Excellence in Compliance Testing

Certification Test Report

FCC ID: HSW-DNT2400P
ISED Canada: 4492A-DNT2400P

FCC Rule Part: 15.247
ISED Canada Radio Standards Specification: RSS-247

ACS Report Number: 16-0346.W04.1A

Manufacturer: Murata Electronics North America
Models: DNT2400PC, DNT2400PP

Test Begin Date: July 25, 2016
Test End Date: July 31, 2016

Report Issue Date: September 1, 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 16 pages

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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 ISED Canada's Radio Standards Specification RSS-247 for a Class 2 Permissive Change.

The purpose of this class II permissive change is due to a new power amplifier replacing an obsolete power amplifier. The power amplifier used on the unmodified DNT2400 was the PA2423L. This amplifier has become obsolete and replaced with the SE2433T power amplifier. Associated tuning elements, such as capacitors and inductors, have been changed to accommodate the new power amplifier.

1.2 Product description

The DNT2400 is a 2.4 GHz frequency hopping transceiver designed for use in Industrial monitoring and control markets. Basic operating parameters of the radio are:

Band of operation:	2409.33 – 2467.11 MHz
Number of hopping channels:	37
Channel spacing	1.444 MHz
Output power (maximum):	18 dBm
Over the air data rates:	38.4 Kbps, 115.2 Kbps, 200 Kbps and 500 Kbps
Modulation format:	Gaussian filtered FSK
Emission Designator:	F1D
Antennas:	9 dBi Omni, Mobile Mark Antennas, Part Number–OD9-2400 6 dBi Patch, Cirronet/RFM custom design, Part Number PA2400
RF connector:	U.FL

The DNT2400PC and DNT2400PP models are electrically identical and differ only by their mounting option. The DNT2400PC is designed for reflow soldering and the DNT2400PP is designed for socket mounting. To allow use of a test fixture during testing the DNT2400PP model was evaluated.

Manufacturer Information:
Murata Electronics North America
2200 Lake Park Drive
Smyrna, GA 30080

EUT Serial Numbers: 3

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

1.3 Test Methodology and Considerations

A test evaluation board was utilized to supply power and program the EUT for test modes. See Section 5.0 – 6.0 for additional details.

For radiated emissions, the EUT was programmed to generate a continuously modulated carrier on the lowest, middle, and highest channels. The EUT was tested in three orthogonal orientations. The worst case orientation was the Y-orientation. Both antennas were evaluated for radiated emissions. See the test setup photos for more information.

For RF Conducted emissions, the EUT was programmed to generate a continuously modulated carrier on the lowest, middle, and highest channels. The EUT was evaluated for amplitude related tests including conducted output power, conducted spurious emissions, and conducted band-edges.

Power setting during test: 36

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:

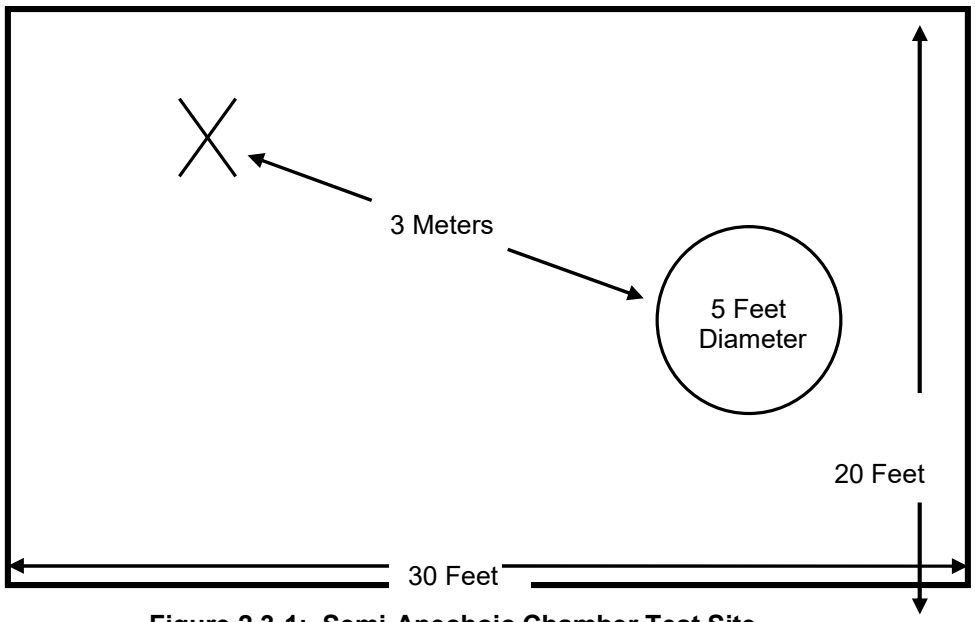

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

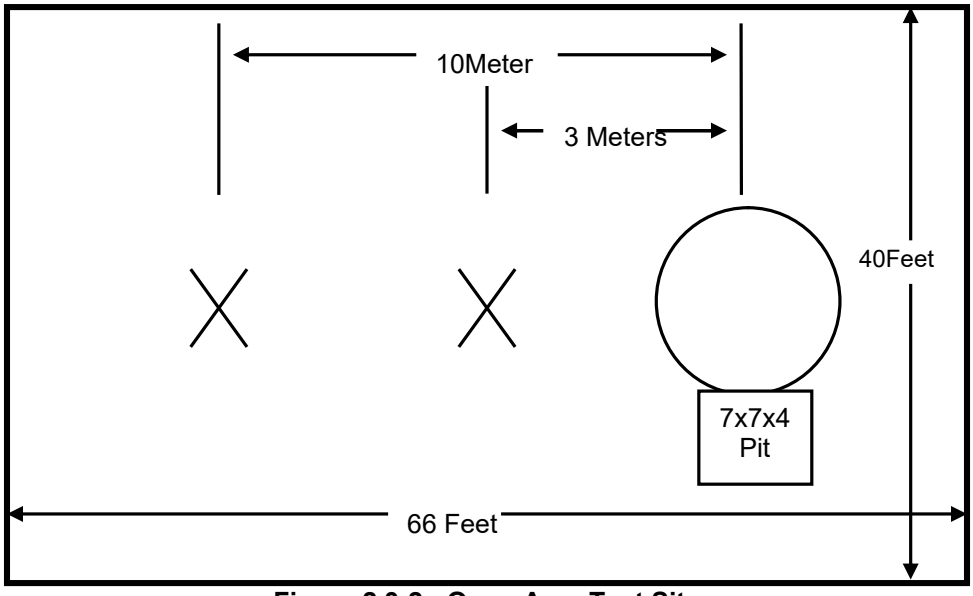

Figure 2.3-2: Open Area Test Site

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 2.4-1:

