



Hermon Laboratories Ltd.
Harakevet Industrial Zone, Binyamina 30500,
Israel
Tel. +972-4-6288001
Fax. +972-4-6288277
E-mail: mail@hermonlabs.com

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

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



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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:

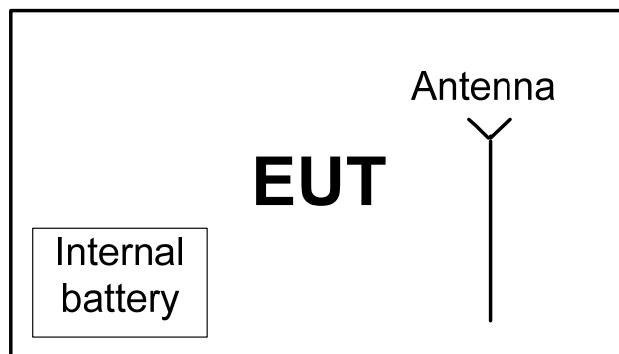
- 1) DTS- BPSK in 905.43 – 923.546 MHz
- 2) DTS- FSK at 916.3 MHz
- 3) FHSS- Wide channel in 902.3-927.8 MHz
- 4) FHSS- Narrow channel in 904-927.9 MHz

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					
			minimum RF power					
			maximum RF power					
Antenna connection								
unique coupling	standard connector		X integral	with temporary RF connector 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)					



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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:		

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





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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:					

Table 7.1.2 The 20 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902 – 928 MHz
 DETECTOR USED: Peak
 SWEEP TIME: Auto
 VIDEO BANDWIDTH: \geq 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: \geq 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

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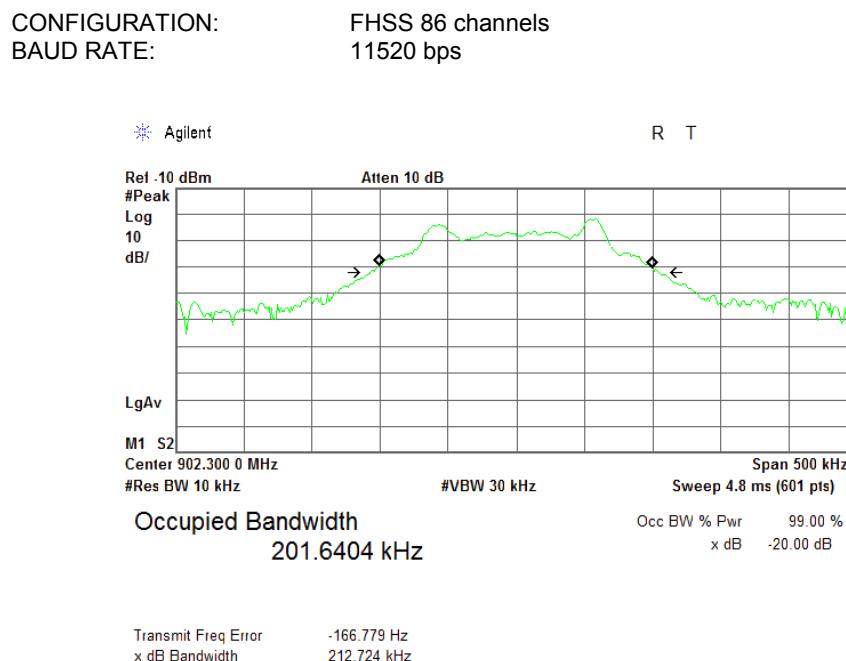
Full description is given in Appendix A.



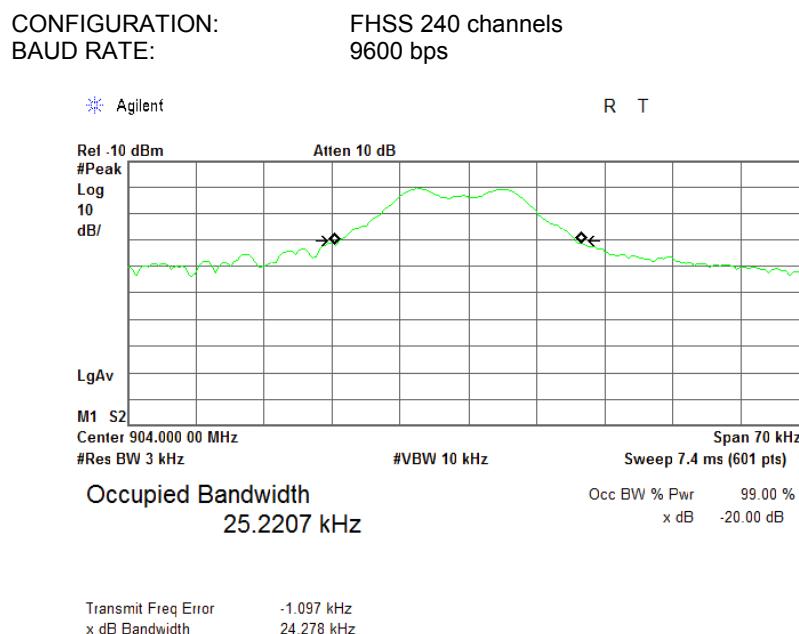
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Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth			
Test procedure:	ANSI C63.10, section 7.8.7		
Test mode:	Compliance		
Date(s):	31-Aug-16		Verdict: PASS
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1008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

Plot 7.1.1 The 20 dB bandwidth test result at low frequency



Plot 7.1.2 The 20 dB bandwidth test result at low frequency



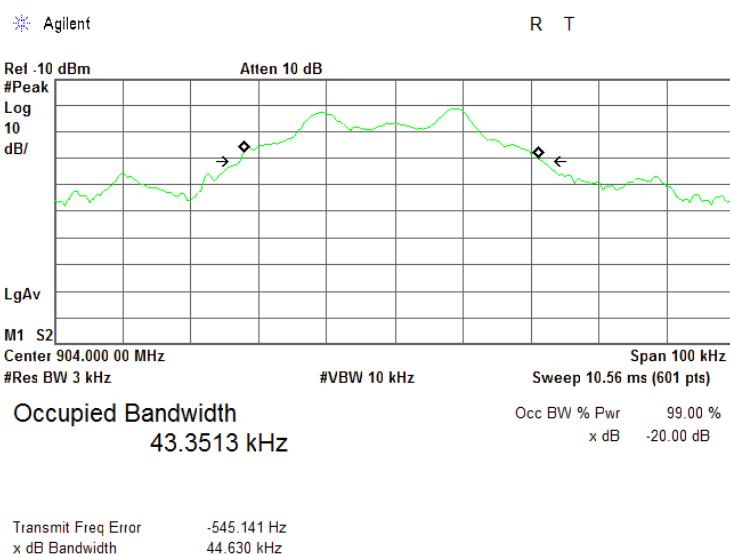


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Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth			
Test procedure:	ANSI C63.10, section 7.8.7		
Test mode:	Compliance		
Date(s):	31-Aug-16		Verdict: PASS
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1008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

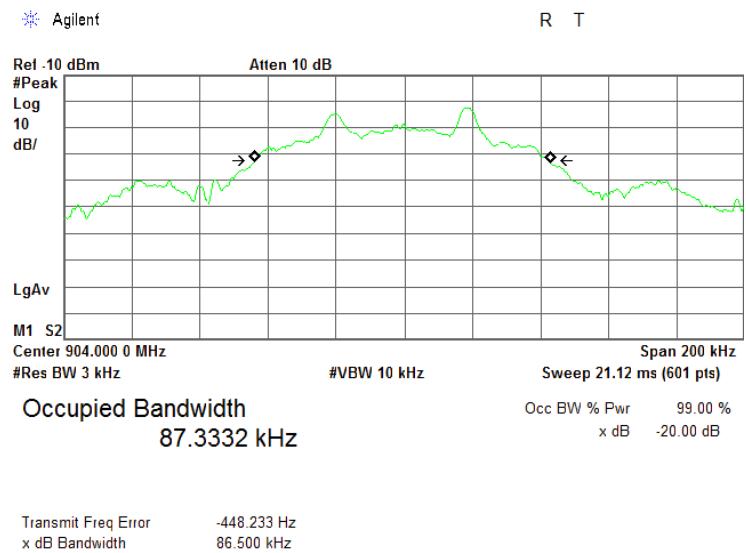
Plot 7.1.3 The 20 dB bandwidth test result at low frequency

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

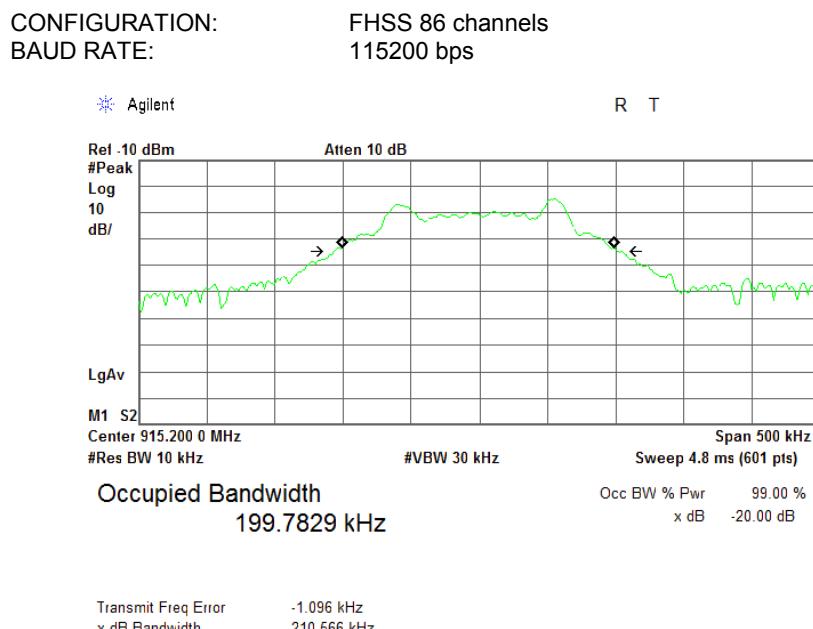




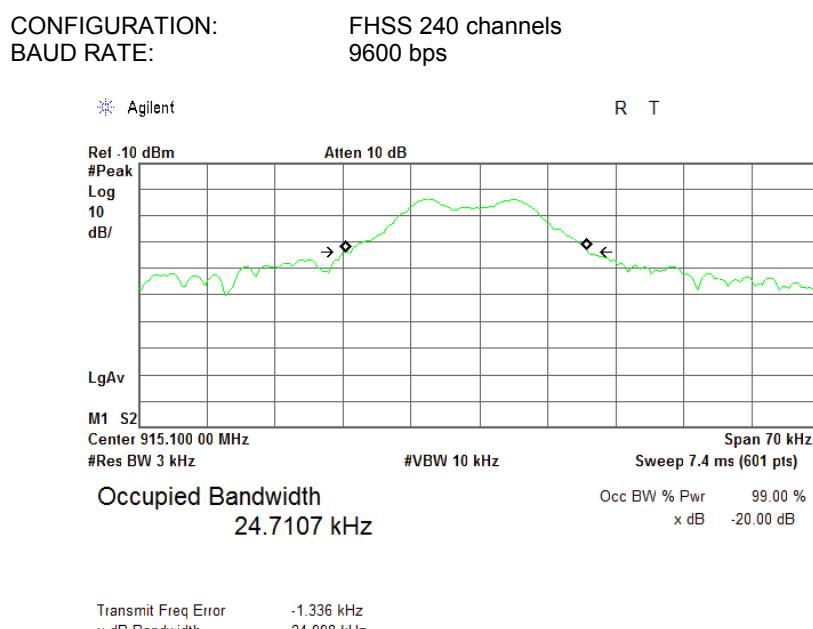
HERMON LABORATORIES

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
Remarks:		Power: Battery

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



Plot 7.1.6 The 20 dB bandwidth test result at mid frequency



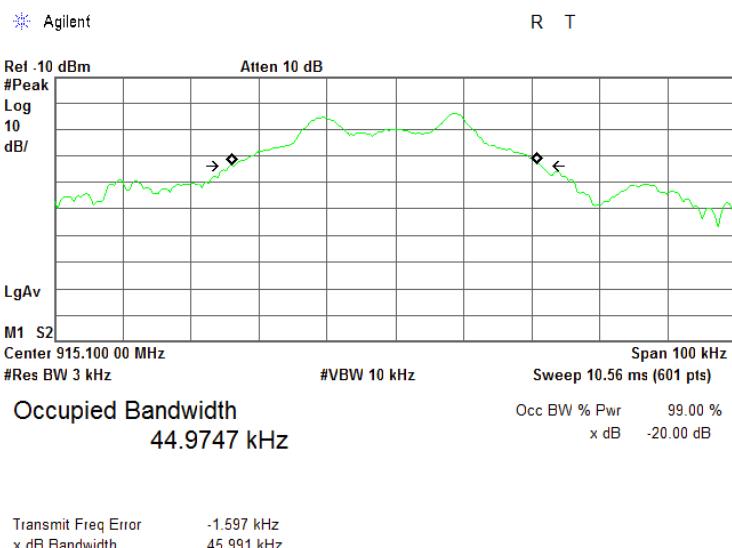


HERMON LABORATORIES

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
Remarks:		Power: Battery

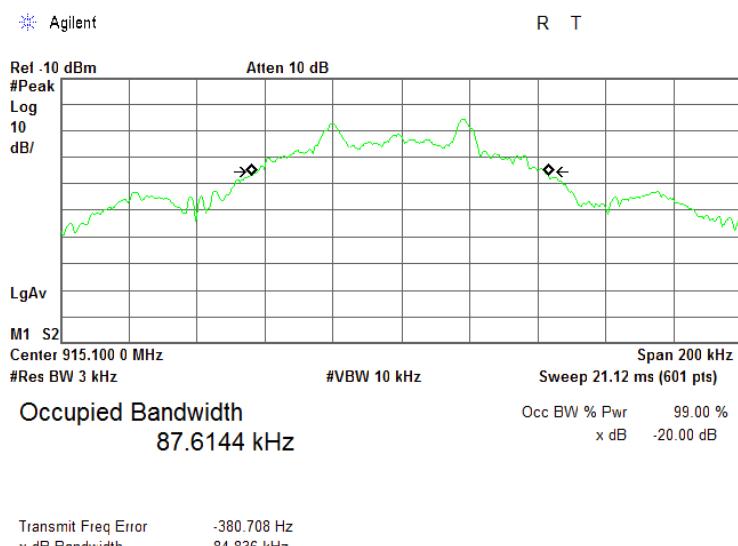
Plot 7.1.7 The 20 dB bandwidth test result at mid frequency

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



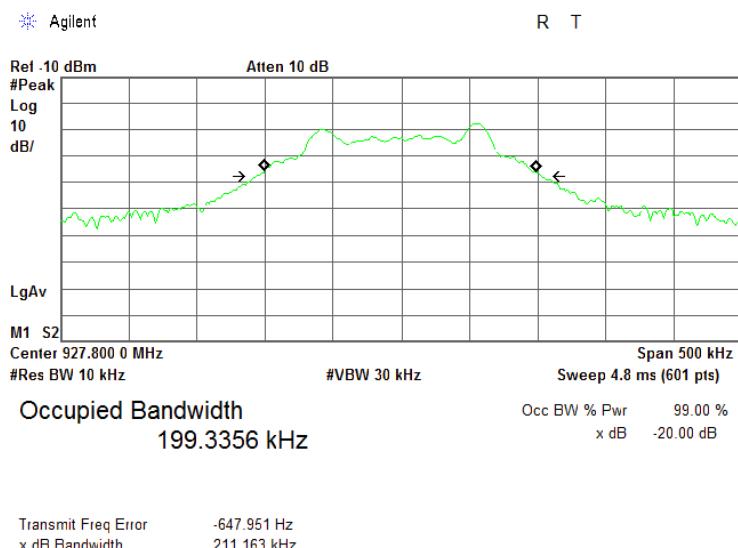


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Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth		
Test procedure: ANSI C63.10, section 7.8.7		
Test mode: Compliance		Verdict: PASS
Date(s): 31-Aug-16		
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1008 hPa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

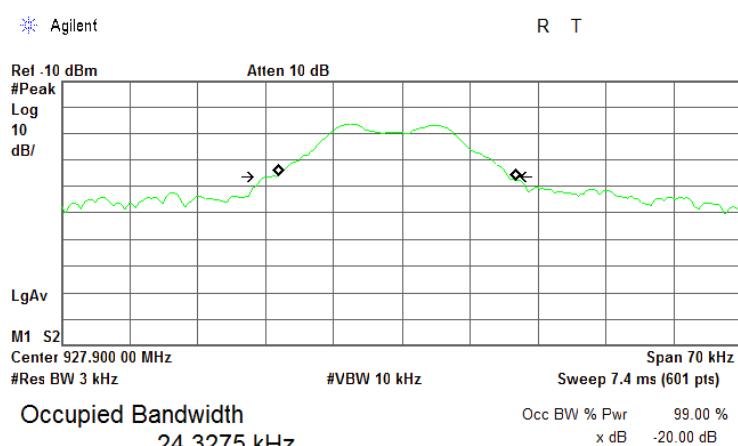
Plot 7.1.9 The 20 dB bandwidth test result at high frequency

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

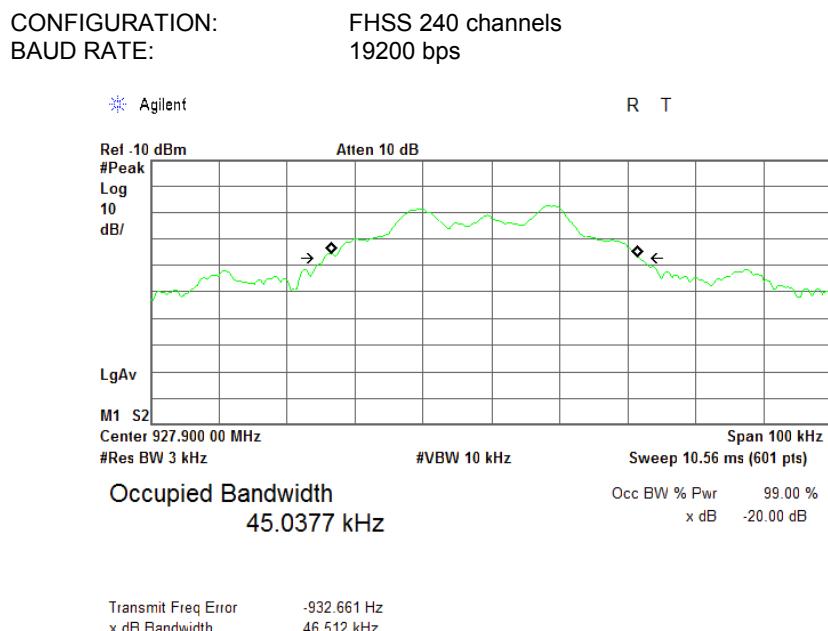




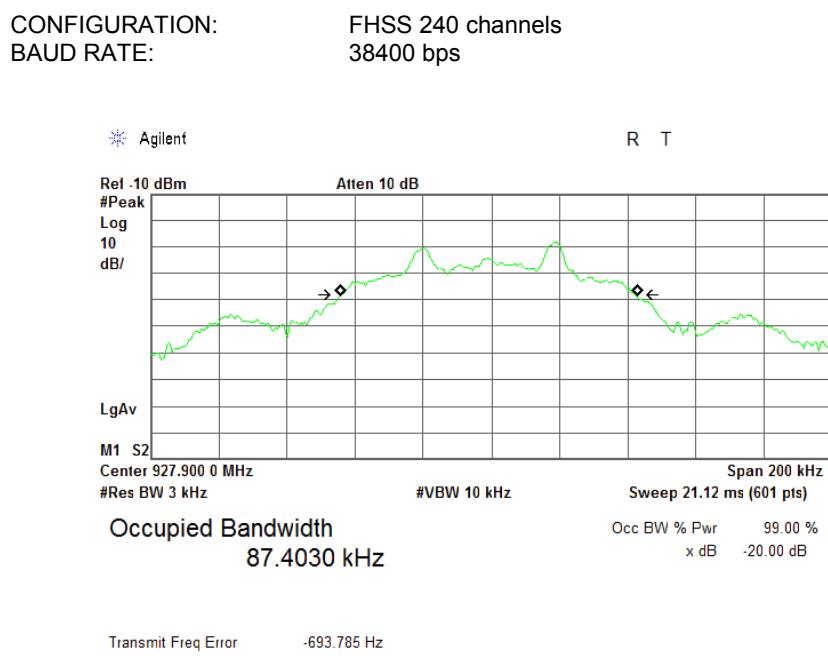
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Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth		
Test procedure: ANSI C63.10, section 7.8.7		
Test mode: Compliance		Verdict: PASS
Date(s): 31-Aug-16		
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1008 hPa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

