EMC Technologies Pty Ltd
ABN 82 057 105 549
Unit 3/87 Station Road
Seven Hills NSW 2147 Australia

Telephone +61 2 9624 2777
Facsimile +61 2 9838 4050
Email syd@emctech.com.au
www.emctech.com.au

EMI TEST REPORT
for
CERTIFICATION of
FCC PART 15.249 & FCC PART 15.207 TRANSMITTER

FCC ID:	ZT7-CVM-CSLV
Manufacturer:	Syndetic Pty Ltd
Test Sample:	Wireless Sensor Module
Model Number:	CVM-CSLV-R07
Serial Number:	None
Date:	30th August 2011

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EMI TEST REPORT FOR CERTIFICATION
FOR
CERTIFICATION OF FCC Part 15.249 & FCC PART 15.207 TRANSMITTER

FCC ID: ZT7-CVM-CSLV
EMC Technologies Report No. T110807_F
Date: 25th August 2011

CONTENTS

EMI TEST REPORT FOR CERTIFICATION OF FCC PART 15.249 & FCC PART 15.207 TRANSMITTER

Report Number:	T110807_F
Test Sample Name:	Wireless Sensor Module
Model Number:	CVM-CSLV-R07
Serial Number:	None
FCC ID:	ZT7-CVM-CSLV
Manufacturer:	Syndetic Pty Ltd
Tested For:	MIPAC
Address:	39 Navigator Place Hendra QLD 4011
Phone Number:	(07) 3212 5600
Fax Number:	(07) 3212 5699
Responsible Party:	Mr Ross Varnes
Test Standards:	**FCC Part 15.249 Intentional Radiators** **FCC Part 15.207 Conducted Limits** **ANSI C63.4:2009**
Test Dates:	15th August 2011 – 18th August 2011
Testing Officers:	**Alan Wilcox** **Dale Matthews**
Attestation:	*I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*
Authorised Signature:	**Christian Kai** **Facility Manager** **EMC Technologies Pty Ltd**

Issued by EMC Technologies Pty Ltd, Unit 3/87 Station Road, Seven Hills, NSW, 2147, Australia.
Phone: +61 2 9624 2777 Fax: +61 2 9838 4050

EMI TEST REPORT FOR CERTIFICATION of FCC PART 15.249 & FCC PART 15.207 TRANSMITTER on the WIRELESS SENSOR MODULE

1.0 SUMMARY of RESULTS

This report details the results of EMI tests and measurements performed on the Wireless Sensor Module with Model: CVM-CSLV-R07, in accordance with the Federal Communications Commission (FCC) regulations as detailed in Title 47 CFR, Part 15 Rules for intentional radiators. All results are detailed in this report.

Part 15.31e	
Amplitude stability with supply variation:	Not applicable
Part 15.207	
Conducted Emissions:	Not applicable
Part 15.249 a &e	
Carrier Signal Field Strength:	Complied
Part 15.249 d (15.209)	
Field Strength Outside 2400 – 2483.5MHz:	Complied
Part 15.249 e	
Frequency Tolerance:	Not applicable

2.0 GENERAL INFORMATION

2.1 General Description of Test Sample

Manufacturer	:	Syndetic Pty Ltd
Test Sample	:	Wireless Sensor Module
Model Number	:	CVM-CSLV-R07
Serial Number	:	None
FCC ID	:	ZT7-CVM-CSLV
Equipment Type	:	Intentional Radiator

2.2 Test Sample Description

The Wireless Sensor is used as part of an industrial measurement and control system.

2.3 Technical Specifications and System Overview

Supply Voltage	:	3.7V Nominal (Single Cell Lithium Primary Battery
Microcontroller	:	Atmel ATMEGA644P
CPU Clock Frequency	:	8MHz (internal RC Oscillator)
RF Operating Frequency	:	2401MHz to 2482MHz in 1MHz steps (Channel 1 to 82)
RF Output Power	:	0dBm (±1dB)
Antenna Gain	:	~0dBi
Radio Reference Frequency	:	16MHz
Modulation	:	GFSK

Refer to Appendix JInstallation Manual and Appendix G Customer Test Plan.

