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Compliance test report ID **211905-1TRFWL**

Date of issue
October 3, 2012

FCC 47 CFR Part 15 Subpart C, §15.247

Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
and

RSS-210, Issue 8 Annex 8

Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands

Applicant	**Thales Canada Inc.**
Product	**ComTrac Radio**
Model	**1964500-901**
FCC ID	**PXOCBTC-RADIO**
IC Reg. #	**7489B-CBTCRADIO**

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

SCC Accredited LAB
LAB Accrédité CCN

Test location

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

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Tested by Andrey Adelberg, Senior Wireless/EMC Specialist

Reviewed by Kevin Rose, Wireless/EMC Specialist

October 3, 2012
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.

Copyright notification

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Section 1 Report summary

1.1 Applicant and manufacturer

Thales Canada Inc.
1 Chrysalis Way
Nepean, Ontario
K2G 6P9 Canada

1.2 Test specifications

Standard	Description
FCC 47 CFR Part 15, Subpart C, Chapter 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
RSS-210, Issue 8 Annex 8	Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands

1.3 Test guidance

DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

1.4 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.

1.5 Exclusions

None

1.6 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	Not applicable[1]
§15.31(e)	Variation of power source	Pass[2]
§15.203	Antenna requirement	Pass

Notes:
[1] The EUT is powered from DC power line.
[2] 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
§15.247(a)(1)	Frequency hopping systems	
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Not applicable
§15.247(b)	Maximum conducted peak output power and EIRP	
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Pass
§15.247(b)(2)	Maximum peak output power of frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Not applicable
§15.247(b)(4)	Conducted peak output power limitations	
§15.247(b)(4)(i)	Maximum peak output power for systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations.	Not applicable
§15.247(b)(4)(ii)	Maximum peak output power for systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations.	Not applicable
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Pass
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Pass
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Not applicable
§15.247(f)	Time of occupancy and power spectral density for hybrid systems	Not applicable

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[1]
6.2	Receiver spurious emissions limits (antenna conducted)	Not applicable[1]
7.2.4	AC power lines conducted emission limits	Not applicable[2]

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] The EUT is powered from DC power line.

2.4 IC RSS-210, Issue 8, test results

Part	Test description	Verdict
A8.1	Frequency hopping systems	
A8.1 (a)	Bandwidth of a frequency hopping channel	Pass
A8.1 (b)	Minimum channel spacing for frequency hopping systems	Pass
A8.1 (c)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
A8.1 (d)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
A8.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
A8.2	Digital modulation systems	
A8.2 (a)	Minimum 6 dB bandwidth	Not applicable
A8.2 (b)	Maximum power spectral density	Not applicable
A8.3	Hybrid systems	
A8.3 (1)	Digital modulation turned off	Not applicable
A8.3 (2)	Frequency hopping turned off	Not applicable
A8.4	Transmitter output power and e.i.r.p. requirements	
A8.4 (1)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
A8.4 (2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
A8.4 (3)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
A8.4 (4)	Systems employing digital modulation techniques	Not applicable
A8.4 (5)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
A8.4 (6)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Pass
A8.5	Out-of-band emissions	Pass

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	July 16, 2012
Nemko sample ID number	1

3.2 EUT information

Product name	ComTrac Radio
Model	1964500-901
Serial number	12-X016
Part number	1964500-901

3.3 Technical information

Operating band	2400–2483.5 MHz
Operating frequency	2402–2480 MHz
Modulation type	Gaussian Frequency Shift Keying (GFSK) for 802.11/FHSS
Occupied bandwidth (99 %)	907.1 kHz
Emission designator	907KG1D
Power requirements	12 V_{DC} from DC power line of car battery
Antenna information	Huber+Suhner Linear polarized directional WiFi-Antenna, 1324.17.0098 8.5 dBi (MR application) Huber+Suhner Linear polarized directional WiFi-Antenna, 1324.99.0025, 8.5 dBi (MR application) Andrew Flat Planar Array Microceptor Antenna, QD-2402, 16 dBi (AP applications) The EUT is professionally installed.

3.4 Product description and theory of operation

ComTrac is a data communication system utilized with the Seltrac Railway Signaling System that uses a wireless system operating in unlicensed spectrum (2.4 GHz Industrial, Scientific, and Medical (ISM)) to provide a robust and reliable communications link between trains and the control network infrastructure.

The ComTrac Software Defined Radio (CSDR) is a radio that, through software configuration, is backwards compatible with existing ComTrac radios and provides a platform to implement future radio communication requirements. The CSDR implements a IEEE 802.11 Frequency Hopping Spread Spectrum (FHSS) compliant modem that is compatible with existing ComTrac FHSS radios.

The ComTrac Software Defined Radio is to be deployed in two different scenarios:

1. A Wayside Radio Unit (WRU): deployed on the trackside, where it provides the trackside half of the wireless link to connect the control network infrastructure to trains. The system is powered through an external Direct Current (DC) power supply.
2. An On Board Radio Unit (OBRU): deployed on a train, where it provides the train based half of the wireless link.

3.5 EUT exercise details

EUT was controlled from Laptop via Hyper terminal.

3.6 EUT setup diagram

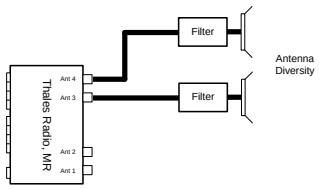


***Diagram 3.6-1**: Setup diagram for MR application*

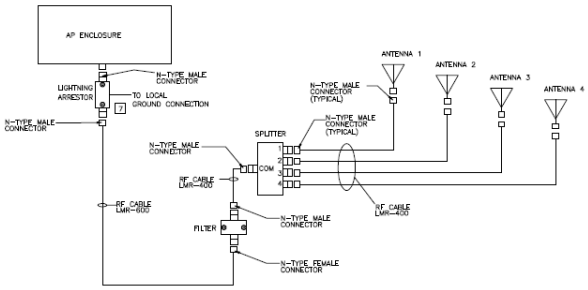


***Diagram 3.6-2**: Setup diagram for AP application (maximum load)*

3.7 EUT sub assemblies

Description	Brand name	Model/Part number	Serial number	Rev.
EUT	Thales	1964500-901	12-X016	–
Antenna (for MR applications)	Huber+Suhner	1324.17.0098	–	–
Antenna (for MR applications)	Huber+Suhner	1324.99.0025	–	–
Filter	L-Com	SP69772	–	–
Lightning arrestor	–	AL-NMNFB-9	–	–
Splitter	L-Com	SC240xN	–	–
Cable	–	LMR-400	–	–
Cable	–	LMR-600	–	–

3.8 Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	IBM	ThinkPad/ Lenovo E60	LV-AD828 07/02	–

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 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 26	FA002043	1 year	May 16/13
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Feb. 09/13
Bilog antenna	Sunol	JB3	FA002108	1 year	Feb. 07/13
Horn antenna #2	EMCO	3115	FA000825	1 year	Feb. 24/13
1–18 GHz pre-amplifier	JCA	JCA118-503	FA002091	1 year	July 03/13
Horn antenna 18–26.5 GHz	Electro-metrics	SH-50/60-1	FA000479	—	VOU
18–26 GHz pre-amplifier	Narda	BBS-1826N612	FA001550	—	VOU
Note: NCR - no calibration required, VOU - verify on use					

Section 8 Testing data

8.1 Frequency hopping requirements

8.1.1 Definitions and limits

FCC Clause 15.247(a)(1) and RSS-210 Clause A8.1: Frequency hopping requirements

FCC:

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(ii) Frequency hopping systems operating in the 5725–5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

IC:

A8.1 (a) Bandwidth of a frequency hopping channel

The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system RF bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset while the long term distribution appears evenly distributed.

A8.1 (b) Minimum channel spacing for frequency hopping systems

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125 W. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

A8.1 (d) Frequency hopping systems operating in the 2400–2483.5 MHz band

Frequency hopping systems operating in the 2400–2483.5 MHz band shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

8.1.2 Test summary

Test date	July 30, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1005 mbar	**Relative humidity**	33 %

8.1.3 Observations/special notes and procedures

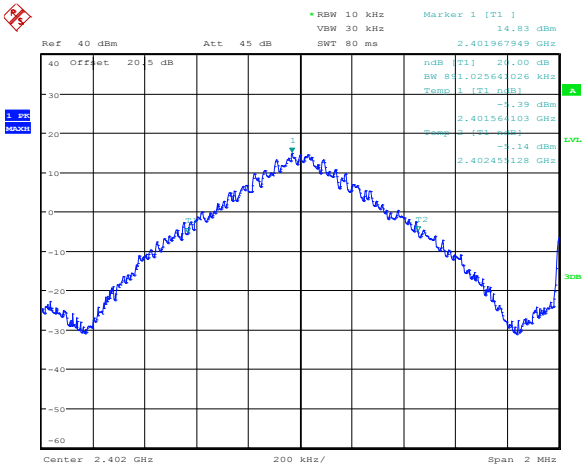
Carrier Frequency Separation
The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span
Video (or Average) Bandwidth (VBW) ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Number of Hopping Frequencies
The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
Span = the frequency band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

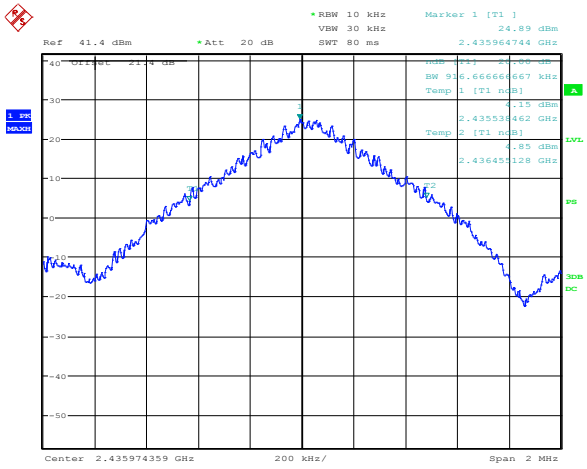
Time of Occupancy (Dwell Time)
The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
Span = zero span, centered on a hopping channel
RBW = 1 MHz
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector function = peak
Trace = max hold

20 dB Bandwidth
Use the following spectrum analyzer settings:
Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
RBW ≥ 1% of the 20 dB bandwidth
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

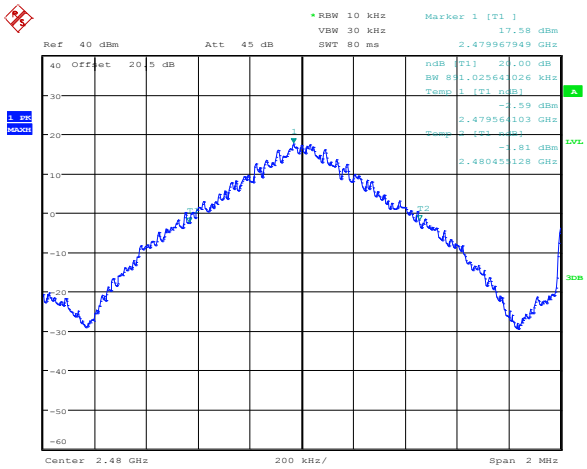
8.1.1 Test data



Plot 8.1-1: *20 dB bandwidth on low channel*



Plot 8.1-2: *20 dB bandwidth on mid channel*

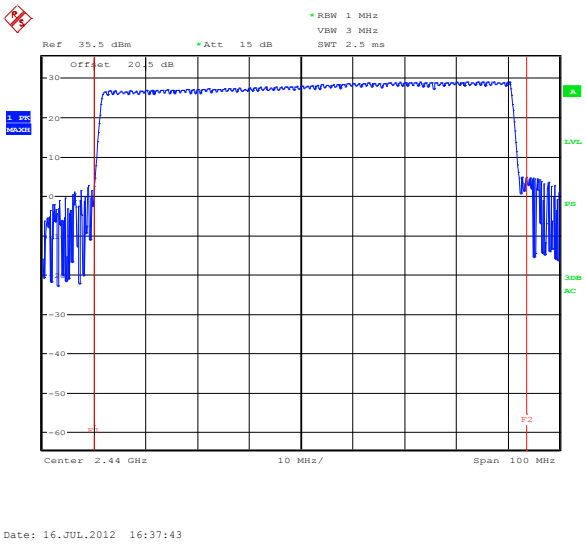


Plot 8.1-3: *20 dB bandwidth on high channel*

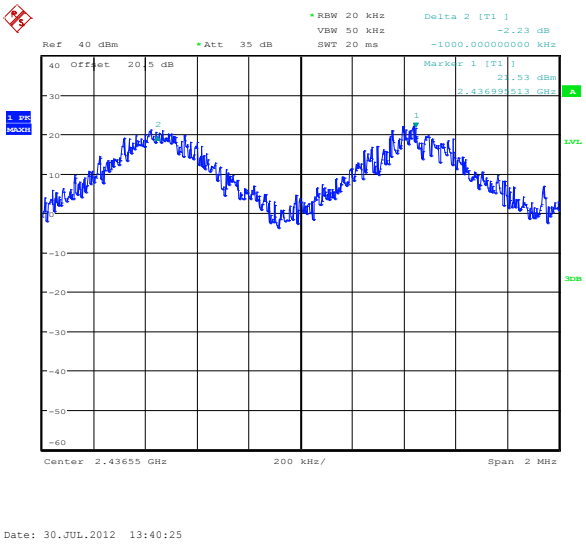
Table 8.1-1: *20 dB bandwidth results*

Frequency (MHz)	20 dB bandwidth (kHz)
2402	891.026
2436	916.667
2480	891.026

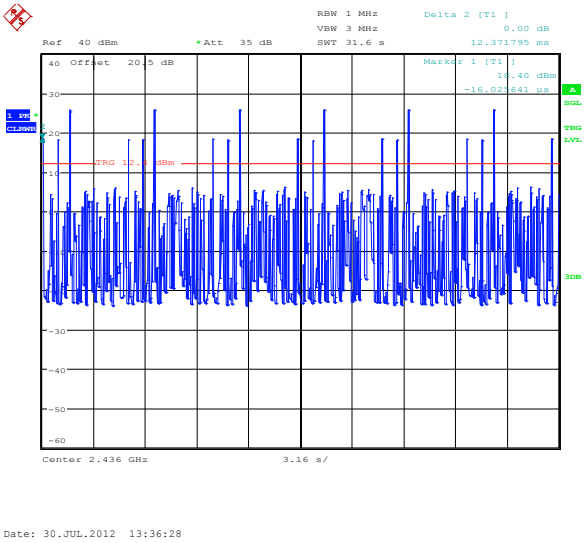
8.1.4 Test data, continued



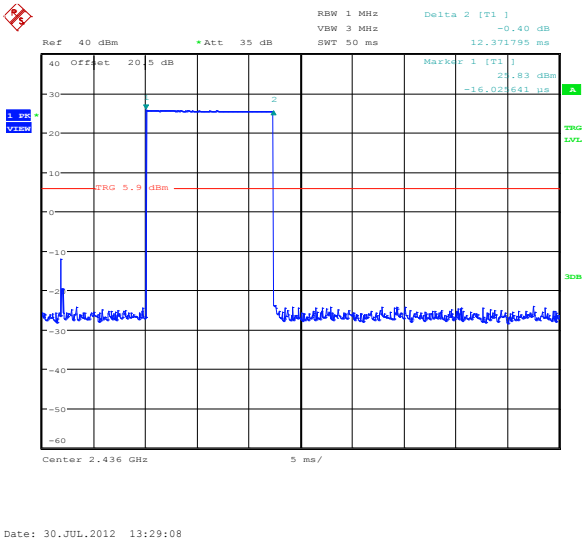
Plot 8.1-4: *Number of hopping channels (79 channels)*