Plot 7.1.11 The 20 dB bandwidth test result at high frequency



Plot 7.1.12 The 20 dB bandwidth test result at high frequency





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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:		

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,
2400.0 – 2483.5	whichever is greater
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

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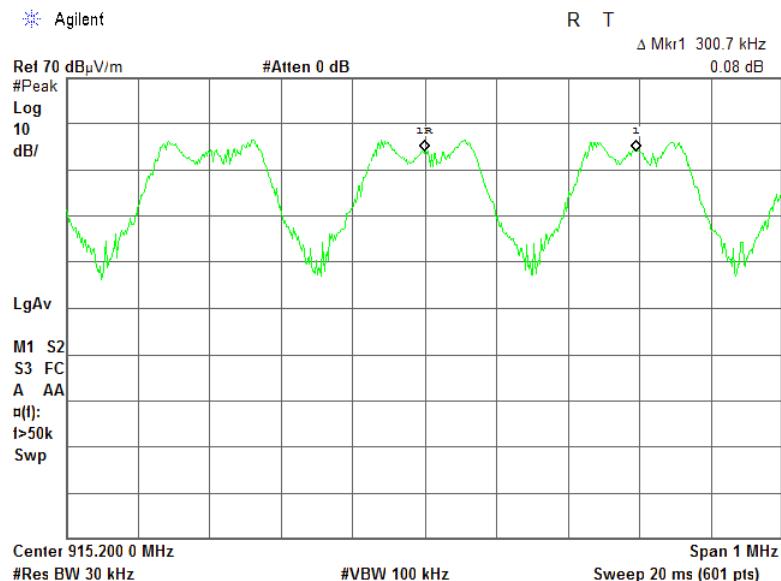
Full description is given in Appendix A.



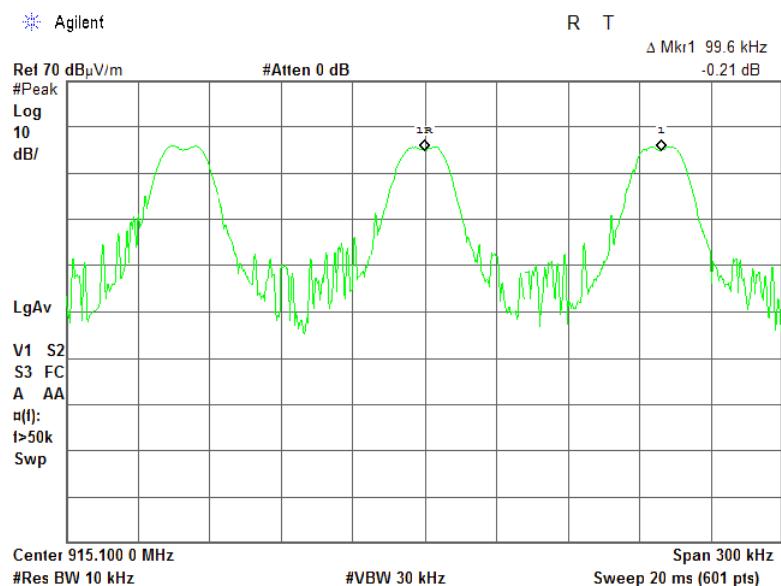
HERMON LABORATORIES

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
Remarks:		

Plot 7.2.1 Carrier frequency separation, 86 channels mode



Plot 7.2.2 Carrier frequency separation, 240 channels mode





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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:		

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

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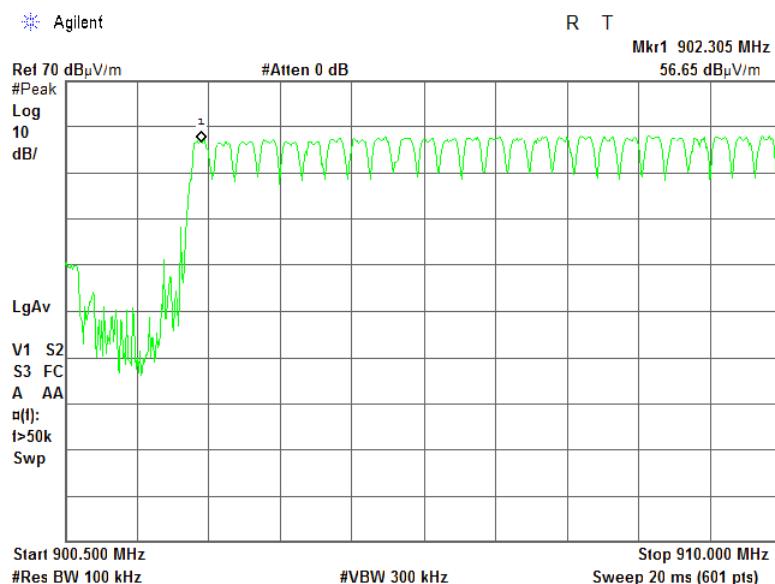
Full description is given in Appendix A.



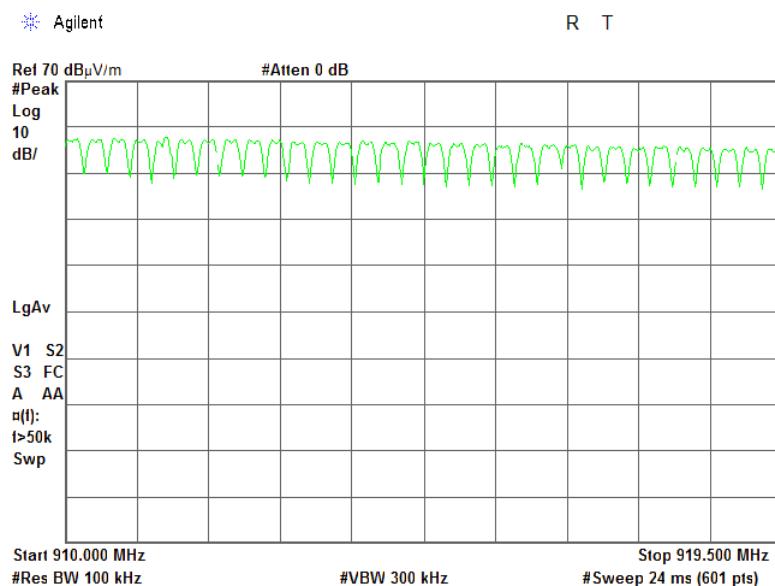
HERMON LABORATORIES

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
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)

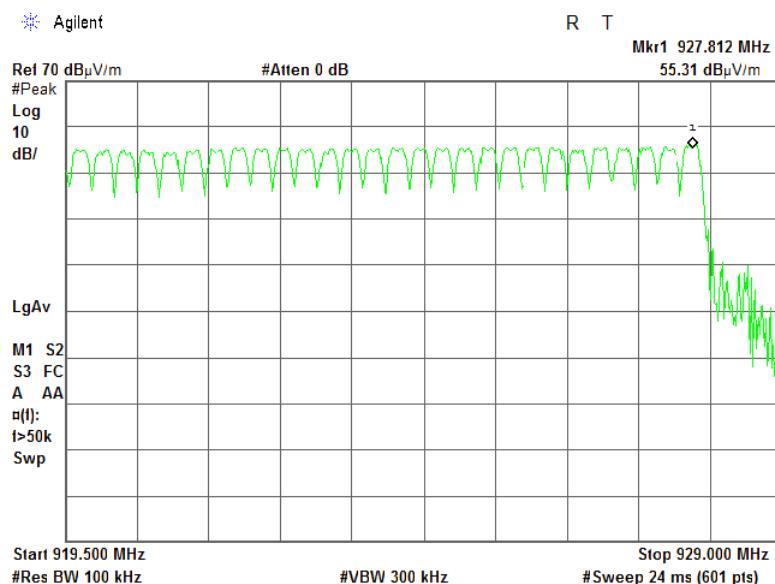




HERMON LABORATORIES

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
Remarks:		

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

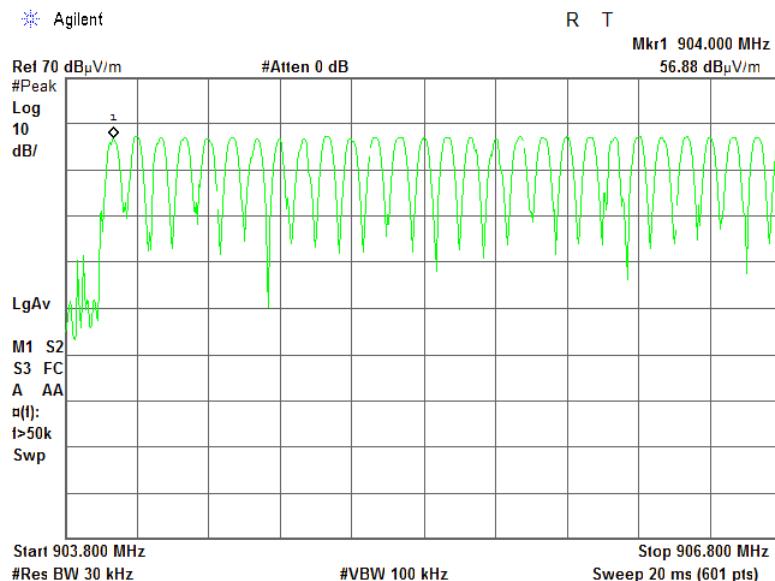




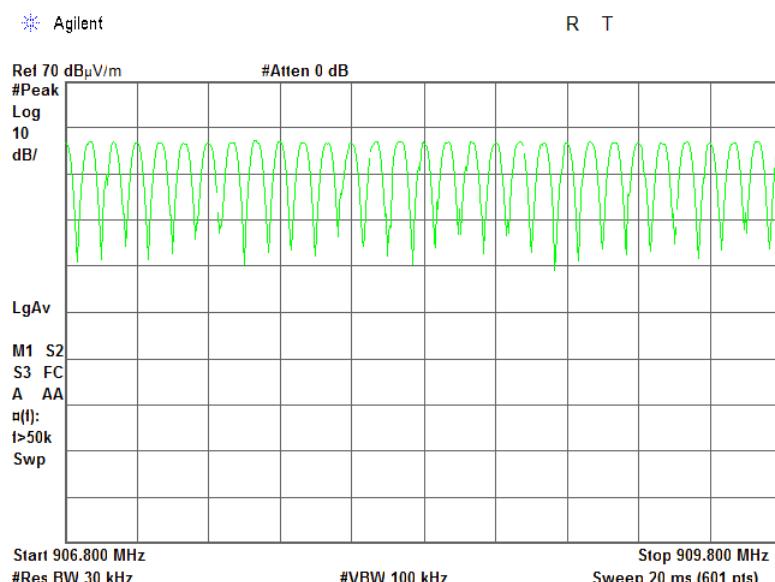
HERMON LABORATORIES

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



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

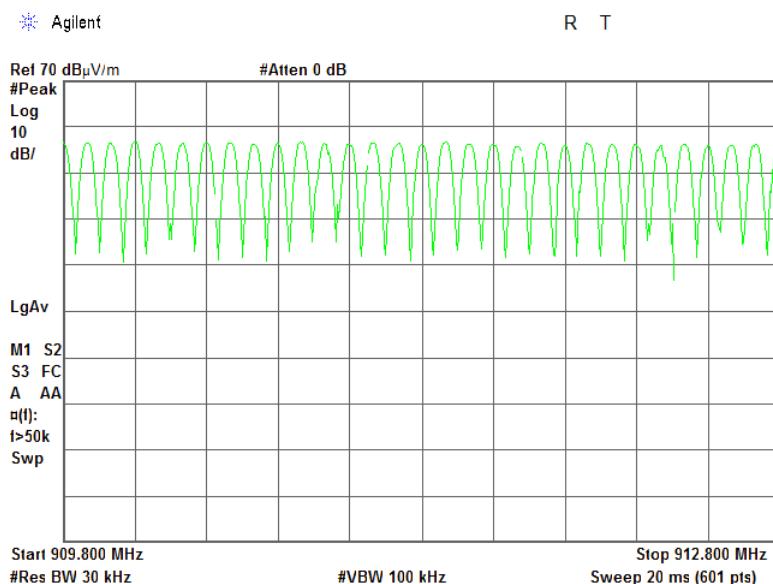




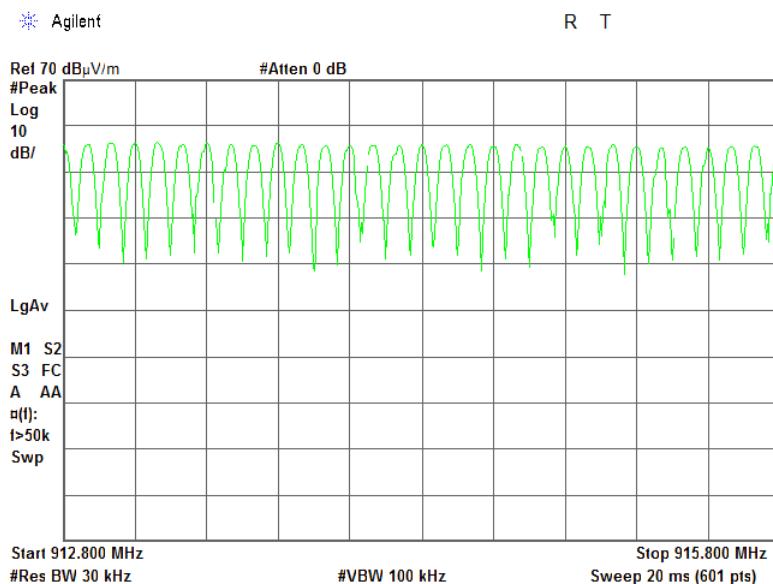
HERMON LABORATORIES

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
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)

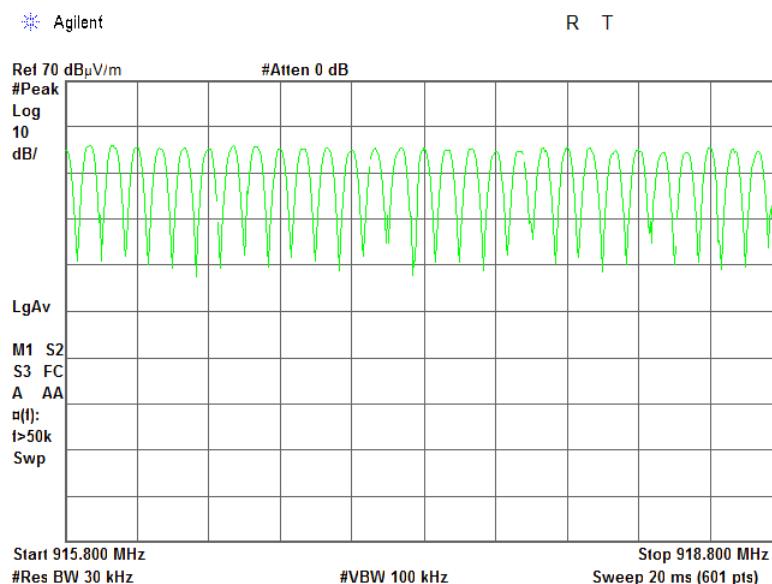




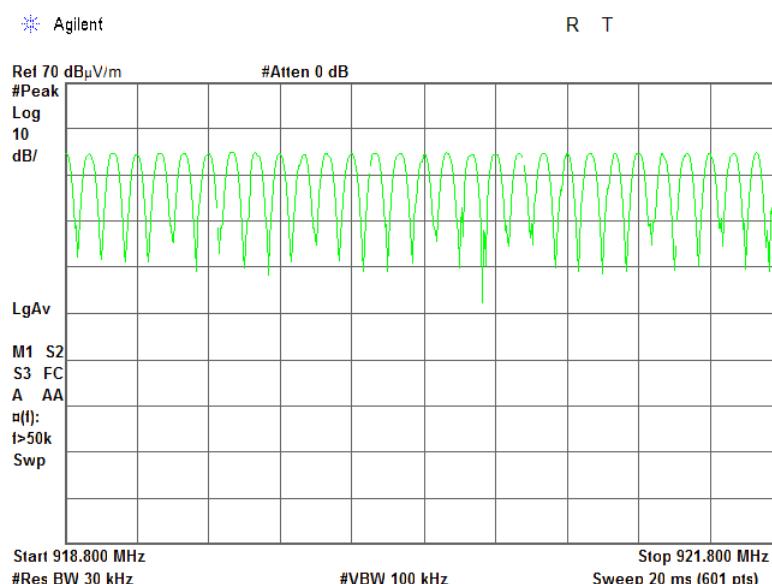
HERMON LABORATORIES

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



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

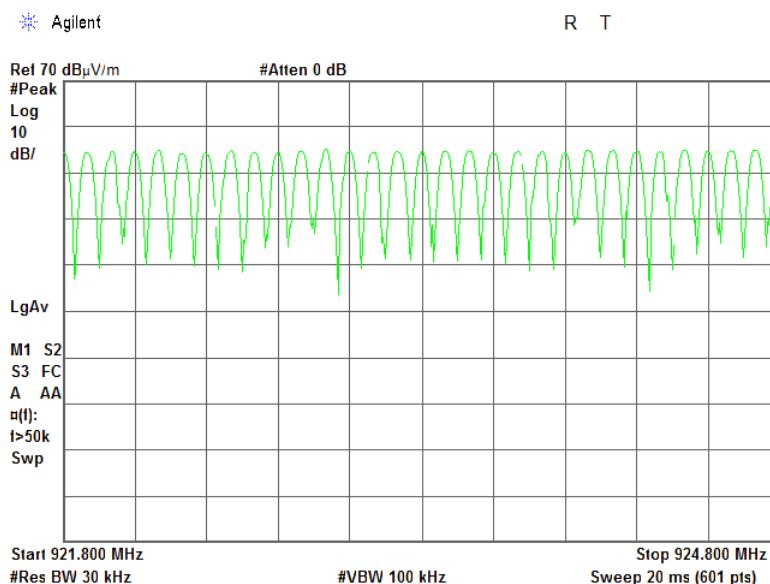




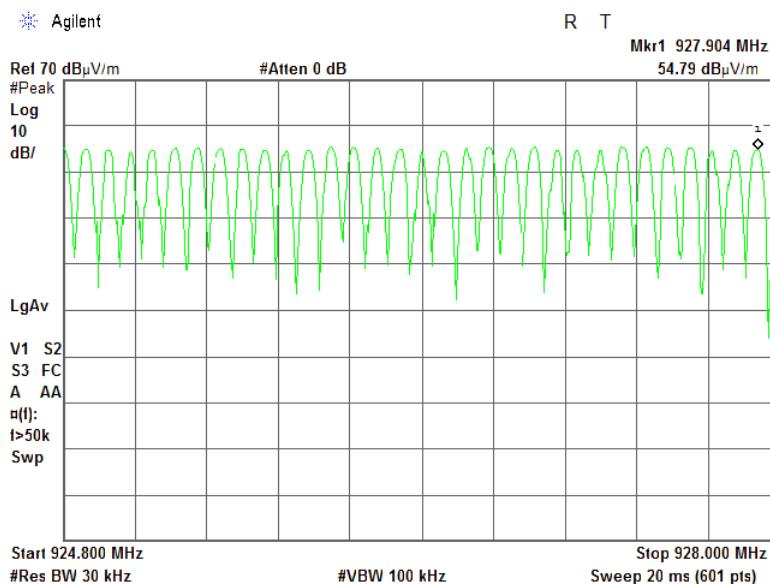
HERMON LABORATORIES

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



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





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: 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





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:	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							
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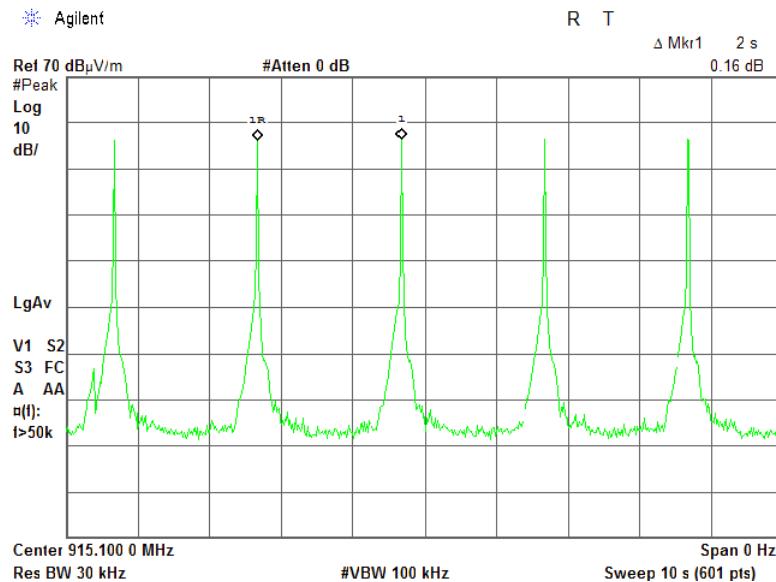
Full description is given in Appendix A.



