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Report Reference ID:	153671-1TRFWL
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Test specification:	Title 47 - Telecommunication Chapter I - Federal Communications Commission Subchapter A - General Part 15 - Radio Frequency Devices Subpart C - Intentional Radiators §15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz
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Applicant:	Energate Inc. 2415 Holly Lane, Suite 210 Ottawa, ON K1V 7P1, Canada
Apparatus:	ZigBee radio module
Model:	RM30 ST, RM30 LC
FCC ID:	WUR-RM30

Testing laboratory:	Nemko Canada Inc. 303 River Road Ottawa, ON, Canada K1V 1H2 Telephone: (613) 737-9680 Facsimile: (613) 737-9691
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	Name and title	Date
Tested by:	Andrey Adelberg, Senior Wireless/EMC Specialist	July 28, 2010
Reviewed by:	 Richard Brazeau, Laboratory Manager	July 28, 2010



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.

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Section 1: Report summary

1.1 Test specification

Specifications	FCC Part 15 Subpart C, 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz.
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1.2 Statement of compliance

Compliance	In the configuration tested the EUT was found compliant Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> This report contains an assessment of apparatus against specifications based upon tests carried out on samples submitted at Nemko Canada Inc. These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15; Subpart C. Radiated tests were conducted in accordance with ANSI C63.4-2003.
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1.3 Exclusions

Exclusions	None
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1.4 Registration number

Test site FCC ID number	176392 (3 m Semi anechoic chamber)
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1.5 Test report revision history

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

1.6 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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Section 2: Summary of test results

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

General requirements for FCC Part 15

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

Specific requirements for FCC Part 15 Subpart C, 15.247

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	N/A
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	N/A
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	N/A
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
§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	N/A
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	N/A
§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	Pass
§15.247(b)(4)	Maximum peak output power	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	N/A
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	N/A
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Pass
§15.247(f)	Time of occupancy for hybrid systems	N/A

Notes: None

Section 3: Equipment under test (EUT) and application details

3.1 Applicant details

Applicant complete business name	Name:	Energate Inc.
	Federal Registration Number (FRN):	0018227421
	Grantee code	WUR
Mailing address	Address:	2415 Holly Lane, Suite 210
	City:	Ottawa
	Province/State:	Ontario
	Post code:	K1V 7P1
	Country:	Canada

3.2 Modular equipment

a) Single modular approval	Single modular approval Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
b) Limited single modular approval	Limited single modular approval Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>

3.3 Product details

FCC ID	Grantee code:	WUR
	Product code:	-RM30
Equipment class	DTS – Digital Transmission system	
Description of product as it is marketed	ZigBee Radio Module	
	Model name/number:	RM30 ST, RM30 LC
	Part number:	(ST) 0001250221, (LC) 0001260231
	Serial number:	(ST) C32ER00004, (LC) C32ER00021

3.4 Application purpose

Type of application	<input checked="" type="checkbox"/> Original certification
	<input type="checkbox"/> Change in identification of presently authorized equipment Original FCC ID: _____ Grant date: _____
	<input type="checkbox"/> Class II permissive change or modification of presently authorized equipment

3.5 Composite/related equipment

a) Composite equipment	The EUT is a composite device subject to an additional equipment authorization Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
b) Related equipment	The EUT is part of a system that operates with, or is marketed with, another device that requires an equipment authorization Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
c) Related FCC ID	If either of the above is "yes": <input type="checkbox"/> has been granted under the FCC ID(s) listed below: <input type="checkbox"/> is in the process of being filled under the FCC ID(s) listed below: <input type="checkbox"/> is pending with the FCC ID(s) listed below: <input type="checkbox"/> has a mix of pending and granted statuses under the FCC ID(s) listed below: i FCC ID: ii FCC ID:

3.6 Sample information

Receipt date:	July 12, 2010
Nemko sample ID number:	1, 2

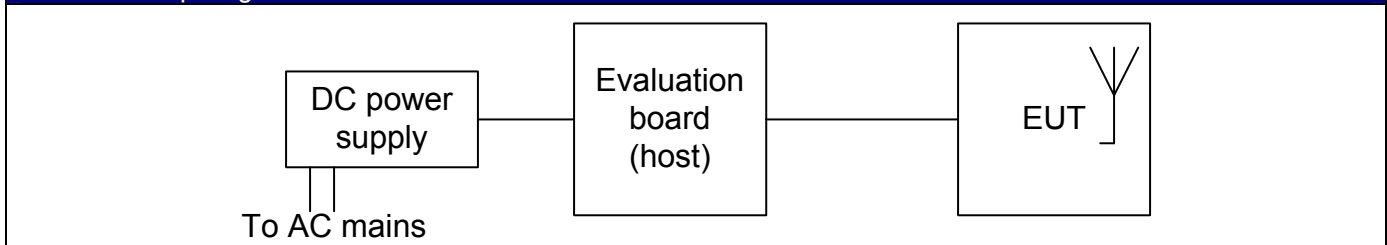
3.7 EUT technical specifications

Operating band:	2400–2483.5 MHz
Operating frequency:	2405–2480 MHz
Modulation type:	Offset-QPSK
Occupied bandwidth:	1.578 MHz (6 dB BW)
Emission designator:	G1D
Antenna type:	Integral, 1.5 dBi chip antenna Permanent fixed antenna, which may be built-in, (Equipment does not have an external 50 Ω RF connector)
Power source:	120 VAC, 60 Hz from host

3.8 Operation of the EUT during testing

Details:	EUT was controlled by PC using Hyper terminal to force continuous transmission on low mid and high channels.
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3.9 EUT setup diagram



Section 4: Engineering considerations

4.1 Modifications incorporated in the EUT

Modifications

Modifications performed to the EUT during this assessment

 None Yes , performed by Client or Nemko

 Details: In order to comply with upper band edge requirement, upper channel's power has been reduced to -0.78 dBm

4.2 Deviations from laboratory tests procedures

Deviations

Deviations from laboratory test procedures

 None Yes - details are listed below:

4.3 Technical judgment

Judgment

The RM30 Radio Module has two variants: RM30 ST and RM30 LC. These two variants differs in the values of two components, Z2 and Z3, used to tune the on-board chip antenna, that is, to match the impedance of the antenna to the Transmit and Receive circuits.

The following table shows the differences:

Model	Z2 value	Z3 value
RM30 ST	3.0 nHy	0.2 pF
RM30 LC	3.9 nHy	0.5 pF

Section 5: Test conditions

5.1 Power source and ambient temperatures

Normal temperature, humidity and air pressure test 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.

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 $\pm 5\%$, for which the equipment was designed.

Section 6: Measurement uncertainty

Nemko Canada measurement uncertainty has been calculated using guidance of UKAS LAB 34:2003 and TIA-603-B Nov 7, 2002. All calculations have been performed to provide a confidence level of 95 % and can be found in Nemko Canada document MU-003.



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Section 7: Test equipment

Product: ZigBee radio module

Section 7: Test equipment

7.1 Test equipment list

Equipment	Manufacturer	Model No.	Asset/Serial No.	Next cal.
3 m EMI Test Chamber	TDK	SAC-3	FA002047	Mar. 09/11
Flush Mount Turntable	Sunol	FM2022	FA002082	NCR
Controller	Sunol	SC104V	FA002060	NCR
Antenna Mast	Sunol	TLT2	FA002061	NCR
Receiver/Spectrum Analyzer	Rohde & Schwarz	ESU 26	FA002043	Jan. 14/11
Bilog Antenna	Sunol	JB3	FA002108	Jan. 18/11
Horn Antenna #2	EMCO	3115	FA000825	Jan. 18/11
1-18 GHz Amplifier	JCA	JCA118-503	FA002091	Oct. 07/10

Note: NCR = No cal required



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Section 8: Testing data		Product: ZigBee radio module
Test name: Clause 15.31(e) Variation of power source		
Test date: July 12, 2010	Test engineer: Andrey Adelberg	Verdict: Pass
Specification: FCC Part 15 Subpart A		

Section 8: Testing data

8.1 Clause 15.31(e) Variation of power source

§ 15.31 Measurement standards.

(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. For battery-operated equipment, the equipment tests shall be performed using a new battery.

Special notes

None

Test data

– Transmit output power was measured while supply voltage was varied from 102 VAC to 138 VAC (85 % to 115 % of the nominal rated supply voltage). No change in transmit output power was observed.



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Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.31(m) Number of operating frequencies			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	Verdict: Pass
Specification: FCC Part 15 Subpart A			

8.2 Clause 15.31(m) Number of operating frequencies

§ 15.31 Measurement standards.

(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz and less	1	Middle
1 to 10 MHz	2	1 near top and 1 near bottom
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom


Special notes

None

Test data

The frequency band is 83.5 MHz therefore number of operating frequencies is 3.

Low frequency / channel	2405 MHz
Mid frequency / channel	2440 MHz
High frequency / channel	2480 MHz

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	Test name: Clause 15.203 Antenna requirement		
	Test date: July 12, 2010	Test engineer: Andrey Adelberg	Verdict: Pass
	Specification: FCC Part 15 Subpart C		

8.3 Clause 15.203 Antenna requirement

§ 15.203 Antenna requirement.

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Special notes


None

Test data

- The EUT uses a non-detachable antenna to the intentional radiator.

Detailed photo of antenna:



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	Test name: Clause 15.207(a) Conducted limits			
	Test date: July 12, 2010		Test engineer: Andrey Adelberg	
	Verdict: Pass		Supply input: 120 VAC, 60 Hz	
	Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C				

8.4 Clause 15.207(a) Conducted limits

§ 15.207 Conducted limits.

- (a) 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 μ H/50 ohms 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.

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	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.