Plot 8.1-5: *Carrier frequency separation (1 MHz)*



Plot 8.1-6: *Period for average time of occupancy, 31.6 s*



Plot 8.1-7: *Average time of occupancy, pulse width*

Number of channels: 79
Period for average time of occupancy measurement: 0.4 s × 79 channels = 31.6 s
Channel utilization within test period: 6 times (in the plot above, only pulses above 20 dBm are actual occurrences on the selected channel)
Pulse width: 12.37 ms
Average time of occupancy: 6 × 12.37 ms = 74.22 ms

Table 8.1-2: *Average time of occupancy*

Average time of occupancy (ms)	Limit (ms)	Margin (ms)
74.22	400	325.78

8.2 RSS-Gen Clause 4.6.1 Occupied bandwidth

8.2.1 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.

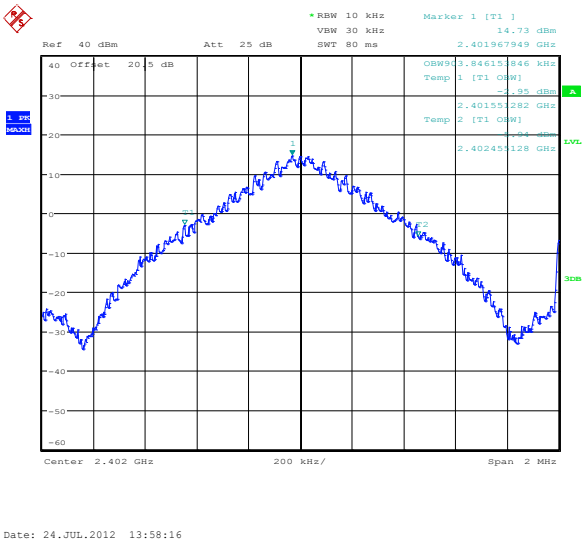
8.2.2 Test summary

Test date	July 23, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1003 mbar	**Relative humidity**	31 %

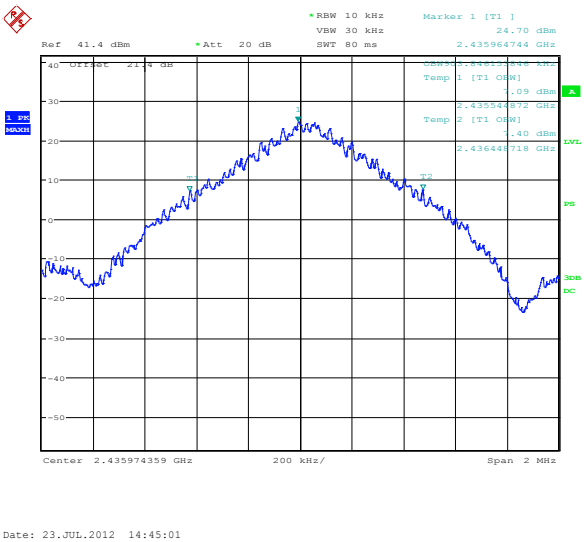
8.2.3 Observations/special notes

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

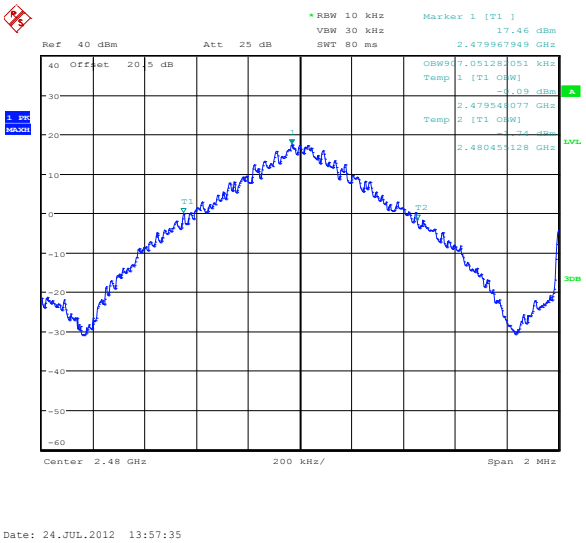
8.2.4 Test data



Plot 8.2-1: *99 % bandwidth – Low channel*



Plot 8.2-2: *99 % bandwidth – Mid channel*



Plot 8.2-3: *99 % bandwidth – High channel*

Table 8.2-1: *99 % bandwidth results*

Frequency (MHz)	99 % bandwidth (kHz)
2402	903.8
2436	903.8
2480	907.1

8.3 Transmitter output power and EIRP requirements for frequency hopping systems

8.3.1 Definitions and limits

FCC Clause 15.247(b) and RSS-210 Clause A8.4 (1, 2, 3) Transmitter output power and e.i.r.p. requirements for frequency hopping systems

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 W (30 dBm). For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 W (21 dBm).

(2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 W (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation, as used in paragraph (b)(4)(i) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

IC:

With the digital modulation operation of the hybrid system turned off, the frequency hopping operation shall have an average time of occupancy on any frequency not exceeding 0.4 seconds within a duration in seconds equal to the number of hopping frequencies multiplied by 0.4.

A8.4 (2) Transmitter Output Power and e.i.r.p. Requirements for Frequency hopping systems operating in the 2400–2483.5 MHz band

For frequency hopping systems operating in the band 2400–2483.5 MHz employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W (21 dBm). Except as provided in Section A8.4(5), the e.i.r.p. shall not exceed 4 W (36 dBm).

A8.4 (5) Point-to-point systems in the bands 2400–2483.5 MHz and 5725–5850 MHz.

Point-to-point systems in the bands 2400–2483.5 MHz and 5725–5850 MHz are permitted to have an e.i.r.p. higher than 4 W (36 dBm) provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding 4 W (36 dBm) e.i.r.p. However, remote stations of point-to-multipoint systems shall be allowed to operate at greater than 4 W (36 dBm) e.i.r.p. under the same conditions as for point-to-point systems.

8.3.2 Test summary

Test date	July 27, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1002 mbar	**Relative humidity**	32 %

8.3.3 Observations/special notes and procedures

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
RBW > the 20 dB bandwidth of the emission being measured
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the NOTE above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.

Describe how the EUT complies with the de facto EIRP limit for every antenna proposed for use with the EUT. This includes those devices that will be used in point-to-point applications. If the peak output power, as measured above, must be reduced so that the de facto EIRP limit may be met for a particular antenna, describe exactly how much it will be reduced for that antenna. If the peak output power level is raised above the limit in order to compensate for cable loss between the EUT and the antenna, specify the minimum length of cable which will always be used, the type of cable, and its loss, in dB per unit length, for the frequency of the emission. The limit is specified in one of the subparagraphs of this Section. Also, specify who will be responsible for ensuring that compliant operation is maintained for every antenna that will be used with the EUT.

Point-to-Point Operation

If the EIRP relaxation for point-to-point operation is proposed for any particular antenna, describe who will be responsible for ensuring that the EUT is only used in such an application.

8.3.4 Test data

Table 8.3-1: *Antenna path loss for AP configurations*

AP scenario, Number of antennas	Lightning Arrestor (AL-NMNFB-9):	Filter: (L-COM, SP69772)	Splitter: (L-COM, SC240xN)	1st Cable type: (LMR-600, 3m)	2nd Cable type: (LMR-400, 1m)	Total path attenuation (dB)
1	0.4 dB	2 dB	–	0.5 dB	0.5 dB	3.4
2	0.4 dB	2 dB	3.5 dB	0.5 dB	0.5 dB	6.9
3	0.4 dB	2 dB	6.5 dB	0.5 dB	0.5 dB	9.9
4	0.4 dB	2 dB	9.5 dB	0.5 dB	0.5 dB	12.9
1	0.4 dB	–	–	0.5 dB	0.5 dB	1.4
2	0.4 dB	–	3.5 dB	0.5 dB	0.5 dB	4.9
3	0.4 dB	–	6.5 dB	0.5 dB	0.5 dB	7.9
4	0.4 dB	–	9.5 dB	0.5 dB	0.5 dB	10.9

Table 8.3-2: *Conducted output power results for AP application with filter at antenna port 1*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	19.97	23.40	3.43
	2436	23.22	23.40	0.18
	2480	22.88	23.40	0.52
2	2402	20.89	23.89	3.00
	2436	23.28	23.89	0.61
	2480	23.89	23.89	0.00
3	2402	21.77	25.13	3.36
	2436	24.11	25.13	1.02
	2480	24.84	25.13	0.29
4	2402	23.84	26.88	3.04
	2436	26.13	26.88	0.75
	2480	26.80	26.88	0.08

8.3.4 Test data, continued

Table 8.3-3: *EIRP calculation results for AP application with filter at antenna port 1*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	19.97	3.4	16.00	32.57	36.00	3.43
	2436	23.22	3.4	16.00	35.82	36.00	0.18
	2480	22.88	3.4	16.00	35.48	36.00	0.52
2	2402	20.89	6.9	19.01	33.00	36.00	3.00
	2436	23.28	6.9	19.01	35.39	36.00	0.61
	2480	23.89	6.9	19.01	36.00	36.00	0.00
3	2402	21.77	9.9	20.77	32.64	36.00	3.36
	2436	24.11	9.9	20.77	34.98	36.00	1.02
	2480	24.84	9.9	20.77	35.71	36.00	0.29
4	2402	23.84	12.9	22.02	32.96	36.00	3.04
	2436	26.13	12.9	22.02	35.25	36.00	0.75
	2480	26.80	12.9	22.02	35.92	36.00	0.08

Table 8.3-4: *Conducted output power results for AP application with filter at antenna port 2*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	19.96	23.40	3.44
	2436	23.37	23.40	0.03
	2480	23.00	23.40	0.40
2	2402	20.00	23.89	3.89
	2436	23.39	23.89	0.50
	2480	23.29	23.89	0.60
3	2402	21.93	25.13	3.20
	2436	24.45	25.13	0.68
	2480	25.10	25.13	0.03
4	2402	23.88	26.88	3.00
	2436	26.57	26.88	0.31
	2480	26.13	26.88	0.75

Table 8.3-5: *EIRP calculation results for AP application with filter at antenna port 2*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	19.96	3.4	16.00	32.56	36.00	3.44
	2436	23.37	3.4	16.00	35.97	36.00	0.03
	2480	23.00	3.4	16.00	35.60	36.00	0.40
2	2402	20.00	6.9	19.01	32.11	36.00	3.89
	2436	23.39	6.9	19.01	35.50	36.00	0.50
	2480	23.29	6.9	19.01	35.40	36.00	0.60
3	2402	21.93	9.9	20.77	32.80	36.00	3.20
	2436	24.45	9.9	20.77	35.32	36.00	0.68
	2480	25.10	9.9	20.77	35.97	36.00	0.03
4	2402	23.88	12.9	22.02	33.00	36.00	3.00
	2436	26.57	12.9	22.02	35.69	36.00	0.31
	2480	26.13	12.9	22.02	35.25	36.00	0.75

8.3.4 Test data, continued

Table 8.3-6: *Conducted output power results for AP application with filter at antenna port 3*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	20.01	23.40	3.39
	2436	22.60	23.40	0.80
	2480	22.64	23.40	0.76
2	2402	20.89	23.89	3.00
	2436	23.58	23.89	0.31
	2480	23.79	23.89	0.10
3	2402	22.03	25.13	3.10
	2436	24.86	25.13	0.27
	2480	24.61	25.13	0.52
4	2402	23.88	26.88	3.00
	2436	26.67	26.88	0.21
	2480	26.59	26.88	0.29

Table 8.3-7: *EIRP calculation results for AP application with filter at antenna port 3*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	20.01	3.4	16.00	32.61	36.00	3.39
	2436	22.60	3.4	16.00	35.20	36.00	0.80
	2480	22.64	3.4	16.00	35.24	36.00	0.76
2	2402	20.89	6.9	19.01	33.00	36.00	3.00
	2436	23.58	6.9	19.01	35.69	36.00	0.31
	2480	23.79	6.9	19.01	35.90	36.00	0.10
3	2402	22.03	9.9	20.77	32.90	36.00	3.10
	2436	24.86	9.9	20.77	35.73	36.00	0.27
	2480	24.61	9.9	20.77	35.48	36.00	0.52
4	2402	23.88	12.9	22.02	33.00	36.00	3.00
	2436	26.67	12.9	22.02	35.79	36.00	0.21
	2480	26.59	12.9	22.02	35.71	36.00	0.29