2.4 EUT Configurations

Refer to Appendix G, Customers Test Plan for EUT Configuration.

2.5 Test Sample Support Equipment

Refer to Customers Test Plan (Appendix G) for Support Equipment details.

2.6 Test Sample Block Diagram

Refer to Appendix E, Block Diagram.

2.7 EUT Operation Conditions

The EUT was operated in accordance with the standards and the Customers Test Plan (Appendix G).

2.8 Modifications

No modifications were performed on the EUT in order to comply with the standards.

2.9 Test Procedure

Radiated Emissions measurements were performed in accordance with the procedures of ANSI C63.4:2009. The measurement distance for radiated emissions was 3 metres from the EUT for the frequency range 30 MHz to 25GHz.

2.10 Test Facility

2.10.1 General

Conducted Emission measurements were not applicable, because the EUT is powered by internal battiery. Radiated Emission measurements in the ranges 30MHz-25GHz were performed at EMC Technologies' open area test site (OATS) situated at Upper Colo, NSW, Australia.

The above sites have been fully described in a report submitted to the FCC office. EMC Technologies Pty Ltd has FCC registration number 507687 and we have been designated by the Australian Communications and Media Authority under the APAC TELMRA and our designation number is AU0002 which will expire on the 1st March 2012.

2.10.2 NATA Accreditation

EMC Technologies is accredited in Australia to test to the following standards by the National Association of Testing Authorities (NATA).

"FCC Part 15 unintentional and intentional emitters in the frequency range 9kHz to 18GHz excluding TV receivers (15.117 and 15.119), TV interface devices (15.115), cable ready consumer electronic equipment (15.118), cable locating equipment (15.213) and unlicensed national information infrastructure devices (Sub part E)."

The current full scope of accreditation can be found on the NATA website:
www.nata.asn.au
It also includes a large number of emission, immunity, SAR, EMR and Safety standards.

NATA is the Australian national laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A^2LA).

2.11 Units of Measurements

2.11.1 Conducted Emissions

Measurements are reported in units of dB relative to one microvolt (dBμV).

2.11.2 Radiated Emissions

Measurements are reported in units of dB relative to one microvolt per metre (dBμV/m). The measurement distance was 3 metres from the EUT for ranges 30MHz to 25GHz.

2.12 Test Equipment Calibration

All measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI). All equipment calibration is traceable to Australia national standards at the National Measurement Institute. The reference antenna calibration was performed by NMI and the working antennas (biconical and log-periodic) calibrated by the NATA approved procedures. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A of this report.

2.13 Ambients at OATS

The Open Area Test Site (OATS) is an area of low background ambient signals. No significant broadband ambients are present however commercial radio and TV signals exceed the limit in the FM radio, VHF and UHF television bands. Radiated prescan measurements were performed in the shielded enclosure to check for possible radiated emissions at the frequencies where the OATS ambient signals exceeded the test limit.

3.0 CONDUCTED EMISSION MEASUREMENTS

3.1 Test Procedure

The arrangement specified in ANSI C63.4:2009 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2-1987 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all duration peaks were captured.

3.2 Peak Maximizing Procedure

For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector was then invoked to measure the actual Quasi-Peak level of the most significant peaks which were detected.

The highest recorded EMI signals are shown on the Peaks List on the bottom right side of the graph. Peaks that were greater than 20dB below the limit were not measured. For each numbered peak the frequency, peak field strength, Quasi-peak field strength, Average field strength and the margin relative to the limit in dB is listed. A negative margin is the level below the limit.

3.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

$V_{EMI} = V_{Rx} + L_{BPF}$

Where:

V_{EMI} = The Measured EMI voltage in dBµV to be compared to the limit.
V_{Rx} = The Voltage in dBµV read directly at the EMI receiver.
L_{BPF} = The insertion loss in dB of the cables and the Limiter and Pass Filter.