Special notes

None

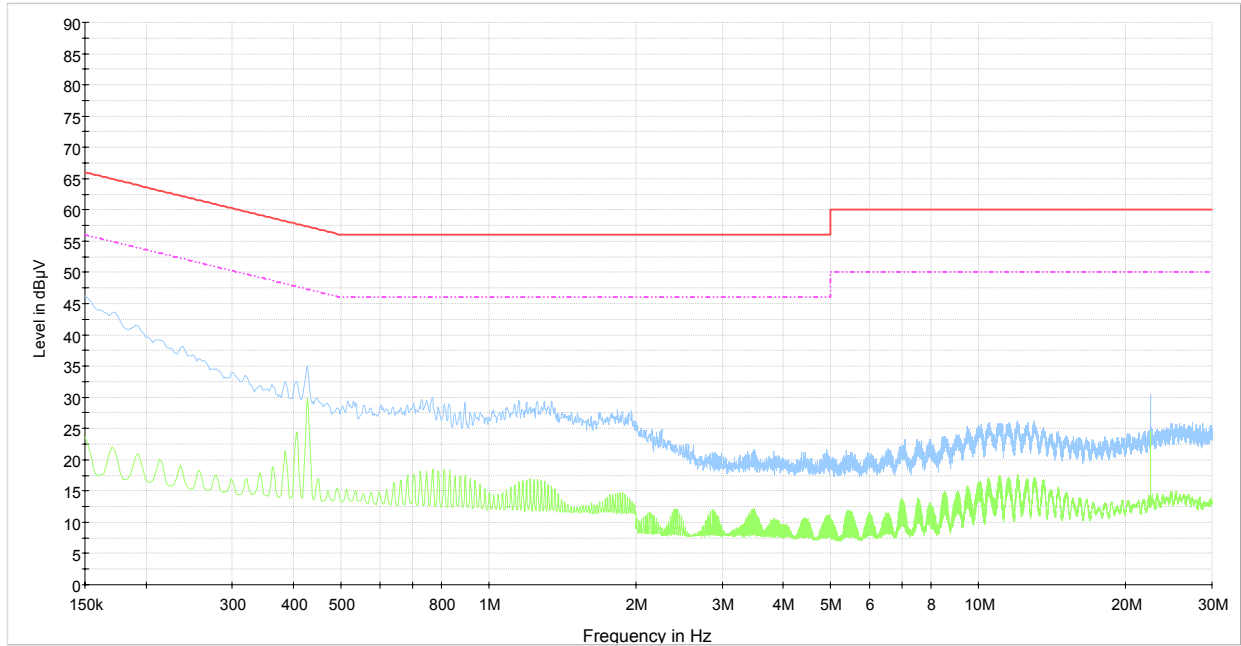


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Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.207(a) Conducted limits			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

Test data

LC model



Conducted emissions on phase line
 — CISPR 22 Mains QP Class B.LimitLine
 - - - CISPR 22 Mains AV Class B.LimitLine
 — Preview Result 1
 — Preview Result 2

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

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.

Receiver/Spectrum analyzer settings:

0.15 MHz to 30 MHz

Preview measurements

Receiver: 9 kHz RBW, Peak and Average detector, max hold

Measurement time 100 ms

Final measurement

Receiver: 9 kHz RBW, Quasi-peak and Average detector

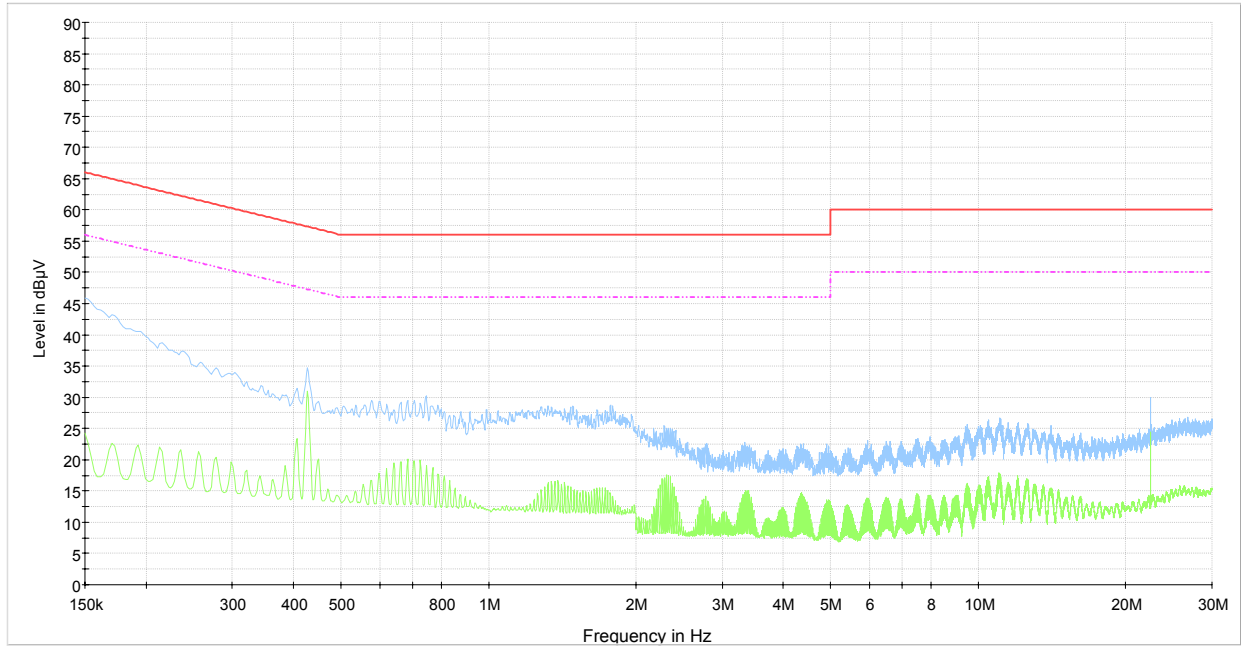


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Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.207(a) Conducted limits			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

Test data, continued

LC model



Conducted emissions on neutral line
 — CISPR 22 Mains QP Class B.LimitLine
 - - - CISPR 22 Mains AV Class B.LimitLine
 — Preview Result 1
 — Preview Result 2

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

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.

Receiver/Spectrum analyzer settings:

0.15 MHz to 30 MHz

Preview measurements

Receiver: 9 kHz RBW, Peak and Average detector, max hold

Measurement time 100 ms

Final measurement

Receiver: 9 kHz RBW, Quasi-peak and Average detector

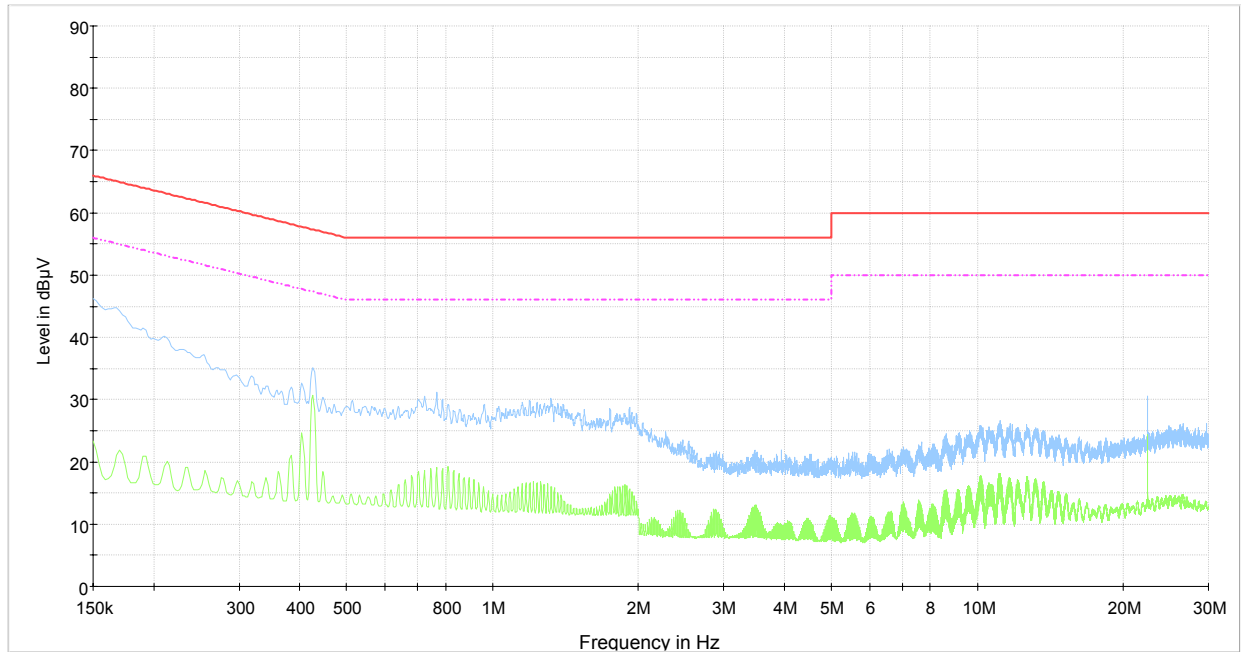


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Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.207(a) Conducted limits			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

Test data, continued

ST model



Conducted emissions on phase line
 — CISPR 22 Mains QP Class B.LimitLine
 - - - CISPR 22 Mains AV Class B.LimitLine
 — Preview Result 1
 — Preview Result 2

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

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.