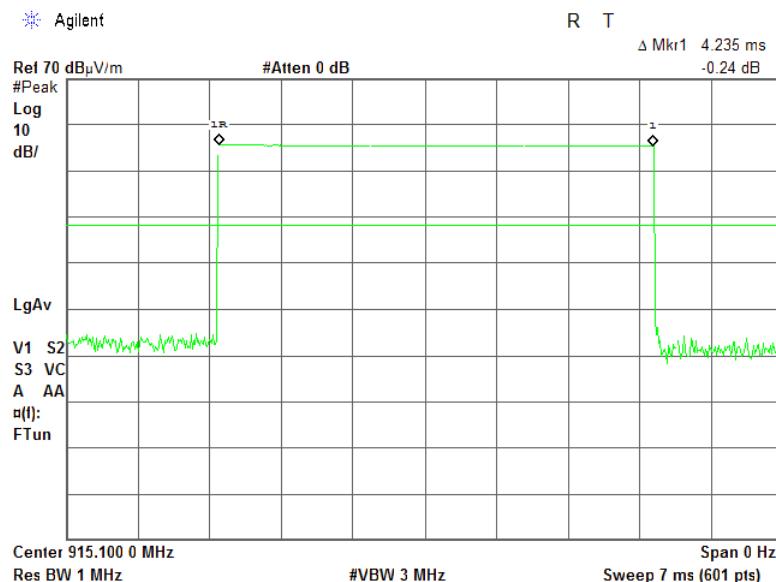
HERMON LABORATORIES

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: Compliance		Verdict: PASS
Date(s): 13-Sep-16		
Temperature: 25 °C	Relative Humidity: 56 %	Air Pressure: 1008 hPa
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)

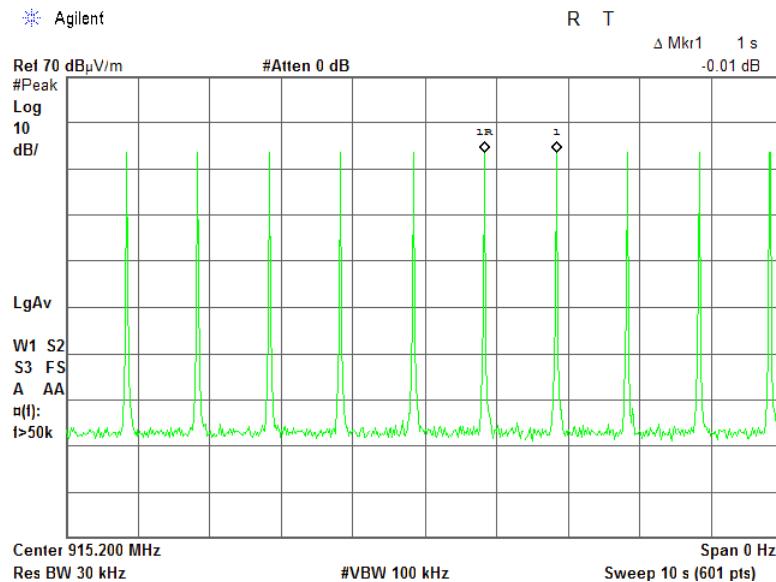




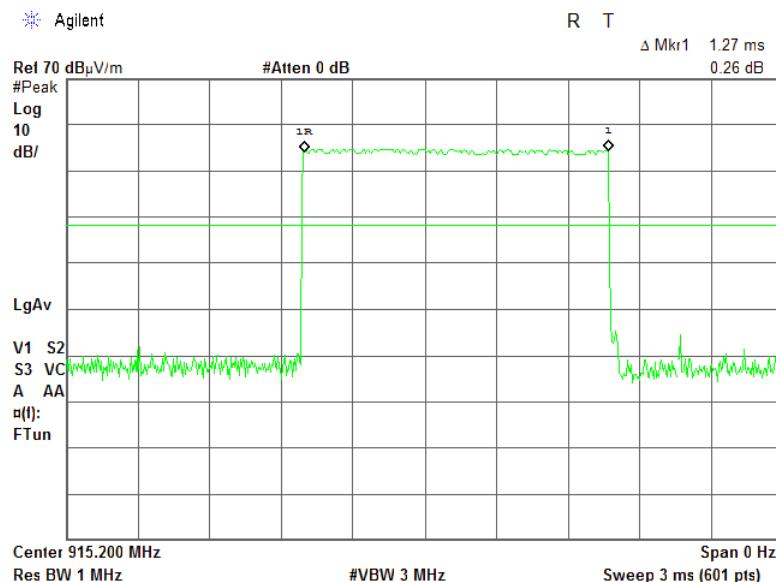
HERMON LABORATORIES

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: Compliance		Verdict: PASS
Date(s): 13-Sep-16		
Temperature: 25 °C	Relative Humidity: 56 %	Air Pressure: 1008 hPa
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)





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: 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	
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)	6.0*
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:

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

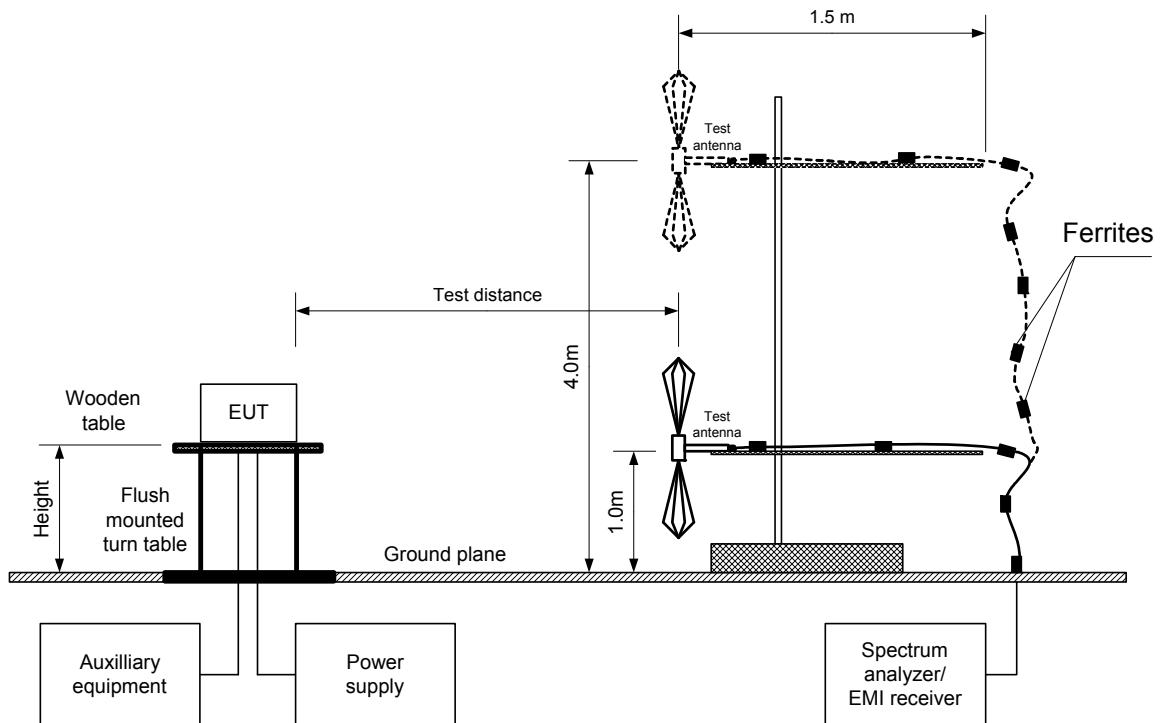
- 7.5.2.6 The worst test results (the lowest margins) were recorded in Table 7.5.2.



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: Compliance		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





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:	Compliance
Date(s):	04-Sep-16
Temperature: 24 °C	Relative Humidity: 57 %
	Air Pressure: 1008 hPa
	Power: Battery
Remarks:	

Table 7.5.2 Peak output power test results

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

FHSS CONFIGURATION: 86 Channels

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

FHSS CONFIGURATION: 240 Channels

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

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

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

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

Reference numbers of test equipment used

HL 0415	HL 3818	HL 4280	HL 4294				
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Full description is given in Appendix A.

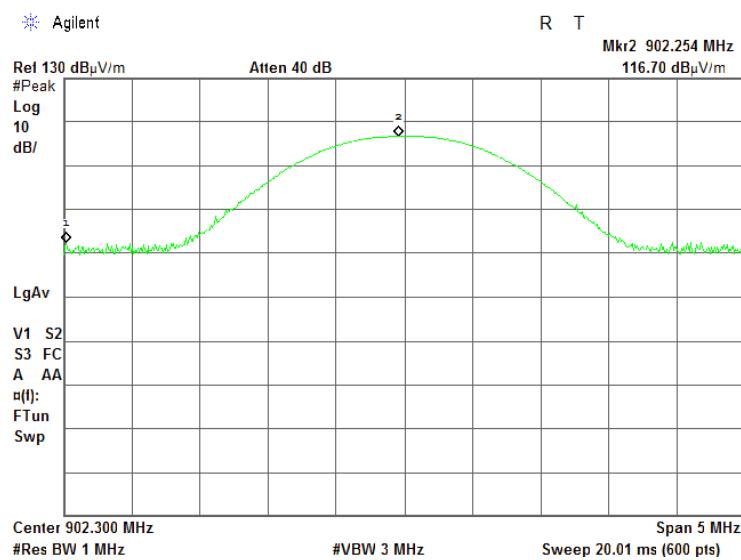


HERMON LABORATORIES

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:	Compliance		
Date(s):	04-Sep-16		Verdict: PASS
Temperature: 24 °C	Relative Humidity: 57 %		Air Pressure: 1008 hPa
Remarks:		Power: Battery	

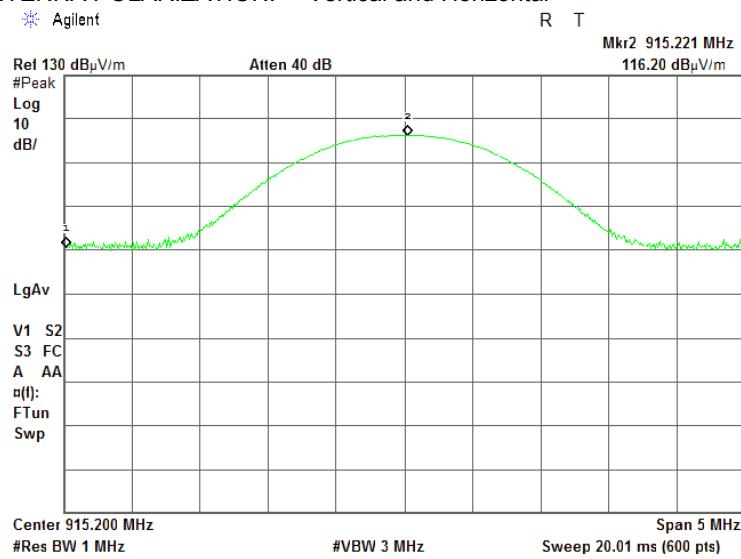
Plot 7.5.1 Field strength of carrier at low frequency

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



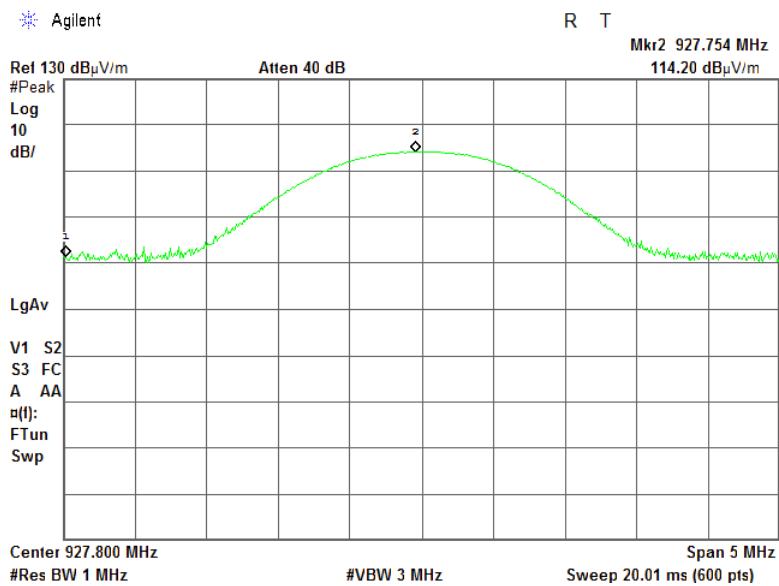


HERMON LABORATORIES

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: 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



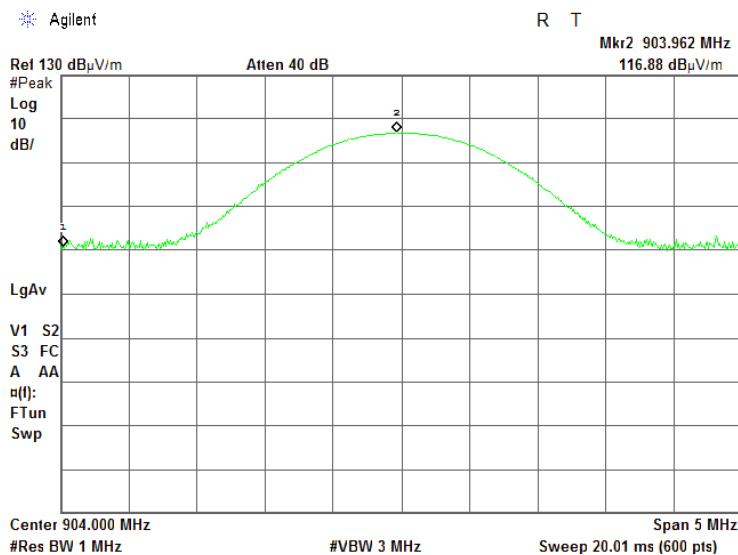


HERMON LABORATORIES

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: Compliance			Verdict: PASS
Date(s): 04-Sep-16			
Temperature: 24 °C	Relative Humidity: 57 %		Air Pressure: 1008 hPa
Remarks:		Power: Battery	

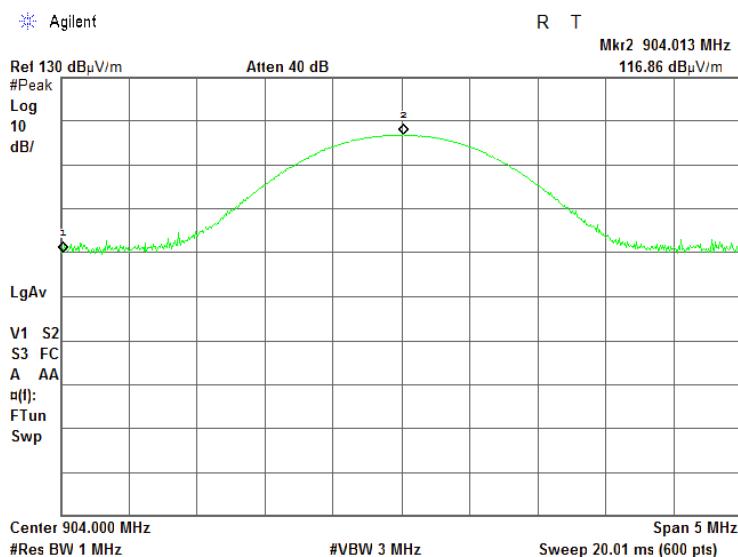
Plot 7.5.4 Field strength of carrier at low frequency

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

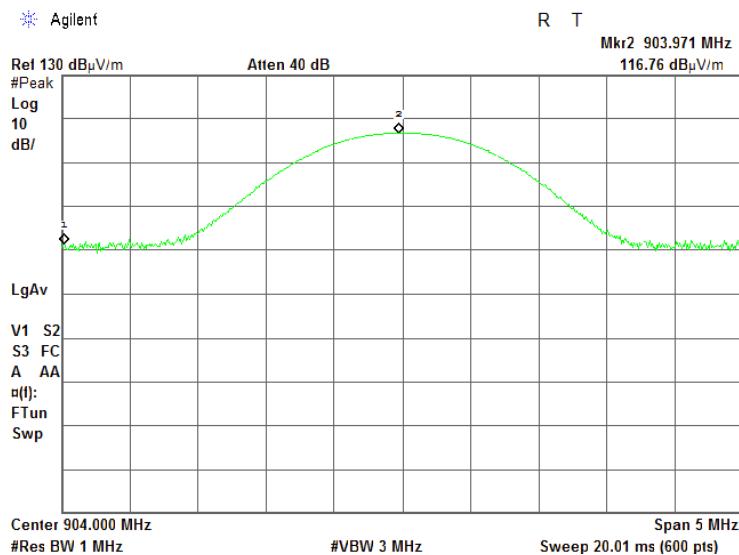




Test specification:	Section 15.247(b), RSS-247 section 5.4(1), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	04-Sep-16		
Temperature: 24 °C	Relative Humidity: 57 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

