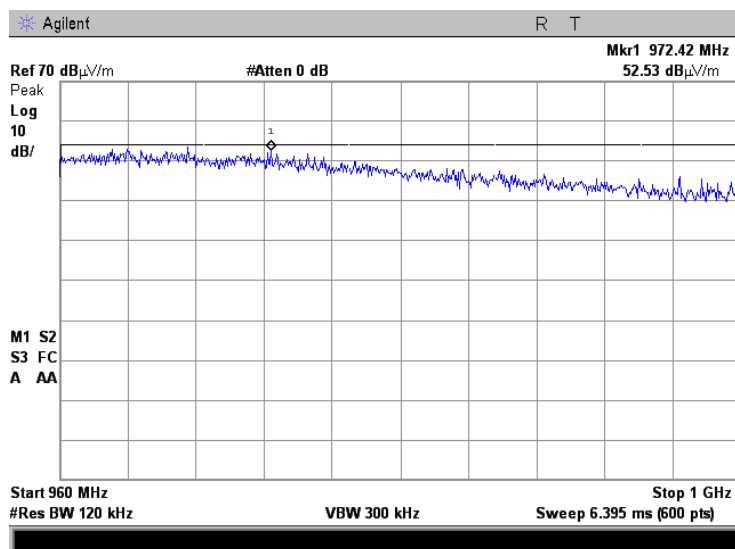
TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

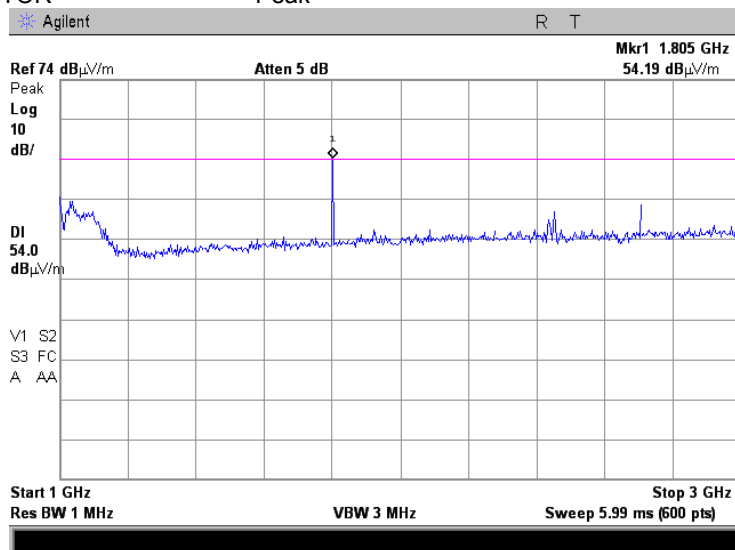
Plot 7.6.14 Radiated emission measurements from 960 to 1000 MHz at carrier frequency 927.8 MHz

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



Plot 7.6.15 Radiated emission measurements from 1000 to 3000 MHz at carrier frequency 902.3 MHz

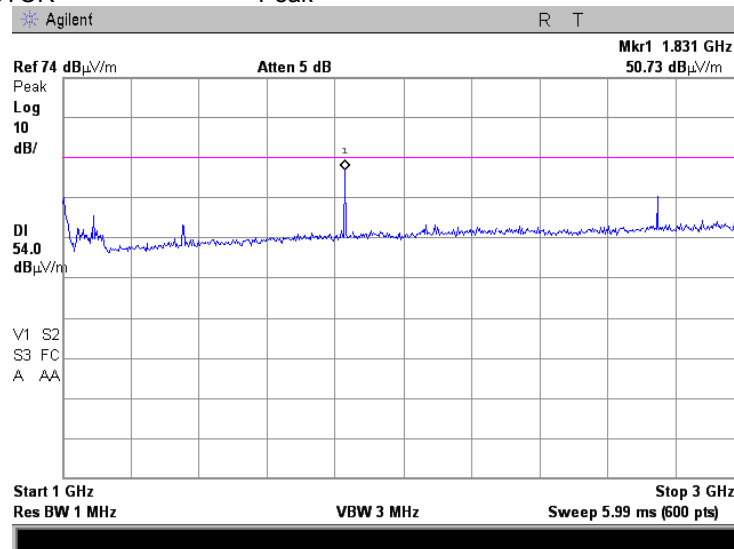
TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR Peak



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

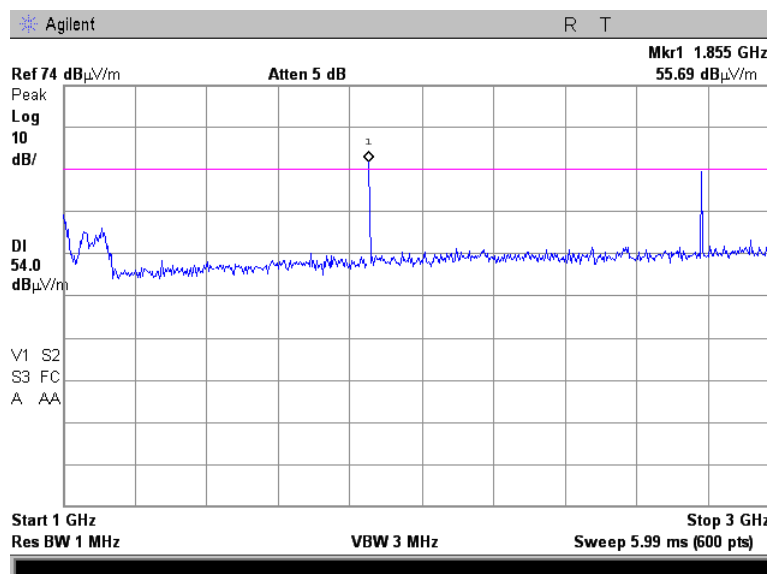
Plot 7.6.16 Radiated emission measurements from 1000 to 3000 MHz at carrier frequency 915.2 MHz

TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
DETECTOR: Peak



Plot 7.6.17 Radiated emission measurements from 1000 to 3000 MHz at carrier frequency 927.8 MHz

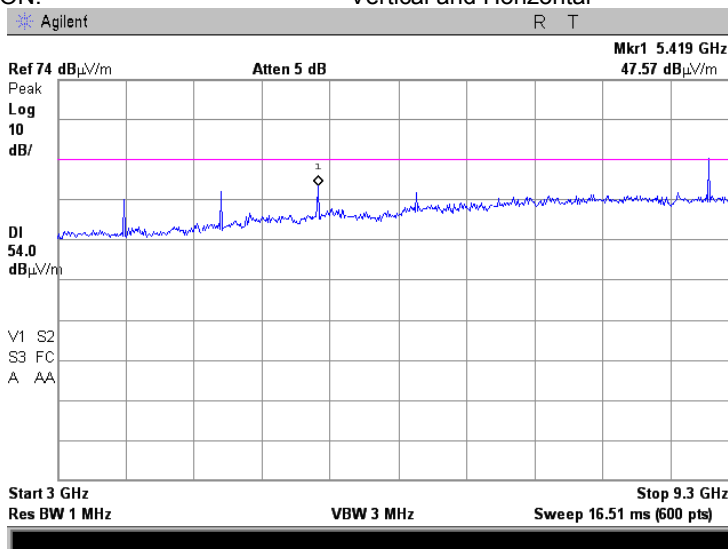
TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

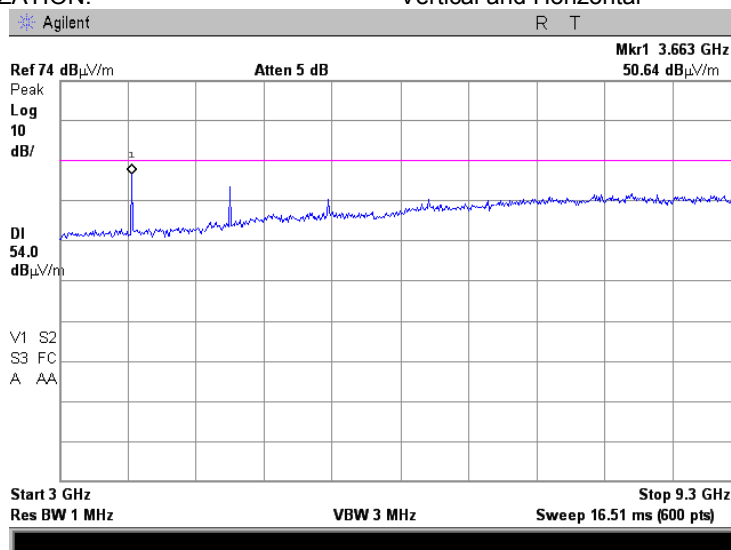
Plot 7.6.18 Radiated emission measurements from 3000 to 9300 MHz at carrier frequency 902.3 MHz

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



Plot 7.6.19 Radiated emission measurements from 3000 to 9300 MHz at carrier frequency 915.2 MHz

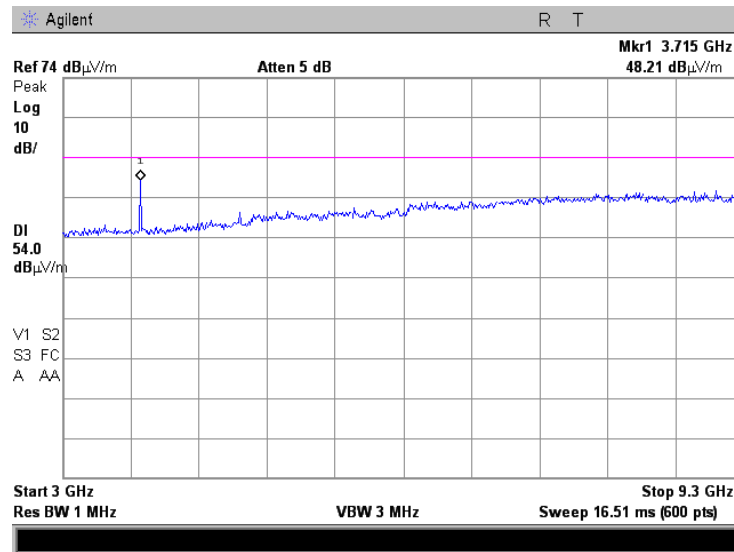
TEST SITE: Full anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.6.20 Radiated emission measurements from 3000 to 9300 MHz at carrier frequency 927.8 MHz

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





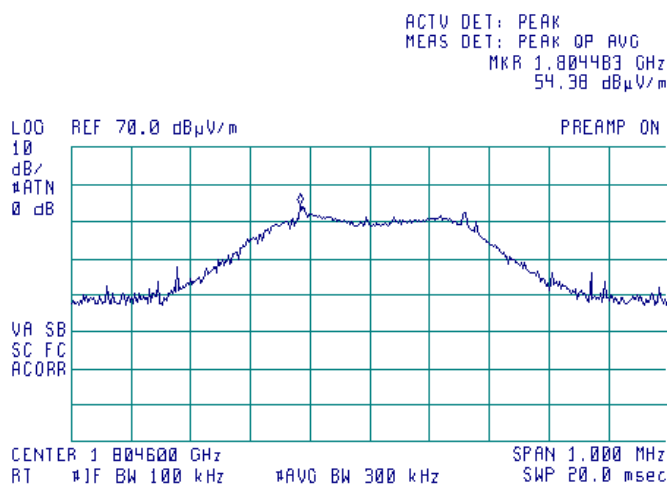
HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.6.21 Radiated emission measurements at the second harmonic of low carrier frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION

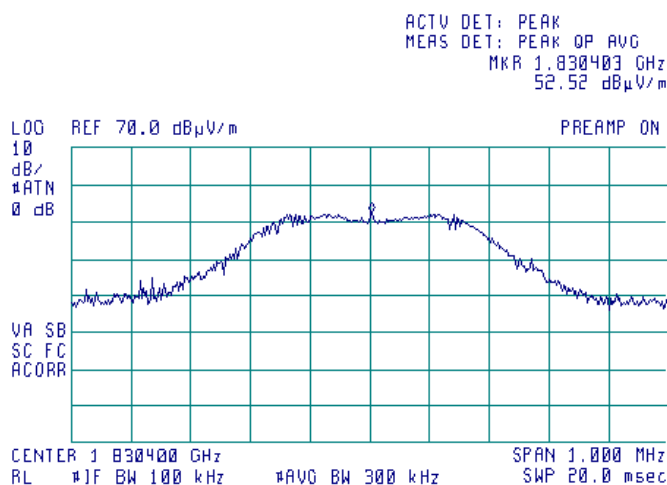
Semi anechoic chamber
3 m
Vertical & Horizontal



Plot 7.6.22 Radiated emission measurements at the second harmonic of mid carrier frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION

Semi anechoic chamber
3 m
Vertical & Horizontal



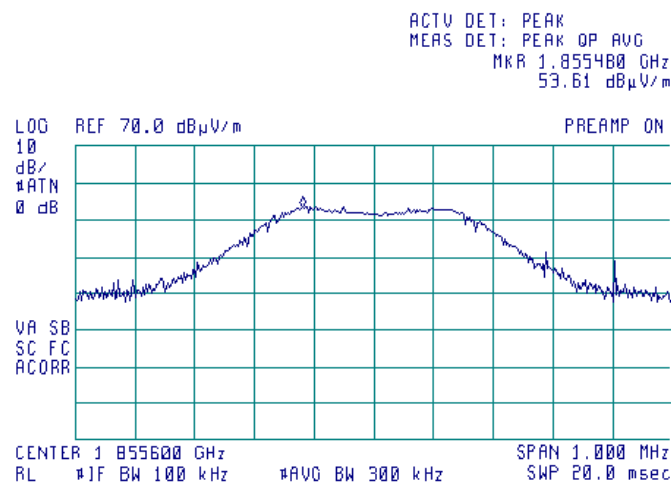


HERMON LABORATORIES

| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

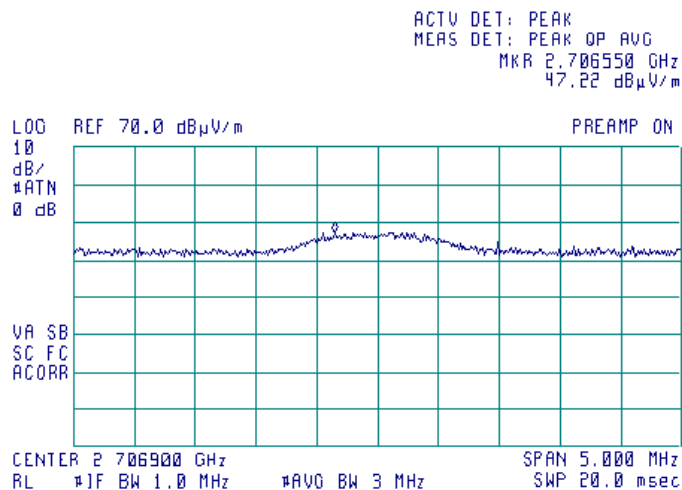
Plot 7.6.23 Radiated emission measurements at the second harmonic of high carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical1 & Horizontal



Plot 7.6.24 Radiated emission measurements at the third harmonic of low carrier frequency

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



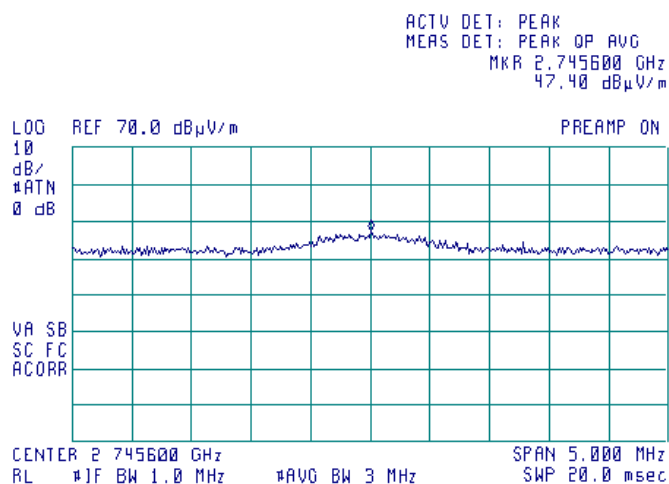


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

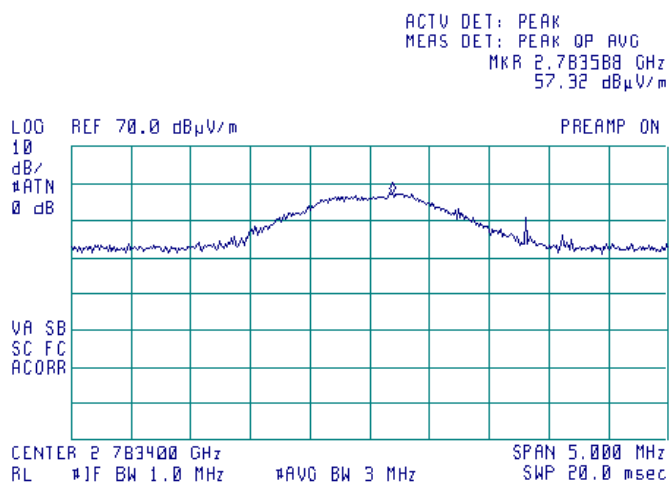
Plot 7.6.25 Radiated emission measurements at the third harmonic of mid carrier frequency

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



Plot 7.6.26 Radiated emission measurements at the third harmonic of high carrier frequency

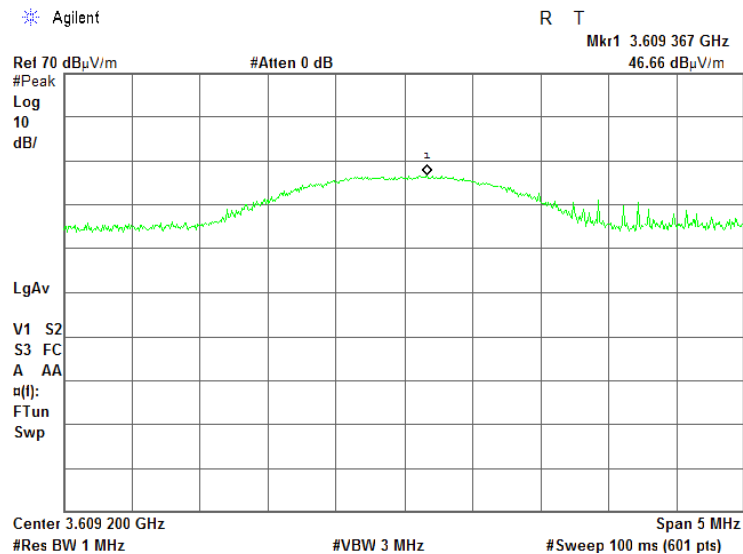
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical & Horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

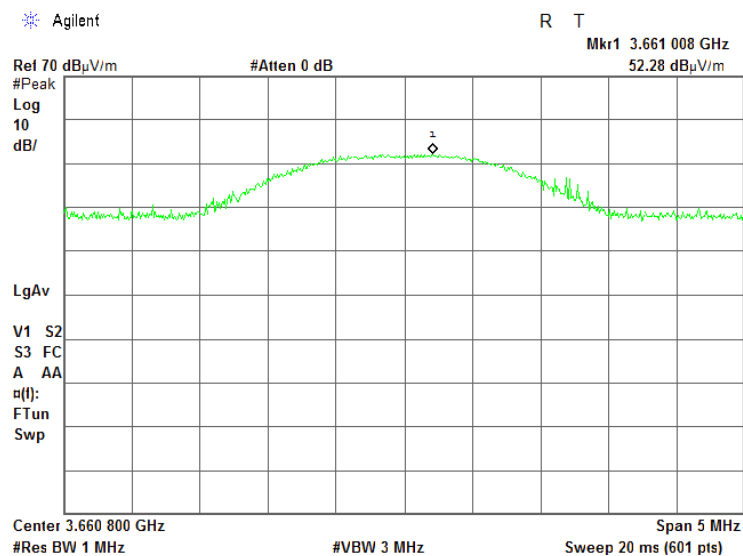
Plot 7.6.27 Radiated emission measurements at the fourth harmonic of low carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical & Horizontal



Plot 7.6.28 Radiated emission measurements at the fourth harmonic of mid carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical & Horizontal



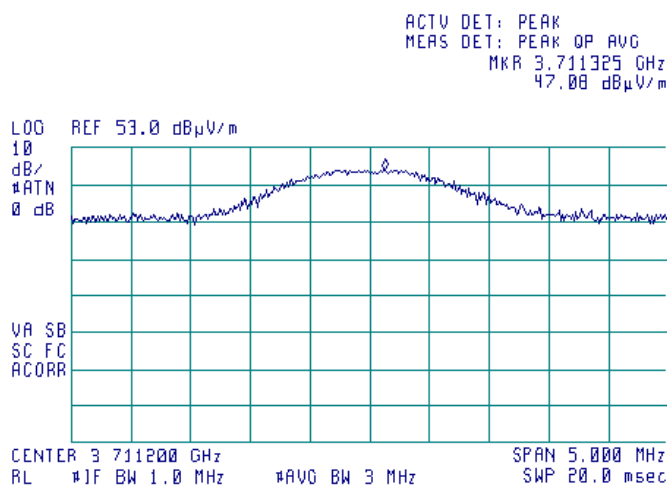


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

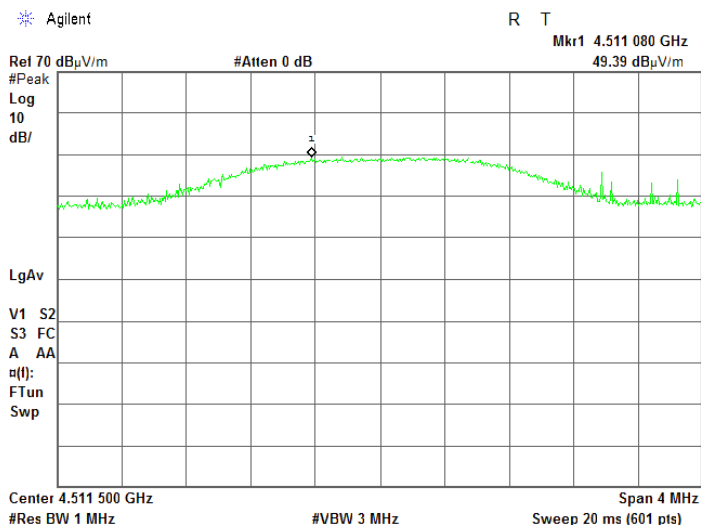
Plot 7.6.29 Radiated emission measurements at the fourth harmonic of high carrier frequency

TEST SITE: Semi Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical &Horizontal



Plot 7.6.30 Radiated emission measurements at the fifth harmonic of low carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical &Horizontal