Table 8.3-8: *Conducted output power results for AP application with filter at antenna port 4*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	19.60	23.40	3.80
	2436	23.35	23.40	0.05
	2480	22.73	23.40	0.67
2	2402	20.89	23.89	3.00
	2436	23.29	23.89	0.60
	2480	23.89	23.89	0.00
3	2402	21.54	25.13	3.59
	2436	24.17	25.13	0.96
	2480	24.73	25.13	0.40
4	2402	23.51	26.88	3.37
	2436	26.35	26.88	0.53
	2480	26.88	26.88	0.00

8.3.4 Test data, continued

Table 8.3-9: *EIRP calculation results for AP application with filter at antenna port 4*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	19.60	3.4	16.00	32.20	36.00	3.80
	2436	23.35	3.4	16.00	35.95	36.00	0.05
	2480	22.73	3.4	16.00	35.33	36.00	0.67
2	2402	20.89	6.9	19.01	33.00	36.00	3.00
	2436	23.29	6.9	19.01	35.40	36.00	0.60
	2480	23.89	6.9	19.01	36.00	36.00	0.00
3	2402	21.54	9.9	20.77	32.41	36.00	3.59
	2436	24.17	9.9	20.77	35.04	36.00	0.96
	2480	24.73	9.9	20.77	35.60	36.00	0.40
4	2402	23.51	12.9	22.02	32.63	36.00	3.37
	2436	26.35	12.9	22.02	35.47	36.00	0.53
	2480	26.88	12.9	22.02	36.00	36.00	0.00

Table 8.3-10: *Conducted output power results for AP application without filter at antenna port 1*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	17.86	21.40	3.54
	2436	21.10	21.40	0.30
	2480	20.83	21.40	0.57
2	2402	18.65	21.89	3.24
	2436	21.12	21.89	0.77
	2480	21.67	21.89	0.22
3	2402	19.65	23.13	3.48
	2436	22.80	23.13	0.33
	2480	22.64	23.13	0.49
4	2402	21.71	24.88	3.17
	2436	24.71	24.88	0.17
	2480	24.42	24.88	0.46

Table 8.3-11: *EIRP calculation results for AP application without filter at antenna port 1*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	17.86	1.4	16.00	32.46	36.00	3.54
	2436	21.1	1.4	16.00	35.70	36.00	0.30
	2480	20.83	1.4	16.00	35.43	36.00	0.57
2	2402	18.65	4.9	19.01	32.76	36.00	3.24
	2436	21.12	4.9	19.01	35.23	36.00	0.77
	2480	21.67	4.9	19.01	35.78	36.00	0.22
3	2402	19.65	7.9	20.77	32.52	36.00	3.48
	2436	22.8	7.9	20.77	35.67	36.00	0.33
	2480	22.64	7.9	20.77	35.51	36.00	0.49
4	2402	21.71	10.9	22.02	32.83	36.00	3.17
	2436	24.71	10.9	22.02	35.83	36.00	0.17
	2480	24.42	10.9	22.02	35.54	36.00	0.46

8.3.4 Test data, continued

Table 8.3-12: *Conducted output power results for AP application without filter at antenna port 2*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	18.18	21.40	3.22
	2436	21.24	21.40	0.16
	2480	20.74	21.40	0.66
2	2402	18.15	21.89	3.74
	2436	21.24	21.89	0.65
	2480	21.89	21.89	0.00
3	2402	20.10	23.13	3.03
	2436	22.42	23.13	0.71
	2480	22.86	23.13	0.27
4	2402	21.07	24.88	3.81
	2436	24.58	24.88	0.30
	2480	24.88	24.88	0.00

Table 8.3-13: *EIRP calculation results for AP application without filter at antenna port 2*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	18.18	1.4	16.00	32.78	36.00	3.22
	2436	21.24	1.4	16.00	35.84	36.00	0.16
	2480	20.74	1.4	16.00	35.34	36.00	0.66
2	2402	18.15	4.9	19.01	32.26	36.00	3.74
	2436	21.24	4.9	19.01	35.35	36.00	0.65
	2480	21.89	4.9	19.01	36.00	36.00	0.00
3	2402	20.10	7.9	20.77	32.97	36.00	3.03
	2436	22.42	7.9	20.77	35.29	36.00	0.71
	2480	22.86	7.9	20.77	35.73	36.00	0.27
4	2402	21.07	10.9	22.02	32.19	36.00	3.81
	2436	24.58	10.9	22.02	35.70	36.00	0.30
	2480	24.88	10.9	22.02	36.00	36.00	0.00

Table 8.3-14: *Conducted output power results for AP application without filter at antenna port 3*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	17.52	21.40	3.88
	2436	21.05	21.40	0.35
	2480	21.39	21.40	0.01
2	2402	18.47	21.89	3.42
	2436	21.05	21.89	0.84
	2480	21.35	21.89	0.54
3	2402	19.62	23.13	3.51
	2436	23.10	23.13	0.03
	2480	23.10	23.13	0.03
4	2402	21.66	24.88	3.22
	2436	24.88	24.88	0.00
	2480	23.98	24.88	0.90

8.3.4 Test data, continued

Table 8.3-15: *EIRP calculation results for AP application without filter at antenna port 3*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	17.52	1.4	16.00	32.12	36.00	3.88
	2436	21.05	1.4	16.00	35.65	36.00	0.35
	2480	21.39	1.4	16.00	35.99	36.00	0.01
2	2402	18.47	4.9	19.01	32.58	36.00	3.42
	2436	21.05	4.9	19.01	35.16	36.00	0.84
	2480	21.35	4.9	19.01	35.46	36.00	0.54
3	2402	19.62	7.9	20.77	32.49	36.00	3.51
	2436	23.10	7.9	20.77	35.97	36.00	0.03
	2480	23.10	7.9	20.77	35.97	36.00	0.03
4	2402	21.66	10.9	22.02	32.78	36.00	3.22
	2436	24.88	10.9	22.02	36.00	36.00	0.00
	2480	23.98	10.9	22.02	35.10	36.00	0.90

Table 8.3-16: *Conducted output power results for AP application without filter at antenna port 4*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
1	2402	18.40	21.40	3.00
	2436	21.29	21.40	0.11
	2480	20.47	21.40	0.93
2	2402	18.39	21.89	3.50
	2436	21.29	21.89	0.60
	2480	21.48	21.89	0.41
3	2402	19.50	23.13	3.63
	2436	22.25	23.13	0.88
	2480	22.38	23.13	0.75
4	2402	21.53	24.88	3.35
	2436	24.31	24.88	0.57
	2480	24.64	24.88	0.24

Table 8.3-17: *EIRP calculation results for AP application without filter at antenna port 4*

AP scenario, Number of antennas	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	2402	18.40	1.4	16.00	33.00	36.00	3.00
	2436	21.29	1.4	16.00	35.89	36.00	0.11
	2480	20.47	1.4	16.00	35.07	36.00	0.93
2	2402	18.39	4.9	19.01	32.50	36.00	3.50
	2436	21.29	4.9	19.01	35.40	36.00	0.60
	2480	21.48	4.9	19.01	35.59	36.00	0.41
3	2402	19.50	7.9	20.77	32.37	36.00	3.63
	2436	22.25	7.9	20.77	35.12	36.00	0.88
	2480	22.38	7.9	20.77	35.25	36.00	0.75
4	2402	21.53	10.9	22.02	32.65	36.00	3.35
	2436	24.31	10.9	22.02	35.43	36.00	0.57
	2480	24.64	10.9	22.02	35.76	36.00	0.24

8.3.4 Test data, continued

Table 8.3-18: *Antenna path loss for MR configurations*

MR scenario,	Filter: (L-COM, SP69772)	Cable: (LMR-600, 3m)	Total path attenuation (dB)
Without filter	–	0.5	0.5
With filter	2	0.5	2.5

Table 8.3-19: *Conducted output power results for MR application at antenna port 1*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.47	28.00	3.53
	2436	27.89	28.00	0.11
	2480	27.42	28.00	0.58
With filter	2402	26.99	30.00	3.01
	2436	29.31	30.00	0.69
	2480	29.29	30.00	0.71

Table 8.3-20: *EIRP calculation results for MR application at antenna port 1*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.47	0.5	8.50	32.47	36.00	3.53
	2436	27.89	0.5	8.50	35.89	36.00	0.11
	2480	27.42	0.5	8.50	35.42	36.00	0.58
With filter	2402	26.99	2.5	8.50	32.99	36.00	3.01
	2436	29.31	2.5	8.50	35.31	36.00	0.69
	2480	29.29	2.5	8.50	35.29	36.00	0.71

Table 8.3-21: *Conducted output power results for MR application at antenna port 2*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.99	28.00	3.01
	2436	27.55	28.00	0.45
	2480	27.83	28.00	0.17
With filter	2402	26.82	30.00	3.18
	2436	29.80	30.00	0.20
	2480	29.67	30.00	0.33

Table 8.3-22: *EIRP calculation results for MR application at antenna port 2*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.99	0.5	8.50	32.99	36.00	3.01
	2436	27.55	0.5	8.50	35.55	36.00	0.45
	2480	27.83	0.5	8.50	35.83	36.00	0.17
With filter	2402	26.82	2.5	8.50	32.82	36.00	3.18
	2436	29.8	2.5	8.50	35.80	36.00	0.20
	2480	29.67	2.5	8.50	35.67	36.00	0.33

8.3.4 Test data, continued

Table 8.3-23: *Conducted output power results for MR application at antenna port 3*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.77	28.00	3.23
	2436	27.75	28.00	0.25
	2480	27.69	28.00	0.31
With filter	2402	26.45	30.00	3.55
	2436	29.86	30.00	0.14
	2480	29.63	30.00	0.37

Table 8.3-24: *EIRP calculation results for MR application at antenna port 3*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.77	0.5	8.50	32.77	36.00	3.23
	2436	27.75	0.5	8.50	35.75	36.00	0.25
	2480	27.69	0.5	8.50	35.69	36.00	0.31
With filter	2402	26.45	2.5	8.50	32.45	36.00	3.55
	2436	29.86	2.5	8.50	35.86	36.00	0.14
	2480	29.63	2.5	8.50	35.63	36.00	0.37

Table 8.3-25: *Conducted output power results for MR application at antenna port 4*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.52	28.00	3.48
	2436	27.39	28.00	0.61
	2480	27.58	28.00	0.42
With filter	2402	26.99	30.00	3.01
	2436	29.98	30.00	0.02
	2480	29.93	30.00	0.07

Table 8.3-26: *EIRP calculation results for MR application at antenna port 4*

MR scenario	Frequency (MHz)	Conducted output power (dBm)	Path loss (dB)	Total antenna gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Without filter	2402	24.52	0.5	8.50	32.52	36.00	3.48
	2436	27.39	0.5	8.50	35.39	36.00	0.61
	2480	27.58	0.5	8.50	35.58	36.00	0.42
With filter	2402	26.99	2.5	8.50	32.99	36.00	3.01
	2436	29.98	2.5	8.50	35.98	36.00	0.02
	2480	29.93	2.5	8.50	35.93	36.00	0.07

8.4 Spurious (out-of-band) emissions

8.4.1 Definitions and limits

FCC Clause 15.247(d): Spurious emissions
RSS-210 Clause A8.5 Out-of-band emissions

FCC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

IC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Table 8.4-1 is not required.

Table 8.4-1: *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	$67.6-20\times\log_{10}(F)$	300
0.490–1.705*	24000/F	$87.6-20\times\log_{10}(F)$	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			

Table 8.4-2: *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			

8.4.1 Definitions and limits, continued

Table 8.4-3: *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 8.4-3 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

8.4.2 Test summary

Test date	July 30, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1003 mbar	**Relative humidity**	31 %

8.4.3 Observations/special notes and procedures

Due to large margin (40 dBc) and very long time of data acquisition only sample plots were presented for band edges with hopping sequence turned on.
All measurements were performed with EUT setup at highest power settings scenario (both AP and MR configurations with filter scenarios).
The EUT was set to transmit with 100 % duty cycle in order to facilitate the measurement process.
Radiated Peak measurements were taken with RBW set to 1 MHz and VBW was set to 3 MHz. Average measurements were taken with RBW 1 MHz and VBW was set to 10 Hz. DCCF was also applied to the average measurement in order to respect duty cycle settings of the typical transmission pattern.

Unwanted Emissions into Non-Restricted Frequency Bands
If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level.
If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured inband average PSD level.
In either case, attenuation to levels below the general emission limits specified in §15.209(a) is not required.
The following procedures can be utilized to demonstrate compliance to these limits:
First, establish a reference level by using the following procedure for measuring the peak power level in any 100 kHz bandwidth within the fundamental emission:

8.4.3 Observations/special notes and procedures, continued

Measurement Procedure – Reference Level

a. Set the RBW = 100 kHz.
b. Set the VBW ≥ 300 kHz.
c. Set the span to 5–30 % greater than the EBW.
d. Detector = peak.
e. Sweep time = auto couple.
f. Trace mode = max hold.
g. Allow trace to fully stabilize.
h. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Next, determine the power in 100 kHz band segments outside of the authorized frequency band using the following measurement:

Measurement Procedure - Unwanted Emissions

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Set span to encompass the spectrum to be examined.
4. Detector = peak.
5. Trace Mode = max hold.
6. Sweep = auto couple.
7. Allow the trace to stabilize (this may take some time, depending on the extent of the span).

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified above.

