Excellence in Compliance Testing

Certification Test Report

FCC ID: 2AG9G-FCL5320A
IC: 5248W-FCL5320A

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-247

ACS Report Number: 16-0157.W06.1A

Manufacturer: Flextronics America LLC
Model: FCL5320v02

Test Begin Date: April 18, 2016
Test End Date: June 28, 2016

Report Issue Date: June 29, 2016

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: AT-2021

This report must not be used by the client to claim product certification, approval, or endorsement by ANAB, NIST, or any agency of the Federal Government.

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This report contains 21 pages

TABLE OF CONTENTS

1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-247 Certification for modular approval.

1.2 Product Description

The FCL5320v02 product is a Zigbee to Wi-Fi gateway device that works in a residential consumer home. Once installed by a professional installer / technician it stays plugged-in to the wall AC outlet for the product lifecycle. The Wi-Fi radio on this device connects to the existing residential Wi-Fi network. The Zigbee radio acts as a hub for controlling and monitoring Zigbee sensors within the home. This report documents the compliance of the Zigbee transceiver for operation in the 2.4GHz ISM band.

Technical Information:

Detail	Description
Frequency Range	2405 - 2480 MHz
Number of Channels	16
Modulation Format	O-QPSK
Data Rates	250kbps
Number of Inputs/Outputs	1
Operating Voltage	120Vac / 60Hz
Antenna Type(s) / Gain(s)	Inverted F Antenna / 2.5dBi

Manufacturer Information:
Flextronics America, LLC
3300 Holcomb Bridge Rd.Suite #290
Norcross, GA 30092

EUT Serial Numbers: 0001341605A1

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

The EUT was evaluated for radiated, power line, and RF conducted emissions. A laptop and USB hub were used to facilitate control of the EUT test modes only and removed during the test.

For radiated emissions the EUT was evaluated in an orientation that reflects the professional installation guide.

The RF conducted emission measurements were performed for the EUT modified with a temporary RF connector for direct coupling to the measurement equipment.

Radiated inter-modulation testing was performed for all combinations of simultaneous transmission and found to be in compliance.

Power settings utilized during testing are as follows:

Channel 11 (2405 MHz): 0x2
Channel 18 (2440 MHz): 0x2
Channel 25 (2475 MHz): 0x2
Channel 26 (2480 MHz): 0xF4

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by the ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-2021 in recognition of this accreditation. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 391271
Industry Canada Lab Code: IC 4175A
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

