



LS RESEARCH LLC

Wireless Product Development

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ENGINEERING TEST REPORT # 312288 A

LSR Job #: C-1611

Compliance Testing of:

Cavitron PLUS Foot Pedal

Test Date(s):

May 30-31 and June 1, 4, 6, 10 2013

Prepared For:

Dentsply Professional

Attn: Kevin Lint

1301 Smile Way

York, PA 17404

This Test Report is issued under the Authority of:

Adam Alger, EMC Engineer

Signature: Date: 9-23-13

Test Report Reviewed by:

Peter Feilen, EMC Engineer

Signature: Date: 6-26-13

Report by:

Adam Alger, EMC Engineer

Signature: Date: 6-20-13

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Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
Report: TR 312288A FCCICTX	Model: DPD81861
LSR: C-1611	Serial: N/A (engineering sample)

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LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:



TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756



Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1

File Number: IC 3088-A

On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1

File Number: IC 3088



U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).

Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

Date of Validation: November 20, 2002

Notified Body Identification Number: 1243

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1.0 Summary of Test Report

In May and June 2013 the EUT footswitch was tested and MEETS the following requirements:

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC:15.247 (a)(2) IC: RSS 210 A8.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC:15.247 (d) IC: RSS 210 A8.2 (b)	Power Spectral Density of a Digital Modulation System	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
FCC : 2.1055 (d)	Frequency Stability	Yes
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Not Applicable

2.0 Test Facilities

All testing was performed at:

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted.

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3.0 Client Information

Manufacturer Name:	Dentsply Professional
Address:	1301 Smile Way York, PA 17404
Contact Person:	Kevin Lint

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	Cavitron PLUS Foot Pedal
Model Number:	DPD81861
Serial Number:	N/A (Engineering Sample)
FCC ID	TF3-DPD81861
IC Number	4681B-DPD81861

3.2 Product Description

Foot pedal used in system with base unit to control various dental tools.

3.3 Modifications Incorporated In the EUT for Compliance Purposes

Channel 15 (2480 MHz) was reduced in output power for compliance with upper band-edge restricted band (power setting 12). All other channels (0-14) are at maximum power (power setting 15).

3.4 Deviations & Exclusions from Test Specifications

None noted at time of test

3.5 Additional Information

EUT was set into test mode via a ribbon cable attached to a programming board that connected to a computer running a hyper terminal type program. Menu selections for channel, power, and continuous transmit were available.

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4.0 Conditions of Test

Environmental:

Temperature: 20-25° C
Relative Humidity: 30-60%
Atmospheric Pressure: 86-106 kPa

DC Voltage via two type AA batteries: 3.0 VDC

5.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited by A2LA to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

Frequency Range	Resolution Bandwidth
9 kHz – 150 kHz	200 Hz
150 kHz – 30 MHz	9 kHz
30 MHz – 1000 MHz	120 kHz
Above 1000 MHz	1 MHz

6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210, Issue 8 (2010), Annex 8.

If some emissions are seen to be within 3 dB of their respective limits:

As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
Report: TR 312288A FCCICTX	Model: DPD81861
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Appendix A – Test Equipment



Date: 20-Jun-2013

Type Test: Radiated and RF Conducted Emissions

Job #: C-1611

Prepared By: Adam A

Customer: Dentsply Professional

Quote #: 312288

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960156	100kHz-1GHz Analog Signal Generator	Agilent	N5181A	MY49060062	6/30/2012	6/30/2013	Active Calibration
2	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/29/2012	6/29/2013	Active Calibration
3	EE 960158	RF Preselector	Agilent	N9039A	MY46520110	6/29/2012	6/29/2013	Active Calibration
4	AA 960004	Log Periodic Antenna	EMCO	93146	9512-4276	9/17/2012	9/17/2013	Active Calibration
5	AA 960005	Biconical Antenna	EMCO	93110B	9601-2280	6/26/2012	6/26/2013	Active Calibration
6	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	2/1/2013	2/1/2014	Active Calibration
7	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/29/2013	1/29/2014	Active Calibration
8	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/28/2013	5/28/2014	Active Calibration
9	AA 960154	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-02	6/28/2012	6/28/2013	Active Calibration
10	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMC	WLA622-4 / 3160-09	123001	9/26/2012	9/26/2013	Active Calibration
11	CC 000221C	Spectrum Analyzer	HP	E4407B	US39160256	6/17/2013	6/17/2014	Active Calibration

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Appendix B – Test Data

B.1 – RF Conducted Emissions

Manufacturer	Dentsply Professional
Test Location	LS Research, LLC
Rule Part	FCC Part 15.247 / RSS-210 Annex 8
General Measurement Procedure	FCC KDB 558074 D01 DTS Meas Guidance v03r01 ANSI C63.10-2009 Section 6.7
General Description of Measurement	A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings thereby allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

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B.1.1 – RF Conducted – Fundamental Bandwidth

Manufacturer	Dentsply Professional
Date	6-6-13
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	FCC Part 15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 8.0 DTS bandwidth ANSI C63.10-2009 Section 6.9 RSS-GEN Section 4.6
Additional Description of Measurement	Peak detector used
Additional Notes	Continuous transmit modulated used for this test.

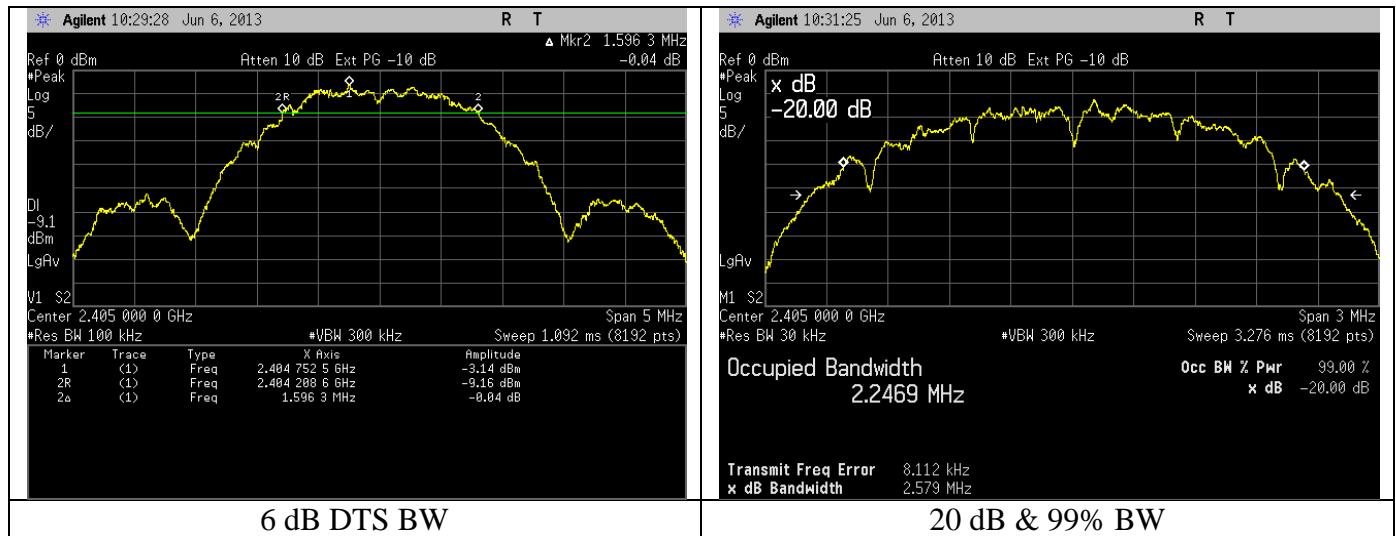
Table

Frequency (MHz)	6 dB DTS BW (MHz)	20 dB BW (MHz)	99 % BW (MHz)
2405	1.596	2.579	2.247
2440	1.595	2.586	2.256
2475	1.581	2.561	2.257
2480	1.589	2.592	2.268

