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Compliance test report ID **215809-1TRFWL**

Date of issue
February 5, 2013

FCC 47 CFR Part 15 Subpart C, §15.255

Operation within the band 57–64 GHz
and

RSS-210, Issue 8 Annex 13.2

Licence-exempt radio apparatus (all frequency bands): category I equipment
Annex 13.2 - Devices operating in the band 57–64 GHz

Applicant	**DragonWave Inc.**
Product	**Horizon Compact Plus CPHP58B1X**
Model	**HC+ CPHP58B1X**
FCC ID	**QB8HCP58UL**
IC Reg #	**4679A-HCP58UL**

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada. The tests included in this report are within the scope of this accreditation

Test location

Nemko Canada Inc.
303 River Road
Ottawa, ON, K1V 1H2
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FCC test site registration number: 176392 and IC registered site number: 2040A-4 (3 m semi anechoic chamber)

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Tested by Kevin Rose, Wireless/EMC Specialist

Reviewed by 

Andrey Adelberg, Senior Wireless/EMC Specialist

February 5, 2013
Date

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Table of Contents

Section 1 Report summary

1.1 Applicant and manufacturer

DragonWave Inc.
600-411 Legget Drive
Ottawa, ON K2K 3C9
Canada

1.2 Test specifications

Standard	Description
FCC 47 CFR Part 15, Subpart C, Chapter 15.255	Operation within the band 57–64 GHz
RSS-210, Issue 8 Annex 13.2	Devices operating in the band 57–64 GHz
MILLIMETER WAVE TEST PROCEDURES & Extrapolation of Measurement Distance in Millimeter Wave Test Procedure	Procedure from TCB council members – accepted by FCC lab

1.3 Statement of compliance

In the configuration tested, the EUT was found Compliant.

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

See “Summary of test results” for full details.

1.4 Exclusions

None

1.5 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2 Summary of test results

2.1 FCC Part 15 Subpart C – general requirements, test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass

Notes:
[1] Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

2.2 FCC Part 15 Subpart C – Intentional Radiators, test results

Part	Test description	Verdict
§15.255(a)	Operation under the provisions of this section is not permitted for the following products:	Pass
§15.255(b)	Radiated average density and peak density requirements	Pass
§15.255(c)	Spurious emissions	Pass
§15.255(d)	Operating in 57–57.05 GHz band	Pass
§15.255(e)	Total peak transmitter output power	Pass
§15.255(f)	Frequency stability	Pass
Note: EUT is a Point to point radio *EUT is not operating in 57–57.05 GHz band*		

2.3 IC RSS-GEN, Issue 3, test results

Part	Test description	Verdict
4.6.1	Occupied bandwidth	Pass
6.1	Receiver spurious emissions limits (radiated)	Not Applicable
6.2	Receiver spurious emissions limits (antenna conducted)	Not Applicable
7.2.4	AC power lines conducted emission limits	Pass
Notes: [1] According to Notice 2012-DRS0126 (from January 2012) section 2.2 of RSS-Gen, Issue 3 has been revised. The EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.		

2.4 IC RSS-210, Issue 8, test results

Part	Test description	Verdict
A13.2.1	General Restrictions	Pass
A13.2.2 (1)	Limits of radiated emissions	Pass
A13.2.2 (2)	Spurious emissions	Pass
A13.2.3	Peak transmitter output power	Pass
A13.2.5	Frequency Stability	Pass
Notes: EUT is not operating in 46.7–46.9 GHz and 76–77 GHz		

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	August 18, 2012
Nemko sample ID number	1 and 2

3.2 EUT information

Product name	Horizon Compact Plus CPHP58B1X
Model	HC+ CPHP58B1X
Serial number	Low band (C1X13AFH002) and High band (C1X14AFH002)
Part number	Low band (PLHP58B1SSR1) and High band (PHHP58B1SSR1)

3.3 Technical information

Operating band	57–64 GHz
Operating frequency	Low band: 57137.5–57512.5 MHz High band: 58037.5–58412.5 MHz
Modulation type	QPSK, 16-QAM, 32-QAM, 64-QAM, 128-QAM, 256-QAM, 256-QAM 1
Occupied bandwidth (99 %)	51.44 MHz
Emission designator	D7W
Power requirements	PoE via 120 V_{AC} (AC adapter CINCON Electronics Model TR100A480)
Antenna information	

Antenna 24” (0.6 m)	Mfg: RadioWave Inc.	Model Number: HP2-60	Gain: 46.5 dBi
Antenna 12” (0.3 m)	Mfg: RadioWave Inc.	Model Number: HPCPE-60	Gain: 42.5 dBi
Antenna 5” (0.14 m)	Mfg: DragonWave Inc.	Part Number: 74-000347-03-01	Gain: 35.5 dBi

Low Band Radio		
Channel	**Software designation**	**Frequency (GHz)**
Lowest	C1	57.1375
Middle	C3	57.2875
Highest	C6	57.5125

High Band Radio		
Channel	**Software designation**	**Frequency (GHz)**
Lowest	C1'	58.0375
Middle	C3'	58.1875
Highest	C6'	58.4125

3.4 Product description and theory of operation

Point to Point high capacity packet microwave system.

3.5 EUT exercise details

The EUT was programmed via Telnet session to transmit constantly on desired channel and with various modulation types. Modulations used for 75 MHz channels testing are as follows: QPSK, 16-QAM, 32-QAM, 64-QAM, 128-QAM, 256-QAM, and 256-QAM1

3.6 EUT setup diagram

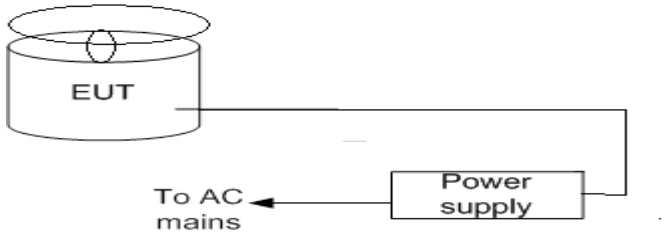


Diagram 3.6-1: Setup diagram

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment

4.2 Technical judgment

None.