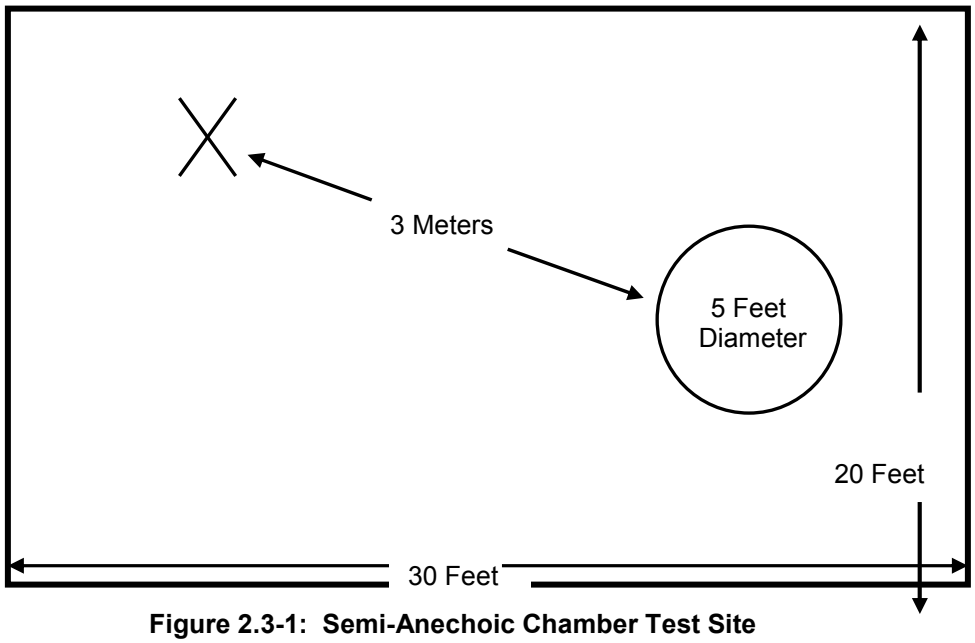

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

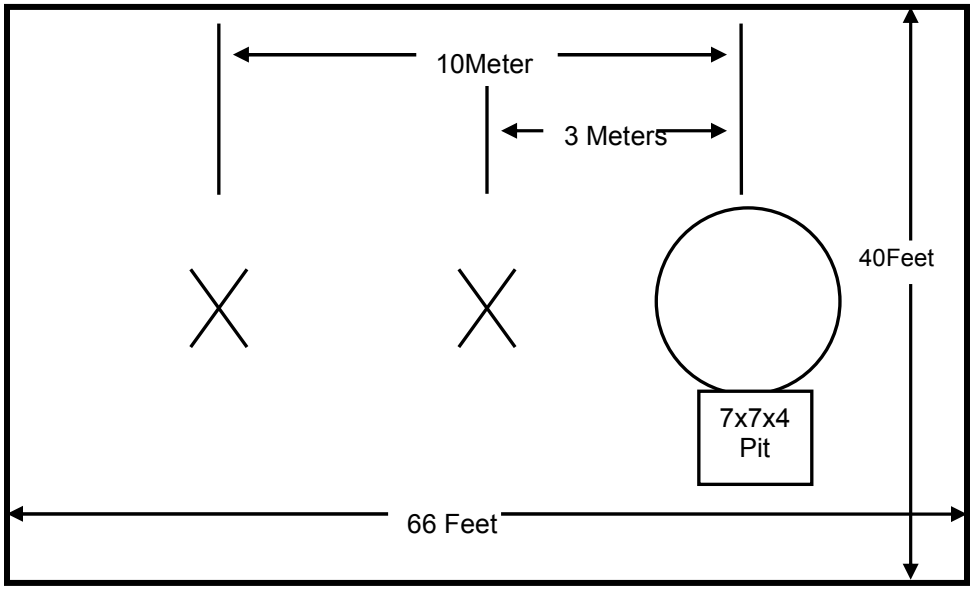

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.10.

A diagram of the room is shown below in figure 4.1.3-1:

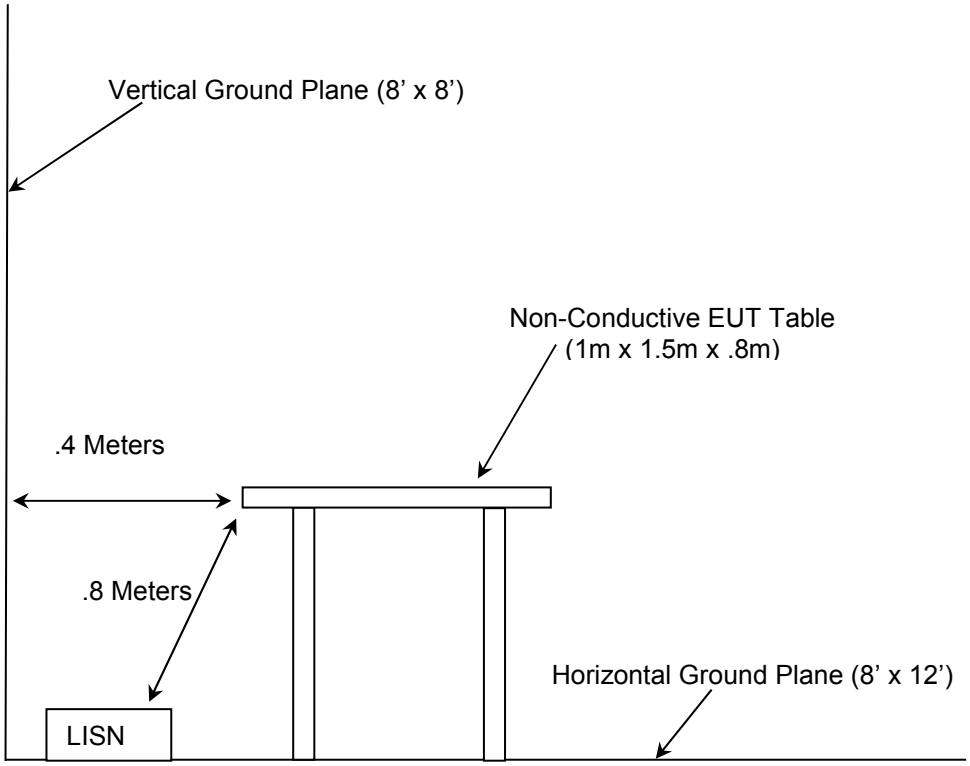

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2016
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2016
- FCC KDB 558074 D01 DTS Meas Guidance v03r04 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, January 7, 2016
- Industry Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 4, Nov 2014.

