HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C §15.247 (FHSS) and subpart B, RSS-247 Issue 2, RSS-Gen Issue 5, ICES-003 Issue 6

FOR:

Tyco Safety Products Canada Ltd.
PowerG beam detector with 200ft range
Model: PG9200AX
FCC ID:F5321PG9200AX
IC:160A-PG9200AX

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1 Applicant information

Client name:	Tyco Safety Products Canada Ltd.
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Telephone:	+1-647 480 0430
Fax:	+1-905 760 3020
E-mail:	dnita@tycoint.com
Contact name:	Mr. Dan Nita

2 Equipment under test attributes

Product name:	PowerG beam detector with 200ft range
Product type:	Transceiver
Model:	PG9200AX
Serial number:	Prototype
Hardware version:	90-209777 Receiver beam detector 90-209778 Transmitter beam detector E-209773 PCA RF OPTEX (915) RF module
Software release of RF molule:	JS-703920

3 Manufacturer information

Manufacturer name:	Visonic Ltd.
Address:	24 Habarzel street, Tel Aviv 69710, Israel
Telephone:	+972 3645 6832
Fax:	+972 3645 6788
E-Mail:	zuri.rubin@jci.com
Contact name:	Mr. Zuri Rubin

4 Test details

Project ID:	31388
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	30-Aug-18
Test completed:	03-Sep-18
Test specifications:	FCC 47CFR part 15 subpart C § 15.247 (FHSS), subpart B; RSS-247 issue 2, RSS-Gen issue 5 with Am.1:2019, ICES-003 Issue 6: 2019 (updated)

5 Tests summary

Test	Status
Transmitter characteristics	
Section 15.247(a)1 / RSS-247 section 5.1(c), 20 dB bandwidth	Pass
Section 15.247(a)1 / RSS-247 section 5.1(b), Frequency separation	Pass
Section 15.247(a)1 / RSS-247 section 5.1(c), Number of hopping frequencies	Pass
Section 15.247(a)1 / RSS-247 section 5.1(c), Average time of occupancy	Pass
Section 15.247(b) / RSS-247 section 5.4(a), 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 6.8, Antenna requirements	Pass
Section 15.207(a) / RSS-Gen section 8.8, Conducted emission	Not required
Unintentional emissions	
Section 15.107/ICES-003, Section 6.1, Class B, Conducted emission at AC power port	Not required
Section 15.109/ RSS-Gen section 7.3 /ICES-003, Section 6.2, Class B, Radiated emission	Pass

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.
The test results relate only to the items tested. Pass/fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt, test engineer	September 3, 2018	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	April 7, 2021	
Approved by:	Mr. S. Samokha, Technical Manager, EMC and Radio	May 3, 2021	

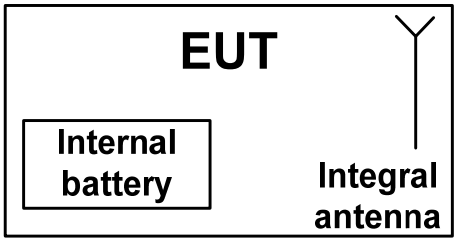
6 EUT description

6.1 General information

The EUT is a wireless outdoor photoelectric beam detector. It uses PowerG two-way communication protocol.

The EUT wireless transceiver module operates in 912.750 – 919.106 MHz range. The EUT is equipped with integral antenna and is powered by 3.6 VDC internal battery.

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented in the EUT during the testing.

6.4 Transmitter characteristics

Type of equipment	
X	Stand-alone (Equipment with or without its own control provisions)
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)
	Plug-in card (Equipment intended for a variety of host systems)

Intended use		**Condition of use**
	fixed	Always at a distance more than 2 m from all people
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 ranges	902 – 928 MHz
Operating frequencies	912.750 – 919.106 MHz

Maximum rated output power	At transmitter 50 Ω RF output connector	dBm
	Peak output power	12.87 dBm

Is transmitter output power variable?	X	No		
		Yes		continuous variable
				stepped variable with stepsize dB
			minimum RF power	dBm
			maximum RF power	dBm

Antenna connection			
unique coupling	standard connector	X integral	with temporary RF connector
			X without temporary RF connector

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Integral	Ocean	H-306097	-2 dBi

Transmitter aggregate data rate/s	50 kbps
Type of modulation	GFSK
Modulating test signal (baseband)	PRBS

Transmitter power source					
X	Battery	**Nominal rated voltage**	3.6 VDC	Battery type	LHS20, lithium
	DC	**Nominal rated voltage**			
	AC mains	**Nominal rated voltage**		Frequency	

Common power source for transmitter and receiver		X yes	no
Spread spectrum technique used	X	Frequency hopping (FHSS)	
		Digital transmission system (DTS)	
		Hybrid	

Spread spectrum parameters for transmitters tested per FCC 15.247 only		
FHSS	Total number of hops	50
	Bandwidth per hop	108.543 kHz
	Max. separation of hops	129.4 kHz

Test specification:	Section 15.247(a)1, RSS-247 section 5.1(c), 20 dB bandwidth		
Test procedure:	ANSI C63.10, section 7.8.7		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-Aug-18		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
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 the 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

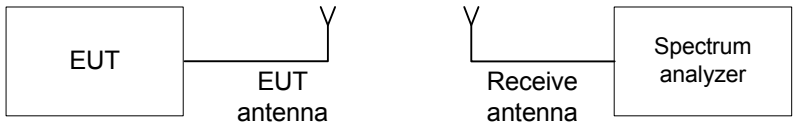
7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

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 Table 7.1.2 and associated plot.

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

Figure 7.1.1 The 20 dB bandwidth test setup



Test specification:	Section 15.247(a)1, RSS-247 section 5.1(c), 20 dB bandwidth		
Test procedure:	ANSI C63.10, section 7.8.7		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-Aug-18		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Table 7.1.2 The 20 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902.0 – 928.0 MHz
DETECTOR USED: Peak
SWEEP TIME: Auto
VIDEO BANDWIDTH: ≥ RBW
MODULATION ENVELOPE REFERENCE POINTS: 20.0 dBc
FREQUENCY HOPPING: Disabled

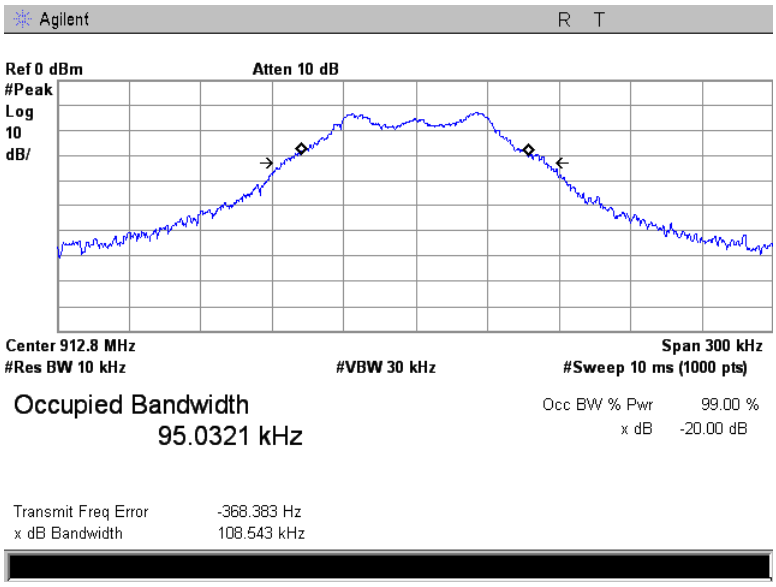
Carrier frequency, MHz	Type of modulation	Data rate, kbps	Symbol rate, Msymbols/s	20 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
912.750	GFSK	50	NA	108.543	250	-141.457	Pass
915.863				106.071	250	-143.929	Pass
919.106				107.927	250	-142.073	Pass

Reference numbers of test equipment used

HL 2909	HL 4136							

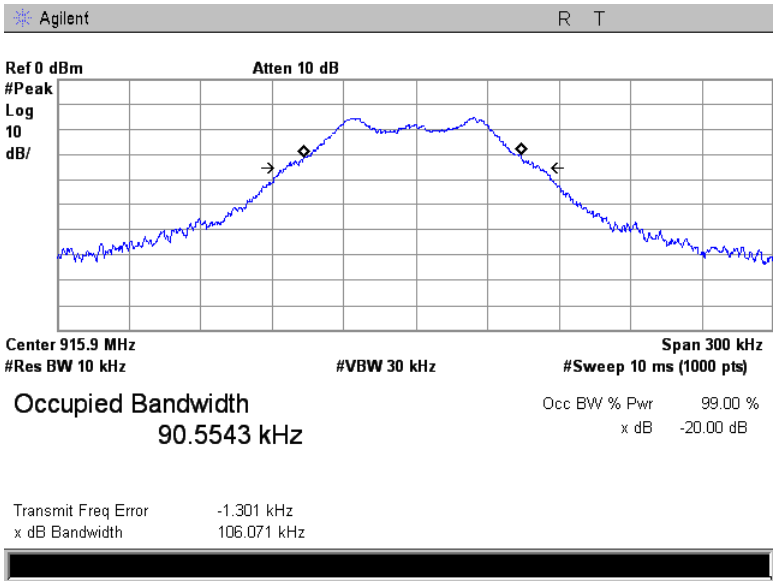
Full description is given in Appendix A.

Plot 7.1.1 The 20 dB bandwidth test result at low frequency

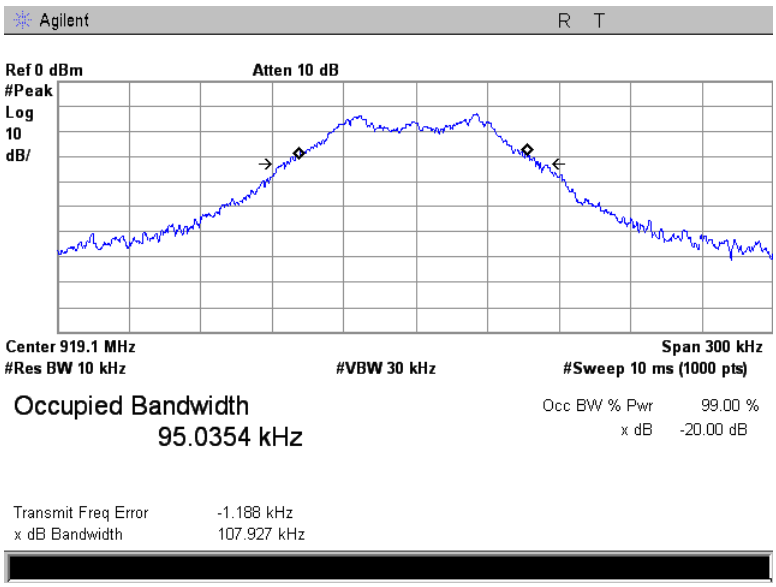


Test specification:	Section 15.247(a)1, RSS-247 section 5.1(c), 20 dB bandwidth		
Test procedure:	ANSI C63.10, section 7.8.7		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-Aug-18		
Temperature: 24 ºC	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.1.2 The 20 dB bandwidth test result at mid frequency



Plot 7.1.3 The 20 dB bandwidth test result at high frequency



Test specification:	Section 15.247(a)1, RSS-247 section 5.1(b), Frequency separation		
Test procedure:	ANSI C63.10, section 7.8.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 50 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
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	
	Output power 30 dBm	Output power 21 dBm
902.0 – 928.0	25 kHz or 20 dB bandwidth of the hopping channel, whichever is greater	25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater
2400.0 – 2483.5		
5725.0 – 5850.0		

7.2.2 Test procedure

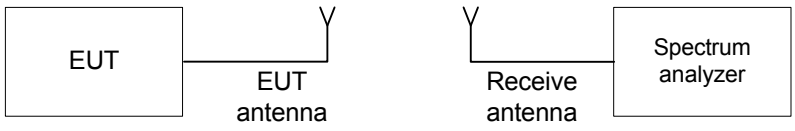
7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized with frequency hopping function enabled and its proper operation was checked.