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory test procedures

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature: 15–30 °C
Relative humidity: 20–75 %
Air pressure: 86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Section 7 Test equipment

7.1 Test equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Mar. 09/13
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power supply	California Inst.	3001I	FA001021	1 year	Feb 08/13
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Feb. 09/13
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jan. 16/14
Bilog antenna	Sunol	JB3	FA002108	1 year	Feb. 07/13
Horn antenna #1	EMCO	3115	FA000649	1 year	Mar. 08/13
Horn antenna 18–26.5 GHz	Electro-metrics	SH-50/60-1	FA000479	—	VOU
Horn antenna 26.5–40 GHz	Electro-metrics	SH-50/60-2	FA000485	—	VOU
50 coax cable	Huber + Suhner	NONE	FA002392	1 year	June. 27/13
50 coax cable	Huber + Suhner	NONE	FA002074	1 year	Aug. 23/13
1–18 GHz pre-amplifier	JCA	JCA118-503	FA002091	1 year	July 03/13
40–60 GHz Harmonic mixer	OML	WR19 M19HWD	FA002322	3 year	Mar. 16/14
40–60 GHz Standard gain horn	Millitech	U SGH-19	FA002322	—	VOU
60–90 GHz Harmonic mixer	OML	WR12 M12HWD	FA001524	3 year	Mar. 16/14
60–90 GHz Standard gain horn	Millitech	U SGH-12	FA001524	—	VOU
90–140 GHz Harmonic mixer	OML	WR08 M08HWD	FA001525	3 year	Mar. 16/14
90–140 GHz Standard gain horn	Millitech	U SGH-08	FA001525	—	VOU
140–220 GHz Harmonic mixer	OML	WR05 M05HWD	FA001526	3 year	Mar. 16/14
140–220 GHz Standard gain horn	Millitech	U SGH-05	FA001526	—	VOU
40–60 GHz Harmonic mixer	OML	WR19 M19HWD	FA002322	3 year	Mar. 16/14
40–60 GHz Standard gain horn	Millitech	U SGH-19	FA002322	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Nov. 18/13
V Band power sensor	Agilent	V8486A	—	1 year	May 07/13
Note: NCR = No Calibrate Required, VOU = Verify On Use					

Section 8 Testing data

8.1 AC power line conducted emissions

8.1.1 Definitions and limits

FCC Clause 15.207(a): Conducted limits
RSS-Gen Clause 7.2.4: AC power line conducted emissions limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:
The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

Except when the requirements applicable to a given device state otherwise, for any licence-exempt radiocommunication device equipped to operate from the public utility AC power supply, either directly or indirectly, the radio frequency voltage that is conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in Table 2. The tighter limit applies at the frequency range boundaries.

The conducted emissions shall be measured with a 50 Ω/50 µH line impedance stabilization network (LISN).

Table 8.1-1: Conducted emissions limit

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50
* - Decreases with the logarithm of the frequency.		

8.1.2 Test summary

Test date	August 18, 2012	Test engineer	Kevin Rose	Verdict	Pass
Temperature	24 °C	Air pressure	1003 mbar	Relative humidity	32 %

8.1.3 Observations/special notes

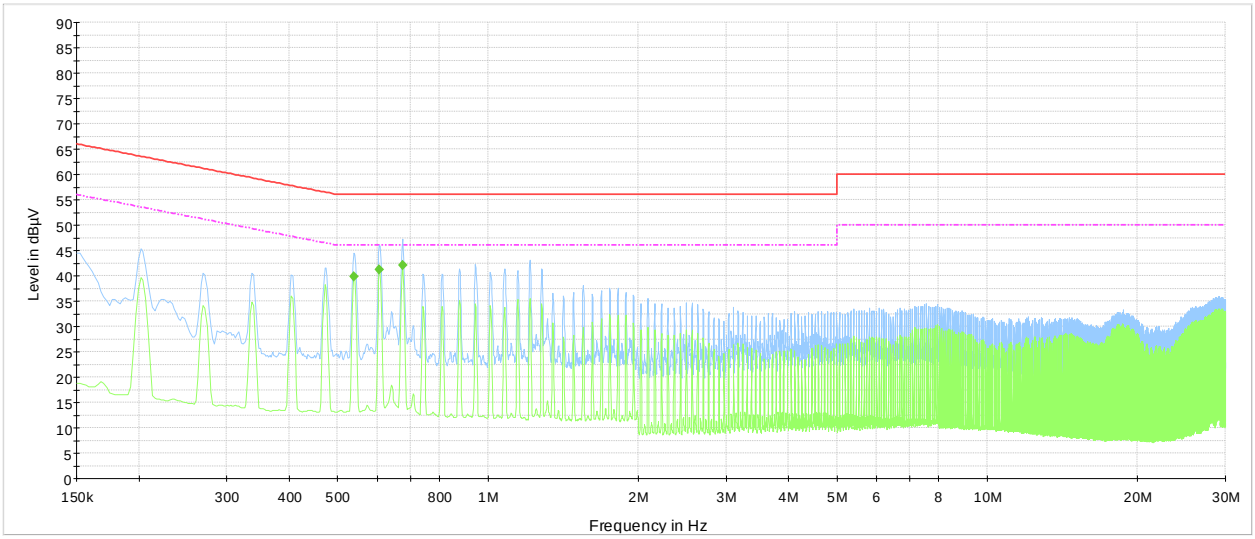
The EUT was set up as Tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

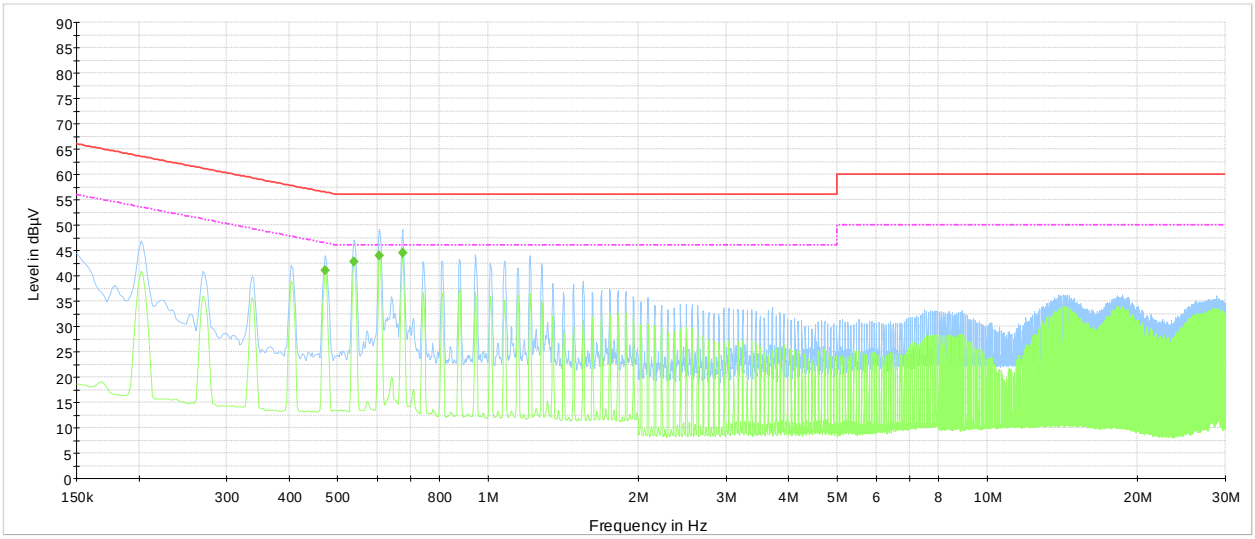
Receiver/spectrum analyzer settings
Preview measurements – Receiver:
Peak and Average detector (Max hold), RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms
Final measurements – Receiver:
Q-Peak and Average detector, RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms

Measurement details
A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement. The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

