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Test report

283898-1TRFWL

Date of issue: June 11, 2015

Applicant:

Synapse Electronique

Product:

Z-Wave Transceiver Module

Model:

SYN-RF-ZW01Ux-L

FCC ID: OW7-ZW01UL

IC Registration number: 10525A-ZW01UL

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.249
  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHz and 24.0–24.25 GHz
- RSS-210, Issue 8, December 2010, Annex 2.9
  Devices Operating in 902–928, 2400–2483.5 and 5725–5875 MHz Frequency Bands for Any Application

Test location

Company name:	Nemko Canada Inc.
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Country:	Canada
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Toll free:	+1 800 563 6336
Website:	www.nemko.com
Site number:	FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by:	David Duchesne, Senior EMC/Wireless Specialist
Reviewed by:	Kevin Rose, Wireless/EMC Specialist
Date:	June 11, 2015
Signature:	

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 1 Report summary

1.1 Applicant and manufacturer

Company name	Synapse Electronique
Address	1010, 7e Avenue
City	Grand-Mere Quebec
Province/State	QC
Postal/Zip code	G9T 2B8
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.249	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHz and 24.0–24.25 GHz
RSS-210, Issue 8 Annex A2.9	Devices Operating in 902–928, 2400–2483.5 and 5725–5875 MHz Frequency Bands for Any Application

1.3 Test methods

ANSI C63.10 v 2009	American National Standard for Testing Unlicensed Wireless Devices

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

Table 1.6-1: *Test report revision history*

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

Notes: None

Section 2 Summary of test results

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

Table 2.1-1: *FCC Part 15 Subpart C – Intentional Radiators, test result*

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.215(c)	Emission bandwidth	Pass
§15.249(a)	Radiated emissions not in restricted bands	Pass
§15.249(b)	Fixed Point-to-Point operation in the 24.0–24.25 GHz band	Not applicable
§15.249(d)	Spurious emissions (except harmonics)	Pass

Notes: None

2.2 IC RSS-GEN, Issue 4, test results

Table 2.2-1: *IC RSS-GEN, test result*

Part	Test description	Verdict
§6.6	Occupied bandwidth	Pass
§8.8	AC power lines conducted emission limits	Pass

Notes: None

2.3 RSS-210, Issue 8, test results

Table 2.3-1: *RSS-210, test result*

Part	Test description	Verdict
§A2.9a	Radiated emissions not in restricted bands	Pass
§A2.9b	Spurious emissions (except harmonics)	Pass

Notes: None

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	April 27, 2015
Nemko sample ID number	133001229

3.2 EUT information

Product name	Z-Wave Transceiver Module
Model	SYN-RF-ZW01Ux-L *Note: "x" can change depending of the software, per example: RS for routing Slave, ES for Enhanced Slave, etc. We want to mark "x" as the hardware is independent of the software.*
Serial number	None

3.3 Technical information

Operating band	902 – 928 MHz
Operating frequency	908.4 – 916.0 MHz
Modulation type	GFSK
Occupied bandwidth (99 %)	118.6 kHz
Emission designator	118K6F1D
Power requirements	9 V_{DC} (Powered via an external AC-DC adapter 120–230 V_{AC} 50/60 Hz)
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The product is a Z-Wave interface module with an integrated antenna etched on the PCB and a microcontroller-transceiver. A host product can embed this module to implement Z-Wave communication.

3.5 EUT exercise details

The EUT was tested in continuous transmit state.

3.6 EUT setup details

Table 3.6-1: Support equipment

Description	Brand name	Model/Part number	Serial number
AC-DC adapter	CUI	EMSA090067/EMSA090067-P5P-SZ	None
Laptop	Dell	Nemko Asset: FA002360	

Notes: None

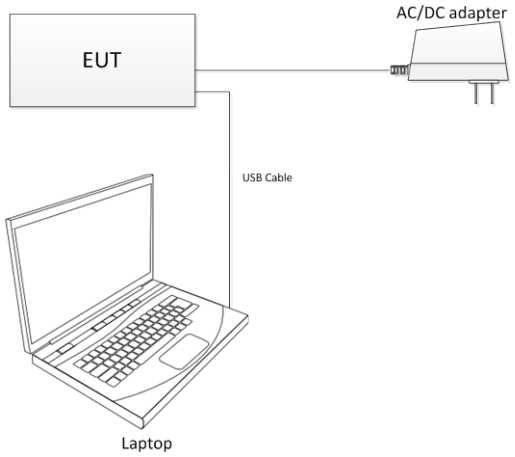


Figure 3.6-1: Setup diagram

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

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

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 6.1-1: *Measurement uncertainty*

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Notes: None

Section 7 Test equipment

7.1 Test equipment list

Table 7.1-1: *Test equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Feb. 25/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power source	California Instruments	3001i	FA001021	1 year	June 27/15
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/16
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Jan. 09/16
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 12/16
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 01/16
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 23/15
50 Ω coax cable	C.C.A.	None	FA002556	1 year	June 23/15

Notes: NCR - no calibration required

Table 7.1-2: *test software details*

Test description	**Manufacturer of Software**	**Details**
Radiated emissions	Rhode & Schwarz	EMC32, Software for EMC Measurements, Version 8.53.0
Conducted emissions	Rhode & Schwarz	EMC32, Software for EMC Measurements, Version 8.53.0

Notes: None

Section 8 Testing data

8.1 Clause 15.207(a), RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

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

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

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

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

Table 8.1-1: *AC power line conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Notes: * - Decreases with the logarithm of the frequency.