Receiver/Spectrum analyzer settings:

0.15 MHz to 30 MHz

Preview measurements

Receiver: 9 kHz RBW, Peak and Average detector, max hold

Measurement time 100 ms

Final measurement

Receiver: 9 kHz RBW, Quasi-peak and Average detector

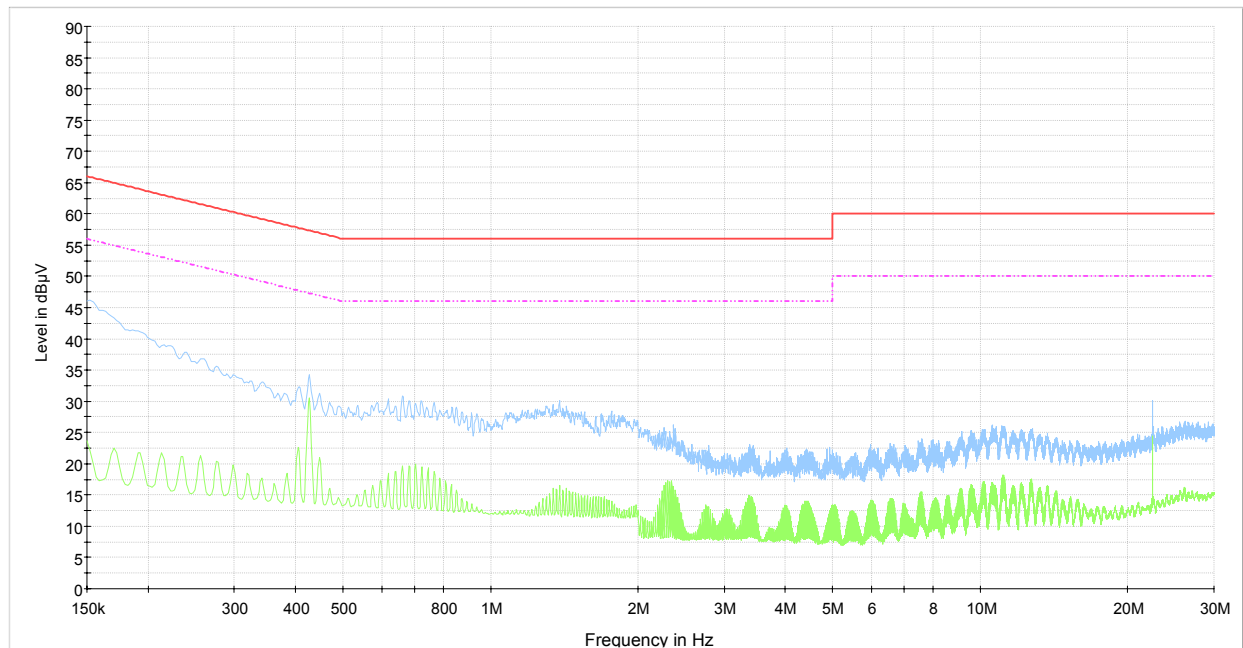


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Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.207(a) Conducted limits			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

Test data, continued

ST model



Conducted emissions on neutral line
 — CISPR 22 Mains QP Class B.LimitLine
 - - - CISPR 22 Mains AV Class B.LimitLine
 — Preview Result 1
 — Preview Result 2


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

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.

Receiver/Spectrum analyzer settings:

0.15 MHz to 30 MHz

Preview measurements	Final measurement
Receiver: 9 kHz RBW, Peak and Average detector, max hold	Receiver: 9 kHz RBW, Quasi-peak and Average detector
Measurement time 100 ms	

 Nemko Canada Inc., 303 River Rd, Ottawa, ON, Canada, K1V 1H2	Section 8: Testing data		Product: ZigBee radio module	
	Test name: Clause 15.247(a)(2) Minimum 6 dB bandwidth for systems using digital modulation techniques			
	Test date: July 12, 2010		Test engineer: Andrey Adelberg	
	Verdict: Pass		Supply input: 120 VAC, 60 Hz	
	Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
	Specification: FCC Part 15 Subpart C			

8.5 Clause 15.247(a)(2) Minimum 6 dB bandwidth for systems using digital modulation techniques

§ 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
- (2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Special notes

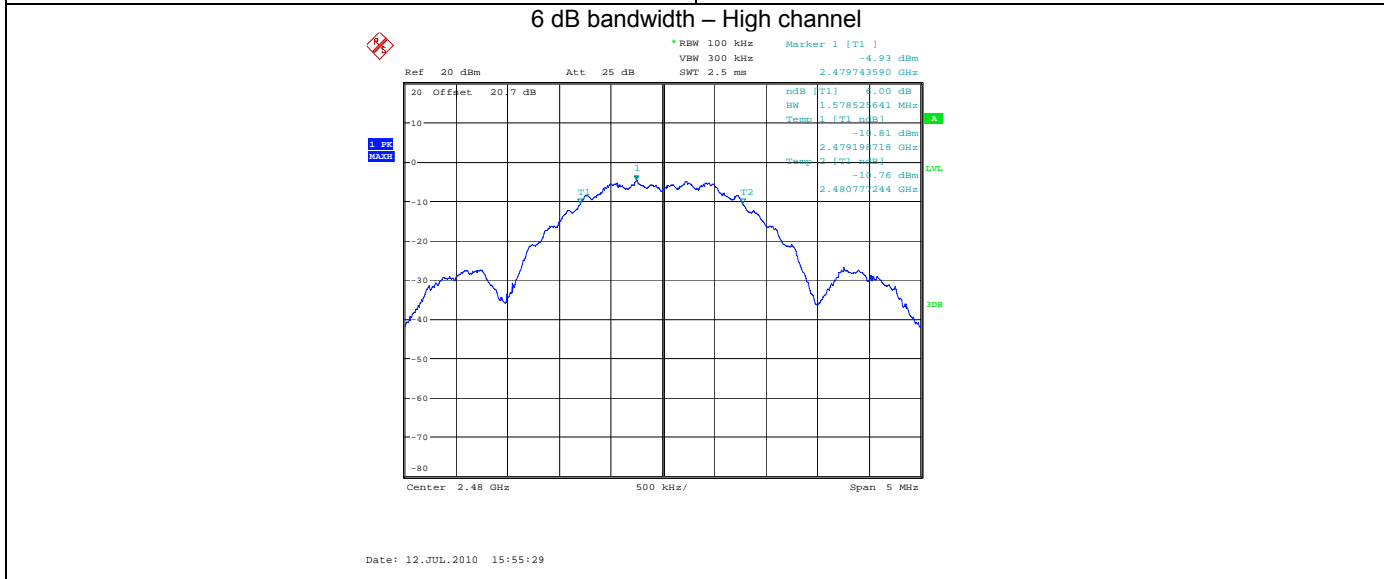
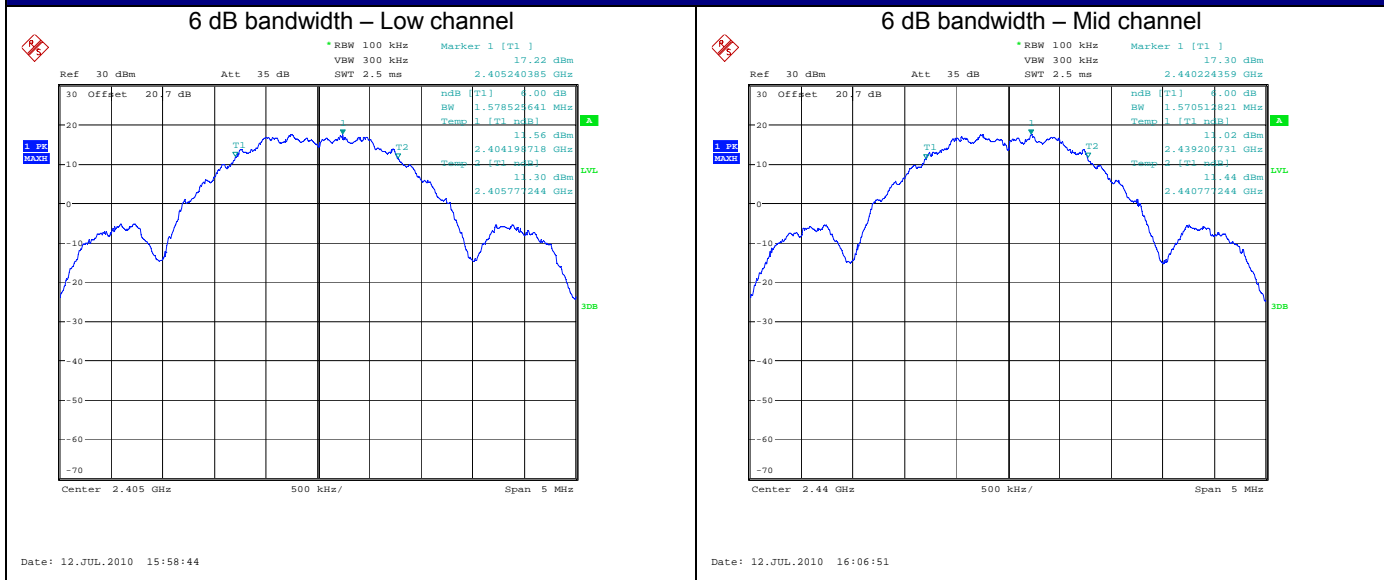
None



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Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.247(a)(2) Minimum 6 dB bandwidth for systems using digital modulation techniques			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

Test data



Frequency (MHz)	6 dB bandwidth (MHz)	Limit (MHz)	Margin (MHz)
2405	1.578	> 0.5	1.075
2440	1571	> 0.5	1.071
2480	1.578	> 0.5	1.078

- The peak detector was used with 100 kHz/300 kHz RBW/VBW
- The span was wider than RBW.

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	Test name: Clause 15.247(b)(3) and (4) Maximum peak output power for systems using digital modulation			
	Test date: July 12, 2010		Test engineer: Andrey Adelberg	
	Verdict: Pass		Supply input: 120 VAC, 60 Hz	
	Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C				


8.6 Clause 15.247(b) Maximum peak conducted output power

§ 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

- (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 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.
 - (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 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
 - (3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
 - (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.
 - (ii) Systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.
 - (iii) Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) 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.

Special notes

- The test was performed using guidelines of ANSI C63.10-2009, Clause 6.10.2.1 and 6.10.2.2.
- Power option 1 was used for the power output measurements:
 - RBW was set wider than emission bandwidth.

