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EMC Test Report

Application for FCC Grant of Equipment Authorization
Canada Certification
Class II Permissive Change/Reassessment

Innovation, Science and Economic Development Canada
RSS-Gen Issue 5 / RSS-247 Issue 2
FCC Part 15 Subpart C

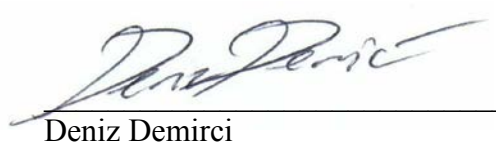
Model: Whitebox Rev. 003

FCC ID:	2AMS3WBOX1
APPLICANT:	Sanmina Corporation 13000 S. Memorial Pkwy Huntsville, AL 35807
TEST SITE(S):	National Technical Systems 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-7
PROJECT NUMBER:	PR094191
REPORT DATE:	March 4, 2019
FINAL TEST DATES:	February 12, 13 and 14, 2019
TOTAL NUMBER OF PAGES:	43

ACCREDITED
Testing Cert #0214.26

VALIDATING SIGNATORIES

PROGRAM MGR



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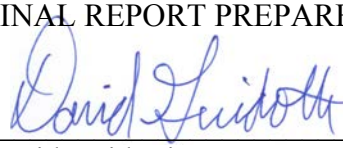

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REVISION HISTORY

Rev#	Date	Comments	Modified By
-	March 4, 2019	First release	

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SCOPE

Class II Permissive Change/Reassessment to add a new integral chip antenna to the device.

An electromagnetic emissions test has been performed on the Sanmina Corporation model Whitebox Rev. 003, pursuant to the following rules:

RSS-Gen Issue 5 "General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 2 "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"
FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems test procedures:

ANSI C63.10-2013
FCC Measurement Guidance KDB558074

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.
Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

National Technical Systems is accredited by the A2LA, certificate number 0214.26, to perform the test(s) listed in this report, except where noted otherwise.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Sanmina Corporation model Whitebox Rev. 003 complied with the requirements of the following regulations:

RSS-Gen Issue 5 " General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 2 "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"
FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of Sanmina Corporation model Whitebox Rev. 003 and therefore apply only to the tested sample. The sample was selected and prepared by Matthew Buxton of Sanmina Corporation.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

FREQUENCY HOPPING SPREAD SPECTRUM (902 – 928 MHz, 50 channels or more)

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247 (a) (1) (i)	RSS 247 5.1 (1) & (3)	20 dB Bandwidth	Unchanged from original application	≤ 500 kHz	Complies
15.247 (a) (1)	RSS 247 5.1 (2)	Channel Separation	Unchanged from original application	Channel spacing > 20 dB bandwidth (minimum 25 kHz)	Complies
15.247 (a) (1) (i)	RSS 247 5.1 (3)	Number of Channels	Unchanged from original application	50 or more	Complies
15.247 (a) (1) (i)	RSS 247 5.1 (3)	Channel Dwell Time	Unchanged from original application	<0.4 second within a 20 second period	Complies
15.247 (a) (1)	RSS 247 5.1 (1)	Channel Utilization	Unchanged from original application	All channels shall, on average, be used equally	Complies
15.247 (b) (3)	RSS 247 5.4 (1)	Output Power	Unchanged from original application 19.8 dBm (0.0962 Watts) EIRP = 0.119 W Note 1	1 Watt, EIRP limited to 4 Watts.	Complies
15.247 (d)	RSS 247 5.5	Antenna Port Spurious Emissions	Unchanged from original application	< -20dBc	Complies
15.247 (d) / 15.209	RSS 247 5.5	Radiated Spurious Emissions 9 kHz – 10 GHz	52.0 dBµV/m @ 9022.9 MHz (-2.0 dB)	Refer to the limits section (p18) for restricted bands, all others < -20 dBc	Complies
15.247 (a) (1)	RSS 247 5.1(2)	Receiver bandwidth	Unchanged from original application	Shall match the channel bandwidth	Complies
Note 1: EIRP calculated using antenna gain of 0.92 dBi for the highest EIRP system.					

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Integral antenna	Unique or integral antenna required	Complies
15.407 (b) (6)	RSS-Gen Table 4	AC Conducted Emissions	Not applicable as the EUT is 3 V Battery powered		
15.109	RSS GEN Table 3	Receiver spurious emissions	Unchanged from original application (sDoC)	N/A	N/A
15.247 (i) 15.407 (f)	RSS 102	RF Exposure Requirements	Unchanged from original application Refer to MPE calculations in separate exhibit, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSS-Gen 6.8	User Manual	Unchanged from original application	Statement for products with detachable antenna	Complies
-	RSS-Gen 8.4	User Manual	Unchanged from original application	Statement for all products	Complies
-	RSP-100 RSS-Gen 6.7	Occupied Bandwidth	Unchanged from original application	Information only	N/A

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Sanmina Corporation model Whitebox Rev. 003 is a sensor that is designed to transmit temperature and humidity information. Since the EUT would be placed on a tabletop during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The EUT is 3 V battery operated

The sample was received on February 12, 2019 and tested on February 12, 13 and 14, 2019. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Sanmina	Whitebox	Transmitter	-	2AMS3WBOX1

OTHER EUT DETAILS

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes. In some cases, the highest internal source determines the frequency range of test for radiated emissions. The highest internal source of the EUT was declared as: 914.9 MHz

ANTENNA SYSTEM

Integral chip antenna (0.92 dBi)

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 8 cm wide by 4 cm deep by 3 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

No support equipment was used during testing.

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
None	-	-	-	-

EUT OPERATION

During emissions testing the EUT was transmitting continuously in required frequencies.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 7	US0027	2845B-7	41039 Boyce Road Fremont, CA 94538-2435

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Results from testing performed in this chamber have been correlated with results from an open area test site. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20 Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000 MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

Software is used to view and convert receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers. The software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1 m above the ground plane.

ANSI C63.10 specifies that the test height above ground for table mounted devices shall be 80 cm for testing below 1 GHz and 1.5 m for testing above 1 GHz. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.10, and the worst-case orientation is used for final measurements.

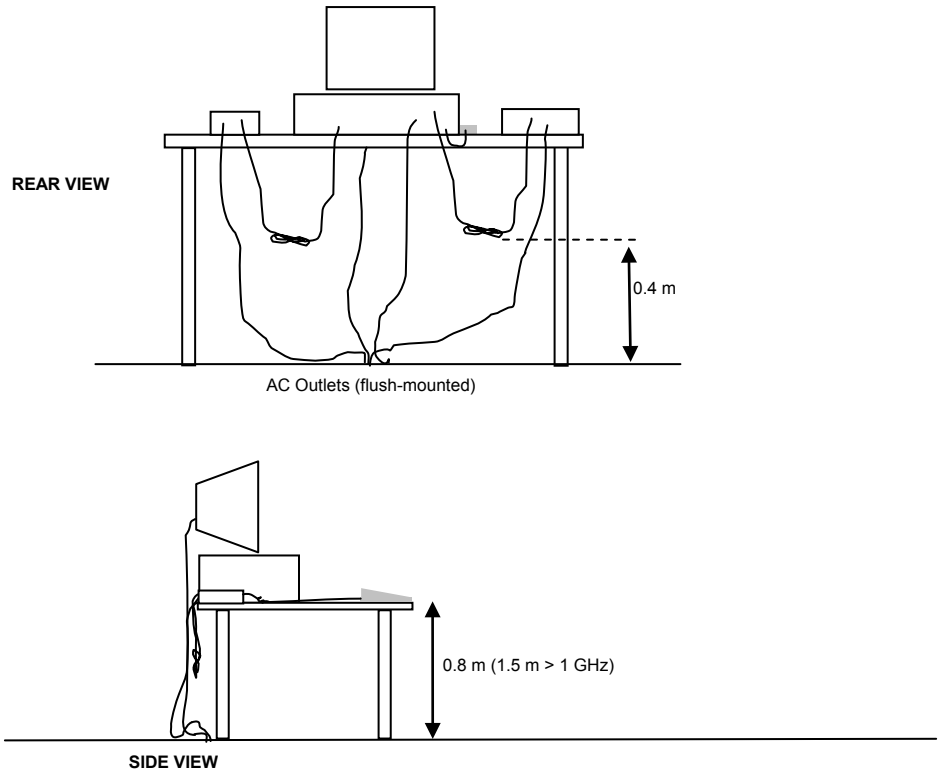
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