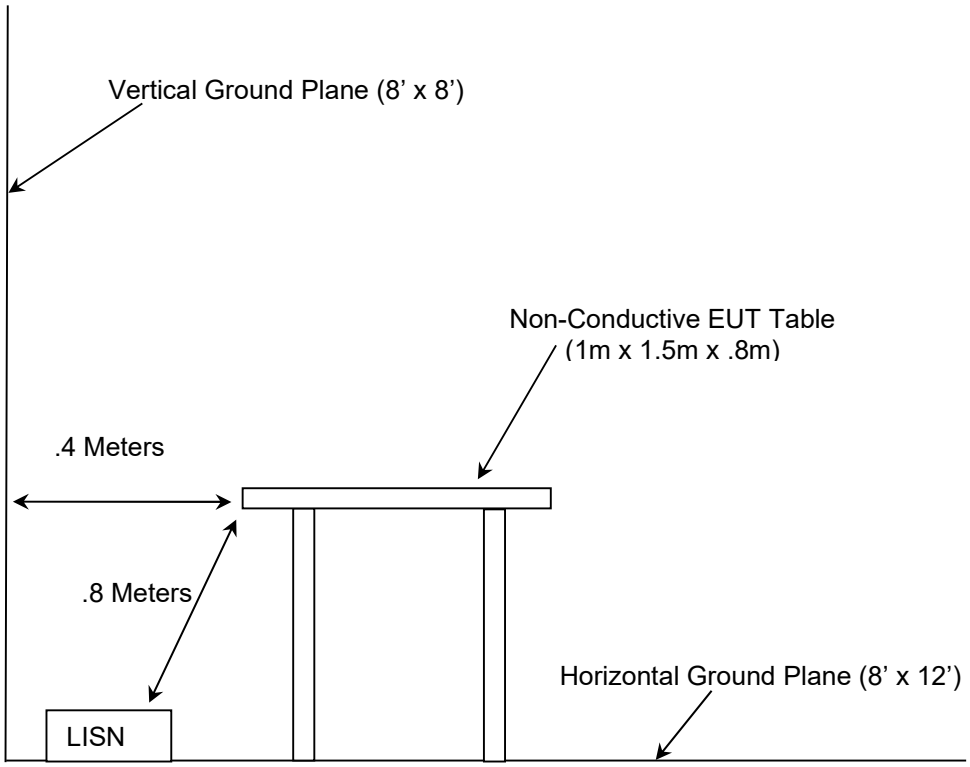

Figure 2.4-1: AC Mains Conducted EMI Site

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
- ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015.
- ISED 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
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	7/21/2016	7/21/2017
167	ACS	hamber EMI Cable S	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
338	Hewlett Packard	8449B	Amplifiers	3008A01111	8/21/2015	8/21/2017
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	7/12/2016	7/12/2017
422	Florida RF	MS-200AW-72.0-SM	Cables	805	10/30/2015	10/30/2016
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	7/15/2016	7/15/2018
676	Florida RF Labs	SMS-290AW-480.0-SMS	Cables	MFR2Y194	9/3/2015	9/3/2016
1377	EMCO	3146	Antennas	1247	5/14/2015	5/14/2017
RE112	Rohde & Schwarz	ESIB26	Receiver	836119/012	7/13/2016	7/13/2017
RE619	Rhode & Schwarz	ESU26	Spectrum Analyzers	1302.6005K26 Ser. 100190	11/5/2014	11/5/2016

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Evaluation Board	Murata	DNT900 Eval Board	Z 100268
2	Wall Wart Power Supply	Volgen	SPU10R-2	N/A

