| | |
|---|---|
| **Nemko Test Report:** | 131498-1TRFWL |
| **Applicant:** | SMART Technologies ULC<br>3636 Research Road NW<br>Calgary, AB<br>T2L 1Y1 Canada |
| **Apparatus:** | Smart Response Base Station |
| **FCC ID:** | QCISPR02 |
| **In Accordance With:** | FCC Part 15 Subpart C, 15.247<br>FHSS System and Digitally Modulated Radiators<br>902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz |
| **Authorized By:** | Sim Jagpal, Production Manager |
| **Date:** | July 24, 2009 |
| **Total Number of Pages:** | 24 |

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# TABLE OF CONTENTS

# Section 1 : Report Summary

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.

The assessment summary is as follows:

| | |
|---|---|
| **Apparatus Assessed:** | Smart Response Base Station |
| **Specification:** | FCC Part 15 Subpart C, 15.247 |
| **Compliance Status:** | Complies |
| **Exclusions:** | None |
| **Non-compliances:** | None |
| **Report Release History:** | Original Release |
| **Test Location:** | Nemko Canada Inc.<br>303 River Road<br>Ottawa, Ontario<br>K1V 1H2 |
| **Registration Number:** | 176392 (3 m Semi-Anechoic Chamber) |
| **Tests Performed By:** | Andrey Adelberg, Senior Wireless/EMC Specialist<br>Kevin Ma, Wireless/EMC Specialist |
| **Test Dates:** | May 5 and July 16, 2009 |

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.

# Section 2 : Equipment Under Test

## 2.1 Identification of Equipment Under Test (EUT)

The following information identifies the EUT under test:

| | |
|---|---|
| Type of Equipment: | Classroom Response Base Station |
| Brand Name: | SMART Response |
| Model Name or Number: | 03-00099-21 |
| Serial Number: | 037633 |
| Nemko Sample Number: | 1 |
| FCC ID: | QCISPR02 |
| Date of Receipt: | May 5, 2009 |

## 2.2 Accessories

The following information identifies accessories used to exercise the EUT during testing:

| | |
|---|---|
| Description: | Laptop |
| Brand Name: | IBM |
| Model Name or Number: | A30P |
| Serial Number: | 78ZZ570 |
| Connection Port: | USB |
| Cable Length and Type: | 2 m |

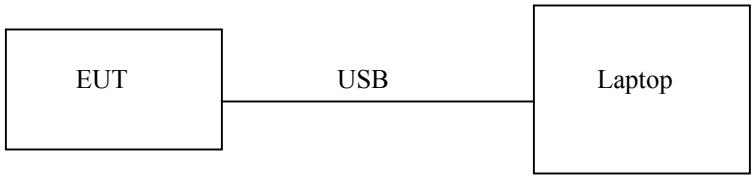
## 2.3 EUT Description

Fixed transmitter operates at 2.4–2.4835 GHz ISM band.

## 2.4 Technical Specifications of the EUT

| | |
|---|---|
| **Operating Band:** | 2400–2483.5 MHz |
| **Operating Frequency:** | F = 2405+5(k-11) MHz, k=11, 12, …, 26 |
| **Modulation:** | DSSS |
| **Occupied Bandwidth:** | 1.707 MHz |
| **Emission Designator:** | 1M71G1D |
| **Channel Number:** | 16 |
| **Antenna Data:** | Integral 3 dBi |
| **Power Supply Requirements:** | 120 VAC, 60 Hz to the Laptop |

## 2.5 EUT Setup diagram




## 2.6 Operation of the EUT during testing

The EUT has been controlled from PC to transmit constantly at the low, mid and high channel.

## 2.7 Modifications incorporated in the EUT

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

# Section 3 : Test Conditions

## 3.1 Specifications

The apparatus was assessed against the following specifications:

FCC Part 15 Subpart C, 15.247
FHSS System and Digitally Modulated Radiators
902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

## 3.2 Deviations From Laboratory Test Procedures

No deviations were made from laboratory test procedures.

## 3.3 Test Environment

All tests were performed under the following environmental conditions:

| | | |
|---|---|---|
| Temperature range | : | 15–30 °C |
| Humidity range | : | 20–75 % |
| Pressure range | : | 86–106 kPa |
| Power supply range | : | ±5 % of rated voltages |

## 3.4 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.

## 3.5 Test Equipment

| Equipment | Manufacturer | Model No. | Asset/Serial No. | Cal. Date | Next Cal. |
|---|---|---|---|---|---|
| 3 m EMI Test Chamber | TDK | SAC-3 | FA002047 | May 06/09 | May 06/10 |
| Bilog | Sunol | JB3 | FA002108 | Jan. 27/09 | Jan. 27/10 |
| Flush Mount Turntable | Sunol | FM2022 | FA002082 | NCR | NCR |
| Controller | Sunol | SC104V | FA002060 | NCR | NCR |
| Mast | Sunol | TLT2 | FA002061 | NCR | NCR |
| International Power Supply | California Inst. | 3001i | FA001021 | Jan. 13/09 | Jan. 13/10 |
| Receiver/Spectrum Analyzer | Rohde & Schwarz | ESU 26 | FA002043 | Dec. 16/08 | Dec. 16/09 |
| Horn Antenna #2 | EMCO | 3115 | FA000825 | Jan. 21/09 | Jan. 21/10 |
| 1 – 18 GHz Amplifier | JCA | JCA118-503 | FA002091 | Oct 2/08 | Oct 2/09 |
| 50 Coax cable | HUBER + SUHNER | None | FA002015 | Aug. 05/08 | Aug. 05/09 |
| 50 Coax cable | HUBER + SUHNER | None | FA002022 | July 07/09 | July 07/10 |
| 50 Coax cable | HUBER + SUHNER | None | FA002074 | July 07/09 | July 07/10 |
| LISN | Rohde & Schwarz | ENV216 | FA002023 | Sept. 02/08 | Sept. 02/09 |
| Spectrum Analyzer | Rohde & Schwarz | FSU | FA001877 | Sept. 03/08 | Sept. 03/09 |