Spurious RF Conducted Emissions (frequency hopping)

Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

8.4.4 Test data

Duty cycle/average factor calculations

§15.35(c) permits a duty cycle reduction to the measured field strength (or equivalent power) when pulsed operation is employed. This allowance is only applicable to unwanted emissions that demonstrate the same pulse characteristics as does the fundamental emission (e.g., harmonic emissions). The duty cycle (d.c.) is determined as follows:

For a pulse train ≤ 100 msec:

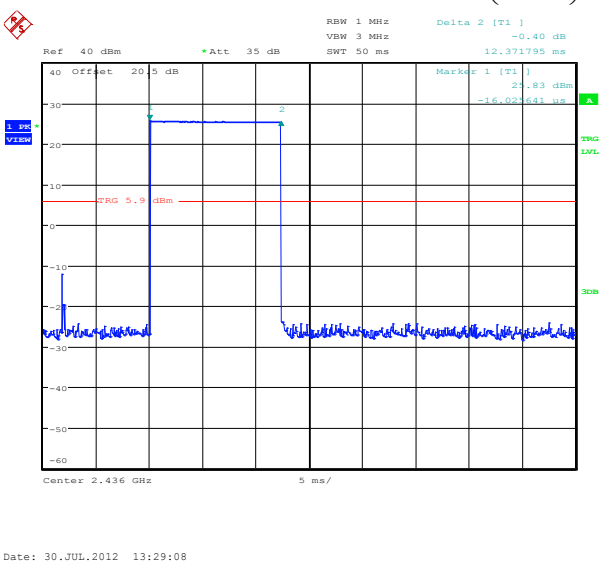
d.c. = cumulative on time/cumulative off time over the pulse train.

For a pulse train > 100 msec:

d.c. = cumulative on time/100 msec.

See C63.10 for further guidance in determining the applicable duty cycle.

$$Duty\,cycle\,/\,average\,factor = 20 \times \log_{10}\left(\frac{Tx_{100\,ms}}{100\,ms}\right)$$



Plot 8.4-1: *Transmission pulse width within 100 ms*

Duty cycle / average factor = 20 × $\log_{10}$ (12.37 ÷ 100) = −18.15 dB

8.4.4 Test data, continued

Table 8.4-4: *Radiated spurious emissions within restricted bands for AP configuration*

Channel	Frequency, (MHz)	Peak measurement			Average measurement				
		Field strength, (dBµV/m)	Limit, (dBµV/m)	Margin, (dB)	Field strength, (dBµV/m)	DCCF, (dB)	Final average, (dBµV/m)	Limit, (dBµV/m)	Margin, (dB)
Low	2390	73.83	74.00	0.17	70.36	-18.15	52.21	54.00	1.79
Low	3500	50.54	74.00	23.46	35.89	-18.15	17.74	54.00	36.26
Mid	5000	56.52	74.00	17.48	51.47	-18.15	33.32	54.00	20.68
High	2483.5	70.63	74.00	3.37	67.16	-18.15	49.01	54.00	4.99

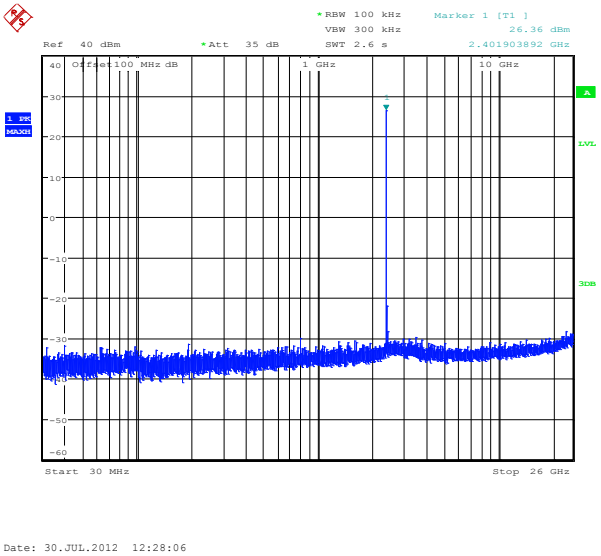
Table 8.4-5: *Radiated spurious emissions within restricted bands for MR configuration with 1324.99.0025 antenna*

Channel	Frequency, (MHz)	Peak measurement			Average measurement				
		Field strength, (dBµV/m)	Limit, (dBµV/m)	Margin, (dB)	Field strength, (dBµV/m)	DCCF, (dB)	Final average, (dBµV/m)	Limit, (dBµV/m)	Margin, (dB)
Low	2390	73.80	74.00	0.20	70.95	-18.15	52.80	54.00	1.20
Low	4804	55.11	74.00	18.89	48.18	-18.15	30.03	54.00	23.97
Mid	4872	57.20	74.00	16.80	51.77	-18.15	33.62	54.00	20.38
High	2483.5	66.26	74.00	7.74	63.41	-18.15	45.26	54.00	8.74

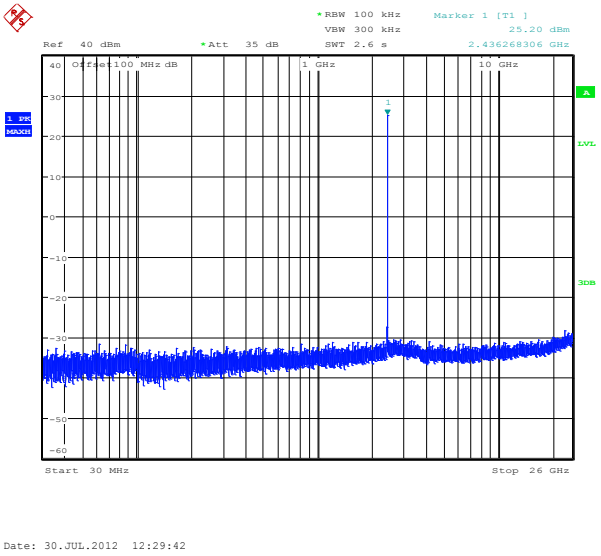
Table 8.4-6: *Radiated spurious emissions within restricted bands for MR configuration with 1324.17.0098 antenna*

Channel	Frequency, (MHz)	Peak measurement			Average measurement				
		Field strength, (dBµV/m)	Limit, (dBµV/m)	Margin, (dB)	Field strength, (dBµV/m)	DCCF, (dB)	Final average, (dBµV/m)	Limit, (dBµV/m)	Margin, (dB)
Low	2390	73.76	74.00	0.24	70.60	-18.15	52.45	54.00	1.55
Low	4804	54.35	74.00	19.65	51.19	-18.15	33.04	54.00	20.96
Mid	4872	54.02	74.00	19.98	50.86	-18.15	32.71	54.00	21.29
High	2483.5	70.12	74.00	3.88	66.96	-18.15	48.81	54.00	5.19
High	5000	55.79	74.00	18.21	52.63	-18.15	34.48	54.00	19.52

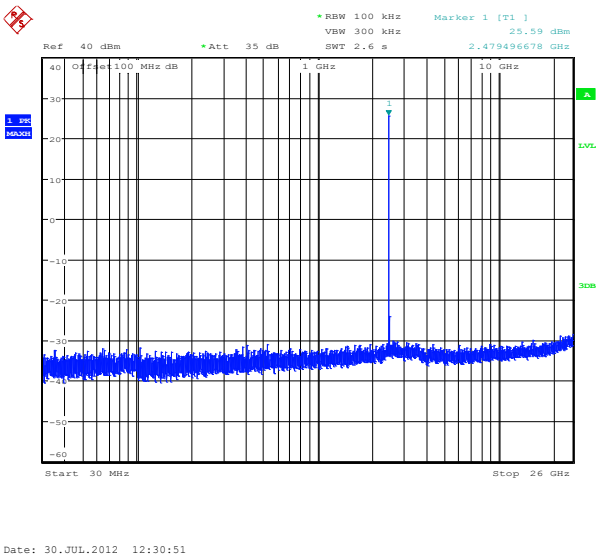
8.4.4 Test data, continued



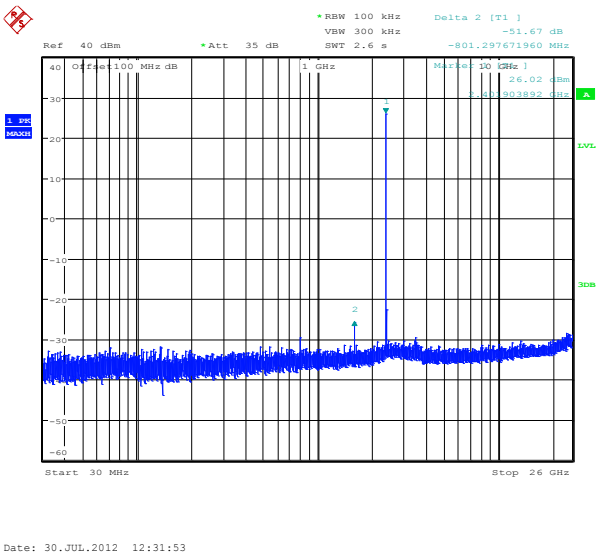
Plot 8.4-2: *Conducted spurious emissions of AP configuration with filter, antenna port 1, low channel*



Plot 8.4-3: *Conducted spurious emissions of AP configuration with filter, antenna port 1, mid channel*

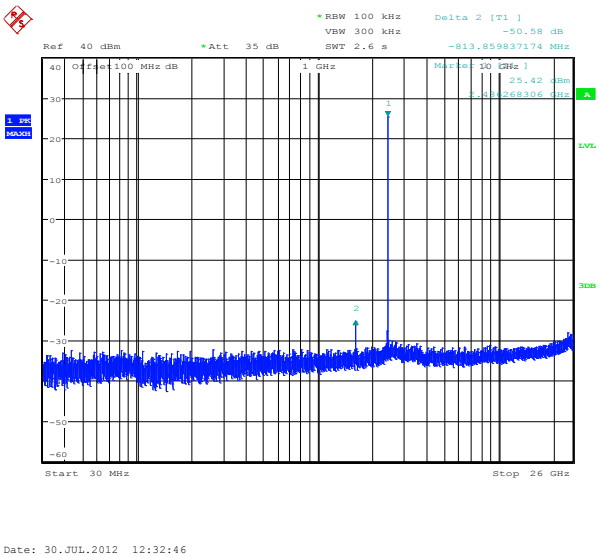


Plot 8.4-4: *Conducted spurious emissions of AP configuration with filter, antenna port 1, high channel*

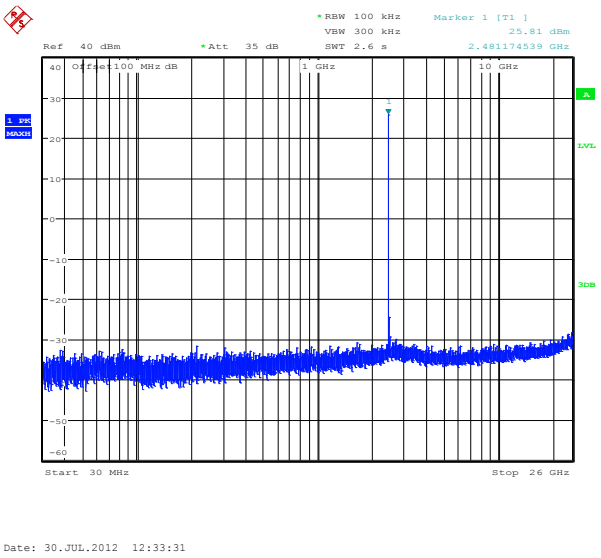


Plot 8.4-5: *Conducted spurious emissions of AP configuration with filter, antenna port 2, low channel*

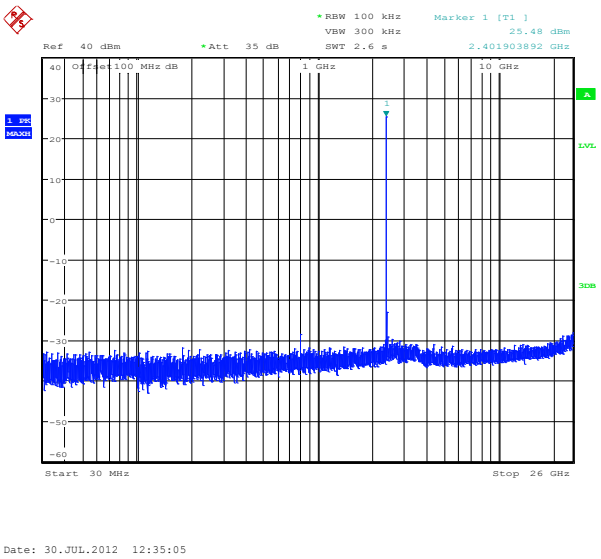
8.4.4 Test data, continued



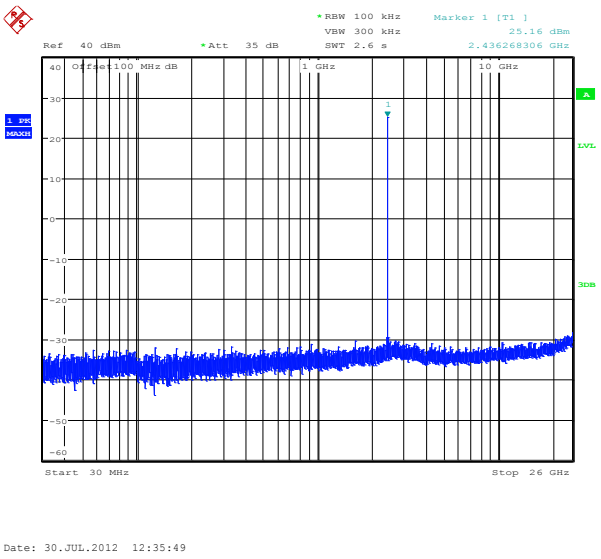
Plot 8.4-6: *Conducted spurious emissions of AP configuration with filter, antenna port 2, mid channel*



Plot 8.4-7: *Conducted spurious emissions of AP configuration with filter, antenna port 2, high channel*