8.1.2 Test summary

Verdict	Pass		
Test date	May 1, 2015	Temperature	20 °C
Test engineer	David Duchesne	Air pressure	1002 mbar
Test location	Ottawa	Relative humidity	37.7 %

8.1.3 Observations, settings and special notes

Port under test	AC input of AC-DC adapter
EUT setup configuration	Table top
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average (preview measurement); Quasi-peak and Average (final measurement)
Trace mode	Max Hold
Measurement time	100 ms (preview measurement); 1000 ms (final measurement)

8.1.4 Test data

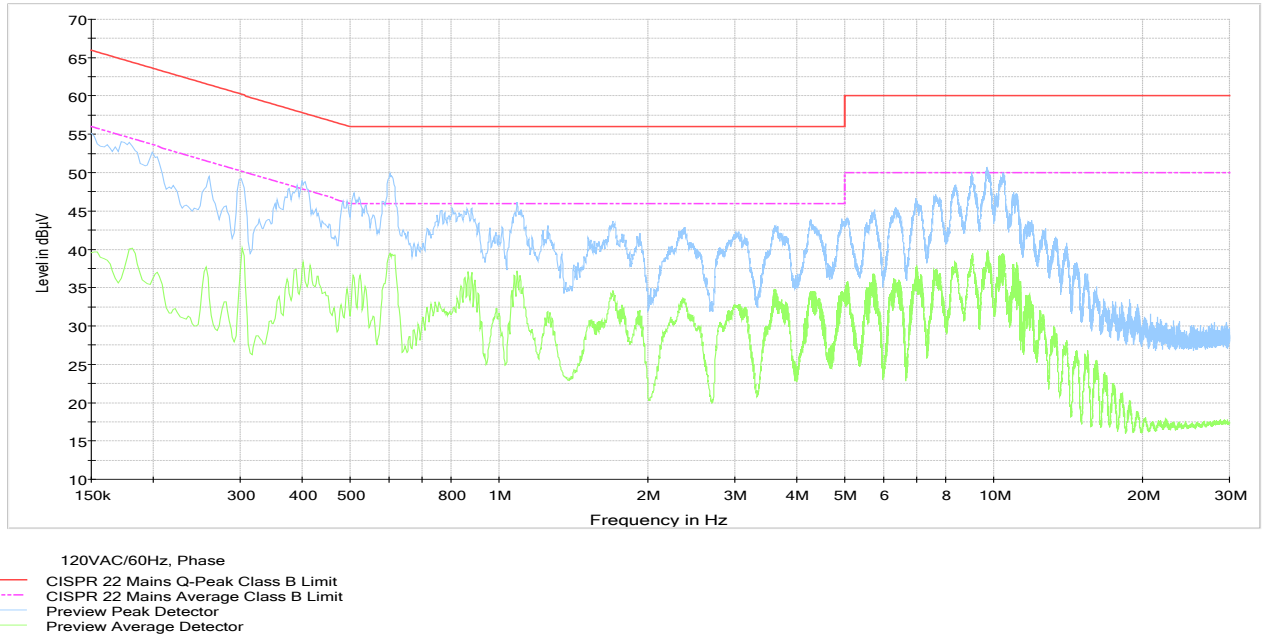


Figure 8.1-1: *AC power line conducted emissions on phase line*

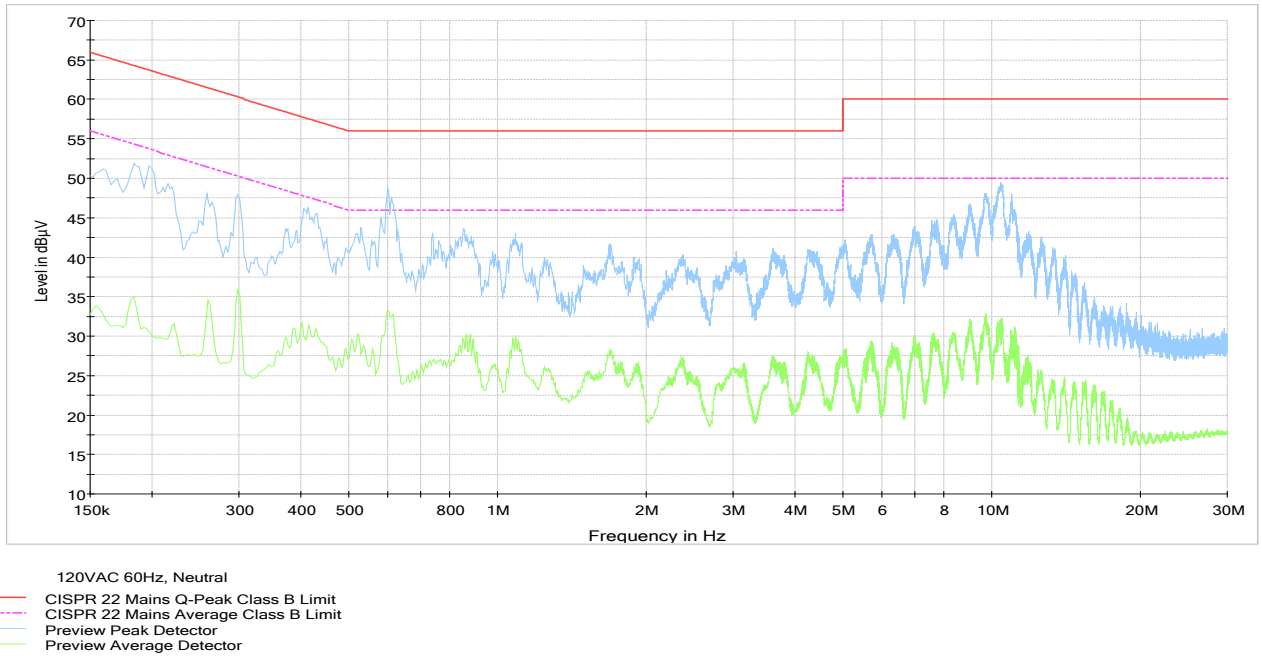


Figure 8.1-2: *AC power line conducted emissions on neutral line*

8.1.5 Setup photos

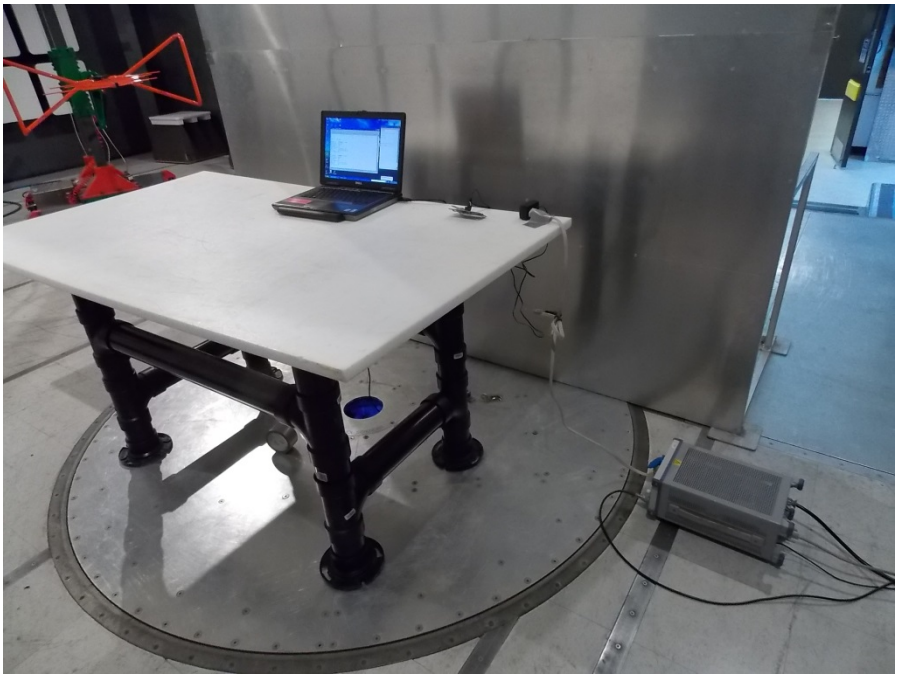


Figure 8.1-3: *AC power line conducted emissions setup photo*

