

Axonn LLC FCC Part 15, Certification Application STAMP Modular Frequency Hopping Transceiver Developer Board

UST Project: 06-0204 Issue Date: October 31, 2006



I certify that I am authorized to sign for the manufacturer and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

UNITED STATES TECHNOLOGIES, INC. (AGENT RESPONSIBLE FOR TEST):

_	O_{+} I
Ву:	
Name:	Louis A. Feudi
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Date: _	October 31, 2006
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MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: Axonn LLC

STAMP

MODEL:

FCC ID:	L2V-STAMP
DATE:	October 31, 2006
This report concerns (check o	e): Original grant <u>X</u> ass II change
Equipment type: Low Pov	er 2.4 GHz Frequency Hopping Transceiver Developer Board
Deferred grant requested per lif yes, defer until:	7 CFR 0.457(d)(1)(ii)? yes No_X
N.A. agrees to notify the	Commission by <u>N.A.</u> date cement of the product so that the grant can be issued on that date.
Report prepared by:	
United States Te 3505 Francis Circ Alpharetta, GA 30	e
Phone Number: Fax Number:	

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SECTION 1 GENERAL INFORMATION

GENERAL INFORMATION

1.1 Product Description

The Equipment Under Test (EUT) is an Axonn LLC, Model STAMP modular Frequency Hopping Transceiver. The EUT is a 2.4 GHz Frequency Hopping Transceiver module which is intended for use as an interface to wireless sensor networks. The unit is being submitted as a Developer Board, with no shielding.

1.2 Related Submittal(s)/Grant(s)

The EUT will be used to send/receive data. The Frequency Hopping Transceiver presented in this report will be used with other like Frequency Hopping Transceivers:

The EUT is subject to the following authorizations:

- a) Certification as a low power Frequency Hopping Transceiver Developer Board under 15.249
- b) Verification as a digital device

The information contained in this report is presented for the certification & verification authorization(s) for the EUT.

SECTION 2 TESTS AND MEASUREMENTS

TEST AND MEASUREMENTS

2.1 Configuration of Tested System

The sample was tested per ANSI C63.4, Methods of Measurement from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (1992). Conducted and radiated emissions data were taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off throughout the evaluation process. Block diagrams of the tested systems are shown in Figures 1. Test configuration photographs for spurious and fundamental emissions are shown in Figure 2a -g.

The sample used for testing was received by U.S. Technologies on October 18, 2006 in good condition.

2.2 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and submitted to the FCC, and accepted in their letter marked 31040/SIT. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number IC2982.

2.3 Test Equipment

Table 2 describes test equipment used to evaluate this product.

2.4 Modifications

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15, Class B Limits for the transmitter portion of the EUT or the Class B Digital Device Requirements.

FIGURE 1 TEST CONFIGURATION

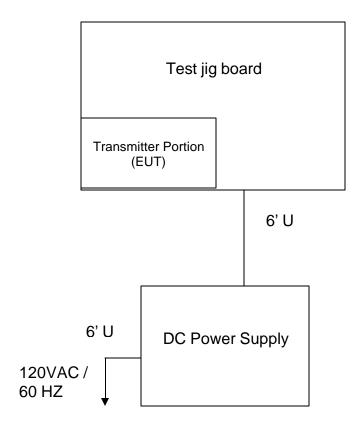


TABLE 1

Test Date: October 17 & 18, 2006

UST Project: 06-0204 Customer: Axonn LLC Model: STAMP

EUT and Peripherals

PERIPHERAL MANU.	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D	
Axonn LLC (EUT)	STAMP	None	None	None	
Hewlett Packard DC Power Supply	E3610A	GE13499	None	6' U 3.6 Vdc 6'U 120VAC / 60 Hz	

TABLE 2 TEST INSTRUMENTS

EQUIPMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	8558B	HEWLETT-PACKARD	2332A10055	3/21/06
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	7/3/06
SIGNAL GENERATOR	8648B	HEWLETT-PACKARD	3642U01679	10/13/06
RF PREAMP	8447D	HEWLETT-PACKARD	2944A06291	4/6/05
BICONICAL ANTENNA	3110B	EMCO	9307-1431	10/11/06
LOG PERIODIC	3146	EMCO	3110-3236	9/15/05 2 Yr.
HORN ANTENNA	SAS-571	A. H. SYSTEMS	605	04/1/05 2 Yr.
PREAMP	8449B	HEWLETT PACKARD	3008A00480	8/10/06
CALCULATION PROGRAM	N/A	N/A	Ver. 6.0	N/A

2.5 Antenna Description (Paragraph 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

Axonn LLC Corporation will sell the STAMP with the following antenna integrally mounted on the pwb.