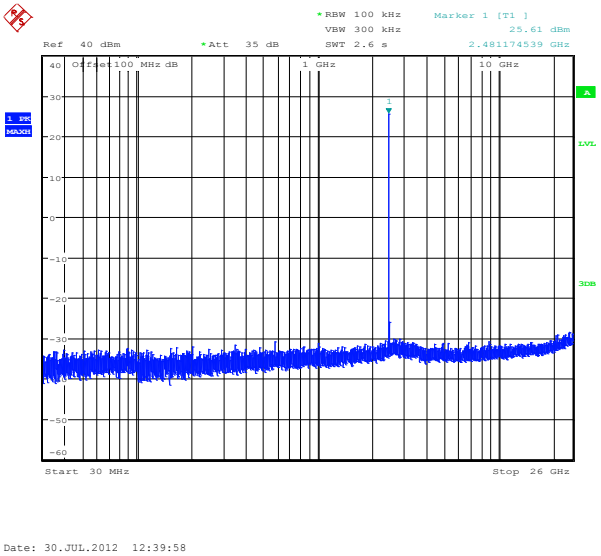


Plot 8.4-8: *Conducted spurious emissions of AP configuration with filter, antenna port 3, low channel*

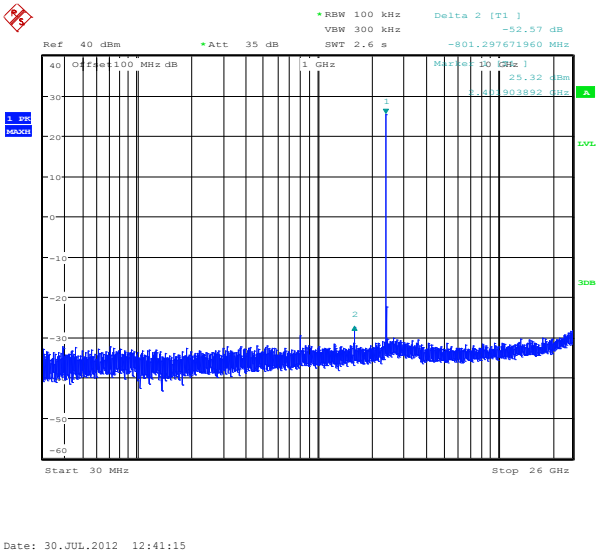


Plot 8.4-9: *Conducted spurious emissions of AP configuration with filter, antenna port 3, mid channel*

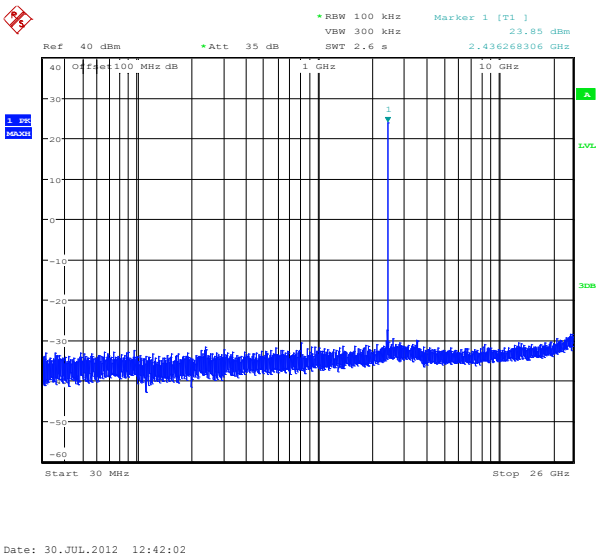
8.4.4 Test data, continued



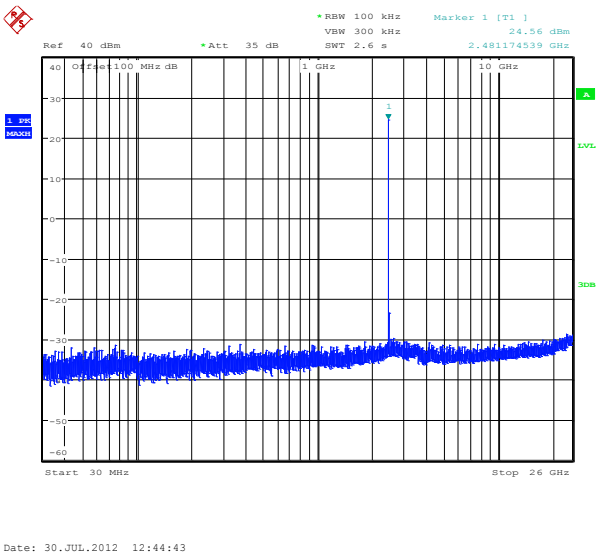
Plot 8.4-10: *Conducted spurious emissions of AP configuration with filter, antenna port 3, high channel*



Plot 8.4-11: *Conducted spurious emissions of AP configuration with filter, antenna port 4, low channel*

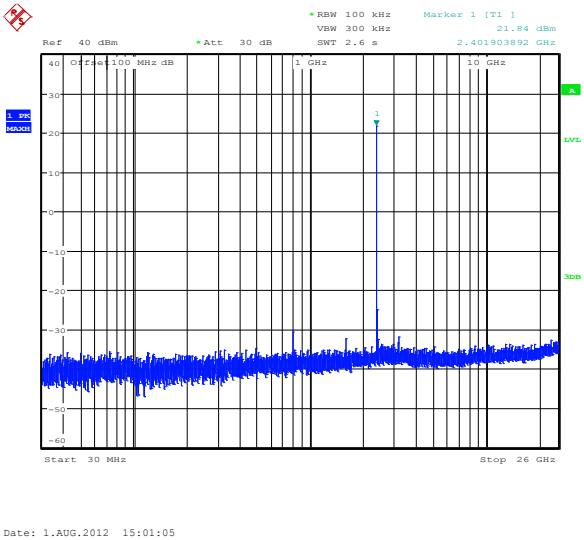


Plot 8.4-12: *Conducted spurious emissions of AP configuration with filter, antenna port 4, mid channel*

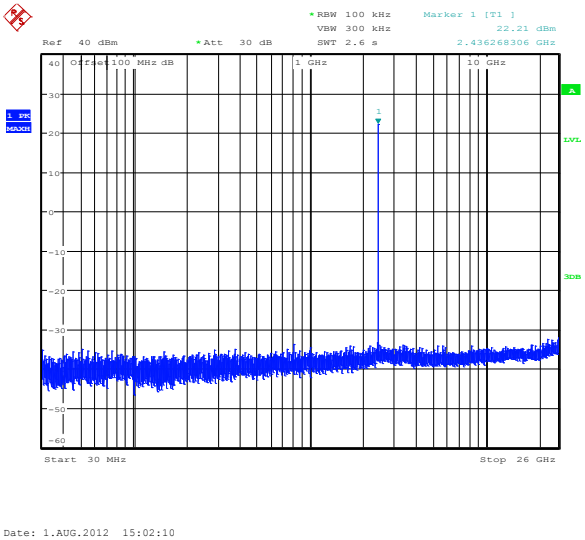


Plot 8.4-13: *Conducted spurious emissions of AP configuration with filter, antenna port 4, high channel*

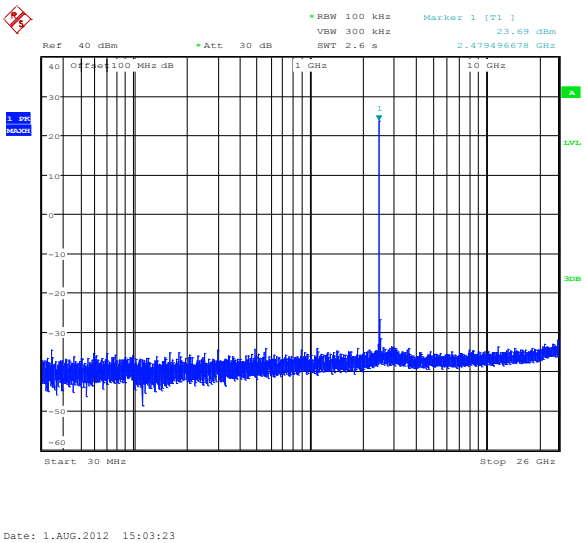
8.4.4 Test data, continued



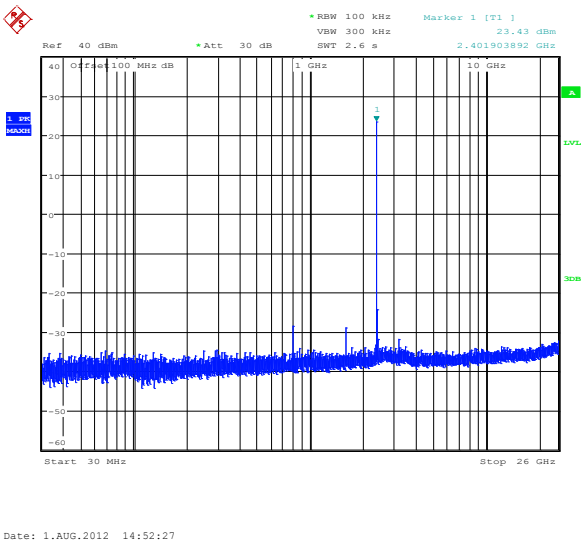
Plot 8.4-14: *Conducted spurious emissions of AP configuration without filter, antenna port 1, low channel*



Plot 8.4-15: *Conducted spurious emissions of AP configuration without filter, antenna port 1, mid channel*

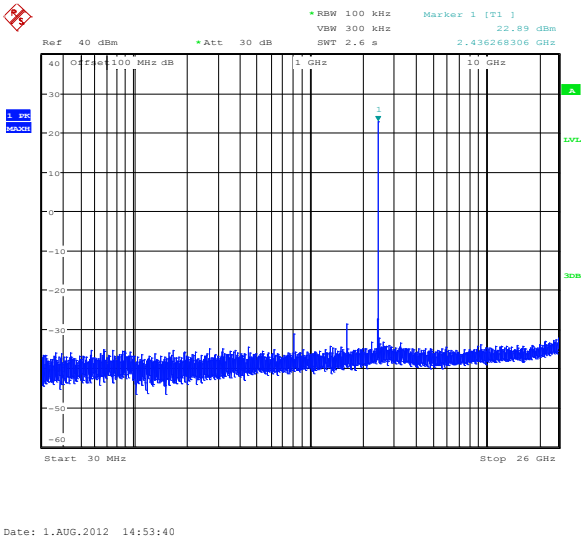


Plot 8.4-16: *Conducted spurious emissions of AP configuration without filter, antenna port 1, high channel*

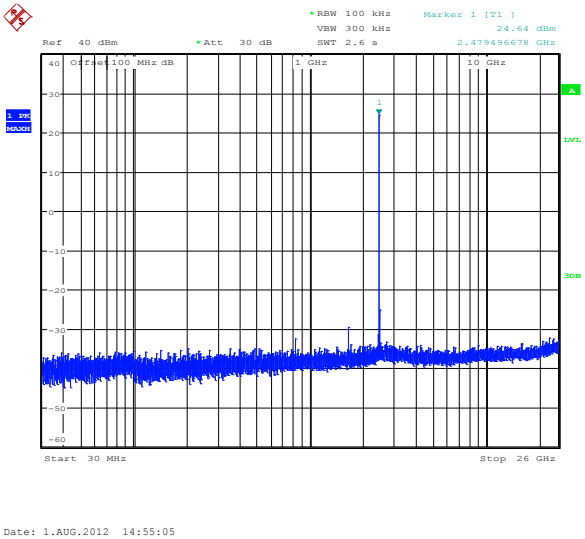


Plot 8.4-17: *Conducted spurious emissions of AP configuration without filter, antenna port 2, low channel*

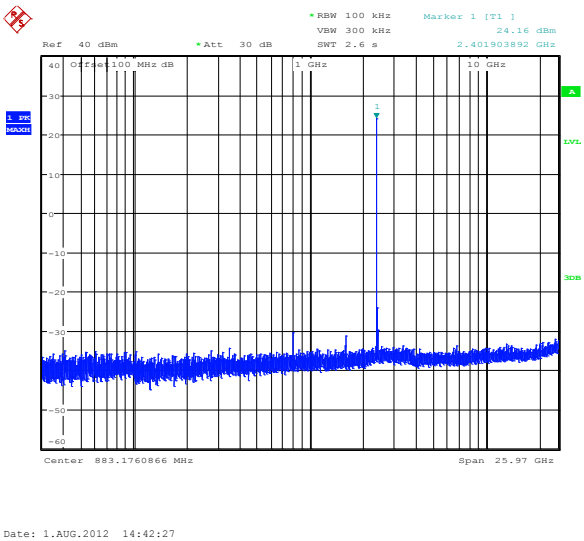
8.4.4 Test data, continued



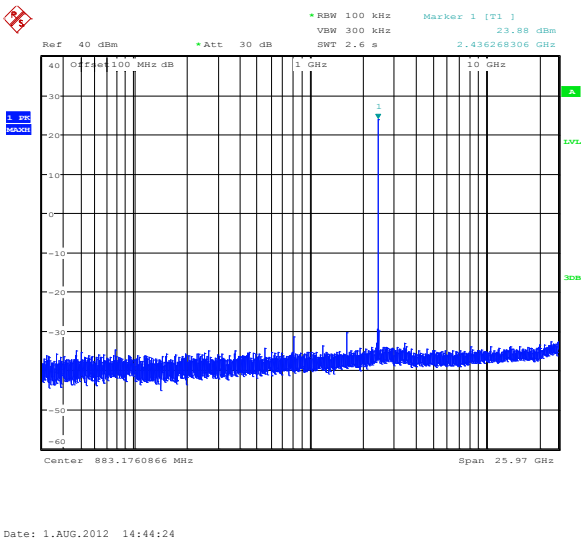
Plot 8.4-18: *Conducted spurious emissions of AP configuration without filter, antenna port 2, mid channel*



Plot 8.4-19: *Conducted spurious emissions of AP configuration without filter, antenna port 2, high channel*