8.1.4 Test data

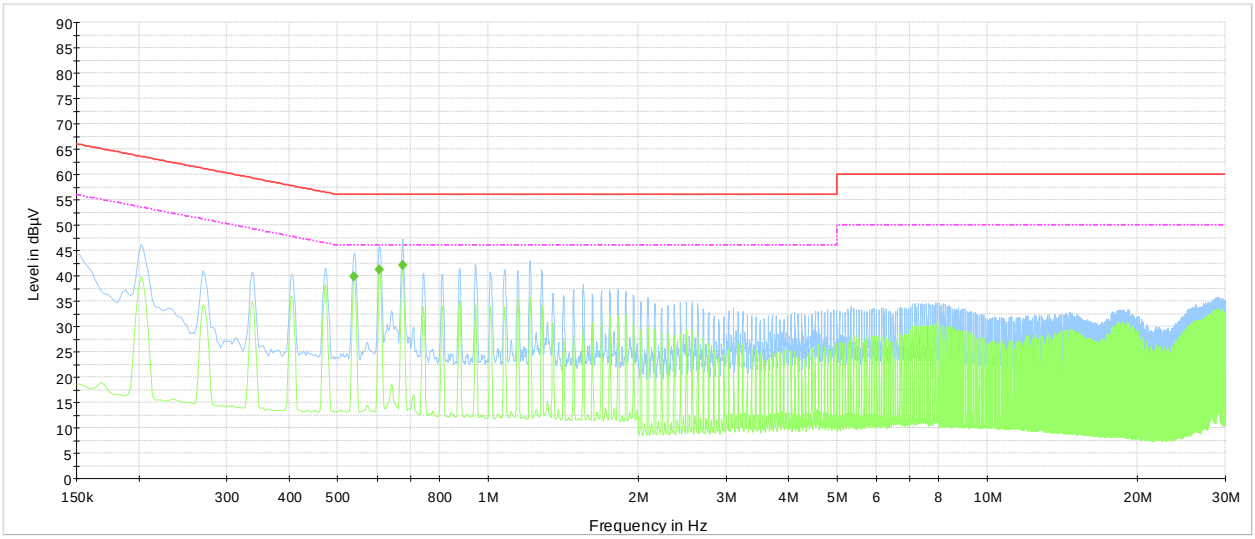


Plot 8.1-1: Conducted emissions on phase line High Radio

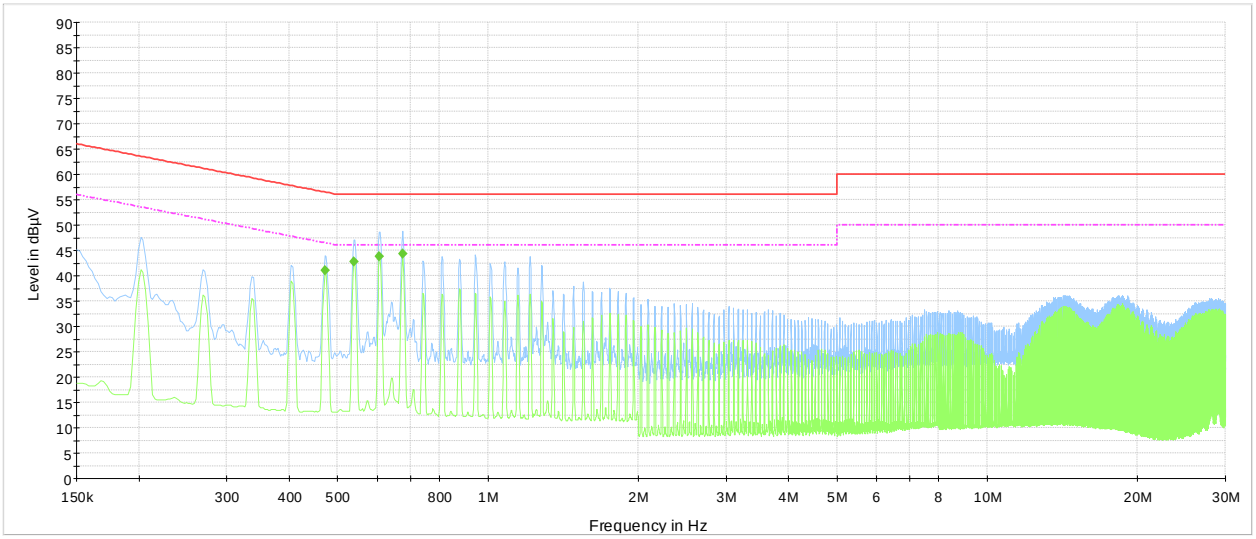


Plot 8.1-2: Conducted emissions on neutral line High Radio

8.1.4 Test data continued



Plot 8.1-3: Conducted emissions on phase line Low Radio



Plot 8.1-4: Conducted emissions on neutral line Low Radio

8.1.4 Test data, continued

Table 8.1-2: Average conducted emissions results

Frequency (MHz)	Average result (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Conductor	Correction (dB)	Margin (dB)	Limit (dBµV)
Low band Radio								
0.471750	41.0	100	9	On	N	10.1	5.5	46.5
0.539250	42.8	100	9	On	N	10.1	3.2	46.0
0.606750	43.9	100	9	On	N	10.1	2.1	46.0
0.674250	44.3	100	9	On	N	10.1	1.7	46.0
0.539250	39.8	100	9	On	L1	10.1	6.2	46.0
0.606750	41.3	100	9	On	L1	10.1	4.7	46.0
0.674250	42.1	100	9	On	L1	10.1	3.9	46.0
High band Radio								
0.471750	41.1	100	9	On	N	10.1	5.4	46.5
0.539250	42.8	100	9	On	N	10.1	3.2	46.0
0.606750	43.9	100	9	On	N	10.1	2.1	46.0
0.674250	44.4	100	9	On	N	10.1	1.6	46.0
0.539250	39.9	100	9	On	L1	10.1	6.1	46.0
0.606750	41.2	100	9	On	L1	10.1	4.8	46.0
0.674250	42.1	100	9	On	L1	10.1	3.9	46.0

Sample calculation:
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
Result (dBµV) = XX dBµV (reading from receiver) + XX dB (Correction factor)

Example:
43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.2 Radiated in-band emissions

8.2.1 Definitions and limits

FCC 15.255 Operation within the band 57–64 GHz.
(b) Within the 57–64 GHz band, emission levels shall not exceed the following:

(1) For products other than fixed field disturbance sensors, the average power density of any emission, measured during the transmit interval, shall not exceed 9 μW/cm^2, as measured 3 m from the radiating structure, and the peak power density of any emission shall not exceed 18 μW/cm^2, as measured 3 m from the radiating structure.

(2) For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0–61.5 GHz, the average power density of any emission, measured during the transmit interval, shall not exceed 9 μW/cm^2, as measured 3 m from the radiating structure, and the peak power density of any emission shall not exceed 18 μW/cm^2, as measured 3 m from the radiating structure. In addition, the average power density of any emission outside of the 61–61.5 GHz band, measured during the transmit interval, but still within the 57–64 GHz band, shall not exceed 9 nW/cm^2, as measured 3 m from the radiating structure, and the peak power density of any emission shall not exceed 18 nW/cm^2, as measured three meters from the radiating structure.