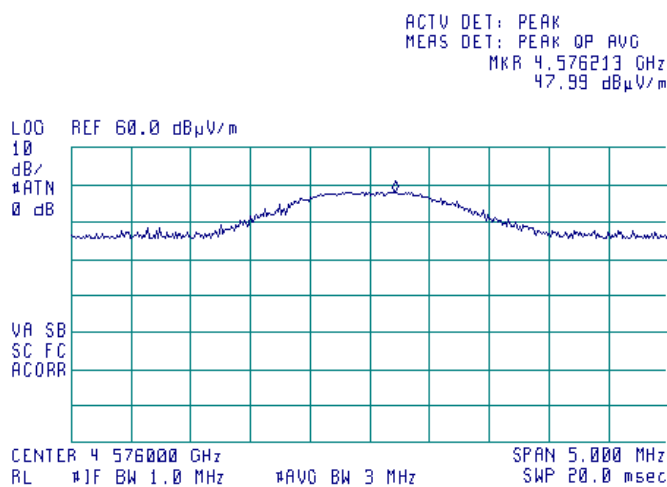


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

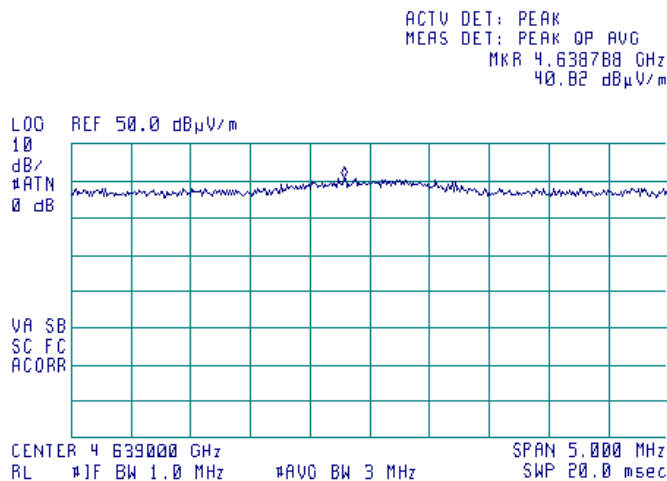
Plot 7.6.31 Radiated emission measurements at the fifth harmonic of mid carrier frequency

TEST SITE: Semi Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical &Horizontal



Plot 7.6.32 Radiated emission measurements at the fifth harmonic of high carrier frequency

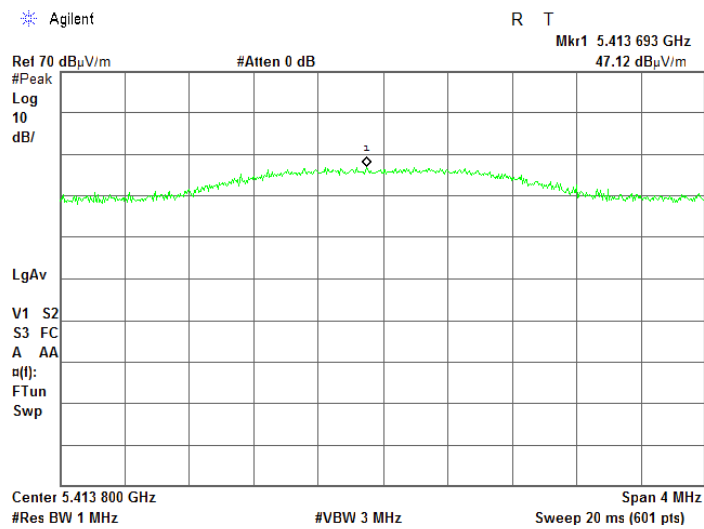
TEST SITE: Semi Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical &Horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

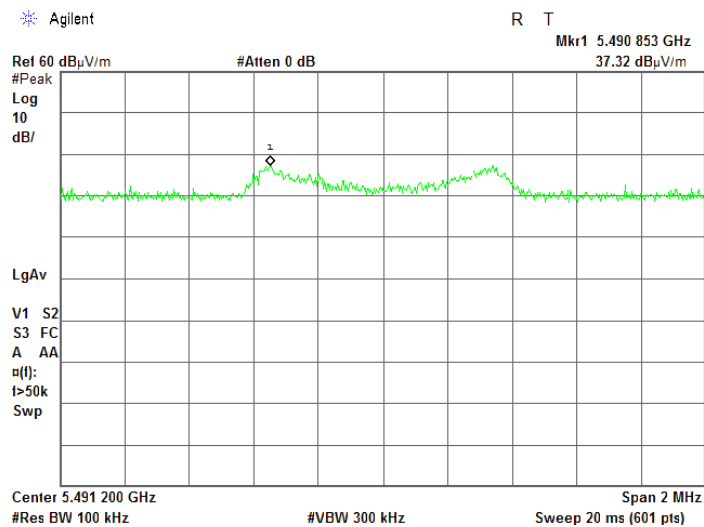
Plot 7.6.33 Radiated emission measurements at the sixth harmonic of low carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical & Horizontal



Plot 7.6.34 Radiated emission measurements at the sixth harmonic of mid carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



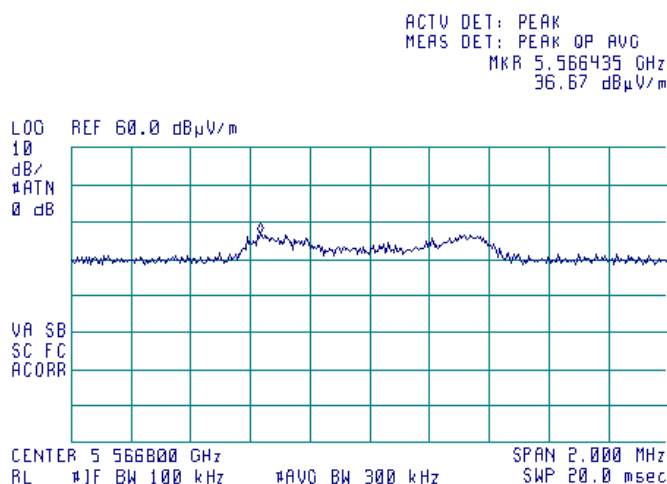


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | | | |
| Test procedure: ANSI C63.10, sections 6.5, 6.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

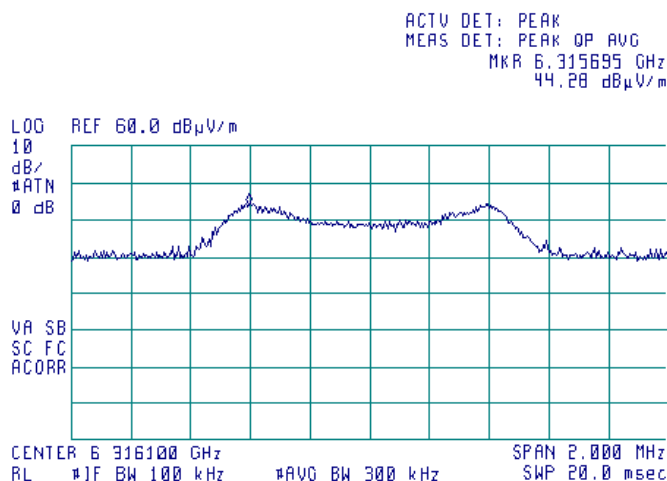
Plot 7.6.35 Radiated emission measurements at the sixth harmonic of high carrier frequency

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



Plot 7.6.36 Radiated emission measurements at the seventh harmonic of low carrier frequency

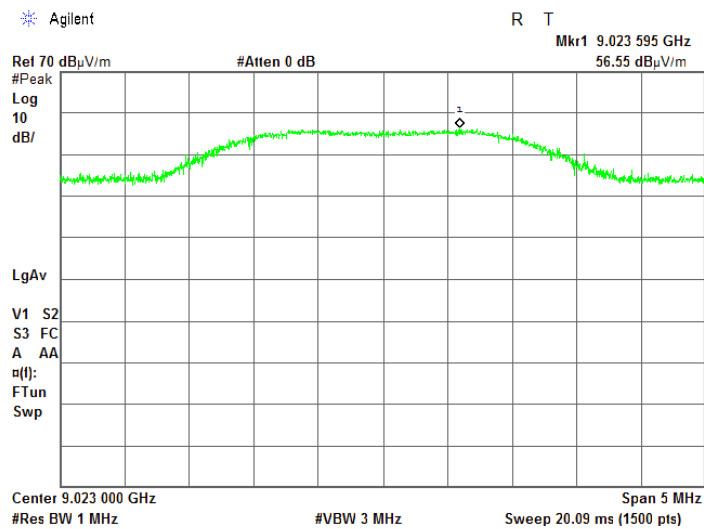
TEST SITE: Semi Anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

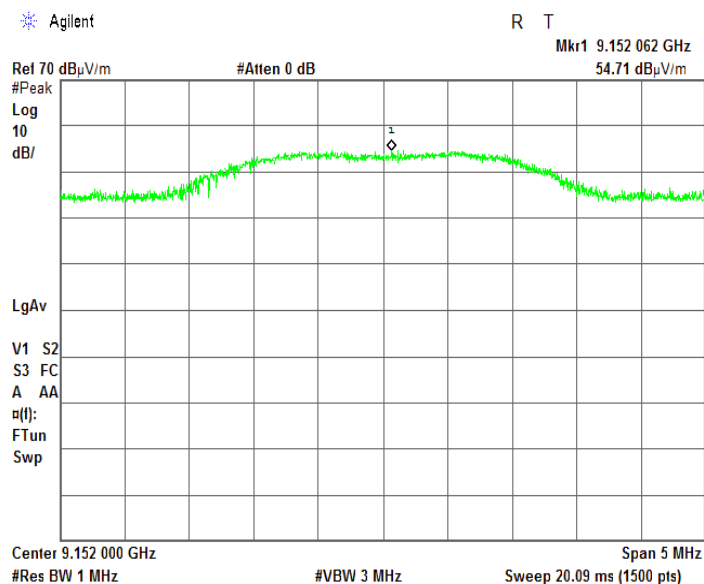
Plot 7.6.37 Radiated emission measurements at the tenth harmonic of low carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.6.38 Radiated emission measurements at the tenth harmonic of mid carrier frequency

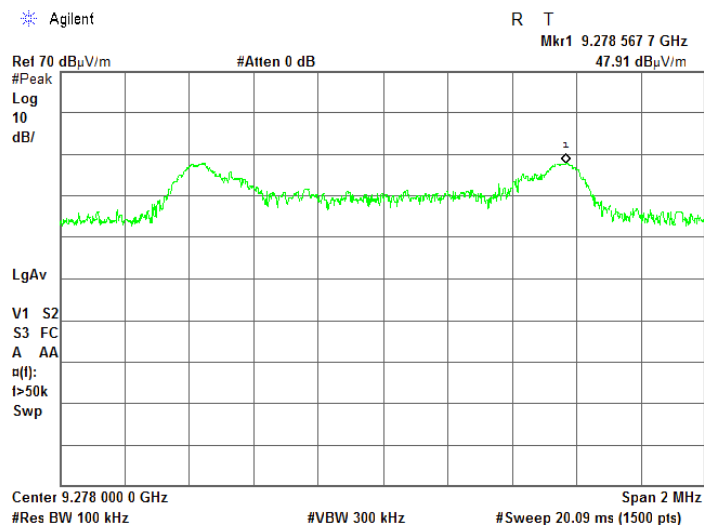
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



| | | | |
|----------------------------|--------------------------------|--|-----------------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

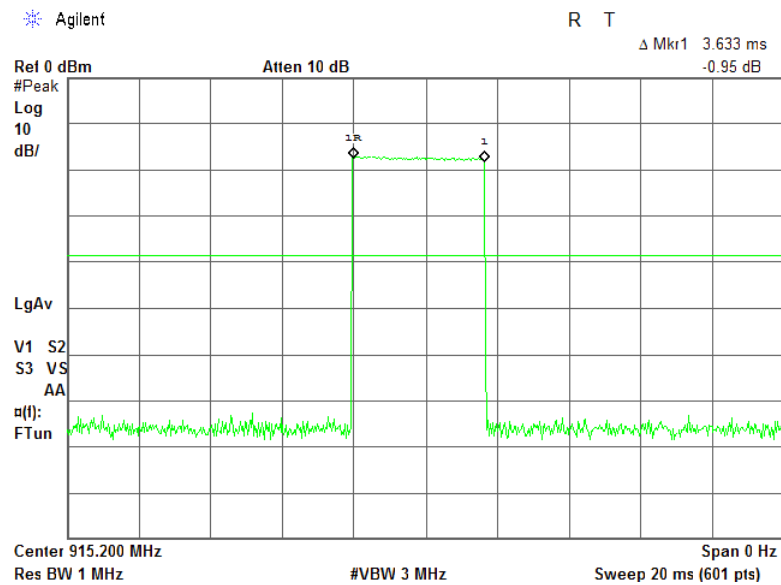
Plot 7.6.39 Radiated emission measurements at the tenth harmonic of high carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal

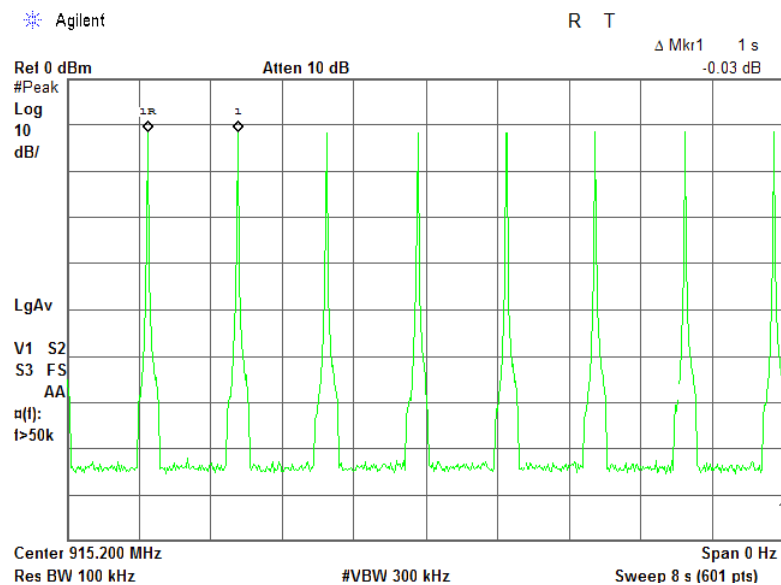


| | | | |
|-----------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions | |
| Test procedure: | | ANSI C63.10, sections 6.5, 6.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 06-Sep-16 - 22-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.6.40 Transmission pulse duration



Plot 7.6.41 Transmission pulse period



| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

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 |
| 902.0 – 928.0 | 20.0 | 74.0 | 54.0 |
| 2400.0 – 2483.5 | | | |
| 5725.0 – 5850.0 | | | |

* - 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. 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.

7.7.2.3 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.

7.7.2.4 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.

7.7.2.5 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

7.7.2.6 The above procedure was repeated with the frequency hopping function enabled.

Figure 7.7.1 Band edge emission test setup





| | | | |
|---|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Table 7.7.2 Band edge emission test results

ASSIGNED FREQUENCY RANGE: 902 – 928 MHz
DETECTOR USED: Peak
MODULATION: FSK
OPERATIONAL MODE: FHSS 86 Channels

| OPERATIONAL MODE: | | | | | | | | PHSS 66 Channels | |
|----------------------------|----------------|-------------------------|--------------------------|--------------------------------|------------|-------------|---------|------------------|--|
| Frequency, MHz | Bit rate, kbps | Band edge emission, dBm | Emission at carrier, dBm | Attenuation below carrier, dBc | Limit, dBc | Margin, dB* | Verdict | | |
| Frequency hopping disabled | | | | | | | | | |
| 902.00 | 115200 | -40.83 | -5.85 | 34.98 | 20 | 14.98 | Pass | | |
| 928.00 | | -43.74 | -9.44 | 34.3 | | 14.3 | | | |
| Frequency hopping enabled | | | | | | | | | |
| 901.610 | 115200 | -36.44 | -9.03 | 27.41 | 20 | 7.41 | Pass | | |
| 928.027 | | 35.26 | -10.86 | 24.40 | | 4.40 | | | |

OPERATIONAL MODE: FHSS 240 Channels

| Frequency, MHz | Bit rate, bps | Band edge emission, dBm | Emission at carrier, dBm | Attenuation below carrier, dBc | Limit, dBc | Margin, dB* | Verdict |
|----------------------------|---------------|-------------------------|--------------------------|--------------------------------|------------|-------------|---------|
| Frequency hopping disabled | | | | | | | |
| 902.000 | 9600 | -60.48 | -5.84 | 54.64 | 20.0 | 34.64 | Pass |
| 928.000 | | -43.60 | -6.73 | 36.87 | | 16.87 | |
| 902.000 | 19200 | -61.17 | -5.86 | 55.31 | | 35.31 | |
| 928.000 | | -37.58 | -6.75 | 30.83 | | 10.83 | |
| 902.000 | 38400 | -60.37 | -5.79 | 54.58 | | 34.58 | |
| 928.000 | | -33.63 | -6.72 | 26.91 | | 6.91 | |
| Frequency hopping enabled | | | | | | | |
| 901.905 | 9600 | -57.95 | -9.38 | 48.57 | 20.0 | 28.57 | Pass |
| 928.217 | | -37.22 | -11.09 | 26.13 | | 6.13 | |
| 901.875 | 19200 | -57.83 | -9.29 | 48.54 | | 28.54 | |
| 928.060 | | -35.81 | -10.35 | 25.46 | | 5.46 | |
| 901.945 | 38400 | -57.89 | -9.37 | 48.52 | | 28.52 | |
| 928.033 | | -36.07 | -10.99 | 25.08 | | 5.08 | |

*- Margin = Attenuation below carrier – specification limit.

Reference numbers of test equipment used

| | | | | | | | |
|---------|--|--|--|--|--|--|--|
| HL 3818 | | | | | | | |
|---------|--|--|--|--|--|--|--|

Full description is given in Appendix A.



HERMON LABORATORIES

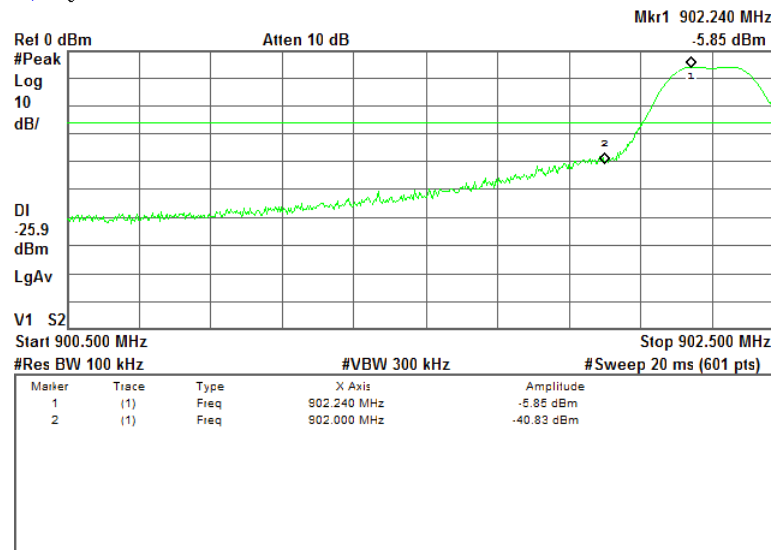
| | | | |
|---------------------|-------------------------|---|----------------|
| Test specification: | | Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | |
| Test procedure: | | ANSI C63.10, section 7.8.6 | |
| Test mode: | | Verdict: PASS | |
| Date(s): | | | |
| 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.1 The band edge emission at wide channel configuration with hopping function disabled

BIT RATE: 115200 bps

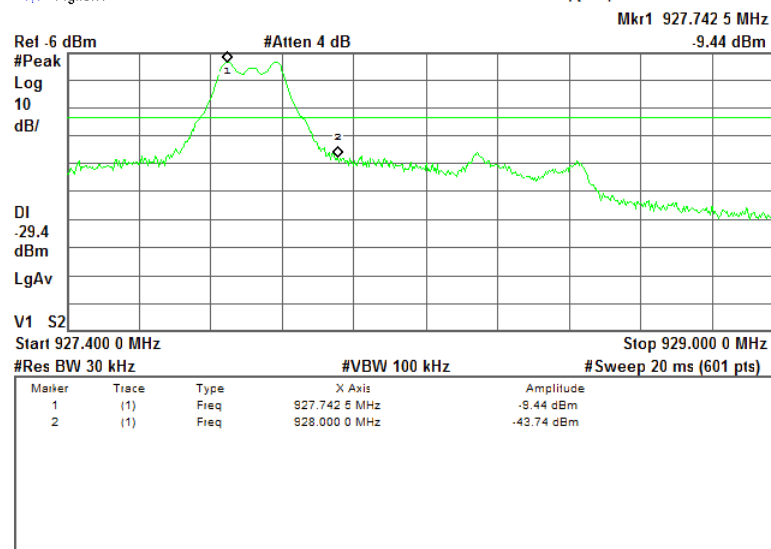
Agilent

R T



Agilent

R T





HERMON LABORATORIES

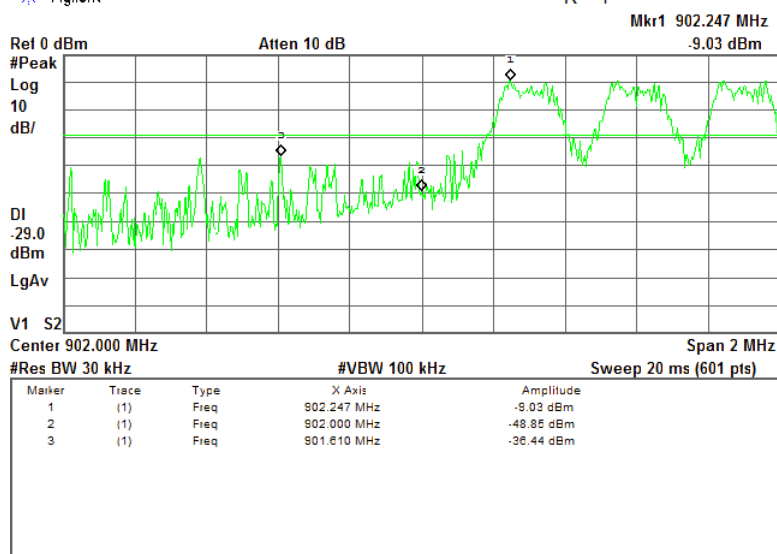
| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.2 The band edge emission at wide channel configuration with hopping function enabled