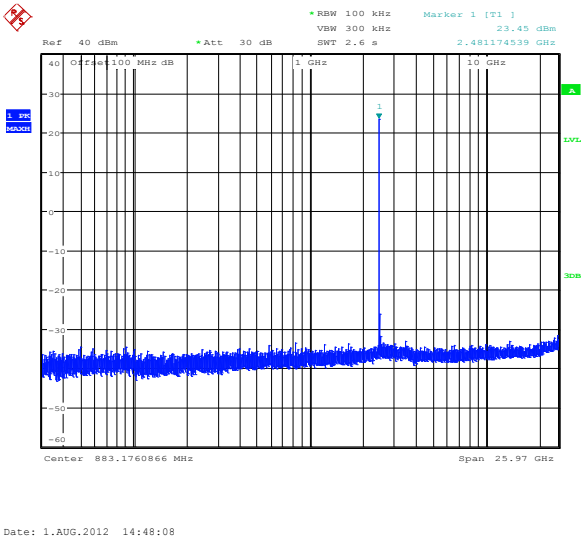


Plot 8.4-20: *Conducted spurious emissions of AP configuration without filter, antenna port 3, low channel*

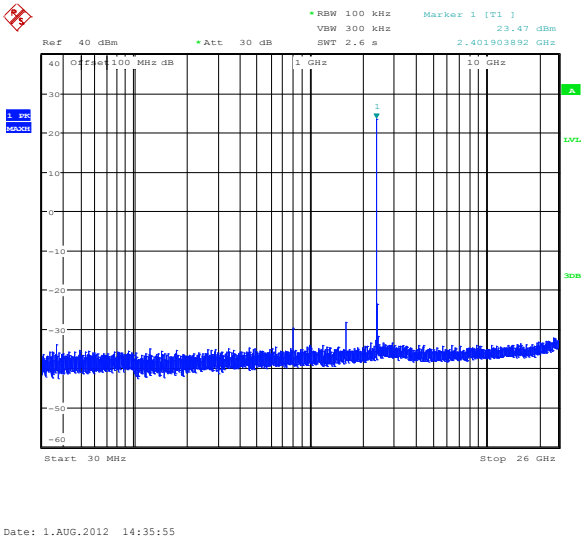


Plot 8.4-21: *Conducted spurious emissions of AP configuration without filter, antenna port 3, mid channel*

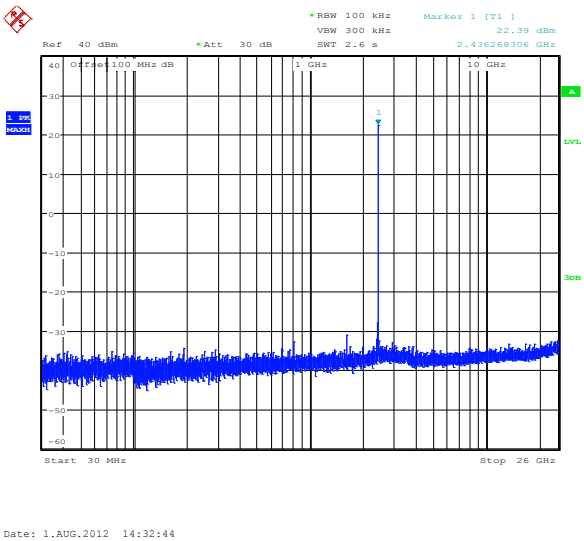
8.4.4 Test data, continued



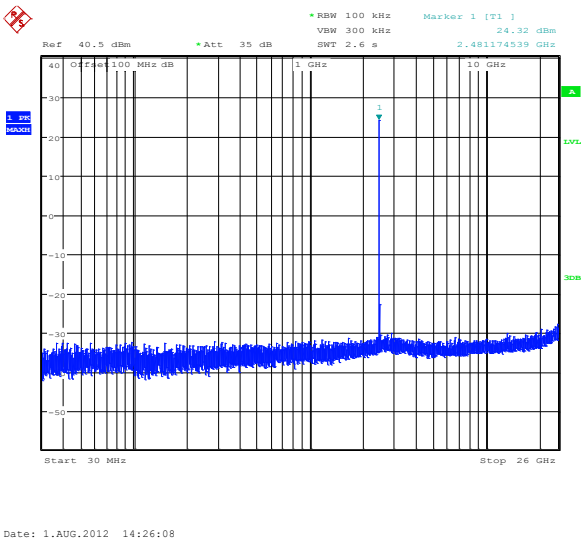
Plot 8.4-22: *Conducted spurious emissions of AP configuration without filter, antenna port 3, high channel*



Plot 8.4-23: *Conducted spurious emissions of AP configuration without filter, antenna port 4, low channel*

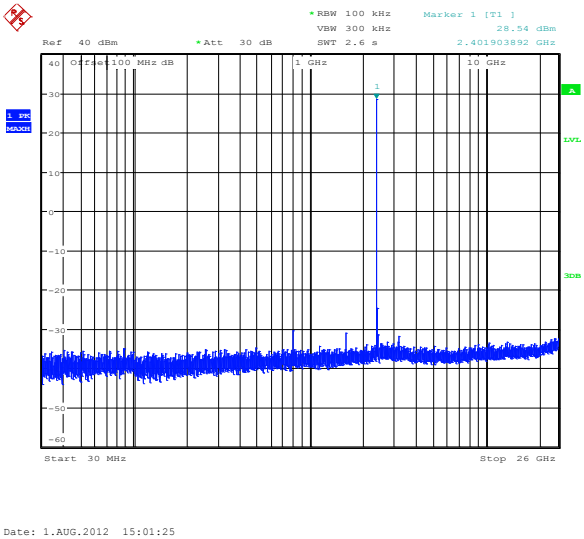


Plot 8.4-24: *Conducted spurious emissions of AP configuration without filter, antenna port 4, mid channel*

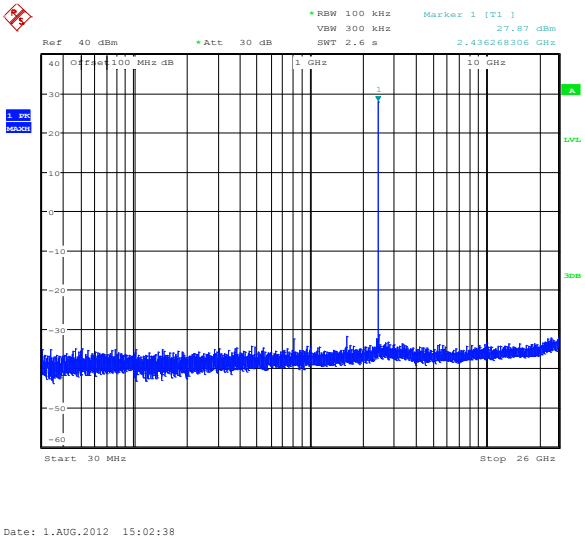


Plot 8.4-25: *Conducted spurious emissions of AP configuration without filter, antenna port 4, high channel*

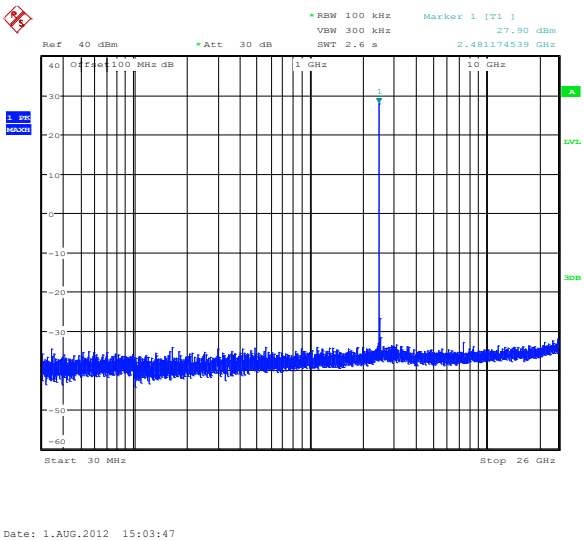
8.4.4 Test data, continued



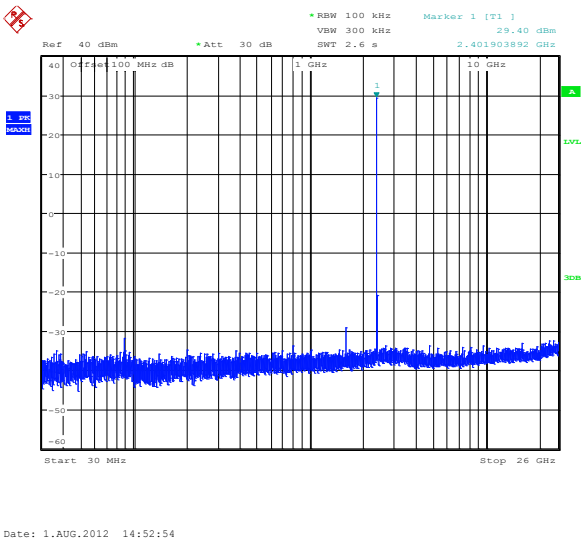
Plot 8.4-26: *Conducted spurious emissions of MR configuration, antenna port 1, low channel*



Plot 8.4-27: *Conducted spurious emissions of MR configuration, antenna port 1, mid channel*

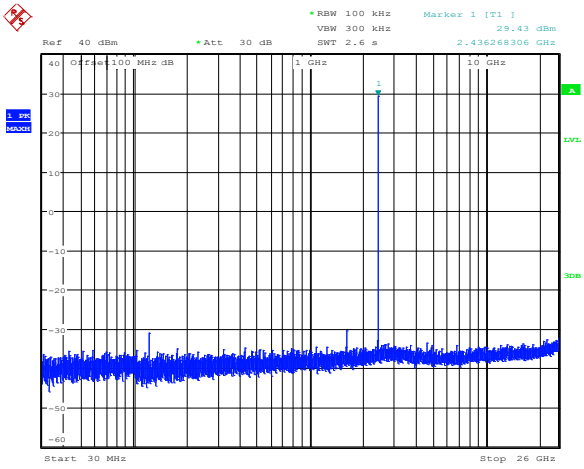


Plot 8.4-28: *Conducted spurious emissions of MR configuration, antenna port 1, high channel*

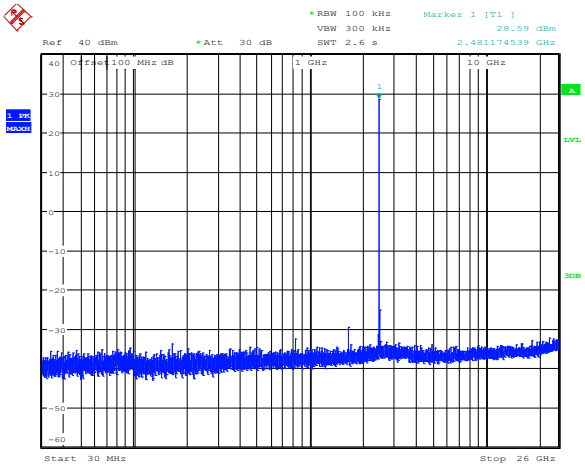


Plot 8.4-29: *Conducted spurious emissions of MR configuration, antenna port 2, low channel*

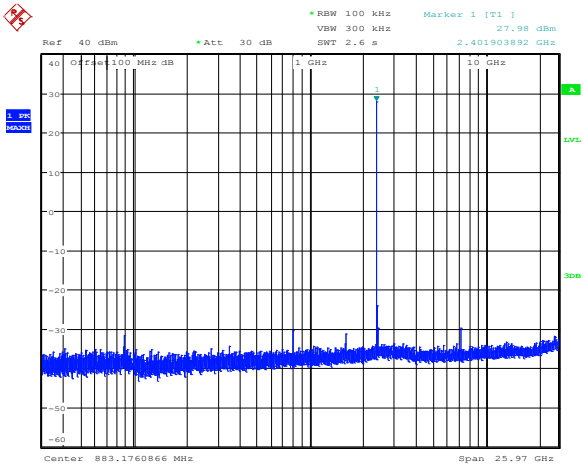
8.4.4 Test data, continued



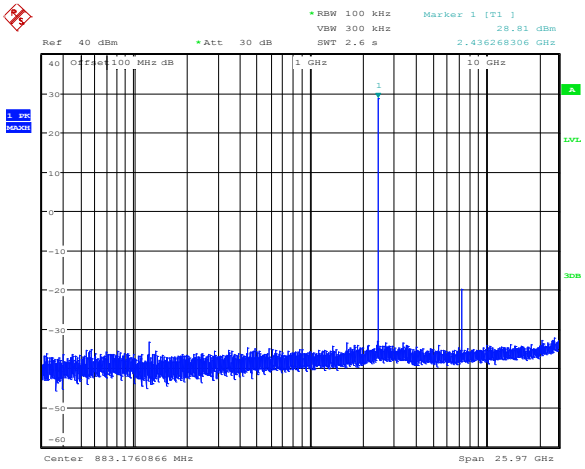
Plot 8.4-30: *Conducted spurious emissions of MR configuration, antenna port 2, mid channel*



Plot 8.4-31: *Conducted spurious emissions of MR configuration, antenna port 2, high channel*

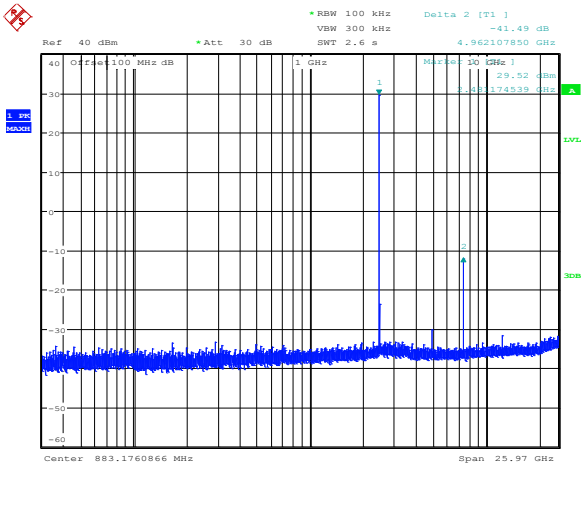


Plot 8.4-32: *Conducted spurious emissions of MR configuration, antenna port 3, low channel*