(3) For fixed field disturbance sensors other than those operating under the provisions of paragraph (b)(2) of this section, the peak transmitter output power shall not exceed 0.1 mW and the peak power density shall not exceed 9 nW/cm^2 at a distance of 3 meters.

RSS-210 A13.2.2 Limits of Radiated Emissions
(1) In-band Emissions: Within the band 57–64 GHz, emission levels measured 3 m from the radiating source shall not exceed the following:
(i) For products other than fixed field disturbance sensors, the average power density of any emission, measured during the transmit interval, shall not exceed 9 μW/cm^2, and the peak power density of any emission shall not exceed 18 μW/cm^2.
(ii) For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0–61.5 GHz, the average power density of any emission, measured during the transmit interval, shall not exceed 9 μW/cm^2, and the peak power density of any emission shall not exceed 18 μW/cm^2.

In addition, the average power density of any emission outside of the band 61.0–61.5 GHz, measured during the transmit interval but still within the band 57–64 GHz, shall not exceed 9 nW/cm^2, and the peak power density of any emission shall not exceed 18 nW/cm^2.

(iii) For fixed field disturbance sensors, other than those operating under the provisions of Section A13.2.2 (1)(ii) above, the peak transmitter output power shall not exceed 0.1 mW (−10 dBm), and the peak power density shall not exceed 9 nW/cm^2.

8.2.2 Test summary

Test date	October 25, 2012	**Test engineer**	Kevin Rose	**Verdict**	Pass
Temperature	22 °C	**Air pressure**	1001 mbar	**Relative humidity**	31 %

8.2.3 Observations/special notes and procedures

Peak power density was measured using spectrum analyser with channel power function to encompass the entire emission bandwidth.
Test Distance: 3 m
Peak power density:
RBW:1 MHz
VBW:10 MHz
Channel Bandwidth:>EBW
Detector type: Peak

Average power density:
RBW:1 MHz
VBW:10 MHz
Channel Bandwidth:>EBW
Detector type: Average

All modulations were investigated; only worst case (QPSK) test results were presented.

According to MILLIMETER WAVE TEST PROCEDURES, and Extrapolation of Measurement Distance in Millimeter Wave Test Procedure, the power density limits specified in the FCC Rules shall be converted mathematically to equivalent field strength values

$P = (E \times d)^2 / (30 \times G)$
where
P is the power, in Watts
E is the measured peak field strength, in Volts/meter
d is the distance at which the measurement was made, in meters
G is the numeric gain of the radiating element

The average emission levels were calculated based on the measured peak levels, over the actual time period during which transmission occurs.

The limit for the average power density of any emissions (in-band):
9 μW/cm^2 = 0.009 mW/cm^2
mW/cm^2 = (V/m)^2 ÷ (120 × π × 10)
E(V/m) = (0.009 × 3770)^{½} = 5.83 V/m = 5.83 × 10^6 μV/m = 20 × Log_{10} (5.83 × 10^6) = 135.3 dBμV/m @ 3 m

9 nW/cm^2 = 0.000009 mW/cm^2
mW/cm^2 = (V/m)^2 ÷ (120 × π × 10)
E(V/m) = (0.000009 × 3770)^{½} = 0.18 V/m = 0.18 × 10^6 μV/m = 20 × Log_{10} (0.18 × 10^6) = 105.3 dBμV/m @ 3 m

The limit for the peak power density of any emissions (in-band):
18 μW/cm^2 = 0.018 mW/cm^2
mW/cm^2 = (V/m)^2 ÷ (120 × π × 10)
E(V/m) = (0.018 × 3770)^{½} = 8.24 V/m = 8.24 × 10^6 μV/m = 20 × Log_{10} (8.24 × 10^6) = 138.3 dBμV/m @ 3 m

18 nW/cm^2 = 0.000018 mW/cm^2
mW/cm^2 = (V/m)^2 ÷ (120 × π × 10)
E(V/m) = (0.000018 × 3770)^{½} = 0.26 V/m = 0.26 × 10^6 μV/m = 20 × Log_{10} (0.26 × 10^6) = 108.3 dBμV/m @ 3 m

Note: although the free-space impedance in near-field is not exact 377 Ω (120 × π), using this assumed impedance value one can obtain an adequately accurate result, if the tests were performed in near-field.

8.2.4 Test data

Table 8.2-1: Radiated Power results for low band radio 42.5 dBi gain

Channel	Modulation	Peak value dBµV/m	Peak limit dBµV/m	Average value dBµV/m	Average limit dBµV/m	Peak margin dB	Average Margin dB
C1	QPSK	136.21	138.3	135.17	135.3	2.09	0.13
C3	QPSK	136.29	138.3	135.28	135.3	2.01	0.02
C6	QPSK	136.27	138.3	135.26	135.3	2.03	0.04

Table 8.2-2: Radiated Power results for high band radio 42.5 dBi gain

Channel	Modulation	Peak value dBµV/m	Peak limit dBµV/m	Average value dBµV/m	Average limit dBµV/m	Peak margin dB	Average Margin dB
C1'	QPSK	136.34	138.3	135.29	135.3	1.96	0.01
C3'	QPSK	136.22	138.3	135.21	135.3	2.08	0.09
C6'	QPSK	136.30	138.3	135.29	135.3	2.00	0.01

Table 8.2-3: Radiated Power results for low band radio 35.5 dBi gain

Channel	Modulation	Peak value dBµV/m	Peak limit dBµV/m	Average value dBµV/m	Average limit dBµV/m	Peak margin dB	Average Margin dB
C1	QPSK	136.20	138.3	135.2	135.3	2.10	0.10
C3	QPSK	136.20	138.3	135.19	135.3	2.10	0.11
C6	QPSK	136.23	138.3	135.22	135.3	2.07	0.08

Table 8.2-4: Radiated Power results for high band radio 35.5 dBi gain

Channel	Modulation	Peak value dBµV/m	Peak limit dBµV/m	Average value dBµV/m	Average limit dBµV/m	Peak margin dB	Average Margin dB
C1'	QPSK	136.25	138.3	135.23	135.3	2.05	0.07
C3'	QPSK	136.25	138.3	135.24	135.3	2.05	0.06
C6'	QPSK	136.27	138.3	135.26	135.3	2.03	0.04

Table 8.2-5: Radiated Power results for low band radio 46.5 dBi gain

Channel	Modulation	Peak value dBµV/m	Peak limit dBµV/m	Average value dBµV/m	Average limit dBµV/m	Peak margin dB	Average Margin dB
C1	QPSK	132.30	138.3	131.27	135.3	6.00	4.03
C3	QPSK	132.72	138.3	131.71	135.3	5.58	3.59
C6	QPSK	134.31	138.3	133.29	135.3	3.99	2.01

Table 8.2-6: Radiated Power results for high band radio 46.5 dBi gain

Channel	Modulation	Peak value dBµV/m	Peak limit dBµV/m	Average value dBµV/m	Average limit dBµV/m	Peak margin dB	Average Margin dB
C1'	QPSK	133.62	138.3	132.59	135.3	4.68	2.71
C3'	QPSK	132.77	138.3	131.76	135.3	5.53	3.54
C6'	QPSK	131.13	138.3	130.11	135.3	7.17	5.19

8.3 Peak Transmitter Output Power

8.3.1 Definitions and limits

FCC 15.255 Operation within the band 57–64 GHz.
(e) Except as specified elsewhere in this paragraph (e), the total peak transmitter output power shall not exceed 500 mW.
(1) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph (e)(1), emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g. for frequency hopping devices).