BIT RATE: 115200 bps

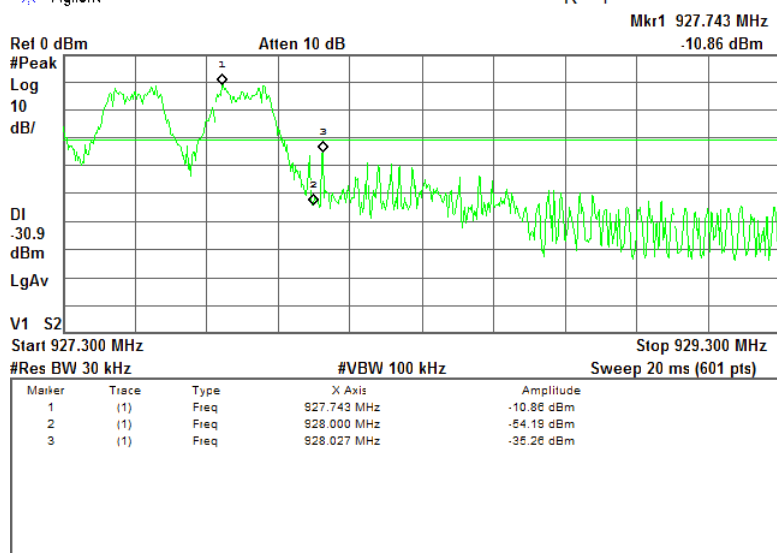
Agilent

R T



Agilent

R T



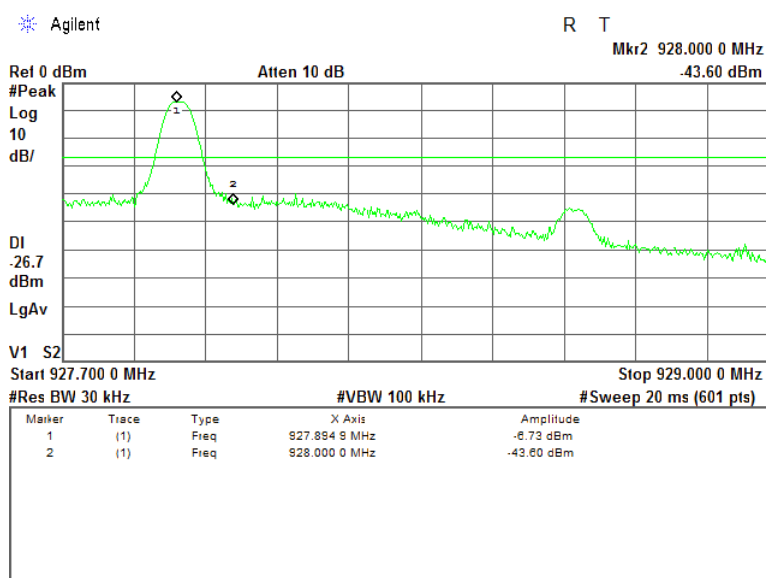
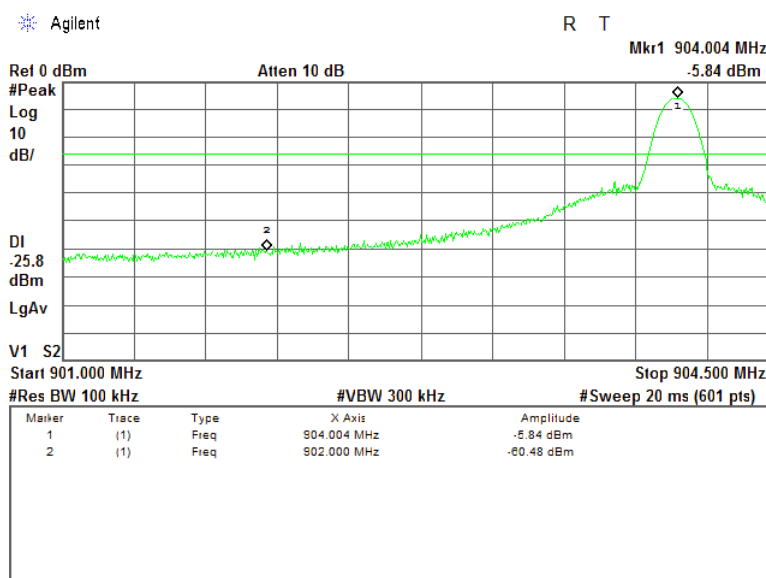


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.3 The band edge emission at narrow channel configuration with hopping function disabled

BIT RATE: 9600 bps



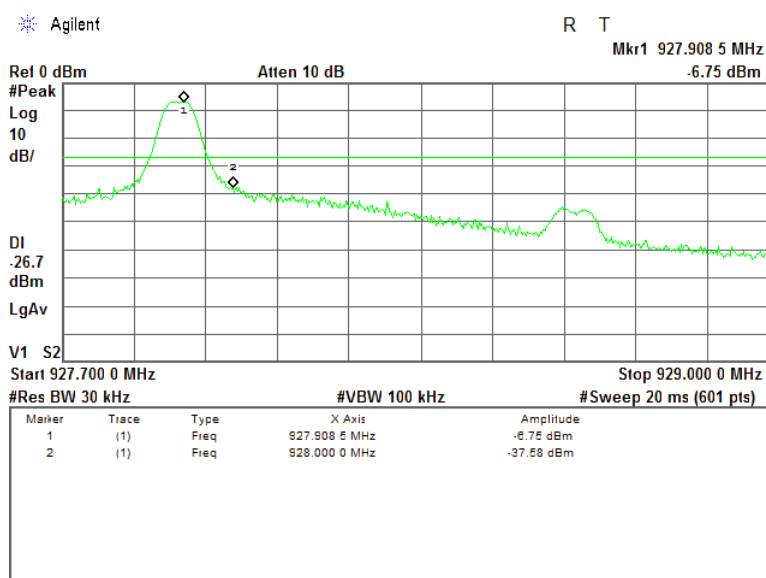
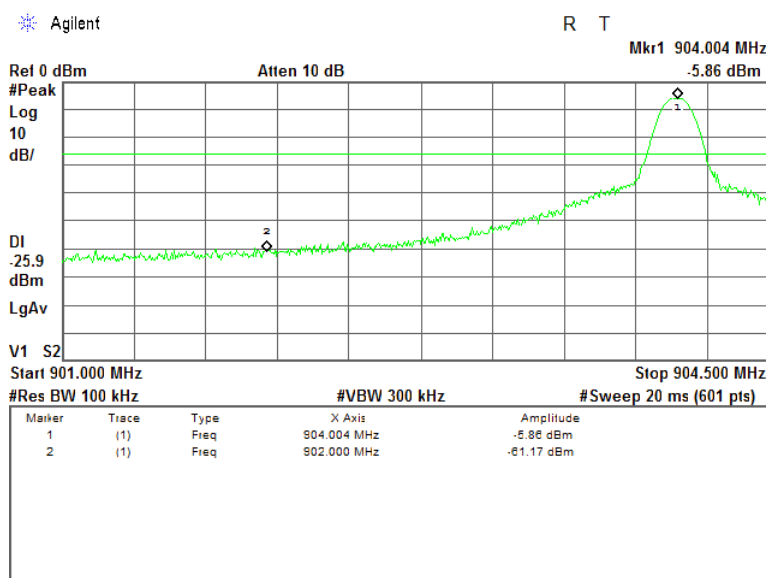


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.4 The band edge emission at narrow channel configuration with hopping function disabled

BIT RATE: 19200 bps



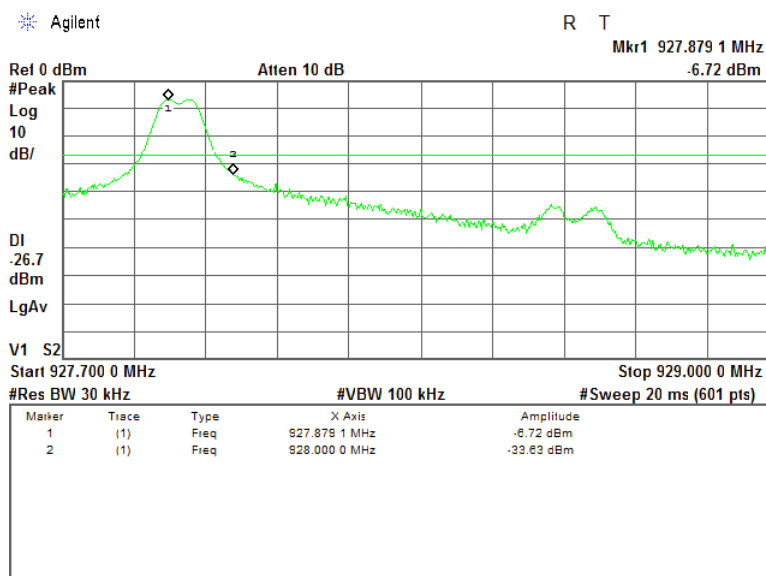
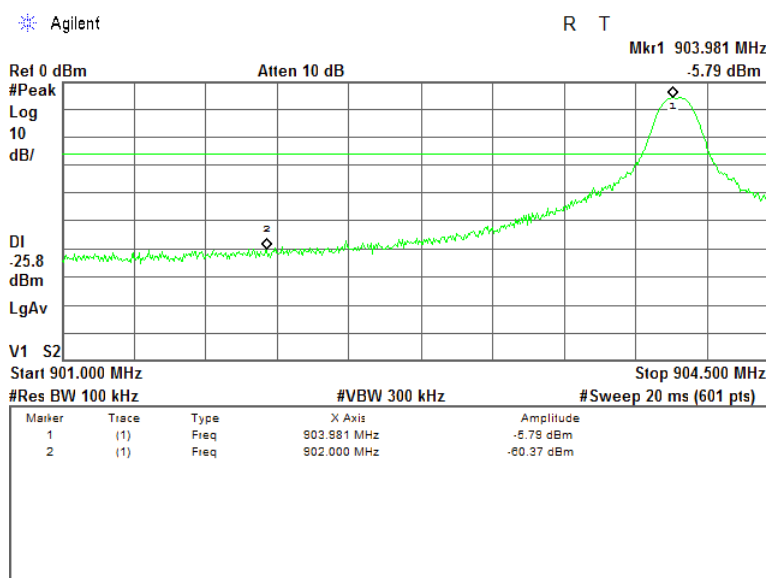


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.5 The band edge emission at narrow channel configuration with hopping function disabled

BIT RATE: 38400 bps



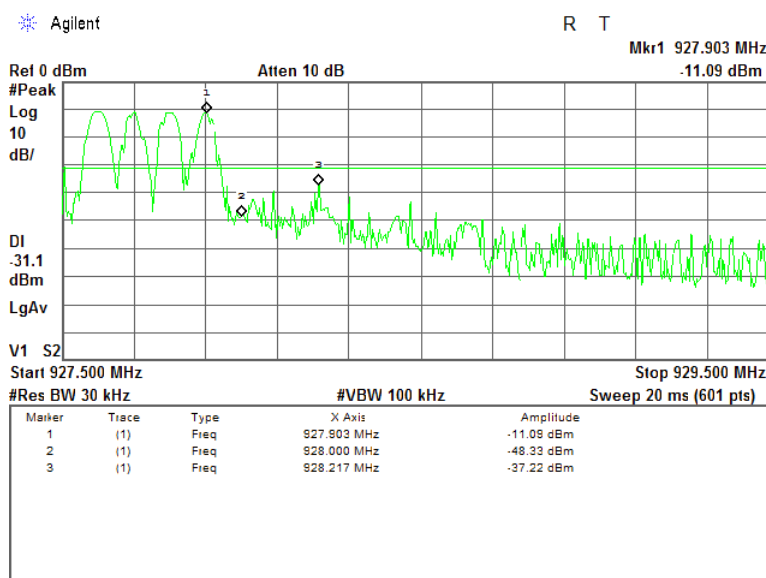
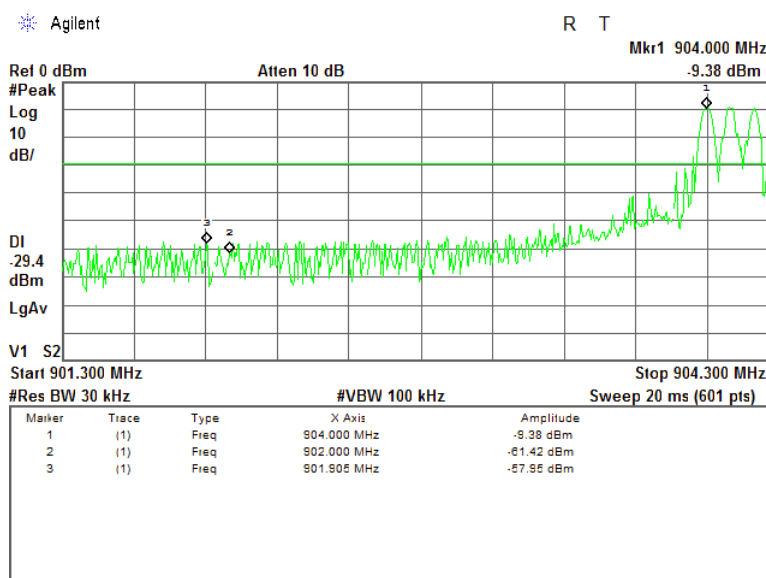


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.6 The band edge emission at narrow channel configuration with hopping function enabled