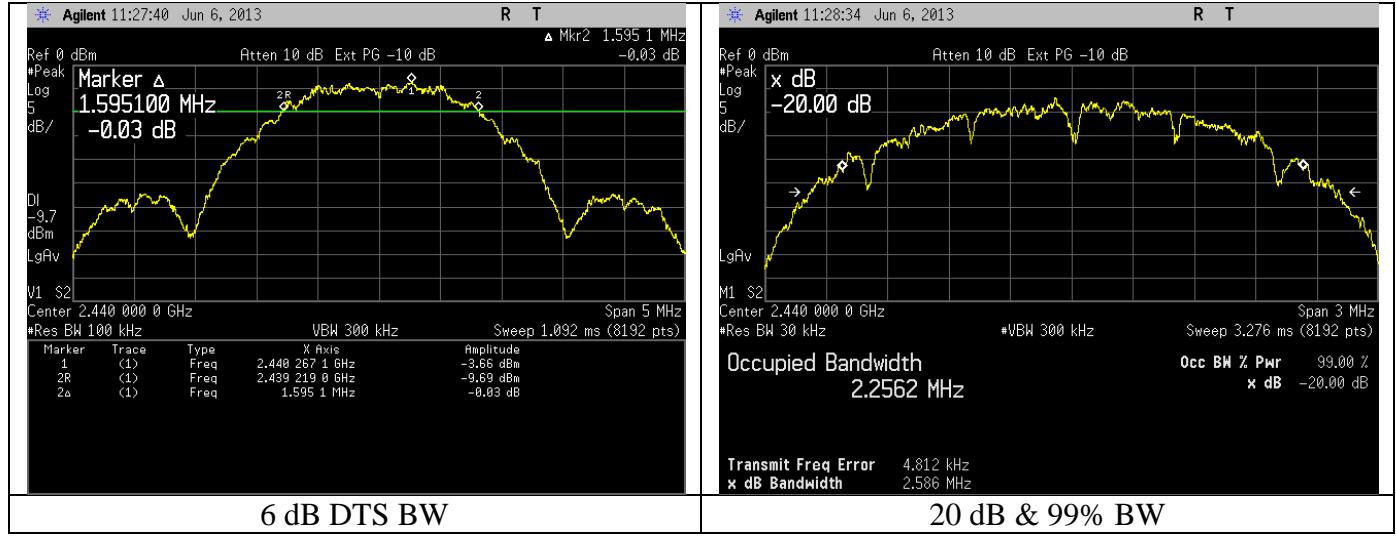
Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
Report: TR 312288A FCCICTX	Model: DPD81861
LSR: C-1611	Serial: N/A (engineering sample)

Plots

Low Channel – 2405 MHz

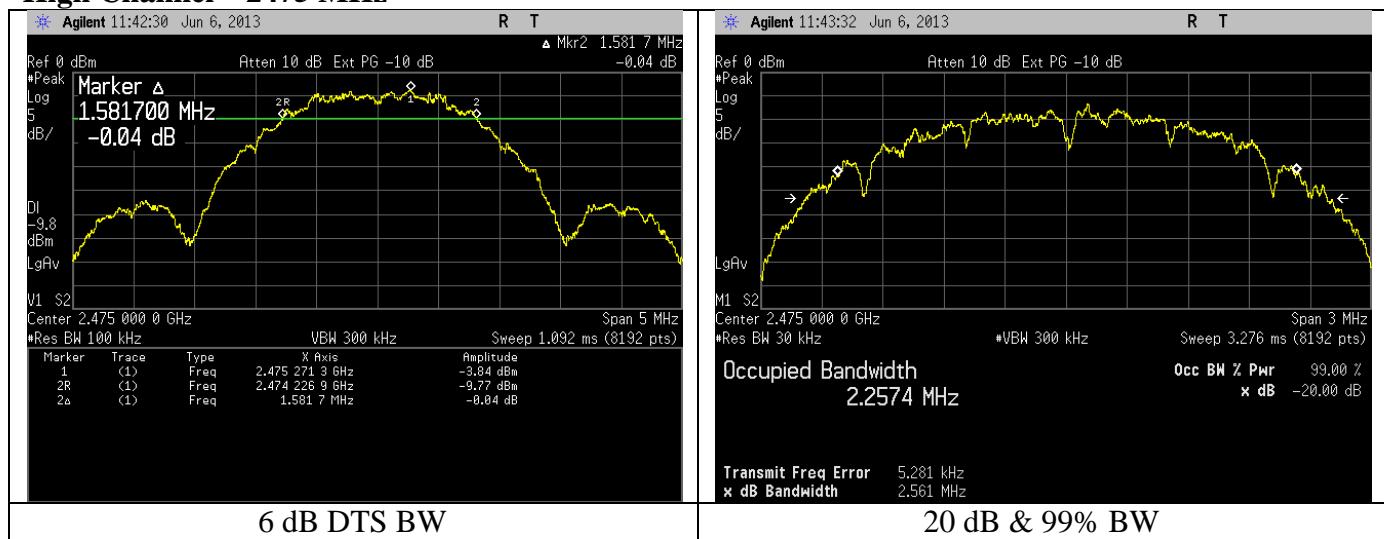


Mid Channel – 2440 MHz

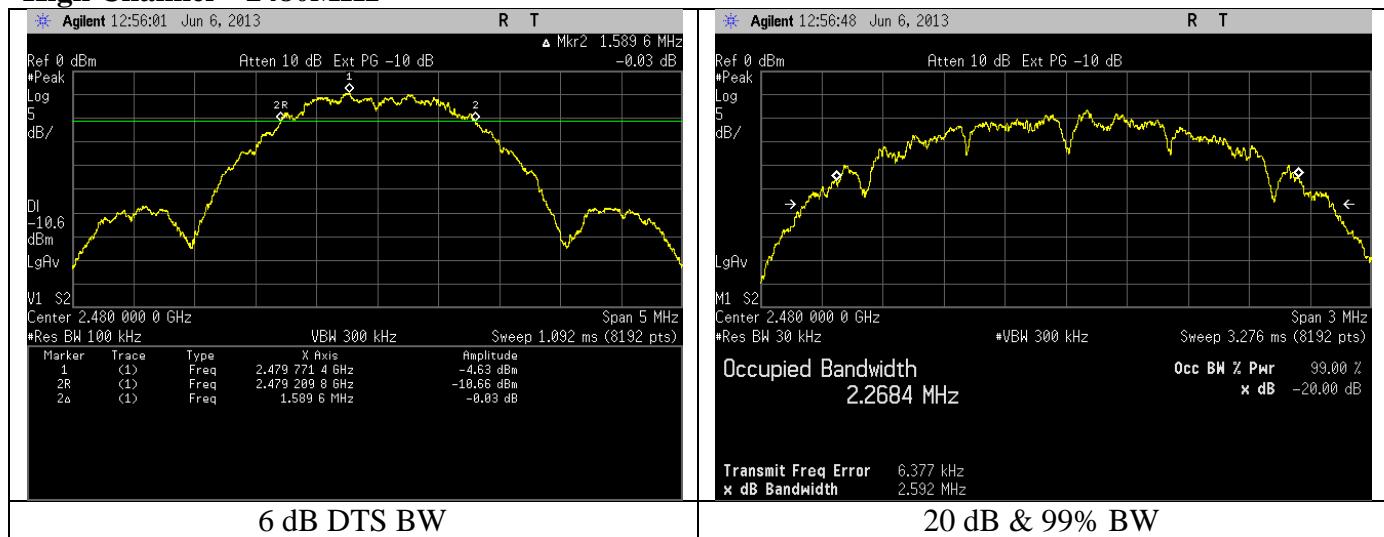


Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
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High Channel – 2475 MHz



High Channel – 2480MHz



Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
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LSR: C-1611	Serial: N/A (engineering sample)

B.1.2 – RF Conducted – Fundamental Power and Spectral Density

Manufacturer	Dentsply Professional
Date	6-6-13
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 9.1.1 – Maximum peak conducted output power FCC KDB 558074 Section 10.2 – Peak PSD
Additional Description of Measurement	3 kHz resolution bandwidth used for Peak Power Spectral Density measurement
Additional Notes	Sample Calculation: Margin (dB) = Limit – Measured level Continuous transmit modulated used for this test.

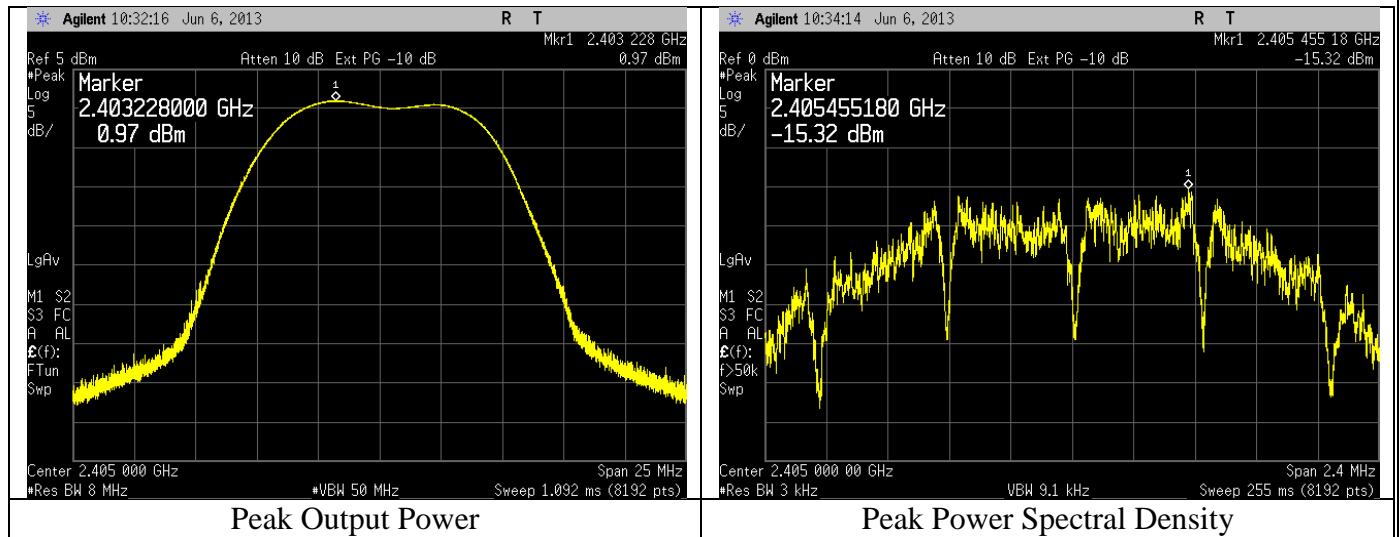
Table

Frequency (MHz)	Power (dBm)	PKPSD (dBm)	Limit (dBm)	Margin (dB)
2405	0.97	-15.32	8.00	23.32
2440	0.79	-14.74	8.00	22.74
2475	0.55	-14.60	8.00	22.60
2480	-0.67	-16.35	8.00	24.35