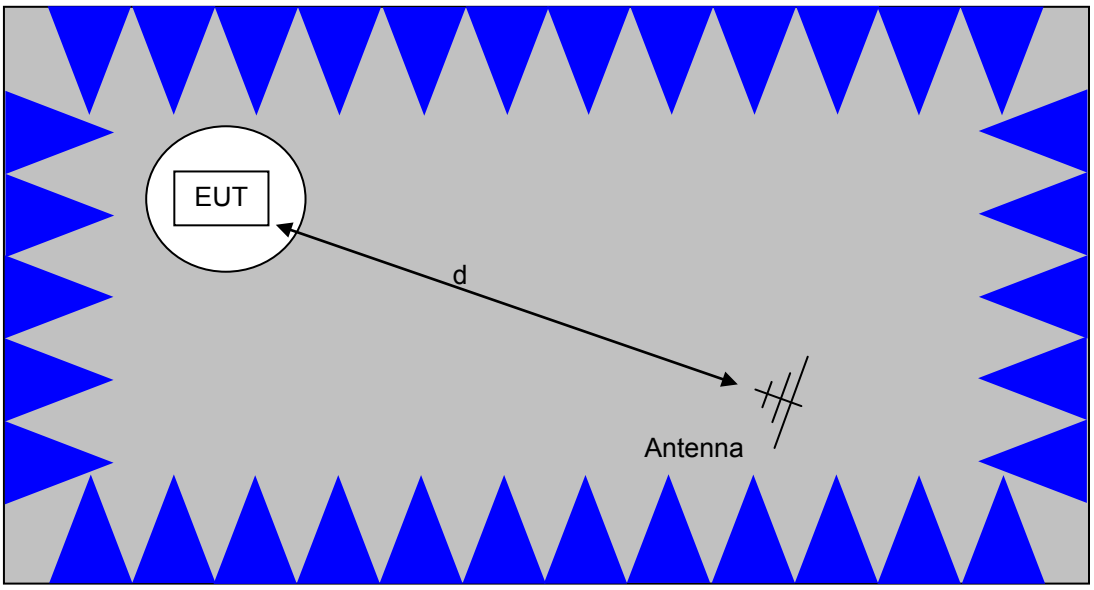
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

When testing above 18 GHz, the receive antenna is located at 1 m from the EUT and the antenna height is restricted to a maximum of 2.5 m.

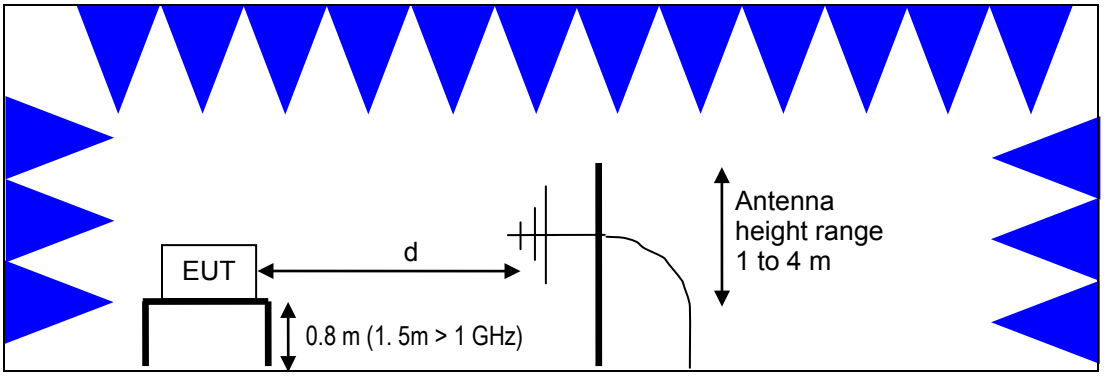


Typical Test Configuration for Radiated Field Strength Measurements



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

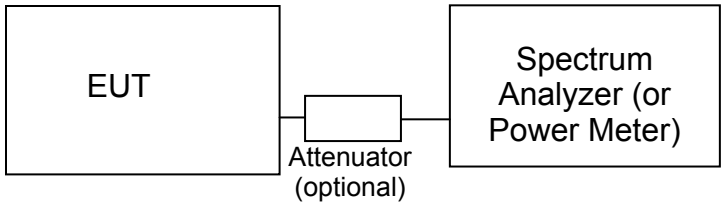
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.



Test Configuration for Antenna Port Measurements

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBµV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBµV/m). The results are then converted to the linear forms of µV and µV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1].

Frequency Range (MHz)	Limit (µV/m)	Limit (dBµV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300 m	$67.6-20*\log_{10}(F_{KHz})$ @ 300 m
0.490-1.705	$24000/F_{KHz}$ @ 30 m	$87.6-20*\log_{10}(F_{KHz})$ @ 30 m
1.705 to 30	30 @ 30 m	29.5 @ 30 m
30 to 88	100 @ 3 m	40 @ 3 m
88 to 216	150 @ 3 m	43.5 @ 3 m
216 to 960	200 @ 3 m	46.0 @ 3 m
Above 960	500 @ 3 m	54.0 @ 3 m

[1] The restricted bands are detailed in FCC 15.205 and RSS-Gen Table 7

OUTPUT POWER LIMITS – DIGITAL TRANSMISSION SYSTEMS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watt (30 dBm)	8 dBm/3 kHz
2400 – 2483.5	1 Watt (30 dBm)	8 dBm/3 kHz
5725 – 5850	1 Watt (30 dBm)	8 dBm/3 kHz

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20 dB below the level of the highest in-band signal level (30 dB if the power is measured using the sample detector/power averaging method).

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB
D_m = Measurement Distance in meters
D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBµV/m
F_d = Distance Factor in dB
R_c = Corrected Reading in dBµV/m
L_s = Specification Limit in dBµV/m
M = Margin in dB Relative to Spec

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radiated Emissions, 30 - 1,000 MHz, 12-Feb-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2237	7/3/2018	7/3/2020
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESI 40	2493	3/22/2018	3/22/2019
Radiated Emissions, 1,000 - 10,000 MHz, 12-Feb-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz	3115	1242	4/11/2017	4/19/2019
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	12/8/2018	12/8/2019
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	8/30/2018	8/30/2019
Hewlett Packard	High Pass filter, 1.5 GHz (Purple System)	P/N 84300-80037	1769	8/18/2018	8/18/2019
Radiated Emissions, 1,000 - 10,000 MHz, 13-Feb-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz	3115	1242	4/11/2017	4/19/2019
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	12/8/2018	12/8/2019
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	8/30/2018	8/30/2019
Hewlett Packard	High Pass filter, 1.5 GHz (Purple System)	P/N 84300-80037	1769	8/18/2018	8/18/2019
Radiated Emissions, 30 - 1,000 MHz, 13-Feb-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2237	7/3/2018	7/3/2020
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESI 40	2493	3/22/2018	3/22/2019
Radiated Emissions, 9 kHz - 30 MHz, 13-Feb-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESI 40	2493	3/22/2018	3/22/2019
Rhode & Schwarz	Magnetic Loop Antenna, 9 kHz-30 MHz	HFH2-Z2	WC062 457	1/5/2018	1/5/2020
RF Power, 14-Feb-19					
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	1071	4/4/2018	4/4/2019
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts (w/ 20 dB pad, SN BJ5155)	NRV-Z32	1536	6/21/2018	6/21/2019