BIT RATE: 9600 bps



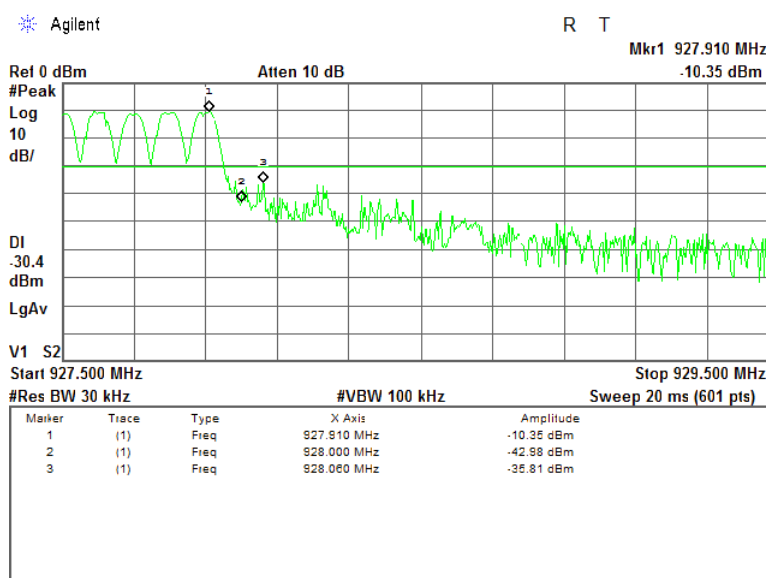
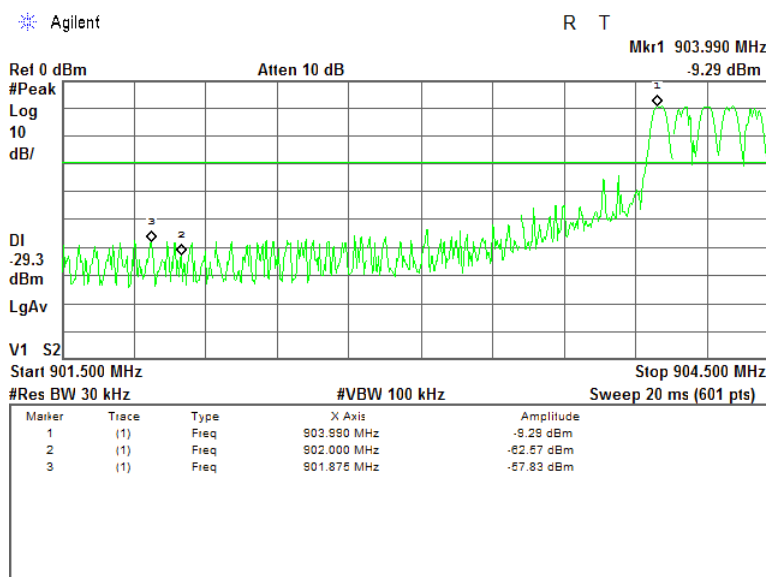


HERMON LABORATORIES

| | | | |
|---|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.7 The band edge emission at narrow channel configuration with hopping function enabled

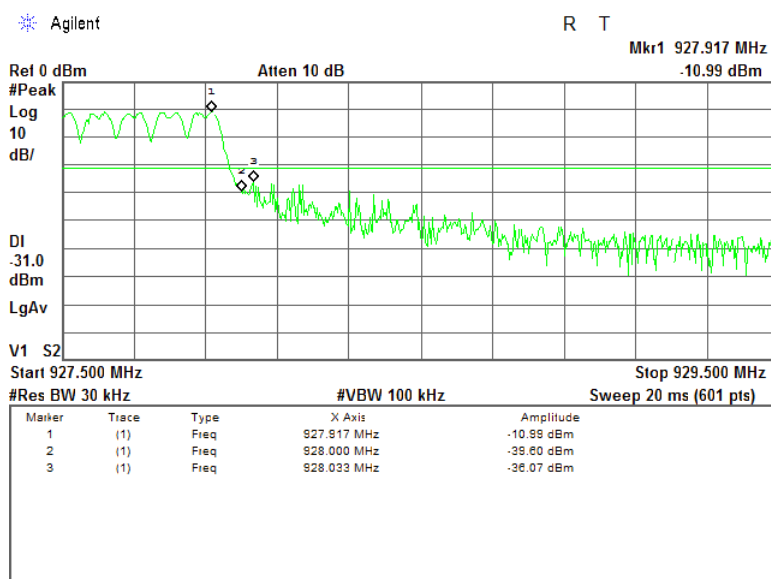
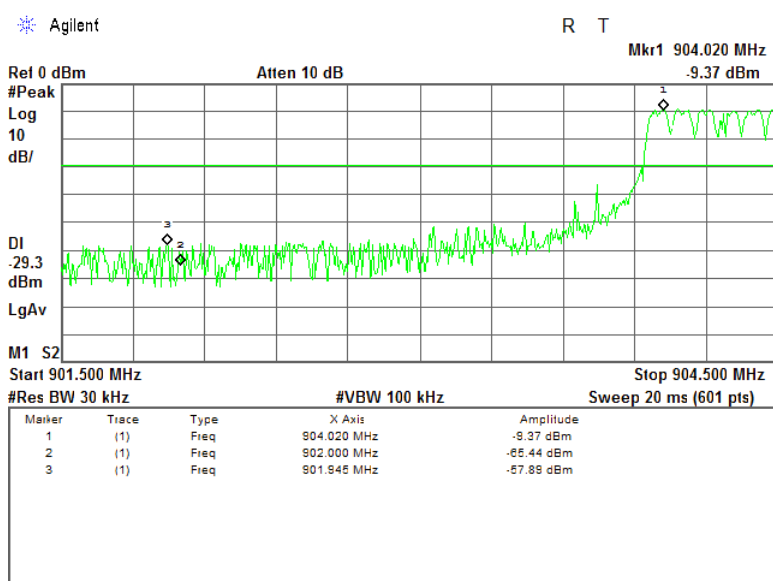
BIT RATE: 19200 bps



| | | | |
|--|--------------------------------|-------------------------------|-----------------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges | | | |
| Test procedure: ANSI C63.10, section 7.8.6 | | | |
| Test mode: Compliance | | Verdict: PASS | |
| Date(s): 13-Sep-16 | | | |
| Temperature: 26 °C | Relative Humidity: 57 % | Air Pressure: 1005 hPa | Power: Battery |
| Remarks: | | | |

Plot 7.7.8 The band edge emission at narrow channel configuration with hopping function enabled

BIT RATE: 38400 bps



| | | | |
|----------------------------|--------------------------------|--|------------------------------|
| Test specification: | | FCC Part 15, Section 203 / RSS-Gen, Section 7.1.4, Antenna requirements | |
| Test procedure: | | Visual inspection | |
| Test mode: | | Compliance | Verdict: PASS |
| Date(s): | | 22-Sep-16 | |
| Temperature: 26 °C | Relative Humidity: 40 % | Air Pressure: 1005 hPa | Power Supply: Battery |
| Remarks: | | | |

7.8 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 7.8.1.

Table 7.8.1 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 | |

Photograph 7.8.1 Antenna assembly



8 APPENDIX A Test equipment and ancillaries used for tests

| HL No | Description | Manufacturer | Model | Ser. No. | Last Cal./ Check | Due Cal./ Check |
|-------|---|-----------------------|-----------------|-----------------------------------|------------------|-----------------|
| 0415 | Cable, Coax, RF, RG-214, 12.3 m | Hermon Laboratories | CC-3 | 056 | 07-Dec-15 | 07-Dec-16 |
| 0446 | Antenna, Loop, Active, 10 kHz - 30 MHz | EMCO | 6502 | 2857 | 18-Jan-16 | 18-Jan-17 |
| 0521 | EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz | Hewlett Packard | 8546A | 3617A 00319, 3448A002 53 | 27-Oct-16 | 27-Oct-17 |
| 0569 | Antenna, Log Periodic, 200 - 1000 MHz | Electro-Metrics | LPA 25/30 | 1953 | 17-Mar-16 | 17-Mar-17 |
| 1984 | Antenna, Double-Ridged Waveguide Horn, 1 to 18 GHz, 300 W | EMC Test Systems | 3115 | 9911-5964 | 28-Mar-16 | 28-Mar-17 |
| 2909 | Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz | Agilent Technologies | E4407B | MY414447 62 | 21-Feb-16 | 21-Feb-17 |
| 3342 | High Pass Filter, 50 Ohm, 2000 to 5200 MHz | Mini-Circuits | VHF-1910+ | NA | 01-Oct-15 | 01-Oct-17 |
| 3347 | High Pass Filter, 50 Ohm, 6000 to 11500 MHz | Mini-Circuits | VHF-5500+ | NA | 01-Oct-15 | 01-Oct-17 |
| 3354 | Low Pass Filter, 50 Ohm, DC to 575 MHz. | Mini-Circuits | VLF-575+ | NA | 01-Oct-15 | 01-Oct-17 |
| 3531 | Amplifier, low noise, 2 to 8 GHz | Quinstar Technology | QLJ-02084040-J0 | 111590020 02 | 30-Dec-15 | 30-Dec-16 |
| 3533 | Amplifier, low noise, 6 to 18 GHz | Quinstar Technology | QLJ-06184040-J0 | 111590010 01 | 30-Dec-15 | 30-Dec-16 |
| 3818 | PSA Series Spectrum Analyzer, 3 Hz- 44 GHz | Agilent Technologies | E4446A | MY482502 88 | 03-May-16 | 03-May-17 |
| 3901 | Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA | Huber-Suhner | SUCOFLE X 102A | 1225/2A | 15-Feb-16 | 15-Feb-17 |
| 4278 | Test Cable , DC-18 GHz, 4.6 m, N/M - N/M | Mini-Circuits | APC-15FT-NMNM+ | 0755A | 26-Sep-16 | 26-Sep-17 |
| 4280 | Test Cable , DC-18 GHz, 4.6 m, N/M - N/M | Mini-Circuits | APC-15FT-NMNM+ | 0763A | 27-Sep-16 | 27-Sep-17 |
| 4294 | Microwave Cable Assembly, 18.0 GHz, 3.4 m, SMA/SMA | Huber-Suhner | Sucoflex P103 | NA | 07-Dec-15 | 07-Dec-16 |
| 4353 | Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M | MegaPhase | NC29-N1N1-244 | 12025101 003 | 15-Mar-16 | 15-Mar-17 |
| 4909 | High Pass Filter, 50 Ohm, 2640 to 6230 MHz., SMA-FM / SMA-M | Mini-Circuits | VHF-2275+ | NA | 01-Oct-15 | 01-Oct-17 |
| 4933 | Active Horn Antenna, 1 GHz to 18 GHz | Com-Power Corporation | AHA-118 | 701046 | 14-Oct-16 | 14-Oct-17 |

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

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.

10 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, 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-808 for OATS, R-1082 for anechoic chamber, G-869 for RE measurements above 1 GHz, C-845 for conducted emissions site, T-1606 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 and environmental simulation (for exact scope please refer to Certificate No. 839.01).

Address: P.O. Box 23, Binyamina 30500, Israel.
Telephone: +972 4628 8001
Fax: +972 4628 8277
e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

Person for contact: Mr. Alex Usoskin, CEO.

11 APPENDIX D Specification references

| | |
|-------------------------|---|
| FCC 47CFR part 15: 2015 | Radio Frequency Devices |
| ANSI C63.10: 2013 | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| 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 1: 2015 | Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence- Exempt Local Area Network (LE-LAN) Devices |
| RSS-Gen Issue 4: 2014 | General Requirements for Compliance of Radio Apparatus |

12 APPENDIX E Test equipment correction factors

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

| Frequency, MHz | Magnetic antenna factor, dB | Electric antenna factor, 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(μ V) to convert it into field strength in dB(μ V/m).