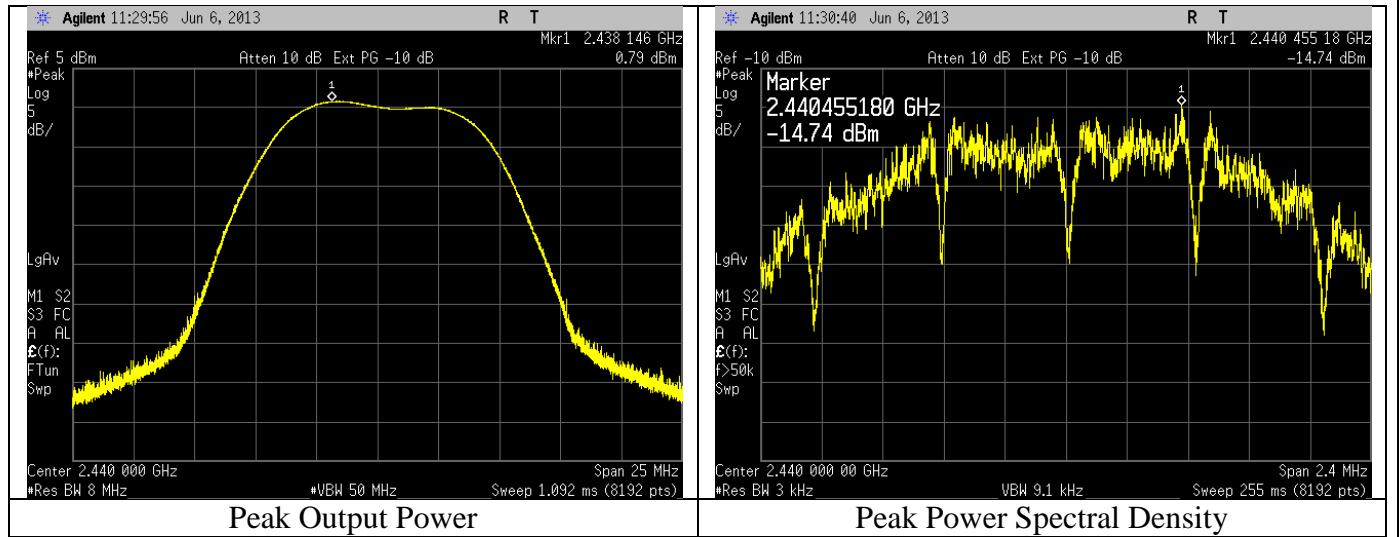
Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
Report: TR 312288A FCCICTX	Model: DPD81861
LSR: C-1611	Serial: N/A (engineering sample)

Plots

Low Channel – 2405 MHz

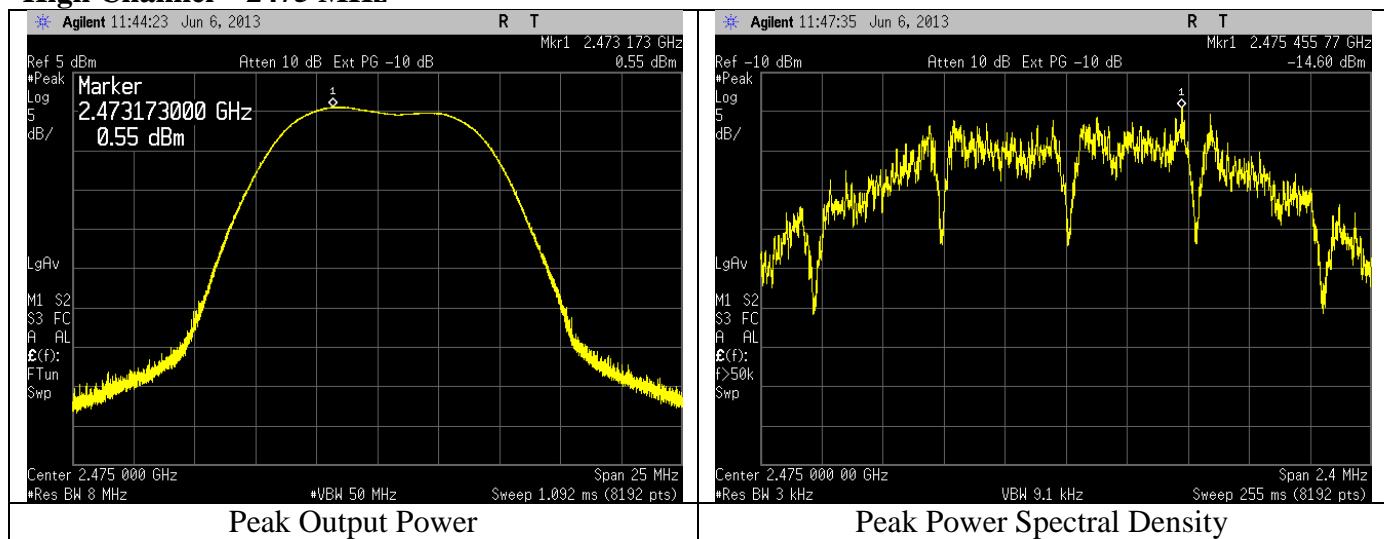


Mid Channel – 2445 MHz

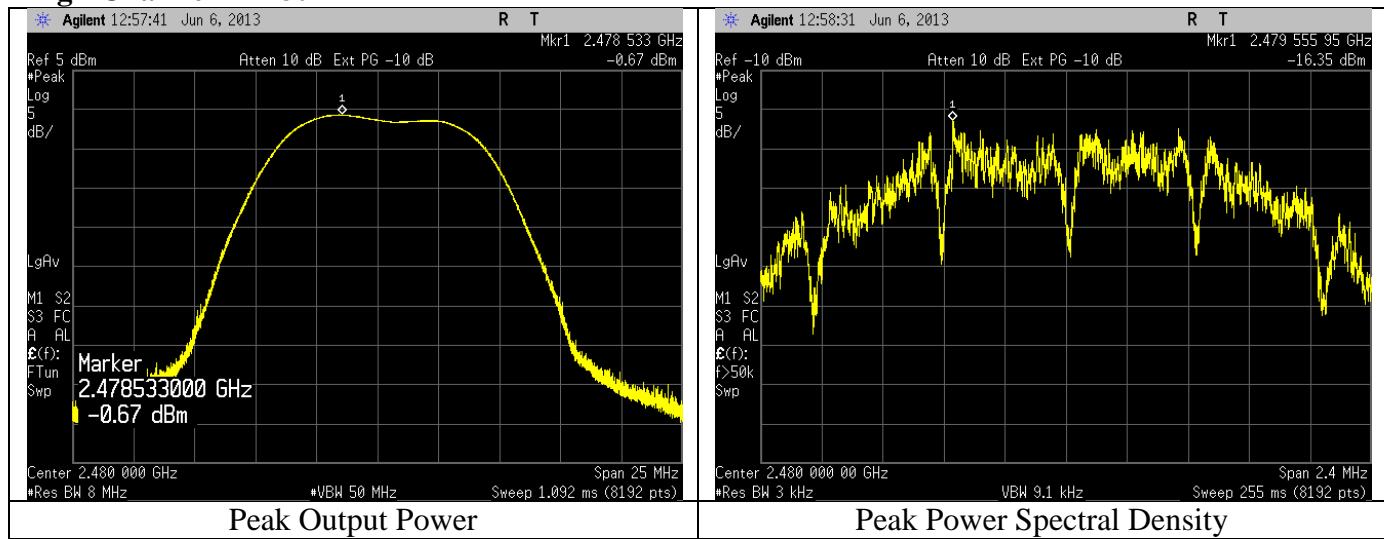


Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
Report: TR 312288A FCCICTX	Model: DPD81861
LSR: C-1611	Serial: N/A (engineering sample)

High Channel – 2475 MHz



High Channel – 2480 MHz



Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
Report: TR 312288A FCCICTX	Model: DPD81861
LSR: C-1611	Serial: N/A (engineering sample)