3.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were then concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph was subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graphs.

3.5 Conducted EMI Results

Conducted emissions was not applicable because the EUT was powered by internal batteries only.

4.0 RADIATED EMISSION MEASUREMENTS – 30 MHz to 25 GHz

4.1 Frequency Range of Radiated Measurements

The highest frequency of the EUT is 2482MHz (refer to section 2.3 of this report).

Highest frequency generated or used in the device or on which the device operates or tunes [MHz]	Upper frequency of measurement range [MHz]
1.705 - 108	1000
108 – 500	2000
500 – 1000	5000
Above 1000	10^{th} harmonic of the highest frequency or 40 GHz, whichever is lower

Frequencies above 1 GHz: Average trace taken (RBW 1MHz, VBW 10 kHz)

According to the table in FCC Part 15, Section 15.33 and the highest radio frequency signal generated or used in the EUT is 2482MHz, the radiated emissions measurement were performed from 9 kHz to 25GHz.

4.2 Test Procedure

Radiated emissions measurements were performed in accordance with the procedures of ANSI C63.4:2009 Radiated emission tests from 30 MHz to 25 GHz were performed at the Open Area Test Site (OATS) an EUT distance of 3 metres. OET Bulletin 65 was used for reference.

The EUT was placed on a timber table 0.8m above an inground and operated in accordance with section 2 of this report. The EMI Receiver was operated under software control via the PC Controller.

4.2.1 0.009 – 30 MHz Range

The 0.009 MHz to 30 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The receive loop antenna was set to 1m above the ground plane with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. The orientation of the receive loop antenna was varied to ensure that the emissions were maximised. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. The carrier test was performed at the worst-case operation voltage.

Measurement distance:
If the measurements were performed at a distance closer than that specified in the regulation, then the results would have been extrapolated by using the square of an inverse linear distance extrapolation factor (40 dB/decade) as described in Section 15.31 (f) (2).

4.2.2 30 – 1000 MHz Range

The 30 MHz to 1000 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.2.3 1 GHz - 25 GHz

The 1 GHz to 25GHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the average detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Average detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.3 Plotting of Measurement Data for Radiated Emissions

4.3.1 0.009 – 30 MHz Range

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 0.009 – 30 MHz. The fundamental frequency was measured at the OATS. The worst case radiated EMI peak measurements as recorded using the Max-Hold data are presented as the **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Quasi-peak field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the quasi-peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.

4.3.2 30 – 1000 MHz

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 30 – 1000 MHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Quasi-peak field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the quasi-peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.

4.3.3 1 GHz– 25 GHz

The stored measurement data was combined to form graphs which comprised of all the frequency sub-ranges over the range 1 GHz – 25 GHz. The accumulated EMI (EUT ON) was plotted as the Red trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Average field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the average level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the Average detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the average level higher than the peak level.

4.4 Calculation of Field Strength

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

E = V + AF - G + L

Where:
- **E** = Radiated Field Strength in dBμV/m.
- **V** = EMI Receiver Voltage in dBμV. (measured value)
- **AF** = Antenna Factor in dB/m (stored as a data array)
- **G** = Preamplifier Gain in dB. (stored as a data array)
- **L** = Cable insertion loss in dB. (stored as a data array)

Example Field Strength Calculation
Assuming a receiver reading of 34.0 dBμV is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB. The cable loss is 1.9dB while the preamplifier gain is 20dB.