 Nemko Canada Inc., 303 River Rd, Ottawa, ON, Canada, K1V 1H2	Section 8: Testing data		Product: ZigBee radio module	
	Test name: Clause 15.247(b)(3) and (4) Maximum peak output power for systems using digital modulation			
	Test date: July 12, 2010		Test engineer: Andrey Adelberg	
	Verdict: Pass		Supply input: 120 VAC, 60 Hz	
	Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C				

Test data			
Section (3) Results, continued			
Conducted output power:			
Frequency (MHz)	Conducted output power (dBm)	Limit (dBm)	Margin (dB)
2405	20.97	30.0	9.03
2440	20.95	30.0	9.05
2480	4.44	30.0	25.56
EIRP calculation:			
Frequency (MHz)	EIRP (dBm)	Limit (dBm)	Margin (dB)
2405	22.47	36.0	13.53
2440	22.45	36.0	13.55
2480	5.94	36.0	30.06
EIRP = Conducted output power [dBm] + antenna gain [dBi] Antenna gain = 1.5 dBi Maximum output power = 20.97 dBm Limit = 30 dBm Maximum EIRP = 22.47 dBm Limit = 36 dBm			
<ul style="list-style-type: none"> - The peak detector was used with RBW of 3 MHz. - The span was wider than RBW. 			



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Section 8: Testing data

Product: ZigBee radio module

Test name: Clause 15.247(b)(3) and (4) Maximum peak output power for systems using digital modulation

Test date: July 12, 2010

Test engineer: Andrey Adelberg

Verdict: Pass

Supply input: 120 VAC, 60 Hz

Temperature: 25 °C

Air pressure: 1005 mbar

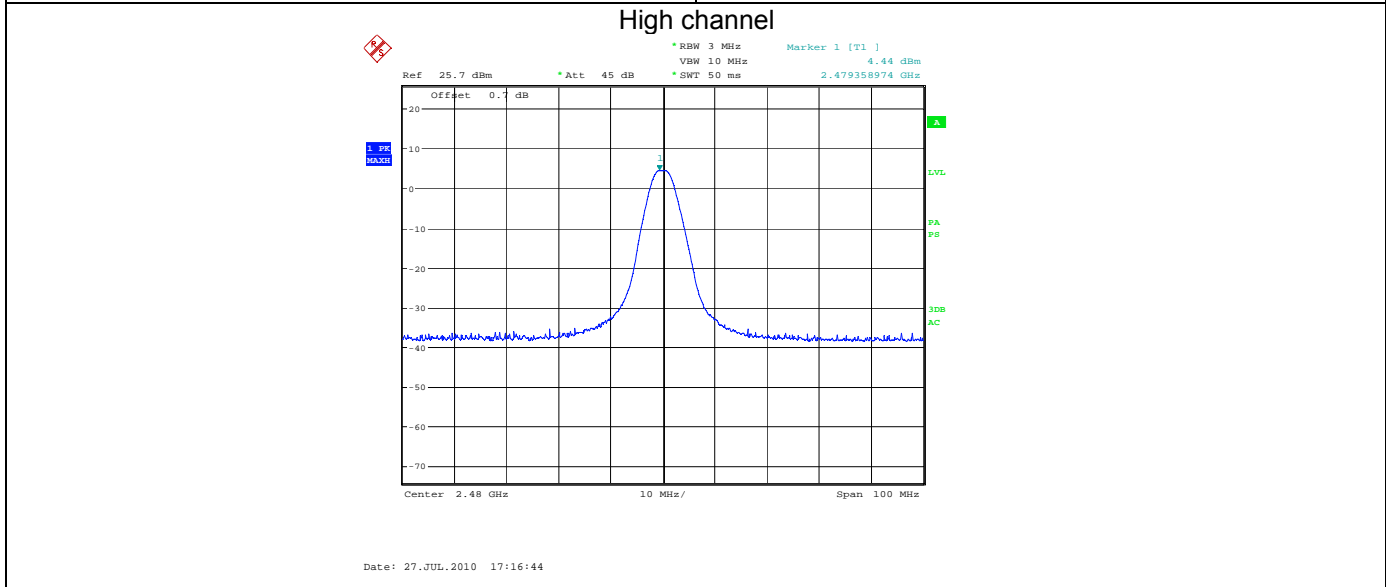
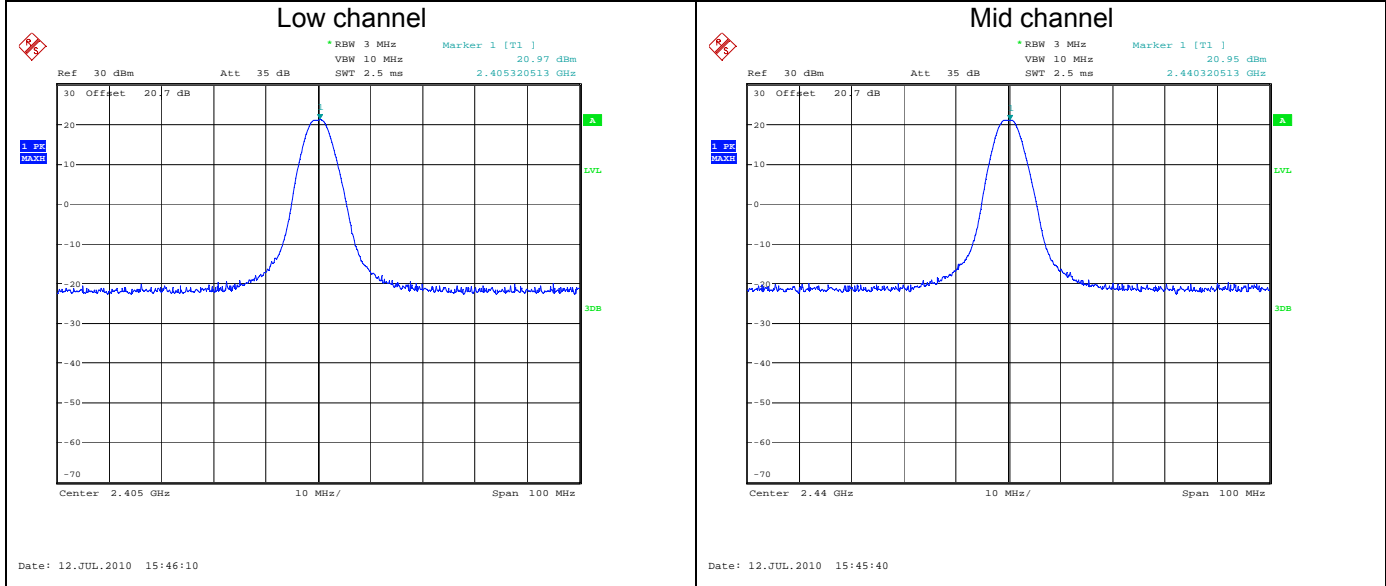
Relative humidity: 36 %


Specification: FCC Part 15 Subpart C

Test data, continued

Section (3) Results, continued

Conducted spectral plots:



 Nemko Canada Inc., 303 River Rd, Ottawa, ON, Canada, K1V 1H2	Section 8: Testing data		Product: ZigBee radio module	
	Test name: Clause 15.247(d) Spurious emissions			
	Test date: July 12, 2010		Test engineer: Andrey Adelberg	
	Verdict: Pass		Supply input: 120 VAC, 60 Hz	
	Temperature: 25 °C		Air pressure: 1005 mbar	Relative humidity: 36 %
	Specification: FCC Part 15 Subpart C			

8.7 Clause 15.247(d) Spurious emissions

§ 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

- (d) 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)).



Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.247(d) Spurious emissions			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

Special notes

§15.209 – Radiated emission limits

Frequency (MHz)	Field strength		Measurement distance (m)
	(μ V/m)	(dB μ V/m)	
0.009–0.490	2400/F	67.6–20log(F)	300
0.490–1.705	24000/F	87.6–20log(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

- Notes:
- F = fundamental frequency in kHz
 - In the emission table above, the tighter limit applies at the band edges.
 - For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

§15.205 – 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			

- The spectrum was searched from 30 MHz to the 10th harmonic.
- All measurements were performed at a distance of 3 m.
- All measurements were performed:
 - within 30–1000 MHz range: using a quasi-peak detector with 120 kHz/300 kHz RBW/VBW,
 - 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 a duty cycle/average factor for average results calculations.



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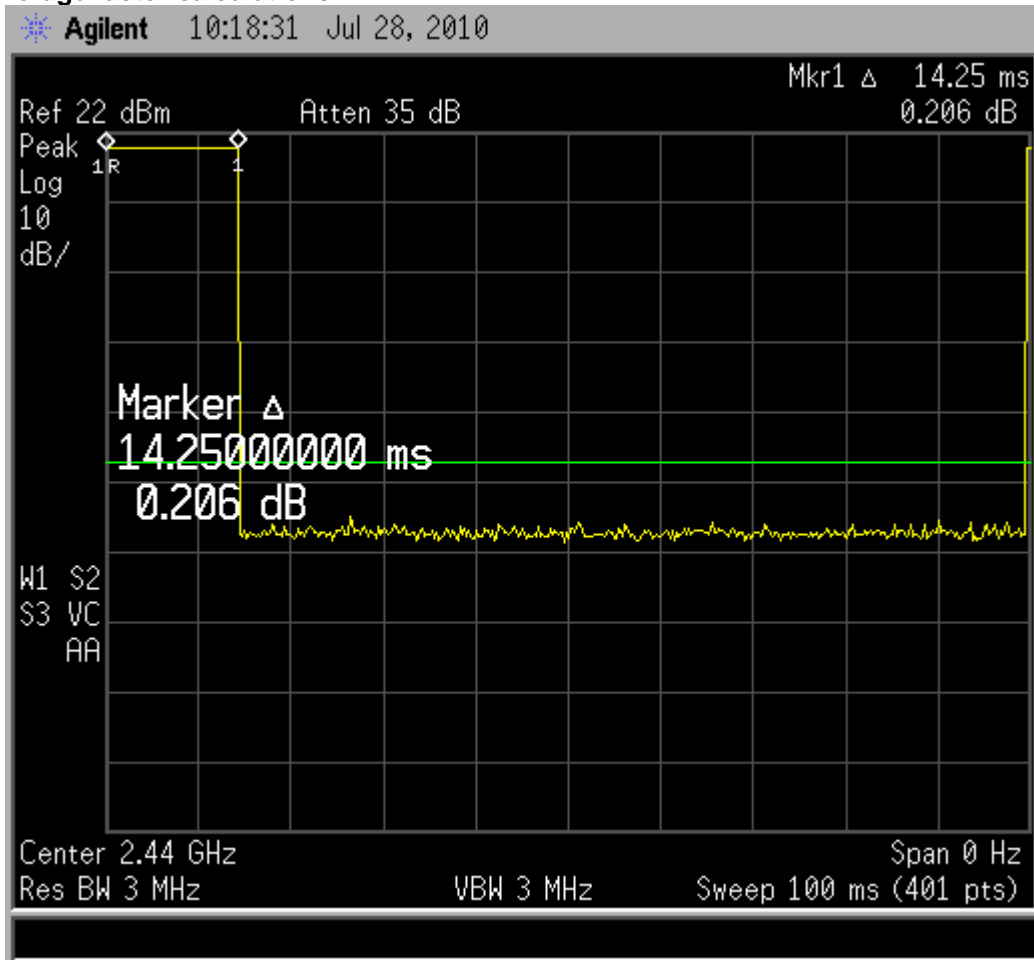
Section 8: Testing data		Product: ZigBee radio module
Test name: Clause 15.247(d) Spurious emissions		
Test date: July 12, 2010		Test engineer: Andrey Adelberg
Verdict: Pass		Supply input: 120 VAC, 60 Hz
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %
Specification: FCC Part 15 Subpart C		

Test data

Duty cycle/average factor calculations

§15.35(c) When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.