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

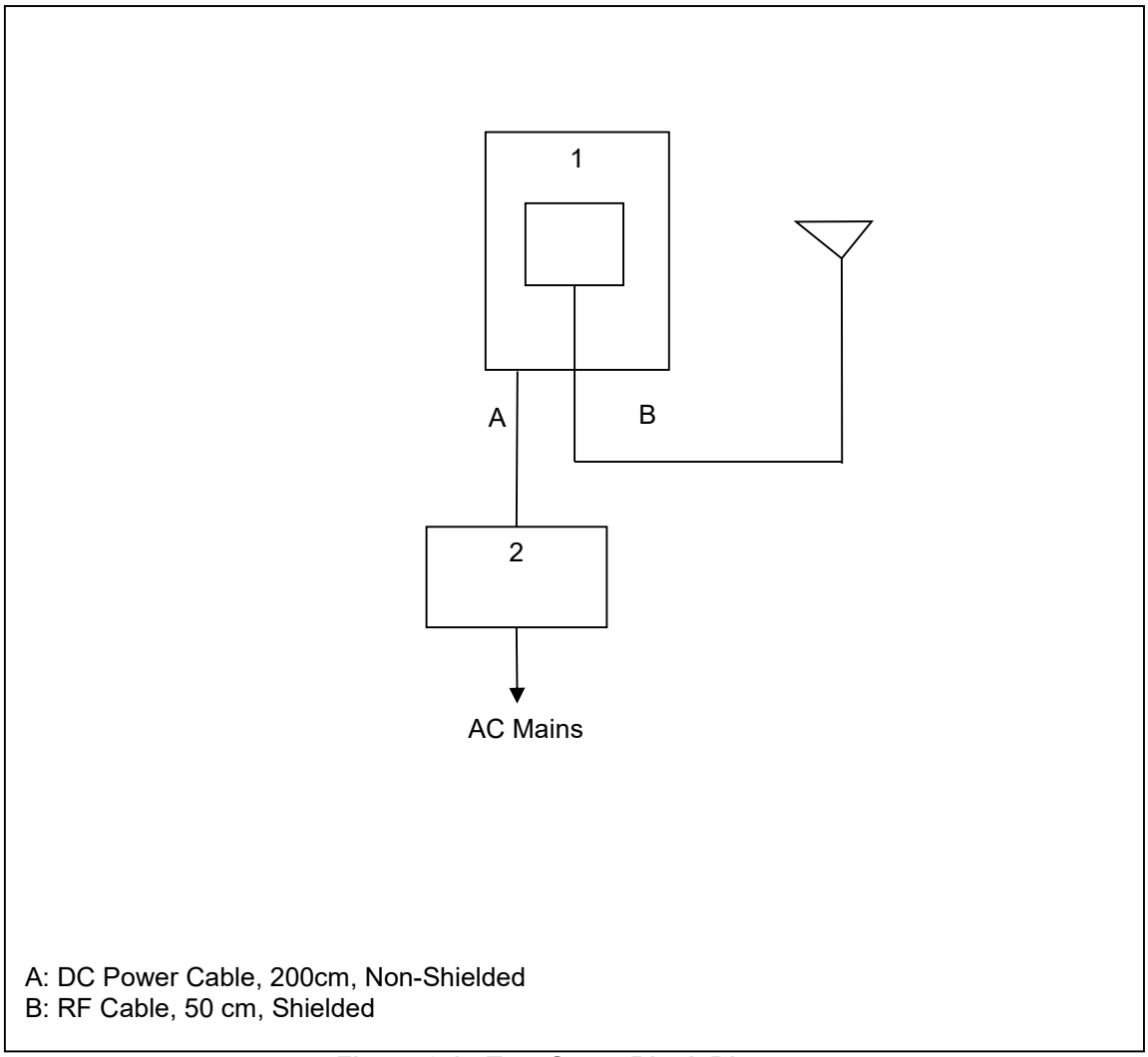

Figure 6-1: Test Setup Block Diagram

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: Section 15.203

The EUT utilizes a U.FL connector soldered directly to the PCB board, therefore satisfying the requirements of Section 15.203.

7.2 Peak Output Power - FCC 15.247(b)(1) ISED Canada: RSS-247 5.4(2)

7.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of a power meter using suitable attenuation. The device employs < 75 channels at any given time, therefore the power is limited to 0.125 Watts.

7.2.2 Measurement Results

Table 7.2.2-1: Maximum Conducted Peak Output Power

Frequency [MHz]	Level [dBm]
2409.33	17.67
2441.11	17.84
2467.11	17.82

7.3 Band-Edge Compliance and Spurious Emissions

7.3.1 Band-Edge Compliance of RF Conducted Emissions - FCC 15.247(d); ISED Canada RSS-247 5.5

7.3.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, and the VBW was set to 300 kHz.