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	7/14/2015	7/14/2016
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	7/14/2015	7/14/2016
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/30/2015	4/30/2017
40	EMCO	3104	Antennas	3211	2/10/2015	2/10/2017
73	Agilent	8447D	Amplifiers	2727A05624	7/15/2015	7/15/2016
167	ACS	Chamber EMI Cable Set	Cable Set	167	10/20/2015	10/20/2016
267	Agilent	N1911A	Meters	MY45100129	8/24/2015	8/24/2017
268	Agilent	N1921A	Sensors	MY45240184	8/13/2015	8/13/2017
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	None	2/17/2016	2/17/2017
324	ACS	Belden	Cables	8214	5/2/2016	5/2/2017
324	ACS	Belden	Cables	8214	5/2/2016	5/2/2017
338	Hewlett Packard	8449B	Amplifiers	3008A01111	8/21/2015	8/21/2017
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	7/13/2015	7/13/2016
412	Electro Metrics	LPA-25	Antennas	1241	7/24/2014	7/24/2016
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	10/30/2015	10/30/2016
432	Microwave Circuits	H3G020G4	Filters	264066	5/13/2016	5/13/2017
432	Microwave Circuits	H3G020G4	Filters	264066	5/13/2016	5/13/2017
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/3/2015	9/3/2016
622	Rohde & Schwarz	FSV40	Analyzers	101338	7/15/2015	7/15/2016
3010	Rohde & Schwarz	ENV216	LISN	3010	7/10/2015	7/10/2016
RE112	Rohde & Schwarz	ESIB26	Receiver	836119/012	7/16/2015	7/16/2016

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
The EUT is a standalone device.				

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

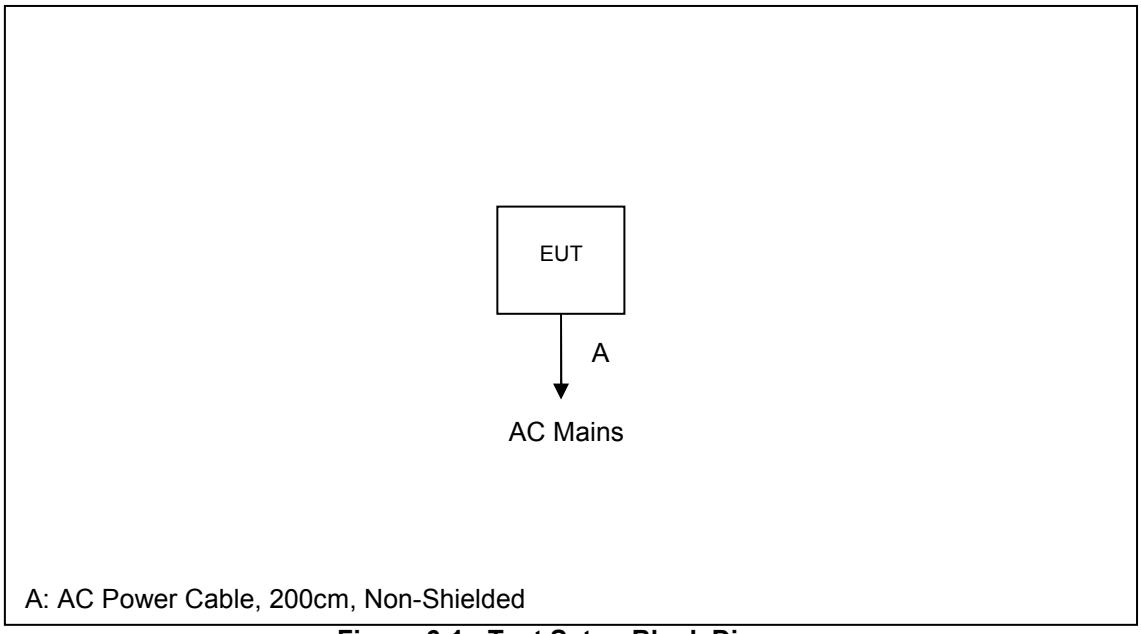

Figure 6-1: Test Setup Block Diagram

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC 15.203

The antenna is an Inverted F Antenna with a gain of 2.5dBi and is permanently attached to the PCB, therefore satisfying the requirements of Section 15.203.

7.2 Power Line Conducted Emissions – FCC 15.207, IC: RSS-Gen 8.8

7.2.1 Measurement Procedure

ANSI C63.10 section 6 was the guiding document for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Measurement Results

Table 7.2.2-1: Conducted EMI Results Line 1

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
1.212725	---	36.33	46.00	9.67	L1	9.8
1.212725	38.88	---	56.00	17.12	L1	9.8
2.424750	---	26.49	46.00	19.51	L1	9.8
2.424750	29.48	---	56.00	26.52	L1	9.8
3.178056	---	14.00	46.00	32.00	L1	9.8
3.178056	24.95	---	56.00	31.05	L1	9.8
3.314128	---	13.36	46.00	32.64	L1	9.8
3.314128	24.90	---	56.00	31.10	L1	9.8
3.335572	---	13.31	46.00	32.69	L1	9.8
3.335572	24.67	---	56.00	31.33	L1	9.8
3.477856	---	12.34	46.00	33.66	L1	9.8
3.477856	23.50	---	56.00	32.50	L1	9.8