Appendix B Test Data

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Client:	Sanmina Corporation	PR Number:	PR094191
Product	Whitebox Sensor	T-Log Number:	TL094191
System Configuration:		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Engineer:	Deniz Demirci
Emissions Standard(s):	FCC 15.247, RSS 247	Class:	B
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

Sanmina Corporation

Product

Whitebox Sensor

Date of Last Test: 2/14/2019

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

RSS-247 and FCC 15.247 Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT was located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 23 °C
Rel. Humidity: 48 %

Summary of Results - Device Operating in the 900 MHz Band

Run #	Mode	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
Scans on center channel in all three orientations to determine the worst case mode.							
1a Flat	LoRa	Center 908 MHz	Default	-	Radiated Emissions, 30 MHz - 10 GHz	FCC Part 15.209 / 15.247(c)	50.8 dBµV/m @ 9079.9 MHz (-3.2 dB)
1b Side	LoRa	Center 908 MHz	Default	-	Radiated Emissions, 30 MHz - 10 GHz	FCC Part 15.209 / 15.247(c)	49.1 dBµV/m @ 8172.0 MHz (-4.9 dB)
1c Upright	LoRa	Center 908 MHz	Default	-	Radiated Emissions, 30 MHz - 10 GHz	FCC Part 15.209 / 15.247(c)	50.0 dBµV/m @ 8171.9 MHz (-4.0 dB)
Measurements on low and high channels in worst-case orientation.							
2 Flat	LoRa	Low 902.3 MHz	Default	-	Radiated Emissions, 30 MHz - 10 GHz	FCC Part 15.209 / 15.247(c)	52.0 dBµV/m @ 9022.9 MHz (-2.0 dB)
3 Flat	LoRa	High 914.9 MHz	Default	-	Restricted Band at 960 MHz	FCC Part 15.209 / 15.247(c)	38.2 dBµV/m @ 960.50 MHz (-15.8 dB)
			Default	-	Radiated Emissions, 30 MHz - 10 GHz	FCC Part 15.209 / 15.247(c)	51.2 dBµV/m @ 9148.9 MHz (-2.8 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1 MHz, VBW=3 MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 98% and was measured using RBW=1 MHz, VBW=10 Hz, peak detector, linear average mode, auto sweep time, max hold.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
LoRa	-	1.00	Yes	-	0	0	10

Sample Notes

Sample S/N: 1
Driver: None
Antenna: Chip antenna 915

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 20 dB below the level of the fundamental and measured in 100 kHz.

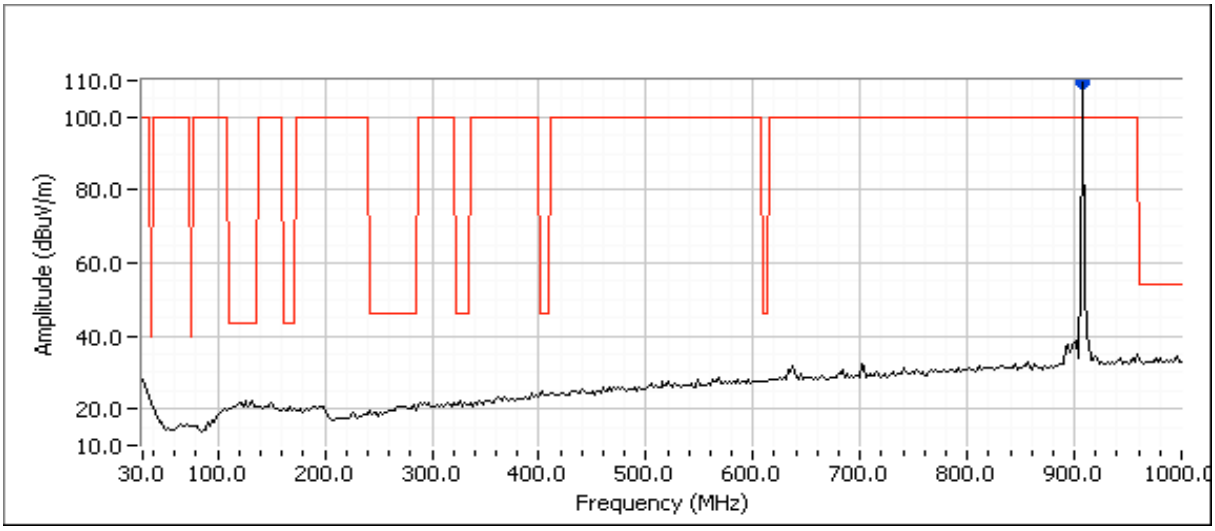
Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

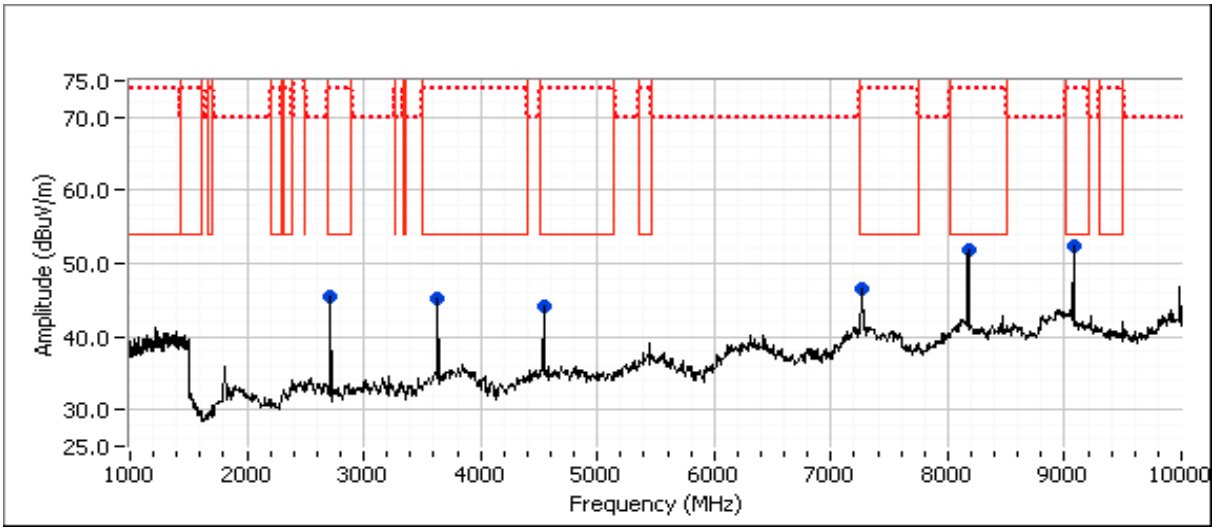
Run #1: Radiated Spurious Emissions, 30 - 10,000 MHz. Center Channel @ 908 MHz

Date of Test: 2/12 & 2/13/2019
Test Engineer: YK Soo
Test Location: Fremont CH #7

Config. Used: 1
Config Change: -
EUT Voltage: +3V

Run #1a: EUT Flat on the table





Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Fundamental Signal Field Strength: Peak value measured in 100 kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
908.014	114.6	H	-	-	Pk	178	1.7	POS; RB 100 kHz; VB: 300 kHz

Fundamental emission level @ 3 m in 100 kHz RBW:	114.6	dBµV/m	
Limit for emissions outside of restricted bands:	94.6	dBµV/m	Limit is -20 dBc (Peak power measurement)