MANUFACTURER	IANUFACTURER TYPE OF ANTENNA		GAIN dB	TYPE OF CONNECTOR	
Johanson	Patch	2450ATA100	3 dBi	Integral to PCB	

2.6 Fundamental, Peak, and Average Radiated Spurious Emissions in the Frequency Range 30 -25000 MHz (FCC Section 15.249)

The EUT was placed into a continuous transmit mode of operation. A preliminary scan was performed on the EUT to determine frequencies that were caused by the transmitter portion of the product. Significant emissions that fell within restricted bands were then measured on an OAT's site. Radiated measurements below 1 GHz were tested with a RBW = 120 kHz. Radiated measurements above 1 GHz were measured using a RBW = VBW = 1 MHz. The results of peak radiated fundamental frequencies and spurious emissions falling within restricted bands are given in Table 3a –3d and Figure 3a – 3d.

Average values were calculated using the following duty cycle correction.

Worst Case Transmit Duty Cycle for STAMP

The duty cycle de-rating factor used in the calculation of average radiated limits (per 15.249) is described below. This factor was calculated by first determining the worst case scenario for system operation The worst case operating scenario is as follows:

Maximum transmit time/on equals 538 us (0.538 ms) over a 1.5 sec period. FCC regulations allow a maximum period of 100 ms.

The transmission duty cycle correction factor is then calculated as:

20 * log10 (0.583 ms/100 ms) = -44.7 dB

This value was subtracted from the peak data listed in Section 2.8 and compared to the average limits in tables 3e and 3f.

Table 3a. PEAK FUNDAMENTAL EMISSIONS

	Radiated Emissions										
					Client:	P	xonn				
	Project:	06-020)4	Class:	В	Model:	S	TAMP			
Frequency	Test	AF Test		AF+CA	Results	Limits	Distance /	Margin	PK = n		
	Data		Data	-AMP							
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/QP		
2401.18	-42.4	2HN3mH	64.6	31.6	64908.0	500000	3m./HORZ	17.7	PK		
2440.03	-46.9	2HN3mH	60.1	31.7	38951.3	500000	3m./HORZ	22.2	PK		
2479.95	-50.4	2HN3mH	56.6	31.8	26141.8	500000	3m./HORZ	25.6	PK		

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-42.4 + 31.6 + 107)/20) = 64908.0

CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: ______ Name: __Austin Thompson

Figure 3a - 1
Peak Radiated Emission 15.247(c) Fundamental Low

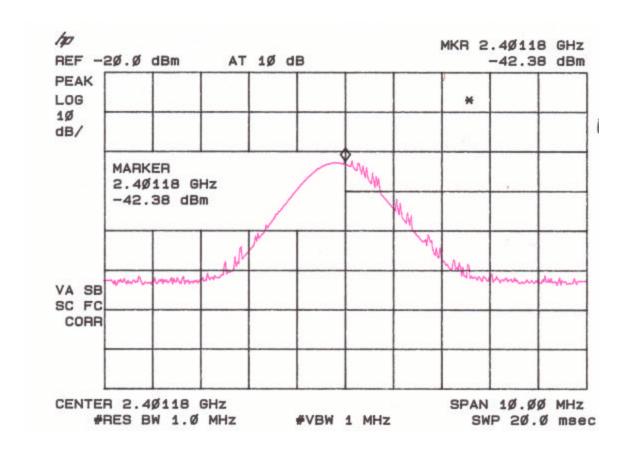


Figure 3a - 2
Peak Radiated Emission 15.247(c) Fundamental Mid

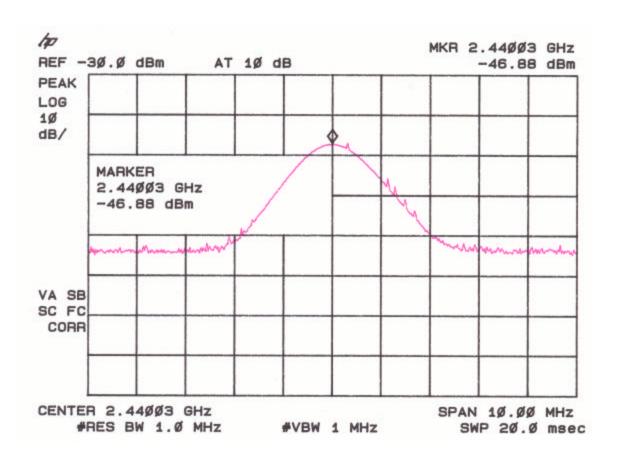


Figure 3a - 3
Peak Radiated Emission 15.247(c) Fundamental High

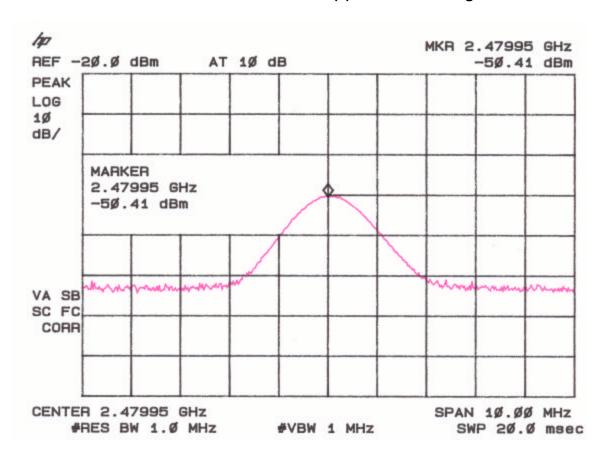


Table 3b. PEAK RADIATED SPURIOUS EMISSIONS (Low)