7.2.2.2 The spectrum analyzer span was set to capture the carrier frequency and both of adjacent channels, the lower and the higher. The resolution bandwidth was set wider than 1 % of the frequency span.

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

7.2.2.4 The frequency separation between the peaks of adjacent channels was measured as provided in Table 7.2.2 and associated plots.

Figure 7.2.1 Carrier frequency separation test setup



Test specification:	Section 15.247(a)1, RSS-247 section 5.1(b), Frequency separation		
Test procedure:	ANSI C63.10, section 7.8.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 50 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Table 7.2.2 Carrier frequency separation test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
MODULATION: GFSK
BIT RATE: 50 kbps
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: ≥ 1% of the span
VIDEO BANDWIDTH: ≥ RBW
FREQUENCY HOPPING: Enabled
20 dB BANDWIDTH: 108.543 kHz

Carrier frequency separation, kHz	Limit, kHz	Margin*	Verdict
129.4	108.543	20.857	Pass

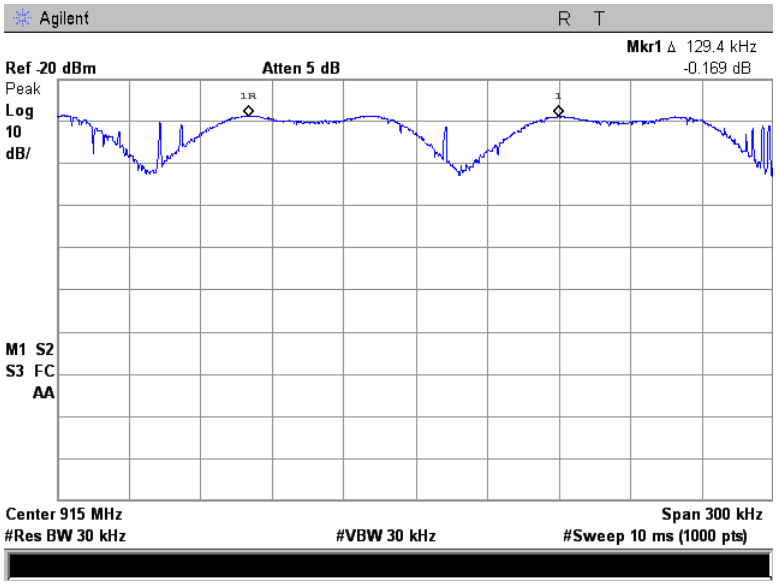
* - Margin = Carrier frequency separation – specification limit.

Reference numbers of test equipment used

HL 2909	HL 4136						

Full description is given in Appendix A.

Plot 7.2.1 Carrier frequency separation



Test specification:	Section 15.247(a)1, RSS-247 section 5.1(c), Number of hopping frequencies		
Test procedure:	ANSI C63.10, section 7.8.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1010 hPa	Power: 3.6 VDC
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

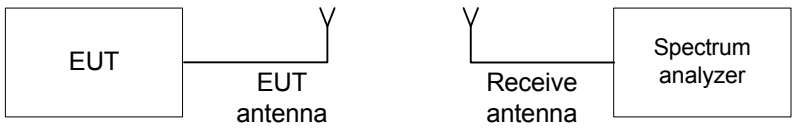
7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized with frequency hopping function enabled and its proper operation was checked.

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 associated plots.

Figure 7.3.1 Hopping frequencies test setup



Test specification:	**Section 15.247(a)1, RSS-247 section 5.1(c), Number of hopping frequencies**		
Test procedure:	ANSI C63.10, section 7.8.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	**Relative Humidity:** 55 %	**Air Pressure:** 1010 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.3.2 Hopping frequencies test results

ASSIGNED FREQUENCY BAND: 902.0 – 928.0 MHz
MODULATION: GFSK
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: ≥ 1% of the span
VIDEO BANDWIDTH: ≥ RBW
FREQUENCY HOPPING: Enabled

Number of hopping frequencies	Minimum number of hopping frequencies	Margin*	Verdict
50	50	0	Pass

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

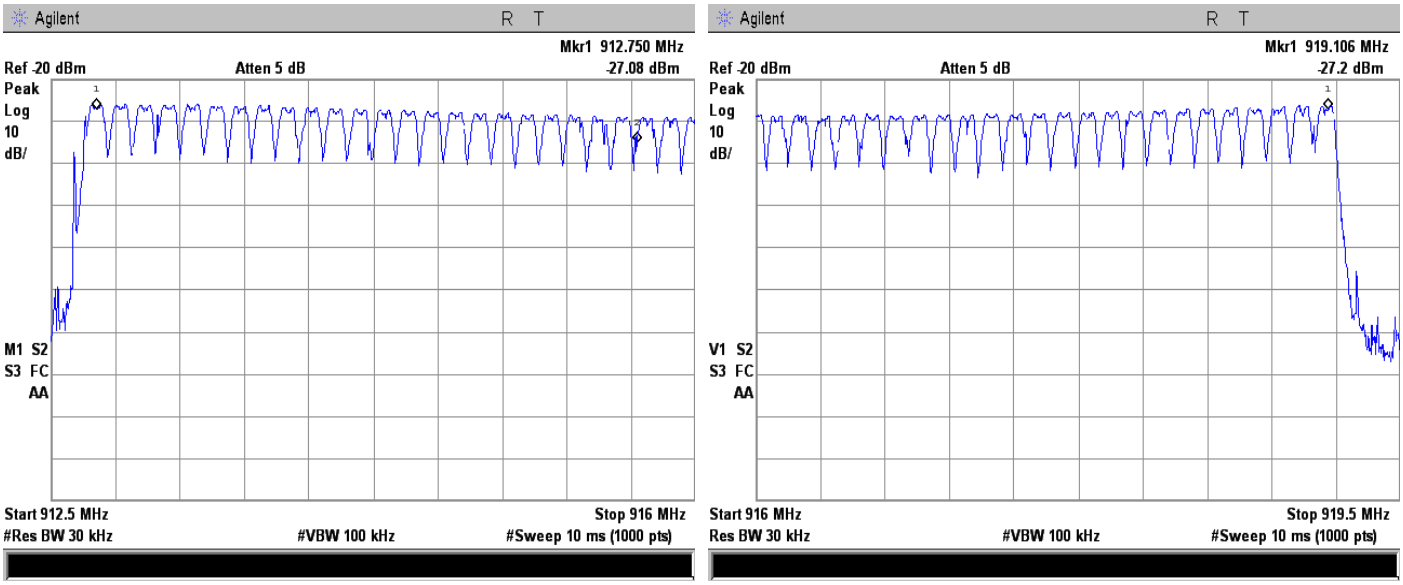
Reference numbers of test equipment used

HL 2909	HL 4135						

Full description is given in Appendix A.

Test specification:	Section 15.247(a)1, RSS-247 section 5.1(c), Number of hopping frequencies		
Test procedure:	ANSI C63.10, section 7.8.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1010 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.3.1 Number of hopping frequencies



Test specification:	Section 15.247(a)1, RSS-247 section 5.1(c), Average time of occupancy		
Test procedure:	ANSI C63.10, section 7.8.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
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 Figure 7.4.1, energized with frequency hopping function enabled and its proper operation was checked.

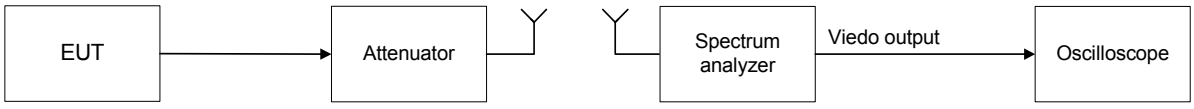
7.4.2.2 The spectrum analyzer span was set to zero centered on a hopping channel.

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 associated plots.

Figure 7.4.1 Average time of occupancy test setup



Test specification:	**Section 15.247(a)1, RSS-247 section 5.1(c), Average time of occupancy**		
Test procedure:	ANSI C63.10, section 7.8.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	**Relative Humidity:** 55 %	**Air Pressure:** 1008 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.4.2 Average time of occupancy test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
MODULATION: GFSK
DETECTOR USED: Peak
NUMBER OF HOPPING FREQUENCIES: 50
INVESTIGATED PERIOD: 20s
FREQUENCY HOPPING: Enabled

Carrier frequency, MHz	Single transmission duration, ms	Number transmissions during 20 s	Average time of occupancy*, s	Bit rate, kbps	Symbol rate, Msymbol/s	Limit, s	Margin, s**	Verdict
915.863	4.7	1	0.0047	50	NA	0.4	-0.3953	Pass

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

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

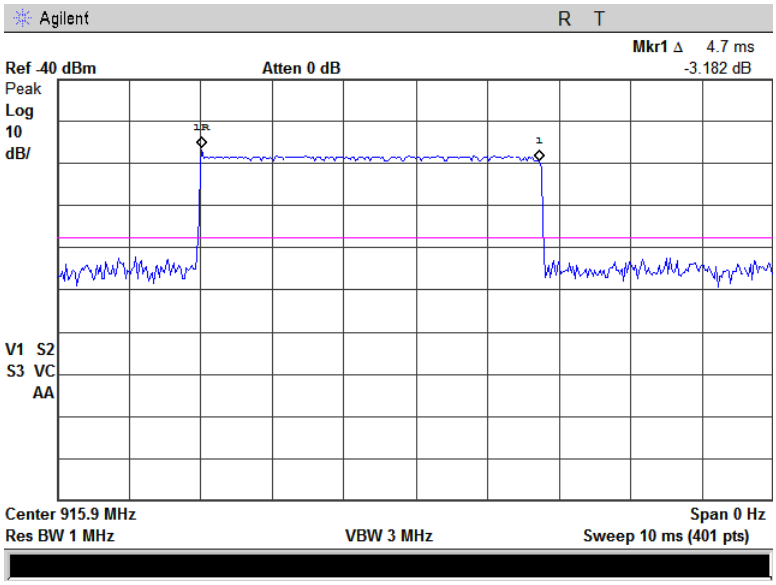
Reference numbers of test equipment used

HL 3818	HL 4778						

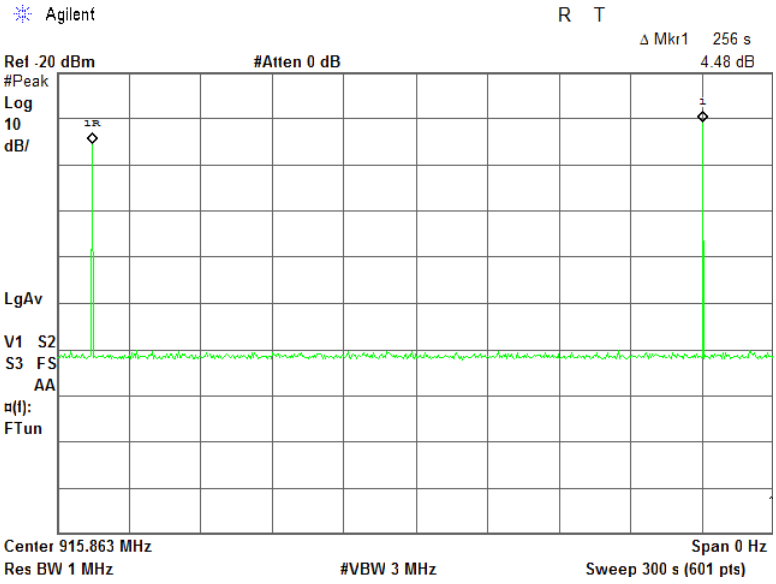
Full description is given in Appendix A.