Table 7.2.2-2: Conducted EMI Results Line 2

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
0.389279	---	20.29	47.92	27.63	N	9.7
0.389279	33.96	---	57.95	23.99	N	9.7
0.403106	---	20.08	47.65	27.57	N	9.7
0.403106	32.94	---	57.67	24.73	N	9.7
0.452004	---	22.32	46.76	24.44	N	9.7
0.452004	34.28	---	56.78	22.50	N	9.7
0.470140	---	28.23	46.47	18.24	N	9.7
0.470140	40.41	---	56.47	16.06	N	9.7
0.651403	---	20.15	46.00	25.85	N	9.7
0.651403	33.01	---	56.00	22.99	N	9.7
1.200802	---	28.59	46.00	17.41	N	9.8
1.200802	33.37	---	56.00	22.63	N	9.8

7.3 6dB / 99% Bandwidth – FCC 15.247(a)(2), IC: RSS-247 5.2(1)

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r04. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 3 times the RBW. The trace was set to max hold with a peak detector active. The marker-delta function of the spectrum analyzer was utilized to determine the 6 dB bandwidth of the emission.

The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth. A peak detector was used.

7.3.2 Measurement Results

Table 7.3.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2405	1.59	2.46
2440	1.61	2.48
2475	1.62	2.49
2480	1.60	2.50