(2) Peak transmitter output power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57–64 GHz band and that has a video bandwidth of at least 10 MHz, or using an equivalent measurement method.
(3) For purposes of demonstrating compliance with this paragraph (e), corrections to the transmitter output power may be made due to the antenna and circuit loss.

RSS-210 A13.2.3 Peak Transmitter Output Power
(1) The total peak transmitter output power shall not exceed 500 mW, with the exception that transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter output power to the product of 500 mW times their emission bandwidth divided by 100 MHz.
(2) For the purposes of demonstrating compliance with this RSS, corrections to the transmitter output power may be made in the event of antenna and circuit loss.

8.3.2 Test summary

Test date	Jan 23, 2013	**Test engineer**	Kevin Rose	**Verdict**	Pass
Temperature	21 °C	**Air pressure**	1003 mbar	**Relative humidity**	29 %

8.3.3 Observations/special notes and procedures

The Output power was measured with CW carrier with attenuation place in front of the mixer as to not saturate the input.
Instrument settings during test (RBW=1 MHz, VBW=3 MHz, Detector: Peak detector).

Output power limit calculation:

FCC limit calculation:
6 dB bandwidth = 51.6 MHz, see section 8.5 of this document
Power limit = 500 mW × (51.6 MHz ÷ 100 MHz) = 258 mW

IC limit calculation:
99% bandwidth = 51.4 MHz, see section 8.5 of this document
Power limit = 500 mW × (51.4 MHz ÷ 100 MHz) = 257 mW

8.3.4 Test data

Table 8.3-1: Conducted Output Power results for Low band radio 35.5 dBi gain

Channel	Modulation	Peak value dBm	Peak value mW	FCC Limit mW	IC Limit mW
C1	CW	8.2	6.61	258	257
C3	CW	8.0	6.31	258	257
C6	CW	6.9	4.90	258	257

Table 8.3-2: Conducted Output Power results for High band radio 35.5 dBi gain

Channel	Modulation	Peak value dBm	Peak value mW	FCC Limit mW	IC Limit mW
C1'	CW	8.1	6.46	258	257
C3'	CW	8.0	6.31	258	257
C6'	CW	9.5	8.91	258	257

8.3.4 Test data, continued

Table 8.3-3: Conducted Output Power results for Low band radio 42.5 dBi gain

Channel	Modulation	Peak value dBm	Peak value mW	FCC Limit mW	IC Limit mW
C1	CW	3.6	2.29	258	257
C3	CW	3.4	2.19	258	257
C6	CW	1.9	1.55	258	257

Table 8.3-4: Conducted Output Power results for High band radio 42.5 dBi gain

Channel	Modulation	Peak value dBm	Peak value mW	FCC Limit mW	IC Limit mW
C1'	CW	1.3	1.35	258	257
C3'	CW	1.2	1.32	258	257
C6'	CW	2.8	1.91	258	257

Table 8.3-5: Conducted Output Power results for Low band radio 46.5 dBi gain

Channel	Modulation	Peak value dBm	Peak value mW	FCC Limit mW	IC Limit mW
C1	CW	10.5	11.22	258	257
C3	CW	10.5	11.22	258	257
C6	CW	10.8	12.02	258	257

Table 8.3-6: Conducted Output Power results for High band radio 46.5 dBi gain

Channel	Modulation	Peak value dBm	Peak value mW	FCC Limit mW	IC Limit mW
C1'	CW	11.2	13.18	258	257
C3'	CW	11.1	12.88	258	257
C6'	CW	11.0	12.59	258	257

8.4 Frequency Stability

8.4.1 Definitions and limits

RSS-210 A13.2.5 Frequency Stability
Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation.

FCC 15.255 (f) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

8.4.2 Test summary

Test date	August 30, 2012	Test engineer	Kevin Rose	Verdict	Pass
Temperature	24 °C	Air pressure	1001 mbar	Relative humidity	37 %

8.4.3 Observations/special notes and procedures

All modulations were checked, only worst case test data were presented.

8.4.4 Test data

Table 8.4-1: Frequency Stability results High band Radio

Test conditions	Frequency GHz	Low edge limit GHz	Low edge margin GHz	High edge limit GHz	High edge margin GHz
+50 °C, Nominal	58.186438	57	1.186438	64	5.813562
+40 °C, Nominal	58.186429	57	1.186429	64	5.813571
+30 °C, Nominal	58.186441	57	1.186441	64	5.813559
+20 °C, +15 %	58.186462	57	1.186462	64	5.813538
+20 °C, Nominal	58.186462	57	1.186462	64	5.813538
+20 °C, −15 %	58.186462	57	1.186462	64	5.813538
+10 °C, Nominal	58.186482	57	1.186482	64	5.813518
0 °C, Nominal	58.186488	57	1.186488	64	5.813512
−10 °C, Nominal	58.186490	57	1.186490	64	5.813510
−20 °C, Nominal	58.186500	57	1.186500	64	5.813500
−30 °C, Nominal	58.186531	57	1.186531	64	5.813469
* Note: Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation.					

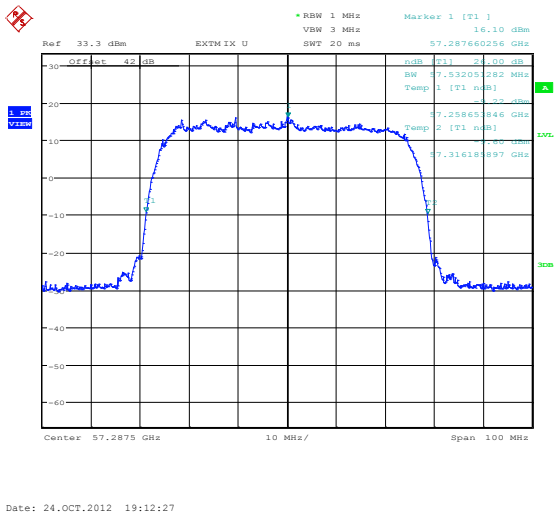
Highest channel was tested

8.4.4 Test data, continued

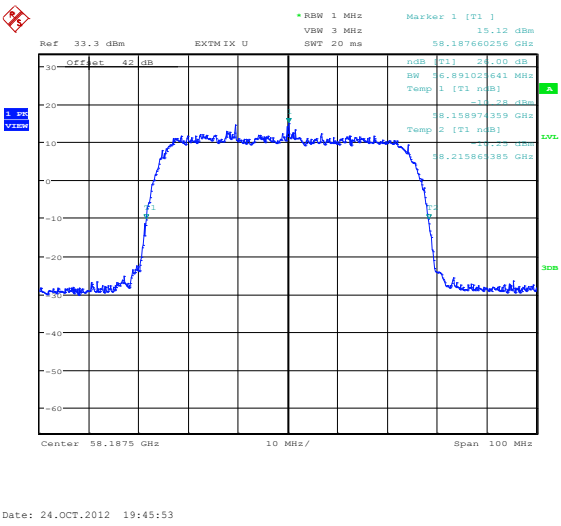
Table 8.4-2: Frequency Stability results Low band Radio