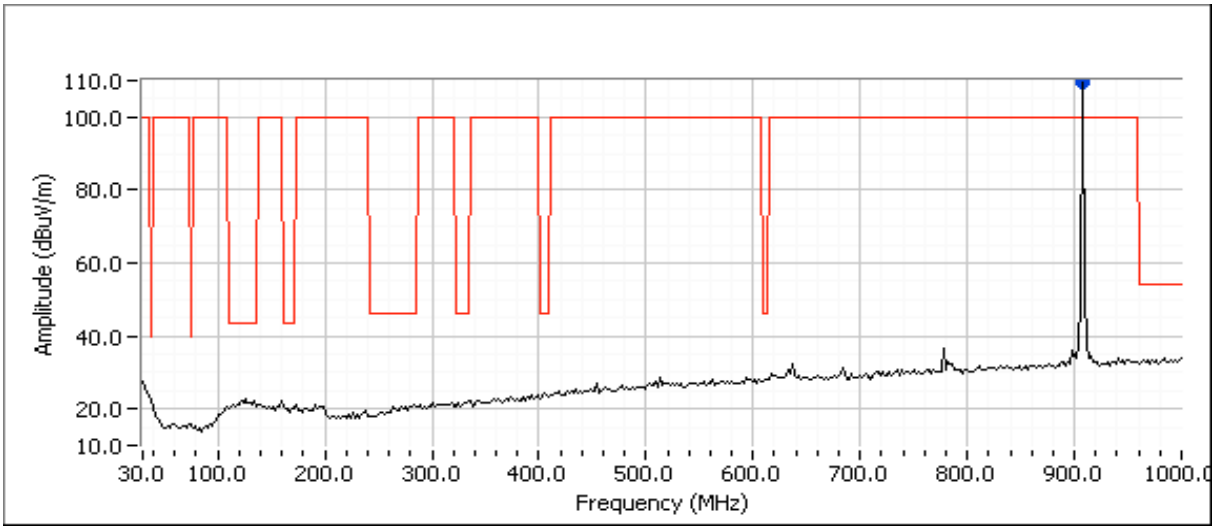
Spurious Emissions

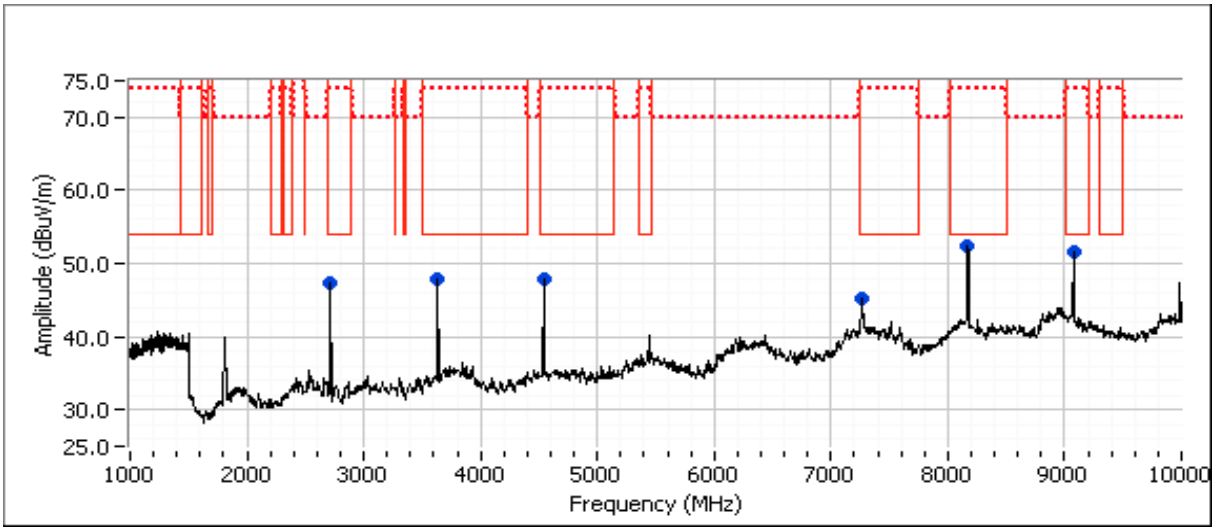
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
9079.900	50.8	V	54.0	-3.2	AVG	86	1.1	RB 1 MHz;VB 10 Hz;Peak
8171.990	48.9	V	54.0	-5.1	AVG	84	1.0	RB 1 MHz;VB 10 Hz;Peak
2723.990	46.0	V	54.0	-8.0	AVG	332	1.1	RB 1 MHz;VB 10 Hz;Peak
7263.960	45.4	V	54.0	-8.6	AVG	90	1.0	RB 1 MHz;VB 10 Hz;Peak
3631.960	43.3	V	54.0	-10.7	AVG	170	1.9	RB 1 MHz;VB 10 Hz;Peak
4539.940	43.1	V	54.0	-10.9	AVG	272	1.7	RB 1 MHz;VB 10 Hz;Peak
9079.680	58.9	V	74.0	-15.1	PK	86	1.1	RB 1 MHz;VB 3 MHz;Peak
8171.540	56.4	V	74.0	-17.6	PK	84	1.0	RB 1 MHz;VB 3 MHz;Peak
7264.170	55.0	V	74.0	-19.0	PK	90	1.0	RB 1 MHz;VB 3 MHz;Peak
2724.200	49.1	V	74.0	-24.9	PK	332	1.1	RB 1 MHz;VB 3 MHz;Peak
4539.740	48.4	V	74.0	-25.6	PK	272	1.7	RB 1 MHz;VB 3 MHz;Peak
3631.820	47.8	V	74.0	-26.2	PK	170	1.9	RB 1 MHz;VB 3 MHz;Peak

Note:	For emissions in restricted band, the limit of 15.209 was used. For all other emissions. The limit was set 20 dB below the level of the fundamental.

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Run #1b: EUT Side on the table





Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Fundamental Signal Field Strength: Peak value measured in 100 kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
907.979	112.1	H	100.0	-	Pk	2	1.7	POS; RB 100 kHz; VB: 300 kHz

Fundamental emission level @ 3 m in 100 kHz RBW:	112.1	dBµV/m	
Limit for emissions outside of restricted bands:	92.1	dBµV/m	Limit is -20 dBc (Peak power measurement)