7.3.1.2 Measurement Results

Single Channel Mode

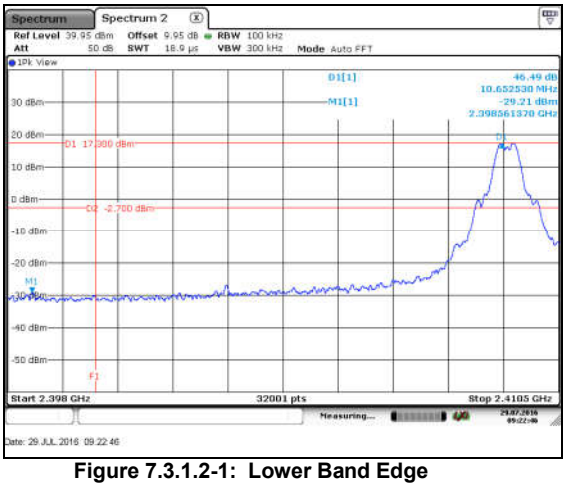

Figure 7.3.1.2-1: Lower Band Edge

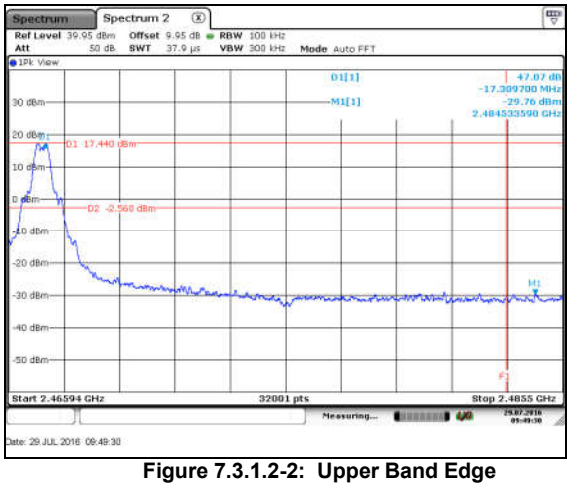

Figure 7.3.1.2-2: Upper Band Edge

Hopping Mode

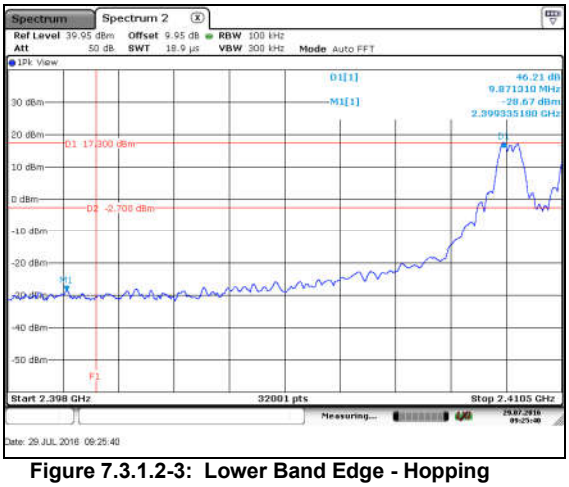

Figure 7.3.1.2-3: Lower Band Edge - Hopping

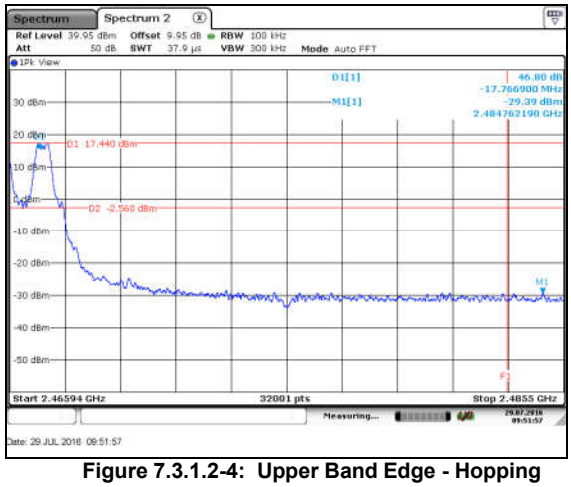

Figure 7.3.1.2-4: Upper Band Edge - Hopping

7.3.2 RF Conducted Spurious Emissions - FCC 15.247(d); ISED Canada RSS-247 5.5

7.3.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. Measurements were made at the low and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100kHz. A peak detector function was used with the trace set to max hold.