COU – Calibrate on Use
NCR – No Calibration Required

# Section 4 : Results Summary

This section contains the following:

FCC Part 15 Subpart C : Test Results

The column headed 'Required' indicates whether the associated clauses were invoked for the apparatus under test. The following abbreviations are used:

N No : not applicable / not relevant.

Y Yes : Mandatory i.e. the apparatus shall conform to these tests.

N/T Not Tested, mandatory but not assessed. (See Report Summary)

## 4.1 FCC Part 15 Subpart C : Test Results

| Part 15 | Test Description | Required | Result |
|---|---|---|---|
| 15.31(e) | Variation of power supply | N | |
| 15.207(a) | Powerline Conducted Emissions | Y | PASS |
| 15.209(a) | Radiated Emissions within Restricted Bands | Y | PASS |
| 15.247(a)(1) | Frequency hopping systems | N | |
| 15.247(a)(1)(i) | Frequency hopping systems operating in the 902–928 MHz band | N | |
| 15.247(a)(1)(ii) | Frequency hopping systems operating in the 5725–5850 MHz band | N | |
| 15.247(a)(1)(iii) | Frequency hopping systems operating in the 2400–2483.5 MHz band | N | |
| 15.247(a)(2) | Minimum 6 dB Bandwidth | Y | 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 | |
| 15.247(b)(2) | Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band | N | |
| 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 | Y | PASS |
| 15.247(b)(4) | Maximum peak output power | Y | PASS |
| 15.247(c)(1) | Fixed point-to-point Operation with directional antenna gains greater than 6 dBi | N | |
| 15.247(c)(2) | Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams | N | |
| 15.247(d) | Radiated Emissions Not in Restricted Bands | Y | PASS |
| 15.247(e) | Power Spectral Density for Digitally Modulated Devices | Y | PASS |
| 15.247(f) | Time of Occupancy for Hybrid Systems | N | |

# Appendix A : Test Results

**Clause 15.207(a) Powerline Conducted Emissions**

Frequency of Conducted limit (dBµV)

| Emission (MHz) | 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.

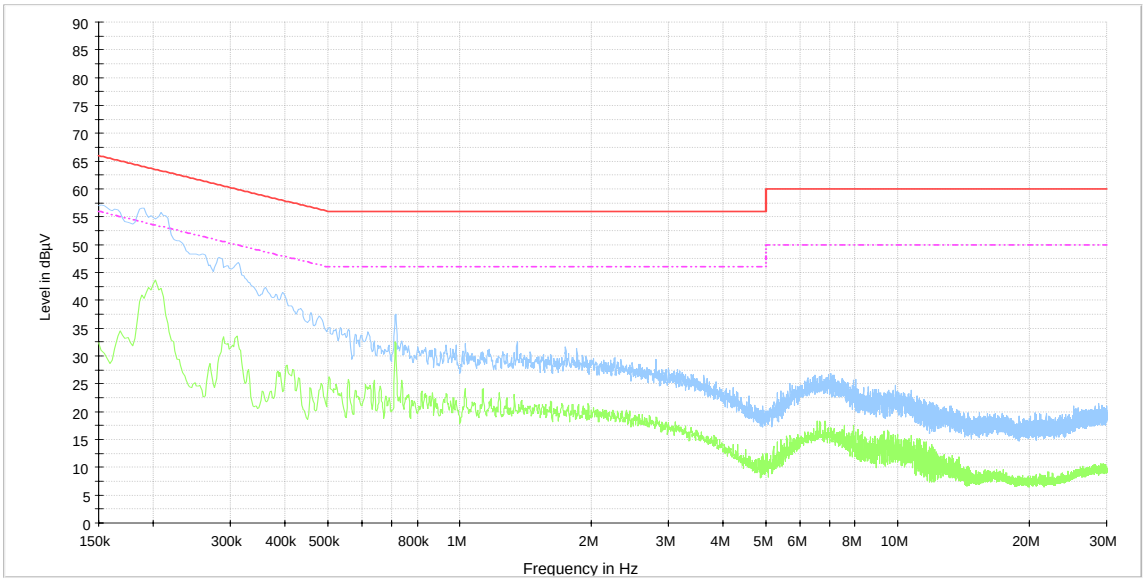
**Test Results:** Pass

**Additional Observations:**

All plots were obtained using a sweeping receiver with an IF of 9 kHz using a Peak and Average detector. The plots have been corrected with the cable loss and LISN loss to show compliance.