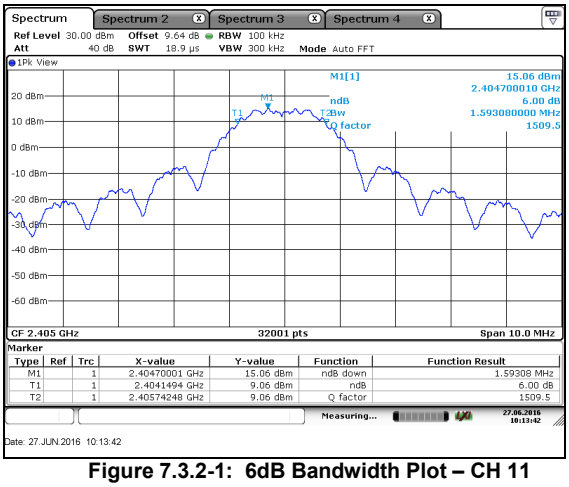

Figure 7.3.2-1: 6dB Bandwidth Plot – CH 11

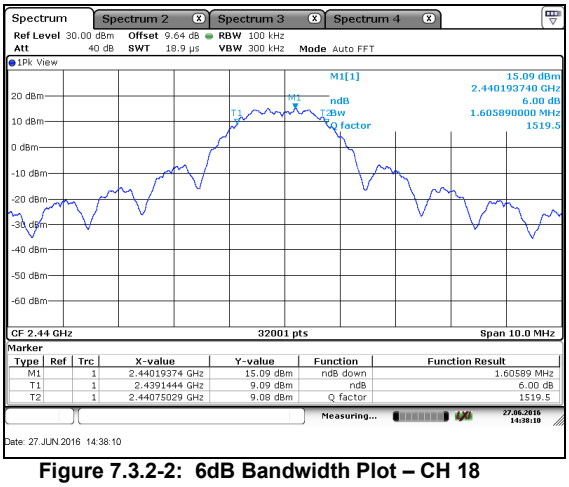

Figure 7.3.2-2: 6dB Bandwidth Plot – CH 18

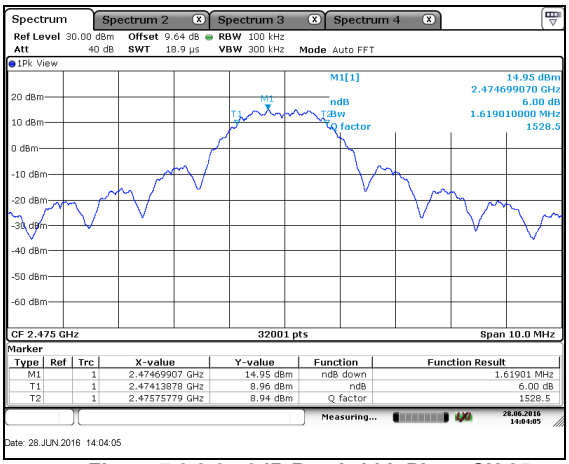

Figure 7.3.2-3: 6dB Bandwidth Plot – CH 25

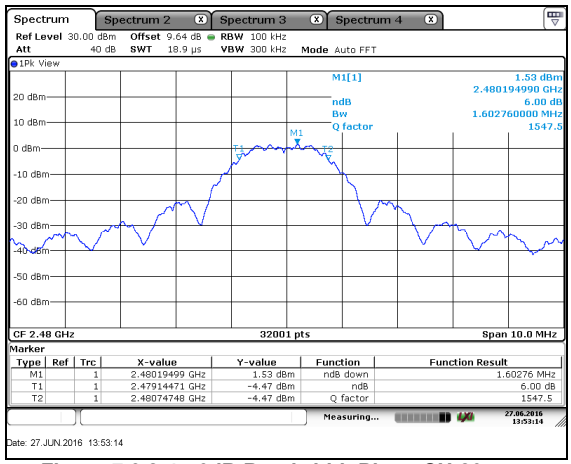

Figure 7.3.2-4: 6dB Bandwidth Plot – CH 26

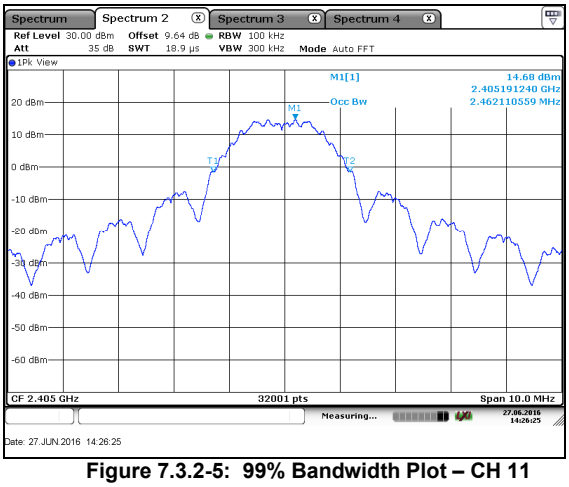

Figure 7.3.2-5: 99% Bandwidth Plot – CH 11

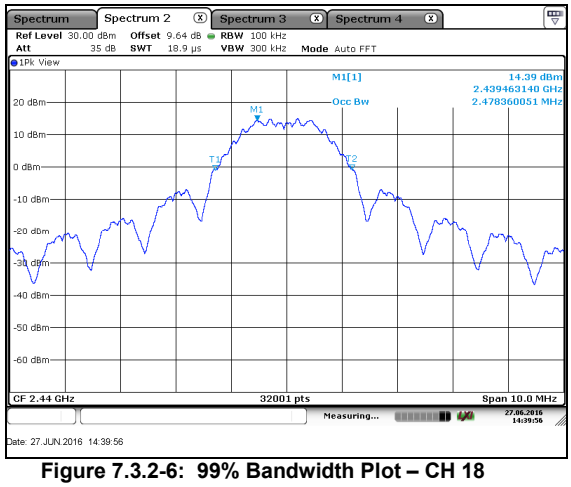

Figure 7.3.2-6: 99% Bandwidth Plot – CH 18

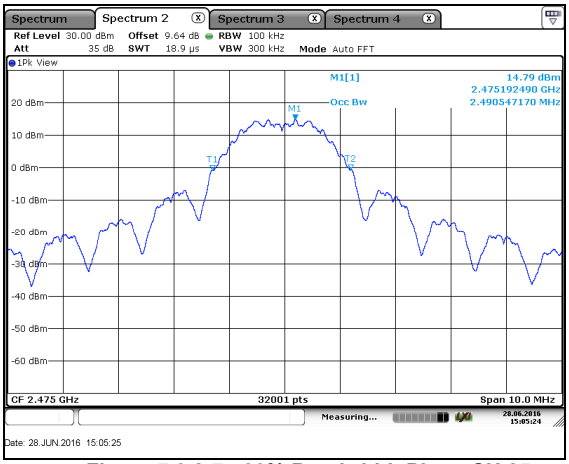

Figure 7.3.2-7: 99% Bandwidth Plot – CH 25

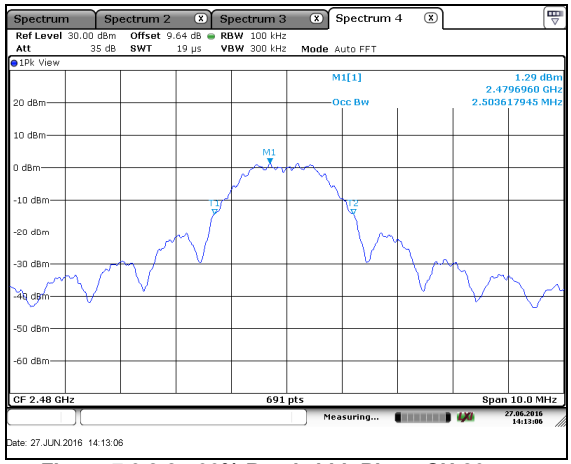

Figure 7.3.2-8: 99% Bandwidth Plot – CH 26

7.4 Fundamental Emission Output Power – FCC 15.247(b)(3), IC: RSS-247 5.4(4)

7.4.1 Measurement Procedure

The maximum conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Meas Guidance v03r04 utilizing the PKPM1 Peak power meter method. The RF output of the equipment under test was directly connected to the input of the power meter applying suitable attenuation.

7.4.2 Measurement Results

Table 7.4.2-1: Maximum Conducted Output Power

Frequency [MHz]	Level [dBm]
2405	18.64
2440	18.77
2475	18.78
2480	5.08

7.5 Emission Levels – FCC 15.247(d), 15.205, 15.209; IC RSS-247 5.5, RSS-Gen 8.9

7.5.1 Emissions into Non-restricted Frequency Bands

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 DTS Meas Guidance v03r04. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. Span was set to 1.5 times the DTS Bandwidth. The trace was set to max hold with a peak detector active. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit. The spectrum span was then adjusted for the measurement of spurious emissions from 30MHz to 25GHz, 10 times the highest fundamental frequency.