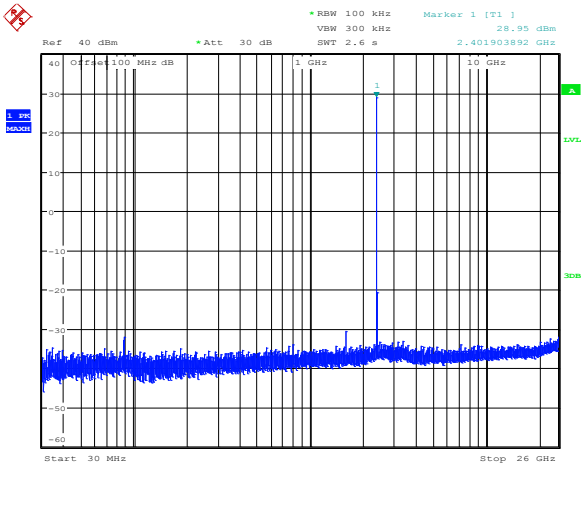


Plot 8.4-33: *Conducted spurious emissions of MR configuration, antenna port 3, mid channel*

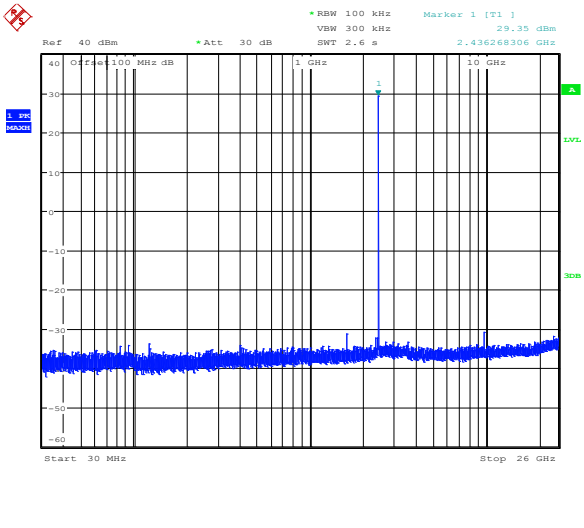
8.4.4 Test data, continued



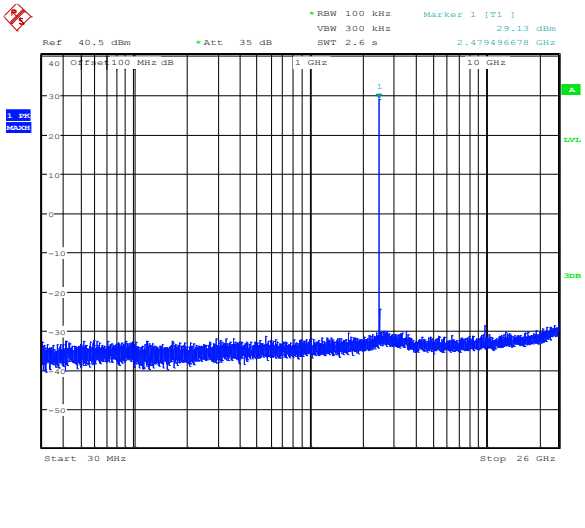
Plot 8.4-34: *Conducted spurious emissions of MR configuration, antenna port 3, high channel*



Plot 8.4-35: *Conducted spurious emissions of MR configuration, antenna port 4, low channel*

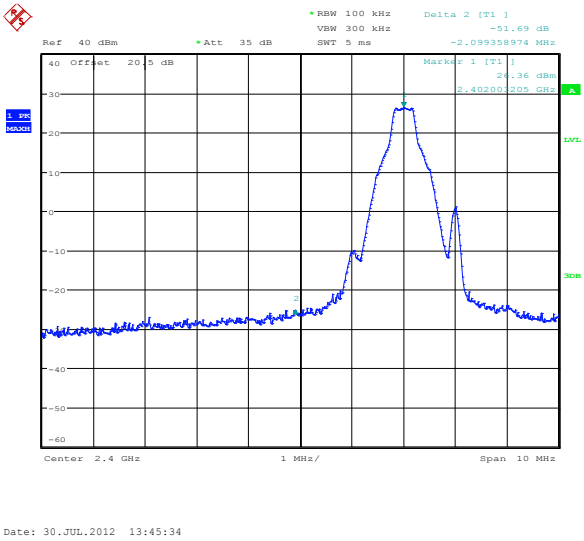


Plot 8.4-36: *Conducted spurious emissions of MR configuration, antenna port 4, mid channel*

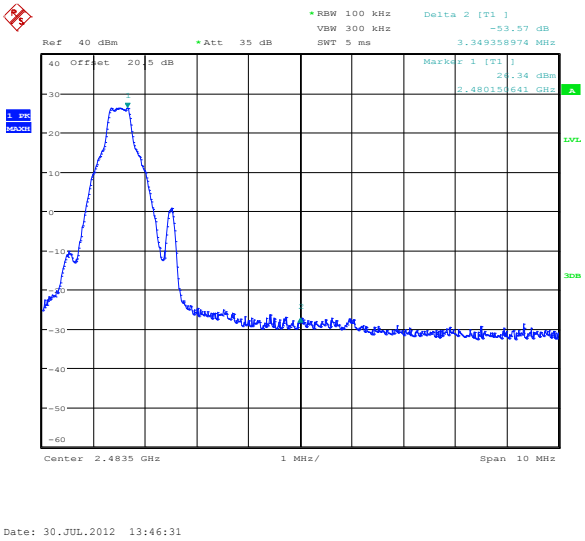


Plot 8.4-37: *Conducted spurious emissions of MR configuration, antenna port 4, high channel*

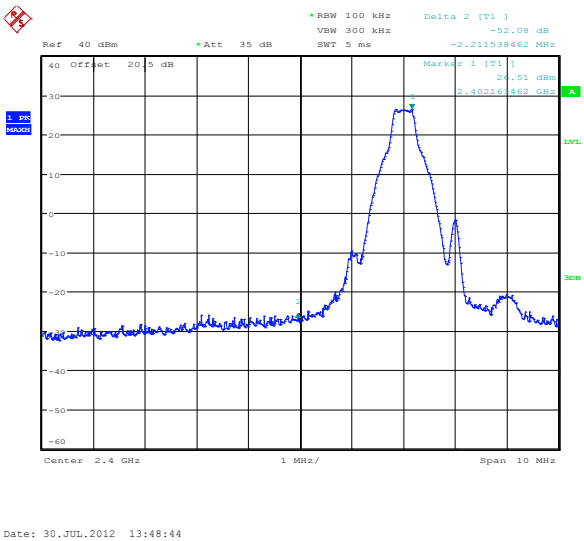
8.4.4 Test data, continued



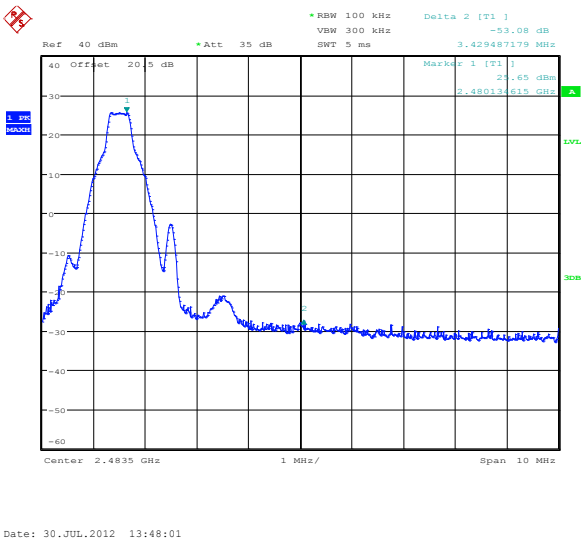
Plot 8.4-38: *Conducted emissions at the lower band edge of AP configuration, antenna port 1*



Plot 8.4-39: *Conducted emissions at the upper band edge of AP configuration, antenna port 1*

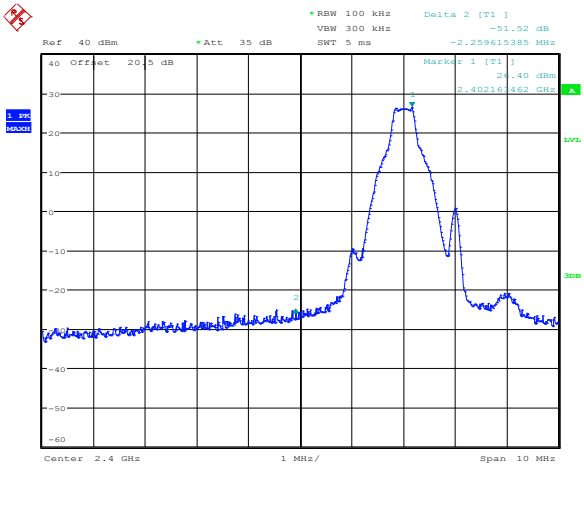


Plot 8.4-40: *Conducted emissions at the lower band edge of AP configuration, antenna port 2*

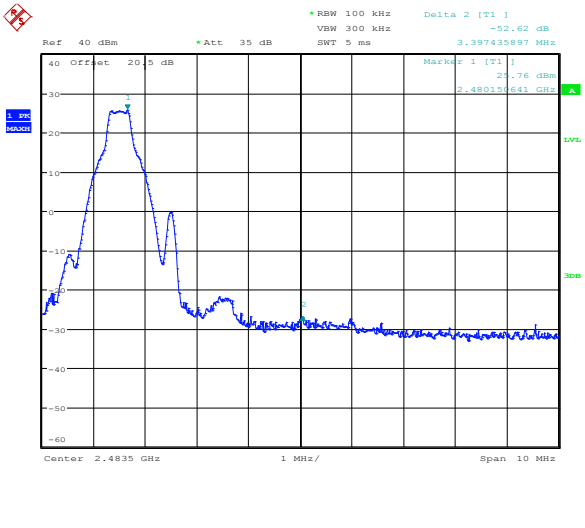


Plot 8.4-41: *Conducted emissions at the upper band edge of AP configuration, antenna port 2*

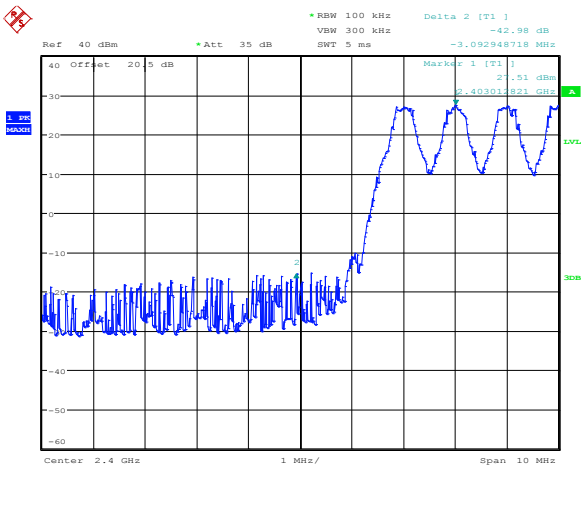
8.4.4 Test data, continued



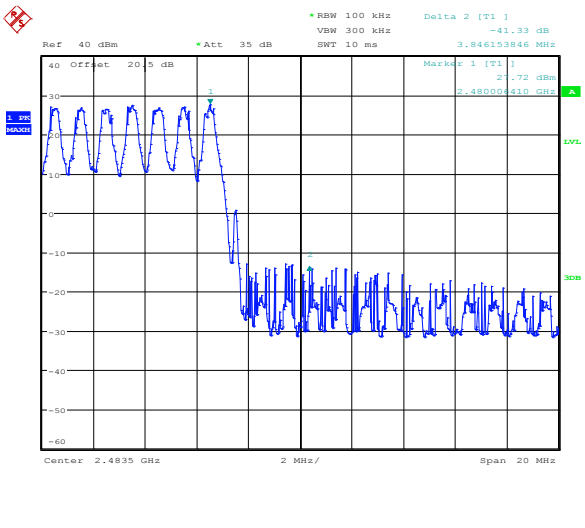
Plot 8.4-42: *Conducted emissions at the lower band edge of AP configuration, antenna port 3*



Plot 8.4-43: *Conducted emissions at the upper band edge of AP configuration, antenna port 3*

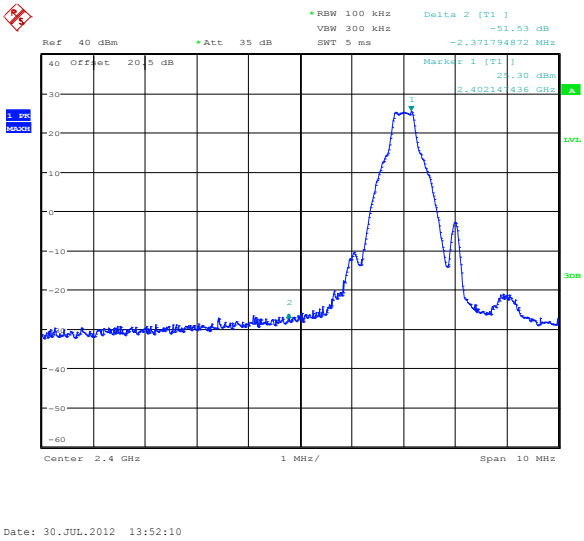


Sample Plot 8.4-44: *Conducted emissions at the lower band edge of AP configuration, antenna port 3, hopping sequence turned on*