Antenna factor
Log periodic antenna
Electro-Metrics, model LPA-25/30
Ser.No.1953, HL 0569

| Frequency MHz | Antenna Factor dB(1/m) | Frequency MHz | Antenna Factor dB(1/m) |
|------------------|---------------------------|------------------|---------------------------|
| 200 | 15.2 | 625 | 25.2 |
| 225 | 15.1 | 650 | 25.8 |
| 250 | 16.3 | 675 | 27.2 |
| 275 | 17.2 | 700 | 27.6 |
| 300 | 19.6 | 725 | 27.6 |
| 325 | 18.4 | 750 | 27.6 |
| 350 | 19.0 | 775 | 28.0 |
| 375 | 20.0 | 800 | 28.2 |
| 400 | 20.9 | 825 | 29.4 |
| 425 | 21.3 | 850 | 29.9 |
| 450 | 22.1 | 875 | 30.0 |
| 475 | 22.7 | 900 | 30.4 |
| 500 | 23.2 | 925 | 30.6 |
| 525 | 23.9 | 950 | 30.8 |
| 550 | 24.2 | 975 | 31.6 |
| 575 | 24.6 | 1000 | 32.1 |
| 600 | 24.7 | | |

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

Antenna factor
Biconilog antenna EMCO Model 3141
Ser.No.1011, HL 0604

| Frequency, MHz | Antenna factor, dB(1/m) | Frequency, MHz | Antenna factor, dB(1/m) | Frequency, MHz | Antenna factor, dB(1/m) |
|-------------------|----------------------------|-------------------|----------------------------|-------------------|----------------------------|
| 26 | 7.8 | 580 | 20.6 | 1320 | 27.8 |
| 28 | 7.8 | 600 | 21.3 | 1340 | 28.3 |
| 30 | 7.8 | 620 | 21.5 | 1360 | 28.2 |
| 40 | 7.2 | 640 | 21.2 | 1380 | 27.9 |
| 60 | 7.1 | 660 | 21.4 | 1400 | 27.9 |
| 70 | 8.5 | 680 | 21.9 | 1420 | 27.9 |
| 80 | 9.4 | 700 | 22.2 | 1440 | 27.8 |
| 90 | 9.8 | 720 | 22.2 | 1460 | 27.8 |
| 100 | 9.7 | 740 | 22.1 | 1480 | 28.0 |
| 110 | 9.3 | 760 | 22.3 | 1500 | 28.5 |
| 120 | 8.8 | 780 | 22.6 | 1520 | 28.9 |
| 130 | 8.7 | 800 | 22.7 | 1540 | 29.6 |
| 140 | 9.2 | 820 | 22.9 | 1560 | 29.8 |
| 150 | 9.8 | 840 | 23.1 | 1580 | 29.6 |
| 160 | 10.2 | 860 | 23.4 | 1600 | 29.5 |
| 170 | 10.4 | 880 | 23.8 | 1620 | 29.3 |
| 180 | 10.4 | 900 | 24.1 | 1640 | 29.2 |
| 190 | 10.3 | 920 | 24.1 | 1660 | 29.4 |
| 200 | 10.6 | 940 | 24.0 | 1680 | 29.6 |
| 220 | 11.6 | 960 | 24.1 | 1700 | 29.8 |
| 240 | 12.4 | 980 | 24.5 | 1720 | 30.3 |
| 260 | 12.8 | 1000 | 24.9 | 1740 | 30.8 |
| 280 | 13.7 | 1020 | 25.0 | 1760 | 31.1 |
| 300 | 14.7 | 1040 | 25.2 | 1780 | 31.0 |
| 320 | 15.2 | 1060 | 25.4 | 1800 | 30.9 |
| 340 | 15.4 | 1080 | 25.6 | 1820 | 30.7 |
| 360 | 16.1 | 1100 | 25.7 | 1840 | 30.6 |
| 380 | 16.4 | 1120 | 26.0 | 1860 | 30.6 |
| 400 | 16.6 | 1140 | 26.4 | 1880 | 30.6 |
| 420 | 16.7 | 1160 | 27.0 | 1900 | 30.6 |
| 440 | 17.0 | 1180 | 27.0 | 1920 | 30.7 |
| 460 | 17.7 | 1200 | 26.7 | 1940 | 30.9 |
| 480 | 18.1 | 1220 | 26.5 | 1960 | 31.2 |
| 500 | 18.5 | 1240 | 26.5 | 1980 | 31.6 |
| 520 | 19.1 | 1260 | 26.5 | 2000 | 32.0 |
| 540 | 19.5 | 1280 | 26.6 | | |
| 560 | 19.8 | 1300 | 27.0 | | |

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

Antenna factor
Double-ridged wave guide horn antenna
Model 3115, S/N 9911-5964, HL1984

| Frequency, MHz | Antenna factor, dB(1/m) |
|-------------------|----------------------------|
| 1000.0 | 24.7 |
| 1500.0 | 25.7 |
| 2000.0 | 27.6 |
| 2500.0 | 28.9 |
| 3000.0 | 31.2 |
| 3500.0 | 32.0 |
| 4000.0 | 32.5 |
| 4500.0 | 32.7 |
| 5000.0 | 33.6 |
| 5500.0 | 35.1 |
| 6000.0 | 35.4 |
| 6500.0 | 34.9 |
| 7000.0 | 36.1 |
| 7500.0 | 37.8 |
| 8000.0 | 38.0 |
| 8500.0 | 38.1 |
| 9000.0 | 39.1 |
| 9500.0 | 38.3 |
| 10000.0 | 38.6 |
| 10500.0 | 38.2 |
| 11000.0 | 38.7 |
| 11500.0 | 39.5 |
| 12000.0 | 40.0 |
| 12500.0 | 40.4 |
| 13000.0 | 40.5 |
| 13500.0 | 41.1 |
| 14000.0 | 41.6 |
| 14500.0 | 41.7 |
| 15000.0 | 38.7 |
| 15500.0 | 38.2 |
| 16000.0 | 38.8 |
| 16500.0 | 40.5 |
| 17000.0 | 42.5 |
| 17500.0 | 45.9 |
| 18000.0 | 49.4 |

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



HERMON LABORATORIES

Antenna factor, HL 4933

**Active Horn Antenna Factor Calibration**

1 GHz to 18 GHz

| | |
|------------------------------|----------------------------|
| Equipment: | ACTIVE HORN ANTENNA |
| Model: | AHA-118 |
| Serial Number: | 701046 |
| Calibration Distance: | 3 Meter |
| Polarization: | Horizontal |
| Calibration Date: | 11/12/2014 |

| Frequency (GHz) | Preamplifier Gain (dB) | Antenna Factor with pre-amp (dB/m) | Frequency (GHz) | Preamplifier Gain (dB) | Antenna Factor with pre-amp (dB/m) |
|--------------------|------------------------------|--|--------------------|------------------------------|--|
| 1 | 40.96 | -16.47 | 10 | 40.94 | -1.97 |
| 1.5 | 41.21 | -14.53 | 10.5 | 40.63 | -1.06 |
| 2 | 41.44 | -13.30 | 11 | 40.74 | -1.50 |
| 2.5 | 41.71 | -12.87 | 11.5 | 40.65 | -0.52 |
| 3 | 41.96 | -12.26 | 12 | 40.76 | -0.15 |
| 3.5 | 42.14 | -11.77 | 12.5 | 41.03 | -0.85 |
| 4 | 42.13 | -10.91 | 13 | 41.37 | -0.81 |
| 4.5 | 41.79 | -9.41 | 13.5 | 41.18 | 0.05 |
| 5 | 41.44 | -7.54 | 14 | 40.98 | 0.36 |
| 5.5 | 40.91 | -6.47 | 14.5 | 40.81 | 1.26 |
| 6 | 40.69 | -5.48 | 15 | 40.65 | 0.25 |
| 6.5 | 40.64 | -5.53 | 15.5 | 40.93 | -1.05 |
| 7 | 40.76 | -4.12 | 16 | 41.31 | -1.44 |
| 7.5 | 40.94 | -3.12 | 16.5 | 40.96 | -0.80 |
| 8 | 40.68 | -1.69 | 17 | 40.64 | -0.02 |
| 8.5 | 40.08 | -1.71 | 17.5 | 40.57 | 1.81 |
| 9 | 40.41 | -1.86 | 18 | 40.08 | 3.63 |
| 9.5 | 41.21 | -2.73 | | | |

Calibration according to ARP 958

Antenna Factor to be added to receiver reading:

Meter Reading (dBuV) + Antenna Factor (dB/m) = Corrected Reading (dBuV/m)

Cable loss
Cable coax, RG-214, 12.3 m, s/n 056, HL 0415

| No. | Frequency, MHz | Cable loss, dB | Measured uncertainty, dB |
|-----|-------------------|-------------------|-----------------------------|
| 1 | 10 | 0.23 | ±0.12 |
| 2 | 30 | 0.44 | ±0.12 |
| 3 | 50 | 0.60 | ±0.12 |
| 4 | 100 | 0.89 | ±0.12 |
| 5 | 150 | 1.11 | ±0.13 |
| 6 | 200 | 1.30 | ±0.13 |
| 7 | 250 | 1.45 | ±0.13 |
| 8 | 300 | 1.61 | ±0.13 |
| 9 | 400 | 1.94 | ±0.13 |
| 10 | 500 | 2.18 | ±0.13 |
| 11 | 600 | 2.45 | ±0.14 |
| 12 | 700 | 2.67 | ±0.14 |
| 13 | 800 | 2.94 | ±0.14 |
| 14 | 900 | 3.16 | ±0.14 |
| 15 | 1000 | 3.38 | ±0.14 |

Cable loss
Microwave Cable Assembly, Huber-Suhner, 40 GHz, 3.5 m, SMA-SMA, S/N 1225/2A
HL 3901

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 10 | 0.09 | 9500 | 4.29 | 21000 | 6.67 |
| 100 | 0.41 | 10000 | 4.40 | 22000 | 6.92 |
| 500 | 0.93 | 10500 | 4.52 | 23000 | 7.00 |
| 1000 | 1.33 | 11000 | 4.64 | 24000 | 7.18 |
| 1500 | 1.63 | 11500 | 4.76 | 25000 | 7.29 |
| 2000 | 1.90 | 12000 | 4.87 | 26000 | 7.55 |
| 2500 | 2.12 | 12500 | 4.99 | 27000 | 7.70 |
| 3000 | 2.33 | 13000 | 5.11 | 28000 | 7.88 |
| 3500 | 2.50 | 13500 | 5.20 | 29000 | 8.02 |
| 4000 | 2.67 | 14000 | 5.31 | 30000 | 8.15 |
| 4500 | 2.82 | 14500 | 5.42 | 31000 | 8.35 |
| 5000 | 2.99 | 15000 | 5.51 | 32000 | 8.40 |
| 5500 | 3.16 | 15500 | 5.58 | 33000 | 8.62 |
| 6000 | 3.32 | 16000 | 5.68 | 34000 | 8.73 |
| 6500 | 3.51 | 16500 | 5.78 | 35000 | 8.78 |
| 7000 | 3.65 | 17000 | 5.91 | 36000 | 8.94 |
| 7500 | 3.79 | 17500 | 5.99 | 37000 | 9.21 |
| 8000 | 3.92 | 18000 | 6.07 | 38000 | 9.37 |
| 8500 | 4.04 | 19000 | 6.36 | 39000 | 9.45 |
| 9000 | 4.18 | 20000 | 6.49 | 40000 | 9.52 |

Cable loss
Test cable, Mini-Circuits, S/N 0755A, 18 GHz, 4.6 m, N/M - N/M
APC-15FT-NMNM+, HL 4278