Test specification:	Section 15.247(a)1, RSS-247 section 5.1(c), Average time of occupancy		
Test procedure:	ANSI C63.10, section 7.8.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.4.1 Single transmission duration



Plot 7.4.2 Number transmissions



Test specification:	Section 15.247(b), RSS-247 section 5.4(a), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
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	0.25 (<50 hopping channels) 1.0 (≥50 hopping channels)	24.0(<50 hopping channels) 30.0 (≥50 hopping channels)	125.2 (<50 hopping channels) 131.2 (≥50 hopping channels)	6.0*
2400.0 – 2483.5	0.125 (<75 hopping channels) 1.0 (≥75 hopping channels)	21.0(<75 hopping channels) 30.0 (≥75 hopping channels)	122.2 (<75 hopping channels) 131.2 (≥75 hopping channels)	
5725.0 – 5850.0	1.0	30.0	131.2	

*- Equivalent field strength limit was calculated from the peak output power as follows: E=sqrt(30×P×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 360^0 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:

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

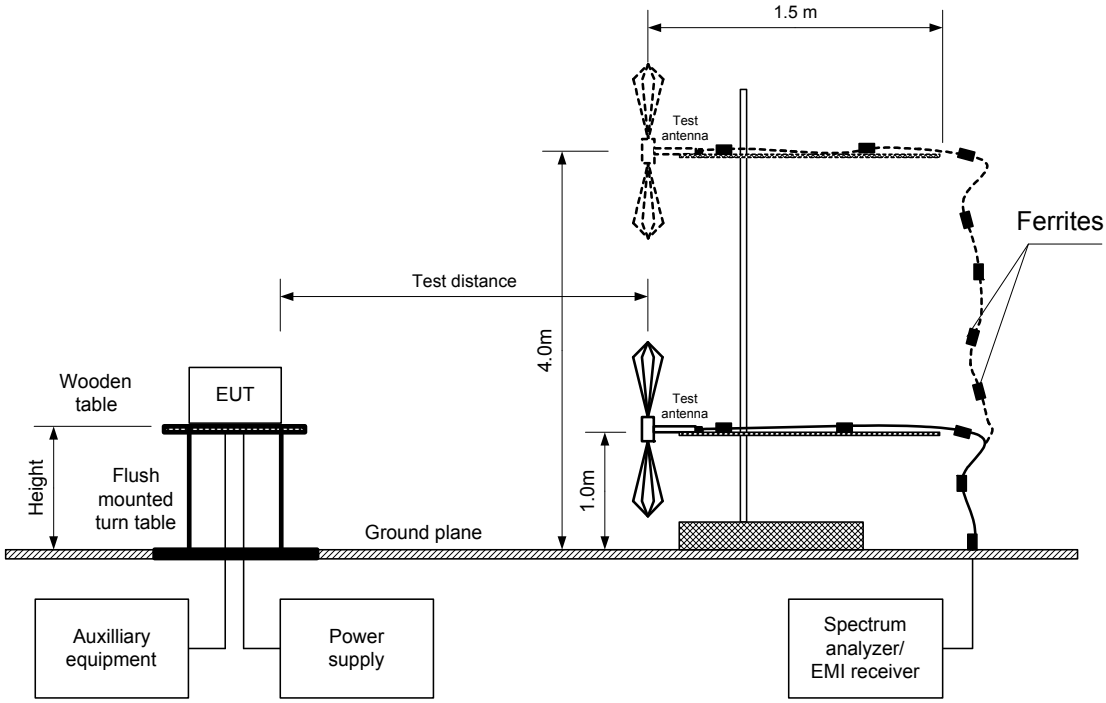
where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.
The above equation was converted in logarithmic units for 3 m test distance:

Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi – 95.2 dB

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

Test specification:	Section 15.247(b), RSS-247 section 5.4(a), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

Figure 7.5.1 Setup for carrier field strength measurements



Test specification:	**Section 15.247(b), RSS-247 section 5.4(a), Peak output power**		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	**Relative Humidity:** 55 %	**Air Pressure:** 1008 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.5.2 Peak output power test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
TEST DISTANCE: 3 m
EUT HEIGHT: 0.8 m
TEST SITE: Semi anechoic chamber
DETECTOR USED: Peak
TEST ANTENNA TYPE: Biconilog (30 MHz – 1000 MHz)
Double ridged guide (above 1000 MHz)
MODULATION: GFSK
BIT RATE: 50 kbps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
DETECTOR USED: Peak
EUT 20 dB BANDWIDTH: 108.543 kHz
RESOLUTION BANDWIDTH: 1 MHz
VIDEO BANDWIDTH: 10 MHz
FREQUENCY HOPPING: Disabled
NUMBER OF FREQUENCY HOPPING CHANNELS: 50

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
912.750	101.94	Vertical	1.3	-77	-2	8.74	30	-21.26	Pass
915.863	100.09	Vertical	1.3	-60	-2	6.89	30	-23.11	Pass
919.106	106.07	Vertical	1.3	-77	-2	12.87	30	-17.13	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.
Note: Maximum peak output power was obtained at U_{nom} input power voltage.

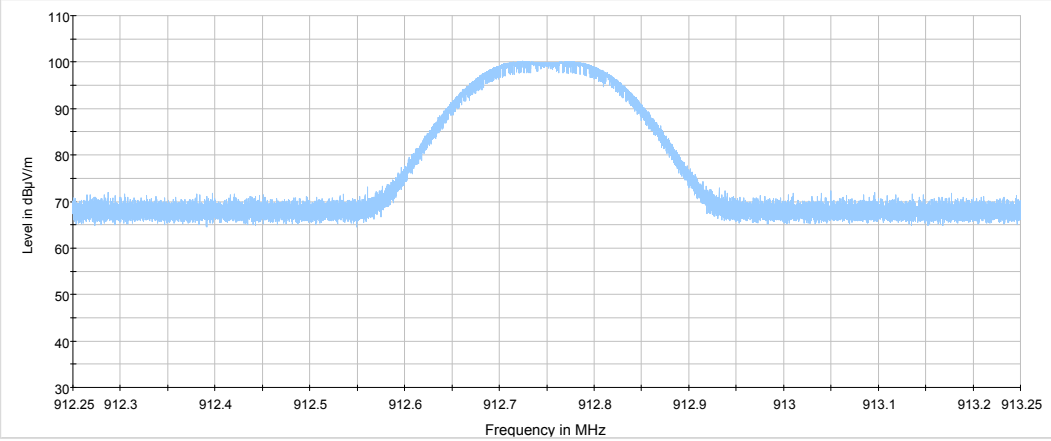
Reference numbers of test equipment used

HL 3615	HL 3903	HL 5404	HL 5288				

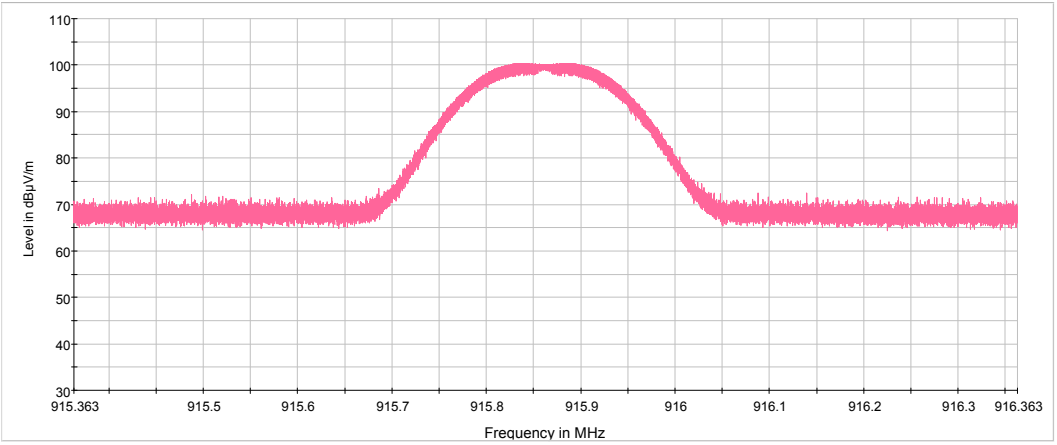
Full description is given in Appendix A.

Test specification:	Section 15.247(b), RSS-247 section 5.4(a), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.5.1 Field strength of carrier at low frequency

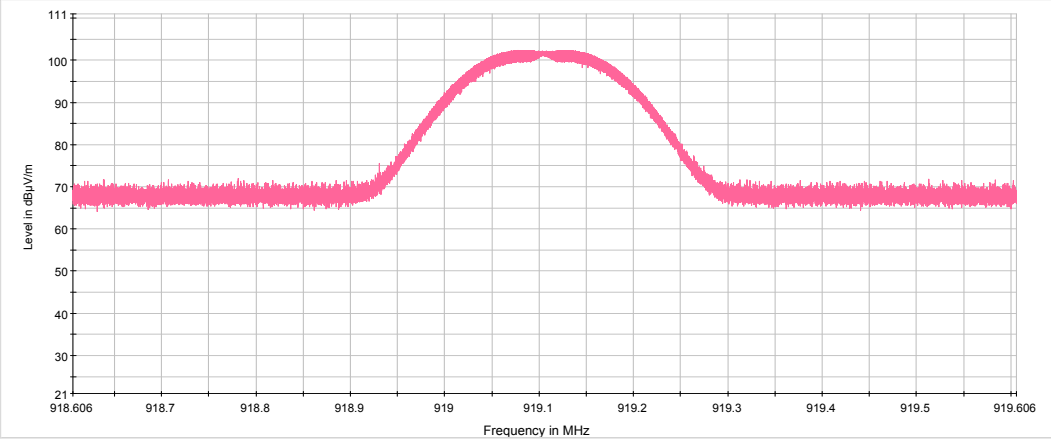


Plot 7.5.2 Field strength of carrier at mid frequency



Test specification:	Section 15.247(b), RSS-247 section 5.4(a), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.5.3 Field strength of carrier at high frequency



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):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
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(μV/m)***			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	20.0
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	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 – 10th harmonic	74.0	NA	54.0	

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

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

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

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

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

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

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

7.6.1.2 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.