	Radiated Emissions										
				Client:	ent: Axonn						
	Project:	06-02	204	Class:	В	Model:		STAMP			
Frequency		AF	Test	AF+CA-	Results	Limits	Distance /	Margin	PK = n		
	Data		Data	AMP							
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/QP		
4802.00	-47.4	2HN3mH	59.6	5.4	1786.3	5000.0	3m./HORZ	8.9	PK		
7203.03	-62.9	2HN3mH	44.1	10.7	549.8	5000.0	3m./HORZ	19.2	PK		
9604.07	-68.2	2HN3mH	38.8	13.3	402.8	5000.0	3m./HORZ	21.9	PK		
12005.25	-67.1	2HN3mH	39.9	18.9	874.0	5000.0	3m./HORZ	15.1	PK		

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-47.5 + 5.4 + 107)/20) = 1765.9 CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: / Custin / hopefson

Name: <u>Austin Thompson</u>

^{*} Conversion from 1 meter to 3 meters = -9.54 dB

Figure 3b - 1
Peak Radiated Spurious Emission 15.247(c) Low

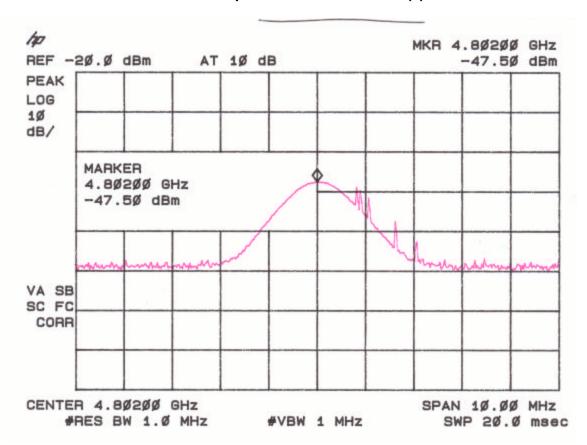


Figure 3b - 2
Peak Radiated Spurious Emission 15.247(c) Low

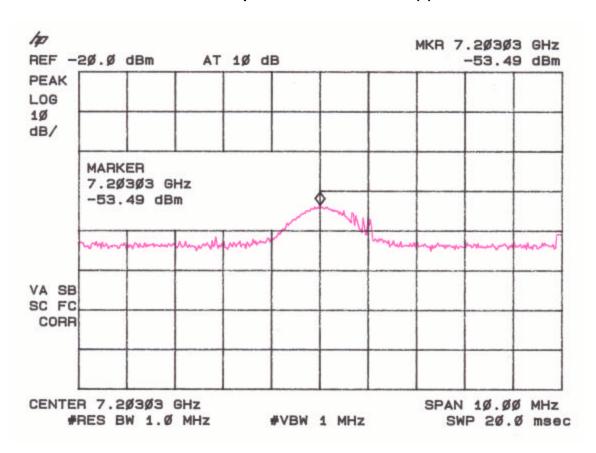


Figure 3b - 3
Peak Radiated Spurious Emission 15.247(c) Low

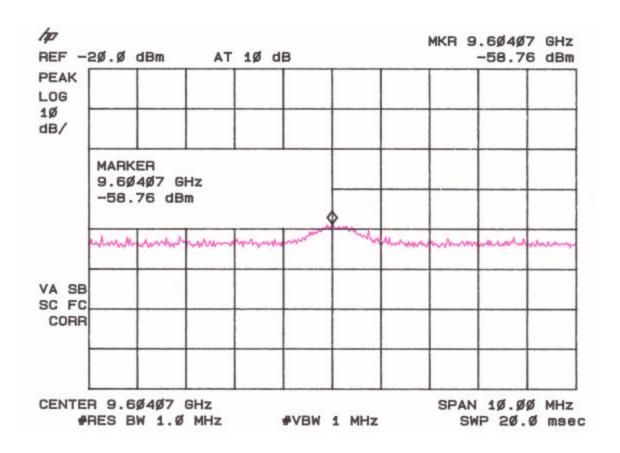


Figure 3b - 4
Peak Radiated Spurious Emission 15.247(c) Low

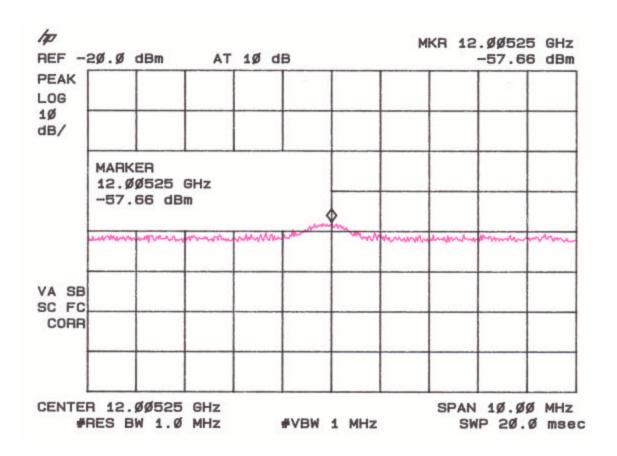


Table 3c. PEAK RADIATED SPURIOUS EMISSIONS (Mid)