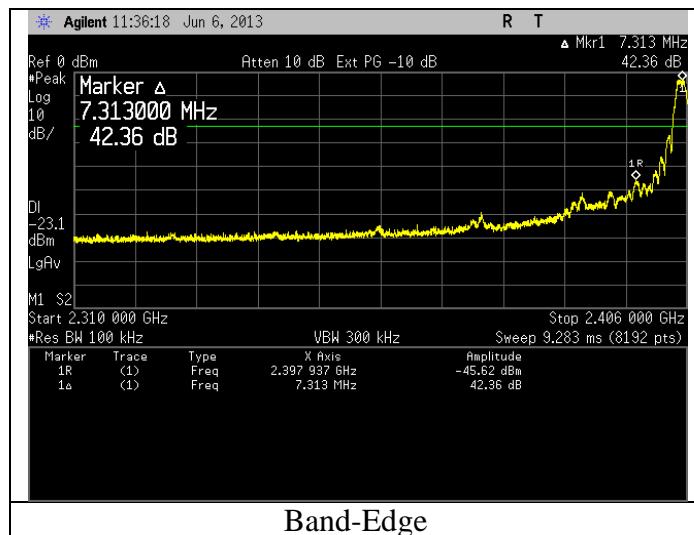
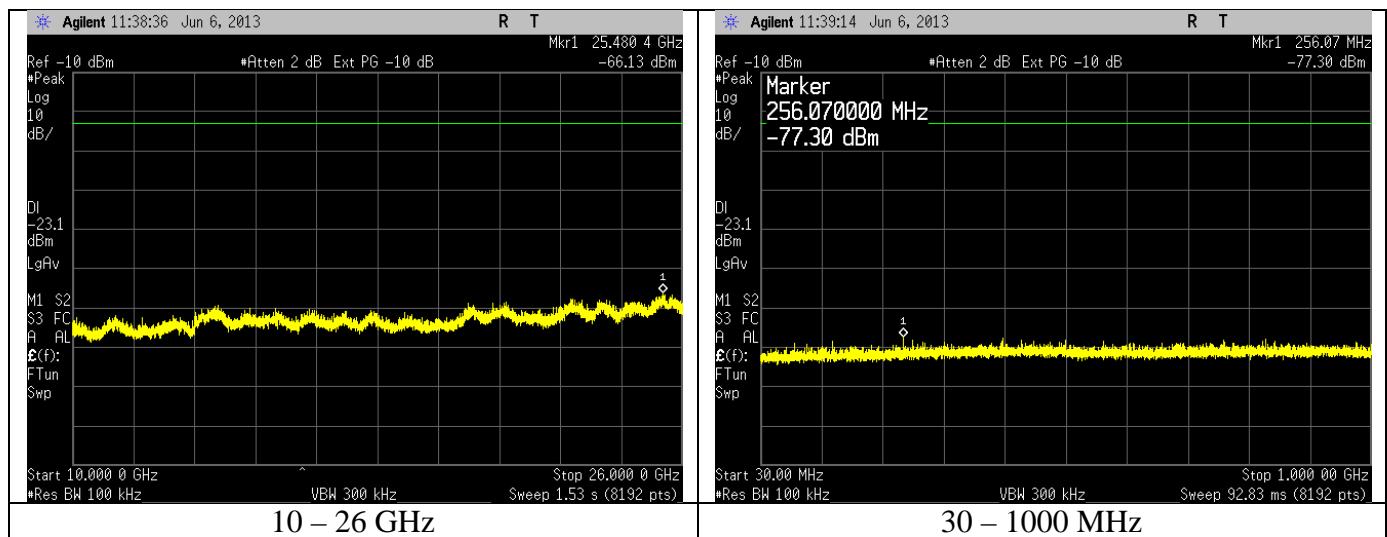
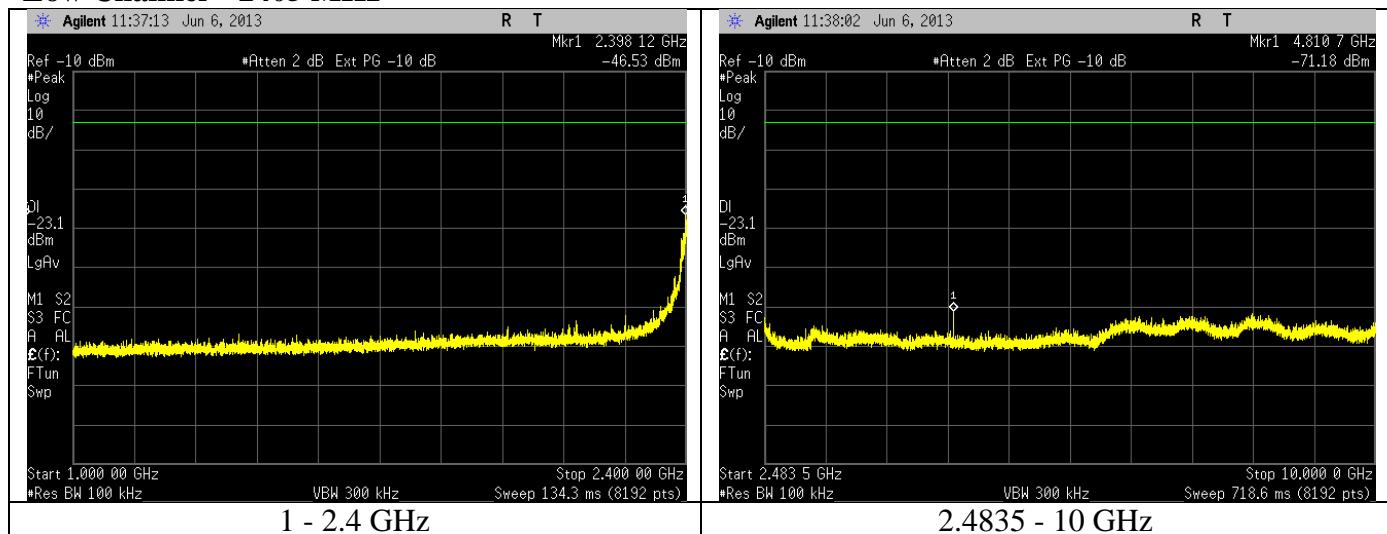
B.1.3 – RF Conducted – Fundamental Spurious

Manufacturer	Dentsply Professional
Date	6-6-13
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 11.0 – Emissions in non-restricted frequency bands
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	No Emissions found to be within 20dB of limit Continuous transmit modulated used for this test.

Plots start next page

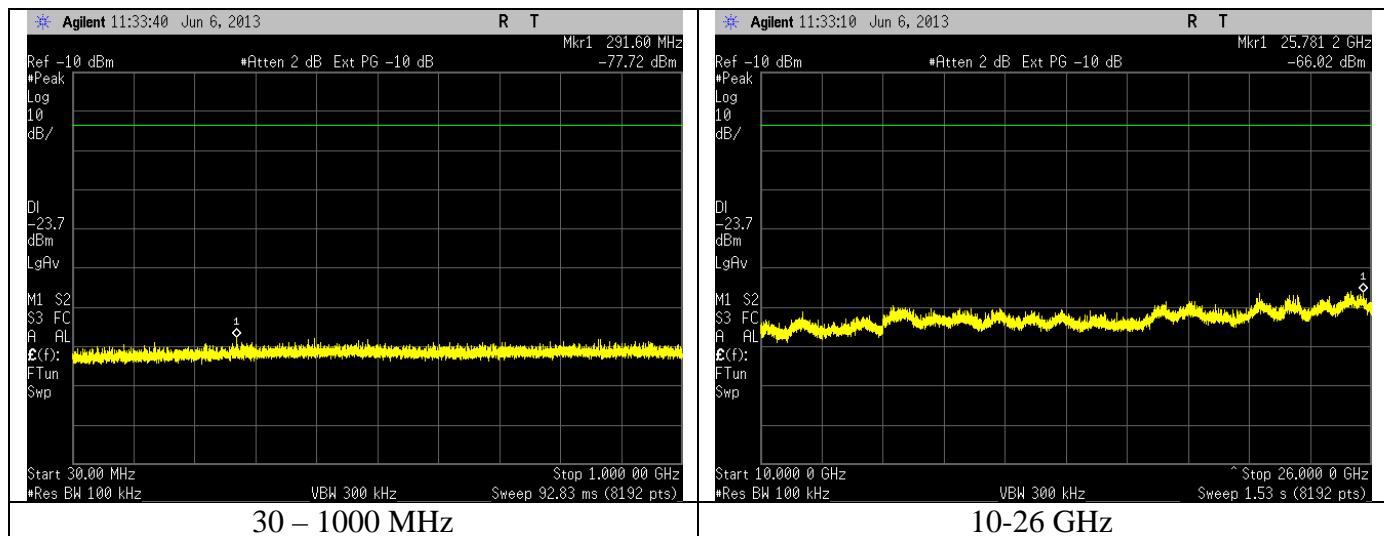
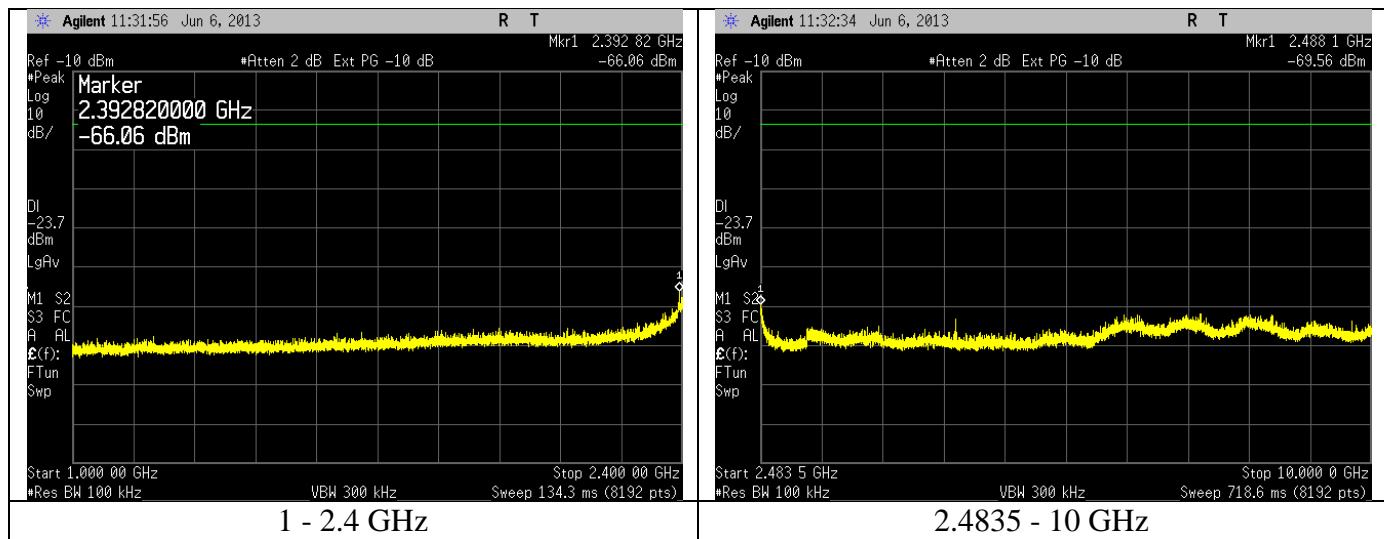
Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
Report: TR 312288A FCCICTX	Model: DPD81861
LSR: C-1611	Serial: N/A (engineering sample)