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

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

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

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

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

Test specification:	Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

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

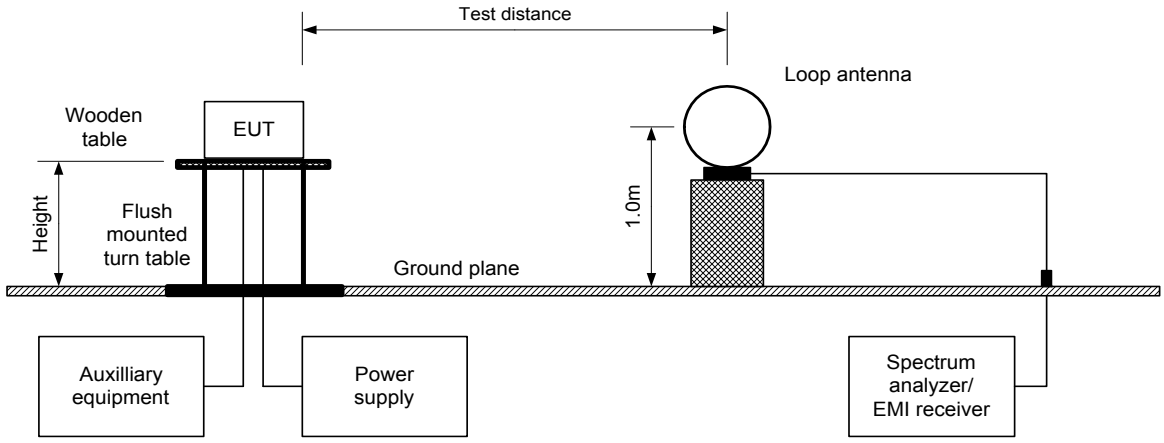
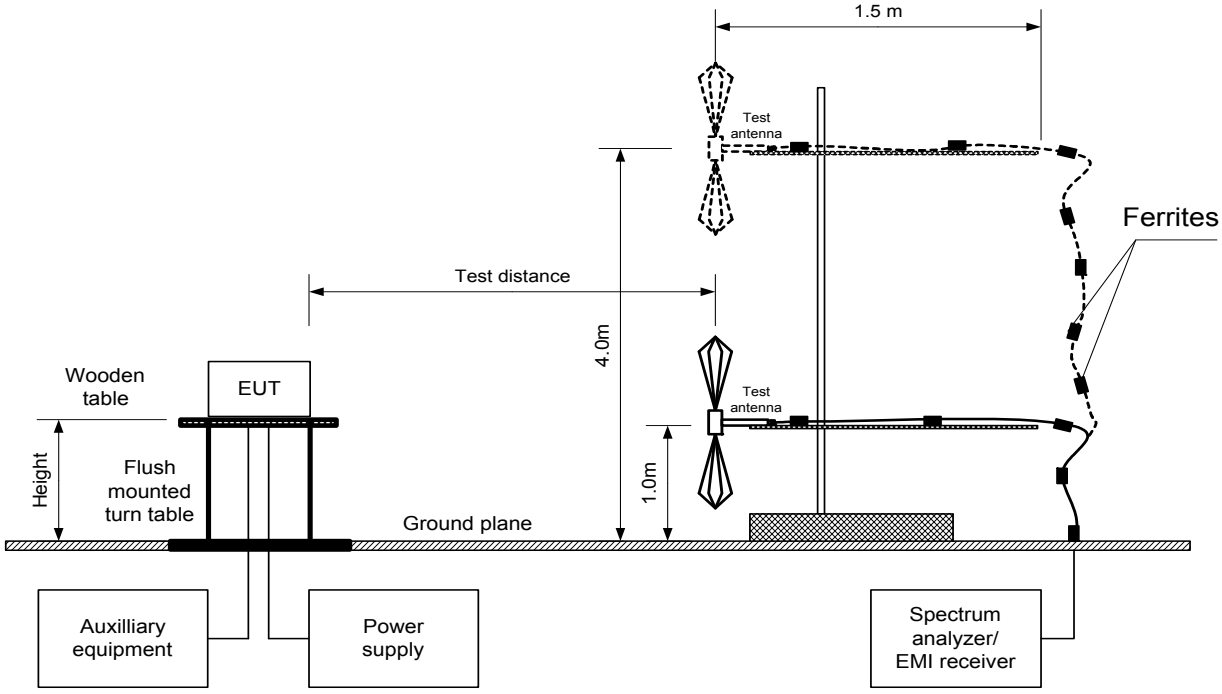
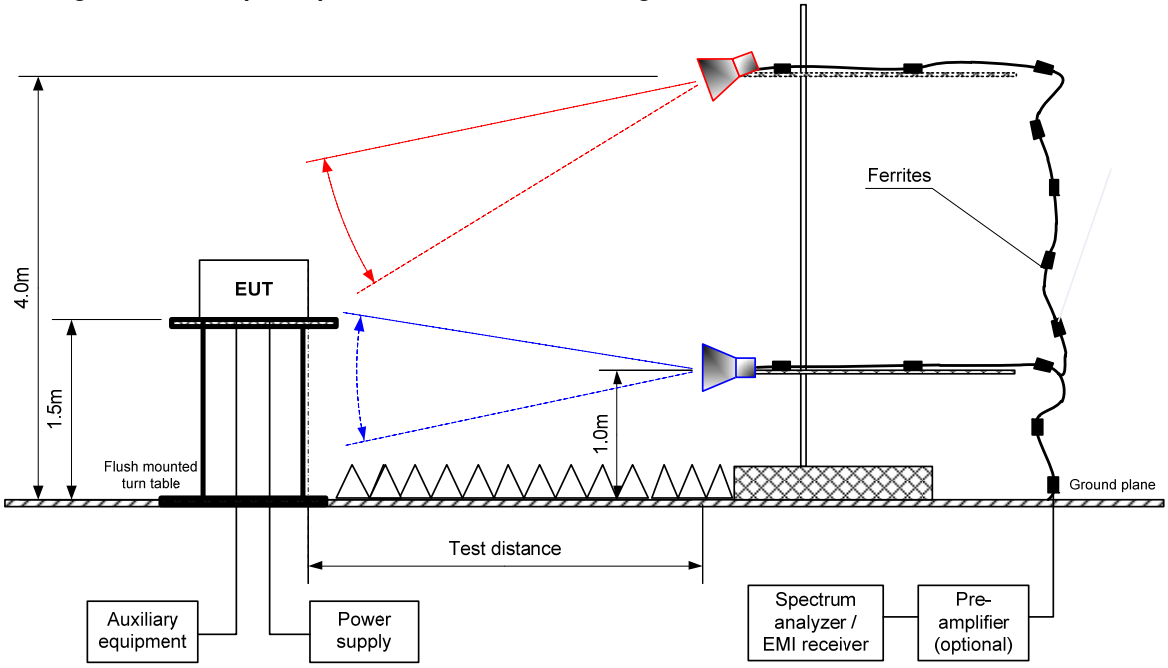


Figure 7.6.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz



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):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

Figure 7.6.3 Setup for spurious emission field strength measurements above1000 MHz



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):	31-Aug-18		
Temperature: 25 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1008 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.6.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY BAND: 902-928 MHz
INVESTIGATED FREQUENCY RANGE: 0.009 – 9500 MHz
TEST DISTANCE: 3 m
MODULATION: GFSK
MODULATING SIGNAL: PRBS
BIT RATE: 50 kbps
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									
1825.72	49.35	H	1.5	-91	101.94	52.59	20.0	32.59	Pass
6389.05	48.73	H	1.6	23		53.21		33.21	
Mid carrier frequency									
1831.57	44.88	H	1.5	-15	100.09	55.21	20.0	35.21	Pass
6355.81	49.20	H	1.5	11		50.89		30.89	
High carrier frequency									
1838.37	47.48	V	1.5	11	106.07	58.59	20.0	38.59	Pass
6433.92	46.49	V	1.9	14		59.58		39.58	

*****- EUT front panel refers to 0 degrees position of turntable.
******- Margin = Attenuation below carrier – specification limit.

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):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
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 – 9500 MHz
TEST DISTANCE:	3 m
MODULATION:	GFSK
BIT RATE:	50 kbps
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	1000 kHz
TEST ANTENNA TYPE:	Double ridged guide
FREQUENCY HOPPING:	Disabled

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength			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***	
Low carrier frequency											
2738.29	V	1.5	8	59.67	74	-14.33	59.67	33.07	54	-20.93	
3651.10	H	1.5	93	46.13	74	-27.87	46.13	19.53	54	-34.47	
4563.67	V	1.5	8	54.78	74	-19.22	54.78	28.18	54	-25.82	Pass
7302.13	V	1.5	-58	45.39	74	-28.61	45.39	18.79	54	-35.21	
8214.93	H	1.5	175	45.29	74	-28.71	45.29	18.69	54	-35.31	
Mid carrier frequency											
2747.63	V	2.1	10	59.98	74	-14.02	59.98	33.38	54	-20.62	
3663.25	H	1.5	110	46.64	74	-27.36	46.64	20.04	54	-33.96	
4579.37	H	1.3	23	54.13	74	-19.87	54.13	27.53	54	-26.47	Pass
6411.04	H	1.4	30	47.94	74	-26.06	47.94	21.34	54	-32.66	
7326.89	H	1.3	9	49.23	74	-24.77	49.23	22.63	54	-31.37	
High carrier frequency											
2757.30	V	1.8	5	61.02	74	-12.98	61.02	34.42	54	-19.58	
3676.23	H	1.9	14	46.88	74	-27.12	46.88	20.28	54	-33.72	
4595.34	V	1.5	7	52.40	74	-21.60	52.40	25.8	54	-28.20	Pass
7352.85	H	1.4	23	44.52	74	-29.48	44.52	17.92	54	-36.08	
8272.00	H	4.0	5	49.26	74	-24.74	49.26	22.66	54	-31.34	

*****- 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	Number of pulses within 100 ms	Duration, ms	Period, ms		
4.7	1	NA	NA	NA	-26.6

Average factor or pulse train shorter than 100 ms was calculated as follows:

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

Average factor or pulse train longer than 100 ms was calculated as follows:

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

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):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
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
MODULATING SIGNAL:	PRBS
BIT RATE:	50 kbps
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
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*				
No spurious emissions have been found								Pass

*****- Margin = Measured emission - specification limit.
******- EUT front panel refer to 0 degrees position of turntable.

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):	31-Aug-18		
Temperature: 25 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1008 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.6.6 Restricted bands according to FCC section 15.205

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

Table 7.6.7 Restricted bands according to RSS-Gen

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

Reference numbers of test equipment used

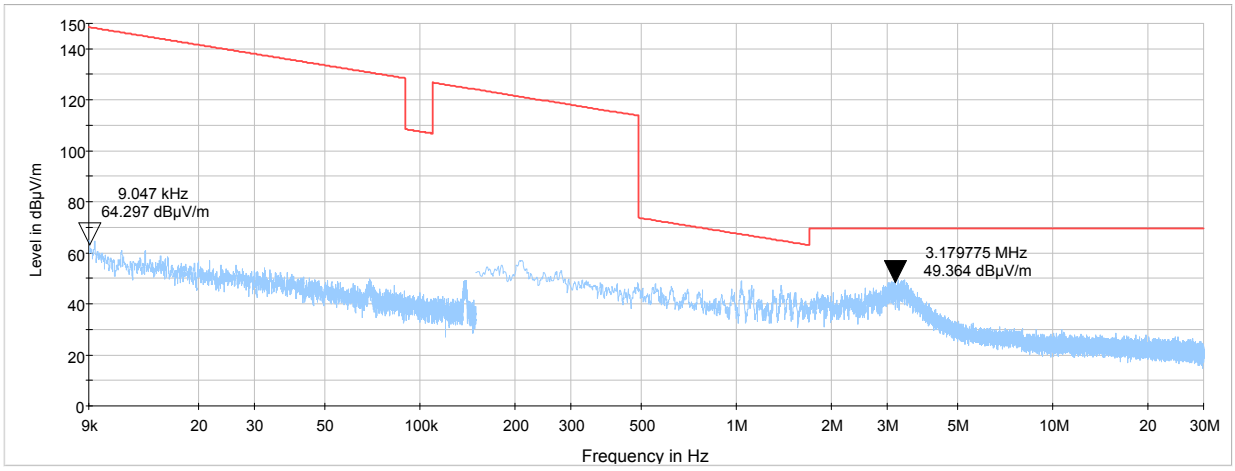
HL 0446	HL 1915	HL 3903	HL 4277	HL 4339	HL 4360	HL 4933	HL 5404
HL 5288							

Full description is given in Appendix A.