Duty cycle/average factor calculations:



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

$$Duty\ cycle\ factor = 20 \times \text{Log}(14.25/100) = -16.92\ dB$$

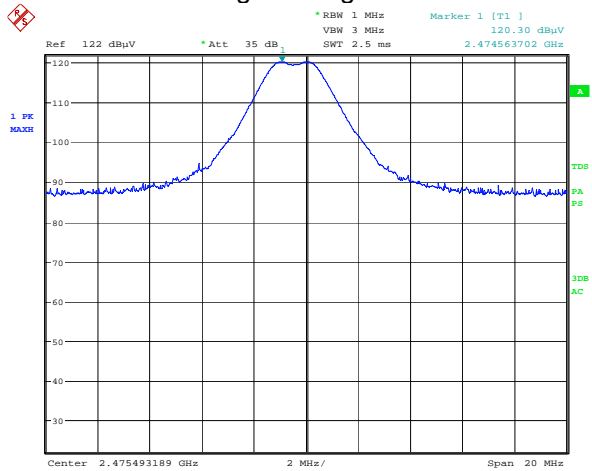


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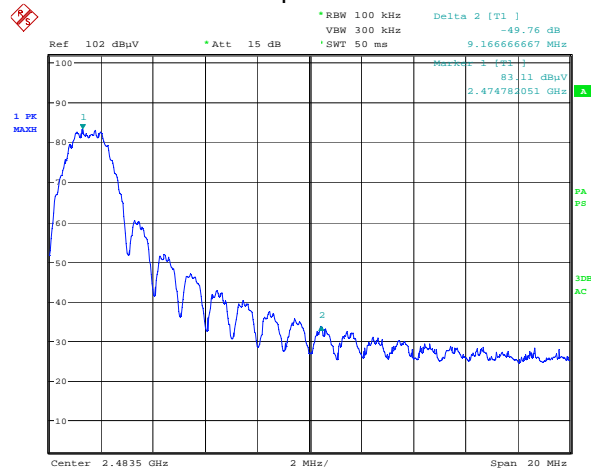
Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.247(d) Spurious emissions			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C		Air pressure: 1005 mbar	Relative humidity: 36 %
Specification: FCC Part 15 Subpart C			

Test data, continued

Marker-delta measurement for 2.4835 GHz Band Edge for channel 25 of 26
Measured field strength for high channel in 1 MHz/3 MHz RBW/VBW = 120.3 dBµV/m



Date: 27.JUL.2010 16:47:34



Date: 27.JUL.2010 16:52:14

Delta marker = 49.76 dB

Therefore, Peak Field Strength = 120.30 dBµV/m – 49.76 dB (Delta marker) = 70.54 dBµV/m

Limit = 74 dBµV/m

Average Field Strength = 70.54 dBµV/m – 16.92 dB (Duty cycle correction factor) = 53.62 dBµV/m

Limit = 54 dBµV/m



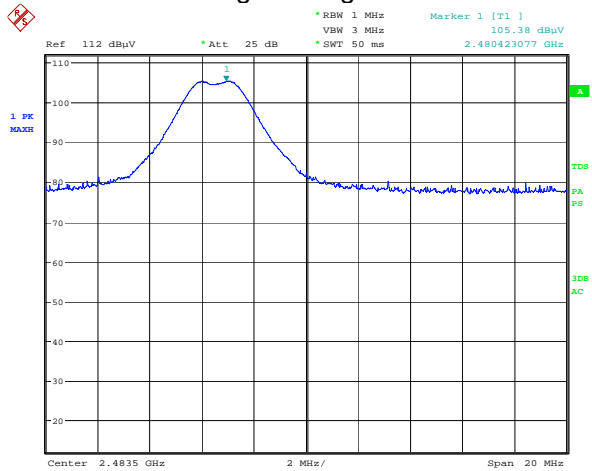
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Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.247(d) Spurious emissions			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

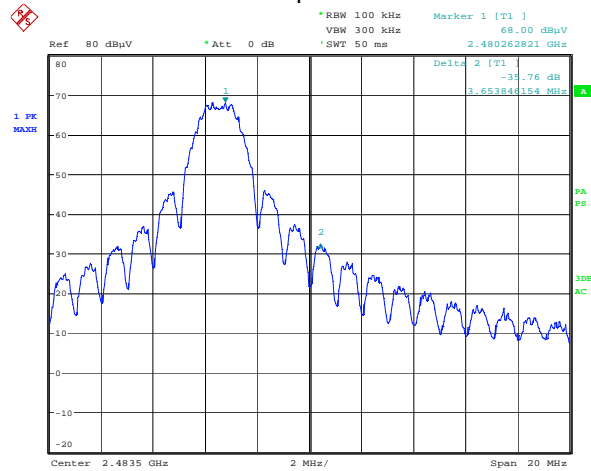
Test data, continued

Marker-delta measurement for 2.4835 GHz Band Edge for channel 26 of 26 on LC model:

Measured field strength for high channel in 1 MHz/3 MHz RBW/VBW = 105.38 dBµV/m



Date: 27.JUL.2010 17:06:27



Date: 27.JUL.2010 17:07:54

Delta marker = 35.76 dB

Therefore, Peak Field Strength = 105.38 dBµV/m – 35.76 dB (Delta marker) = 69.62 dBµV/m

Limit = 74 dBµV/m

Average Field Strength = 69.62 dBµV/m – 16.92 dB (Duty cycle correction factor) = 52.70 dBµV/m

Limit = 54 dBµV/m

Marker-delta measurement for 2.4835 GHz Band Edge for channel 26 of 26 on ST model:

Measured field strength for high channel in 1 MHz/3 MHz RBW/VBW = 103.73 dBµV/m

Delta marker = 35.76 dB

Therefore, Peak Field Strength = 103.73 dBµV/m – 35.76 dB (Delta marker) = 67.97 dBµV/m

Limit = 74 dBµV/m

Average Field Strength = 67.97 dBµV/m – 16.92 dB (Duty cycle correction factor) = 51.05 dBµV/m

