Certification Test Report

FCC ID: 2AD2U-MI001
IC: 12752A-MI001

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

TÜV SÜD Report Number: RD72135816.300

Manufacturer: DJO, LLC
Model(s): 11-4000-0-06000 and 11-4001-0-06000

Test Begin Date: February 7, 2018
Test End Date: February 12, 2018

Report Issue Date: March 1, 2018

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code AT-1921

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

Prepared by:

Jean Tezil
EMC Engineer
TÜV SÜD America, Inc.

Reviewed by:

Randle Sherian
Wireless Engineer
TÜV SÜD America, Inc.

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 Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-247 Certification.

The manufacturer has declared that the models 11-4000-0-06000 and 11-4001-0-06000 mechanically/electrically are equivalent products and only differ in orientation based on the leg for which the X4 knee brace is installed. Therefore, only the 11-4000-0-06000 was evaluated.

1.2 Product Description

The X4 knee brace is intended to provide post-operative knee support during the rehabilitation process. The Motion Intelligence platform together with X4 is intended to be used to measure and evaluate knee joint range of motion during rehabilitation and exercise in the pre-operative and post-operative phases of reconstructive knee surgery. The X4 knee brace is a body worn portable device integrating a Bluetooth Low energy transceiver, which is covered in the present document.

Technical Information:

Details	Description
Frequency Range	2402-2480
Number of Channels	80
Modulation Format	BPSK
Data Rates	1Mbps
Number of Inputs/Outputs	1T/1R
Operating Voltage	3VDC - Battery
Antenna Type / Gain	PCB Trace Antenna / 0dBi

Manufacturer Information:
DJO, LLC
1430 Decision St.
Vista, CA 92081

EUT Serial Numbers: For Conducted measurements: P201801130, For Radiated measurements: P201801124,

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

1.3 Test Methodology and Considerations

The BTLE transceiver was preconfigured by the client for power settings, low, mid, and high channels, and data rates. A test channel is selected by pressing on a button on the EUT, each button incrementing to the next preprogrammed channel, or to receive mode. The EUT was programmed to generate a continuously modulated signal on each channel investigated. This evaluation was performed using a unique modulation scheme and data rates as declared in the manufacturer provided documents supporting the present filing.

The EUT was evaluated in three orthogonal orientations to identify the worst-case configuration. The worst-case configuration was in the X-orientation.

For RF conducted measurements, the EUT was modified with an RF pipe SMA connector bypassing the antenna and providing access to the Front-end of the transceiver.

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America Inc.
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ANAB program and has been issued certificate number AT-1921 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

FCC Registered Test Site Number: 637011
ISED Canada Test Site Registration Number: 20446

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm 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 short #6 copper wire. 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 turntable. 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.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase 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:

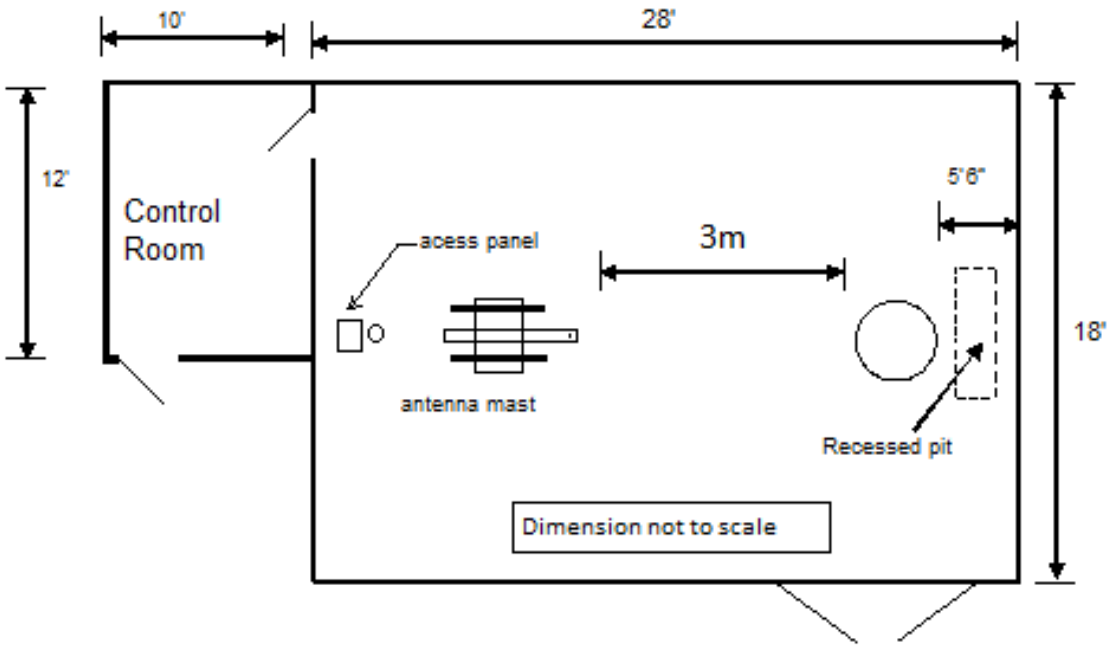

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 10' sheet galvanized steel horizontal ground reference plane (GRP) bonded every 6" to an 8' X 8' aluminum vertical ground plane.

A diagram of the room is shown below in figure 2.4-1:

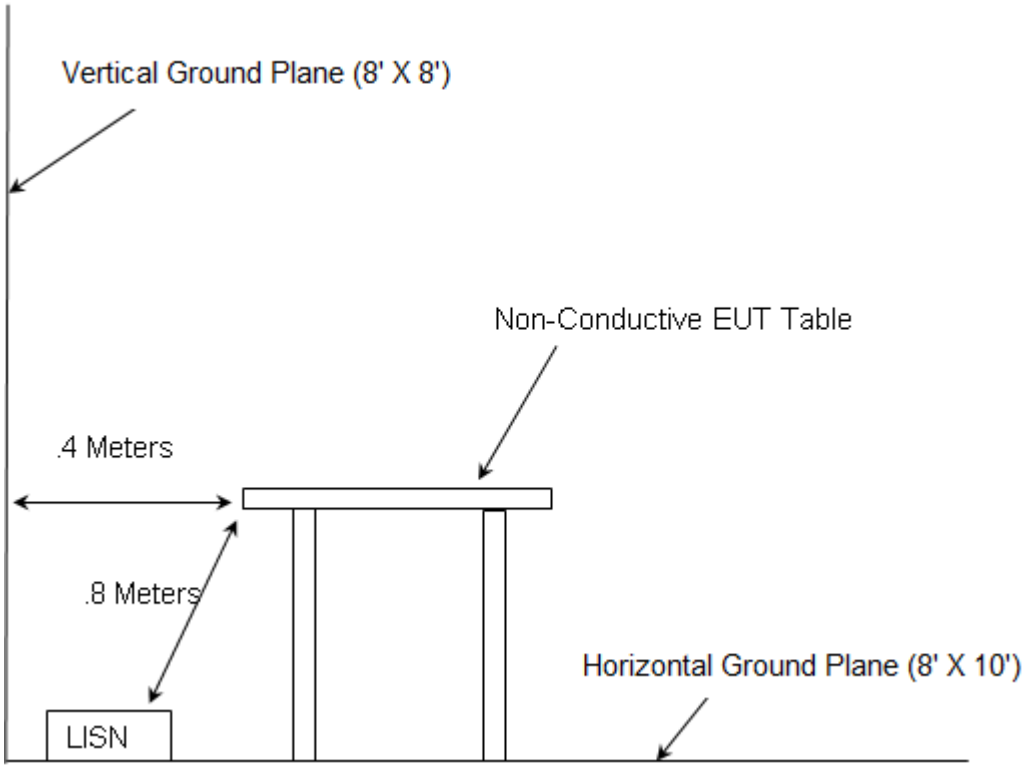

Figure 2.4-1: AC Mains Conducted EMI Site

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, 2017
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2017
- FCC KDB 558074 D01 DTS Meas Guidance v04 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 5, 2017
- 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 2, February 2017
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, 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

Asset ID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
DEMC0277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
DEMC0626	EMCO	3110B	Antennas	9411-1945	3/21/2017	3/21/2019
DEMC3002	Rohde & Schwarz	ESU40	Receiver	100346	7/24/2017	7/24/2018
DEMC3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	1/10/2018	1/10/2019
DEMC3007	Rohde & Schwarz	TS-PR26	Amplifiers	100051	1/10/2018	1/10/2019
DEMC3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
DEMC3014	EMCO	3115	Antennas	9901-5653	3/3/2017	3/3/2019
DEMC3033	Hasco, Inc.	HLL142-S1-S1-36	Cables	1435	1/9/2018	1/9/2019
DEMC3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/5/2018	1/5/2019
DEMC3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/5/2018	1/5/2019
DEMC3046	Aeroflex Inmet	26AH-10	Attenuator	1443	1/9/2018	1/19/2019
DEMC3055	Rohde & Schwarz	3005	Cables	3055	1/8/2018	1/8/2019
DEMC3057	Advanced Technical Materials	42-441-6/BR	Antennas	R110602	NCR	NCR
DEMC3059	Mountain View Cable	A	Cables	3059	1/9/2018	1/9/2019
DEMC3085	Rohde & Schwarz	FSW43	Spectrum Analyzer	103997	6/9/2017	6/9/2018