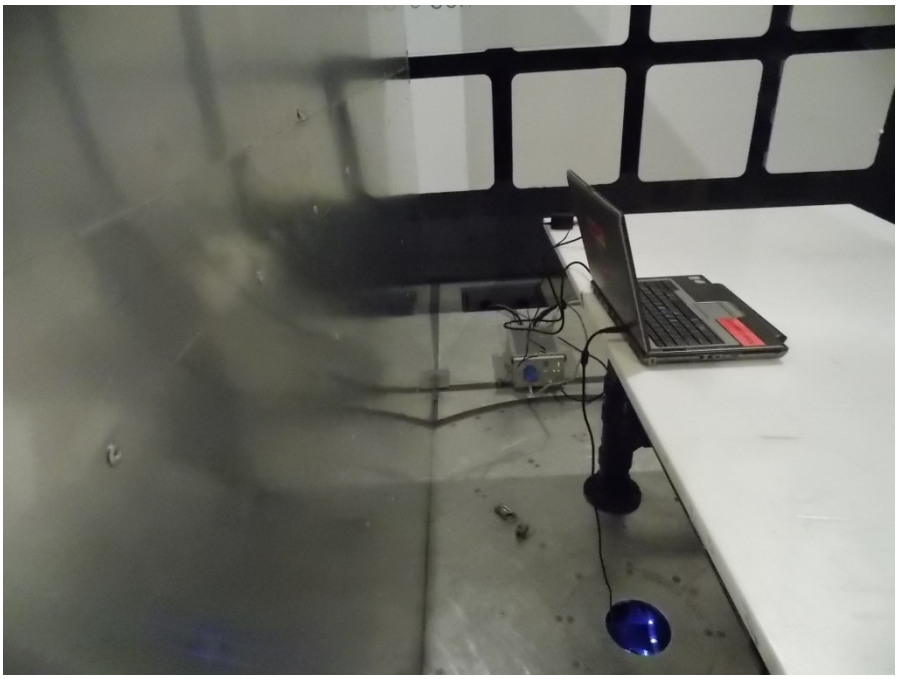


Figure 8.1-4: *AC power line conducted emissions setup photo*

8.2 Clause 15.215(c) 20 dB bandwidth and RSS Gen 6.6 Occupied bandwidth

8.2.1 Definitions and limits

FCC Part 15.215(c)

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80 % of the permitted band in order to minimize the possibility of out-of-band operation.

RSS-Gen Clause 6.6 Occupied bandwidth

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.

8.2.2 Test summary

Verdict	Pass		
Test date	May 1, 2015	Temperature	20 °C
Test engineer	David Duchesne	Air pressure	1002 mbar
Test location	Ottawa	Relative humidity	37.7 %

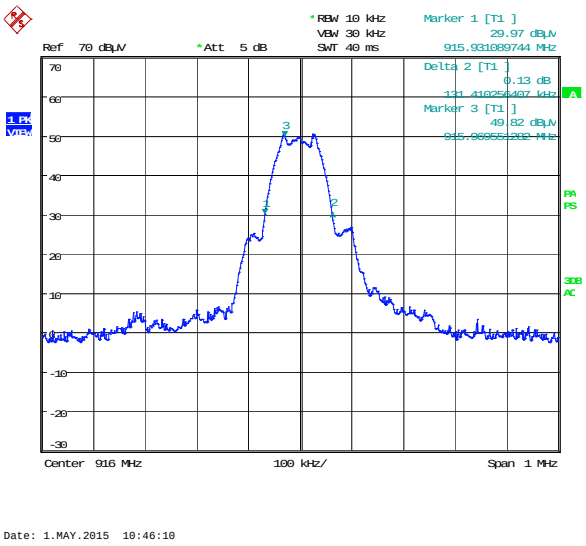
8.2.3 Observations/special notes

The EUT was tested at communication rate 100 kBit as it was determined to provide the largest bandwidth.