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):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.6.1 Radiated emission measurements from 9 kHz to 30 MHz at the low; mid; high carrier frequency

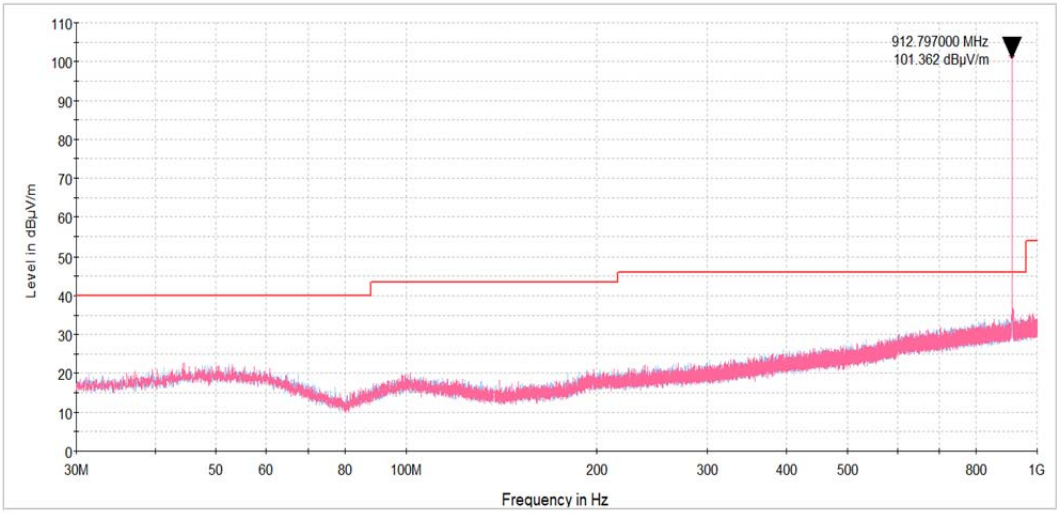
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Test specification:	Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

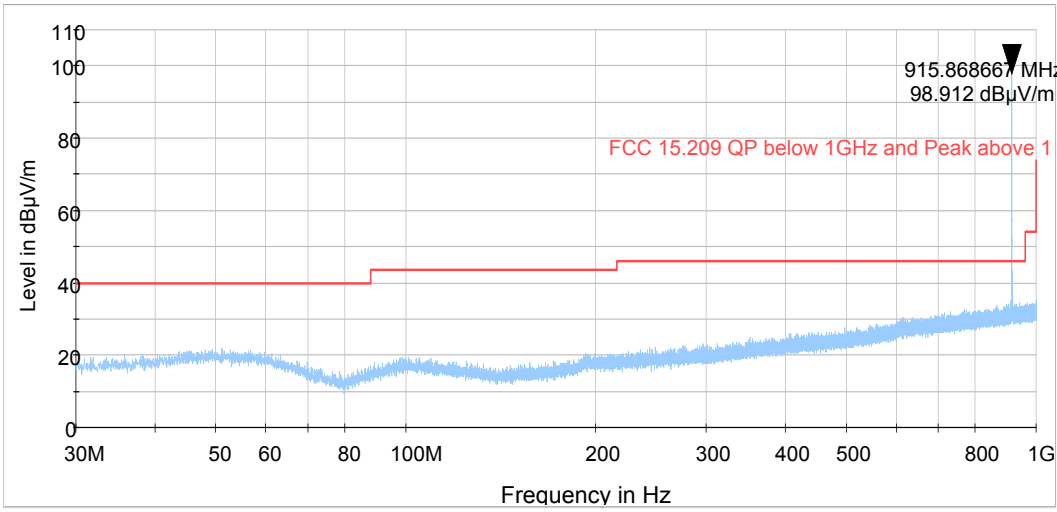
Plot 7.6.2 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

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



Plot 7.6.3 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

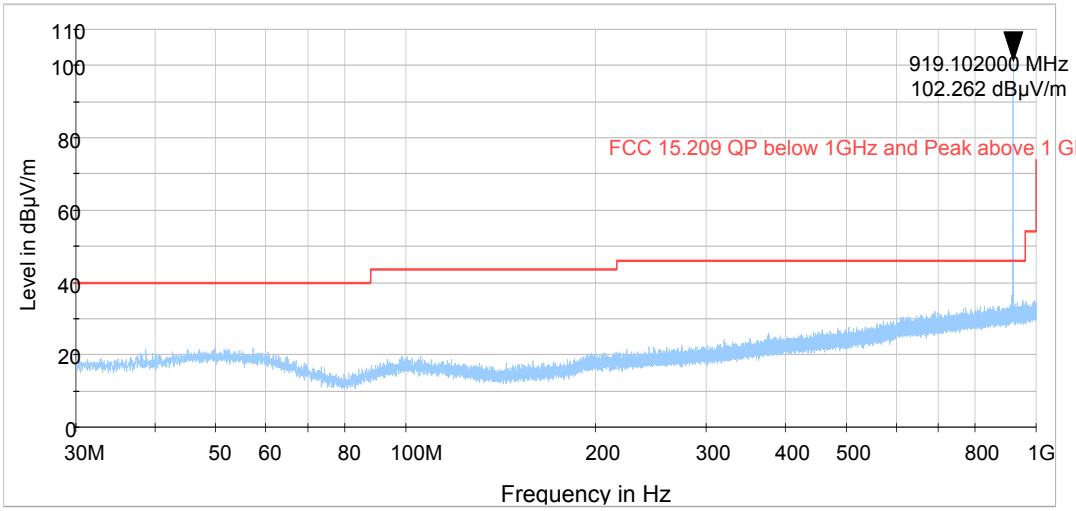
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



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):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

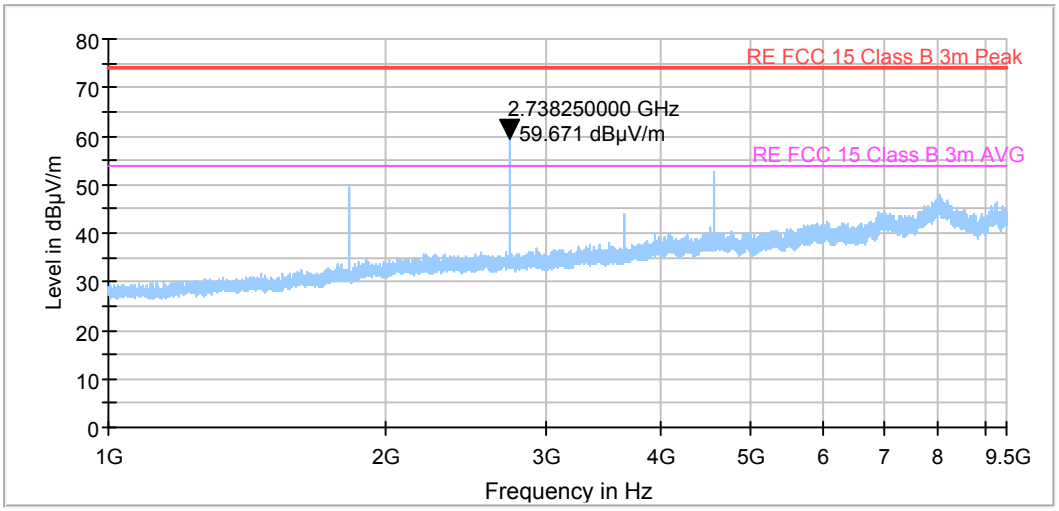
Plot 7.6.4 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

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



Plot 7.6.5 Radiated emission measurements from 1000 to 9500 MHz at the low carrier frequency

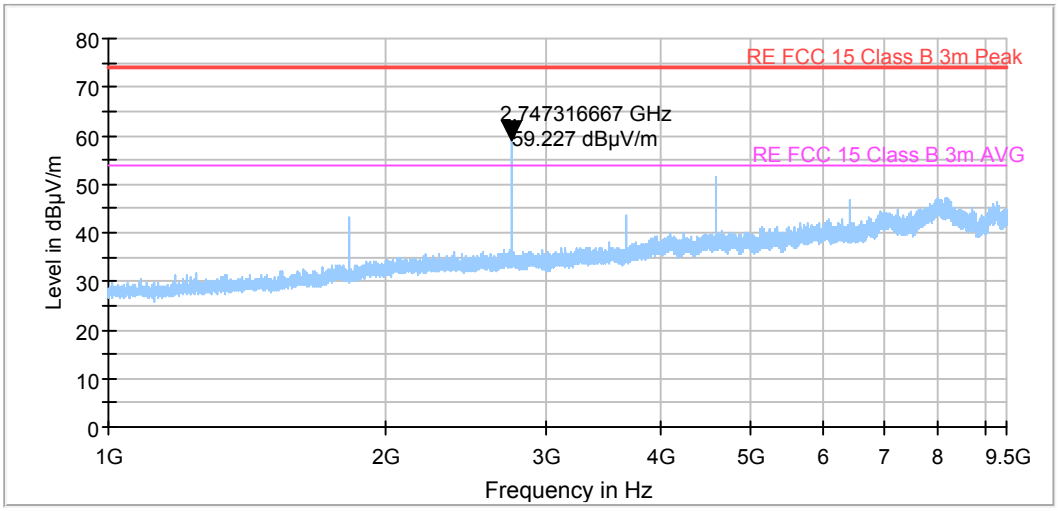
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

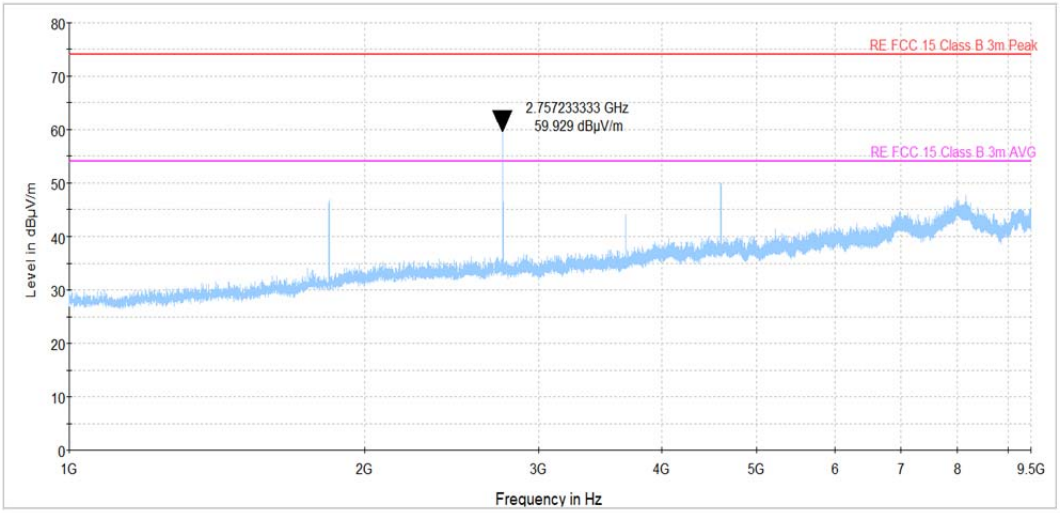
Plot 7.6.6 Radiated emission measurements from 1000 to 9500 MHz at the mid carrier frequency

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



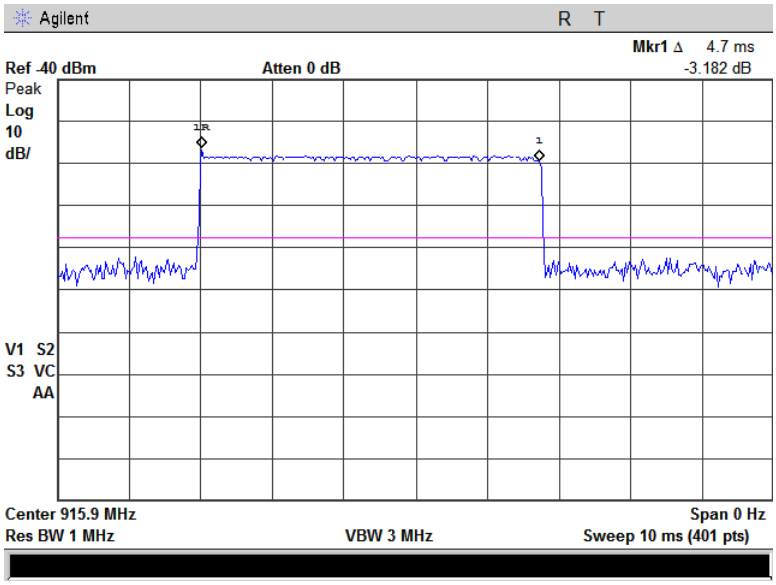
Plot 7.6.7 Radiated emission measurements from 1000 to 9500 MHz at the high carrier frequency