	Radiated Emissions										
			Client:		Axonn						
	Project:	06-0204		Class:	В	Model:	;	STAMP			
Frequency	Test	AF	Test	AF+CA-	Results	Limits	Distance /	Margin	PK = n		
	Data		Data	AMP							
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/QP		
4880.05	-51.2	2HN3mH	55.8	5.7	1190.6	5000.0	3m./HORZ	12.5	PK		
7320.08	-64.3	2HN3mH	42.7	10.9	477.5	5000.0	3m./HORZ	20.4	PK		
9760.02	-67.4	2HN3mH	39.6	13.5	451.2	5000.0	3m./HORZ	20.9	PK		
12200.05	-63.1	2HN3mH	43.9	19.3	1448.5	5000.0	3m./HORZ	10.8	PK		

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-51.3 + 5.7 + 107)/20) = 1183.8 CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: / Cholin / More Som Name: Austin Thompson

^{*} Conversion from 1 meter to 3 meters = -9.54 dB

Figure 3c - 1
Peak Radiated Spurious Emission 15.247(c) Mid

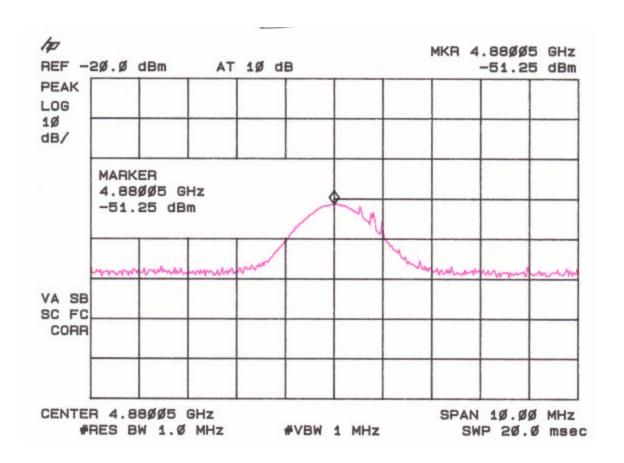


Figure 3c - 2
Peak Radiated Spurious Emission 15.247(c) Mid

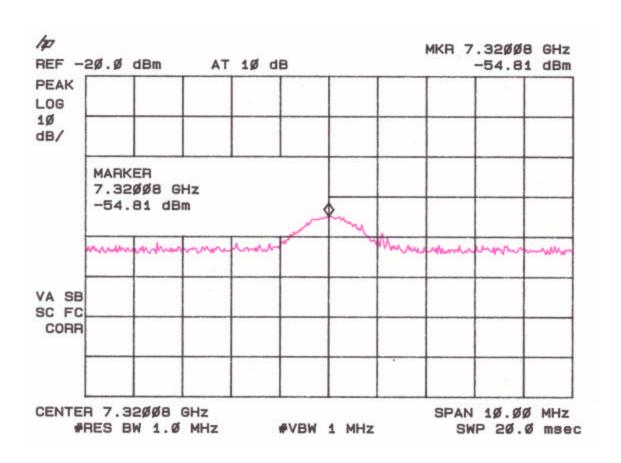


Figure 3c - 3
Peak Radiated Spurious Emission 15.247(c) Mid

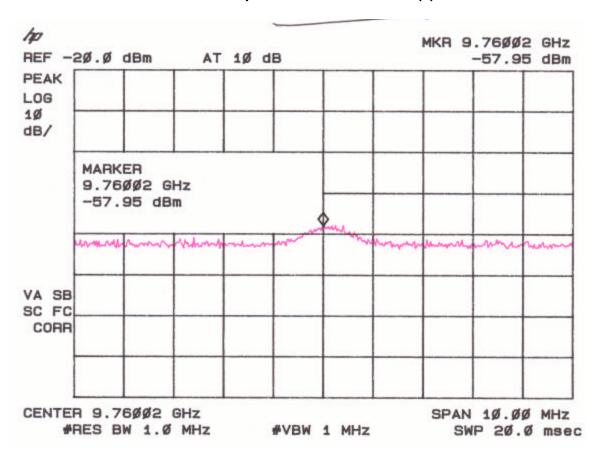


Figure 3c - 4
Peak Radiated Spurious Emission 15.247(c) Mid

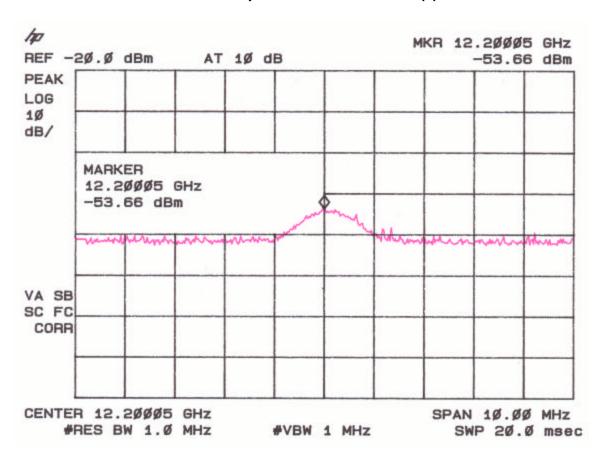


Table 3d. PEAK RADIATED SPURIOUS EMISSIONS (High)

	Radiated Emissions											
			Client:	Axonn								
	Project	06-0	204	Class:	В	Model:		STAMP				
Frequency	Test	AF	Test	AF+CA-	Results	Limits	Distance /	Margin	PK = n			
	Data		Data	AMP								
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/QP			
4960	-48.1	2HN3mH	58.9	6.0	1757.6	5000.0	3m./HORZ	9.1	PK			
7440.15	-64.0	2HN3mH	43.0	11.1	504.7	5000.0	3m./HORZ	19.9	PK			
9920.15	-67.7	2HN3mH	39.3	13.7	445.4	5000.0	3m./HORZ	21.0	PK			
12400.1	-66.3	2HN3mH	40.7	19.7	1049.1	5000.0	3m./HORZ	13.6	PK			

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-48.2 + 6.0 + 107)/20) = 1741.5 CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: _____ Name: __Austin Thompson