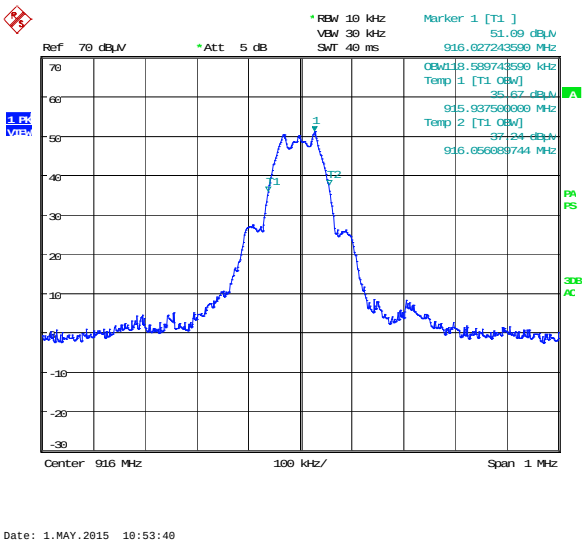
Spectrum analyzer settings:

Resolution bandwidth	10 kHz
Video bandwidth	30 kHz
Detector mode	Peak
Trace mod	Max Hold
Function:	20 dB BW (for FCC); 99 % bandwidth (for IC)

8.2.4 Test data



Plot 8.2-1: *20 dB bandwidth sample plot*



Plot 8.2-2: *99% bandwidth sample plot*

Table 8.2-1: *20 dB bandwidth results*

Frequency, MHz	20 dB bandwidth, kHz
908.4	128.2
916.0	131.4

Notes: None

Table 8.2-2: *99% bandwidth results*

Frequency, MHz	99 % occupied bandwidth, kHz
908.4	115.4
916.0	118.6

Notes: None

Table 8.2-3: *Operation band compliance for FCC*

Lower 20 dB BW frequency, MHz	Lower band edge limit, MHz	Upper 20 dB BW frequency, MHz	Upper band edge limit, MHz
907.9	>902.000	916.1	<928.000

Notes: None

Table 8.2-4: *Operation band compliance for IC*

Lower 99 % OBW frequency, MHz	Lower band edge limit, MHz	Upper 99 % OBW frequency, MHz	Upper band edge limit, MHz
907.9	>902.000	916.1	<928.000

Notes: None

8.3 Clause 15.249(a) and RSS 210 A2.9(a) Field strength of emissions not in restricted bands

8.3.1 Definitions and limits

In addition to the provisions of §15.205 and RSS Gen the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Table 8.3-1: *Field strength limits*

Fundamental frequency (MHz)	Field strength of fundamental (mV/m)	(dBµV/m)	Field strength of spurious emissions (µV/m)	(dBµV/m)
902–928	50	94	500	54
2400–2483.5	50	94	500	54
5725–5875	50	94	500	54
24.0–24.25	250	108	2500	68

Notes: None

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter (128 dBµV/m) at 3 meters along the antenna azimuth.

Table 8.3-2: *§15.209 RSS Gen 7.2.5 – Radiated emission limits*

Frequency (MHz)	Field strength limits (µV/m)	(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

Notes: None

8.3.2 Test summary

Verdict	Pass		
Test date	May 1, 2015	Temperature	20 °C
Test engineer	David Duchesne	Air pressure	1002 mbar
Test location	Ottawa	Relative humidity	37.7 %

8.3.3 Observations/special notes

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.

EUT setup configuration	Table top
Test facility	3 m Semi anechoic chamber
Measuring distance	3 m
Antenna height variation	1–4 m
Turn table position	0–360°
Measurement details	The test was performed with vertical and horizontal antenna polarizations, only the highest emissions were reported
Frequency Range	30 MHz to 10 GHz

Spectrum analyzer settings below 1 GHz:

Resolution bandwidth	100 kHz
Video bandwidth	30 kHz
Detector mode	Peak
Trace mod	Max Hold

Spectrum analyzer settings above 1 GHz:

Resolution bandwidth	1000 kHz
Video bandwidth	3000 kHz
Detector mode	Peak
Trace mod	Max Hold

8.3.4 Test data, continued

Table 8.3-3: *Field strength measurement results for low channel*

Frequency, MHz	Peak Field strength, dBµV/m [1]	Peak limit, dBµV/m	Margin, dB	Duty cycle factor, dB [2]	Average Field strength, dBµV/m [3]	Avg. limit, dBµV/m	Margin, dB
Fundamental							
908.40	92.59	114.00	21.41	0.00	92.59	94.00	1.41
Harmonics							
2725.20	48.20	74.00	25.80	0.00	48.20	54.00	5.80
4542.00	48.50	74.00	25.50	0.00	48.50	54.00	5.50

Notes: [1] Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
[2] The EUT can operate with a 100% duty cycle. No duty correction is 0 dB
[3] Average field strength = Peak Field strength + Duty cycle factor

Table 8.3-4: Field strength measurement results for high channel

Frequency, MHz	Peak Field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Duty cycle factor, dB	Average Field strength, dBµV/m	Avg. limit, dBµV/m	Margin, dB
Fundamental							
916.00	93.18	114.00	20.82	0.00	93.18	94.00	0.82
Harmonics							
2748.00	51.50	74.00	22.50	0.00	51.50	54.00	2.50
4580.00	49.40	74.00	24.60	0.00	49.40	54.00	4.60