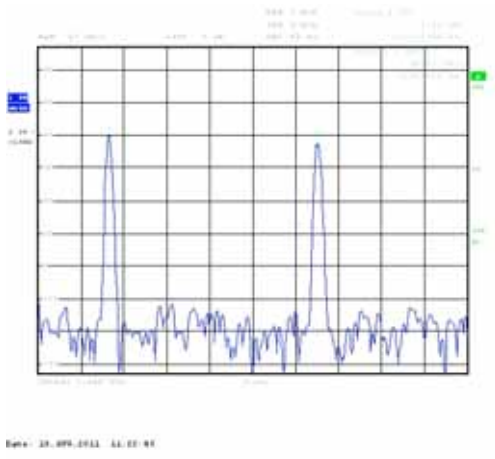
34.0 + 9.2 + 1.9 – 20 = 25.1 dBμV/m

4.5 Radiated Field Strength Measurement Results – Section 15.249

The ETU was set to the lowest channel, the highest channel and to one channel in the middle range. Testing was performed from 30MHz to 25GHz. The result with the highest emissions were recorede in this report.

The measurements were taken with the EUT transmitting continuously. To account for the duty cycle, the measured harmonics emissions levels have to be corrected.

Measured Duty Cycle within any 100ms



Every 29.19ms one impulse of 2.11ms was measured. Therefore, 3 impulses occur in any 100ms period.

On cycles in any 100ms = 3 x 2.11ms = 6.33ms
Duty Cycle: 6.33ms/100ms = 0.0633

Correction Factor for Duty Cycle 0.0633 (6.33%):

$$CorrectionFactor = 20 * \log(DutyCycle) = 20 * \log(0.0633) = \underline{\underline{-23.97dB}}$$

No peaks are allowed to be 20dB above the limits (according section 15.35b), therefore the maximum allowable correction factor is: -20dB.

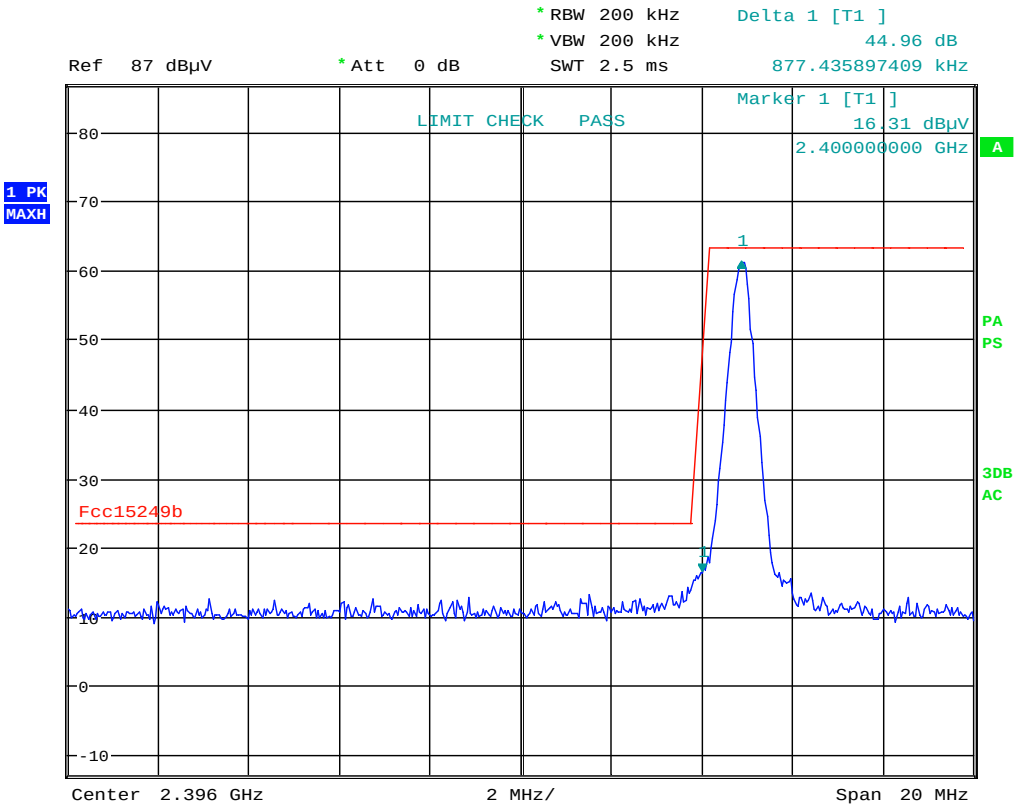
4.5.1 2400MHz Carrier Field Strength Measurement at 3m Antenna Distance