^{*} Conversion from 1 meter to 3 meters = -9.54 dB

Figure 3d – 1
Peak Radiated Spurious Emission 15.247(c) High

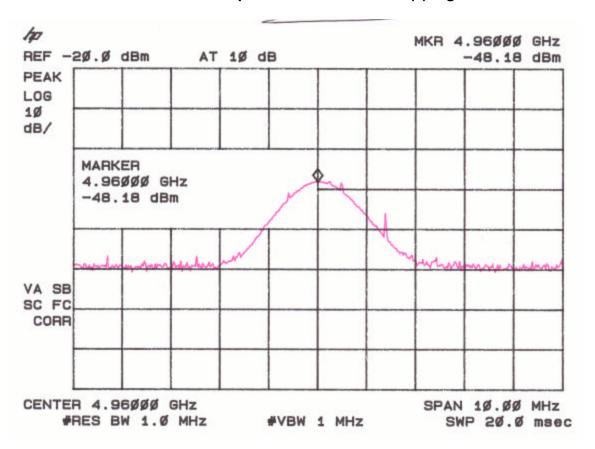


Figure 3d – 2
Peak Radiated Spurious Emission 15.247(c) High

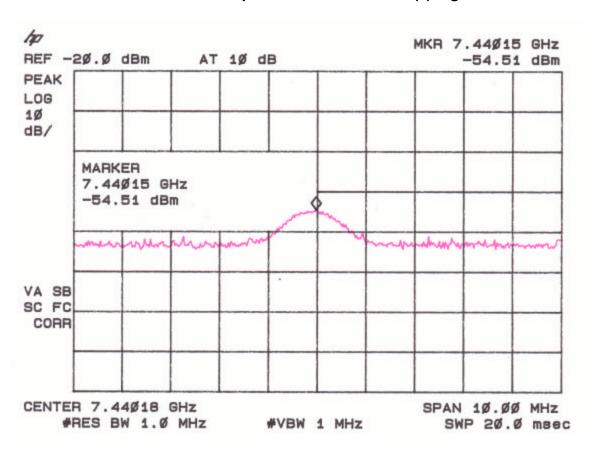


Figure 3d – 3
Peak Radiated Spurious Emission 15.247(c) High

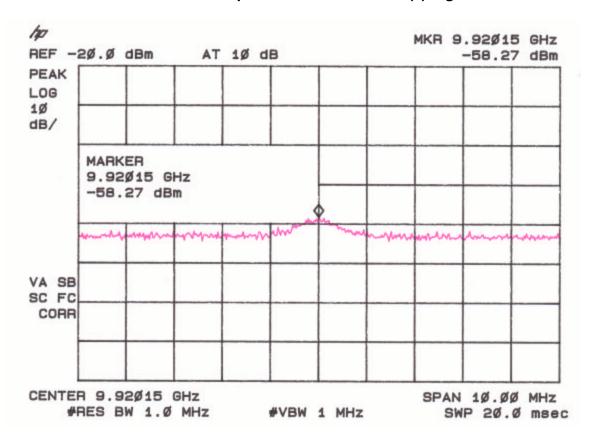


Figure 3d – 4
Peak Radiated Spurious Emission 15.247(c) High

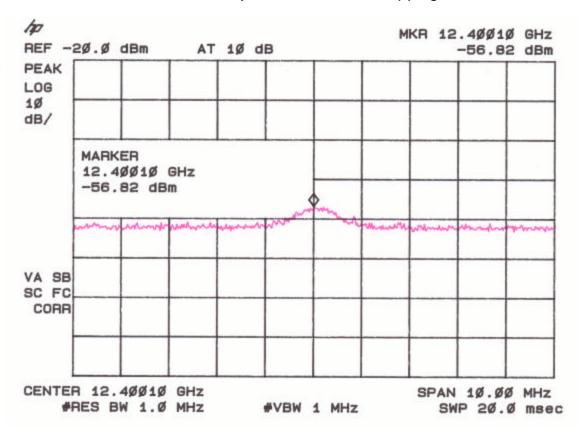


Table 3e. AVERAGE FUNDAMENTAL EMISSIONS

	Radiated Emissions										
Client: Axonn											
Project: 06-0204 Class: B N								Mode	el: S7	TAMP	
Frequency	Test Data	AF	Test Data	AF+CA- AMP	Results	Limits	Dista	ance /	Margi n	PK = n	
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Pol	arity	(dB)	/QP	
2401.03	-87.0	2HN3mH	20.0	31.6	381.3	50000	3m./	HORZ	42.4	AVG	
2440.03	-91.5	2HN3mH	15.5	31.7	228.8	50000	3m./	HORZ	46.8	AVG	
2479.95	-95.0	2HN3mH	12.0	31.8	154.1	50000	3m./	HORZ	50.2	AVG	

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-42.4 -68.2+ 31.6 + 107)/20) = 25.2 CONVERSION FROM dBm TO dBuV = 107 Db Duty Cycle Correction Factor = -68.2 dBm

Tester

Signature:

Name: <u>Austin Thompson</u>

Table 3d. AVERAGE RADIATED SPURIOUS EMISSIONS (Low)

	Radiated Emissions											
					Client:	Axonn						
	P	roject:	06-	0204	Class:	В	Model:		STAMP			
Frequency	Test Data	A	F	Test Data	AF+CA- AMP	Results	Limits	Distance /	Distance / Margin PK =			
(MHz)	(dBm)	Tal	ole	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/QP		
4802.00	-92.1	2HN	3mH	14.9	5.4	10.4	500.0	3m./HORZ	33.6	AVG		
7203.03	-107.6	3 2HN	3mH	-0.6	10.7	3.2	500.0	3m./HORZ	43.9	AVG		
9604.07	-112.9	2HN	3mH	-5.9	13.3	2.3	500.0	3m./HORZ	46.6	AVG		
12005.25	-111.8	3 2HN	3mH	-4.8	18.9	5.1	500.0	3m./HORZ	39.8	AVG		

^{*} Conversion from 1 meter to 3 meters = -9.54 dB

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-115.7 + 5.4 + 107)/20) = 0.7 CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: ______ Name: __Austin Thompson