Low Channel – 2405 MHz



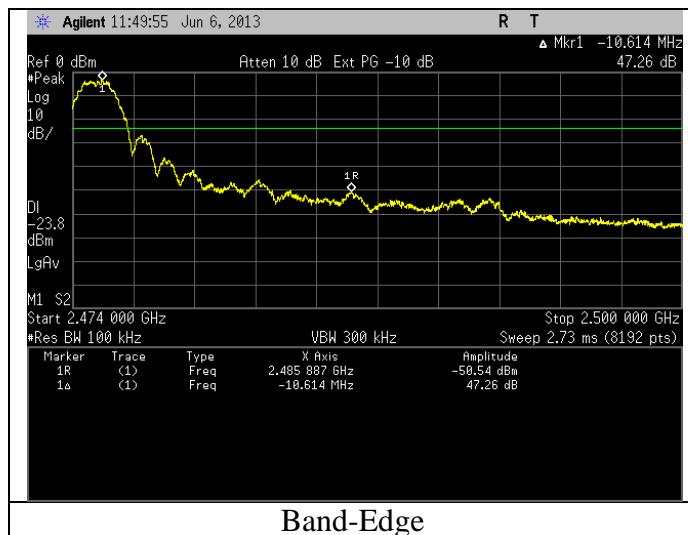
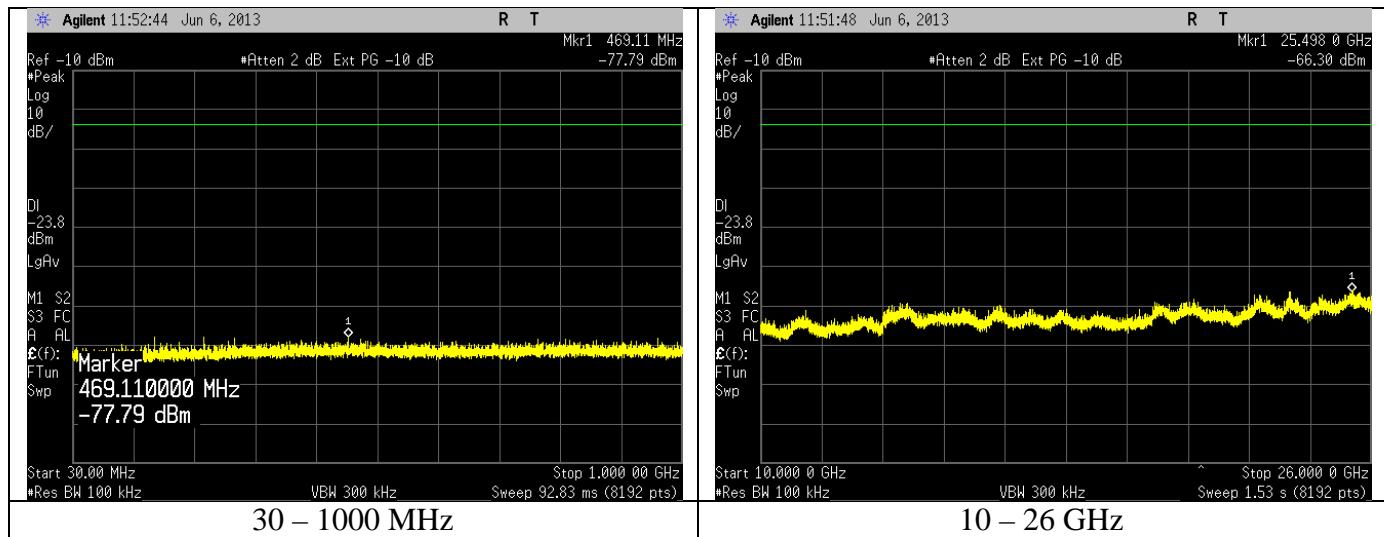
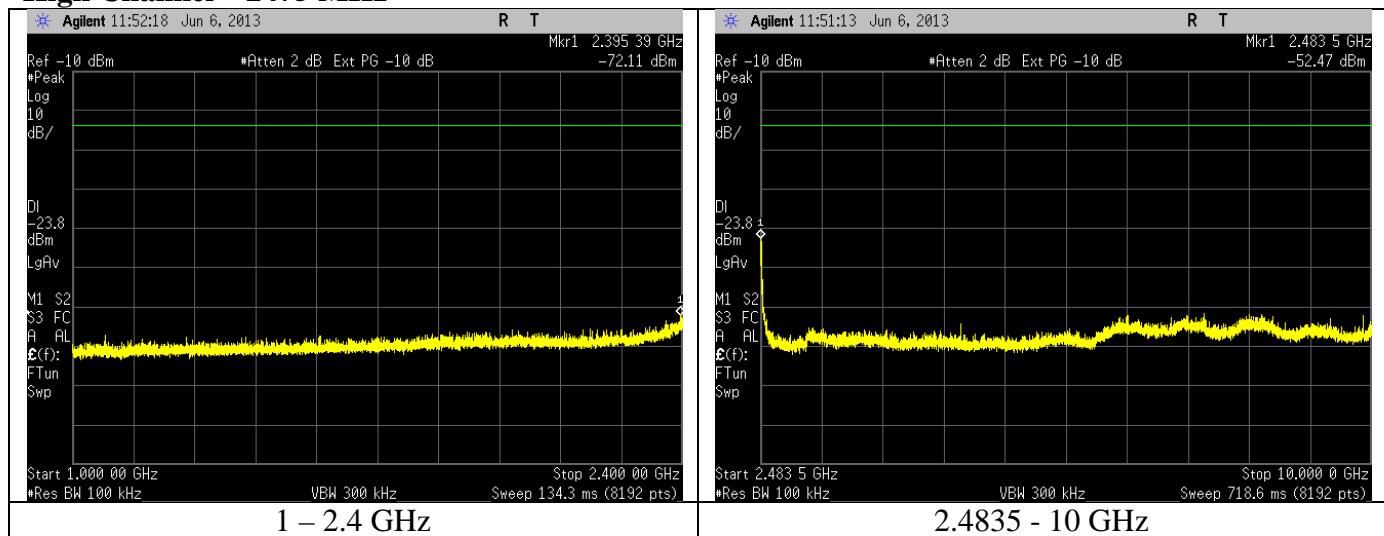
Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
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Mid Channel – 2440 MHz