4.5.1.1 Tested on Low Channel

Frequency MHz	Peak Level dBµV/m	Corr. Factor	Corrected Peak (dB)	Limit @ 3m dBµV/m	Result ± dB
2400.87	93.3	20dB	73.3	94.0	-20.7
2400.87	91.4	20dB	71.4	94.0	-22.6

Complied with a margin of greater than 20dB with Section 15.249 Subpart a, b & c.
Refer to Appendix H, Graph 1.

Low Channel Bandedge Compliance



Date: 7.NOV.2011 14:00:42

The bandedge measurements of the low chanel complied. The edge is more than 20dB below the carrier and the emissions outside of the band are less than 54dBµV/m.

4.5.1.2 Tested on Mid Channel

Frequency MHz	Peak Level dBµV/m	Corr. Factor	Corrected Peak (dB)	Limit @ 3m dBµV/m	Result ± dB
2440.87	93.4	20dB	73.4	94.0	-20.6
2440.87	90.6	20dB	70.6	94.0	-23.4

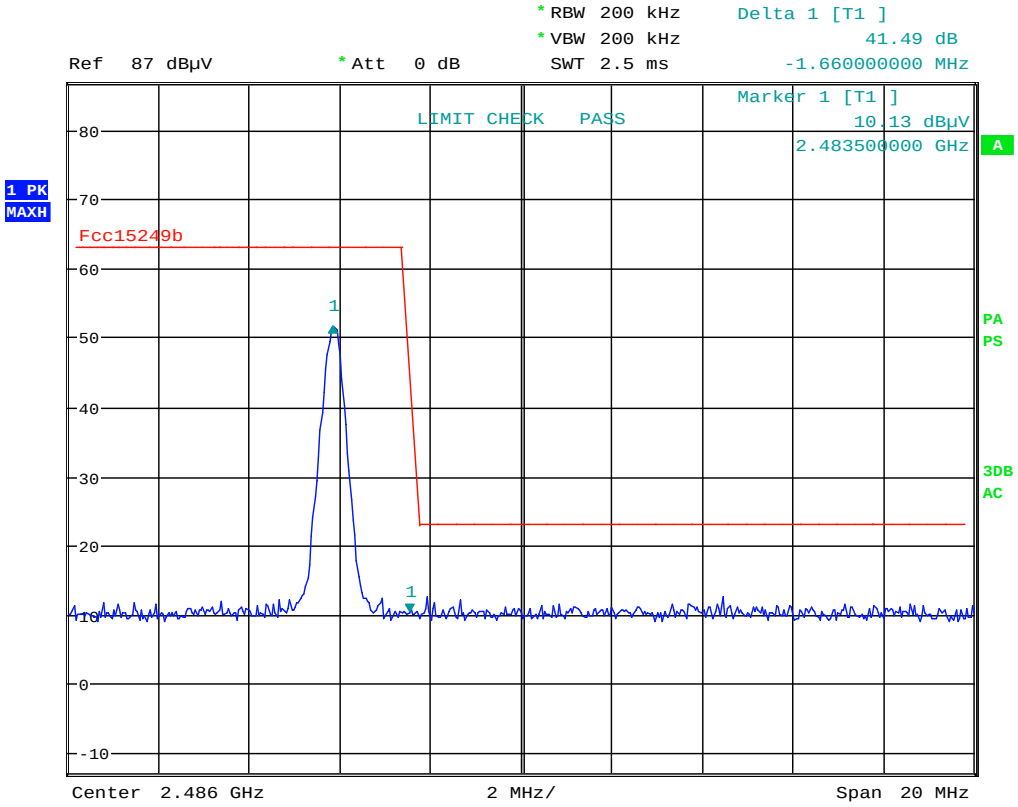
Complied with a margin of greater than 20dB with Section 15.249 Subpart a, b & c.
Refer to Appendix H, Graph 2.