NCR = No Calibration Required
DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.
Asset 3002: Firmware Version: ESU40 is 4.73 SP4
Asset 3012: Software Version: EMC32-B is 9.15
Asset 3085: Instrument Firmware 2.90 SP1

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	DJO Global, LLC	11-4000-0-06000	See EUT Serial Numbers
2	Bench Power Supply	Sorensen	QRD20-4	2716

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power	1. 5 m	No	1 to 2

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

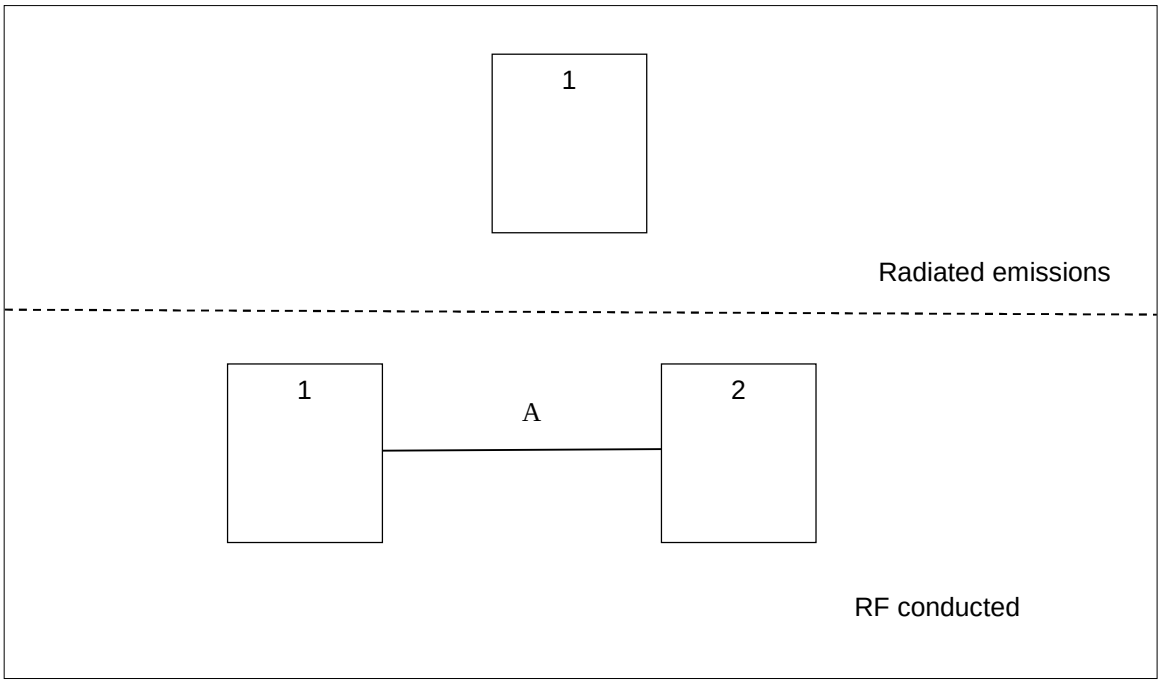

Figure 6-1: EUT Test Setup

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 EUT uses an integral antenna which cannot be modified or replaced without damaging the EUT. Therefore, the antenna requirement stated in section 15.203 is met.

7.2 Power Line Conducted Emissions – FCC: 15.207; ISED Canada: RSS-Gen 8.8

7.2.1 Measurement Procedure

Powerline Conducted Emissions testing was not performed due to this product running on battery and never connected to the public AC power supply.

7.3 6dB / 99% Bandwidth – FCC: 15.247(a)(2); ISED Canada: RSS-247 5.2(a)

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04. 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.