Test conditions	Frequency GHz	Low edge limit GHz	Low edge margin GHz	High edge limit GHz	High edge margin GHz
+50 °C, Nominal	57.13643505	57	0.136435	64	6.863565
+40 °C, Nominal	57.13642480	57	0.136425	64	6.863575
+30 °C, Nominal	57.13642831	57	0.136428	64	6.863572
+20 °C, +15 %	57.13643135	57	0.136431	64	6.863569
+20 °C, Nominal	57.13643087	57	0.136431	64	6.863569
+20 °C, −15 %	57.13643103	57	0.136431	64	6.863569
+10 °C, Nominal	57.13643603	57	0.136436	64	6.863564
0 °C, Nominal	57.13643234	57	0.136432	64	6.863568
−10 °C, Nominal	57.13642697	57	0.136427	64	6.863573
−20 °C, Nominal	57.13641519	57	0.136415	64	6.863585
−30 °C, Nominal	57.13641891	57	0.136419	64	6.863581
* Note: Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation.					

Lowest channel was tested



Plot 8.4-1: Low channel band



Plot 8.4-2: High channel band

8.5 Occupied bandwidth

8.5.1 Definitions and limits

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 percent emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1 percent of the selected span as is possible without being below 1 percent. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 percent of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded.

The span between the two recorded frequencies is the occupied bandwidth.

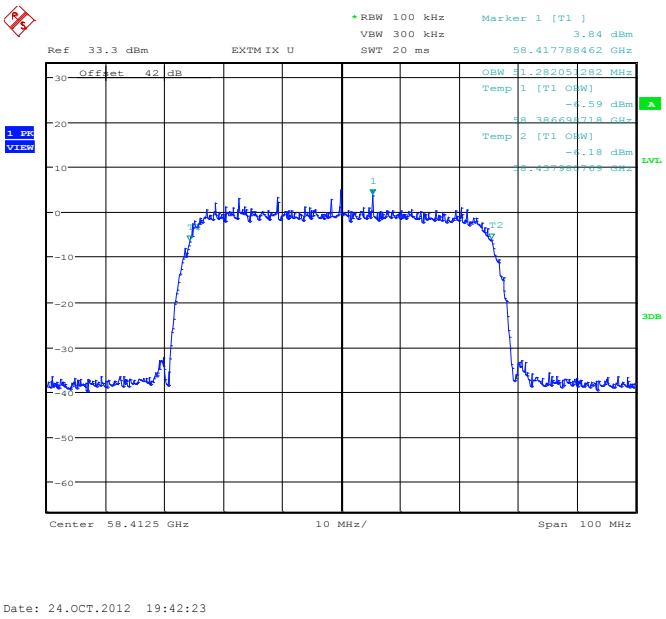
8.5.2 Test summary

Test date	August 30, 2012	Test engineer	Kevin Rose	Verdict	Pass
Temperature	24 °C	Air pressure	1001 mbar	Relative humidity	37 %

8.5.3 Observations/special notes

Measurements were performed with peak detector by using RBW = 1–5 % of EBW. VBW was set to wider than RBW.

8.5.4 Test data



Plot 8.5-1: 99% Occupied bandwidth test settings

8.5.4 Test data, continued

Table 8.5-1: 26 dB bandwidth results

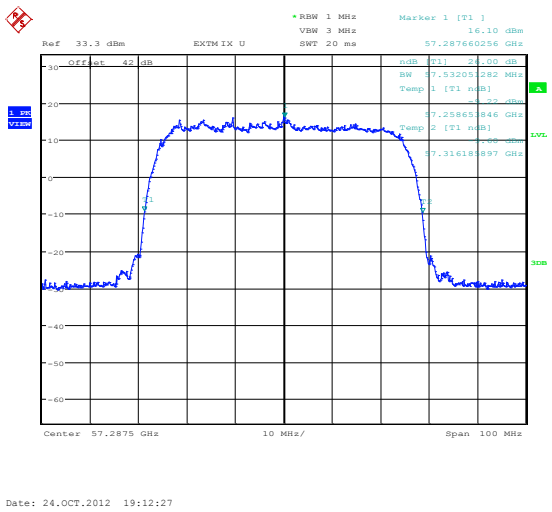
Low band radio frequency, MHz	26 dB Occupied bandwidth, MHz	High band radio frequency, MHz	26 dB Occupied bandwidth, MHz
57137.5	57.53	58037.5	56.89
57287.5	57.21	58187.5	57.21
57512.5	57.37	58412.5	57.53

Table 8.5-2: 6 dB bandwidth results

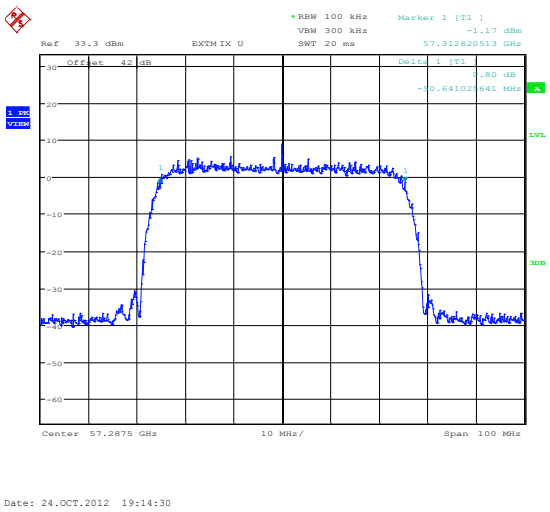
Low band radio frequency, MHz	6 dB Occupied bandwidth, MHz	High band radio frequency, MHz	6 dB Occupied bandwidth, MHz
57137.5	50.64	58037.5	51.79
57287.5	50.32	58187.5	51.12
57512.5	50.16	58412.5	50.16

Table 8.5-3: 99% bandwidth results

Low band radio frequency, MHz	99% Occupied bandwidth, MHz	High band radio frequency, MHz	99% Occupied bandwidth, MHz
57137.5	51.44	58037.5	51.28
57287.5	51.12	58187.5	51.09
57512.5	51.28	58412.5	51.38



Plot 8.5-2: 26dB Occupied bandwidth test settings



Plot 8.5-3: 6dB Occupied bandwidth test settings

8.6 Spurious (out-of-band) emissions

8.6.1 Definitions and limits

FCC Clause 15.255 Spurious emissions
RSS-210 Clause A13.2.2 Out-of-band emissions

15.255 c) Limits on spurious emissions:

(1) The power density of any emissions outside the 57–64 GHz band shall consist solely of spurious emissions.

(2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.

(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 at a distance of 3 meters.

(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

(d) Only spurious emissions and transmissions related to a publicly-accessible coordination channel, whose purpose is to coordinate operation between diverse transmitters with a view towards reducing the probability of interference throughout the 57–64 GHz band, are permitted in the 57–57.05 GHz band.