Band-edge compliance was determined using the conducted marker-delta method in which the radio frequency power that is produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

7.5.1.2 Measurement Results

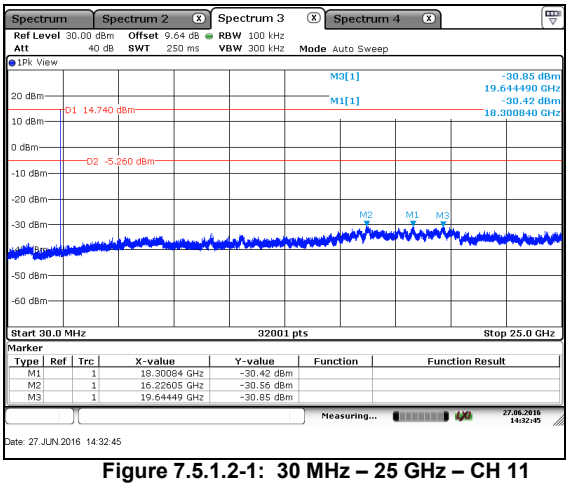

Figure 7.5.1.2-1: 30 MHz – 25 GHz – CH 11

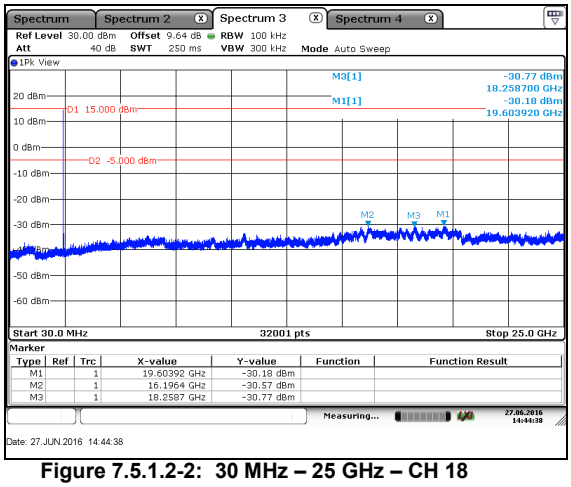

Figure 7.5.1.2-2: 30 MHz – 25 GHz – CH 18

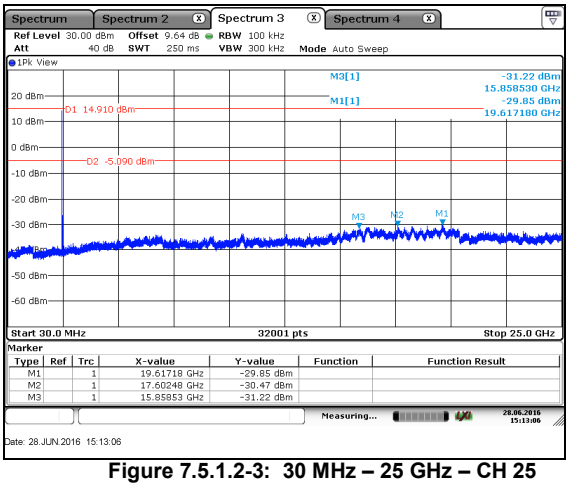

Figure 7.5.1.2-3: 30 MHz – 25 GHz – CH 25

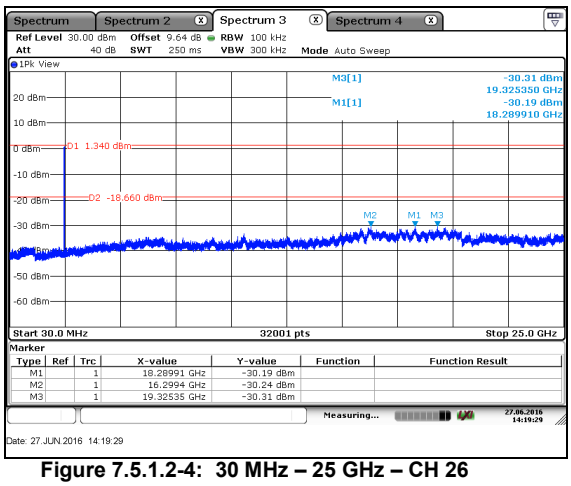

Figure 7.5.1.2-4: 30 MHz – 25 GHz – CH 26

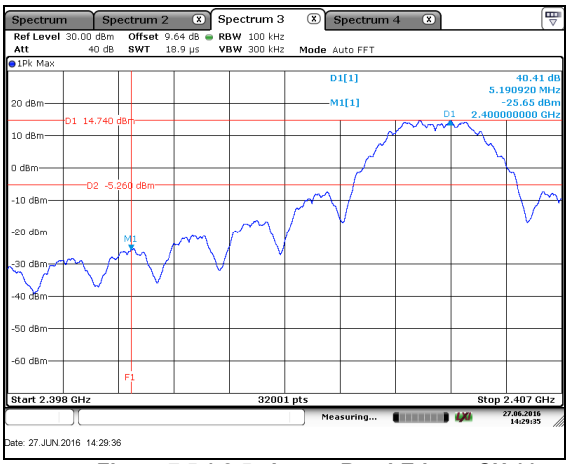

Figure 7.5.1.2-5: Lower Band-Edge – CH 11

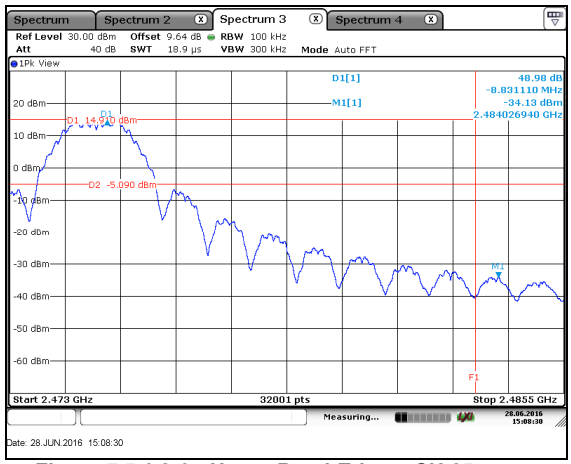

Figure 7.5.1.2-6: Upper Band-Edge – CH 25

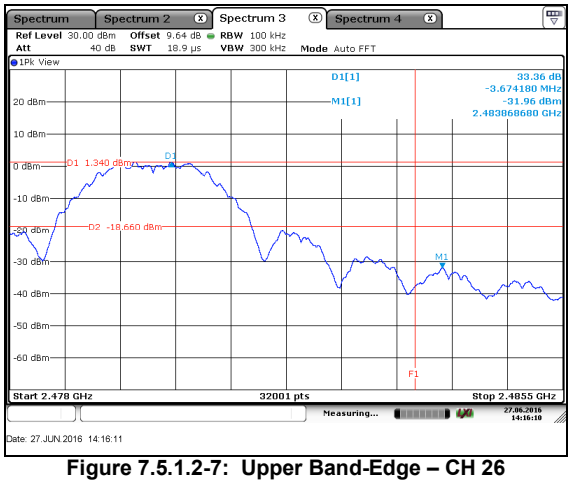

Figure 7.5.1.2-7: Upper Band-Edge – CH 26

7.5.2 Emissions into Restricted Frequency Bands – FCC 15.205, 15.209; RSS-Gen 8.9/8.10

7.5.2.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz to 25GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a RBW of 120 kHz and a VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

7.5.2.2 Duty Cycle Correction

For average radiated measurements, using a 18.48% duty cycle, the measured level was reduced by a factor 14.67dB. The duty cycle correction factor is determined using the formula: 20log (18.48/100) = -14.67dB. A detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying the application for certification.

7.5.2.3 Measurement Results

Table 7.5.2.3-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