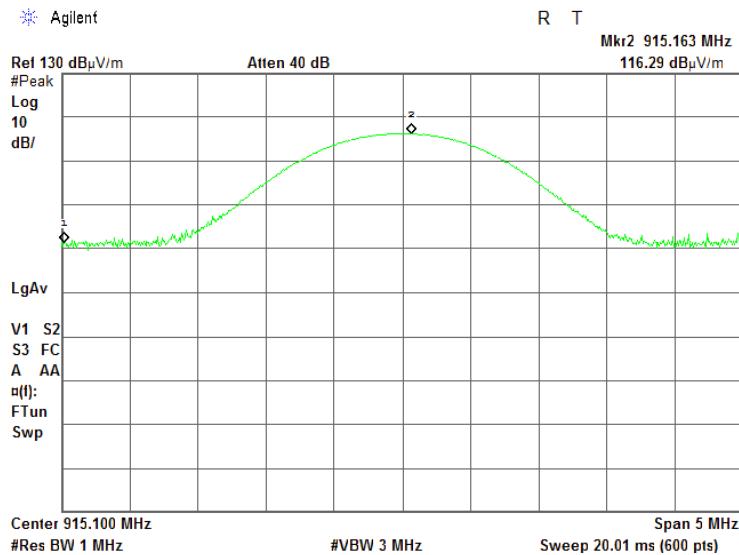
Plot 7.5.6 Field strength of carrier at low frequency

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



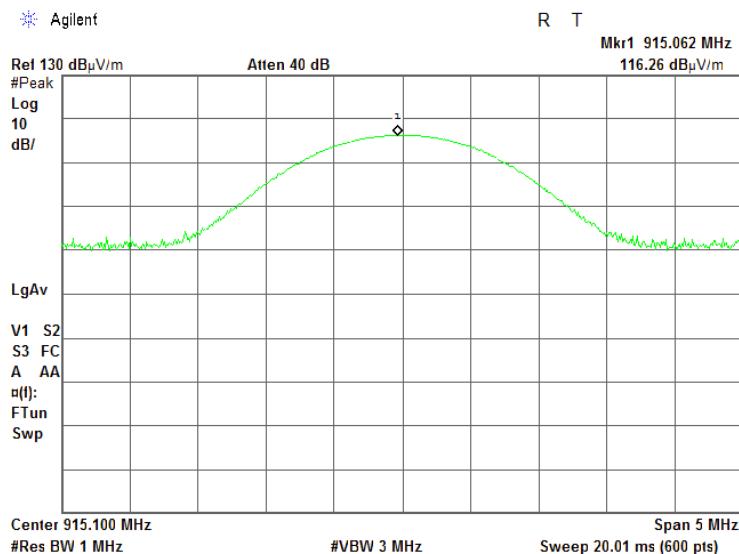


HERMON LABORATORIES

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: Compliance		Verdict: PASS	
Date(s): 04-Sep-16			
Temperature: 24 °C	Relative Humidity: 57 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

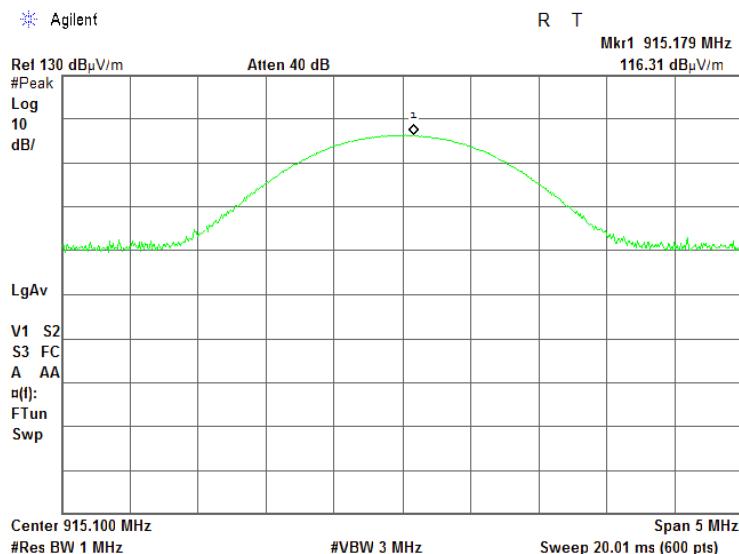
Plot 7.5.8 Field strength of carrier at mid frequency

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



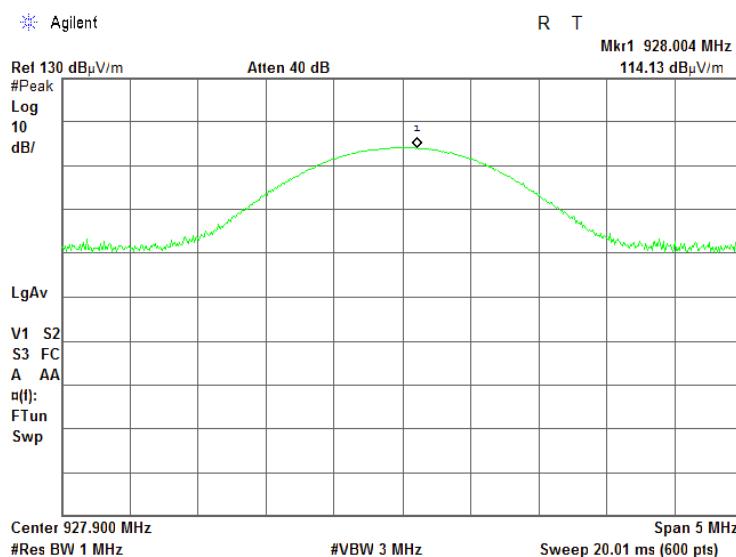


HERMON LABORATORIES

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: Compliance		Verdict: PASS	
Date(s): 04-Sep-16			
Temperature: 24 °C	Relative Humidity: 57 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

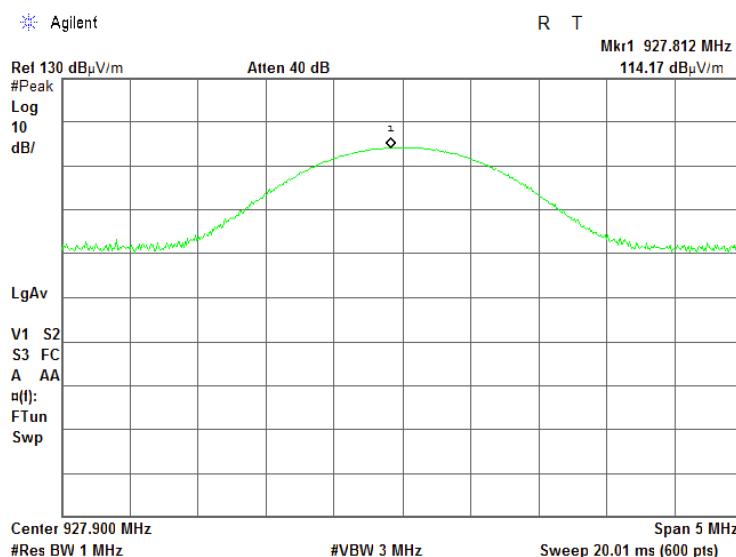
Plot 7.5.10 Field strength of carrier at high frequency

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



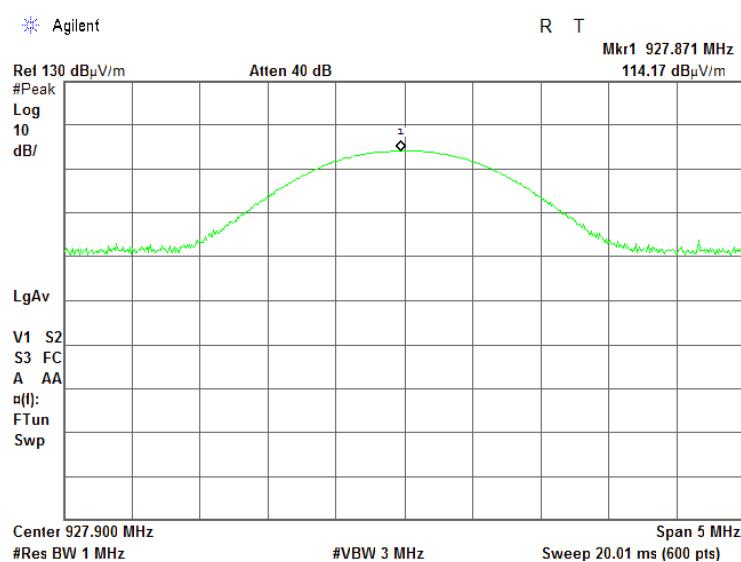


HERMON LABORATORIES

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: Compliance		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





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
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:

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

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

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

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

7.6.2 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.



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:		

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

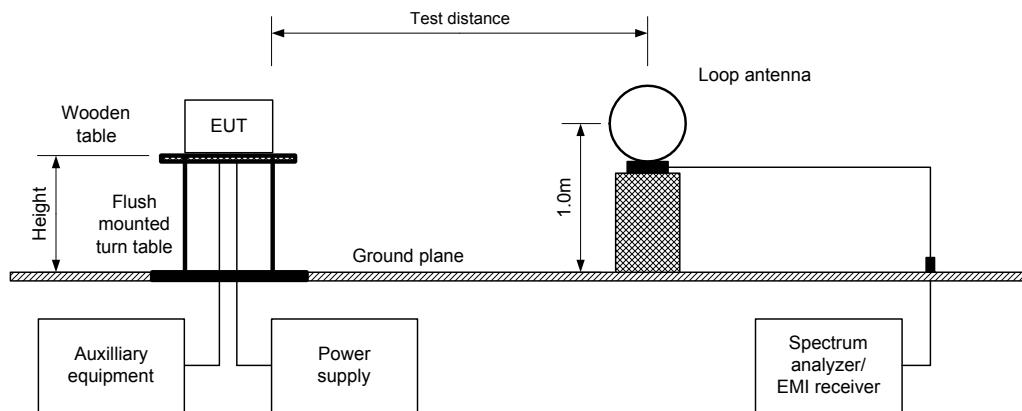
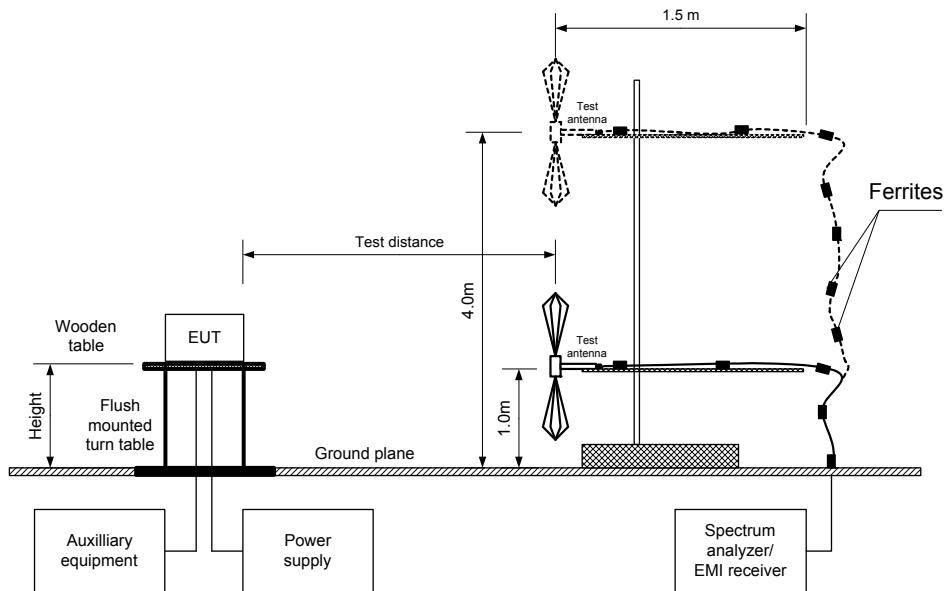


Figure 7.6.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz

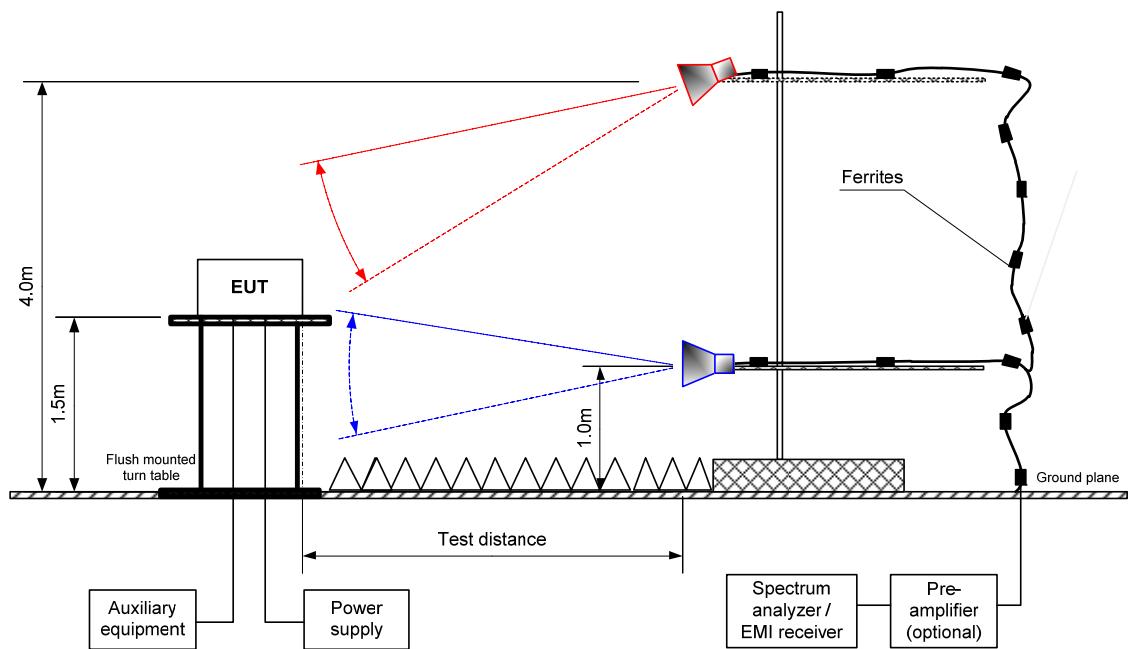




HERMON LABORATORIES

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:		

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
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	Vertical	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	Vertical	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: 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 7.6.3 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: 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 7.6.6 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

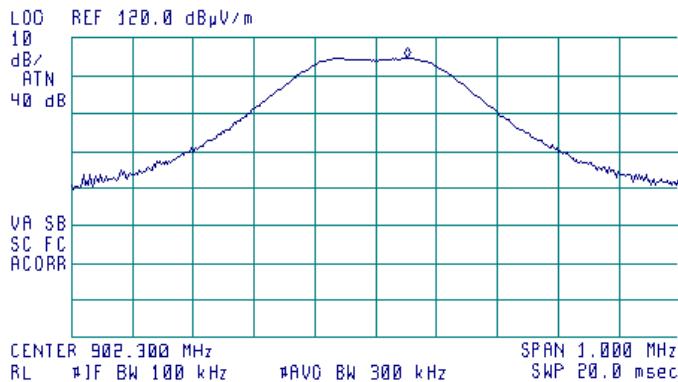
Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure: ANSI C63.10, sections 6.5, 6.6		
Test mode: Compliance		Verdict: PASS
Date(s): 06-Sep-16 - 22-Sep-16		
Temperature: 26 °C	Relative Humidity: 40 %	Air Pressure: 1005 hPa
Remarks:		Power: Battery

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



ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 902.353 MHz
114.76 dB μ V/m

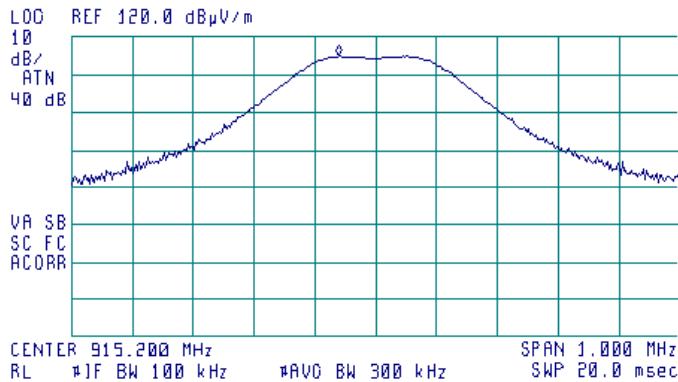


Plot 7.6.2 Radiated emission measurements at carrier frequency 915.2 MHz

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



ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 915.140 MHz
114.99 dB μ V/m





HERMON LABORATORIES

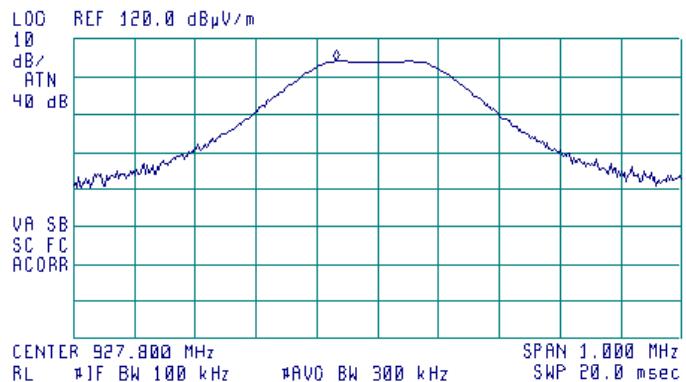
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Test procedure: ANSI C63.10, sections 6.5, 6.6		
Test mode: Compliance	Verdict: PASS	
Date(s): 06-Sep-16 - 22-Sep-16		
Temperature: 26 °C	Relative Humidity: 40 %	Air Pressure: 1005 hPa
Power: Battery		
Remarks:		

Plot 7.6.3 Radiated emission measurements at carrier frequency 927.8 MHz

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



ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 927.733 MHz
114.30 dB μ V/m



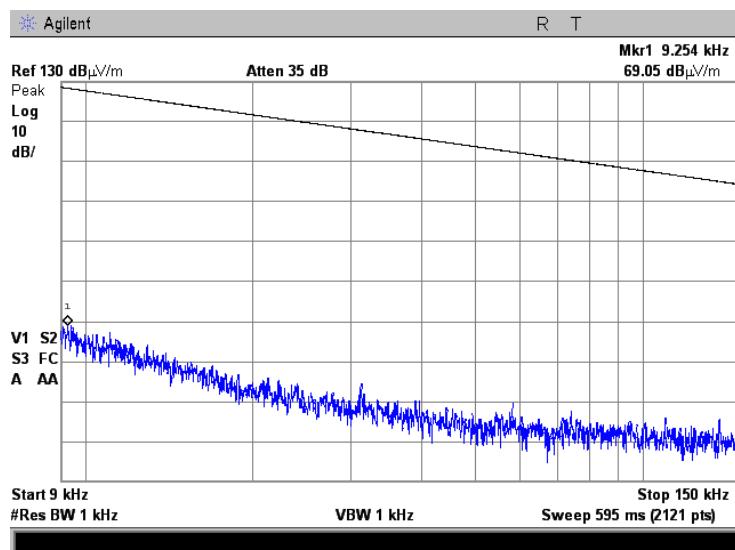


HERMON LABORATORIES

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:		