7.3.2 Measurement Results

Performed by: Jean Tezil

Table 7.3.2-1: 6dB / 99% Bandwidth

Frequency (MHz)	6dB Bandwidth (kHz)	99% Bandwidth (kHz)
2402	501.79	909.04
2440	514.14	926.76
2480	513.49	934.24

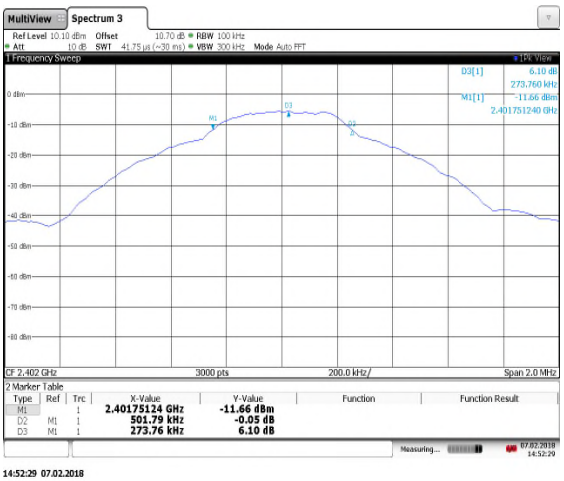

Figure 7.3.2-1: 6dB Bandwidth Low Channel

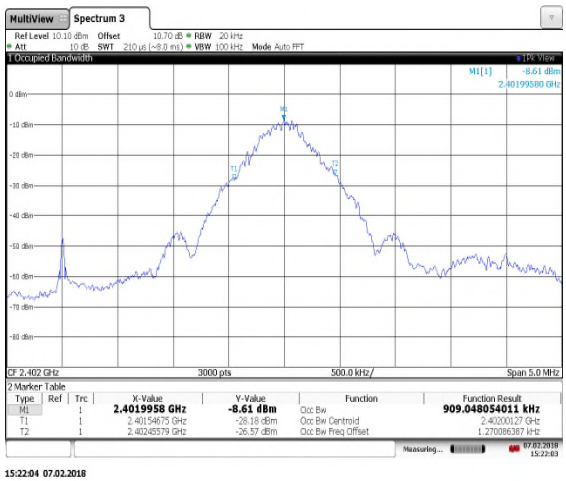

Figure 7.3.2-2: 99% Bandwidth Low Channel

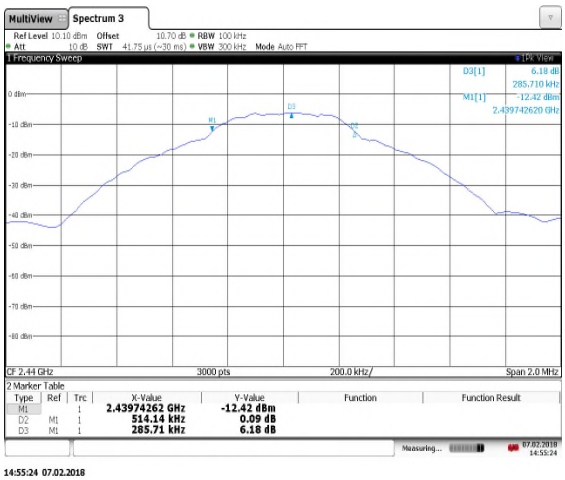

Figure 7.3.2-3: 6dB Bandwidth Mid Channel

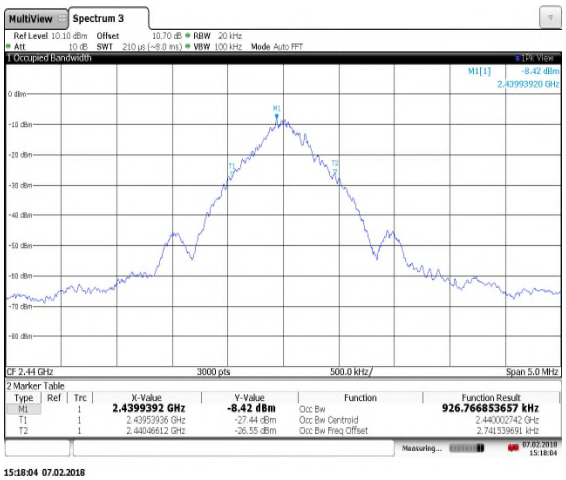

Figure 7.3.2-4: 99% Bandwidth Mid Channel

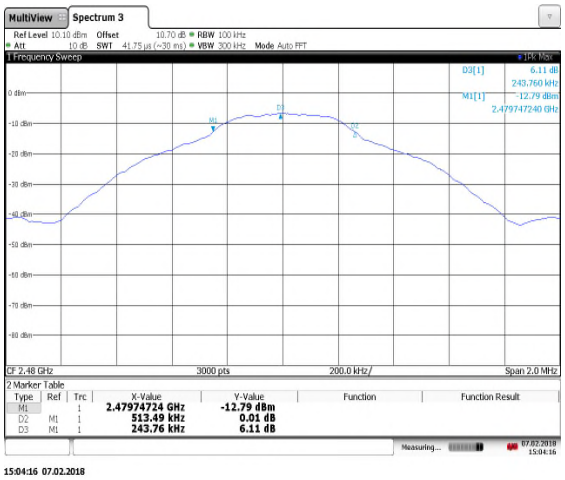

Figure 7.3.2-5: 6dB Bandwidth High Channel

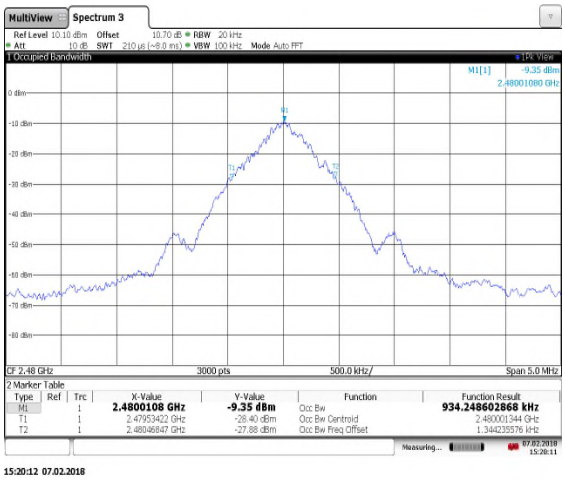

Figure 7.3.2-6: 99% Bandwidth High Channel

7.4 Fundamental Emission Output Power – FCC: 15.247(b)(3); ISED Canada: RSS-247 5.4(d)

7.4.1 Maximum peak conducted output power - Measurement Procedure

The maximum peak conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Measurement Guidance v04 utilizing the PK Peak power SA method. The RF output of the equipment under test was directly connected to the input of the peak power meter applying suitable attenuation.