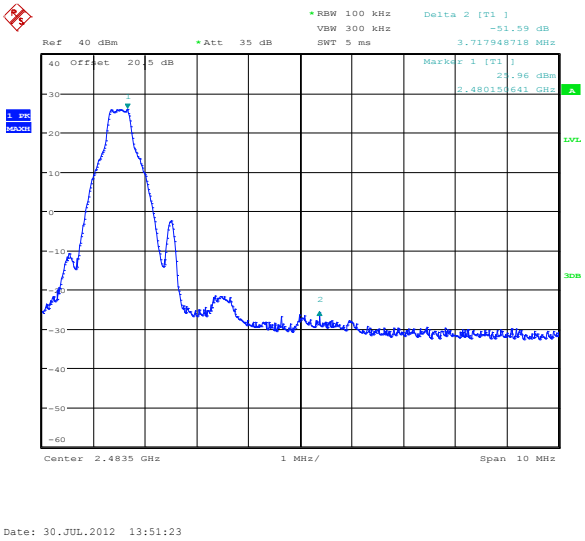


Sample Plot 8.4-45: *Conducted emissions at the upper band edge of AP configuration, antenna port 3, hopping sequence turned on*

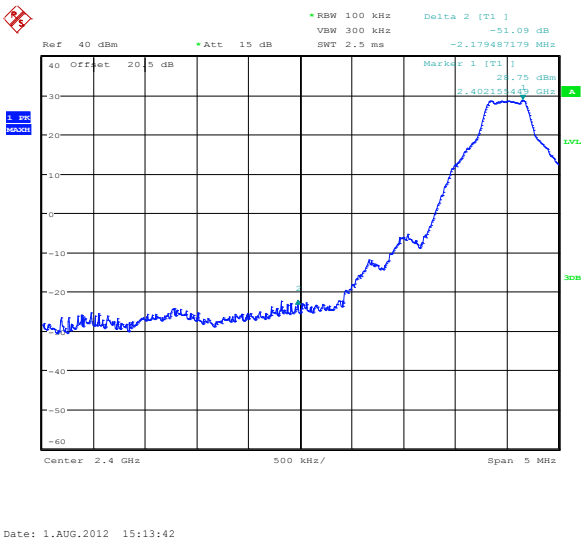
8.4.4 Test data, continued



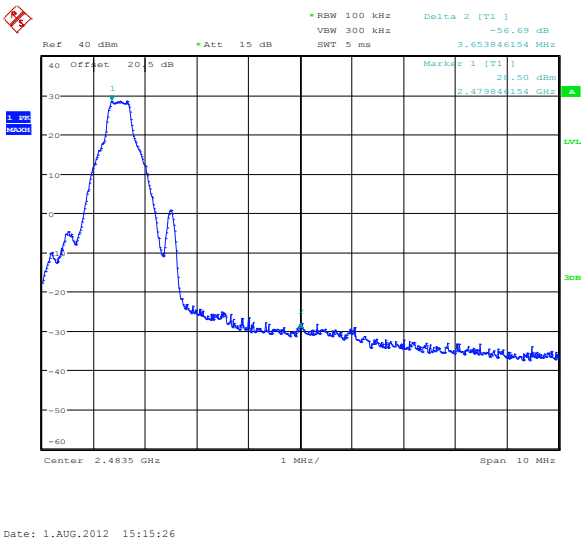
Plot 8.4-46: *Conducted emissions at the lower band edge of AP configuration, antenna port 4*



Plot 8.4-47: *Conducted emissions at the upper band edge of AP configuration, antenna port 4*

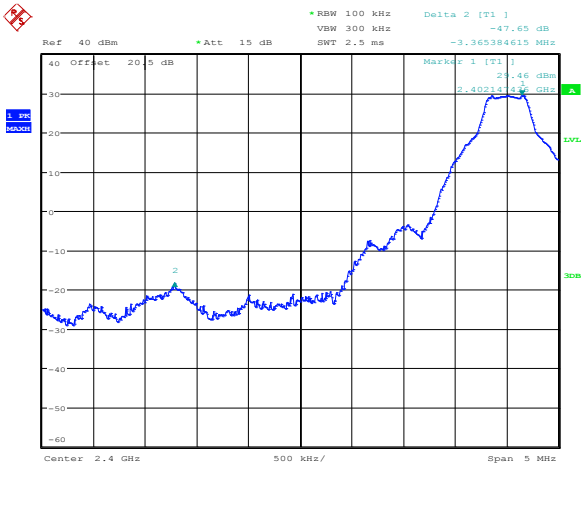


Plot 8.4-48: *Conducted emissions at the lower band edge of MR configuration, antenna port 1*

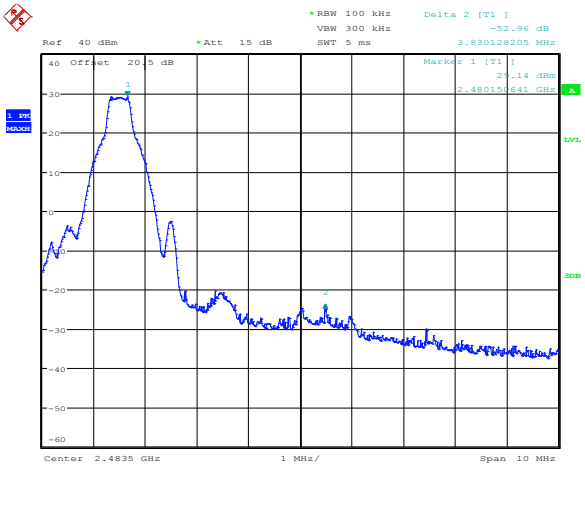


Plot 8.4-49: *Conducted emissions at the upper band edge of MR configuration, antenna port 1*

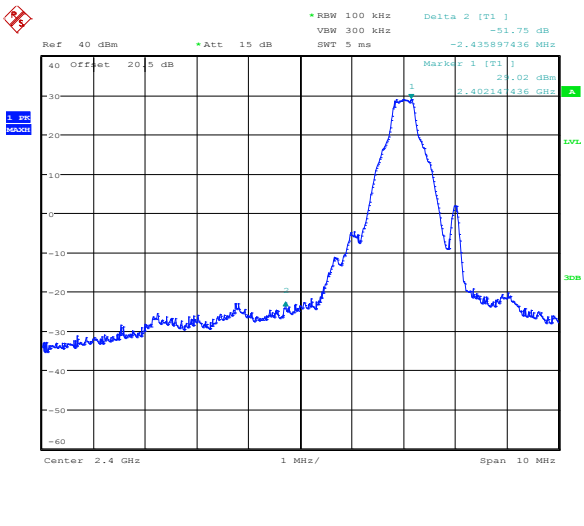
8.4.4 Test data, continued



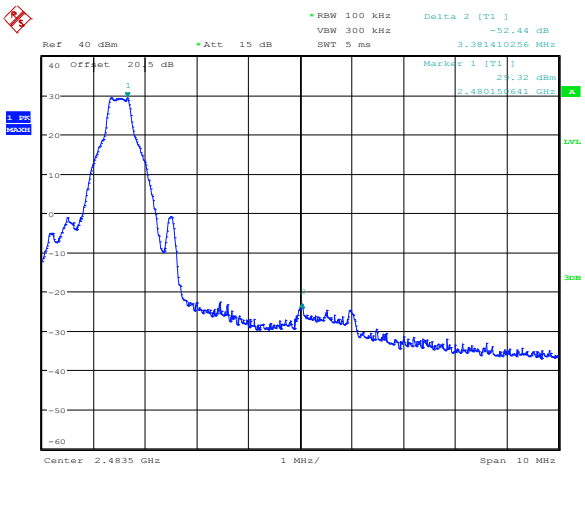
Plot 8.4-50: *Conducted emissions at the lower band edge of MR configuration, antenna port 2*



Plot 8.4-51: *Conducted emissions at the upper band edge of MR configuration, antenna port 2*

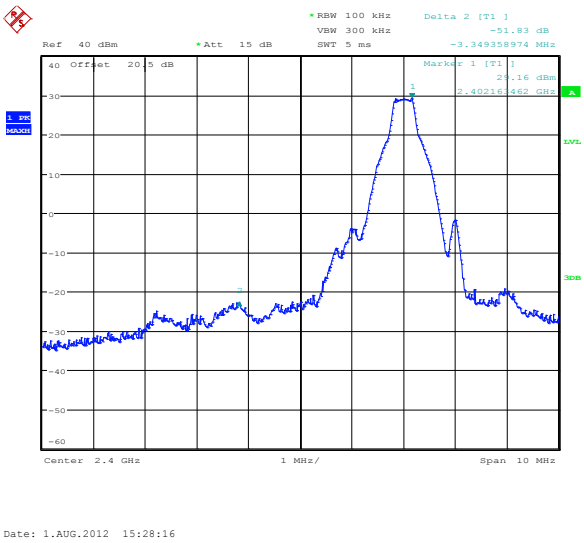


Plot 8.4-52: *Conducted emissions at the lower band edge of MR configuration, antenna port 3*

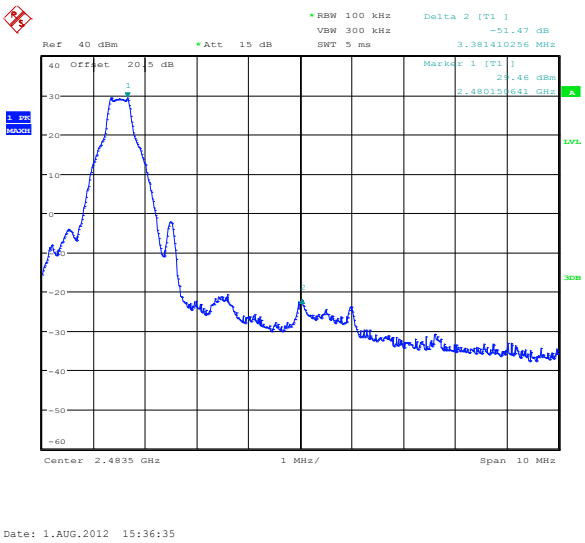


Plot 8.4-53: *Conducted emissions at the upper band edge of MR configuration, antenna port 3*

8.4.4 Test data, continued



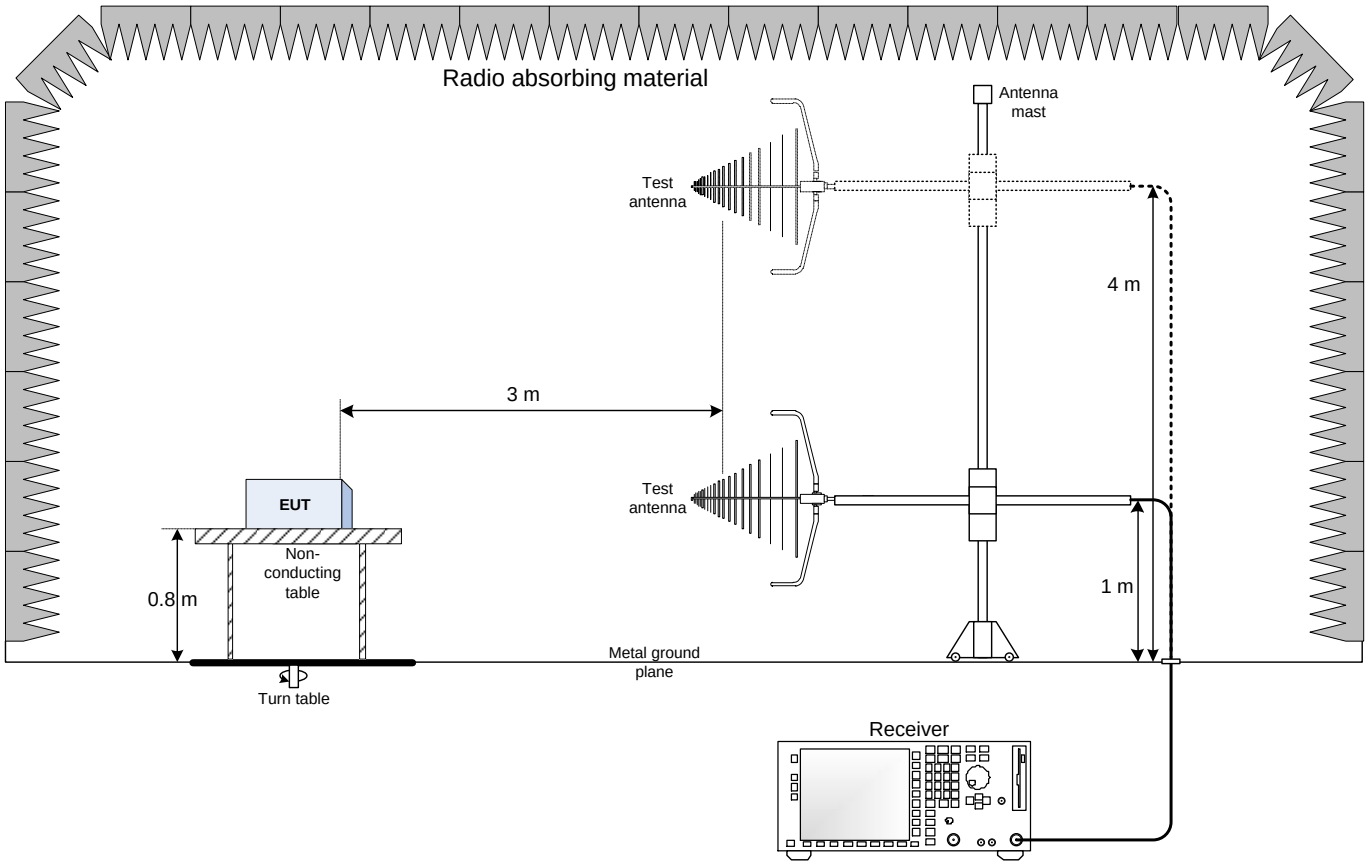
Plot 8.4-54: *Conducted emissions at the lower band edge of MR configuration, antenna port 4*



Plot 8.4-55: *Conducted emissions at the upper band edge of MR configuration, antenna port 4*

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up



Section 10 EUT photos

10.1 External photos

10.1.1 EUT front view

10.1.2 EUT rear view

10.1.3 EUT bottom view