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

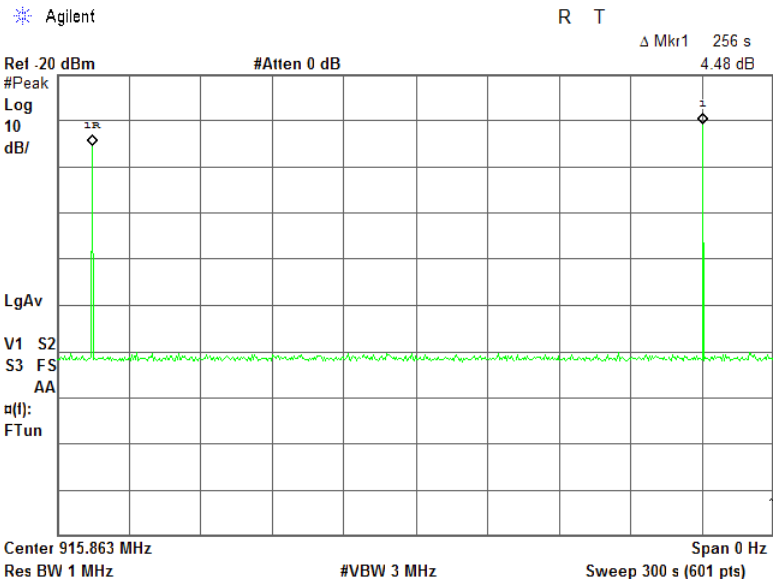


Test specification:	Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.6.8 Transmission pulse duration



Plot 7.6.9 Transmission pulse period



Test specification:	Section 15.247(d), RSS-247 section 5.5, Emissions at band edges		
Test procedure:	ANSI C63.10 section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

7.7 Band edge radiated emissions

7.7.1 General

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

Table 7.7.1 Band edge emission limits

Assigned frequency, MHz	Attenuation below carrier*, dBc	Field strength at 3 m within restricted bands, dB(μV/m)	
		Peak	Average
902.0 – 928.0	20.0	74.0	54.0
2400.0 – 2483.5			
5725.0 – 5850.0			

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

7.7.2 Test procedure

7.7.2.1 The EUT was set up as shown in Figure 7.7.1, energized normally modulated at the maximum data rate with its hopping function disabled and its proper operation was checked.

7.7.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.

7.7.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.

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

7.7.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.7.2 and associated plots and referenced to the highest emission level measured within the authorized band.

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

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

Figure 7.7.1 Band edge emission test setup

Test specification:	Section 15.247(d), RSS-247 section 5.5, Emissions at band edges		
Test procedure:	ANSI C63.10 section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Table 7.7.2 Band edge emission test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
DETECTOR USED: Peak
MODULATION: GFSK
BIT RATE: 50 kbps
RESOLUTION BANDWIDTH: ≥ 1% of the span
VIDEO BANDWIDTH: ≥ RBW

Frequency, MHz	Band edge emission, dBm	Emission at carrier, dBm	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
Frequency hopping disabled						
902	-82.21	-26.71	55.50	20.0	35.50	Pass
928	-85.37	-28.68	56.69		36.69	
Frequency hopping enabled						
902	-83.08	-26.51	56.57	20.0	36.57	Pass
928	-82.10	-28.67	53.43		33.43	

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

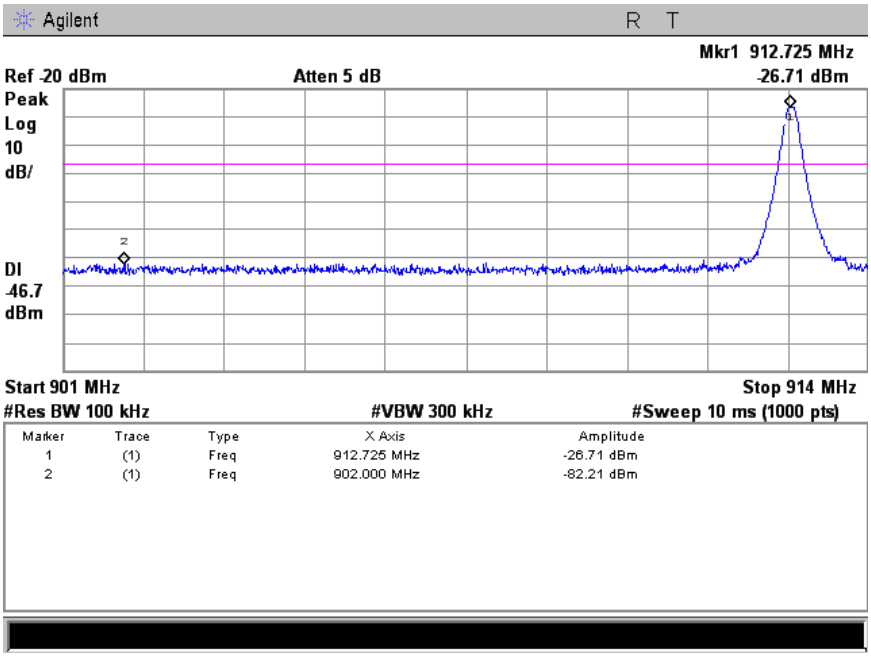
Reference numbers of test equipment used

HL 2909	HL 4135						

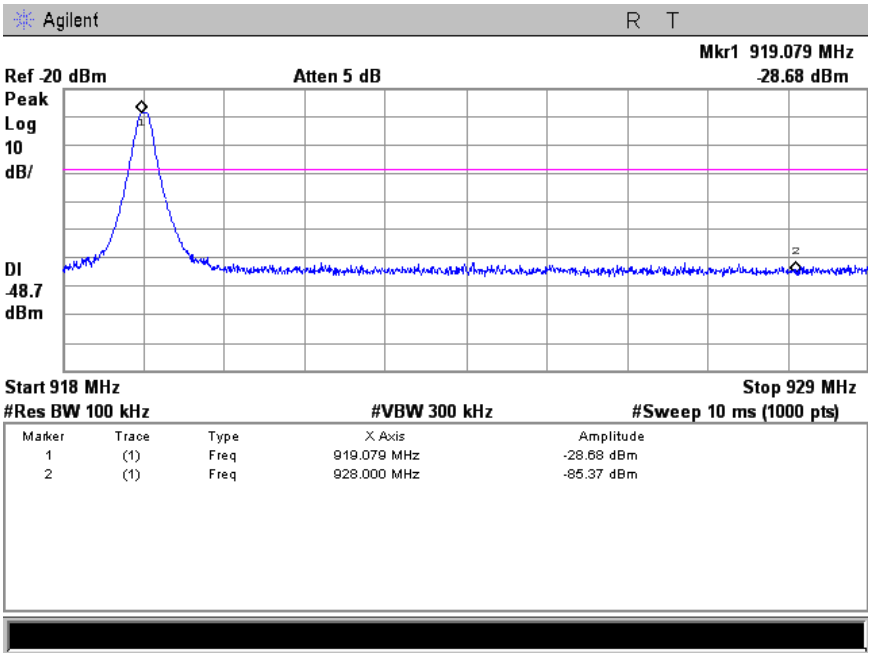
Full description is given in Appendix A.

Test specification:	Section 15.247(d), RSS-247 section 5.5, Emissions at band edges		
Test procedure:	ANSI C63.10 section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.7.1 The highest band edge emission at low carrier frequency with hopping function disabled

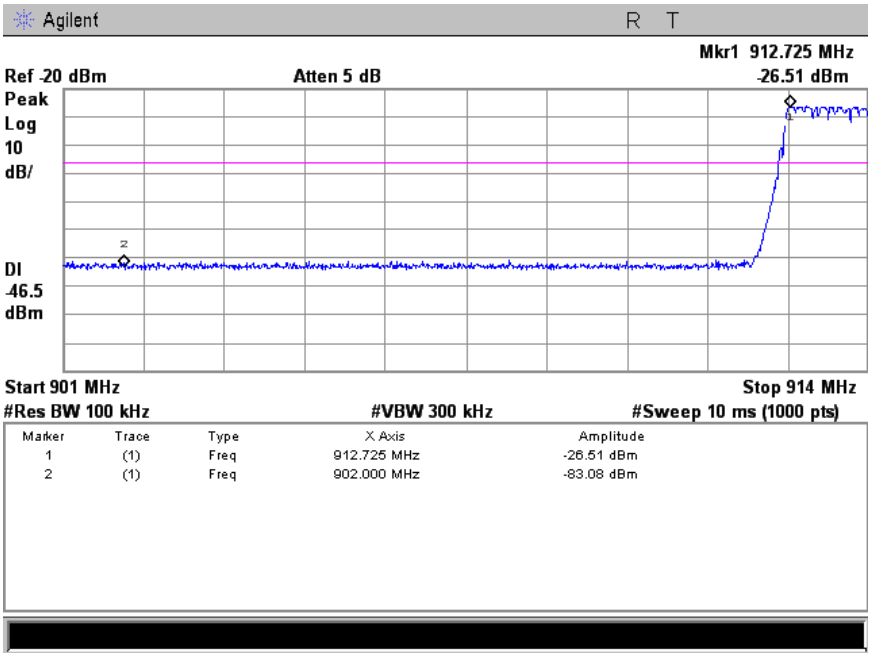


Plot 7.7.2 The highest band edge emission at high carrier frequency with hopping function disabled

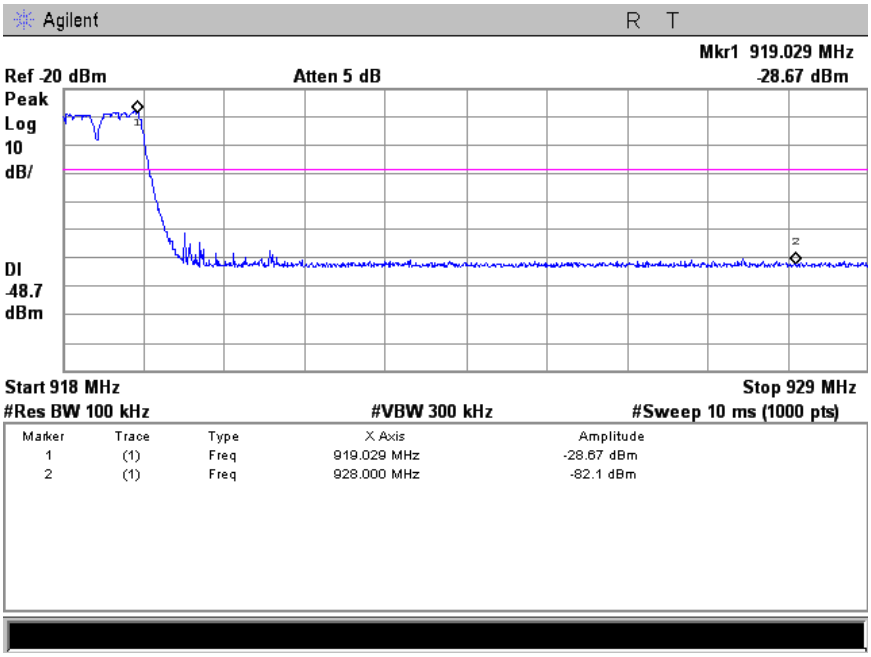


Test specification:	Section 15.247(d), RSS-247 section 5.5, Emissions at band edges		
Test procedure:	ANSI C63.10 section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.7.3 The highest band edge emission at low carrier frequency with hopping function enabled



Plot 7.7.4 The highest band edge emission at high carrier frequency with hopping function enabled



Test specification:	Section 15.203, RSS-Gen section 6.8, Antenna requirements		
Test procedure:	Visual inspection		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 23 ºC	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: 3.6 VDC
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	

Test specification:	FCC Part 15, Section 109 / RSS-Gen section 7.3/ICES-003,Section 6.2, Class B, Radiated emissions		
Test procedure:	ANSI C63.4, Section 8.3, 12.2.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

8 Unintentional emissions according to 47CFR part 15 subpart B and ICES-003 requirements

8.1 Radiated emission measurements

8.1.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits are given in Table 8.1.1.