7.4.2 Measurement Results

Performed by: Jean Tezil

Table 7.4.2-1: Maximum Peak Conducted Output Power

Frequency (MHz)	Output Power (dBm)
2402	-4.86
2440	-5.19
2480	-5.79

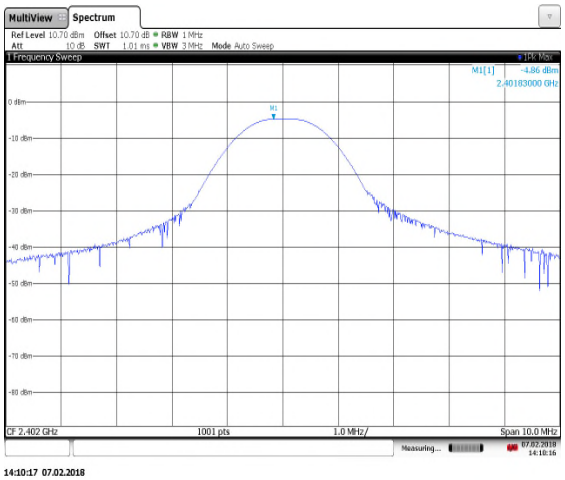

Figure 7.4.2-1: Peak Power - Low Channel

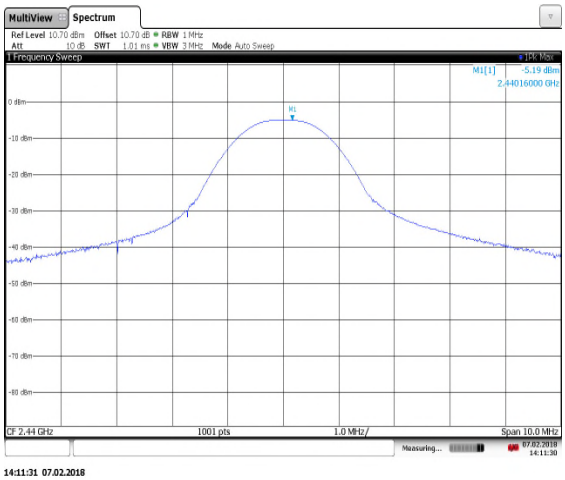

Figure 7.4.2-2: Peak Power - Mid Channel

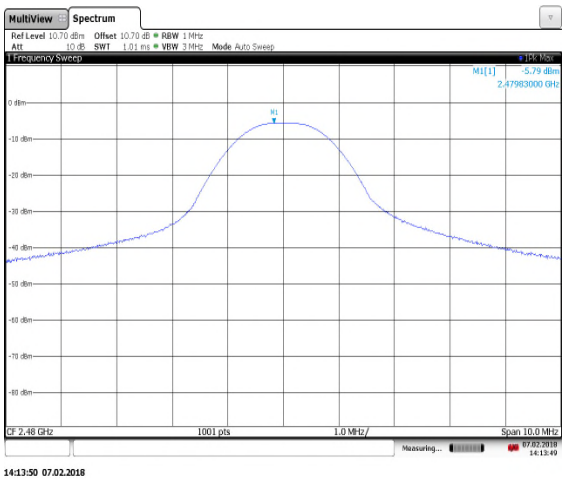

Figure 7.4.2-3: Peak Power – High Channel

7.5 Emission Levels – FCC: 15.247(d), 15.205, 15.209; ISED Canada RSS-247 5.5, RSS-Gen 8.9/8.10

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 Measurement Guidance v04. 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. 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 30 MHz 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 dBc below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