Notes: [1] Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
[2] The EUT can operate with a 100% duty cycle. No duty correction is 0 dB
[3] Average field strength = Peak Field strength + Duty cycle factor

8.3.5 Setup photos

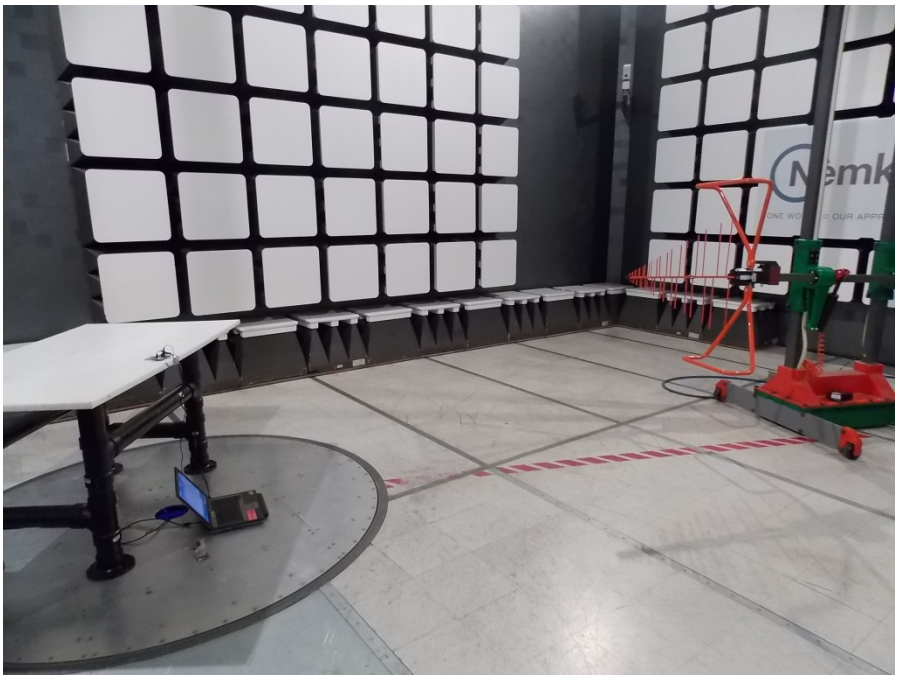


Figure 8.3-1: *Field strength setup photo*



Figure 8.3-2: *Field strength setup photo*

8.4 Clause 15.249(d), RSS-210 A2.9(b), AS/NZS Clause 8.2 Spurious emissions (except for harmonics)

8.4.1 Definitions and limits

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

Table 8.4-1: – 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

Notes:
- F = 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.

8.4.2 Test summary

Verdict	Pass		
Test date	May 1, 2015	Temperature	20 °C
Test engineer	David Duchesne	Air pressure	1002 mbar
Test location	Ottawa	Relative humidity	37.7 %

8.4.3 Observations/special notes

EUT setup configuration	Table top
Test facility	3 m Semi anechoic chamber
Measuring distance	3 m
Antenna height variation	1–4 m
Turn table position	0–360°
Measurement details	The test was performed with vertical and horizontal antenna polarizations, only the highest emissions were reported
Frequency Range	30 MHz to 10 GHz

Spectrum analyzer settings below 1 GHz:

Resolution bandwidth	100 kHz
Video bandwidth	30 kHz
Detector mode	Peak
Trace mod	Max Hold

Spectrum analyzer settings above 1 GHz:

Resolution bandwidth	1000 kHz
Video bandwidth	3000 kHz
Detector mode	Peak
Trace mod	Max Hold

8.4.4 Test results

Table 8.4-2: Spurious emissions (except for harmonics) results

Frequency (MHz)	Peak field strength[1] (dBµV/m)	Measurement time (ms)	Pol. (V/H)	Correction factor[2] (dB)	Quasi-Peak limit (dBµV/m)	Margin (dB)
Low Channel						
70.662	34.20	100	V	9.6	40.00	5.8
144.291	33.00	100	V	14.6	43.50	10.5
167.997	35.50	100	V	13.8	43.50	8.0
High Channel						
144.021	34.20	100	V	14.60	43.50	9.30
168.186	36.10	100	V	13.70	43.50	7.40

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)

All emissions except for harmonics were more than 15 dB below the limits.