CH 11										
2390	57.40	48.79	H	-5.38	52.02	28.74	74.0	54.0	22.0	25.3
2390	57.12	48.67	V	-5.38	51.74	28.62	74.0	54.0	22.3	25.4
4810	51.61	42.85	H	1.98	53.59	30.17	74.0	54.0	20.4	23.8
4810	52.87	43.99	V	1.98	54.85	31.31	74.0	54.0	19.1	22.7
CH 18										
4880	44.04	32.90	H	2.20	46.24	20.44	74.0	54.0	27.8	33.6
4880	52.70	44.35	V	2.20	54.90	31.89	74.0	54.0	19.1	22.1
7320	46.03	35.56	H	7.97	54.00	28.87	74.0	54.0	20.0	25.1
7320	49.02	38.76	V	7.97	56.99	32.07	74.0	54.0	17.0	21.9
12200	46.07	35.11	H	16.05	62.12	36.49	83.5	63.5	21.4	27.1
12200	47.37	35.79	V	16.05	63.42	37.17	83.5	63.5	20.1	26.4
CH 25										
2483.5	66.14	56.39	H	-4.93	61.21	36.80	74.0	54.0	12.8	17.2
2483.5	69.69	59.92	V	-4.93	64.76	40.33	74.0	54.0	9.2	13.7
CH 26										
2483.5	70.01	59.41	H	-4.93	65.08	39.82	74.0	54.0	8.9	14.2
2483.5	73.04	63.27	V	-4.93	68.11	43.68	74.0	54.0	5.9	10.3

7.5.2.4 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation: Peak

Corrected Level: 51.61 + 1.98 = 53.59dBuV/m
Margin: 74.0dBuV/m – 53.59dBuV/m = 20.4dB

Example Calculation: Average

Corrected Level: 42.85 + 1.98 - 14.67 = 30.17dBuV
Margin: 54.0dBuV – 30.17dBuV =23.8dB

7.6 Maximum Power Spectral Density in the Fundamental Emission – FCC 15.247(e) IC: RSS-247 5.2(2)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r04 utilizing the PKPSD method. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 3 kHz. The Video Bandwidth (VBW) was set to 10 kHz. Span was set to 1.5 times the occupied bandwidth. The trace was set to max hold and a peak detector was used.