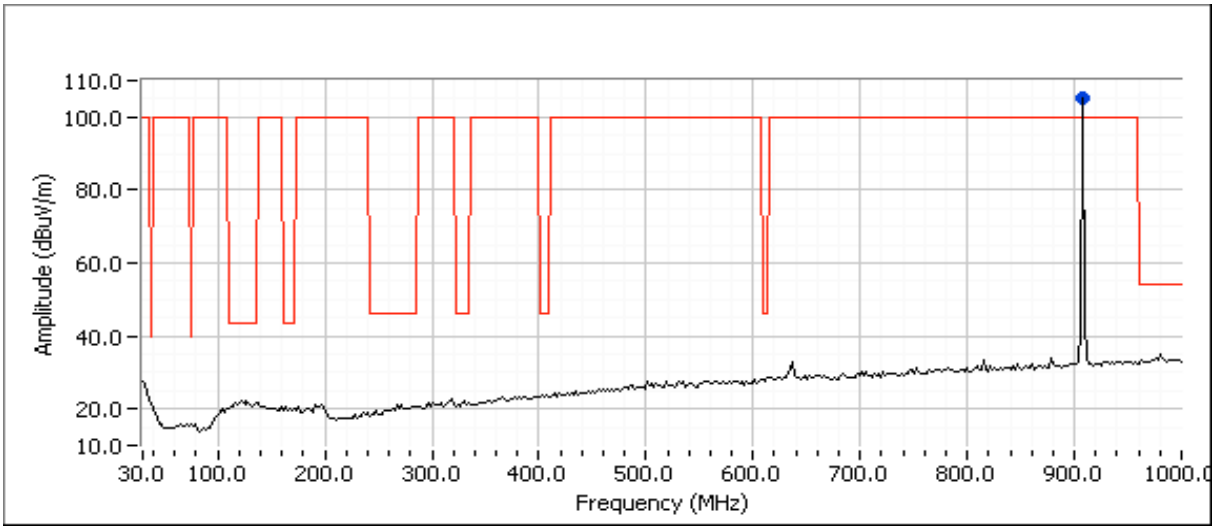
Spurious Emissions

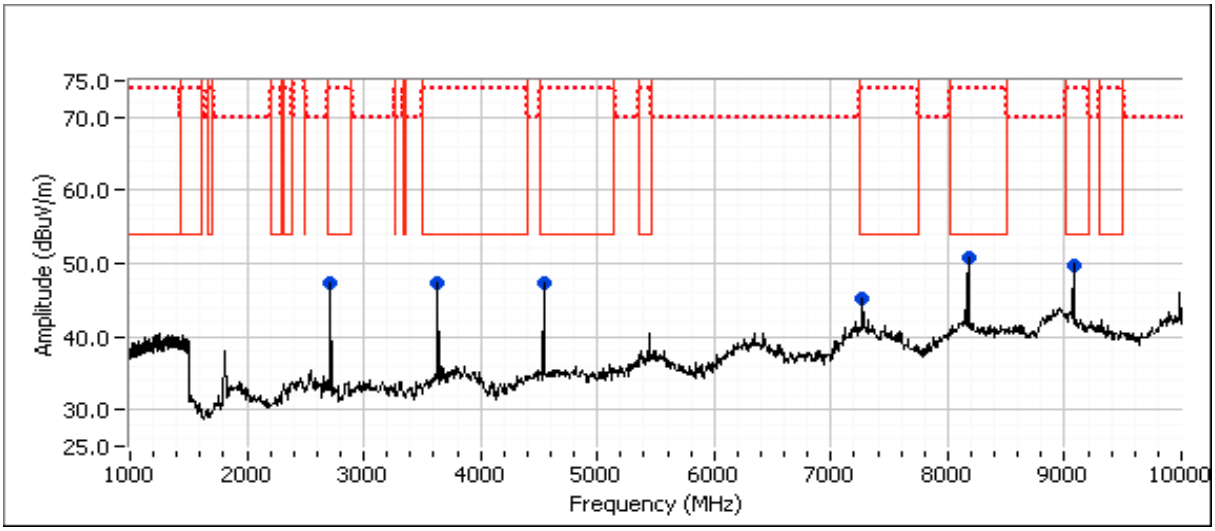
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
8171.970	49.1	H	54.0	-4.9	AVG	86	1.2	RB 1 MHz;VB 10 Hz;Peak
9079.840	47.8	H	54.0	-6.2	AVG	214	1.8	RB 1 MHz;VB 10 Hz;Peak
3631.930	47.8	H	54.0	-6.2	AVG	178	1.3	RB 1 MHz;VB 10 Hz;Peak
2723.980	47.4	H	54.0	-6.6	AVG	156	2.3	RB 1 MHz;VB 10 Hz;Peak
4539.980	46.3	H	54.0	-7.7	AVG	168	1.5	RB 1 MHz;VB 10 Hz;Peak
7263.900	43.7	H	54.0	-10.3	AVG	84	1.3	RB 1 MHz;VB 10 Hz;Peak
8171.460	56.5	H	74.0	-17.5	PK	86	1.2	RB 1 MHz;VB 3 MHz;Peak
9079.580	56.2	H	74.0	-17.8	PK	214	1.8	RB 1 MHz;VB 3 MHz;Peak
7264.140	53.6	H	74.0	-20.4	PK	84	1.3	RB 1 MHz;VB 3 MHz;Peak
3631.640	51.2	H	74.0	-22.8	PK	178	1.3	RB 1 MHz;VB 3 MHz;Peak
4539.900	50.1	H	74.0	-23.9	PK	168	1.5	RB 1 MHz;VB 3 MHz;Peak
2723.820	49.9	H	74.0	-24.1	PK	156	2.3	RB 1 MHz;VB 3 MHz;Peak

Note:	For emissions in restricted band, the limit of 15.209 was used. For all other emissions. The limit was set 20 dB below the level of the fundamental.

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Run #1c: EUT Upright on the table





Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Fundamental Signal Field Strength: Peak value measured in 100 kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
907.957	112.2	V	-	-	Pk	280	1.2	POS; RB 100 kHz; VB: 300 kHz

Fundamental emission level @ 3m in 100 kHz RBW:	112.2	dBµV/m	
Limit for emissions outside of restricted bands:	92.2	dBµV/m	Limit is -20 dBc (Peak power measurement)

Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
8171.910	50.0	H	54.0	-4.0	AVG	122	1.9	RB 1 MHz;VB 10 Hz;Peak
9079.870	47.3	V	54.0	-6.7	AVG	329	1.0	RB 1 MHz;VB 10 Hz;Peak
2723.990	47.1	V	54.0	-6.9	AVG	155	1.5	RB 1 MHz;VB 10 Hz;Peak
3631.960	46.8	V	54.0	-7.2	AVG	162	1.7	RB 1 MHz;VB 10 Hz;Peak
4539.980	46.6	V	54.0	-7.4	AVG	143	1.8	RB 1 MHz;VB 10 Hz;Peak
7264.000	43.9	H	54.0	-10.1	AVG	190	1.9	RB 1 MHz;VB 10 Hz;Peak
8171.380	57.4	H	74.0	-16.6	PK	122	1.9	RB 1 MHz;VB 3 MHz;Peak
9079.450	56.0	V	74.0	-18.0	PK	329	1.0	RB 1 MHz;VB 3 MHz;Peak
7264.230	53.7	H	74.0	-20.3	PK	190	1.9	RB 1 MHz;VB 3 MHz;Peak
4540.180	50.9	V	74.0	-23.1	PK	143	1.8	RB 1 MHz;VB 3 MHz;Peak
3631.920	50.2	V	74.0	-23.8	PK	162	1.7	RB 1 MHz;VB 3 MHz;Peak
2724.120	49.9	V	74.0	-24.1	PK	155	1.5	RB 1 MHz;VB 3 MHz;Peak

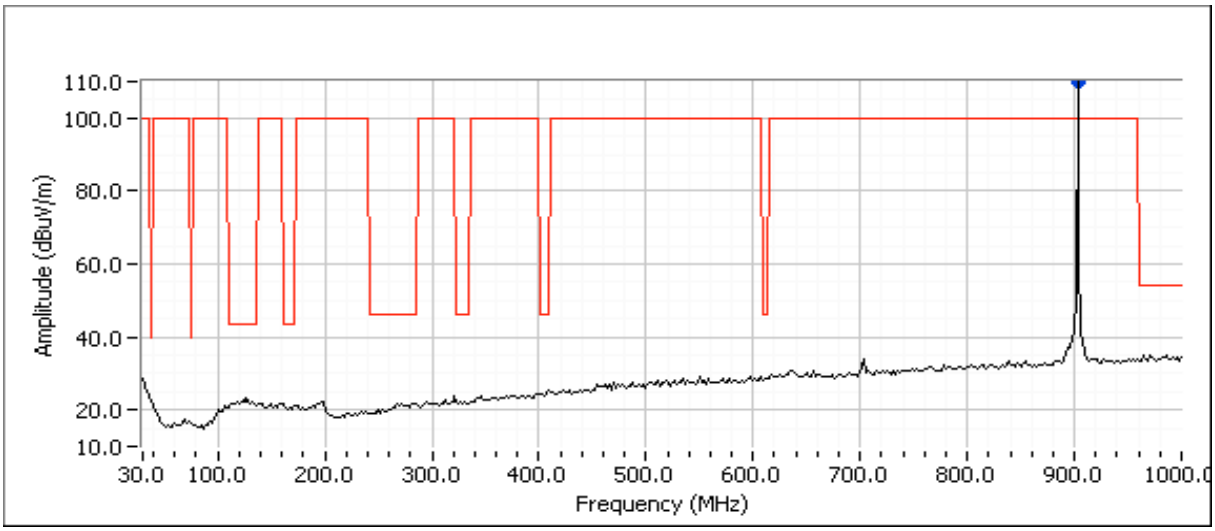
Note:	For emissions in restricted band, the limit of 15.209 was used. For all other emissions. The limit was set 20 dB below the level of the fundamental.