Table 8.1.1 Radiated emission test limits

Frequency, MHz	Class B limit, dB(μV/m)		Class A limit, dB(μV/m)	
	10 m distance	3 m distance	10 m distance	3 m distance
30 - 88	29.5*	40.0	39.0	49.5*
88 - 216	33.0*	43.5	43.5	54.0*
216 - 960	35.5*	46.0	46.4	56.9*
Above 960	43.5*	54.0	49.5	60.0*

* The limit for test distance other than specified was calculated using the inverse linear distance extrapolation factor as follows: $Lim_{S2} = Lim_{S1} + 20 \log (S_1/S_2)$,
where S_1 and S_2 – standard defined and test distance respectively in meters.

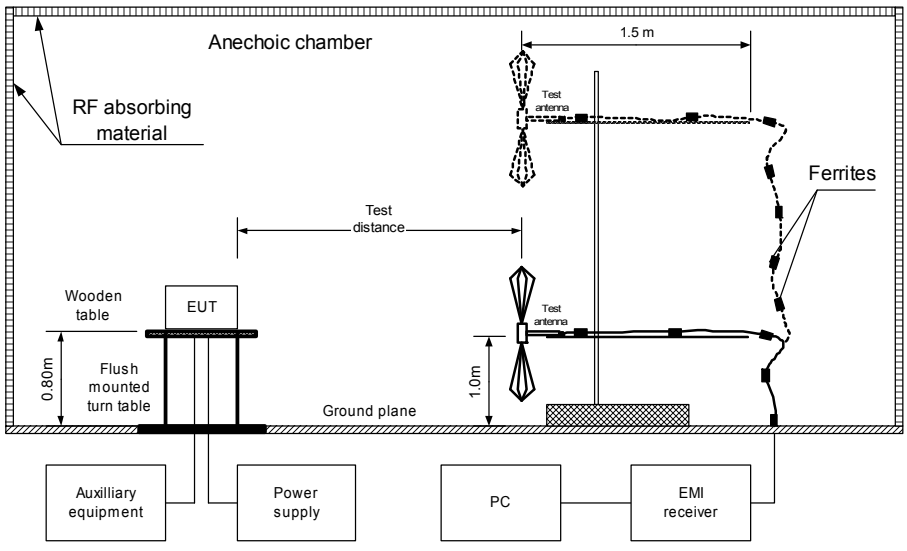
8.1.2 Test procedure

8.1.2.1 The EUT was set up as shown in Figure 8.1.1 and associated photographs, energized and the performance check was conducted.

8.1.2.2 The specified frequency range was investigated with biconilog antenna connected to 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 and the EUT cables position was varied.

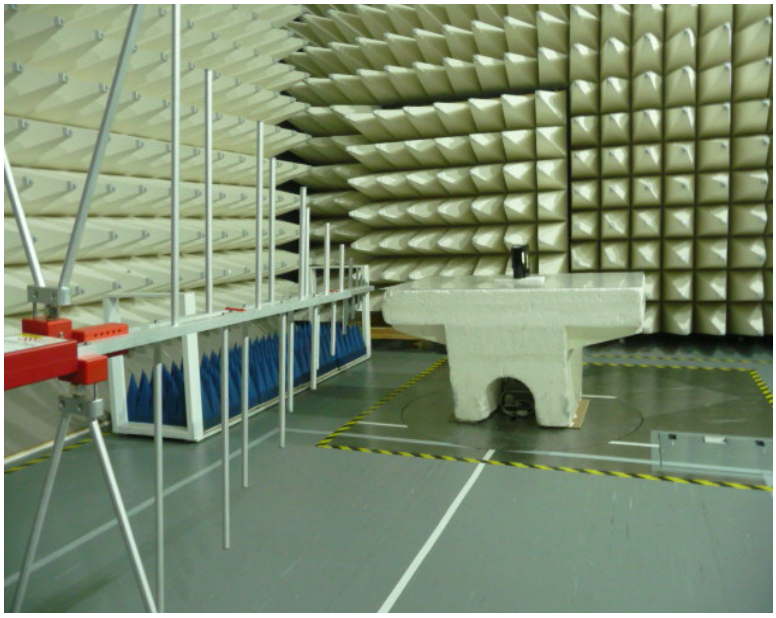
8.1.2.3 The worst test results (the lowest margins) were recorded in Table 8.1.2 and shown in the associated plots.

Figure 8.1.1 Setup for radiated emission measurements in anechoic chamber

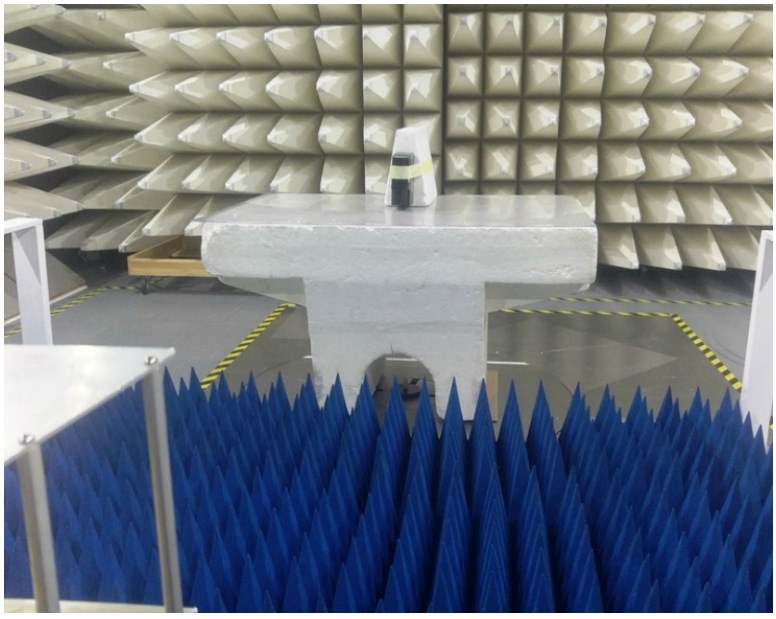


Test specification:	FCC Part 15, Section 109 / RSS-Gen section 7.3/ICES-003,Section 6.2, Class B, Radiated emissions		
Test procedure:	ANSI C63.4, Section 8.3, 12.2.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1009 hPa	**Power:** 3.6 VDC
Remarks:			

Photograph 8.1.1 Setup for radiated emission measurements in 30-1000 MHz



Photograph 8.1.2 Setup for radiated emission measurements above 1 GHz



Test specification:	**FCC Part 15, Section 109 / RSS-Gen section 7.3/ICES-003,Section 6.2, Class B, Radiated emissions**		
Test procedure:	ANSI C63.4, Section 8.3, 12.2.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1009 hPa	**Power:** 3.6 VDC
Remarks:			

Table 8.1.2 Radiated emission test results

EUT SET UP: TABLE-TOP
LIMIT: Class B
EUT OPERATING MODE: Receive
TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / QUASI-PEAK
FREQUENCY RANGE: 30 MHz – 1000 MHz
RESOLUTION BANDWIDTH: 120 kHz

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*				
All emission were found at least 20 dB below limit								Pass

TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 5000 MHz
RESOLUTION BANDWIDTH: 1000 kHz

Frequency, MHz	Peak			Average			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
All emission were found at least 20 dB below limit										Pass

*****- Margin = Measured emission - specification limit.
******- EUT front panel refer to 0 degrees position of turntable.

Reference numbers of test equipment used

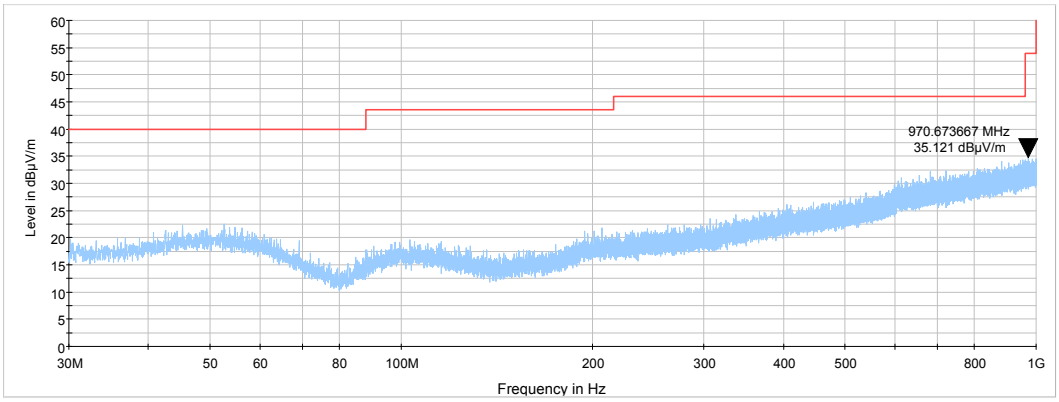
HL 3903	HL 4360	HL 4933	HL 5288	HL 5405			

Full description is given in Appendix A.

Test specification:	FCC Part 15, Section 109 / RSS-Gen section 7.3/ICES-003,Section 6.2, Class B, Radiated emissions		
Test procedure:	ANSI C63.4, Section 8.3, 12.2.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	31-Aug-18		
Temperature: 25 ºC	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

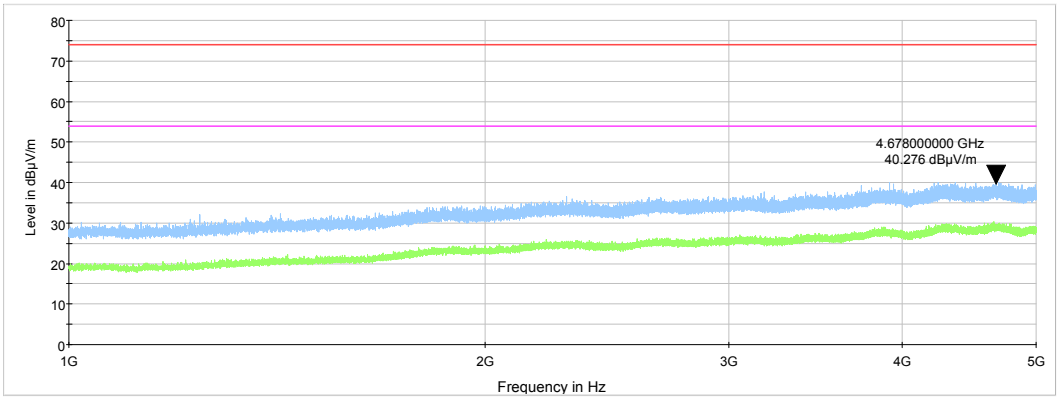
Plot 8.1.1 Radiated emission measurements in 30 - 1000 MHz range, vertical & horizontal antenna polarization

TEST SITE: Semi anechoic chamber
LIMIT: Class B
TEST DISTANCE: 3 m
EUT OPERATING MODE: Receive



Plot 8.1.2 Radiated emission measurements above 1000 MHz, vertical & horizontal antenna polarization

TEST SITE: Semi anechoic chamber
LIMIT: Class B
TEST DISTANCE: 3 m
EUT OPERATING MODE: Receive