IC:
Spurious emissions: Any emissions outside the band 57–64 GHz shall consist solely of spurious emissions and shall not exceed:

(i) the general field strength limits listed in RSS-Gen for emissions below 40 GHz;

(ii) 90 pW/cm^2 at a distance of 3 metres for emissions between 40 GHz and 200 GHz; Within the band 57.0–57.05 GHz, only spurious emissions related to a publicly-accessible coordination channel are permitted.

The band 57–57.05 GHz is reserved exclusively for a publicly-accessible coordination channel.

Table 8.6-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009–0.490*	2400/F	67.6−20×log$_{10}$(F)	300
0.490–1.705*	24000/F	87.6−20×log$_{10}$(F)	30
1.705–30.0*	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3
*– applicable only to FCC requirements			

8.6.1 Definitions and limits, continued

Table 8.6-2: FCC Restricted bands of operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

Table 8.6-3: IC Restricted bands of operation

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677-5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Note: Certain frequency bands listed in Table 8.6-3 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

8.6.2 Test summary

Test date	October 25, 2012	Test engineer	Kevin Rose	Verdict	Pass
Temperature	23 °C	Air pressure	1002 mbar	Relative humidity	27 %

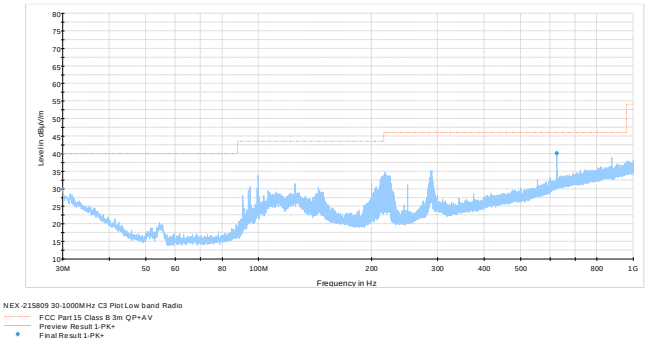
8.6.3 Observations/special notes and procedures

Spectrum was searched on each channel and all modulations from 30 MHz to 220 GHz.

Both low and high band radios, all three antennas, Low, mid, and High channels were tested. Worst case test data were presented. According to MILLIMETER WAVE TEST PROCEDURES, the power density limits specified in the FCC rules shall be converted mathematically to equivalent field strength values; P = (E × d)2/30G (see Page 18 for details).

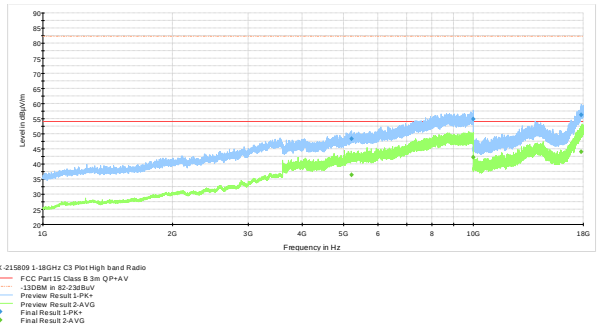
8.6.4 Test data

Radiated measurement



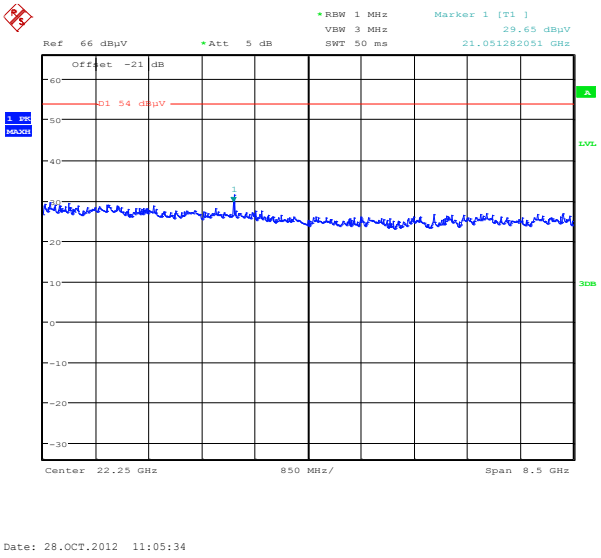
Plot 8.6-1: Radiated spurious emissions 30–1 GHz

3m Distance



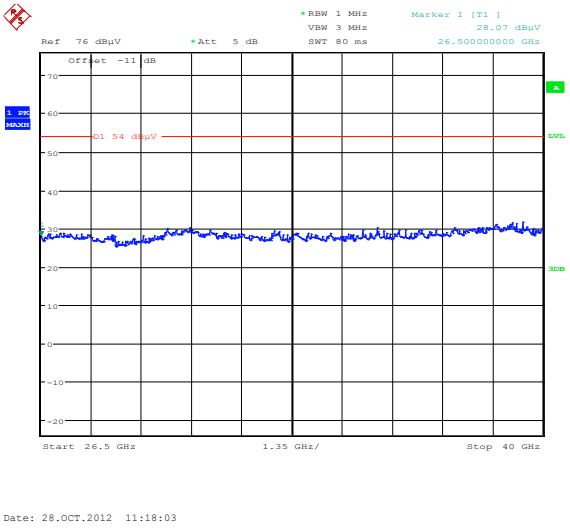
Plot 8.6-2: Radiated spurious emissions 1–18 GHz

3m Distance



Plot 8.6-3: Radiated spurious emissions 18–26.5 GHz

3m Distance



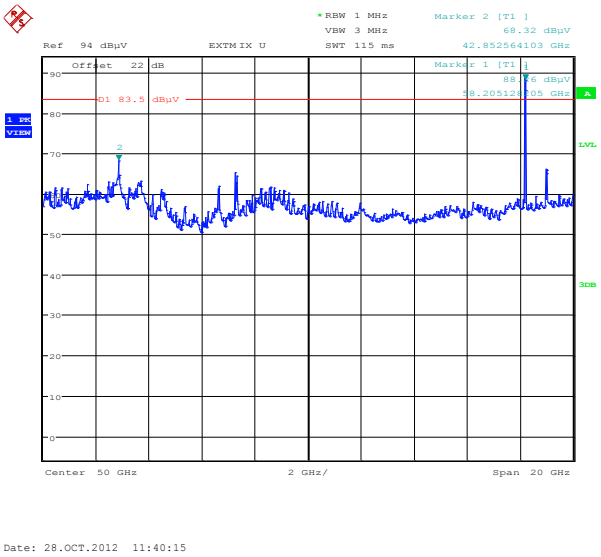
Plot 8.6-4: Radiated spurious emissions 26.5–40 GHz

3m Distance

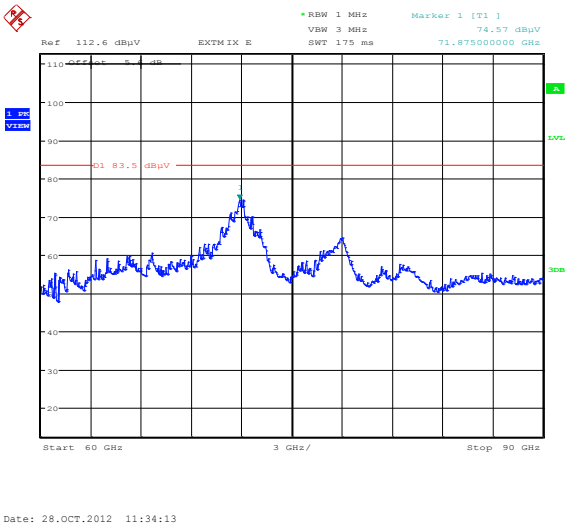
No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

- All measurements were performed at a distance of 3 meter.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW.
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results.
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results.