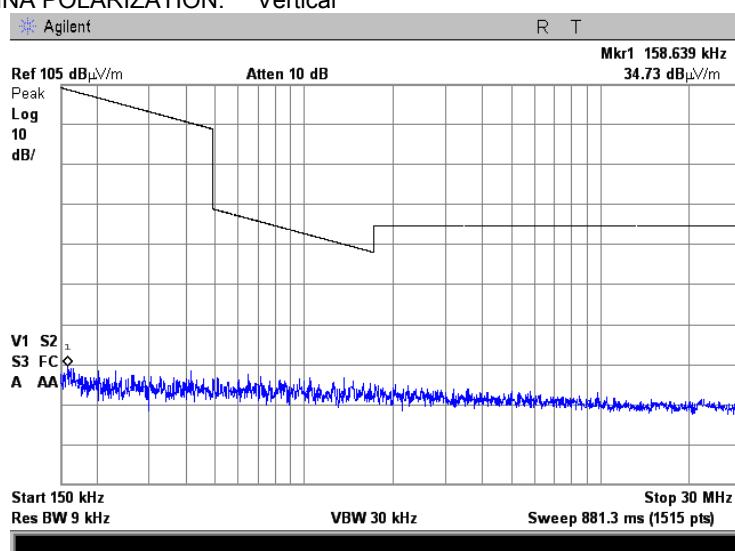
Plot 7.6.4 Radiated emission measurements from 9 to 150 kHz at the low, mid and high carrier frequency

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





HERMON LABORATORIES

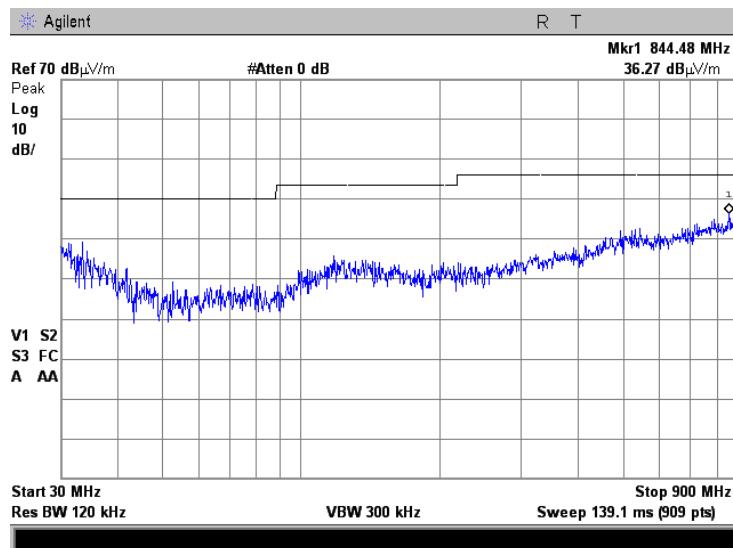
Report ID: TELRAD_FCC.28785_FHSS_rev1.docx

Date of Issue: 6-Dec-16

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
Remarks:		

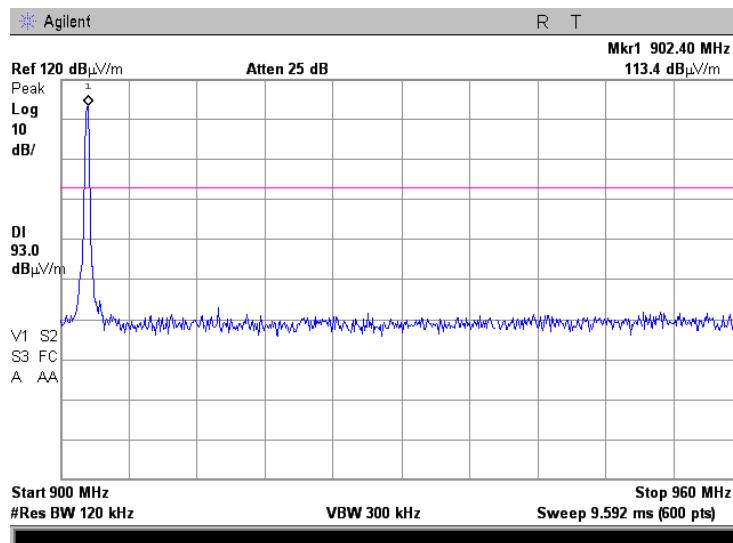
Plot 7.6.6 Radiated emission measurements from 30 to 900 MHz at the low carrier frequency

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



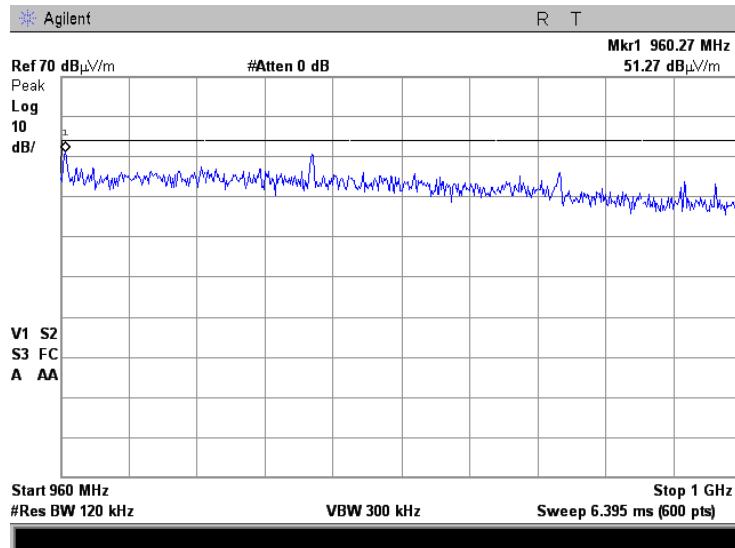


HERMON LABORATORIES

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
Remarks:		Power: Battery

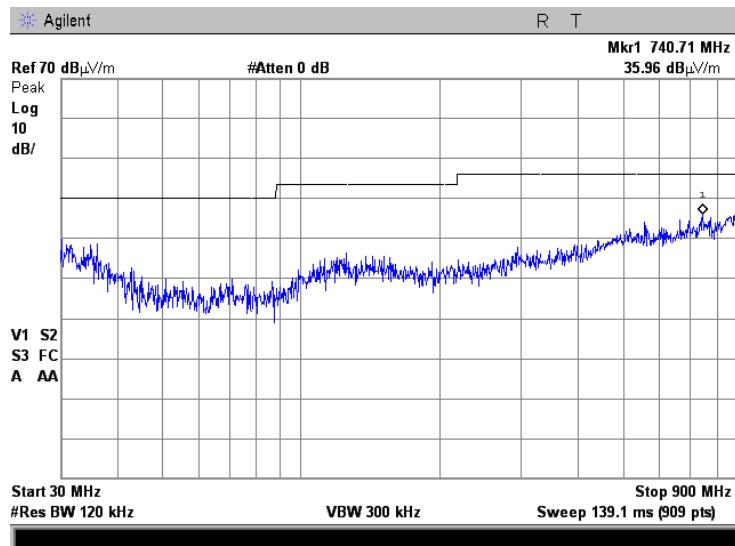
Plot 7.6.8 Radiated emission measurements from 960 to 1000 MHz at the low carrier frequency

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



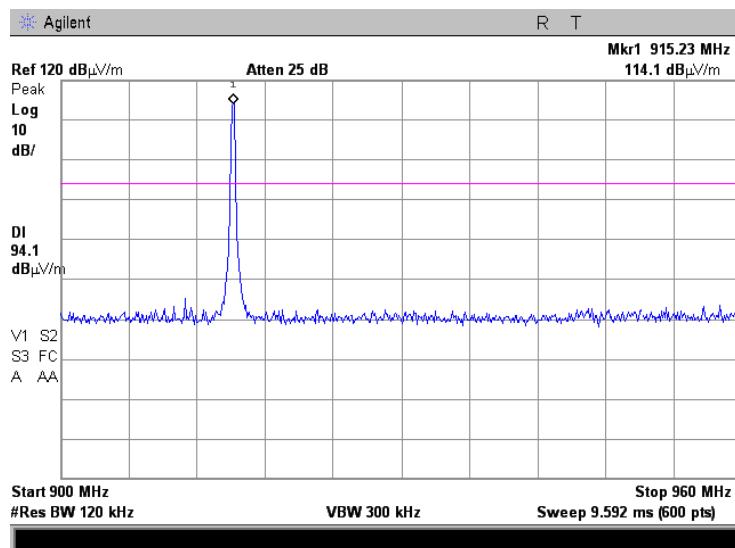


HERMON LABORATORIES

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
Remarks:		

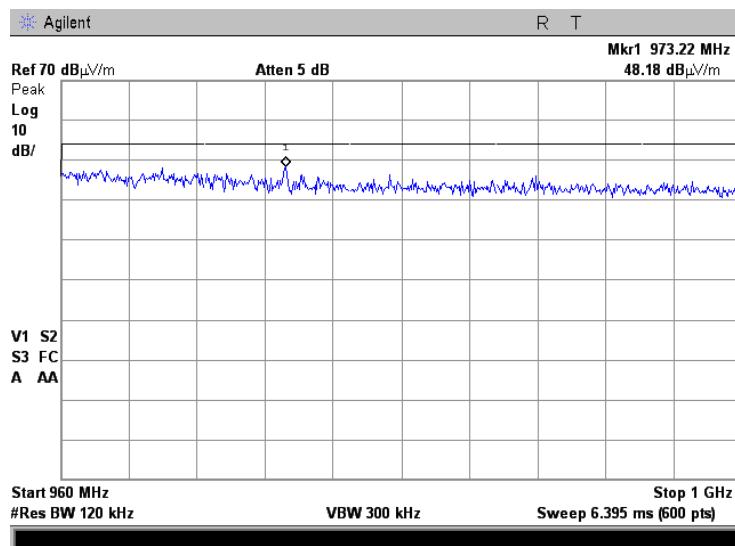
Plot 7.6.10 Radiated emission measurements from 900 to 960 MHz at carrier frequency 915.2 MHz

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



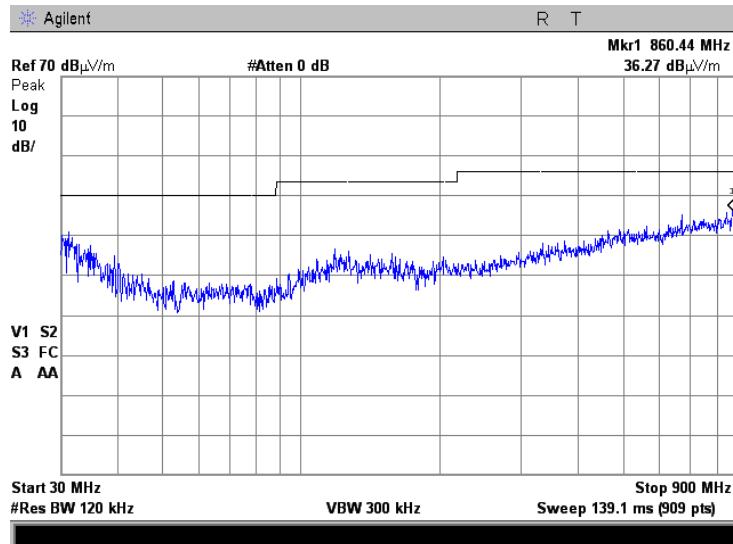


HERMON LABORATORIES

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
Remarks:		

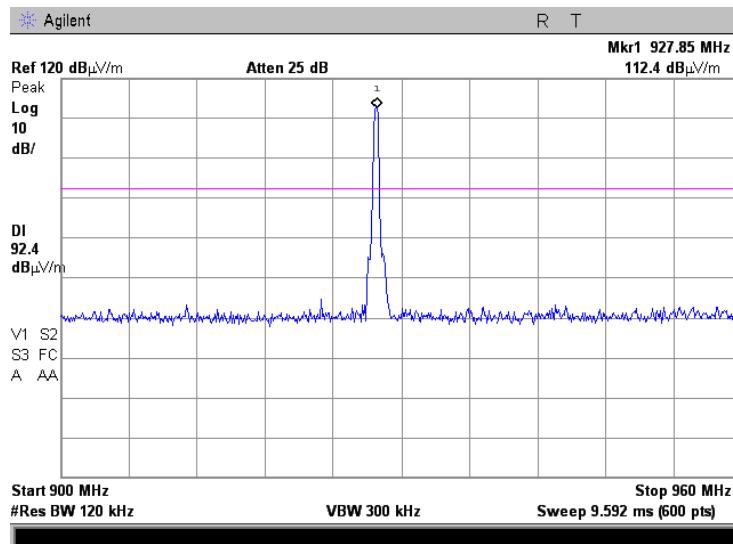
Plot 7.6.12 Radiated emission measurements from 30 to 900 MHz at carrier frequency 927.8 MHz

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



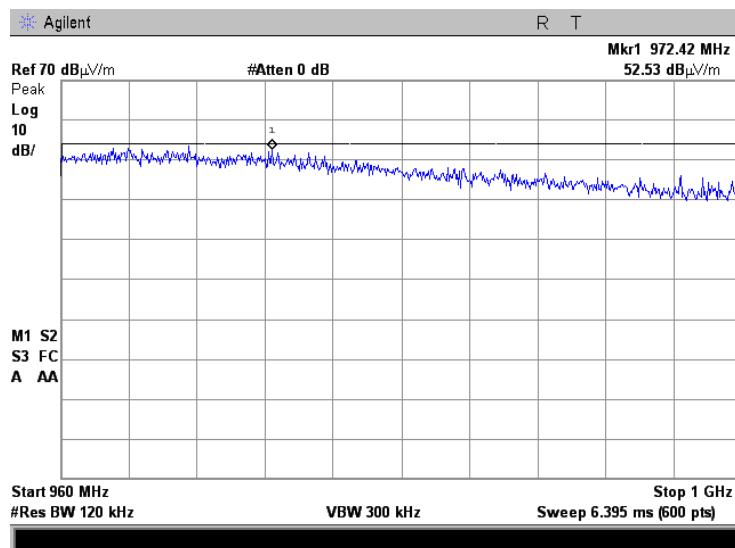


HERMON LABORATORIES

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
Remarks:		

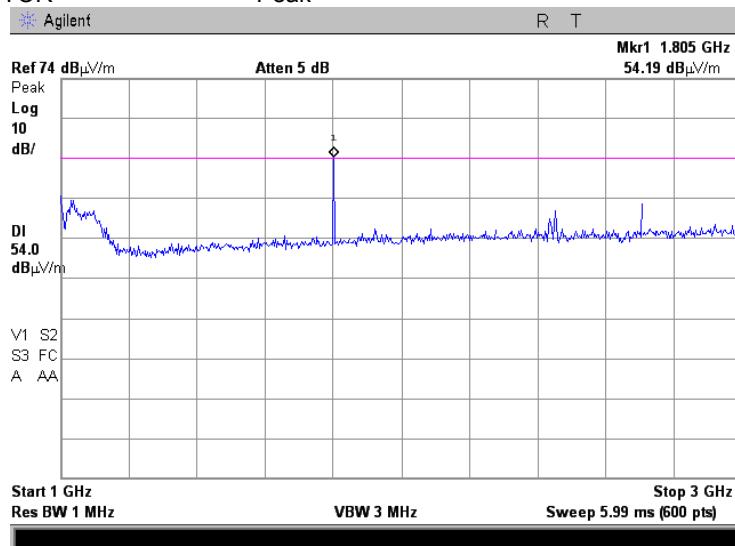
Plot 7.6.14 Radiated emission measurements from 960 to 1000 MHz at carrier frequency 927.8 MHz

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



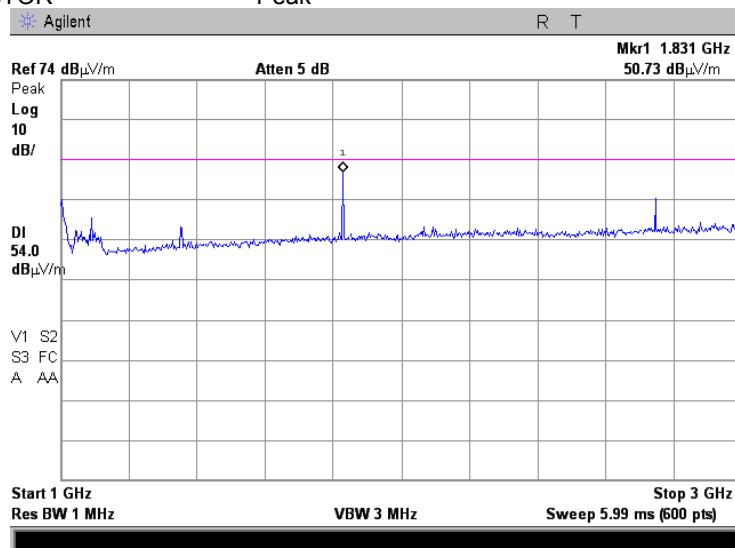


HERMON LABORATORIES

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:			

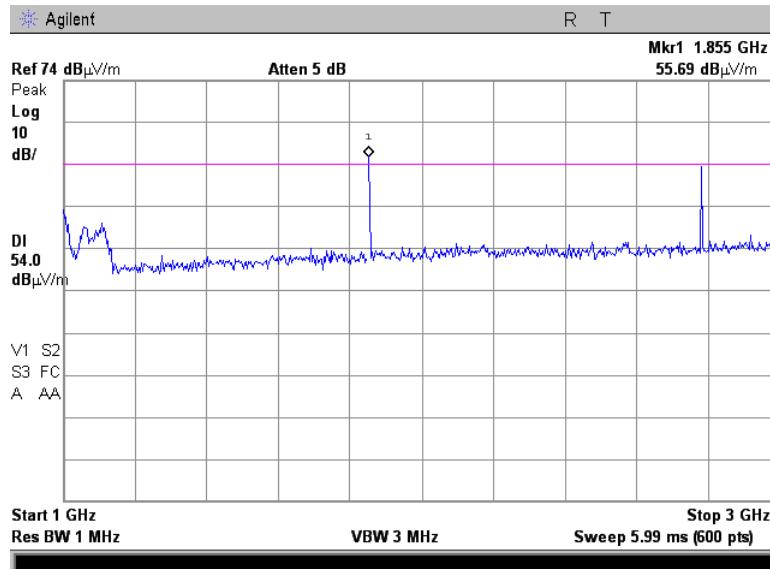
Plot 7.6.16 Radiated emission measurements from 1000 to 3000 MHz at carrier frequency 915.2 MHz