9 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check*	Due Cal./ Check*
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	28-Feb-21	28-Feb-22
1915	Antenna, Loop, Active Receiving, 1 kHz - 30 MHz	EMC Test Systems	6507	1457	28-Feb-21	28-Feb-22
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	05-Apr-20	05-May-21
3615	Cable RF, 6.5 m, N type-N type, DC-6 GHz	Suhner Switzerland	RG 214/U	NA	10-Jun-20	10-Jun-21
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	27-Apr-20	27-Apr-21
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	06-Apr-21	06-Apr-22
4135	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000136	23-Apr-20	23-Apr-21
4136	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000137	23-Apr-20	23-Apr-21
4277	Test Cable , DC-18 GHz, 3.05 m, N/M - N/M	Mini-Circuits	APC-10FT-NMNM+	0748A	09-Aug-20	09-Aug-21
4339	High pass Filter, 50 Ohm, 1000 to 18000 MHz, SMA-FM / SMA-M	Micro-Tronics	HPM50115-02	001	05-Jun-19	05-Jun-21
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	19-Jan-21	19-Jan-22
4778	EMI Receiver, 9 kHz - 2.9 GHz, System: HL1431, HL4777	Hewlett Packard	8542E	30807A00262, 3427A00123	09-Nov-20	09-Nov-21
4933	Active Horn Antenna, 1 GHz to 18 GHz	Com-Power Corporation	AHA-118	701046	26-Jan-21	26-Jan-22
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5404	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500024/18	19-Nov-20	19-Nov-21
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500023/118	19-Nov-20	19-Nov-21

*The calibration was valid at the testing time

10 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

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

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.
Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.
In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards.
The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

11 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.
Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for relevant parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; Recognized by Innovation, Science and Economic Development Canada for wireless and terminal testing (ISED), ISED #2186A, CAB identifier is IL1001; Certified by VCCI, Japan (the registration numbers for OATS are R-10808 for RE measurements below 1 GHz, G-20112 for RE measurements above 1 GHz, R-11082 for anechoic chamber for RE measurements below 1 GHz, G-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 for conducted emissions at telecommunication ports).
The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

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

12 APPENDIX D Specification references

FCC 47CFR part 15: 2020	Radio Frequency Devices
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.2: 2016	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications
ANSI C63.4: 2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
RSS-247 Issue 2: 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence- Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 5 with Am.1: 2019	General Requirents for Compliance of Radio Apparatus
ICES-003 Issue 6: 2019 (updated)	Information Technology Equipment (Including Digital Apparatus)— Limits and Methods of Measurement

13 APPENDIX E Test equipment correction factors

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

Frequency, MHz	Measured antenna factor, dBS/m
0.009	-32.5
0.010	-33.4
0.020	-37.9
0.050	-40.6
0.075	-41.0
0.100	-41.2
0.150	-41.2
0.250	-41.2
0.500	-41.3
0.750	-41.3
1.000	-41.4
2.000	-41.4
3.000	-41.4
4.000	-41.5
5.000	-41.5
10.000	-41.8
15.000	-42.2
20.000	-42.9
25.000	-43.9
30.000	-45.4

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

Antenna factor
Active loop antenna
EMC Test Systems
Model 6507, S/N 1457, HL 1915

Frequency, kHz	Measured antenna factor, dBS/m
10	-22.7
20	-27.6
50	-31.3
75	-31.8
100	-32.2
150	-32.3
250	-32.6
500	-32.8
750	-33.0
1000	-33.1
2000	-33.4
3000	-33.7
4000	-34.0
5000	-34.3
10000	-34.9
15000	-35.6
20000	-35.9
25000	-36.1
30000	-36.7

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμA/m.

Antenna factor
Trilog antenna
Model ALX-8000E, Frankonia, S/N 00809, HL 5288, 30-1000 MHz

Frequency, MHz	Antenna factor, dB/m		
	Vert Up	Vert Down	Delta
30	-51.19	-51.28	0.09
35	-44.03	-44.12	0.09
40	-43.07	-43.12	0.05
45	-39.61	-39.79	0.18
50	-37.84	-38.14	0.3
60	-34.93	-34.9	0.03
70	-29.76	-29.66	0.1
80	-27.69	-27.82	0.13
90	-29.05	-29.07	0.02
100	-31.19	-31.19	0
120	-31.61	-31.6	0.01
140	-28.13	-28.06	0.07
160	-27.71	-27.75	0.04
180	-26.19	-26.15	0.04
200	-28.2	-28.15	0.05
250	-27.45	-27.47	0.02
300	-29.61	-29.63	0.02
400	-31.77	-31.78	0.01
500	-32.81	-32.81	0
600	-33.64	-33.61	0.03
700	-34.21	-34.21	0
800	-35.66	-35.66	0
900	-36.99	-36.91	0.08
1000	-38	-37.91	0.09

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

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

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

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

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

Cable loss
Cable coaxial, RG-214/U, N type-N type, 6.5 m
Suhner Switzerland, HL 3615

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.13	1750	2.47	3550	4.10	5350	5.76
30	0.24	1800	2.53	3600	4.17	5400	5.84
50	0.31	1850	2.59	3650	4.21	5450	5.88
100	0.47	1900	2.61	3700	4.23	5500	5.90
150	0.58	1950	2.66	3750	4.33	5550	5.96
200	0.68	2000	2.74	3800	4.36	5600	6.02
250	0.77	2050	2.76	3850	4.38	5650	6.02
300	0.86	2100	2.80	3900	4.46	5700	6.09
350	0.94	2150	2.84	3950	4.52	5750	6.14
400	1.01	2200	2.89	4000	4.48	5800	6.15
450	1.08	2250	2.94	4050	4.52	5850	6.22
500	1.16	2300	2.98	4100	4.64	5900	6.29
550	1.21	2350	3.03	4150	4.62	5950	6.32
600	1.28	2400	3.07	4200	4.69	6000	6.39
650	1.35	2450	3.11	4250	4.75	6050	6.40
700	1.41	2500	3.15	4300	4.79	6100	6.48
750	1.48	2550	3.21	4350	4.83	6150	6.57
800	1.54	2600	3.25	4400	4.90	6200	6.62
850	1.58	2650	3.29	4450	4.95	6250	6.68
900	1.65	2700	3.33	4500	4.98	6300	6.74
950	1.67	2750	3.39	4550	5.04	6350	6.79
1000	1.74	2800	3.45	4600	5.08	6400	6.82
1050	1.79	2850	3.48	4650	5.12	6450	6.83
1100	1.84	2900	3.51	4700	5.15	6500	6.91
1150	1.91	2950	3.58	4750	5.22		
1200	1.94	3000	3.62	4800	5.26		
1250	1.99	3050	3.65	4850	5.29		
1300	2.06	3100	3.69	4900	5.33		
1350	2.11	3150	3.75	4950	5.36		
1400	2.16	3200	3.77	5000	5.38		
1450	2.21	3250	3.80	5050	5.46		
1500	2.25	3300	3.85	5100	5.49		
1550	2.30	3350	3.90	5150	5.56		
1600	2.35	3400	3.94	5200	5.58		
1650	2.38	3450	4.00	5250	5.64		
1700	2.42	3500	4.03	5300	5.69		

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

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

Cable loss
Test cable, Mini-Circuits, S/N 0748A, 18 GHz, 3.05 m, N/M - N/M
APC-10FT-NMNM+, HL 4277

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.12	4400	3.19	9000	4.82	13600	5.97
30	0.21	4500	3.24	9100	4.87	13700	6.01
50	0.28	4600	3.29	9200	4.90	13800	6.04
100	0.40	4700	3.34	9300	4.96	13900	6.09
200	0.59	4800	3.37	9400	4.99	14000	6.12
300	0.73	4900	3.41	9500	5.03	14100	6.16
400	0.86	5000	3.45	9600	5.07	14200	6.20
500	0.97	5100	3.48	9700	5.11	14300	6.22
600	1.07	5200	3.52	9800	5.13	14400	6.26
700	1.15	5300	3.56	9900	5.15	14500	6.29
800	1.23	5400	3.58	10000	5.17	14600	6.33
900	1.31	5500	3.62	10100	5.19	14700	6.33
1000	1.39	5600	3.65	10200	5.19	14800	6.35
1100	1.46	5700	3.69	10300	5.21	14900	6.38
1200	1.54	5800	3.72	10400	5.22	15000	6.38
1300	1.60	5900	3.76	10500	5.22	15100	6.40
1400	1.67	6000	3.80	10600	5.22	15200	6.42
1500	1.74	6100	3.84	10700	5.25	15300	6.46
1600	1.79	6200	3.89	10800	5.25	15400	6.51
1700	1.86	6300	3.92	10900	5.26	15500	6.55
1800	1.92	6400	3.96	11000	5.29	15600	6.56
1900	1.98	6500	4.00	11100	5.30	15700	6.59
2000	2.04	6600	4.04	11200	5.31	15800	6.60
2100	2.09	6700	4.07	11300	5.35	15900	6.64
2200	2.14	6800	4.11	11400	5.36	16000	6.65
2300	2.20	6900	4.14	11500	5.39	16100	6.65
2400	2.25	7000	4.17	11600	5.41	16200	6.67
2500	2.31	7100	4.21	11700	5.45	16300	6.69
2600	2.36	7200	4.23	11800	5.48	16400	6.71
2700	2.42	7300	4.27	11900	5.51	16500	6.72
2800	2.46	7400	4.30	12000	5.53	16600	6.73
2900	2.51	7500	4.34	12100	5.56	16700	6.75
3000	2.56	7600	4.37	12200	5.59	16800	6.80
3100	2.60	7700	4.40	12300	5.61	16900	6.82
3200	2.65	7800	4.44	12400	5.62	17000	6.85
3300	2.70	7900	4.47	12500	5.65	17100	6.90
3400	2.75	8000	4.49	12600	5.68	17200	6.96
3500	2.80	8100	4.53	12700	5.71	17300	7.02
3600	2.85	8200	4.57	12800	5.73	17400	7.07
3700	2.90	8300	4.60	12900	5.76	17500	7.06
3800	2.95	8400	4.63	13000	5.80	17600	7.06
3900	2.98	8500	4.67	13100	5.83	17700	7.08
4000	3.02	8600	4.69	13200	5.86	17800	7.09
4100	3.07	8700	4.73	13300	5.88	17900	7.07
4200	3.10	8800	4.76	13400	5.91	18000	7.08
4300	3.14	8900	4.79	13500	5.94		

Cable loss
RF Cable, Huber-Suhner, 18 GHz, 6 m,
SF118/11N(x2), S/N 500024/18
HL 5404

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.02	5500	3.62
50	0.23	6000	3.73
100	0.32	6500	3.83
200	0.46	7000	3.92
300	0.56	7500	4.04
400	0.64	8000	4.11
500	0.72	8500	4.19
600	0.79	9000	4.28
700	0.86	9500	4.37
800	0.92	10000	4.46
900	0.97	10500	3.62
1000	1.03	11000	3.73
1100	1.08	11500	3.83
1200	1.14	12000	3.92
1300	1.17	12500	4.04
1400	1.22	13000	4.11
1500	1.27	13500	4.19
1600	1.31	14000	4.28
1700	1.35	14500	4.37
1800	1.39	15000	4.46
1900	1.43	15500	4.54
2000	1.48	16000	4.60
2500	1.66	16500	4.70
3000	1.82	17000	4.80
3500	1.98	17500	4.87
4000	2.12	18000	4.93
4500	2.26		
5000	2.40		

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

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.04	5500	2.61
50	0.24	6000	2.88
100	0.33	6500	2.92
200	0.47	7000	2.97
300	0.57	7500	3.05
400	0.66	8000	3.16
500	0.75	8500	3.28
600	0.81	9000	3.49
700	0.87	9500	3.52
800	0.93	10000	3.63
900	0.99	10500	3.73
1000	1.06	11000	3.84
1100	1.10	11500	3.97
1200	1.15	12000	4.02
1300	1.19	12500	4.13
1400	1.27	13000	4.17
1500	1.31	13500	4.28
1600	1.37	14000	4.35
1700	1.40	14500	4.56
1800	1.42	15000	4.87
1900	1.46	15500	4.76
2000	1.50	16000	4.81
2500	1.71	16500	4.87
3000	1.90	17000	5.01
3500	2.03	17500	5.05
4000	2.23	18000	5.52
4500	2.42		
5000	2.46		

14 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