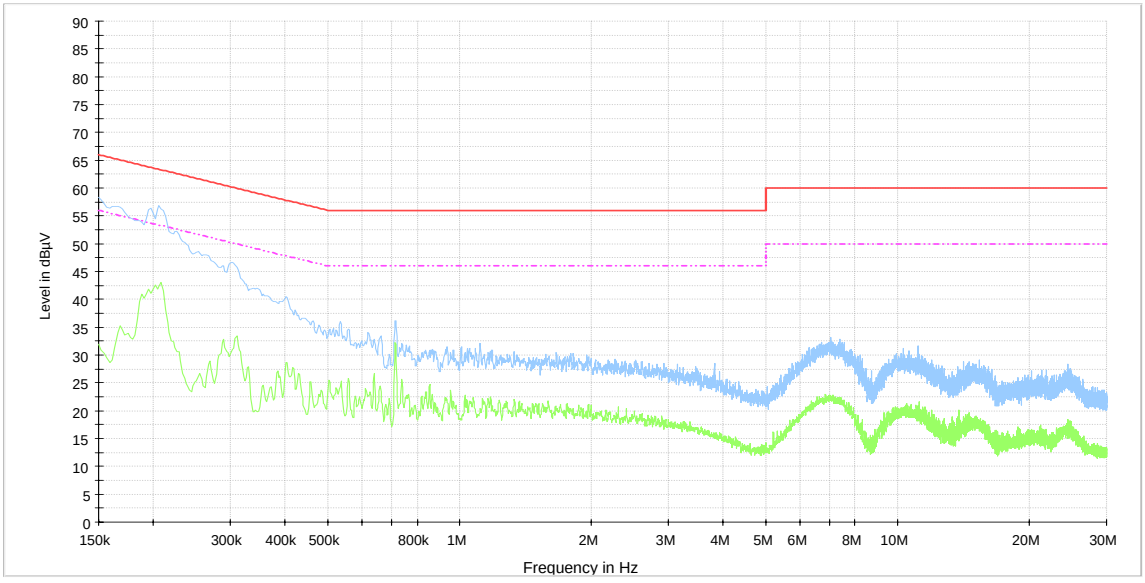
**No emissions within 6 dB below the limits were found.**

## Phase:




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

## Neutral:




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

**Clause 15.209(a) Radiated Emissions within Restricted Bands**

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency (MHz) | Field Strength | | Measurement Distance (meters) |
|---|---|---|---|
| | (µV/m) | (dBµV/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 |

Note: F = fundamental frequency in kHz

**Test Results:** Pass

**Additional Observations:**

The Spectrum was searched from 30 MHz to the 10$^{th}$ Harmonic.

These results apply to emissions found in the restricted bands defined in FCC Part 15 Subpart C, 15.205.

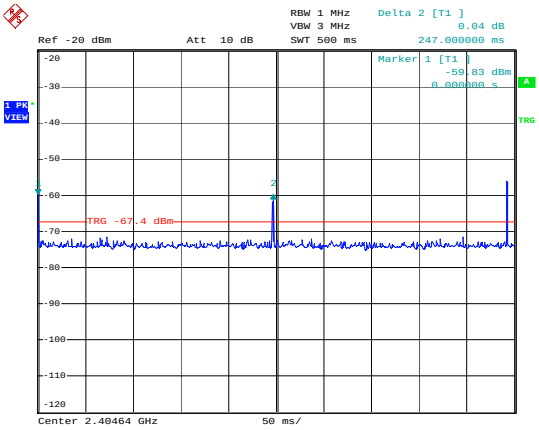
All measurements were performed at the distance of 3 m. Peak detector was used with 100 kHz RBW/300 kHz VBW below 1 GHz and 1 MHz/3 MHz RBW/VBW above 1 GHz.

| Channel | Freq. MHz | Pol. | Peak Field Strength dBµV/m | Peak Limit dBµV/m | Margin dB | Average Factor dB | Average Field Strength dBµV/m | Average Limit dBµV/m | Margin dB |
|---|---|---|---|---|---|---|---|---|---|
| 11 | 4810 | V | 59.13 | 74.00 | 14.87 | −40.26 | 18.87 | 54.00 | 35.13 |
| 11 | 4810 | H | 59.47 | 74.00 | 14.53 | −40.26 | 19.21 | 54.00 | 34.79 |
| 17 | 4868 | V | 60.67 | 74.00 | 13.33 | −40.26 | 20.41 | 54.00 | 33.59 |
| 17 | 4868 | H | 60.11 | 74.00 | 13.89 | −40.26 | 19.85 | 54.00 | 34.15 |
| 26 | 4960 | V | 60.78 | 74.00 | 13.22 | −40.26 | 20.52 | 54.00 | 33.48 |
| 26 | 4960 | H | 60.23 | 74.00 | 13.77 | −40.26 | 19.97 | 54.00 | 34.03 |
| 11 | 7215 | V | 56.57 | 74.00 | 17.43 | −40.26 | 16.31 | 54.00 | 37.69 |
| 11 | 7215 | H | 57.70 | 74.00 | 16.30 | −40.26 | 17.44 | 54.00 | 36.56 |
| 17 | 7302 | V | 63.22 | 74.00 | 10.78 | −40.26 | 22.96 | 54.00 | 31.04 |
| 17 | 7302 | H | 61.39 | 74.00 | 12.61 | −40.26 | 21.13 | 54.00 | 32.87 |
| 26 | 7440 | V | 59.93 | 74.00 | 14.07 | −40.26 | 19.67 | 54.00 | 34.33 |
| 26 | 7440 | H | 63.46 | 74.00 | 10.54 | −40.26 | 23.20 | 54.00 | 30.80 |

Note: Antenna Factor, cable loss and amplifier gain are included in the Peak Field Strength result.