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

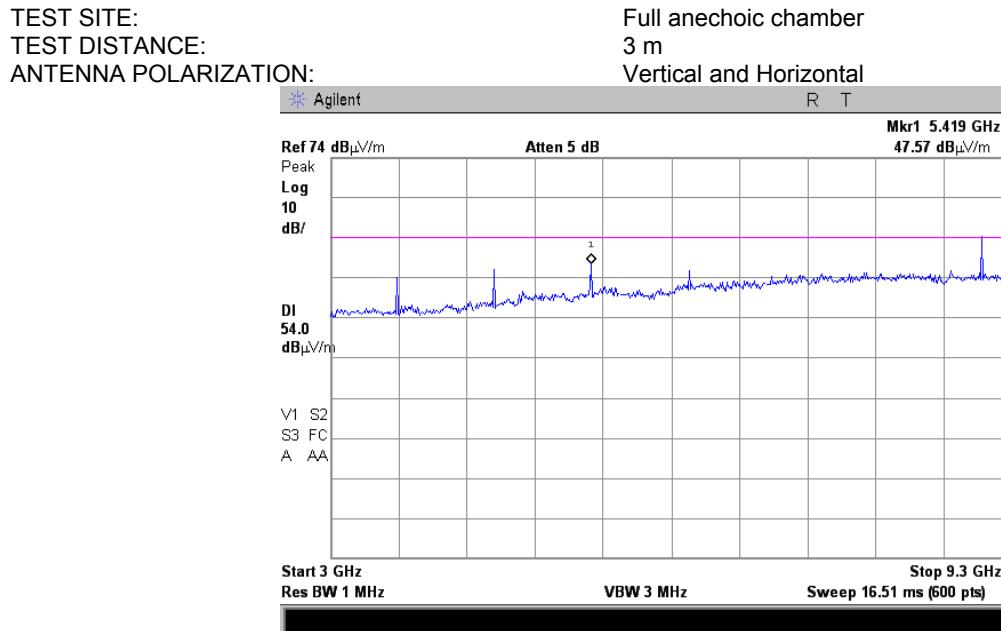




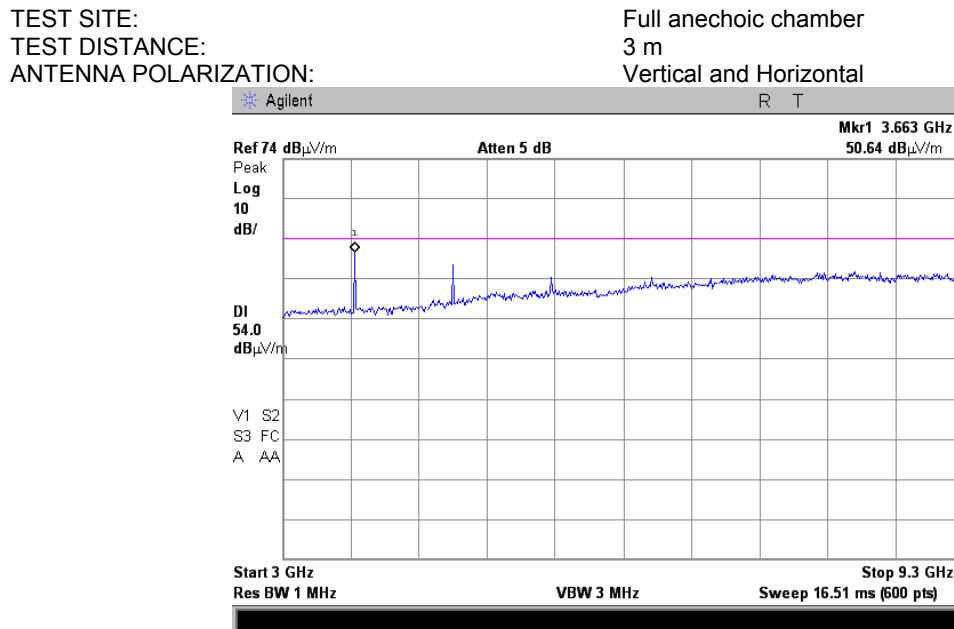
HERMON LABORATORIES

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



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

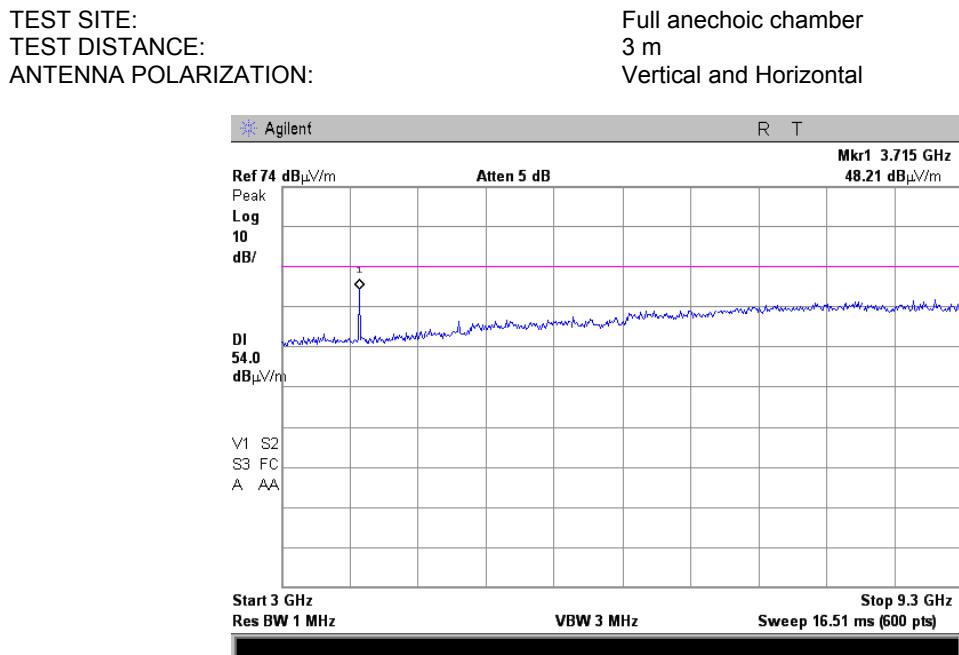




HERMON LABORATORIES

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
Remarks:		Power: Battery

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



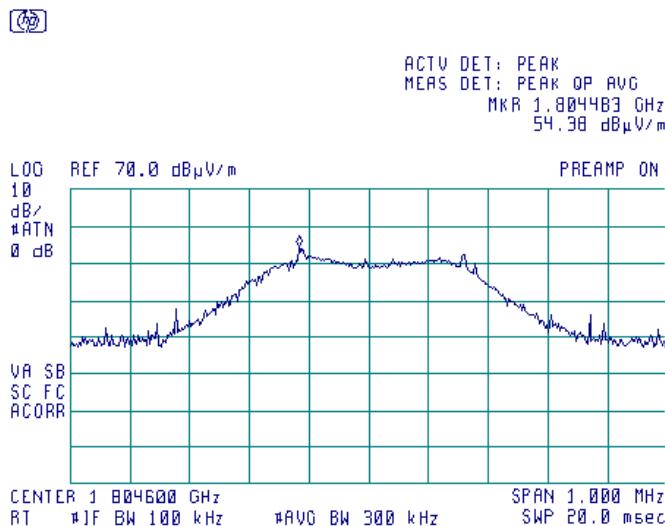


HERMON LABORATORIES

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
Remarks:		Power: Battery

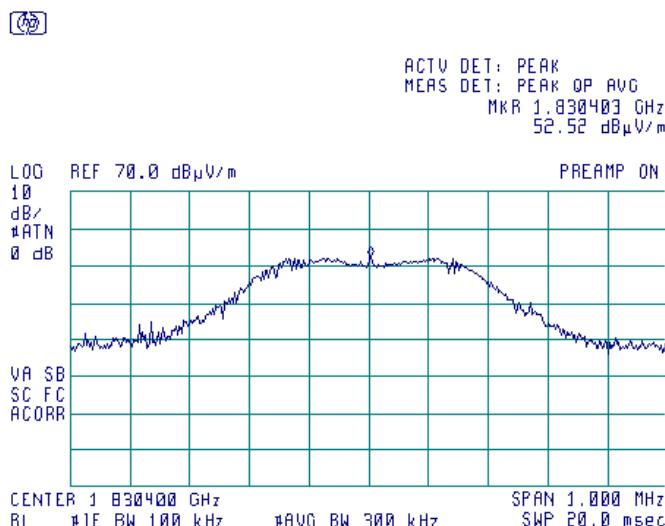
Plot 7.6.21 Radiated emission measurements at the second harmonic of low carrier frequency

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



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

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



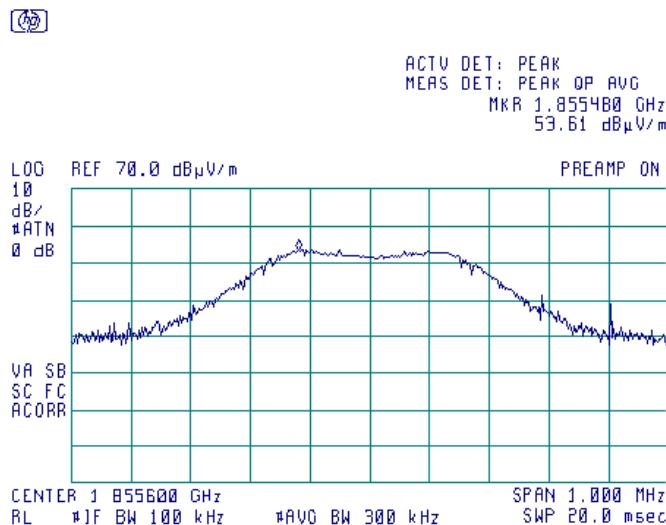


HERMON LABORATORIES

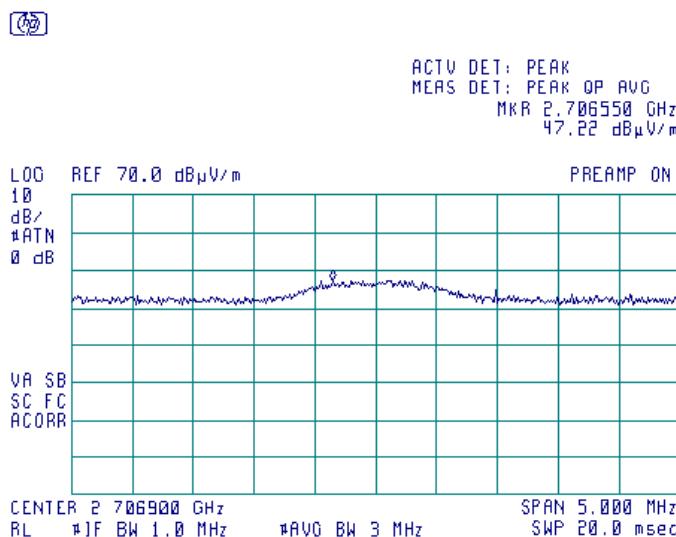
Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure: ANSI C63.10, sections 6.5, 6.6		
Test mode: Compliance		Verdict: PASS
Date(s): 06-Sep-16 - 22-Sep-16		
Temperature: 26 °C	Relative Humidity: 40 %	Air Pressure: 1005 hPa
Remarks:		

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



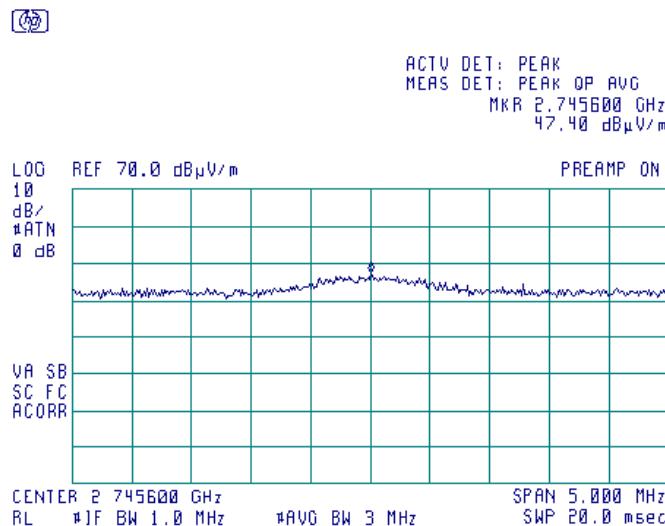


HERMON LABORATORIES

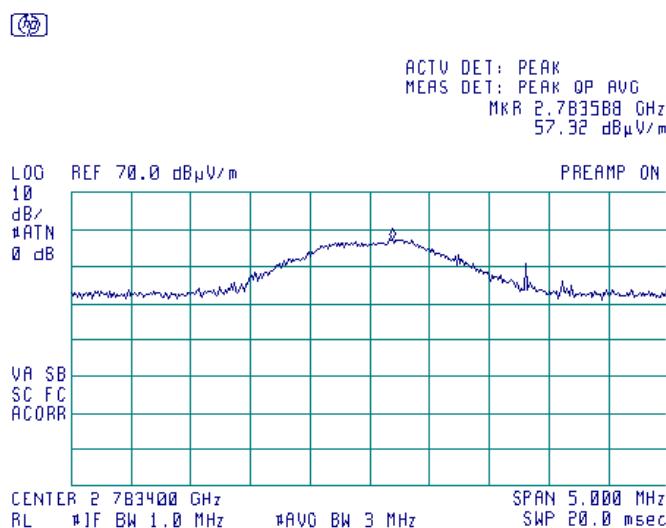
Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure: ANSI C63.10, sections 6.5, 6.6		
Test mode: Compliance		Verdict: PASS
Date(s): 06-Sep-16 - 22-Sep-16		
Temperature: 26 °C	Relative Humidity: 40 %	Air Pressure: 1005 hPa
Remarks:		

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



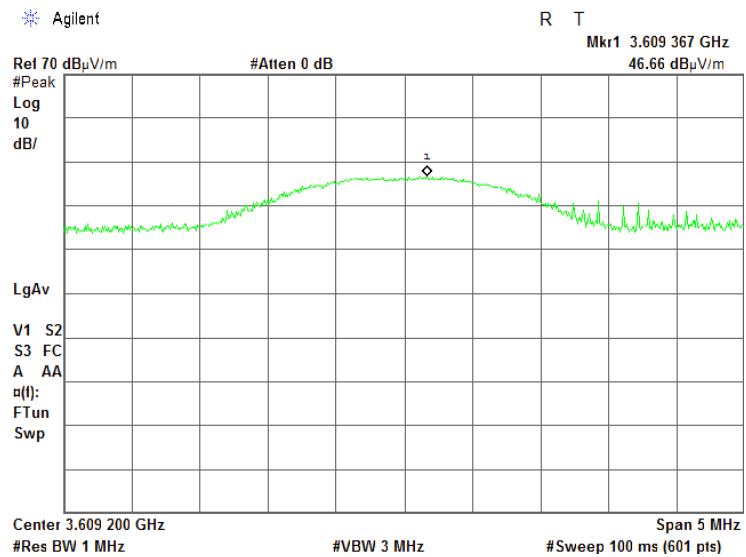


HERMON LABORATORIES

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
Remarks:		Power: Battery

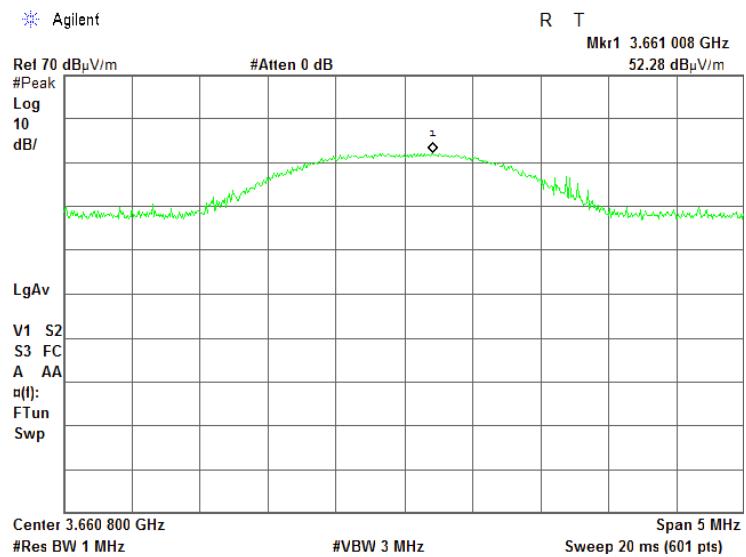
Plot 7.6.27 Radiated emission measurements at the fourth harmonic of low carrier frequency

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



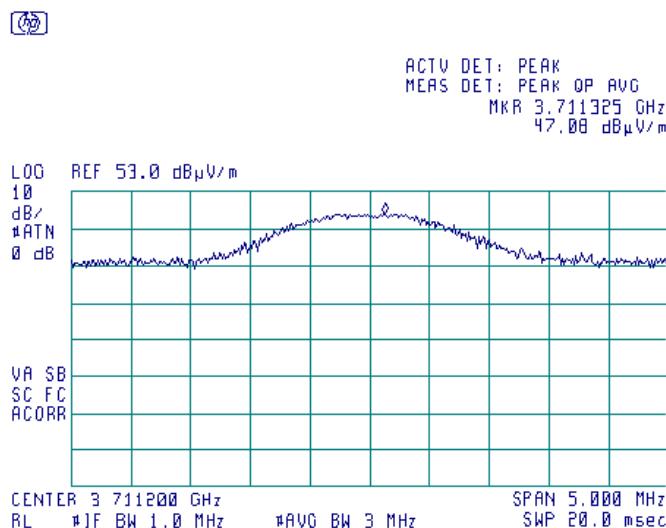


HERMON LABORATORIES

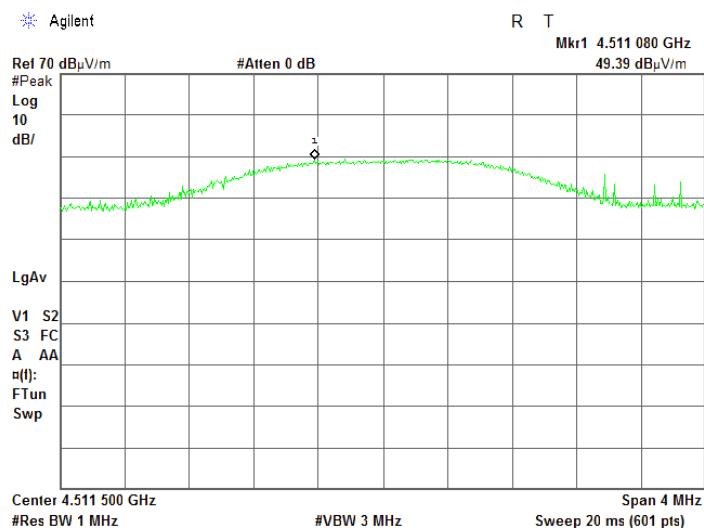
Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure: ANSI C63.10, sections 6.5, 6.6		
Test mode: Compliance		Verdict: PASS
Date(s):	06-Sep-16 - 22-Sep-16	
Temperature: 26 °C	Relative Humidity: 40 %	Air Pressure: 1005 hPa
Remarks:		

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



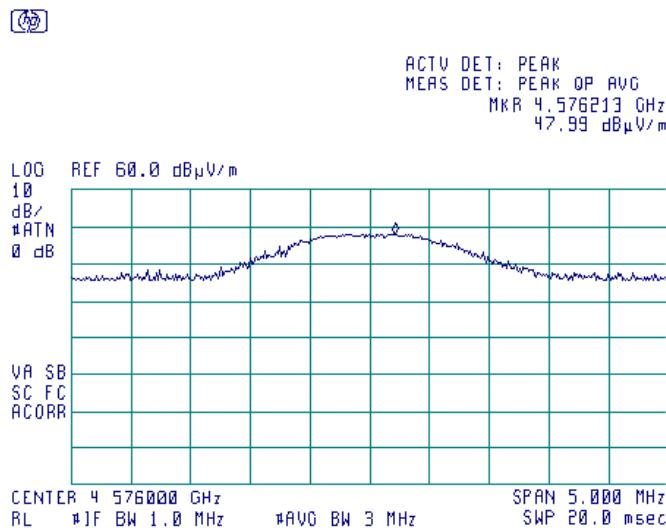


HERMON LABORATORIES

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
Remarks:		Power: Battery

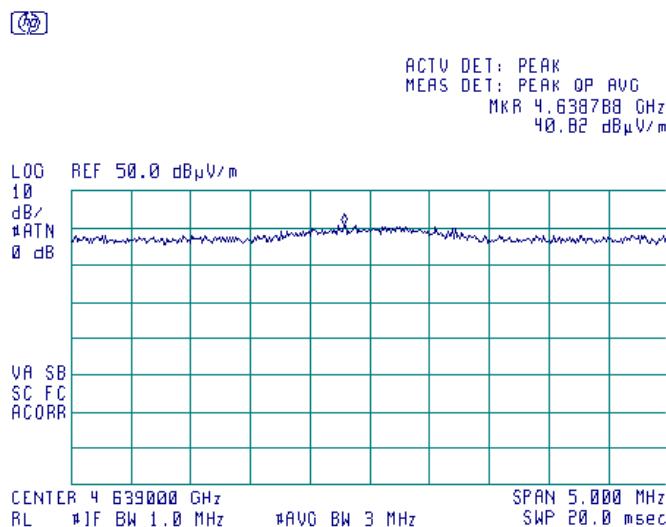
Plot 7.6.31 Radiated emission measurements at the fifth harmonic of mid carrier frequency