7.6.2 Measurement Results

Table 7.6.2-1: Peak Power Spectral Density

Frequency (MHz)	PSD Level (dBm)
2405	3.82
2440	4.61
2475	4.48
2480	-9.17

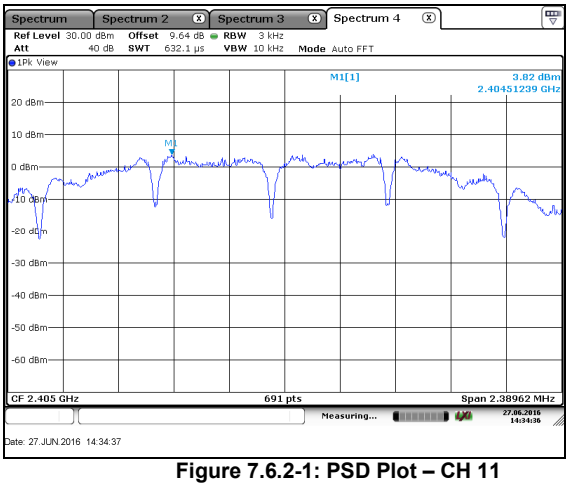

Figure 7.6.2-1: PSD Plot – CH 11

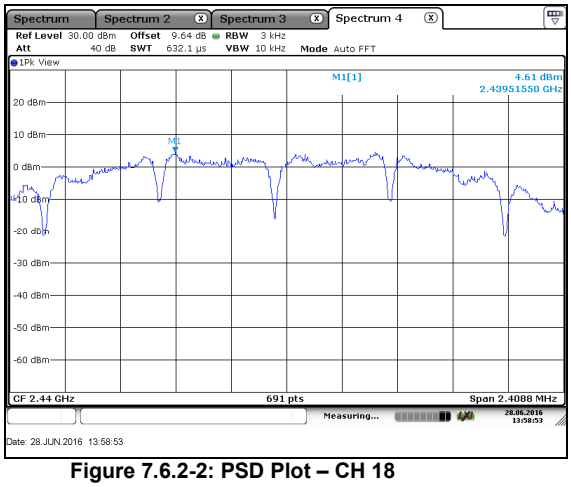

Figure 7.6.2-2: PSD Plot – CH 18

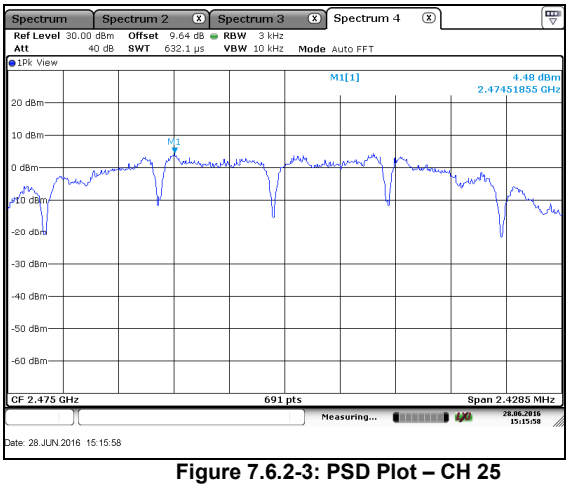

Figure 7.6.2-3: PSD Plot – CH 25

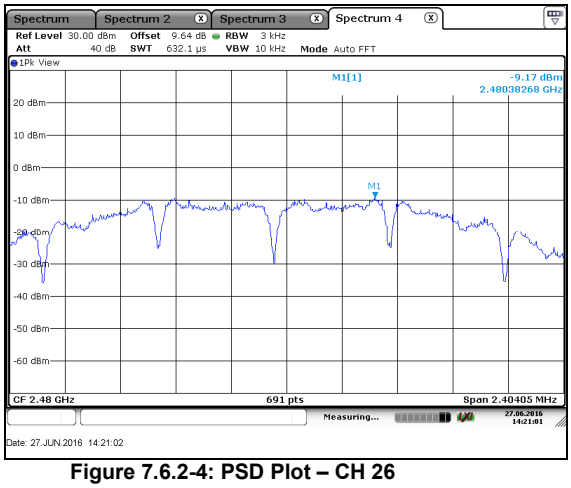

Figure 7.6.2-4: PSD Plot – CH 26

8 CONCLUSION

In the opinion of ACS, Inc. the FCL5320v02, provided by Flextronics America LLC meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-247.

END REPORT