## Duty Cycle:

Pulse Period: 247 ms

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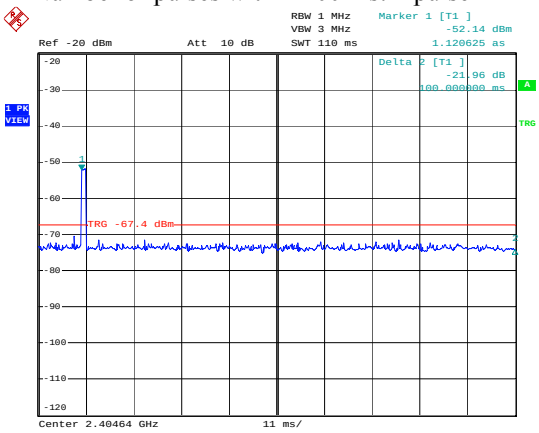
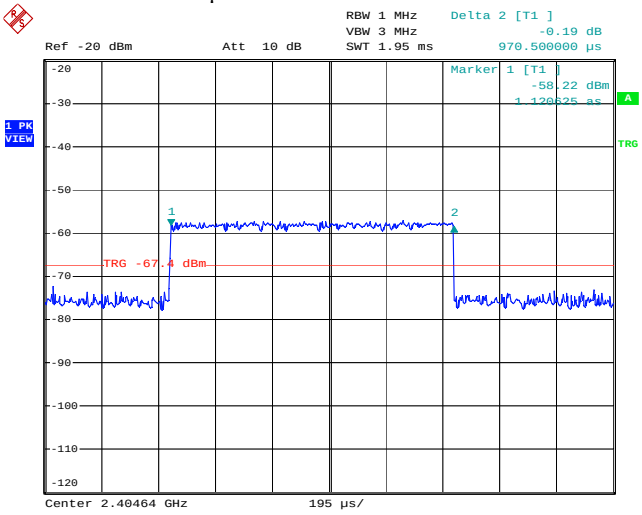
Number of pulses within 100 ms: 1 pulse




Date: 17.JUN.2009 08:31:54

Pulse width: 970.5 µs

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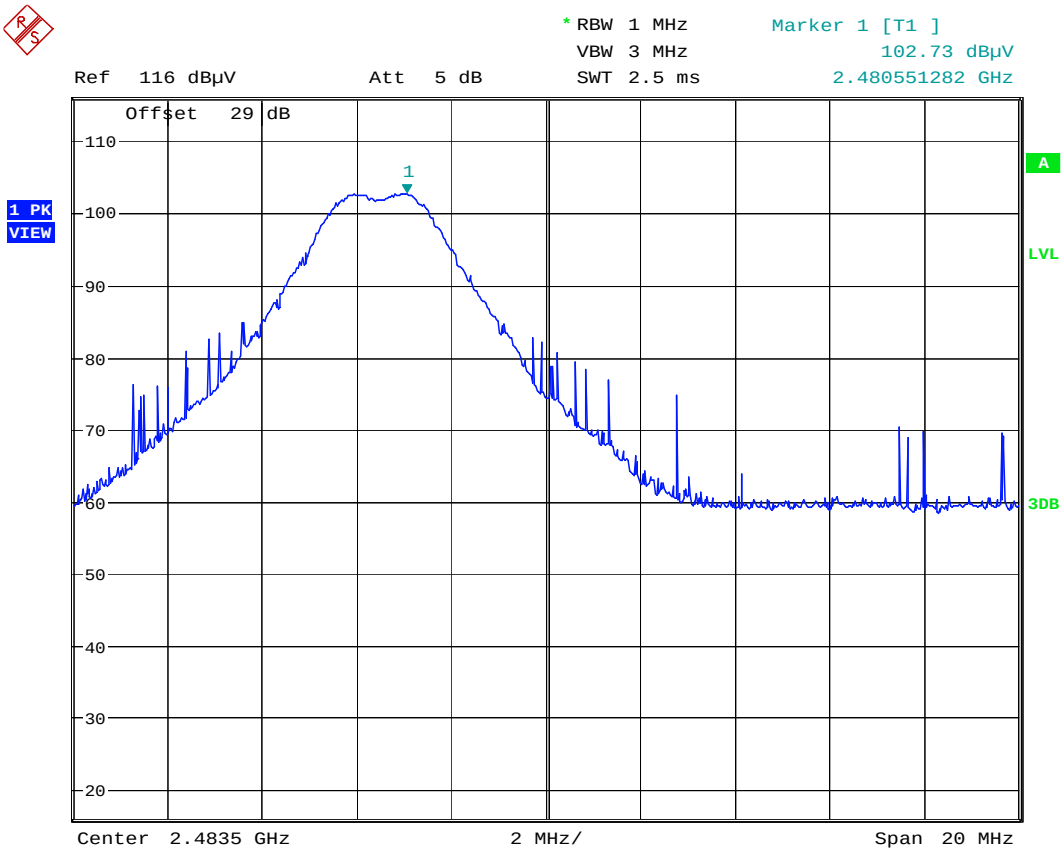
Duty cycle factor calculation with given repetition rate:

$20 \times \log(0.9705/100) = -40.26$ dB

## Delta Marker Measurement for 2.4835 GHz Band Edge

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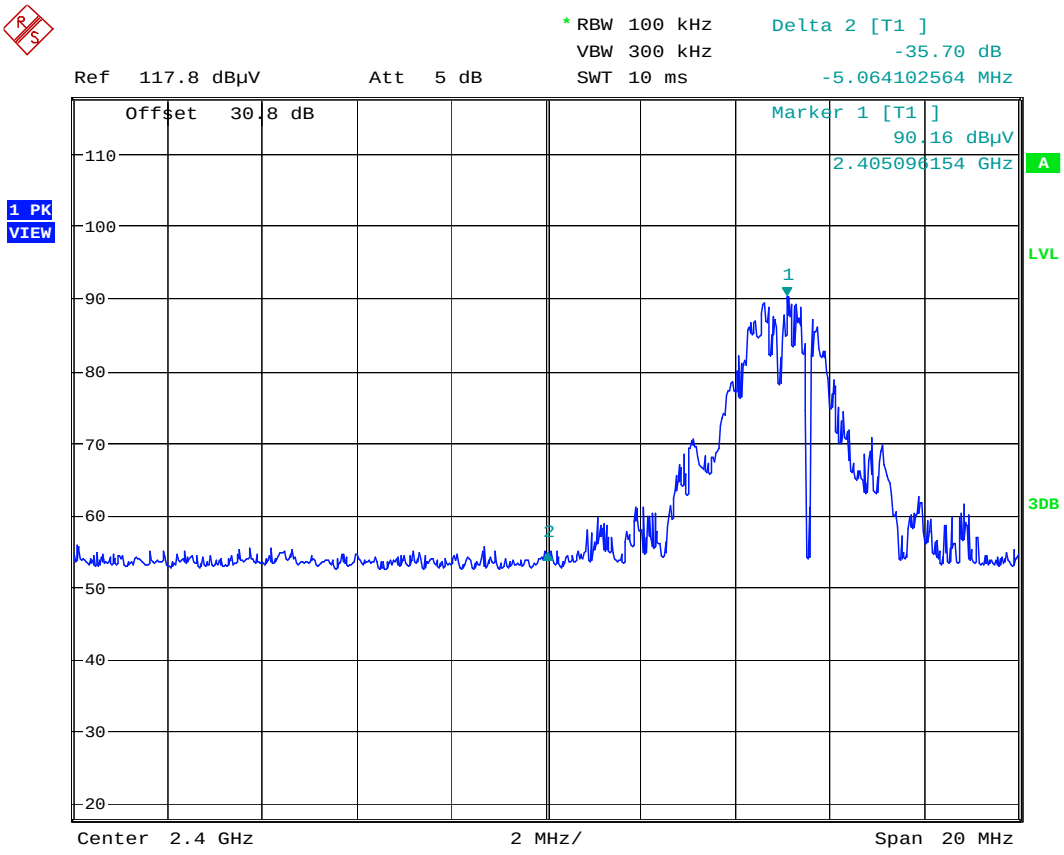
Measured Field Strength for High Channel in 1 MHz RBW = 102.73 dBµV/m

Delta Marker = 32.66 dB (measured separately with 100 kHz RBW)