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



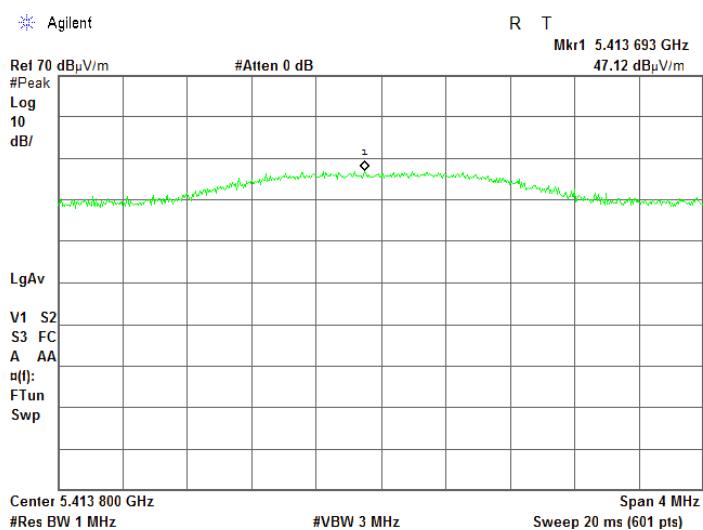


HERMON LABORATORIES

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:		

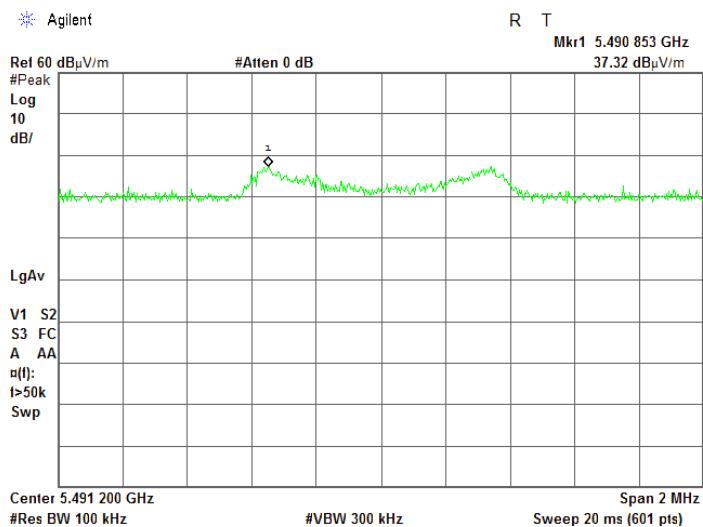
Plot 7.6.33 Radiated emission measurements at the sixth harmonic of low carrier frequency

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



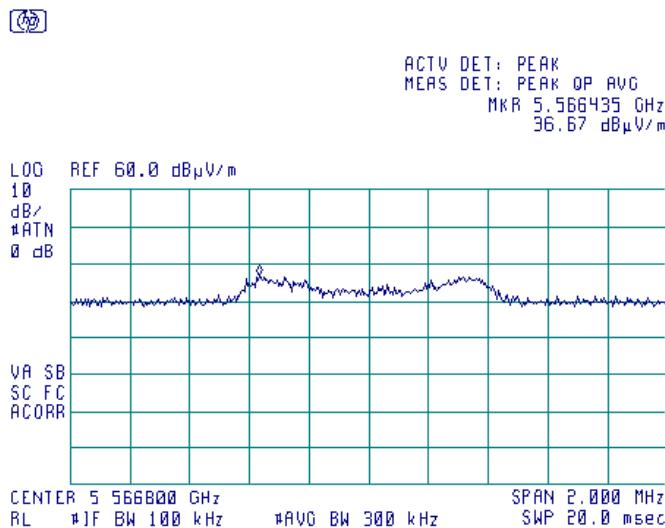


HERMON LABORATORIES

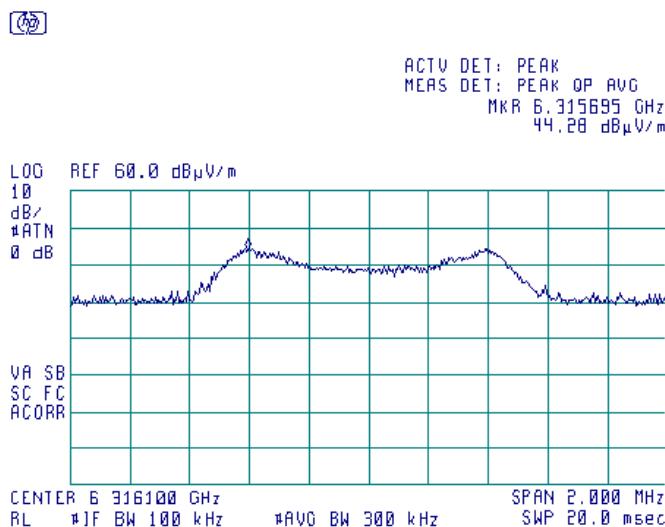
Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure: ANSI C63.10, sections 6.5, 6.6		
Test mode: Compliance		Verdict: PASS
Date(s):	06-Sep-16 - 22-Sep-16	
Temperature: 26 °C	Relative Humidity: 40 %	Air Pressure: 1005 hPa
Remarks:		

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



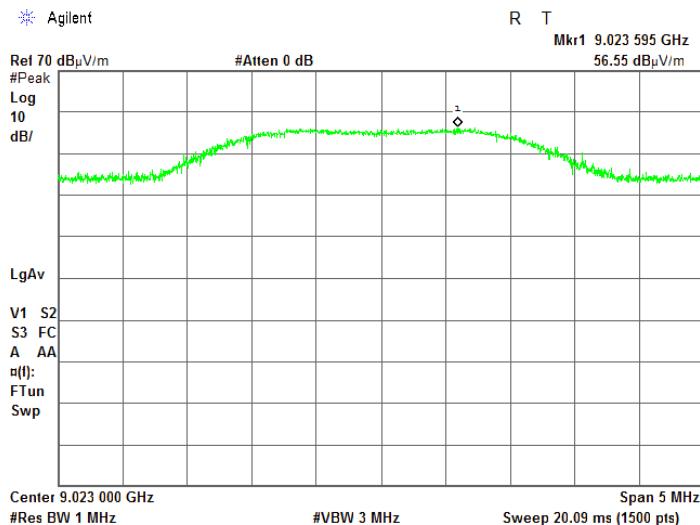


HERMON LABORATORIES

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		
Date(s):	06-Sep-16 - 22-Sep-16		
Temperature: 26 °C	Relative Humidity: 40 %	Air Pressure: 1005 hPa	Power: Battery
Remarks:			

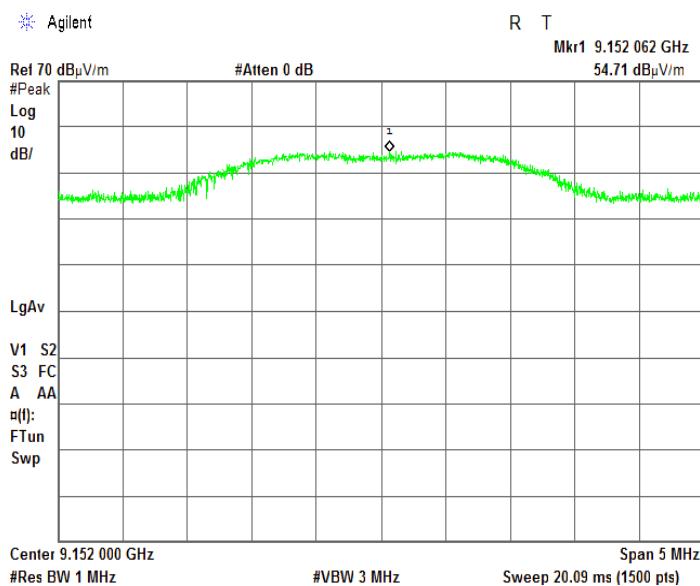
Plot 7.6.37 Radiated emission measurements at the tenth harmonic of low carrier frequency

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

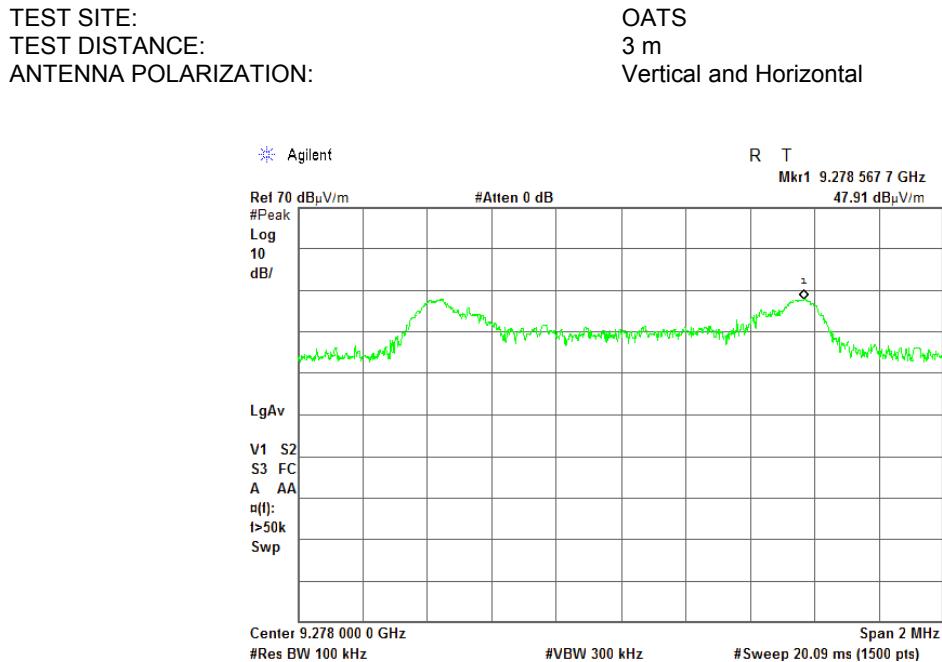




HERMON LABORATORIES

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
Remarks:		Power: Battery

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

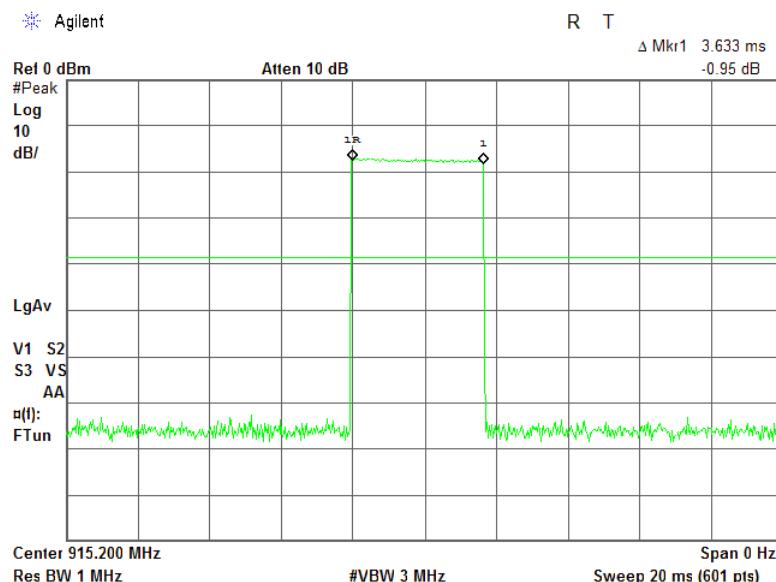




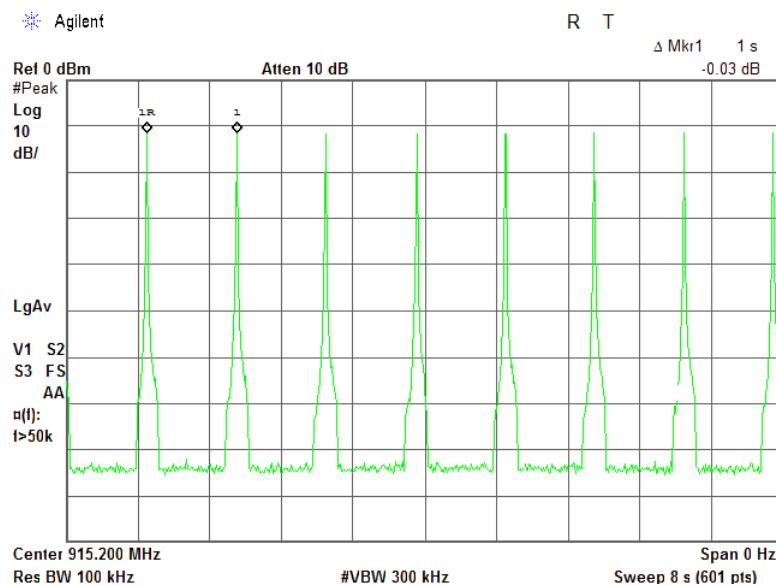
HERMON LABORATORIES

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 7.6.40 Transmission pulse duration



Plot 7.6.41 Transmission pulse period





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
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			
2400.0 – 2483.5	20.0	74.0	54.0
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





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:							

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

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		-61.17	-5.86	55.31		35.31	
928.000		-37.58	-6.75	30.83		10.83	
902.000		-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		-57.83	-9.29	48.54		28.54	
928.060		-35.81	-10.35	25.46		5.46	
901.945		-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							
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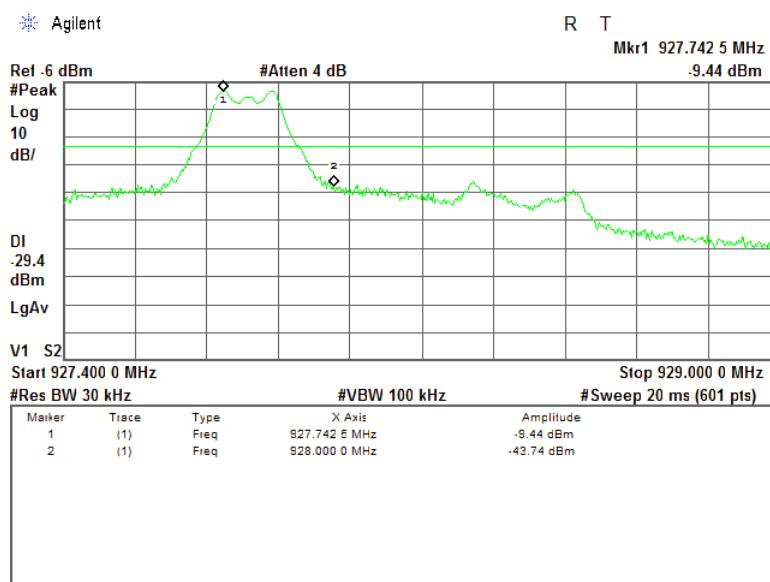
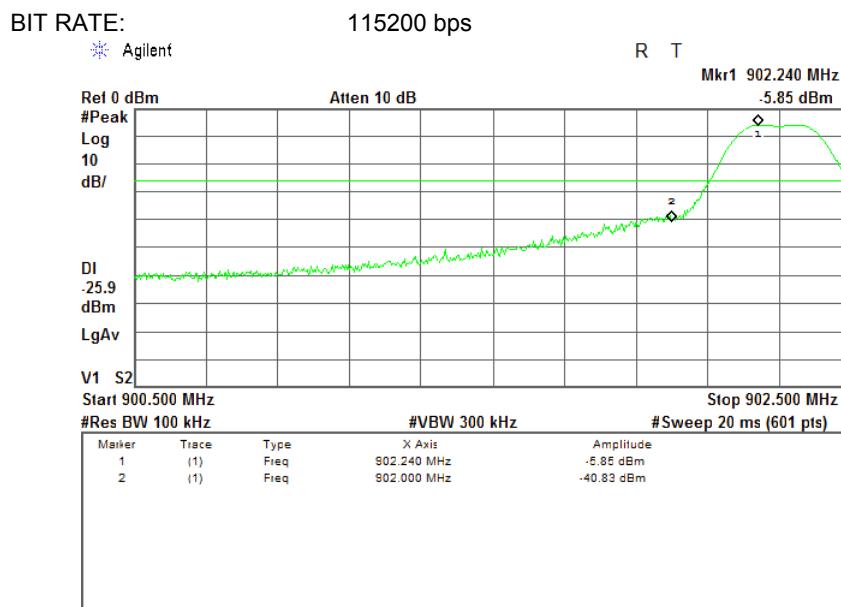
Full description is given in Appendix A.