8.4.5 Setup photos

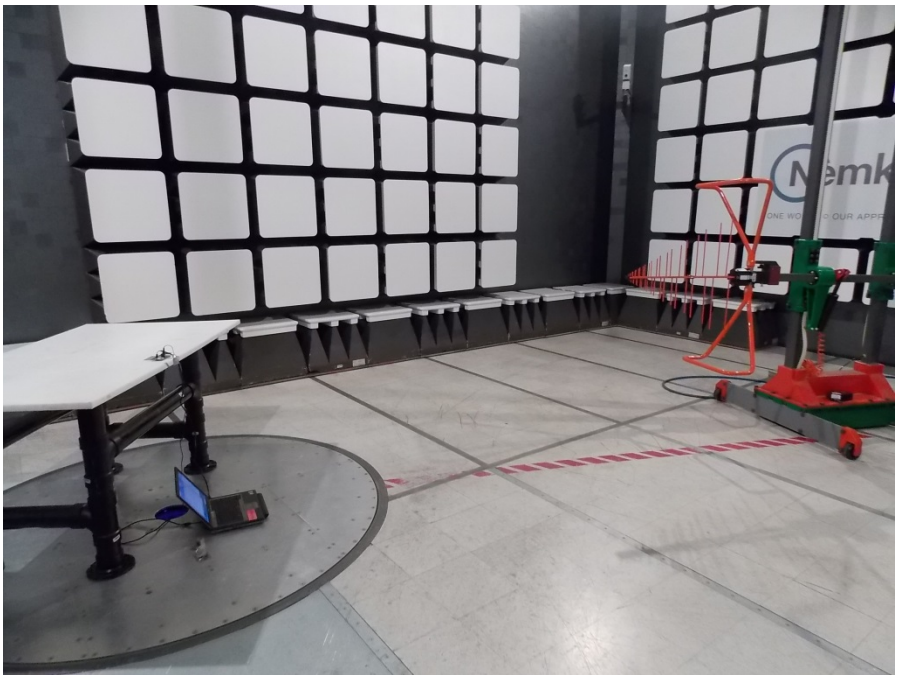


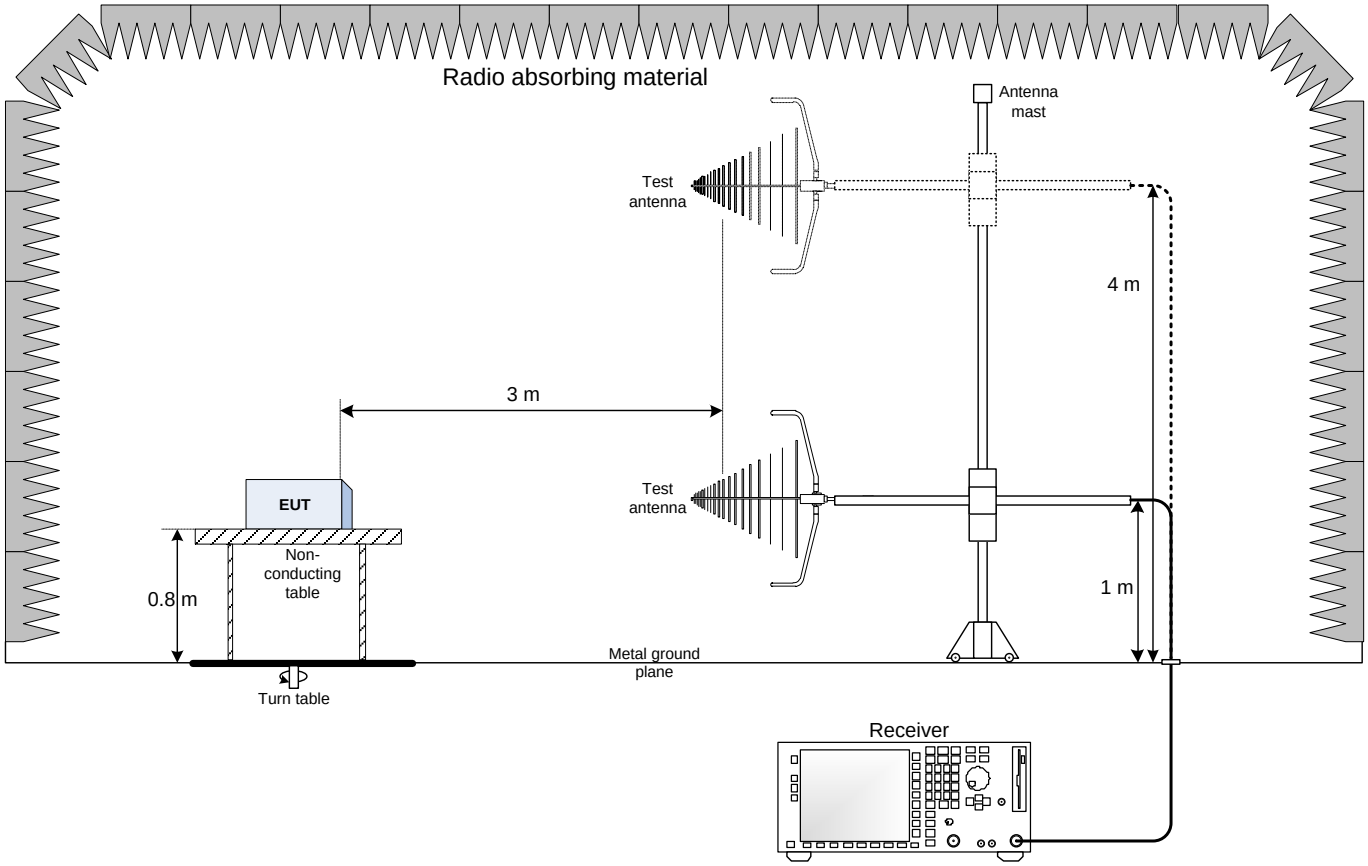
Figure 8.4-1: *Spurious emissions (except for harmonics) setup photo*



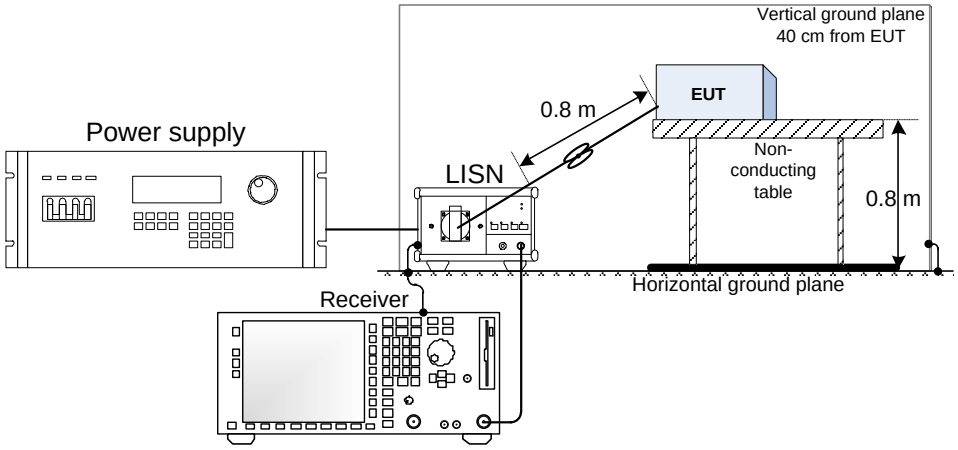
Figure 8.4-2: *Spurious emissions (except for harmonics) setup photo*