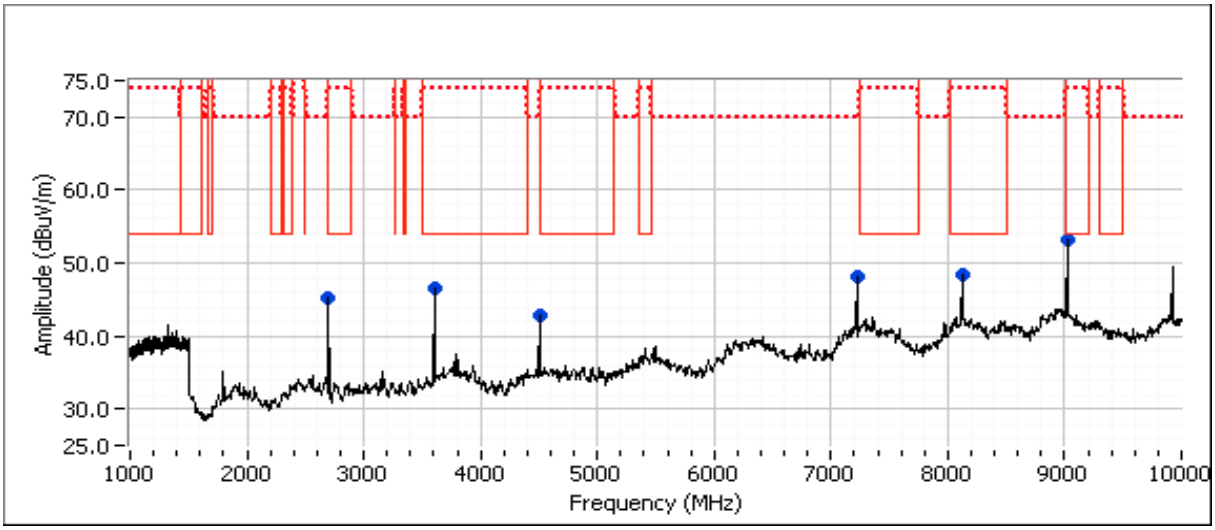
Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Run #2: Radiated Spurious Emissions, 30 - 10,000 MHz. low Channel @ 902.3 MHz. EUT flat on the table

Date of Test: 2/13/2019
Test Engineer: YK Soo
Test Location: Fremont CH #7

Config. Used: 1
Config Change: -
EUT Voltage: +3V





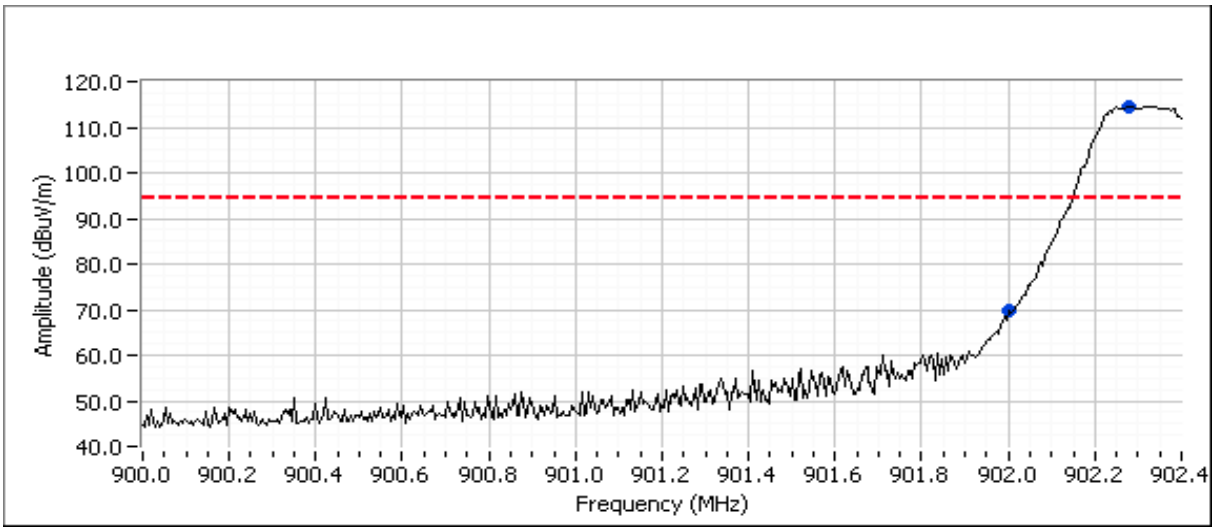
Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
9022.910	52.0	V	54.0	-2.0	AVG	282	1.0	RB 1 MHz;VB 10 Hz;Peak
7218.350	46.6	V	54.0	-7.4	AVG	321	1.1	Note 1: RB 1 MHz;VB 10 Hz;Peak
3609.170	46.4	H	54.0	-7.6	AVG	193	1.7	RB 1 MHz;VB 10 Hz;Peak
8120.590	46.0	V	54.0	-8.0	AVG	242	1.0	RB 1 MHz;VB 10 Hz;Peak
2706.910	44.2	H	54.0	-9.8	AVG	317	1.0	RB 1 MHz;VB 10 Hz;Peak
4511.490	42.6	V	54.0	-11.4	AVG	52	1.4	RB 1 MHz;VB 10 Hz;Peak
9022.570	58.2	V	74.0	-15.8	PK	282	1.0	RB 1 MHz;VB 3 MHz;Peak
7218.120	55.1	V	74.0	-18.9	PK	321	1.1	Note 1: RB 1 MHz;VB 3 MHz;Peak
8120.490	54.6	V	74.0	-19.4	PK	242	1.0	RB 1 MHz;VB 3 MHz;Peak
3609.090	50.2	H	74.0	-23.8	PK	193	1.7	RB 1 MHz;VB 3 MHz;Peak
4511.290	48.0	V	74.0	-26.0	PK	52	1.4	RB 1 MHz;VB 3 MHz;Peak
2706.590	47.7	H	74.0	-26.3	PK	317	1.0	RB 1 MHz;VB 3 MHz;Peak

Note 1: Emission in non-restricted band, but limit of 15.209 used.

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A



Fundamental Signal Field Strength: Peak value measured in 100 kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
902.305	114.5	H	-	-	Pk	360	1.0	POS; RB 100 kHz; VB: 300 kHz

Fundamental emission level @ 3 m in 100 kHz RBW:	113.8 dBµV/m	
Limit for emissions outside of restricted bands:	93.8 dBµV/m	Limit is -20 dBc (Peak power measurement)

Band Edge Signal Field Strength (902 MHz)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
902.001	69.6	H	93.8	-24.2	Pk	162	1.0	POS; RB 100 kHz; VB: 300 kHz