Table 3e. AVERAGE RADIATED SPURIOUS EMISSIONS (Mid)

	Radiated Emissions										
			Client:		Axonn						
	Project 06-0204				В	Model:	;	STAMP			
Frequency	Test Data	AF	Test Data	AF+CA- AMP	Results	Limits	Distance /	PK = n			
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/QP		
4880.05	-95.9	2HN3mH	11.1	5.7	6.9	500.0	3m./HORZ	37.2	AVG		
7320.08	-109.0	2HN3mH	-2.0	10.9	2.8	500.0	3m./HORZ	45.1	AVG		
9760.02	-112.1	2HN3mH	-5.1	13.5	2.6	500.0	3m./HORZ	45.6	AVG		
12200.05	-107.8	2HN3mH	-0.8	19.3	8.4	500.0	3m./HORZ	35.5	AVG		

^{*} Conversion from 1 meter to 3 meters = -9.54 dB

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-119.5 + 5.7 + 107)/20) = 0.9 CONVERSION FROM dBm TO dBuV = 107 dB

Tester Signature:

Table 3f. AVERAGE RADIATED SPURIOUS EMISSIONS (High)

Radiated Emissions										
			Client:	Axonn						
Project 06-0204 Class:					В	Model:	5	STAMP		
	:									
Frequency	Test Data	AF	Test Data	AF+CA- AMP	Results	Limits	Distance /	Margin	PK = n	
(2.51.1.)					() ()	() ()		(ID)		
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/QP	
4960	-92.8	2HN3mH	14.2	6.0	10.2	500.0	3m./HORZ	33.8	AVG	
7440.15	-108.7	2HN3mH	-1.7	11.1	2.9	500.0	3m./HORZ	44.6	AVG	
9920.15	-112.4	2HN3mH	-5.4	13.7	2.6	500.0	3m./HORZ	45.7	AVG	
12400.1	-111.0	2HN3mH	-4.0	19.7	6.1	500.0	3m./HORZ	38.3	AVG	

^{*} Conversion from 1 meter to 3 meters = -9.54 dB

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-110.4 + -3.4 + 107)/20) = 1.3 CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: _____ Name: <u>Austin Thompson</u>

2.7 Band Edge Measurements

Band Edge measurements were made at a Low Channel and High Channel peak at highest EUT related emission outside the occupied bandwidth. A peak measurement was made of the fundamental, and the emission was measured using a peak setting. A Resolution Bandwidth of > 1% of the emission bandwidth was used. This procedure was repeated for the high channel.