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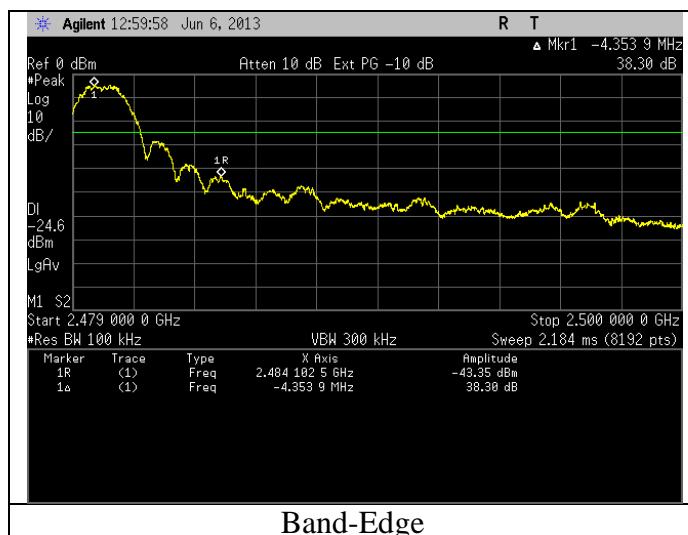
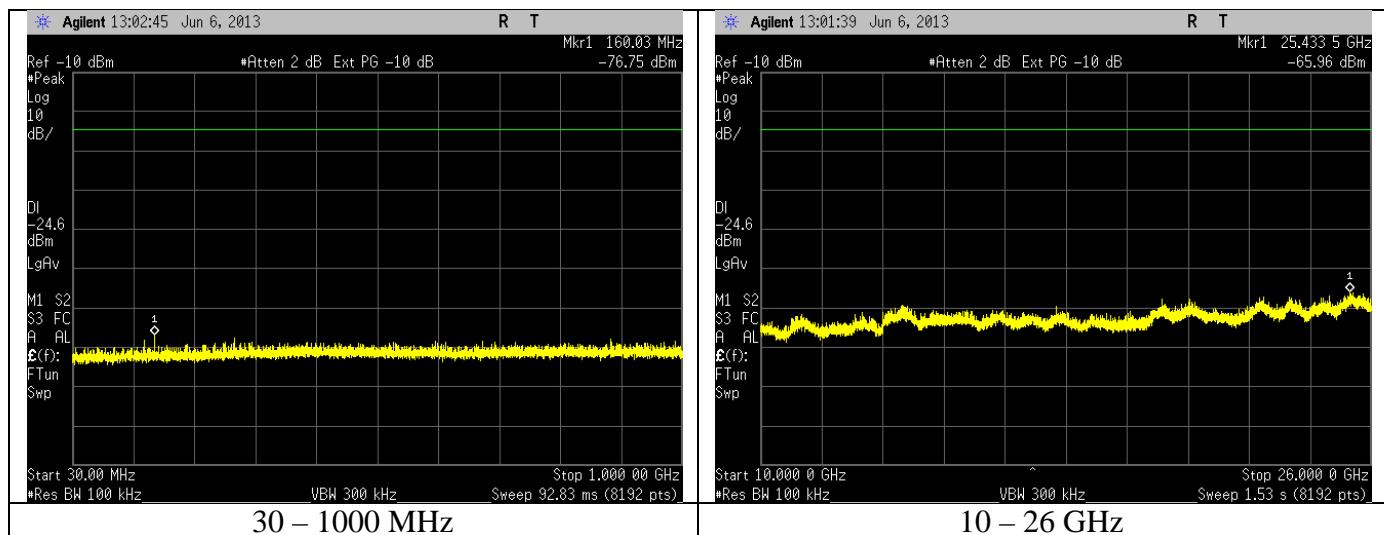
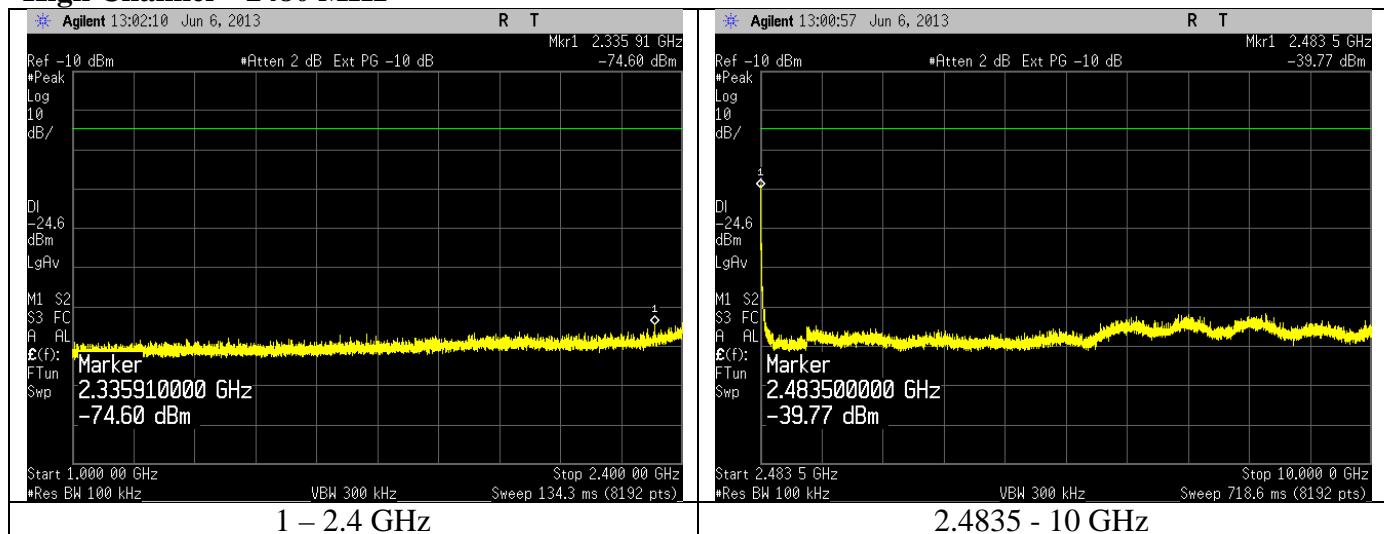
High Channel – 2475 MHz



Prepared For: Dentsply
 Report: TR 31228A FCCICTX
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Name: Cavitron PLUS Foot Pedal
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High Channel – 2480 MHz



Prepared For: Dentsply
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Model: DPD81861
Serial: N/A (engineering sample)

B.2 – Radiated Emissions

Rule Part(s)	FCC: 15.247 / 15.205 / 15.209 IC: RSS-210 A8 / RSS-210 Section 2.2					
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 – 2009 FCC KDB 558074 D01 DTS Meas Guidance v03r01					
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber					
Test Distance	See data section					
EUT Placement	80 cm height non-conductive table above reference ground plane					
Frequency Range of Measurement	Biconical: 30-300 MHz	Log Periodic Dipole Array: 300-1000 MHz	Double-Ridged Waveguide Horn: 1-18 GHz	Standard Gain Horn: 18-26GHz		
Measurement Detectors	30-1000MHz RBW: 120 kHz VBW: As specified		1 - 40 GHz: RBW : 1MHz VBW: As specified			
Description of Measurement	<ol style="list-style-type: none"> 1) The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values. 2) The EUT is placed on a non-conductive pedestal centered on a turn-table in the test location with the antenna at the test distance from the EUT 3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height. 					
Example Calculations	Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable)					

FCC Part 15.209 / IC RSS-210 Section 2.7 Limits:

Frequency (MHz)	3 m Limit (μV/m)	3 m Limit (dBμV/m)	Type
30-88	100	40.0	Quasi-Peak
88-216	150	43.5	Quasi-Peak
216-960	200	46.0	Quasi-Peak
Above 960	500	54.0	Average (>1 GHz)

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B.2.1 – Radiated Band-Edge Restricted Bands

Manufacturer	Dentsply Professional
Date	6-1-13
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 - 2009 FCC KDB 558074
Test Distance	3 meter (1-4 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1MHz VBW 3 MHz (10Hz VBW for average measurements)
Additional Notes	<ol style="list-style-type: none"> 1) Tested in the worst case of continuous transmit modulated mode with EUT in its intended orientation at maximum power. 2) EUT maximized in azimuth and antenna height with maximum results reported. 3) Channel 15 (2480 MHz) reduced power setting for compliance with upper band-edge.

Example Calculation:

FCC 15.209 Peak Limit @ 3 meter (dB μ V/m) – Peak Reading (dB μ V/m) = Peak Margin

Calculated Average (dB μ V/m) = Peak Reading (dB μ V/m) – Duty Cycle Correction (dB)