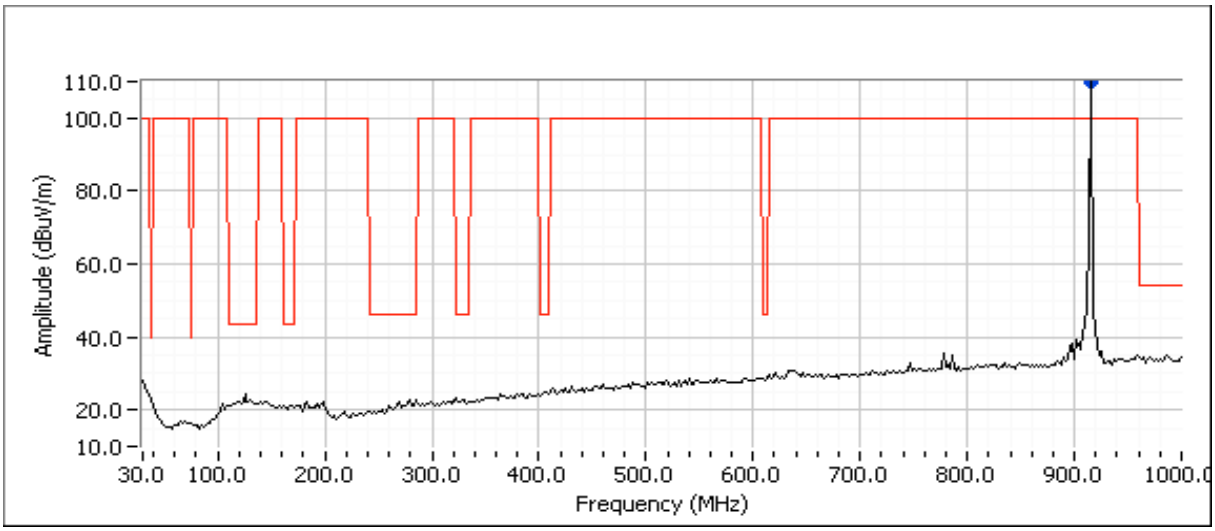
Note:	Original test report shows no measurable spurious emission difference between single channel and hopping mode in band edge measurements hence frequency hoping mode band edge measurements were not repeated with the new antenna.

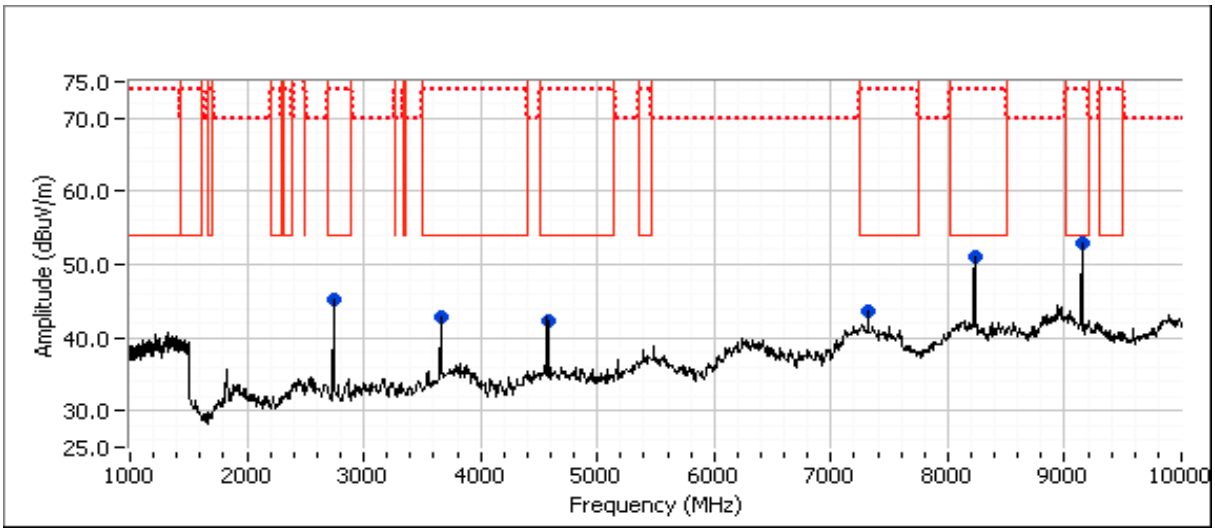
Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Run #3: Radiated Spurious Emissions, 30 - 10,000 MHz. High Channel @ 914.9 MHz. EUT flat on the table

Date of Test: 2/13/2019
Test Engineer: YK Soo
Test Location: Fremont CH #7

Config. Used: 1
Config Change: -
EUT Voltage: +3V



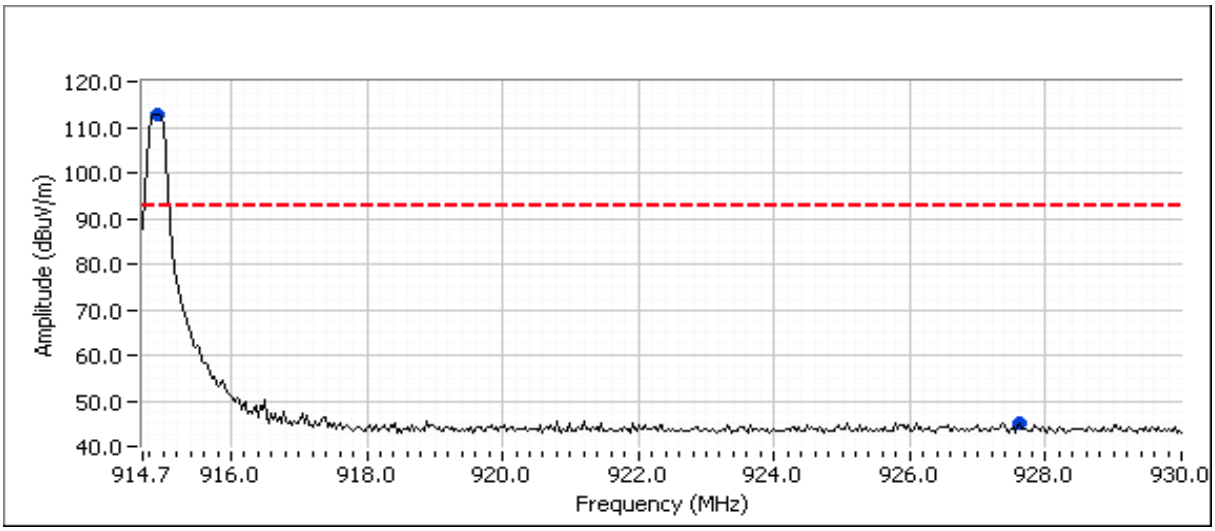


Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
9148.850	51.2	V	54.0	-2.8	AVG	255	1.1	RB 1 MHz;VB 10 Hz;Peak
8234.030	49.6	V	54.0	-4.4	AVG	255	1.0	RB 1 MHz;VB 10 Hz;Peak
2744.650	44.9	V	54.0	-9.1	AVG	156	1.6	RB 1 MHz;VB 10 Hz;Peak
3659.580	42.7	V	54.0	-11.3	AVG	173	1.5	RB 1 MHz;VB 10 Hz;Peak
7319.330	42.0	V	54.0	-12.0	AVG	246	1.9	RB 1 MHz;VB 10 Hz;Peak
4574.480	41.2	H	54.0	-12.8	AVG	289	1.5	RB 1 MHz;VB 10 Hz;Peak
9148.600	59.3	V	74.0	-14.7	PK	255	1.1	RB 1 MHz;VB 3 MHz;Peak
8233.770	56.9	V	74.0	-17.1	PK	255	1.0	RB 1 MHz;VB 3 MHz;Peak
7318.730	52.6	V	74.0	-21.4	PK	246	1.9	RB 1 MHz;VB 3 MHz;Peak
2744.540	48.1	V	74.0	-25.9	PK	156	1.6	RB 1 MHz;VB 3 MHz;Peak
4574.670	47.9	H	74.0	-26.1	PK	289	1.5	RB 1 MHz;VB 3 MHz;Peak
3659.480	47.8	V	74.0	-26.2	PK	173	1.5	RB 1 MHz;VB 3 MHz;Peak

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A



Fundamental Signal Field Strength: Peak value measured in 100 kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
914.915	*112.7*	*H*	*100.0*	*12.7*	*Pk*	*193*	*1.0*	POS; RB 100 kHz; VB: 300 kHz