7.5.1.2 Measurement Results

Performed by: Jean Tezil

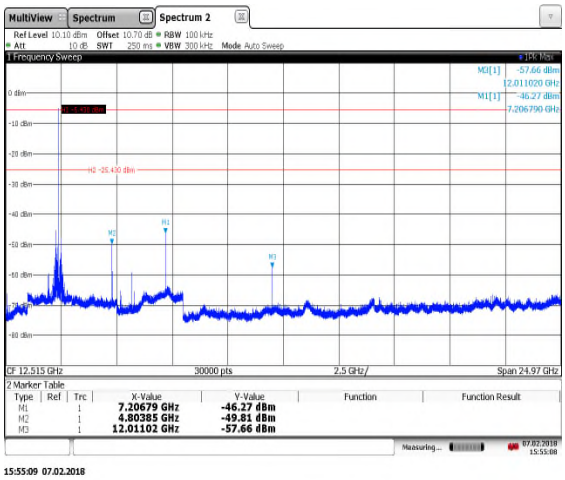

Figure 7.5.1.2-1: 30 MHz – 25 GHz – LCH

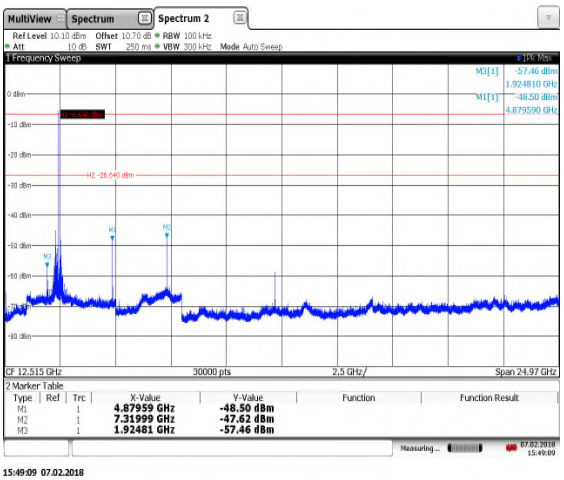

Figure 7.5.1.2-2: 30 MHz – 25 GHz – MCH

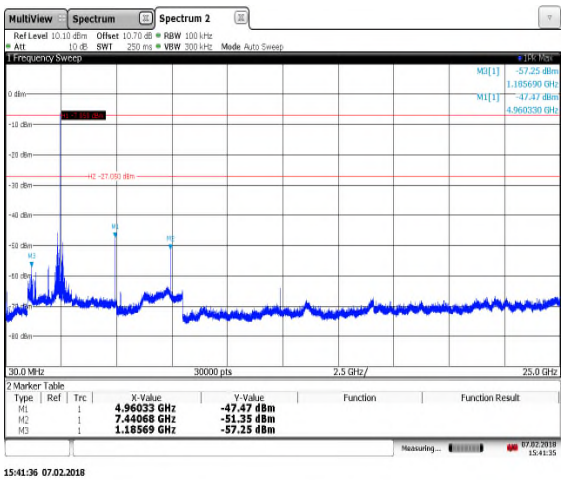

Figure 7.5.1.2-3: 30 MHz – 25 GHz – HCH

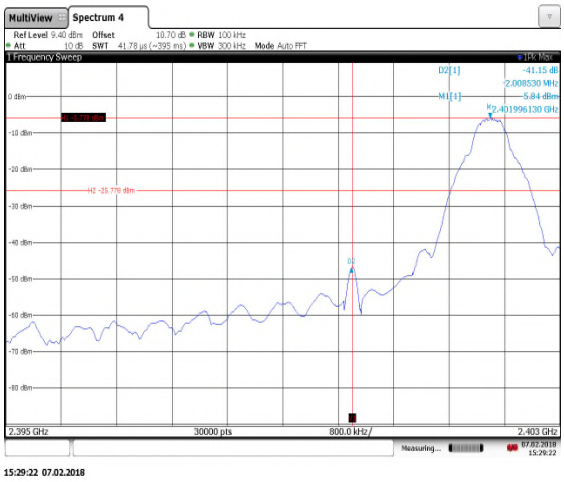

Figure 7.5.1.2-4: Lower Band-edge – LCH

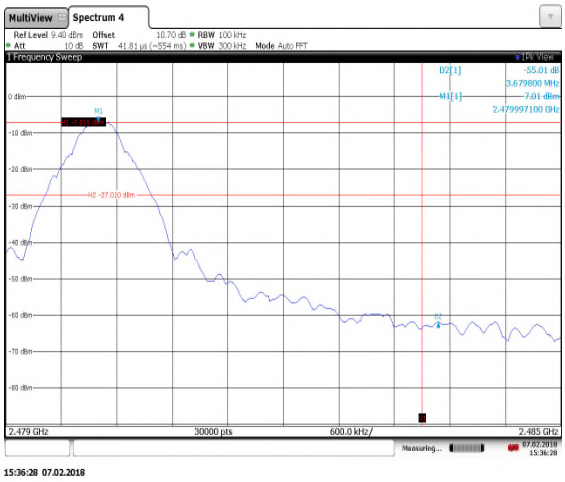

Figure 7.5.1.2-5: Upper Band-edge – HCH

7.6 Emissions into Restricted Frequency Bands

7.6.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz to 24GHz, 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.

7.6.1.1 Duty Cycle Correction

No Duty cycle was used during this evaluation.

7.6.1.2 Measurement Results

Performed by: Randy Sherian

Table 7.6.1.2-1: 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
Low Channel = 2402 MHz										
2390	38.20	24.60	H	-2.37	35.83	22.23	74.0	54.0	38.2	31.8
2390	38.20	24.60	V	-2.37	35.83	22.23	74.0	54.0	38.2	31.8
4804	46.10	41.50	H	3.78	49.88	45.28	74.0	54.0	24.1	8.7
4804	44.80	39.10	V	3.78	48.58	42.88	74.0	54.0	25.4	11.1
12010	44.40	33.50	H	12.98	57.38	46.48	74.0	54.0	16.6	7.5
12010	41.60	30.20	V	12.98	54.58	43.18	74.0	54.0	19.4	10.8
Middle Channel = 2440 MHz										
4880	44.80	39.30	H	4.10	48.90	43.40	74.0	54.0	25.1	10.6