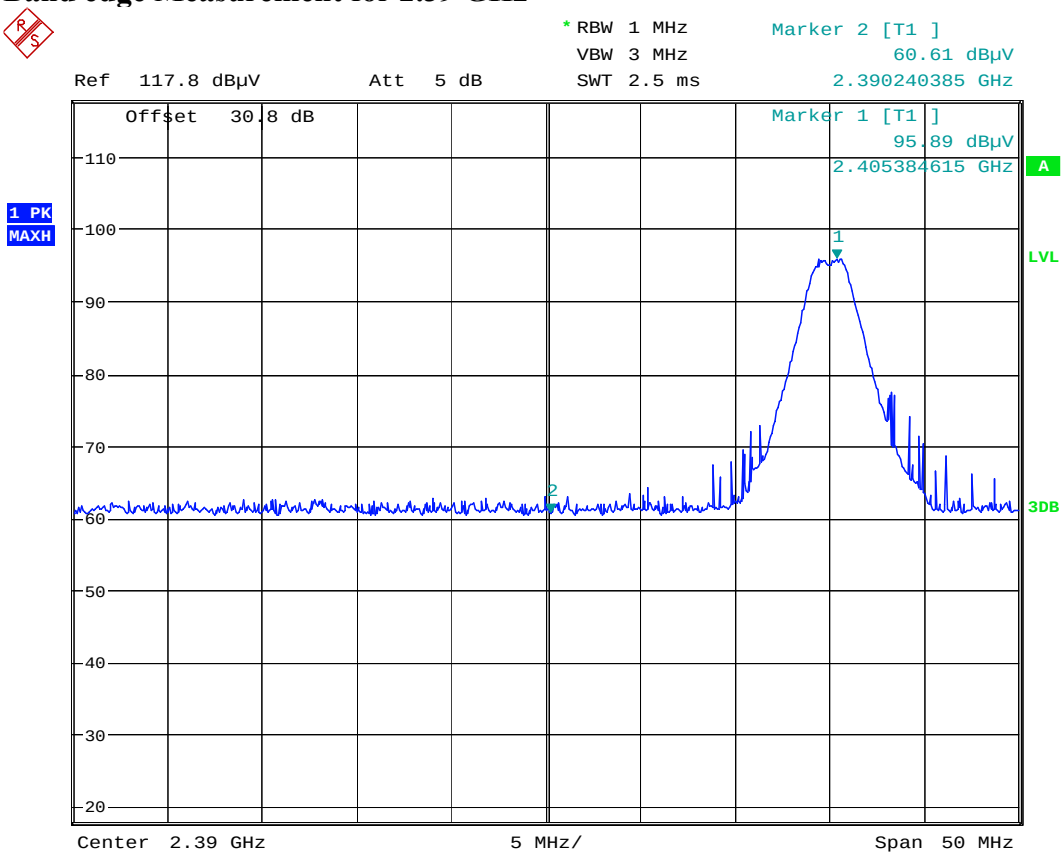
Therefore, Peak Field Strength = 102.73 dBµV/m − 32.66 dB = 70.07 dBµV/m
Limit = 74 dBµV/m
Average Field Strength = 70.07 dBµV/m − 40.26 dB (Duty Cycle) = 29.81 dBµV/m
Limit = 54 dBµV/m

## Band edge Measurement for 2.4 GHz




Outside Restricted Band Limit is −20 dBc/100 kHz
Measurement at 2.4 GHz is −35.7 dBc/100 kHz

## Band edge Measurement for 2.39 GHz




Date: 16.JUL.2009 15:24:17

Measured Field Strength for Lower Restricted Band Edge (2.39 GHz) with 1 MHz RBW = 60.61 dBµV/m
Limit = 74 dBµV/m
Average Field Strength = 60.61 dBµV/m − 40.26 dB (Duty Cycle) = 20.35 dBµV/m
Limit = 54 dBµV/m

## Clause 15.247(a)(2) Minimum 6 dB Bandwidth

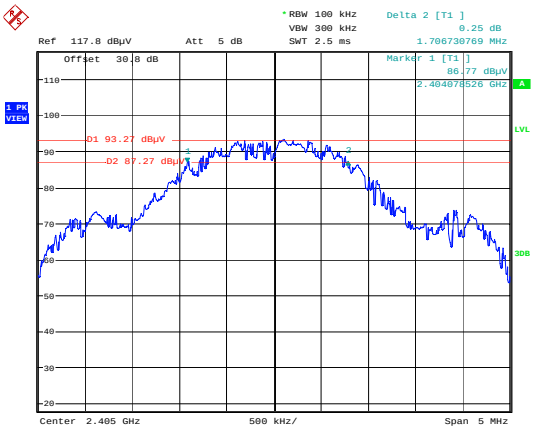
Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

**Test Results:** Pass

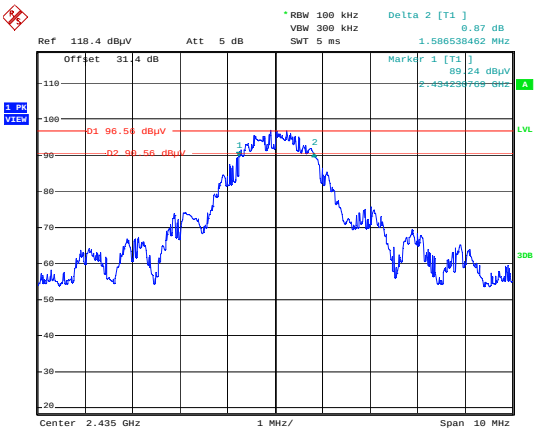
**6 dB Bandwidth:**

| Channel | 6 dB BW, MHz | Limit, MHz | Margin, MHz |
|---|---|---|---|
| Low | 1.707 | 0.5 | 1.207 |
| Mid | 1.587 | 0.5 | 1.087 |
| High | 1.603 | 0.5 | 1.103 |

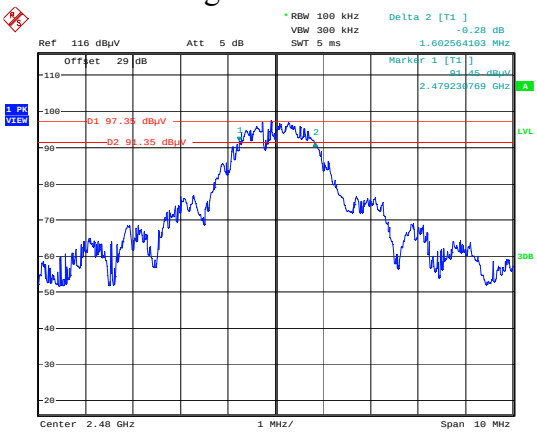
6 dB BW on Low channel:




6 dB BW on Mid channel:




6 dB BW on High channel:



**Clause 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**

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 W. As an alternative to a peak power measurement, compliance with the 1 W 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 signalling 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.