Limit = 54 dBµV/m



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Section 8: Testing data

Product: ZigBee radio module

Test name: Clause 15.247(d) Spurious emissions

Test date: July 12, 2010

Test engineer: Andrey Adelberg

Verdict: Pass

Supply input: 120 VAC, 60 Hz

Temperature: 25 °C

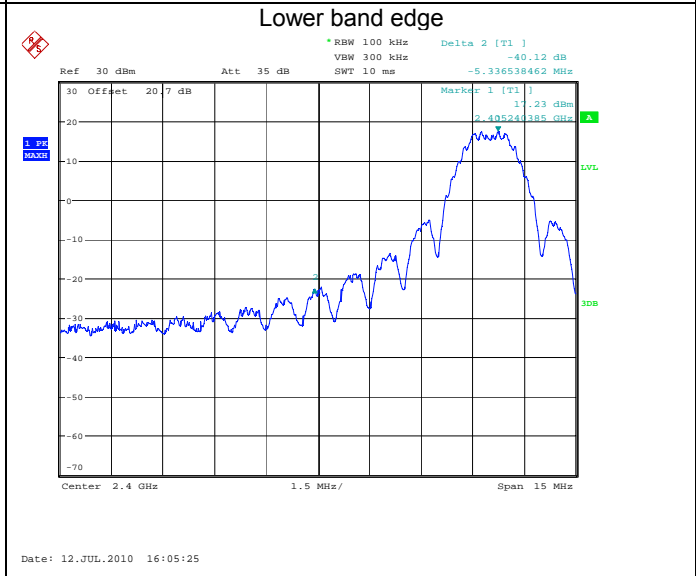
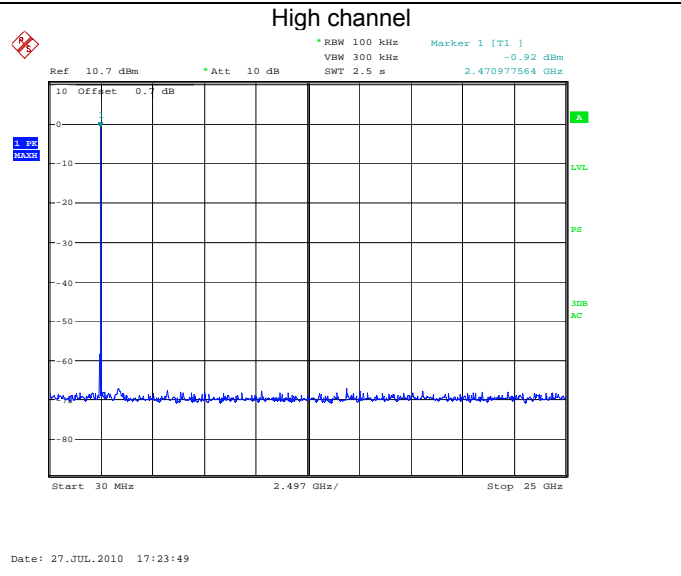
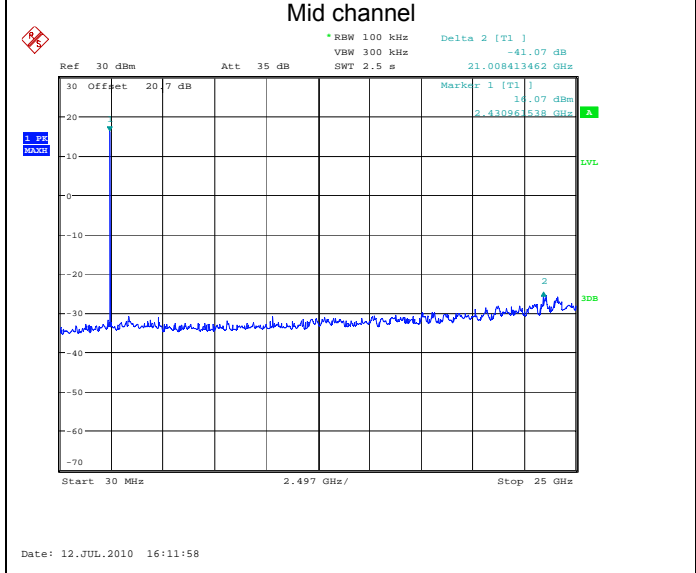
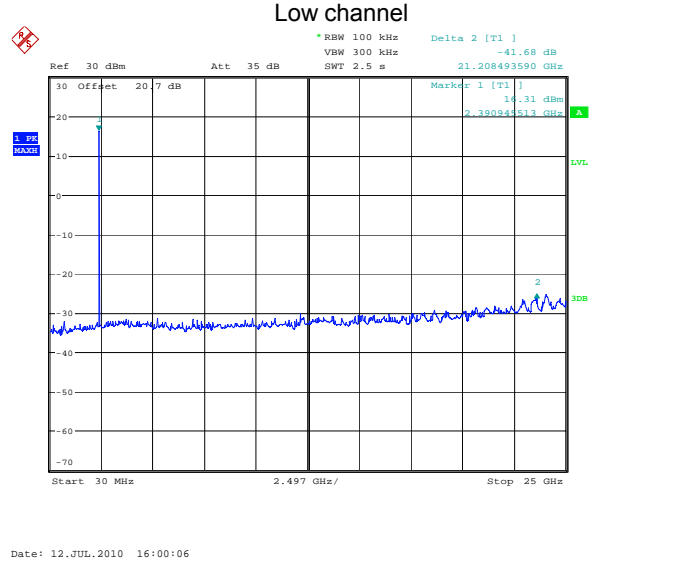
Air pressure: 1005 mbar

Relative humidity: 36 %

Specification: FCC Part 15 Subpart C

Test data

Conducted measurement



Note: lower band edge limit is -20 dBc/100 kHz. The measurement of the LBE was -40.12 dBc/100 kHz.




Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.247(d) Spurious emissions			
Test date: July 12, 2010		Test engineer: Andrey Adelberg	
Verdict: Pass		Supply input: 120 VAC, 60 Hz	
Temperature: 25 °C	Air pressure: 1005 mbar	Relative humidity: 36 %	
Specification: FCC Part 15 Subpart C			

Test data, continued

Radiated Measurements

- All measurements were performed at a distance of 3 m.
- The spectrum was scanned from 30 MHz to 25 GHz.
- 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

Frequency (MHz)	Peak field strength (dBµV/m)	Pk Limit (dBµV/m)	Margin (dB)	Duty cycle factor (dB)	Average Field strength (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)
LC model							
Low channel							
4809.083	57.32	74.00	16.68	-11.06	46.26	54.00	7.74
7216.56	58.32	74.00	15.68	-11.06	47.26	54.00	6.74
9622.81	59.38	74.00	14.62	-11.06	48.32	54.00	5.68
Mid channel							
4880.91	54.00	74.00	20.00	-11.06	42.94	54.00	11.06
7321.56	58.87	74.00	15.13	-11.06	47.81	54.00	6.19
9758.46	58.56	74.00	15.44	-11.06	47.50	54.00	6.50
High channel							
None detected							
ST model							
Low channel							
4810.93	61.21	74.00	12.79	-11.06	50.15	54.00	3.85
7213.78	55.38	74.00	18.62	-11.06	44.32	54.00	9.68
Mid channel							
4881.07	62.57	74.00	11.43	-11.06	51.51	54.00	2.49
7318.59	55.60	74.00	18.40	-11.06	44.54	54.00	9.46
High channel							
4961.07	61.00	74.00	13.00	-11.06	49.94	54.00	4.06
7438.38	56.57	74.00	17.43	-11.06	45.51	54.00	8.49

 Nemko Canada Inc., 303 River Rd, Ottawa, ON, Canada, K1V 1H2	Section 8: Testing data		Product: ZigBee radio module	
	Test name: Clause 15.247(e) Power spectral density for digitally modulated devices			
	Test date: XXXX		Test engineer: XXXX	
	Verdict: XXXX		Supply input: XXXX	
	Temperature: XXX °C	Air pressure: XXXX mbar	Relative humidity: XXX %	
Specification: FCC Part 15 Subpart C				

8.8 Clause 15.247(e) Power spectral density for digitally modulated devices

§ 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

- (e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Special notes

- The test was performed using guidelines of ANSI C63.10-2009, Clause 6.11.2.
- PSD option 1 was used since output power option 1 was used.
- Emission peak was located and zoomed in. RBW was set to 3 kHz, VBW was set > RBW. Sweep time was set to Span/3 kHz. Peak level was measured.



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Section 8: Testing data

Product: ZigBee radio module

Test name: Clause 15.247(e) Power spectral density for digitally modulated devices

Test date: XXXX

Test engineer: XXXX

Verdict: XXXX

Supply input: XXXX

Temperature: XXX °C

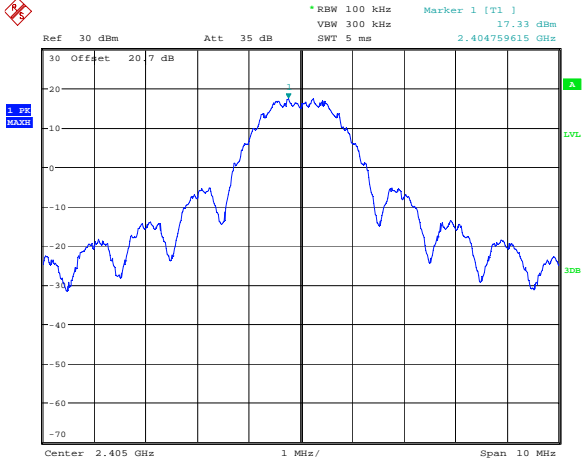
Air pressure: XXXX mbar

Relative humidity: XXX %

Specification: FCC Part 15 Subpart C

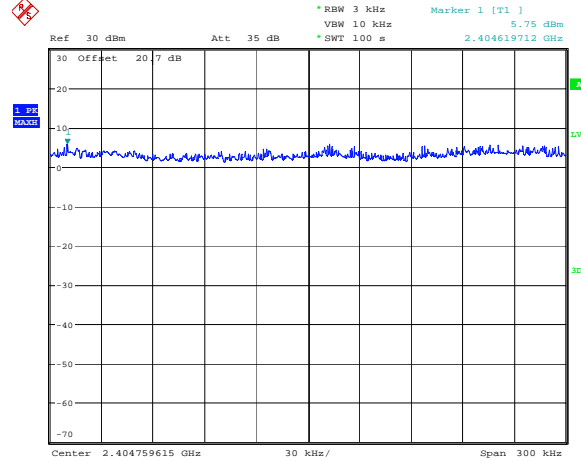
Test data

Low channel



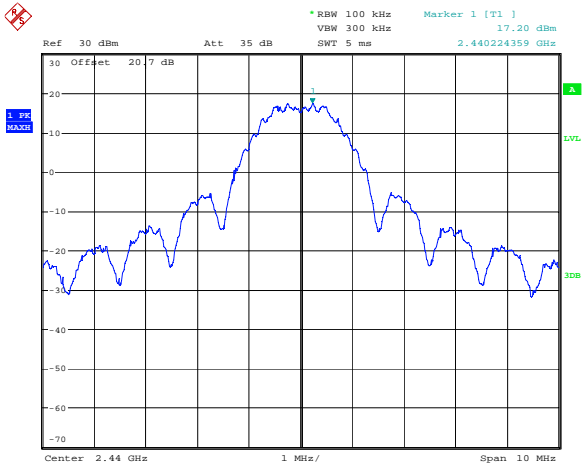
Date: 12.JUL.2010 16:01:49

Low channel, zoomed



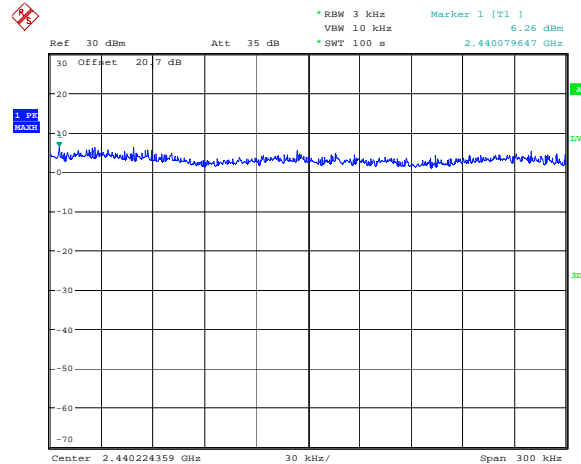
Date: 12.JUL.2010 16:04:11

Mid channel



Date: 12.JUL.2010 16:07:49

Mid channel, zoomed



Date: 12.JUL.2010 16:09:55



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303 River Rd, Ottawa, ON, Canada, K1V 1H2