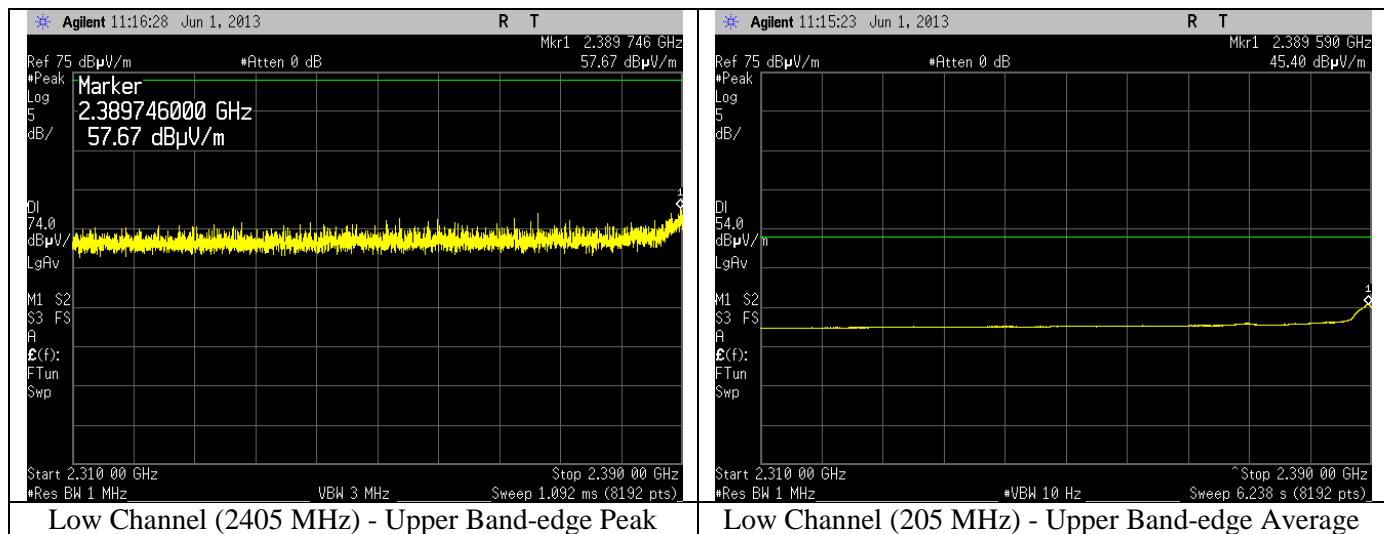
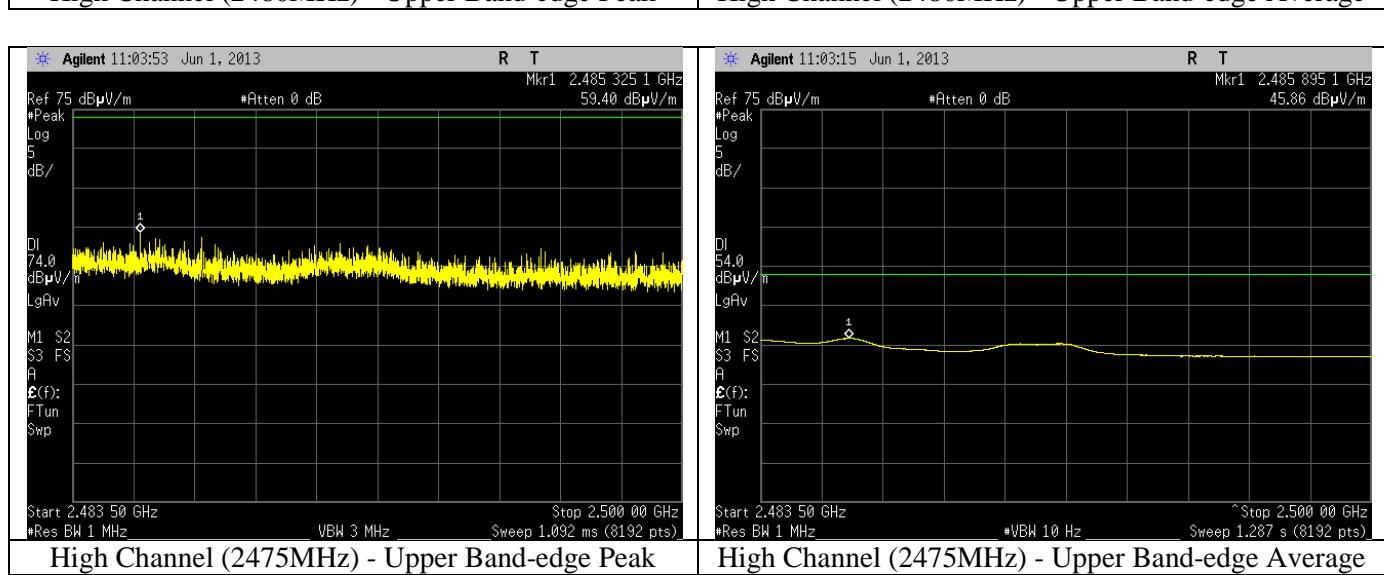
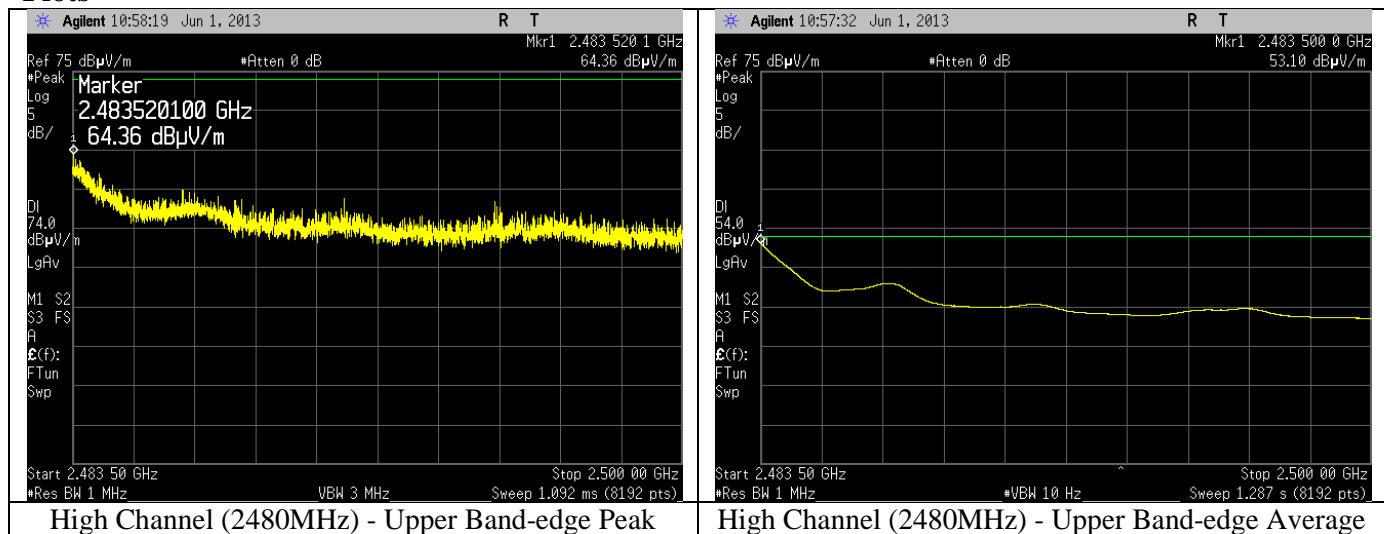
FCC 15.209 Average Limit @ 3 meter (dB μ V/m) – Calculated Average (dB μ V/m) = Average Margin

Data Table

Channel (MHz)	Peak Emission (dB μ V/m)	Peak Limit (dB μ V/m)	Peak Margin (dB)	Average Emission (dB μ V/m)	Average Limit (dB μ V/m)	Average Margin (dB)	Power Setting
2405	57.67	74.00	16.33	45.40	54.00	8.60	15
2475	59.40	74.00	14.60	45.86	54.00	8.14	15
2480	64.36	74.00	9.64	53.10	54.00	0.90	12

Prepared For: Dentsply	Name: Cavitron PLUS Foot Pedal
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Plots



Low Channel (2405 MHz) - Upper Band-edge Peak

Low Channel (205 MHz) - Upper Band-edge Average

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B.2.1 – Radiated Harmonics in Restricted Bands

Manufacturer	Dentsply Professional
Date	6-4, 6-10 2013
Operator	Mike H / Peter F
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 - 2009
Test Distance	1 meter 4-26 GHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1 MHz
Additional Notes	<ol style="list-style-type: none"> 1) Tested in continuous transmit modulated mode with EUT in its intended orientation at maximum power channels 0, 7, 14 and channel 15 at reduced power. 2) Maximum results reported. 3) Tested at 1 meter test distance so a distance correction factor of 9.5 added to 3 meter limit

Example Calculation:

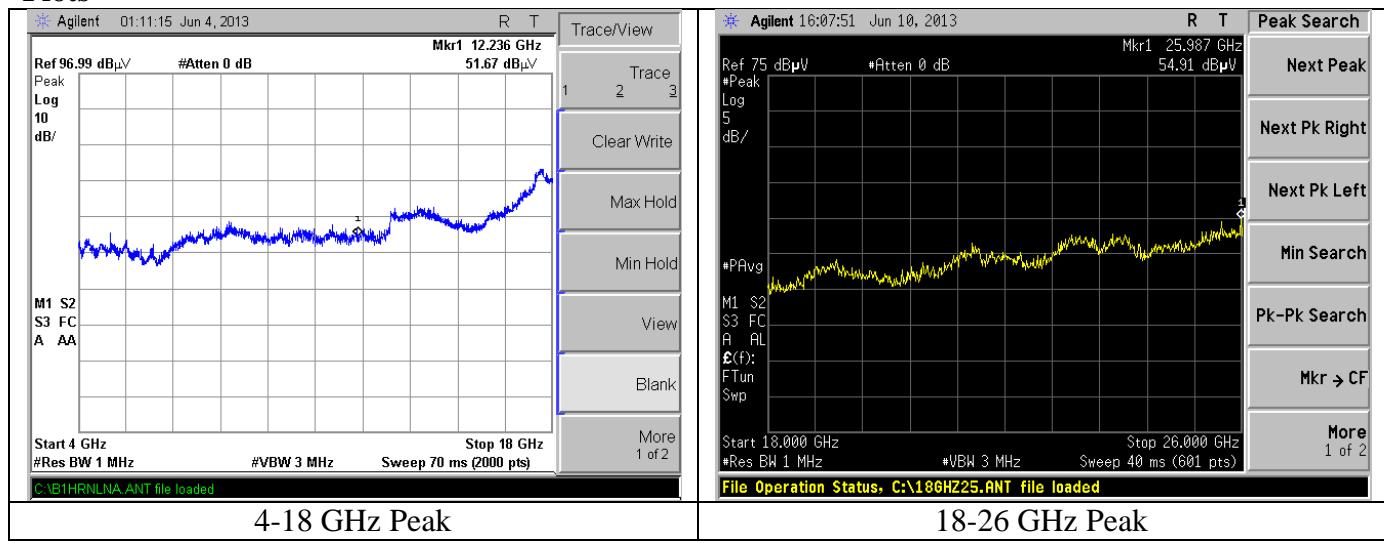
FCC 15.209 Peak Limit @ 1 meter (dB μ V/m) – Peak Reading (dB μ V/m) = Peak Margin