Section 9 Block Figures of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up



Section 10 EUT photos

10.1 Detailed photos

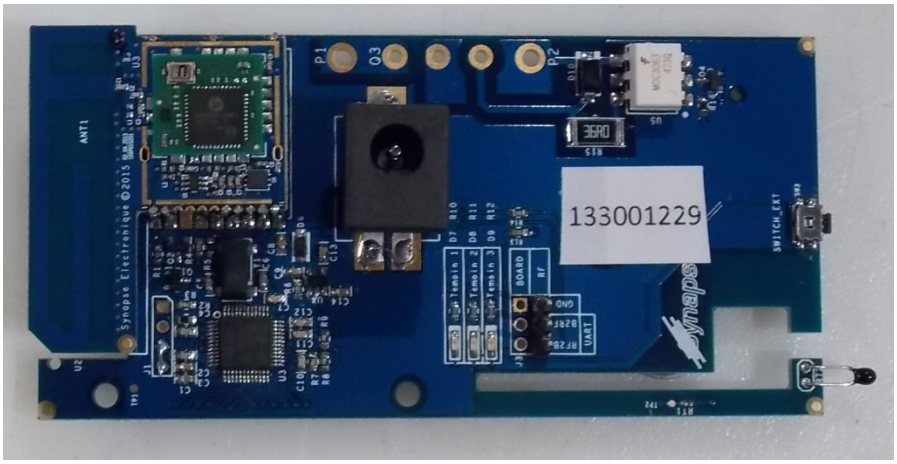


Figure 10.1-1: *Top view*

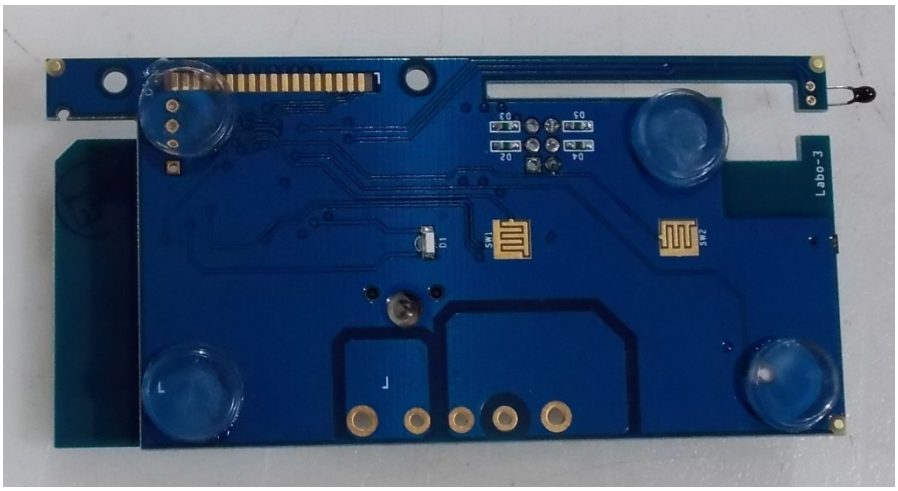


Figure 10.1-2: *Bottom view*