Section 8: Testing data		Product: ZigBee radio module	
Test name: Clause 15.247(e) Power spectral density for digitally modulated devices			
Test date: XXXX		Test engineer: XXXX	
Verdict: XXXX		Supply input: XXXX	
Temperature: XXX °C	Air pressure: XXXX mbar	Relative humidity: XXX %	
Specification: FCC Part 15 Subpart C			

Test data, continued

High channel

Date: 27.JUL.2010 17:18:32

High channel, zoomed

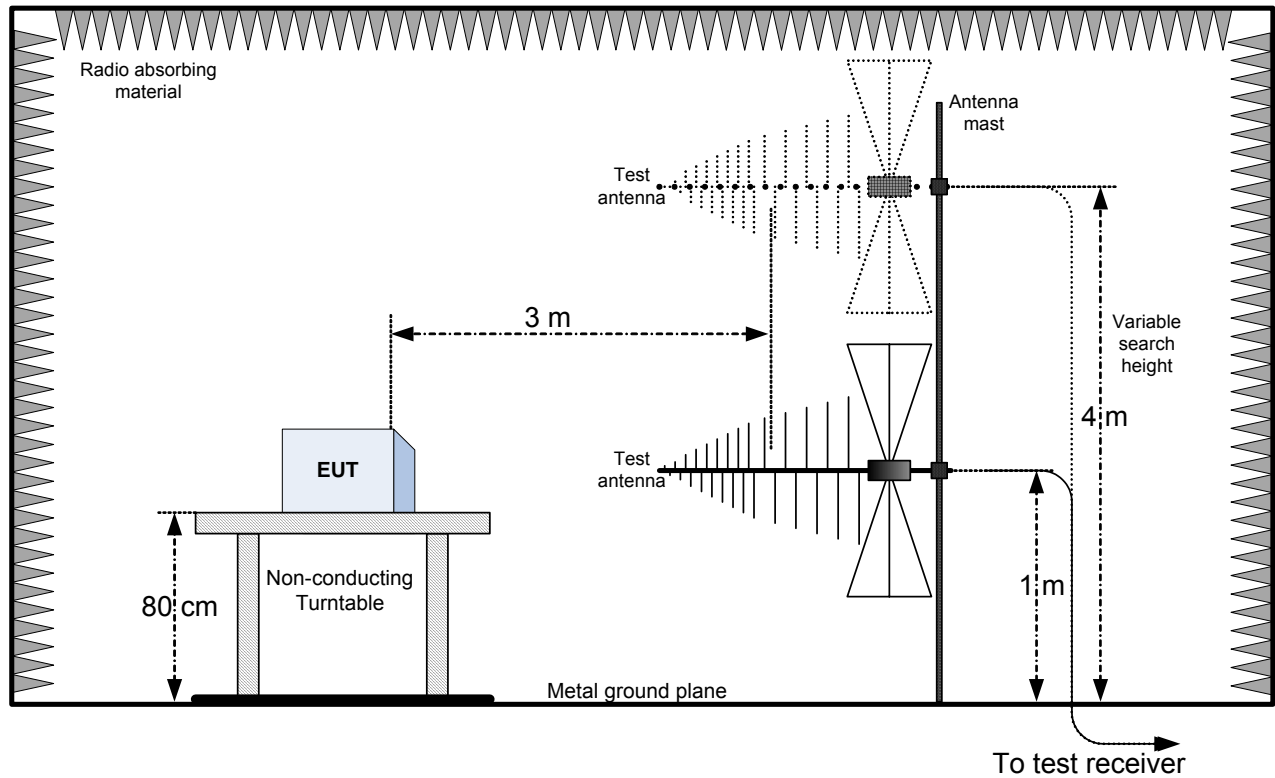
Date: 27.JUL.2010 17:20:40

Frequency (MHz)	PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)
2405	5.75	8.0	2.25
2440	6.26	8.0	1.74
2480	-10.36	8.0	18.36

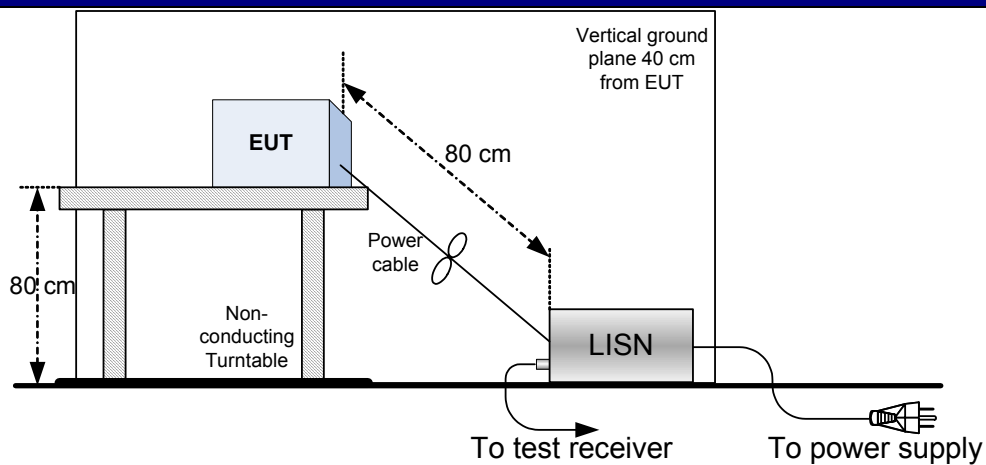
Sweep time = Span/RBW
 Sweep time = (300 kHz/3 kHz)
 Sweep time = 100 s