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: Compliance		Verdict: PASS
Date(s): 13-Sep-16		
Temperature: 26 °C	Relative Humidity: 57 %	Air Pressure: 1005 hPa
Remarks:		

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

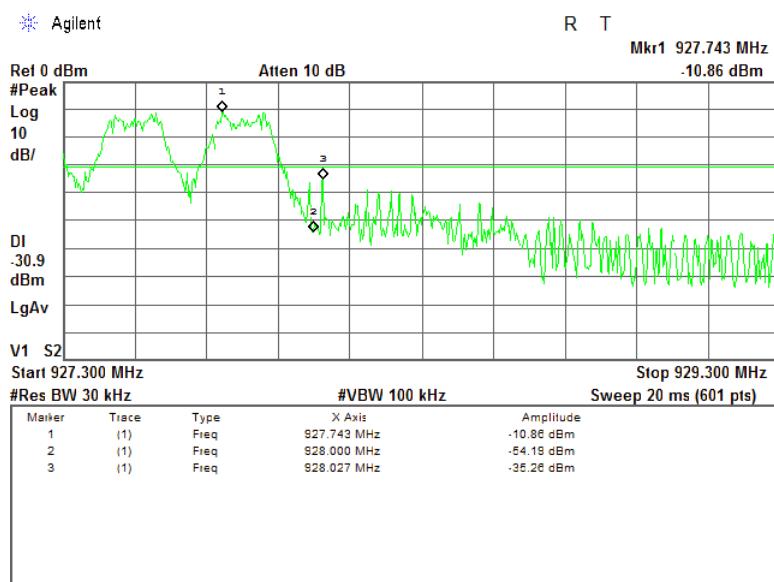
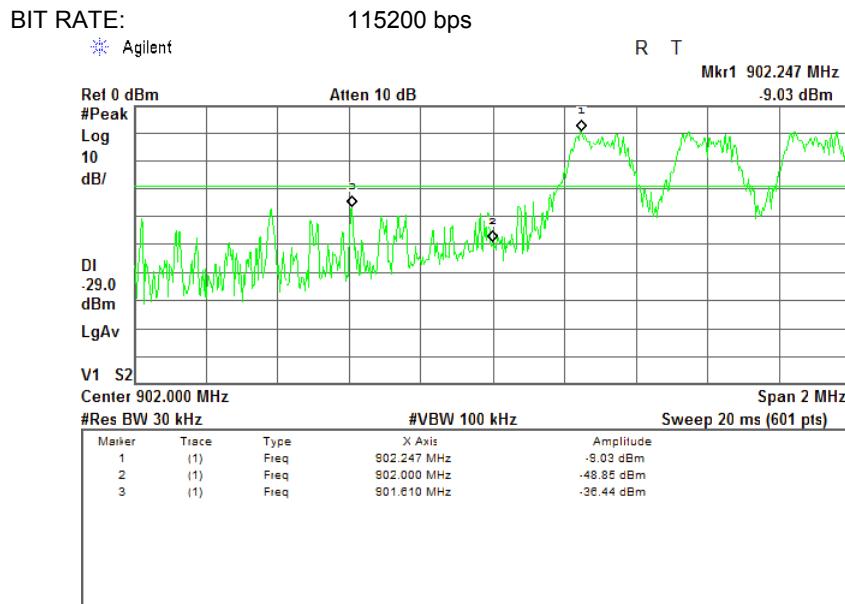




HERMON LABORATORIES

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
Remarks:		

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



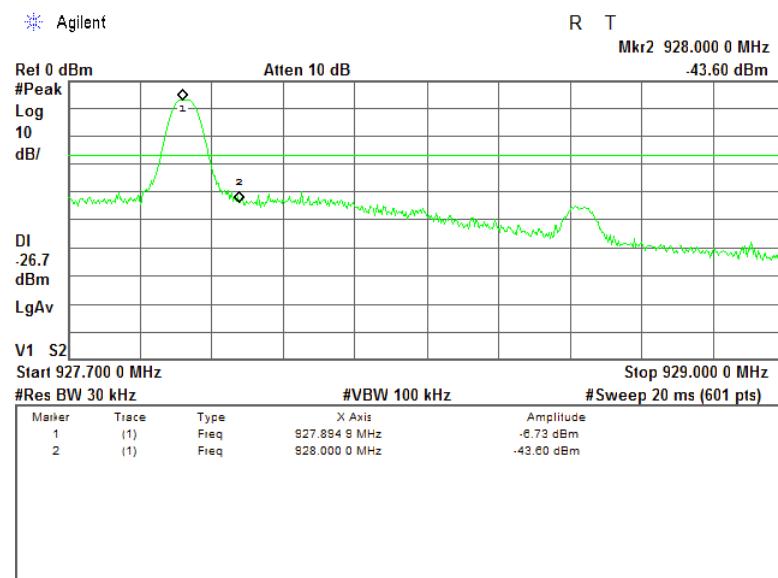
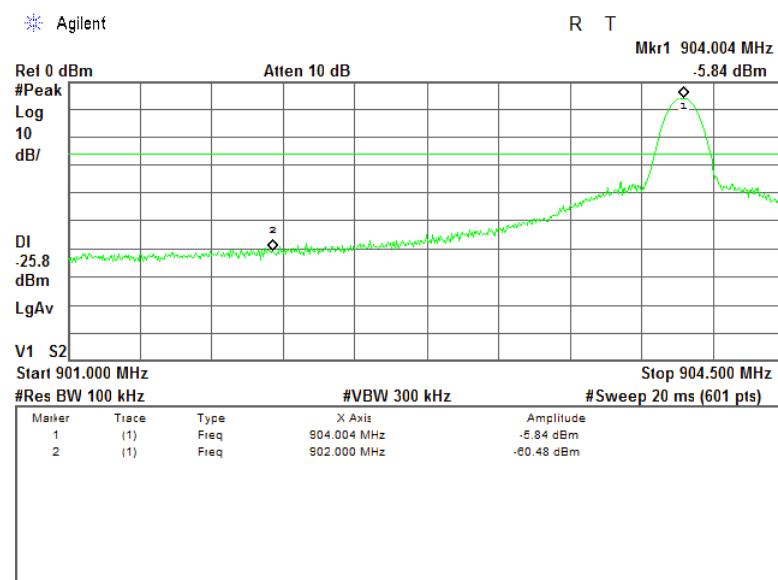


HERMON LABORATORIES

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
Remarks:		

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

BIT RATE: 9600 bps



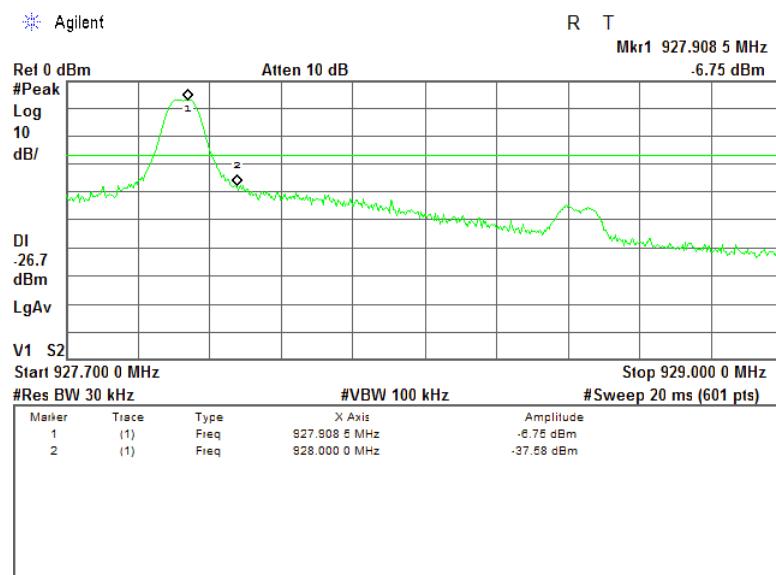
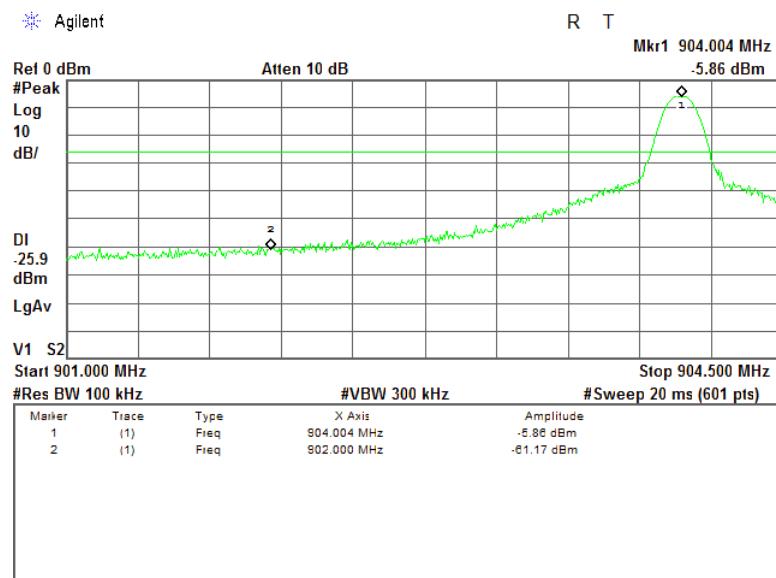


HERMON LABORATORIES

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
Remarks:		Power: Battery

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

BIT RATE: 19200 bps



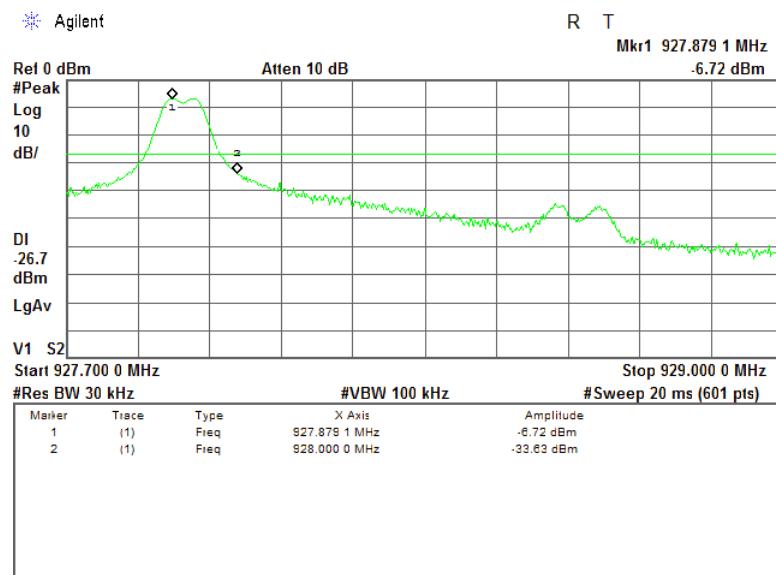
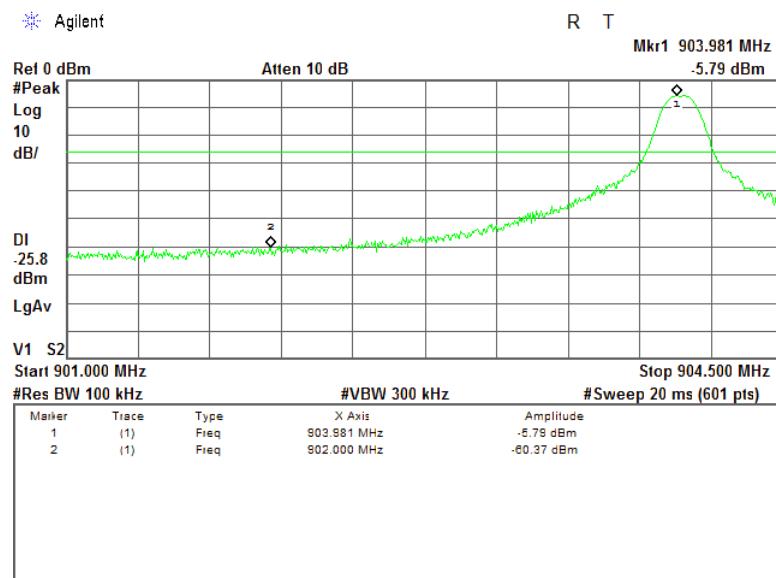


HERMON LABORATORIES

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
Remarks:		

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

BIT RATE: 38400 bps



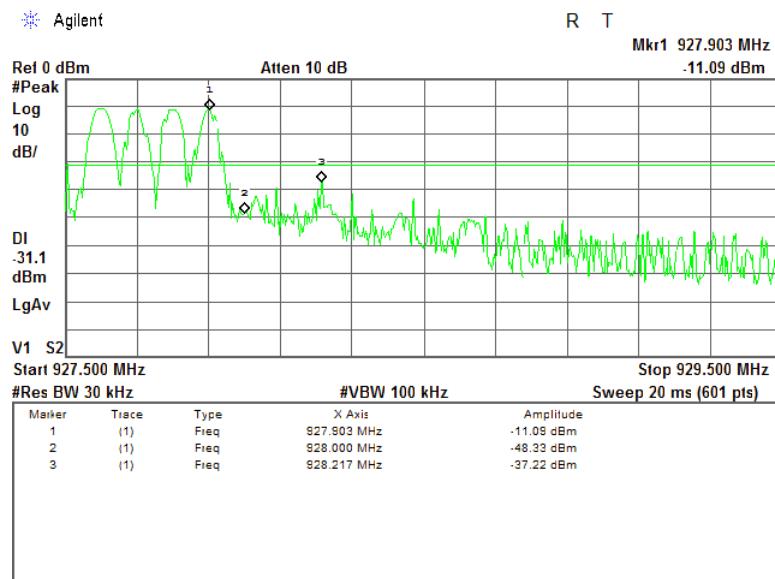
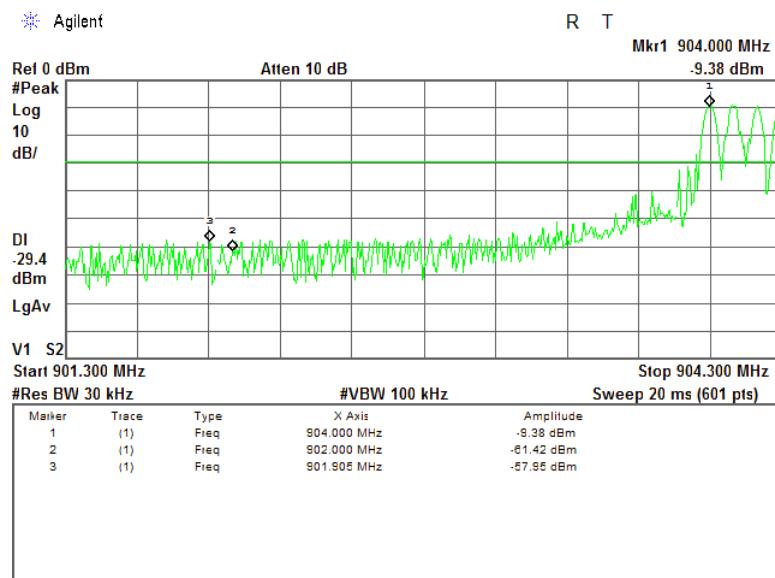


HERMON LABORATORIES

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
Remarks:		

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

BIT RATE: 9600 bps



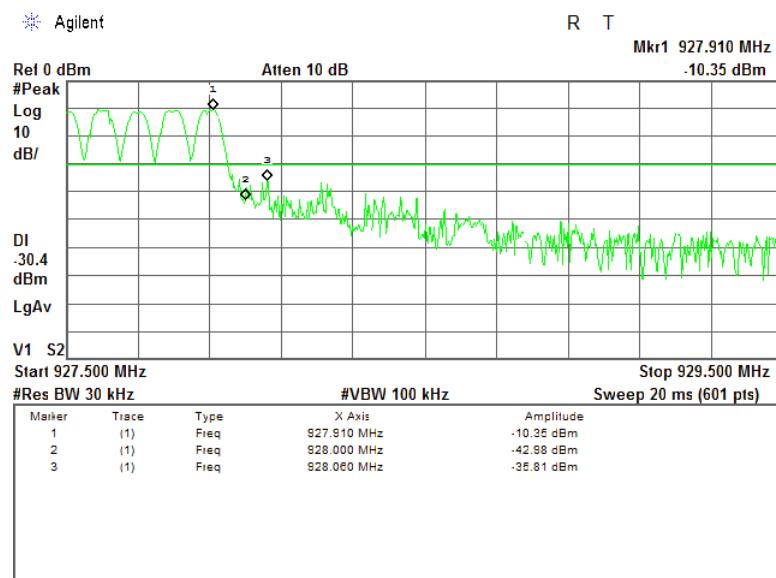
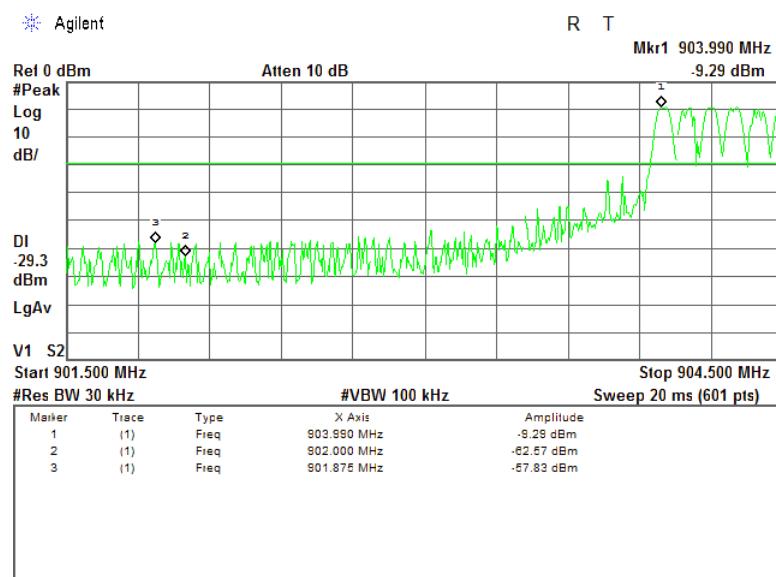


HERMON LABORATORIES

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
Remarks:		

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

BIT RATE: 19200 bps



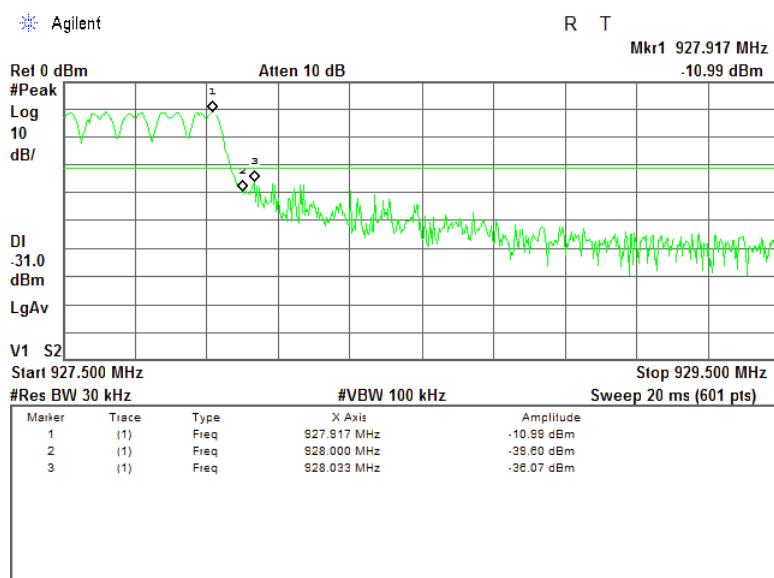
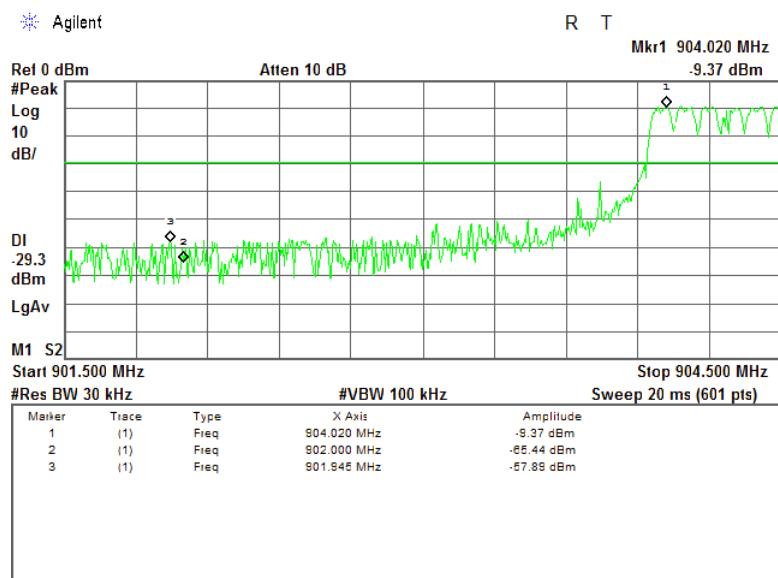


HERMON LABORATORIES

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
Remarks:		Power: Battery

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

BIT RATE: 38400 bps





HERMON LABORATORIES

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





HERMON LABORATORIES

8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./Check	Due Cal./Check
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	SUCOFLEX 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



HERMON LABORATORIES

9 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted carrier power at RF antenna connector	Below 12.4 GHz: ± 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	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
Vertical polarization	

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

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

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



HERMON LABORATORIES

10 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, 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



HERMON LABORATORIES

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).



HERMON LABORATORIES

**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).



HERMON LABORATORIES

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)



HERMON LABORATORIES

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



HERMON LABORATORIES

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



HERMON LABORATORIES

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						
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		



HERMON LABORATORIES

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

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



HERMON LABORATORIES

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

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		



HERMON LABORATORIES

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		



HERMON LABORATORIES

13 APPENDIX F Abbreviations and acronyms

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

END OF DOCUMENT