8.6.4 Test data, continued



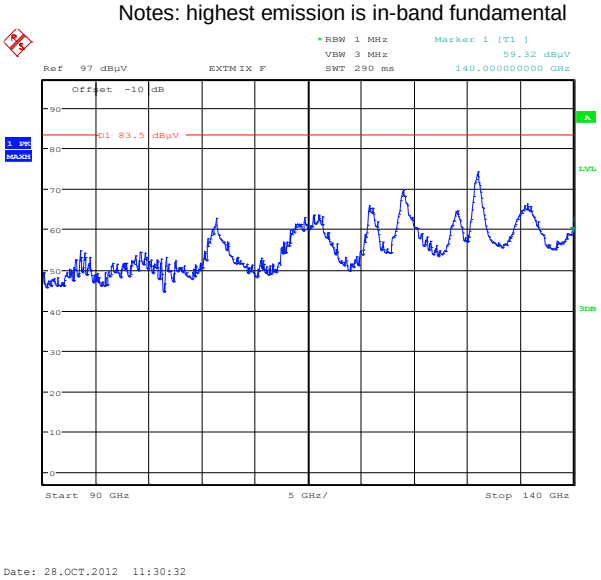
Plot 8.6-5: Radiated spurious emissions 40–60GHz



Plot 8.6-6: Radiated spurious emissions 60–90 GHz

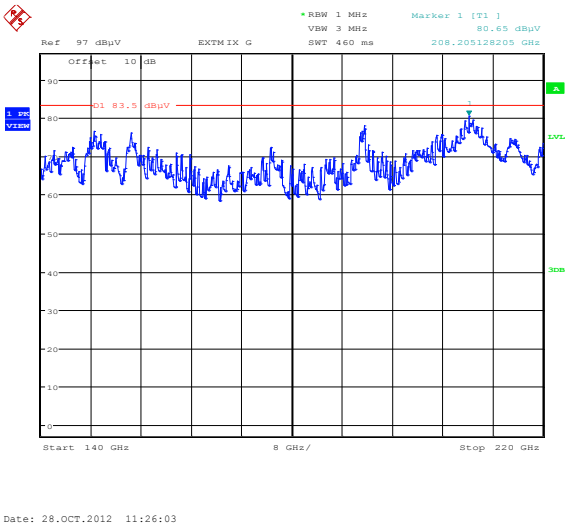
3 m distance

Notes: highest emission is in-band fundamental



Plot 8.6-7: Radiated spurious emissions 90–140 GHz

3 m distance



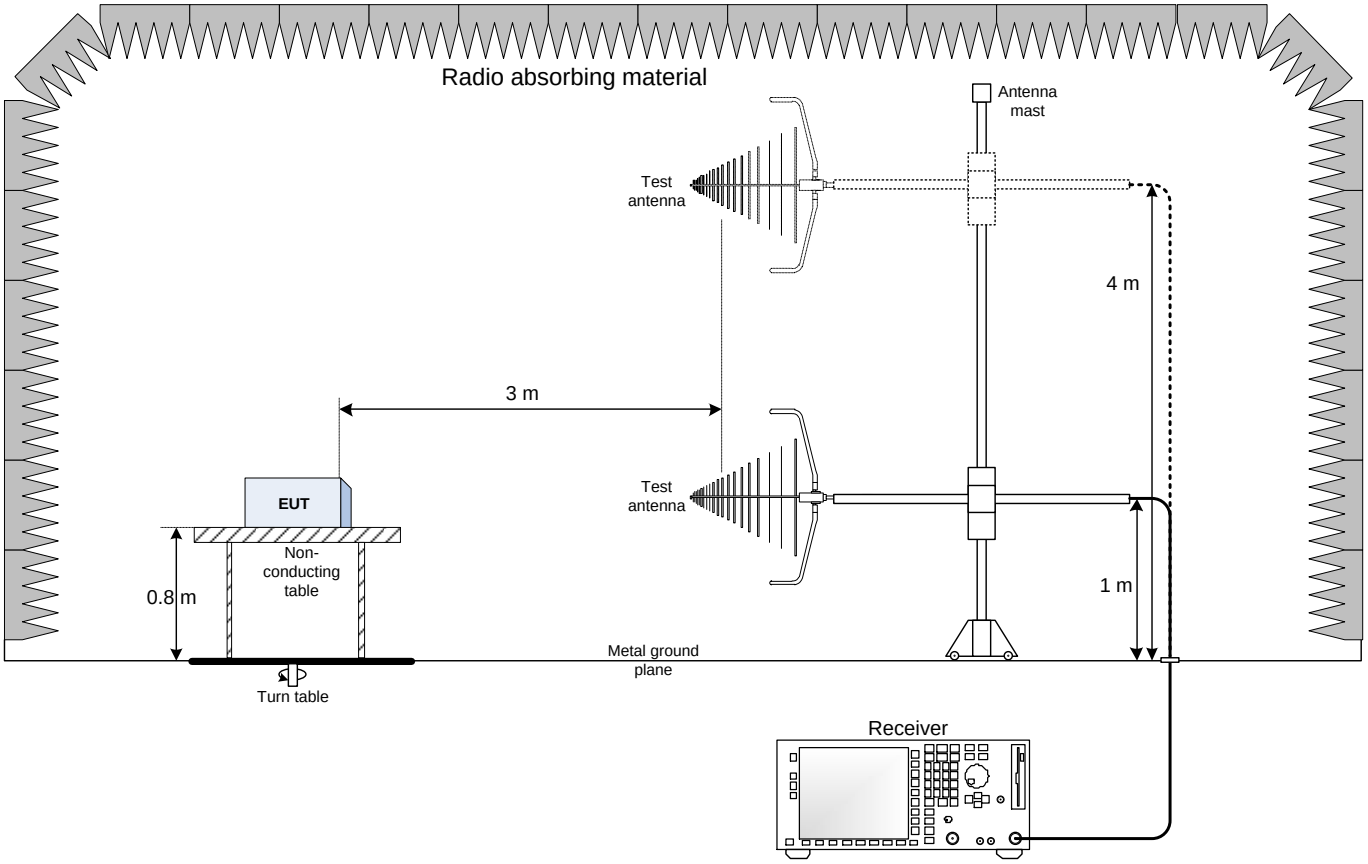
Plot 8.6-8: Radiated spurious emissions 140–220 GHz

3 m distance

- All measurements were performed at a distance of 3m except were we moved in to decrease the noise floor.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up