4880	44.30	37.50	V	4.10	48.40	41.60	74.0	54.0	25.6	12.4
7320	50.00	44.80	H	8.29	58.29	53.09	74.0	54.0	15.7	0.9
7320	46.20	40.00	V	8.29	54.49	48.29	74.0	54.0	19.5	5.7
12200	43.90	33.00	H	13.20	57.10	46.20	74.0	54.0	16.9	7.8
12200	41.20	29.70	V	13.20	54.40	42.90	74.0	54.0	19.6	11.1
High Channel = 2480 MHz										
2483.5	38.70	24.20	H	-2.09	36.61	22.11	74.0	54.0	37.4	31.9
2483.5	39.40	24.20	V	-2.09	37.31	22.11	74.0	54.0	36.7	31.9
4960	45.00	39.70	H	4.43	49.43	44.13	74.0	54.0	24.6	9.9
4960	46.80	42.50	V	4.43	51.23	46.93	74.0	54.0	22.8	7.1
7440	47.80	42.30	H	8.50	56.30	50.80	74.0	54.0	17.7	3.2
7440	42.60	35.20	V	8.50	51.10	43.70	74.0	54.0	22.9	10.3
12400	42.70	32.20	H	13.43	56.13	45.63	74.0	54.0	17.9	8.4
12400	41.20	29.60	V	13.43	54.63	43.03	74.0	54.0	19.4	11.0

7.6.1.3 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: 38.2 - 2.37 = 35.83 dBuV/m
Margin: 74dBuV/m – 35.83dBuV/m = 38.17dB

Example Calculation: Average

Corrected Level: 24.6 - 2.37= 22.23dBuV
Margin: 54dBuV – 22.23dBuV = 31.77dB

7.7 Power Spectral Density – FCC: 15.247(e); ISED Canada: RSS-247 5.2(b)

7.7.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04 utilizing the PKPSD (peak PSD) 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 DTS bandwidth. The trace was set to max hold with a peak detector active.