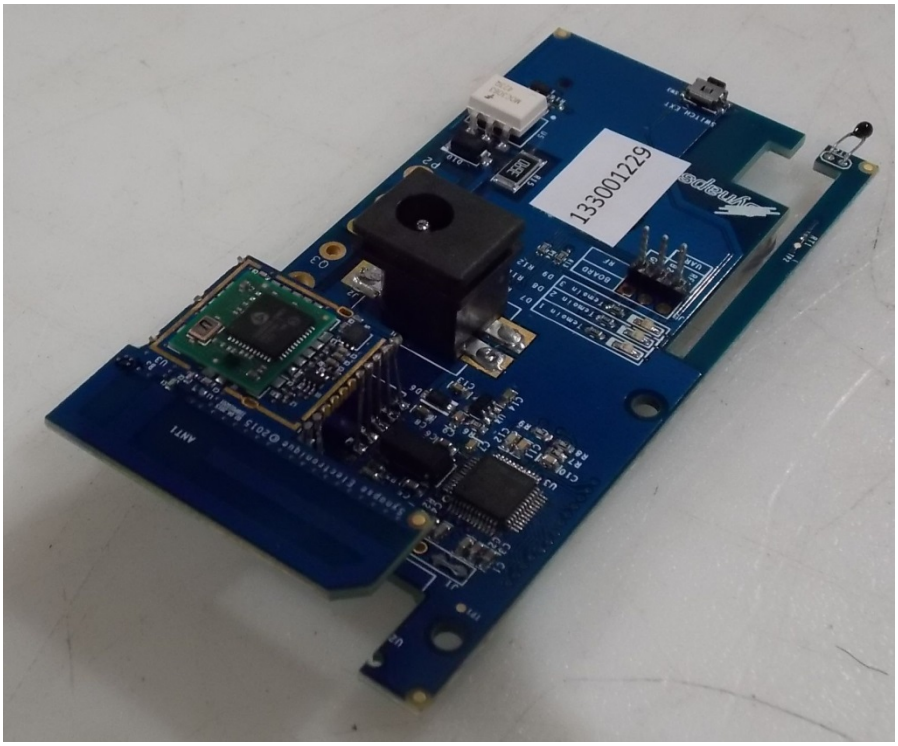


Figure 10.1-3: *Side view*

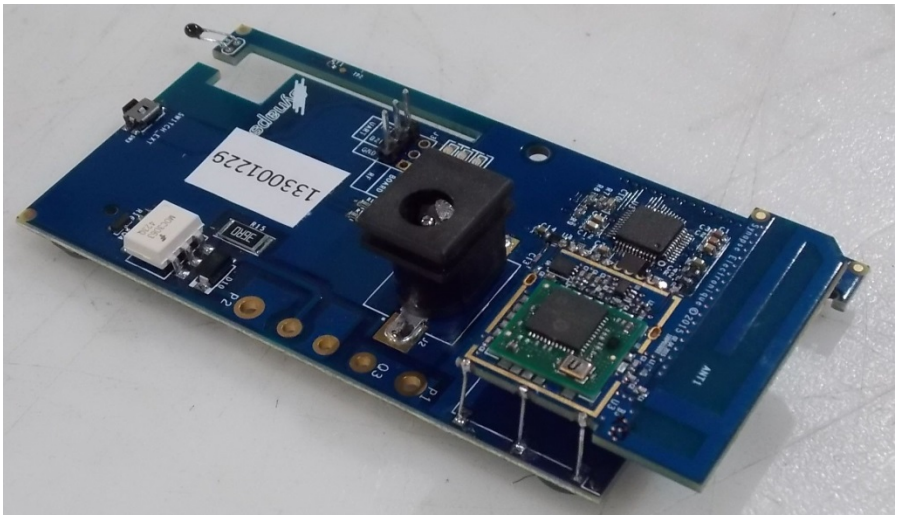


Figure 10.1-4: *Side view*

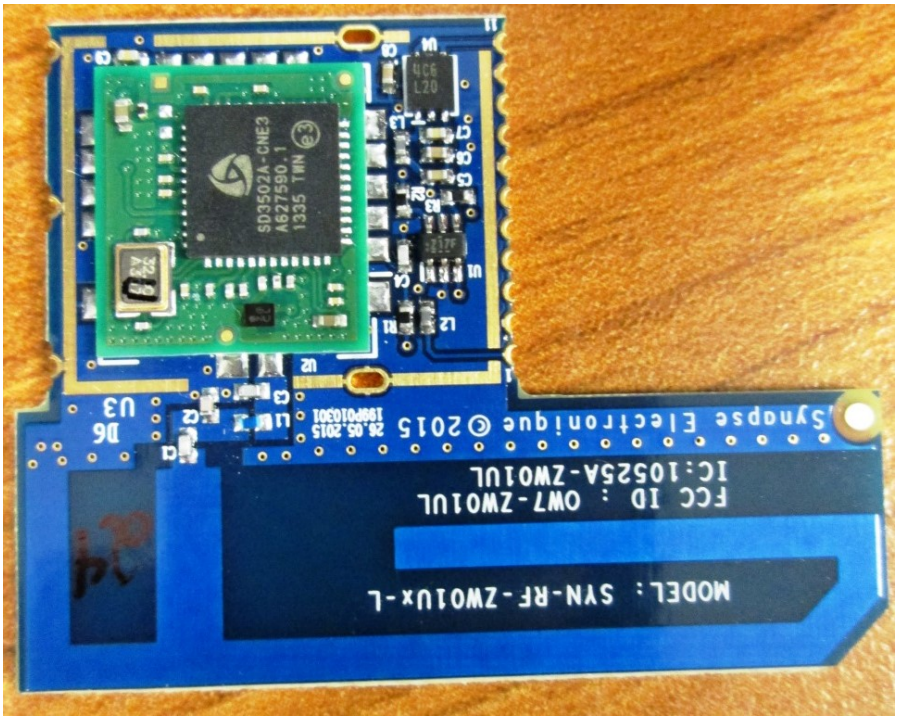


Figure 10.1-5: *RF Module top view*

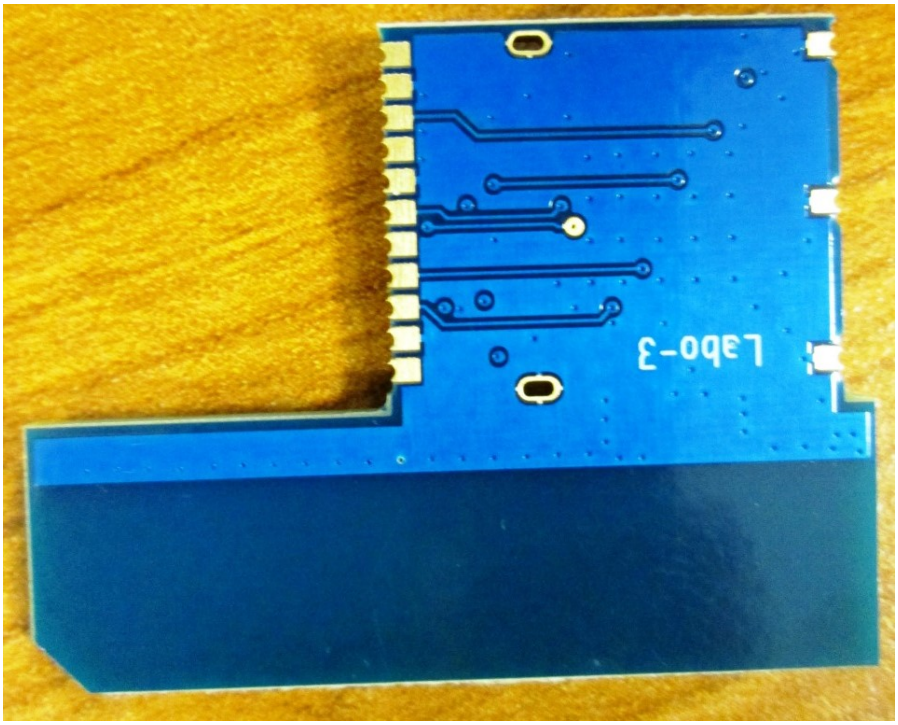


Figure 10.1-6: *RF Module bottom view*