7.3.2.2 Measurement Results

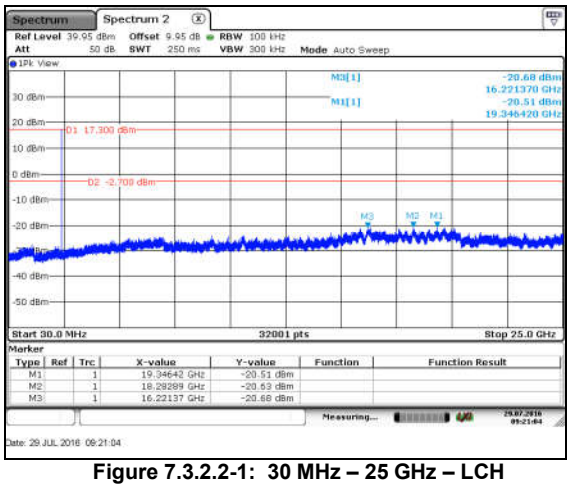

Figure 7.3.2.2-1: 30 MHz – 25 GHz – LCH

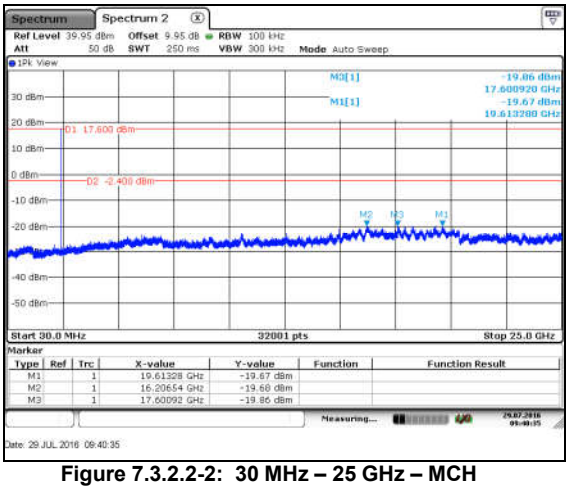

Figure 7.3.2.2-2: 30 MHz – 25 GHz – MCH

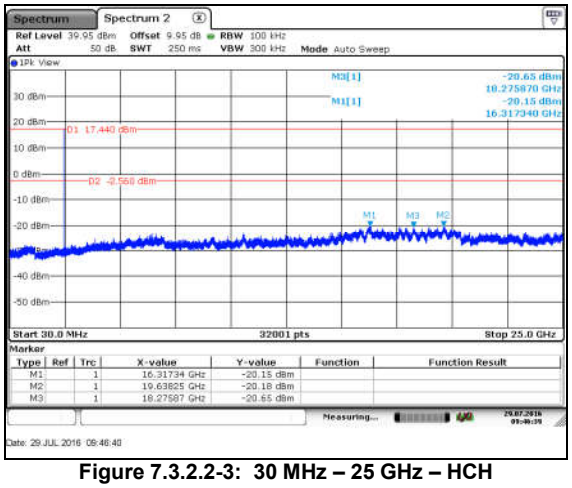

Figure 7.3.2.2-3: 30 MHz – 25 GHz – HCH

7.3.3 Radiated Spurious Emissions - FCC 15.205, 15.209; ISED Canada RSS-Gen 8.9/8.10

7.3.3.1 Measurement Procedure

Radiated emissions tests were made 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 resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3MHz respectively.

Each emission found to be in a restricted band was compared to the applicable radiated emission limits.

7.3.3.2 Measurement Results

Table 7.3.3.2-1: Radiated Spurious Emissions Tabulated Data – Dipole Antenna

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
Low Channel										
4818.66	52.87	46.12	H	1.51	54.38	47.63	74.0	54.0	19.6	6.4
4818.66	41.45	35.12	V	1.51	42.96	36.63	74.0	54.0	31.0	17.4
Mid Channel										
4882.22	50.07	41.71	H	1.70	51.77	43.41	74.0	54.0	22.2	10.6
4882.22	51.07	43.93	V	1.70	52.77	45.63	74.0	54.0	21.2	8.4
High Channel										
4934.22	49.27	39.28	H	1.86	51.13	41.14	74.0	54.0	22.9	12.9
4934.22	48.27	38.16	V	1.86	50.13	40.02	74.0	54.0	23.9	14.0

Table 7.3.3.2-2: Radiated Spurious Emissions Tabulated Data – Patch Antenna

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
Low Channel										
4818.66	54.05	47.21	H	1.51	55.56	48.72	74.0	54.0	18.4	5.3
4818.66	54.75	49.34	V	1.51	56.26	50.85	74.0	54.0	17.7	3.1
Mid Channel										
No emissions detected above the noise floor of the measurement system.										
High Channel										
No emissions detected above the noise floor of the measurement system.										

7.3.3.3 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: 52.87 + 1.51 = 54.38dBuV/m
Margin: 74dBuV/m – 54.38dBuV/m = 19.6 dB

Example Calculation: Average

Corrected Level: 46.12 + 1.51 - 0 = 47.63dBuV
Margin: 54dBuV – 47.63dBuV = 6.4 dB

8 CONCLUSION

In the opinion of ACS, Inc. the DNT2400PC and DNT2400PP, manufactured by Murata Electronics North America meet the requirements of FCC Part 15 subpart C and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-247 for the tests documented in this test report.

END REPORT