7.7.2 Measurement Results

Performed by: Jean Tezil

Table 7.7.2-1: Peak Power Spectral Density

Frequency (MHz)	PSD Level (dBm)
2402	-15.60
2440	-15.50
2480	-15.96

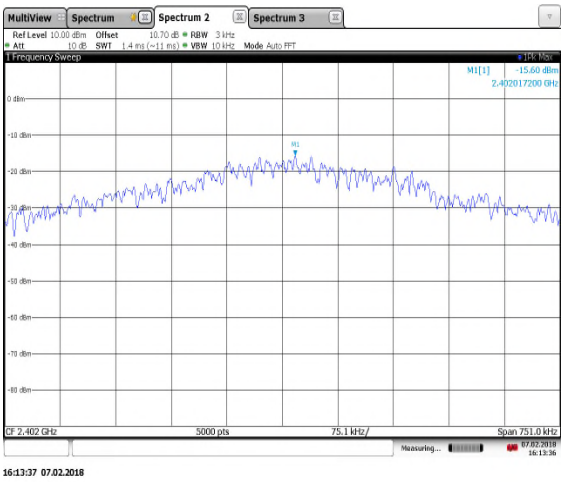

Figure 7.7.2-1: PSD Plot –LCH

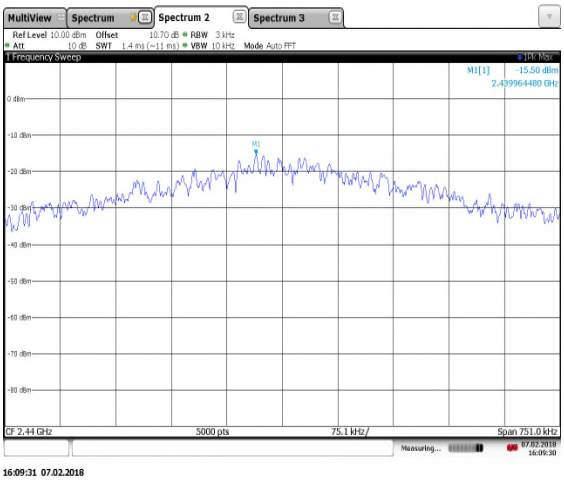

Figure 7.7.2-2: PSD Plot – MCH

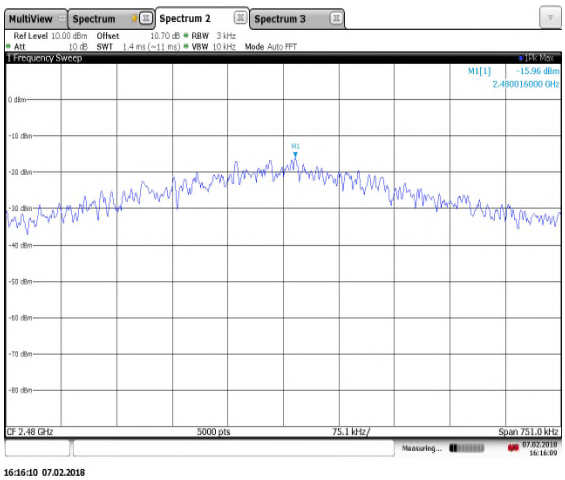

Figure 7.7.2-3: PSD Plot – HCH

8 MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

Parameter	U_{lab}
Occupied Channel Bandwidth	**± 0.004%**
RF Conducted Output Power	**± 0.689 dB**
Power Spectral Density	**±0.5 dB**
Antenna Port Conducted Emissions	**± 2.717 dB**
Radiated Emissions	**± 5.877 dB**
Temperature	**± 0.860 °C**
Radio Frequency	**±2.832 x 10-8**
AC Power Line Conducted Emissions	**±2.85**

9 CONCLUSION

In the opinion of TÜV SÜD America Inc. the 11-4000-0-06000 and 11-4001-0-06000, manufactured by DJO, LLC meets the requirements of FCC Part 15 subpart C and ISED Canada Radio Standards Specification: RSS-247 for the tests documented herein.

END REPORT