Section 8: Block diagrams of test set-ups

Radiated emissions set-up

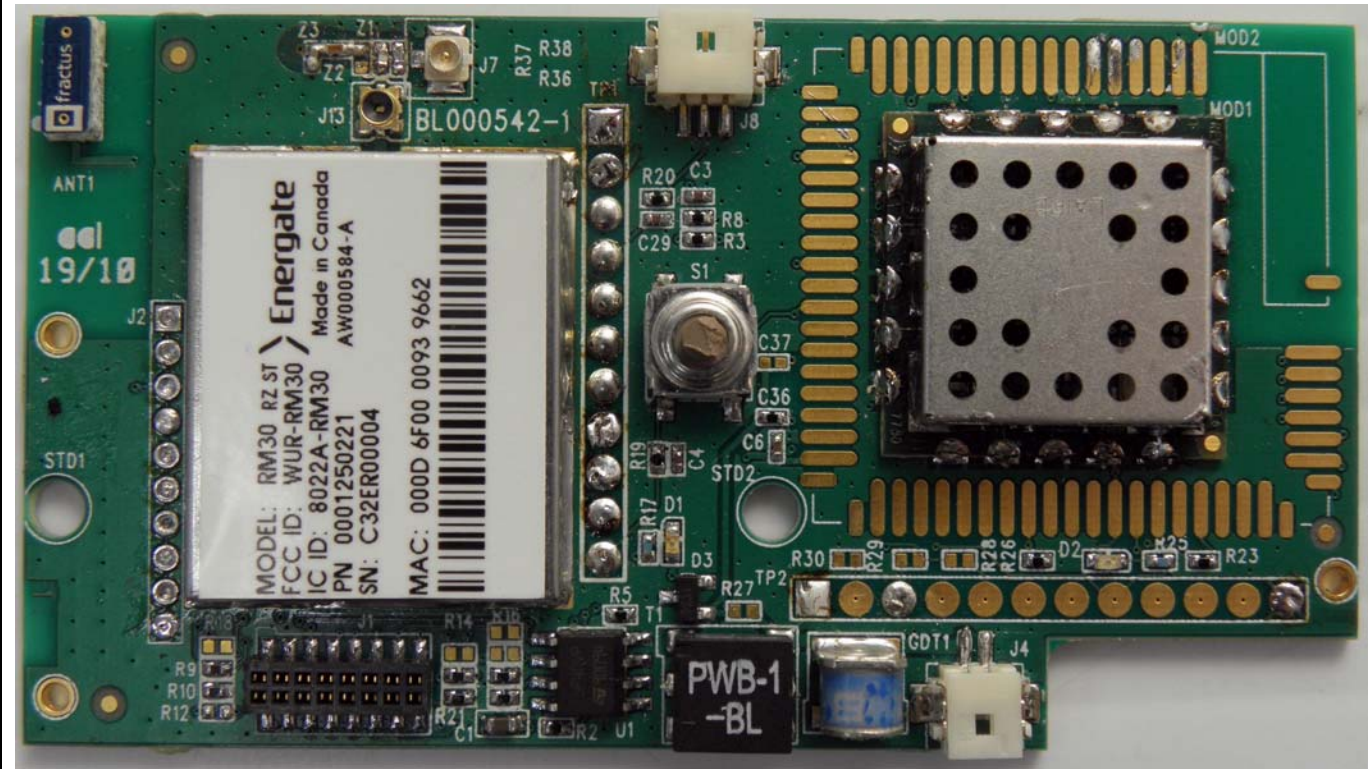


Conducted emissions set-up

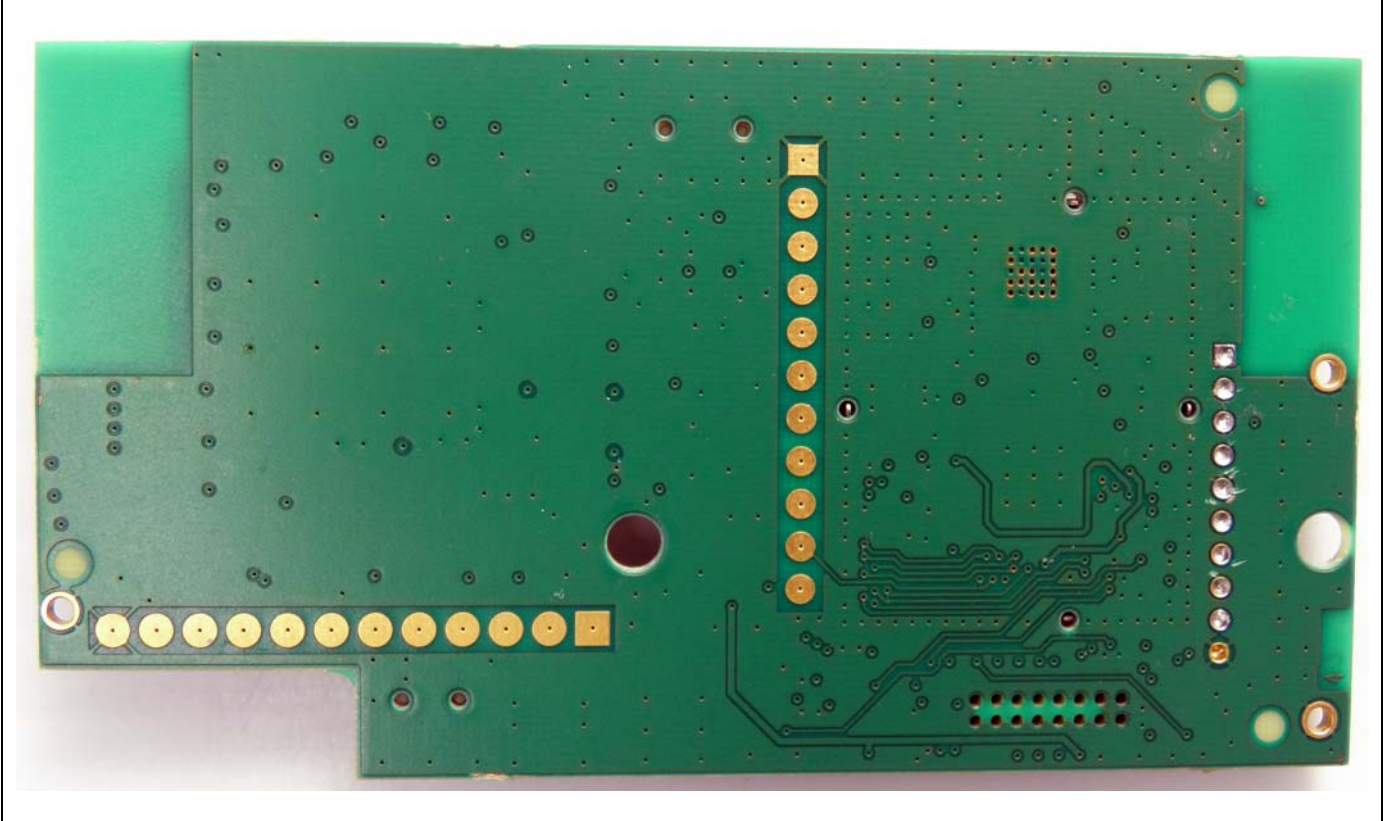


Section 9: EUT photos

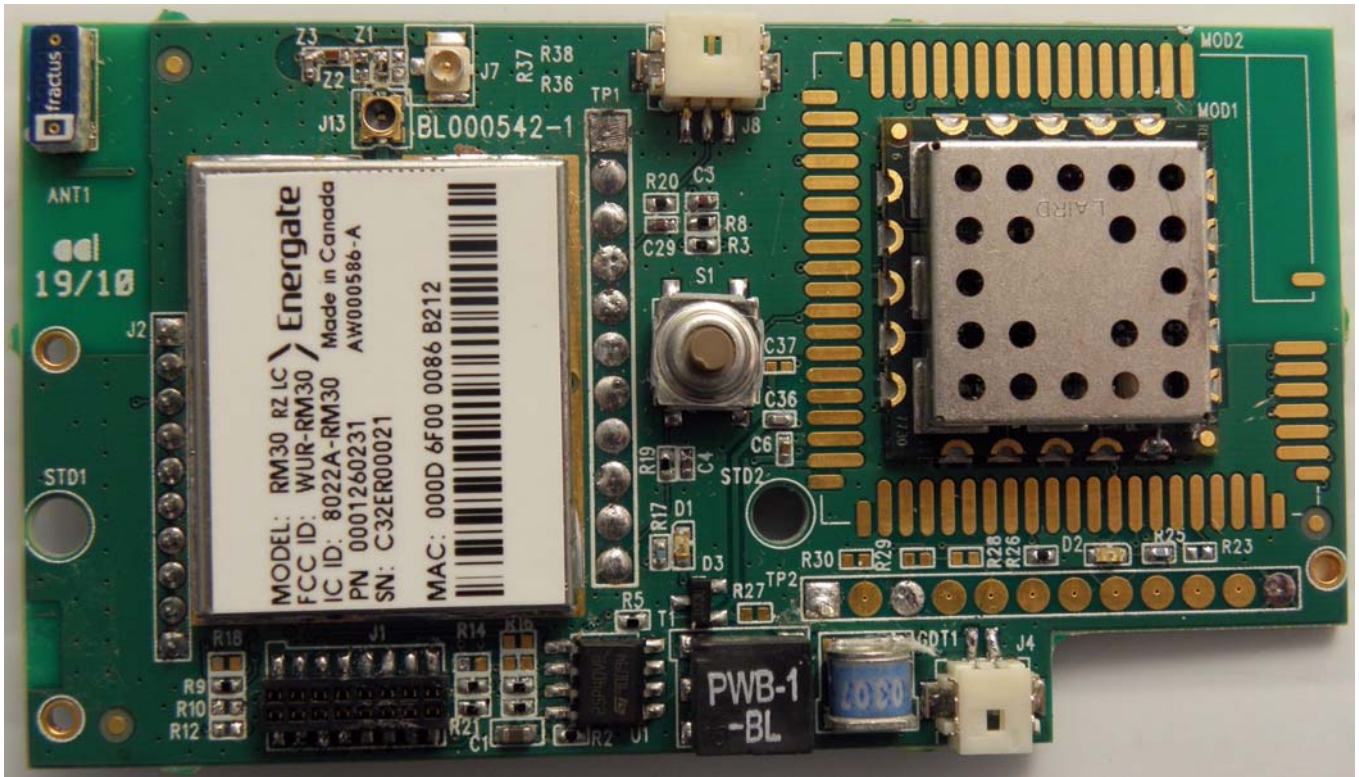
EUT, ST model



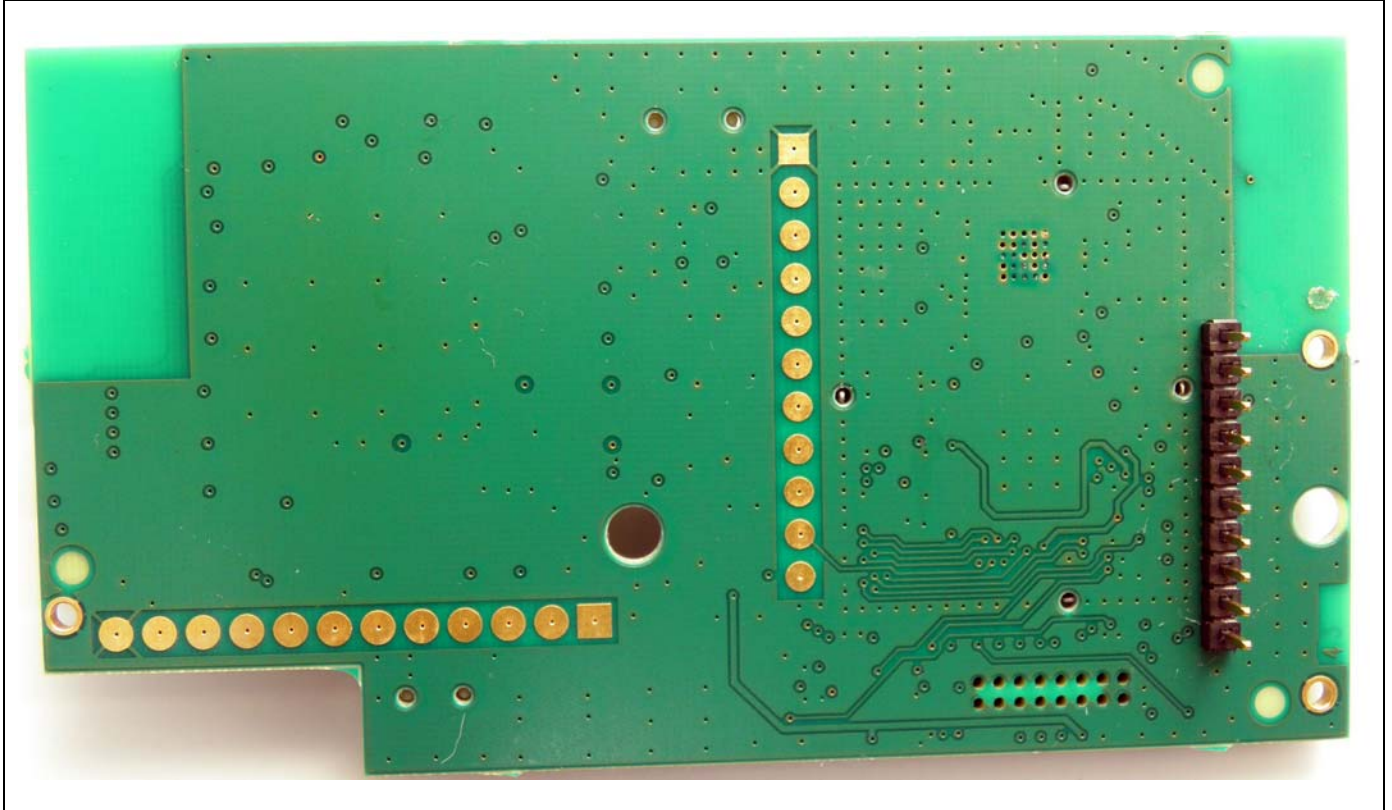
EUT, ST model



EUT, LC model



EUT, LC model



EUT, without shields