FCC 15.209 Average Limit @ 1 meter (dB μ V/m) – Average Reading (dB μ V/m) = Average Margin

Data Table

Channel / Fundamental Frequency (MHz)	Harmonic Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB μ V/m)	Peak Limit (dB μ V/m)	Peak Margin (dB)	Average Reading (dB μ V/m)	Average Limit (dB μ V/m)	Average Margin (dB)	Antenna Polarity
0 / 2405	4810	1.00	217	56.4	83.5	27.1	46.1	63.5	17.4	Vertical
7 / 2440	4880	1.02	226	55.9	83.5	27.6	45.1	63.5	18.4	Vertical
14 / 2475	4950	1.02	227	56.7	83.5	26.8	46.2	63.5	17.3	Vertical
15 / 2480	4960	1.29	233	54.8	83.5	28.7	43.3	63.5	20.2	Vertical

Plots



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B.2.1 – Radiated Emissions Transmit Mode

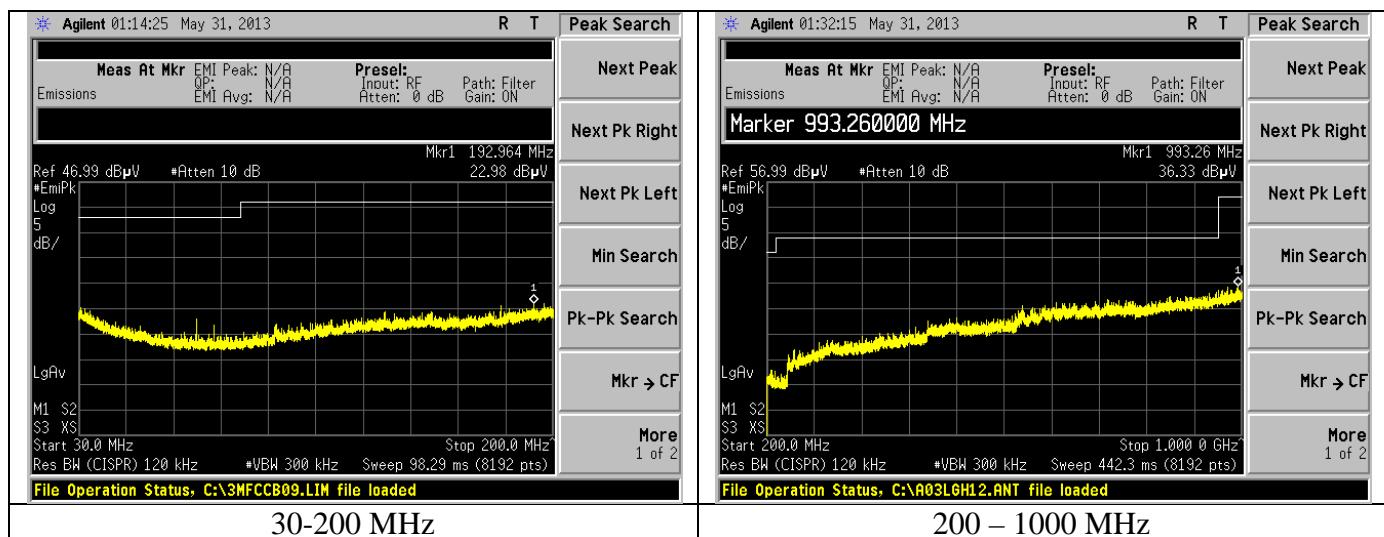
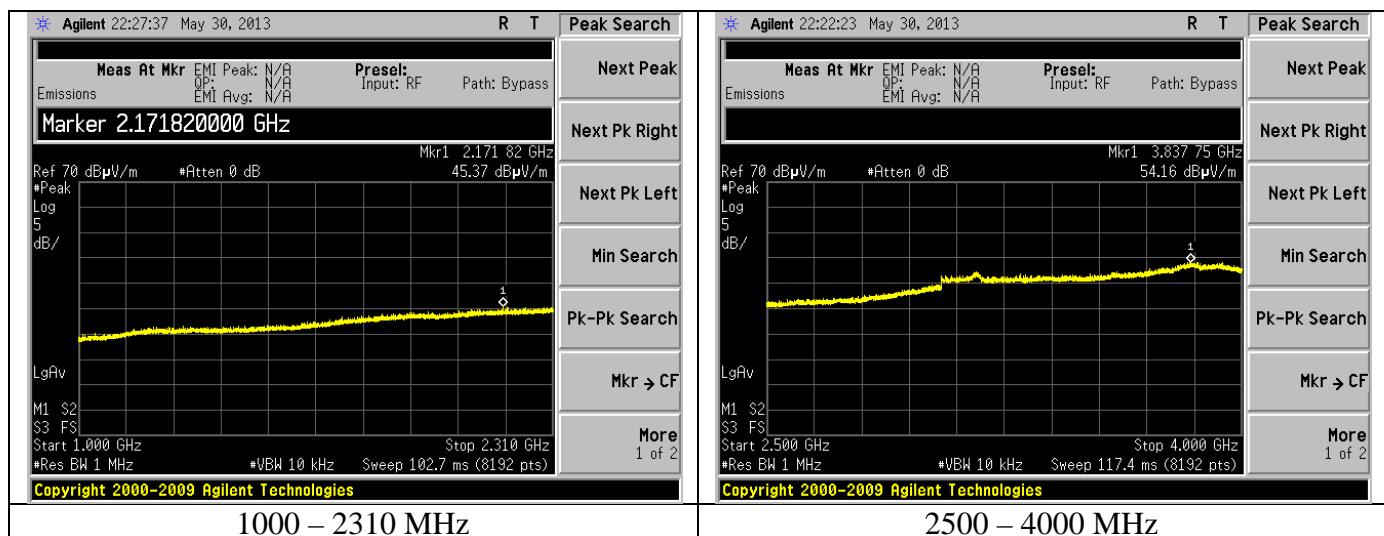
Manufacturer	Dentsply Professional
Date	5-30, 5-31 2013
Operator	Peter F
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 - 2009
Test Distance	3 meter 30-4000 MHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1 MHz
Additional Notes	<ol style="list-style-type: none">1) Tested in continuous transmit modulated mode with EUT in its intended orientation at maximum power channels 0, 7, 14 and channel 15 at reduced power.2) Peak detector with max hold in vertical and horizontal antenna polarizations3) NO EMISSIONS FOUND

Example Calculation:

Limit (dB μ V/m) – Reading (dB μ V/m) = Margin

Plots start next page

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B3 – Frequency Stability

Manufacturer	Dentsply Professional				
Operator	Adam A				
Additional Notes	<p>The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied from the nominal.</p> <p>The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.</p> <p>Continuous transmit modulated used for this test.</p> <p>EUT does not operate below 1.8 VDC</p>				

	3.30 VDC	3.50 VDC	3.00 VDC	2.55 VDC	
	FREQUENCY (Hz)	FREQUENCY (Hz)	FREQUENCY (Hz)	FREQUENCY (Hz)	FREQ DRIFT (Hz)
LOW CHANNEL	2405011676	2405011328	2405011068	2405011482	608
MID CHANNEL	2440011542	2440011303	2440011857	2440011605	554
HIGH CHANNEL	2480011701	2480011297	2480011898	2480011927	630

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B4 – AC Mains Conducted Emissions

THIS TEST DOES NOT APPLY – BATTERY OPERATED EQUIPMENT ONLY

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Appendix C - Uncertainty Summary

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.32 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.63 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64°/ 2.88 %RH

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Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2013	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 3	2010	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Meas Guidance v03r01	2013	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

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END OF REPORT

Date	Version	Comments	Person
6-20-13	V0	Initial Draft Release	Adam A
6-20-13	V1	Initial Review	Peter F
6-26-13	V1	2 nd Review	Peter F
9-23-13	V1	Added customer info and final release	Adam A

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