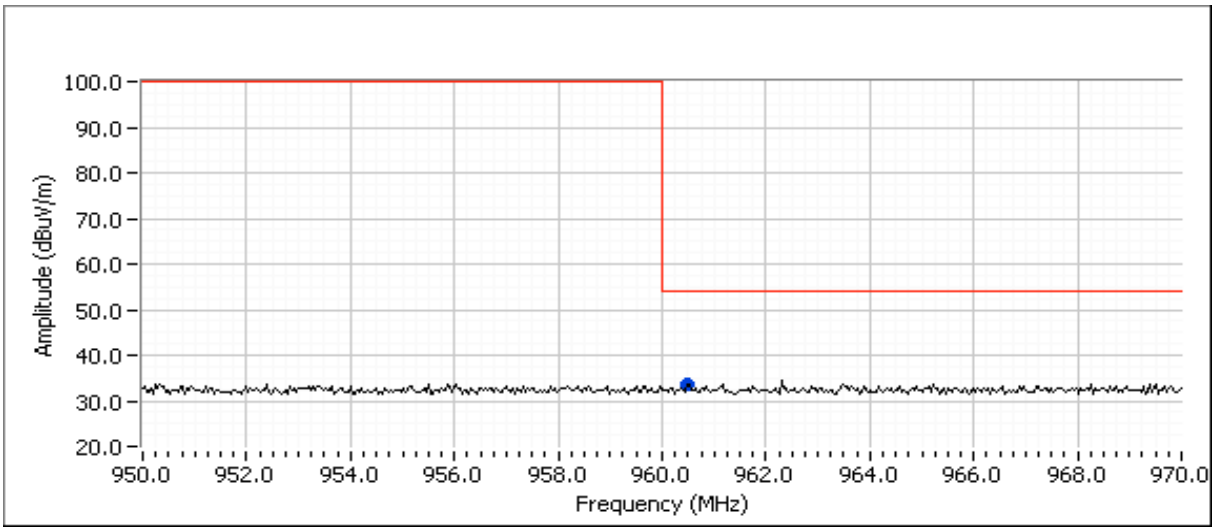
Fundamental emission level @ 3 m in 100 kHz RBW:	112.7 dBµV/m	
Limit for emissions outside of restricted bands:	92.7 dBµV/m	Limit is -20 dBc (Peak power measurement)

Band Edge Signal Field Strength (928 MHz)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
927.608	*44.9*	*H*	*92.7*	*-47.8*	*Pk*	*238*	*1.5*	POS; RB 100 kHz; VB: 300 kHz

Note:	Original test report shows no measurable spurious emission difference between single channel and hopping mode in band edge measurements hence frequency hoping mode band edge measurements were not repeated with the new antenna.

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A



Band Edge Signal Field Strength (960 MHz)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
960.501	38.2	H	54.0	-15.8	QP	360	1.0	QP (1.00s)

Note:	Original test report shows no measurable spurious emission difference between single channel and hopping mode in band edge measurements hence frequency hoping mode band edge measurements were not repeated with the new antenna.

Client:	Sanmina Corporation	PR Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Engineer:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	B

Radiated Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 2/13/2019
Test Engineer: YK Soo
Test Location: Fremont CH #7

Config. Used: 1
Config Change: -
EUT Voltage: +3V

General Test Configuration

The EUT was located on the turntable for radiated emissions testing. No remote support equipment was used
The test distance and extrapolation factor (if used) are detailed under each run description.
Note, preliminary testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. Maximized testing indicated that the emissions were maximized by orientation of the EUT and manipulation of the EUT's interface cables.

Ambient Conditions:

Temperature: 23 °C
Rel. Humidity: 48 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	9 kHz - 30 MHz	FCC 15.209	Pass	-6.50 dBµV/m @ 16.774 MHz (-36.0 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

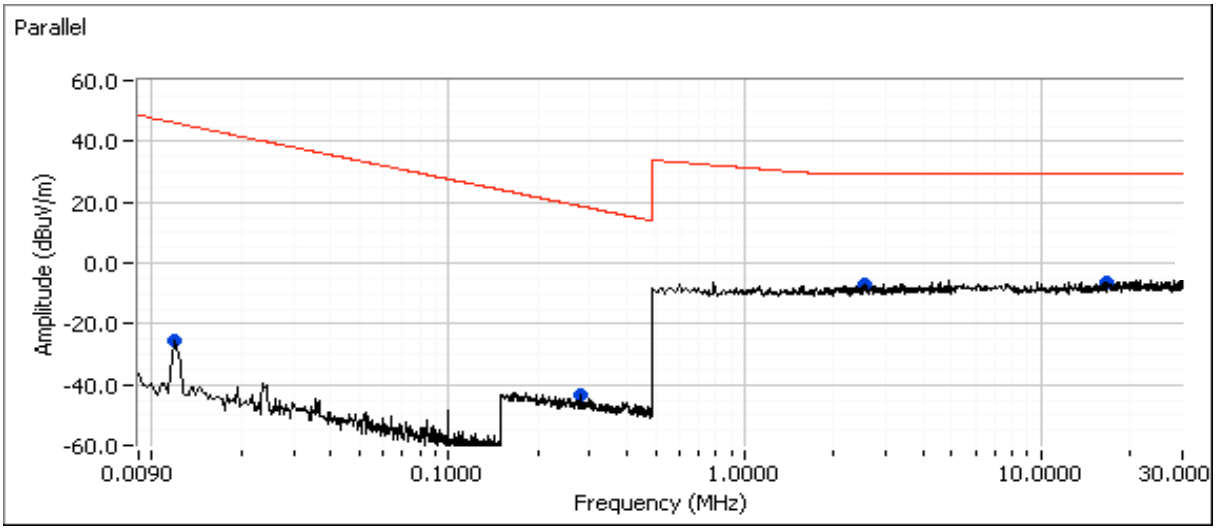
Client:	Sanmina Corporation	PR Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Engineer:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	B

Run #1: Radiated Emissions, 9 kHz - 30 MHz, FCC 15.209, Center Channel @ 908 MHz

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
0.009 - 0.490 MHz	3	300	-80.0
0.490 - 1.705 MHz	3	30	-40.0
1.705 - 30.0 MHz	3	30	-40.0

Note - the extrapolation factor is based on 40log(test distance/limit distance) as permitted by FCC 15.31

EUT Flat on the table



Preliminary readings

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
16.774	-6.5	H	29.5	-36.0	Pk	342	1.0	
2.533	-7.1	H	29.5	-36.6	Pk	14	1.0	
0.280	-43.3	H	18.7	-62.0	Pk	169	1.0	
0.012	-25.5	H	46.1	-71.6	Pk	0	1.0	

Note 1:	The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, with a peak limit 20 dB above the average limit.

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

RSS-247 and FCC 15.247 (DTS) Antenna Port Measurements

Power, PSD, Bandwidth and Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 2/14/2019
Test Engineer: YK Soo
Test Location: Fremont EMC Lab #4A

Config. Used: 1
Config Change: -
EUT Voltage: +3V

General Test Configuration

The EUT was connected to the spectrum analyzer or power meter via a suitable attenuator. All measurements were made on a single chain.

All measurements have been corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 22 °C
Rel. Humidity: 45 %

Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	Default	-	Output Power	15.247(b)	Pass	19.8 dBm

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Sanmina Corporation	Job Number:	PR094191
Model:	Whitebox Sensor	T-Log Number:	TL094191
		Project Manager:	Christine Krebill
Contact:	Matthew Buxton	Project Coordinator:	Deniz Demirci
Standard:	FCC 15.247, RSS 247	Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
LoRa	-	1.00	Yes	-	0	0	10

Sample Notes

Sample S/N: 1
Driver: None

Run #1: Output Power

Mode: LoRa

Power Setting[2]	Frequency (MHz)	Output Power (dBm)[1]	Output Power mW	Antenna Gain (dBi)	Result	EIRP dBm	EIRP W	Output Power (dBm)[3]	Output Power mW
Default	902.3	19.83	96.2	0.92	Pass	20.8	0.119		
Default	908.0	19.80	95.5	0.92	Pass	20.7	0.118		
Default	914.9	19.80	95.5	0.92	Pass	20.7	0.118		

Note 1:	Output power measured using a peak power meter, spurious limit is -20 dBc.

End of Report

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marks the last page of this test report.