**Clause 15.247(b)(4) Maximum peak output power**

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.

**Test Results:** Pass

The output power tested radiated using peak detector of the spectrum analyzer and 3 MHz/3 MHz of RBW/VBW at the distance of 3 m.
Power measurements were also performed with the supply voltage variation between 85–115 %. No noticeable difference in power measurement due to voltage variation was observed.

**Radiated Output Power:**

| Channel | Freq. MHz | Pol. | Peak Field Strength dBµV/m | Conducted Output power dBm | Conducted Power Limit dBm | Margin dB |
|---|---|---|---|---|---|---|
| 11 | 2405 | V | 96.17 | −2.06 | 30.00 | 32.06 |
| 11 | 2405 | H | 99.76 | 1.53 | 30.00 | 28.47 |
| 17 | 2434 | V | 96.43 | −1.80 | 30.00 | 31.80 |
| 17 | 2434 | H | 101.19 | 2.96 | 30.00 | 27.04 |
| 26 | 2480 | V | 96.67 | −1.56 | 30.00 | 31.56 |
| 26 | 2480 | H | 103.11 | 4.87 | 30.00 | 25.12 |

$$\text{E (V/m)} = \frac{10^{(FS/20)}}{1\times10^{6}} = \left(10^{\left(\frac{103.11}{20}\right)}\right)\times10^{-6} = 0.143 \text{ V/m}$$

$$\text{G (numeric)} = 10^{(Ag/10)} = 10^{\left(\frac{3}{10}\right)} = 2$$

$$\text{P (W)} = \frac{E^2R^2}{30G} = 0.003067 \text{ W} = 3.067 \text{ mW}$$

FS = Field Strength (dBµV/m)
Ag = Antenna gain (dBi)
E = Measured Value (V/m)
R = Measurement distance (m)
G = Antenna Gain (numeric)
P = Output power (W)

Output Power (dBm) = $10\times\log(Output\ Power(mW)) = 10\times\log(3.067) = 4.867$ dBm
Conducted Output Power Limit = 30 dBm

EIRP: Conducted Output power + antenna Gain = 4.87 + 3 = 7.87 dBm.
EIRP limit = 36 dBm.

**Clause 15.247(d) Radiated Emissions Not in Restricted Bands**

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)).

**Test Results:** Pass

**Additional Observations:**

The Spectrum was searched from 30 MHz to the 10$^{th}$ Harmonic.

These results apply to emissions found in the restricted bands defined in FCC Part 15 Subpart C, 15.205.

All measurements were performed at the distance of 3 m. Peak detector was used with 100 kHz RBW/300 kHz VBW below 1 GHz and 1 MHz/3 MHz RBW/VBW above 1 GHz.

**No Spurious Emissions were detected.**

**Clause 15.247(e) Power Spectral Density for Digitally Modulated Devices**

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.

**Test Results:** Pass

| Channel | Freq. MHz | Peak Field Strength dBµV/m/3 kHz | Conducted spectral Density dBm/3 kHz | Spectral Density Limit dBm/3 kHz | Margin dB |
|---|---|---|---|---|---|
| 11 | 2405 | 80.71 | −17.52 | 8.00 | 25.52 |
| 17 | 2434 | 85.32 | −12.91 | 8.00 | 20.91 |
| 26 | 2480 | 88.88 | −9.35 | 8.00 | 17.35 |

**Sample calculation for High channel:**

$$E\ (V/m/3\ kHz) = \frac{10^{(FS/20)}}{1\times10^{6}} = 0.027797\ V/m/3\ kHz$$

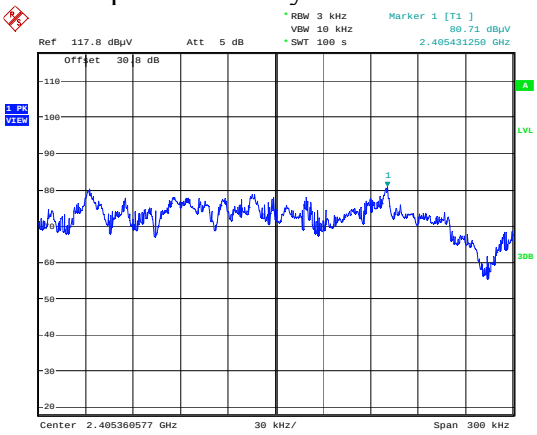
$$G\ (numeric) = 10^{(Ag/10)} = 10^{\left(\frac{3}{10}\right)} = 2$$

$$P\ (W/3\ kHz) = \frac{E^2R^2}{30G} = 0.0001159\ W/3\ kHz = 0.1159\ mW/3\ kHz$$

FS = Field Strength (dBµV/m/3 kHz)
Ag = Antenna gain (dBi)
E = Measured Value (V/m/3 kHz)
R = Measurement distance (m)
G = Antenna Gain (numeric)
P = Spectral power Density (W/3 kHz)

Spectral Power Density (dBm/3 kHz) = 10xLog (0.1159) = −9.35 dBm/3 kHz

Power Spectral Density on Low channel:

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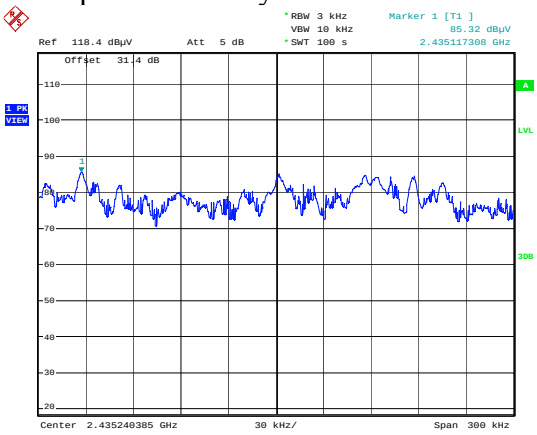
Power Spectral Density on Mid channel:

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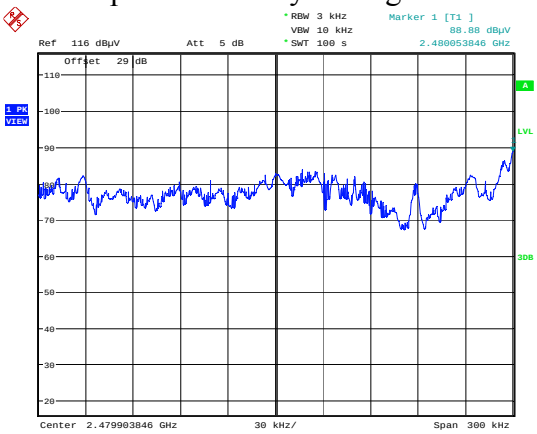
Power Spectral Density on High channel:

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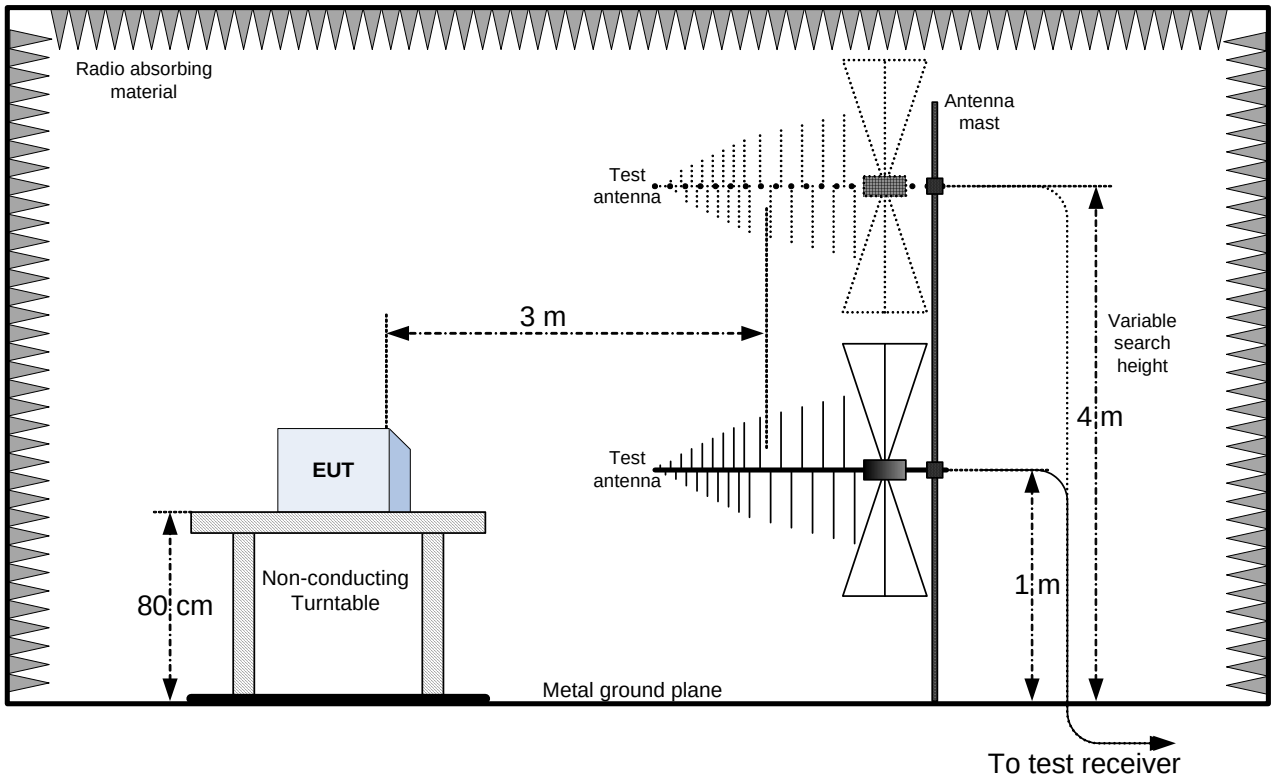
# Appendix B : Setup Photographs

**Conducted Emissions Setup:**

**Spurious Emissions Setup:**

# Appendix C : Block Diagram of Test Setups

## Radiated Emissions above 30 MHz Test Site




## Conducted Emissions Test Site