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|-------------------|----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 10 | 0.24 | 4900 | 4.19 | 10000 | 6.47 | 15100 | 8.33 |
| 30 | 0.26 | 5000 | 4.25 | 10100 | 6.50 | 15200 | 8.35 |
| 50 | 0.34 | 5100 | 4.29 | 10200 | 6.52 | 15300 | 8.37 |
| 100 | 0.50 | 5200 | 4.32 | 10300 | 6.57 | 15400 | 8.40 |
| 200 | 0.72 | 5300 | 4.38 | 10400 | 6.59 | 15500 | 8.42 |
| 300 | 0.90 | 5400 | 4.41 | 10500 | 6.61 | 15600 | 8.46 |
| 400 | 1.06 | 5500 | 4.46 | 10600 | 6.64 | 15700 | 8.50 |
| 500 | 1.20 | 5600 | 4.51 | 10700 | 6.64 | 15800 | 8.52 |
| 600 | 1.32 | 5700 | 4.56 | 10800 | 6.65 | 15900 | 8.56 |
| 700 | 1.44 | 5800 | 4.59 | 10900 | 6.68 | 16000 | 8.61 |
| 800 | 1.54 | 5900 | 4.64 | 11000 | 6.68 | 16100 | 8.64 |
| 900 | 1.64 | 6000 | 4.69 | 11100 | 6.69 | 16200 | 8.66 |
| 1000 | 1.74 | 6100 | 4.72 | 11200 | 6.70 | 16300 | 8.70 |
| 1100 | 1.83 | 6200 | 4.77 | 11300 | 6.74 | 16400 | 8.73 |
| 1200 | 1.92 | 6300 | 4.80 | 11400 | 6.78 | 16500 | 8.74 |
| 1300 | 2.01 | 6400 | 4.83 | 11500 | 6.81 | 16600 | 8.75 |
| 1400 | 2.09 | 6500 | 4.89 | 11600 | 6.84 | 16700 | 8.78 |
| 1500 | 2.18 | 6600 | 4.90 | 11700 | 6.87 | 16800 | 8.79 |
| 1600 | 2.25 | 6700 | 4.95 | 11800 | 6.92 | 16900 | 8.81 |
| 1700 | 2.33 | 6800 | 5.01 | 11900 | 6.98 | 17000 | 8.85 |
| 1800 | 2.39 | 6900 | 4.99 | 12000 | 7.02 | 17100 | 8.90 |
| 1900 | 2.47 | 7000 | 5.04 | 12100 | 7.08 | 17200 | 8.95 |
| 2000 | 2.53 | 7100 | 5.11 | 12200 | 7.15 | 17300 | 8.99 |
| 2100 | 2.60 | 7200 | 5.14 | 12300 | 7.20 | 17400 | 9.03 |
| 2200 | 2.67 | 7300 | 5.21 | 12400 | 7.26 | 17500 | 9.07 |
| 2300 | 2.73 | 7400 | 5.29 | 12500 | 7.31 | 17600 | 9.11 |
| 2400 | 2.80 | 7500 | 5.33 | 12600 | 7.36 | 17700 | 9.15 |
| 2500 | 2.87 | 7600 | 5.38 | 12700 | 7.41 | 17800 | 9.19 |
| 2600 | 2.93 | 7700 | 5.46 | 12800 | 7.46 | 17900 | 9.24 |
| 2700 | 3.00 | 7800 | 5.52 | 12900 | 7.51 | 18000 | 9.28 |
| 2800 | 3.06 | 7900 | 5.58 | 13000 | 7.55 | | |
| 2900 | 3.12 | 8000 | 5.64 | 13100 | 7.59 | | |
| 3000 | 3.18 | 8100 | 5.69 | 13200 | 7.65 | | |
| 3100 | 3.24 | 8200 | 5.75 | 13300 | 7.69 | | |
| 3200 | 3.30 | 8300 | 5.80 | 13400 | 7.72 | | |
| 3300 | 3.35 | 8400 | 5.84 | 13500 | 7.78 | | |
| 3400 | 3.42 | 8500 | 5.90 | 13600 | 7.82 | | |
| 3500 | 3.46 | 8600 | 5.97 | 13700 | 7.86 | | |
| 3600 | 3.52 | 8700 | 5.99 | 13800 | 7.91 | | |
| 3700 | 3.57 | 8800 | 6.04 | 13900 | 7.96 | | |
| 3800 | 3.61 | 8900 | 6.10 | 14000 | 8.01 | | |
| 3900 | 3.67 | 9000 | 6.13 | 14100 | 8.06 | | |
| 4000 | 3.71 | 9100 | 6.17 | 14200 | 8.10 | | |
| 4100 | 3.77 | 9200 | 6.23 | 14300 | 8.13 | | |
| 4200 | 3.83 | 9300 | 6.27 | 14400 | 8.16 | | |
| 4300 | 3.89 | 9400 | 6.30 | 14500 | 8.19 | | |
| 4400 | 3.94 | 9500 | 6.35 | 14600 | 8.21 | | |
| 4500 | 4.00 | 9600 | 6.37 | 14700 | 8.23 | | |
| 4600 | 4.05 | 9700 | 6.40 | 14800 | 8.26 | | |
| 4700 | 4.10 | 9800 | 6.44 | 14900 | 8.28 | | |
| 4800 | 4.16 | 9900 | 6.45 | 15000 | 8.30 | | |

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 | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | 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 | | |

Cable loss
Microwave Cable Assembly, 18.0 GHz, 3.4 m, SMA/SMA, Huber-Suhner,
Sucoflex P103, HL 4294

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|-------------------|----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 10 | 0.11 | 4900 | 2.09 | 10000 | 2.90 | 15100 | 3.61 |
| 30 | 0.17 | 5000 | 2.10 | 10100 | 2.92 | 15200 | 3.67 |
| 50 | 0.22 | 5100 | 2.14 | 10200 | 2.95 | 15300 | 3.63 |
| 100 | 0.30 | 5200 | 2.16 | 10300 | 2.96 | 15400 | 3.64 |
| 200 | 0.42 | 5300 | 2.17 | 10400 | 2.99 | 15500 | 3.68 |
| 300 | 0.51 | 5400 | 2.19 | 10500 | 2.99 | 15600 | 3.71 |
| 400 | 0.59 | 5500 | 2.19 | 10600 | 3.03 | 15700 | 3.74 |
| 500 | 0.66 | 5600 | 2.22 | 10700 | 3.03 | 15800 | 3.71 |
| 600 | 0.72 | 5700 | 2.24 | 10800 | 3.04 | 15900 | 3.74 |
| 700 | 0.77 | 5800 | 2.23 | 10900 | 3.05 | 16000 | 3.71 |
| 800 | 0.82 | 5900 | 2.26 | 11000 | 3.09 | 16100 | 3.73 |
| 900 | 0.88 | 6000 | 2.27 | 11100 | 3.07 | 16200 | 3.76 |
| 1000 | 0.93 | 6100 | 2.26 | 11200 | 3.08 | 16300 | 3.82 |
| 1100 | 0.98 | 6200 | 2.29 | 11300 | 3.11 | 16400 | 3.90 |
| 1200 | 1.02 | 6300 | 2.30 | 11400 | 3.12 | 16500 | 3.81 |
| 1300 | 1.06 | 6400 | 2.34 | 11500 | 3.11 | 16600 | 3.88 |
| 1400 | 1.10 | 6500 | 2.34 | 11600 | 3.15 | 16700 | 3.87 |
| 1500 | 1.14 | 6600 | 2.36 | 11700 | 3.16 | 16800 | 3.89 |
| 1600 | 1.19 | 6700 | 2.36 | 11800 | 3.18 | 16900 | 3.95 |
| 1700 | 1.23 | 6800 | 2.39 | 11900 | 3.19 | 17000 | 4.02 |
| 1800 | 1.27 | 6900 | 2.39 | 12000 | 3.23 | 17100 | 4.04 |
| 1900 | 1.30 | 7000 | 2.44 | 12100 | 3.25 | 17200 | 3.99 |
| 2000 | 1.35 | 7100 | 2.46 | 12200 | 3.22 | 17300 | 4.03 |
| 2100 | 1.38 | 7200 | 2.44 | 12300 | 3.25 | 17400 | 4.03 |
| 2200 | 1.42 | 7300 | 2.48 | 12400 | 3.25 | 17500 | 4.06 |
| 2300 | 1.45 | 7400 | 2.47 | 12500 | 3.28 | 17600 | 4.05 |
| 2400 | 1.48 | 7500 | 2.48 | 12600 | 3.27 | 17700 | 4.12 |
| 2500 | 1.51 | 7600 | 2.50 | 12700 | 3.27 | 17800 | 4.14 |
| 2600 | 1.55 | 7700 | 2.53 | 12800 | 3.30 | 17900 | 4.18 |
| 2700 | 1.59 | 7800 | 2.56 | 12900 | 3.30 | 18000 | 4.14 |
| 2800 | 1.62 | 7900 | 2.55 | 13000 | 3.27 | | |
| 2900 | 1.65 | 8000 | 2.56 | 13100 | 3.32 | | |
| 3000 | 1.66 | 8100 | 2.56 | 13200 | 3.32 | | |
| 3100 | 1.69 | 8200 | 2.57 | 13300 | 3.32 | | |
| 3200 | 1.71 | 8300 | 2.59 | 13400 | 3.35 | | |
| 3300 | 1.74 | 8400 | 2.62 | 13500 | 3.38 | | |
| 3400 | 1.76 | 8500 | 2.67 | 13600 | 3.39 | | |
| 3500 | 1.78 | 8600 | 2.65 | 13700 | 3.42 | | |
| 3600 | 1.80 | 8700 | 2.68 | 13800 | 3.47 | | |
| 3700 | 1.85 | 8800 | 2.68 | 13900 | 3.45 | | |
| 3800 | 1.88 | 8900 | 2.68 | 14000 | 3.49 | | |
| 3900 | 1.90 | 9000 | 2.74 | 14100 | 3.50 | | |
| 4000 | 1.91 | 9100 | 2.74 | 14200 | 3.55 | | |
| 4100 | 1.93 | 9200 | 2.76 | 14300 | 3.59 | | |
| 4200 | 1.96 | 9300 | 2.78 | 14400 | 3.58 | | |
| 4300 | 1.97 | 9400 | 2.79 | 14500 | 3.56 | | |
| 4400 | 1.99 | 9500 | 2.80 | 14600 | 3.57 | | |
| 4500 | 2.02 | 9600 | 2.83 | 14700 | 3.57 | | |
| 4600 | 2.02 | 9700 | 2.84 | 14800 | 3.57 | | |
| 4700 | 2.04 | 9800 | 2.86 | 14900 | 3.64 | | |
| 4800 | 2.05 | 9900 | 2.92 | 15000 | 3.64 | | |

Cable loss
Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,
NC29-N1N1-244S/N 12025101 003,
HL 4353

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|-------------------|-------------------|-------------------|-------------------|
| 50 | 0.20 | 9000 | 2.71 |
| 100 | 0.27 | 9500 | 2.81 |
| 300 | 0.47 | 10000 | 2.90 |
| 500 | 0.61 | 10500 | 2.97 |
| 1000 | 0.87 | 11000 | 3.06 |
| 1500 | 1.07 | 11500 | 3.13 |
| 2000 | 1.24 | 12000 | 3.20 |
| 2500 | 1.39 | 12500 | 3.26 |
| 3000 | 1.53 | 13000 | 3.34 |
| 3500 | 1.65 | 13500 | 3.39 |
| 4000 | 1.77 | 14000 | 3.47 |
| 4500 | 1.89 | 14500 | 3.54 |
| 5000 | 1.99 | 15000 | 3.62 |
| 5500 | 2.07 | 15500 | 3.69 |
| 6000 | 2.20 | 16000 | 3.76 |
| 6500 | 2.30 | 16500 | 3.83 |
| 7000 | 2.39 | 17000 | 3.86 |
| 7500 | 2.51 | 17500 | 3.94 |
| 8000 | 2.58 | 18000 | 4.02 |
| 8500 | 2.65 | | |

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(μ V) | decibel referred to one microvolt |
| dB(μ V/m) | decibel referred to one microvolt per meter |
| dB(μ A) | 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 |
| μ s | 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