4.5.1.3 Tested on High Channel

Frequency MHz	Peak Level dBµV/m	Corr. Factor	Corrected Peak (dB)	Limit @ 3m dBµV/m	Result ± dB
2481.87	94.9	20dB	74.9	94.0	-19.1
2481.87	90.8	20dB	70.8	94.0	-23.2

Complied with a margin of at least 19.1dB with Section 15.249 Subpart a, b & c.
Refer to Appendix H, Graph 3.

High Channel Bandedge Compliance



Date: 7.NOV.2011 14:08:43

The bandedge measurements of the high chanel complied. The edge is more than 20dB below the carrier and the emissions outside of the band are less than 54dBµV/m.

Additional amplituded stability testes according part 15.31e were not applicable, because the EUT is powered by internal batteries. Testing was performd with a fully charged battery.

4.5.2 Radiated Field Strength Measurements

4.5.2.1 9 kHz to 30 MHz Field Strength Spurious Emissions at 3m Antenna Distance

Testing was performed with a calibrated active loop antenna.Complied with a margin of greater than 20dB with Section 15.225 Supart d (15.209).
Refer to Appendix I, Graph 10 and 11 .

4.5.2.2 30MHz to 1GHz

All measured frequencies complied with the quasi peak limits by a margin of greater than 10dB.
Refer to Appendix H, Graphs 4 and 5.

4.5.2.3 1000MHz to 25000MHz with Correction Factor

Frequency (MHz)	Polarisation	Average (dBμV/m)	Corr. Factor	Corrected Peak (dB)	Limit (dBμV/m)	Result [dB]
4960.67	Vertical	52.1	20dB	32.1	54.0	-21.9
4960.67	Horizontal	48.7	20dB	28.7	54.0	-25.3

All measured frequencies complied with the average limits by a margin of greater than 10dB.
Refer to Appendix K, Graphs 6 to 9.

6.0 FREQUENCY TOLERANCE (FCC Part 15 Sections 15.249b)

The frequency tolerance is only applicable for fixed point-to-point operation devices.

7.0 CONCLUSION

The Wireless Sensor Module with Model: CVM-CSLV-R07 and FCC ID: ZT7-CVM-CSLV, complied with the requirements of FCC Part 15 Rules for an internal radiator when tested in accordance with FCC Part 15.31e, 15.207 and 15.249.

Part 15.31e
Amplitude stability with supply variation: Not applicable

Part 15.207
Conducted Emissions: Not applicable

Part 15.249 a &e
Carrier Signal Field Strength: Complied

Part 15.249 d (15.209)
Field Strength Outside 2400 – 2483.5MHz: Complied

Part 15.249 e
Frequency Tolerance: Not applicable

8.0 UNCERTAINTIES

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Conducted Emissions

9kHz to 30 MHz	±3.2 dB

Radiated Emissions

9kHz to 30MHz	±4.1 dB
30MHz to 300MHz	±5.1 dB
300MHz to 1000MHz	±4.7 dB
1GHz to 25GHz	±4.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

APPENDIXES

APPENDIX A. MEASUREMENT INSTRUMENTATION DETAILS

APPENDIX B. PHOTOGRAPHS TEST SETUP

APPENDIX C. PHOTOGRAPHS TEST SAMPLE (EXTERIOR)

APPENDIX D. PHOTOGRAPHS TEST SAMPLE (INTERIOR)

APPENDIX E. BLOCK DIAGRAM

APPENDIX F. TEST SAMPLE SCHEMATICS

APPENDIX G. TEST SAMPLE TEST PLAN

APPENDIX H. LABELLING – LOCATION

APPENDIX I. GRAPHS OF EMI MEASUREMENT

APPENDIX J. INSTALLATION MANUAL

APPENDIX K. OPERATIONAL DESCRIPTION