The plots shown were verified using a 17 foot, Flexco cable and Horn Antenna. No preamp was used.

The limits were derived as follows:

High Bandedge

5000 uV/m = 73.98 dBuV/m limit

Fundamental measured at High Channel from Table 3a: 56.4+32.0 (Antenna + Cable) = 88.4 dBuV/m

Delta from conducted measurement of band edge from fundamental peak to highest spur outside band edge: -42.54 dB

 $88.4 - 42.54 = 45.86 \, dBuV/m$

Low Bandedge

5000 uV/m = 73.98 dBuV/m limit

Fundamental measured at Low Channel from Table 3a: 54.5+31.9 = 86.4 dBuV/m

Delta from conducted measurement of band edge from fundamental peak to highest spur 10 MHz outside band edge: -32.44 dB

 $86.4 - 32.44 = 53.96 \, dBuV/m$

Figure 4a. Band Edge Compliance Antenna Conducted, Low Channel

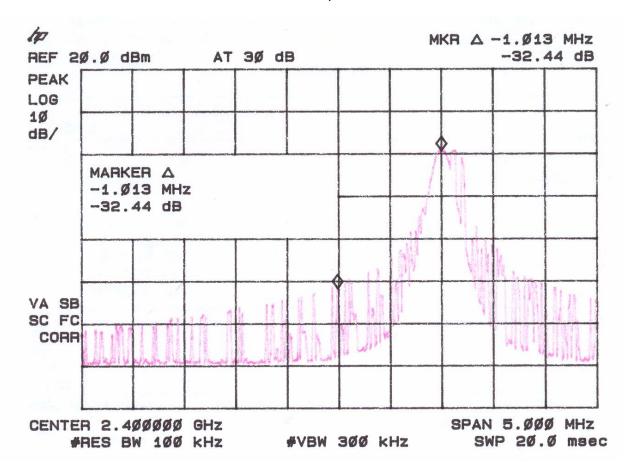
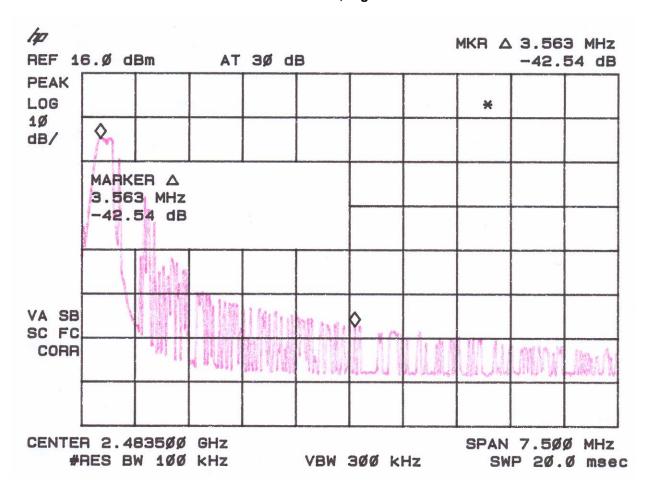


Figure 4b. Band Edge Compliance Antenna Conducted, High Channel



2.8 20 dB Bandwidth per FCC Section 15.247(a)(1)(ii)

The antenna port was connected to a spectrum analyzer that was set for a 50 Ω impedance with the RBW = approximately 1/100 of the manufacturers claimed RBW & VBW > RBW. The results of this test are given in Table 4 and Figure 5.

.

TABLE 4 20 dB Bandwidth

Test Date:

October 18, 2006

UST Project: 06-0204 Customer:

Axonn LLC

Model:

STAMP

Frequency (GHz)	20 dB Bandwidth (MHz)	MAXIMUM FCC LIMIT (MHz)		
2.40103	0.350	1.0		
2.44003	0.375	1.0		
2.48003	0.375	1.0		

Signature:

Figure 5a. 20 dB Bandwidth per FCC Section 15.247(a)(1)(ii) Low

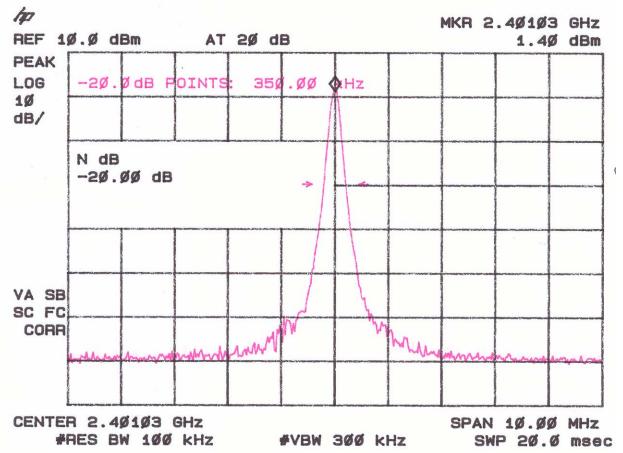


Figure 5b. 20 dB Bandwidth per FCC Section 15.247(a)(1)(ii) Mid

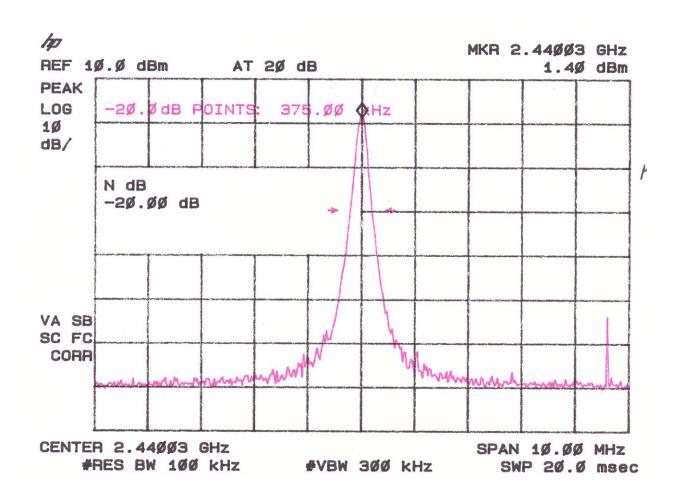
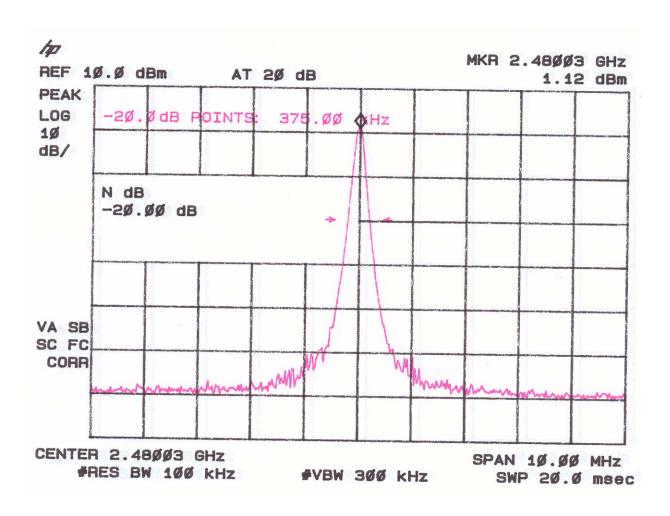


Figure 5c. 20 dB Bandwidth per FCC Section 15.247(a)(1)(ii) High



2.9 Power Line Conducted Emissions for Transmitter FCC Section 15.207

The conducted voltage measurements have been carried out in accordance with FCC Section 15.207, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmit. The results are given in Tables 5a-5b.

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TABLE 5a. CONDUCTED EMISSIONS DATA

CLASS B

Test Date:

October 18, 2006

UST Project: Customer:

06-0204

Axonn LLC

Model:

STAMP

Worse Case Mode of Operaton (TX – Low channel)

(Peak/QP vs QP Limits)

Conducted Emissions										
		Client:	Axonn LLC							
AT	Project: 06-0204 Class: B					Model:	STAMP			
Frequency	Test Data	AF	Test Data	AF+CA- AMP	Results	Limits	Margin	PK = n		
(MHz)	(dBm)	Table	(dBuV)	(dB)	(dBuV)	(dBuV)	(dB)	/ QP		
Not Applicable EUT is Battery Operated										

Signature:

TABLE 5b. CONDUCTED EMISSIONS DATA

CLASS B

Test Date:

October 18, 2006

UST Project: Customer:

06-0204 Axonn LLC

Model:

STAMP

(AVG vs Average Limits)

Conducted Emissions										
		Client: Axor		n LLC						
AT	Project: 06-0204 Class: B					Model:	STAMP			
Frequency	Test	AF	Test	AF+CA-	Results	Limits	Margin	PK = n		
	Data		Data	AMP						
(MHz)	(dBm)	Table	(dBuV)	(dB)	(dBuV)	(dBuV)	(dB)	/ QP		
Not Applicable EUT is Battery Operated										

Tester Signature:

N

2.10 Radiated Emissions for Digital Device & Receiver (47 CFR 15.109a)

Radiated emissions were evaluated from 30 to 14500 MHz while the EUT was placed into a Receive mode of operation. Measurements were made with the analyzer's bandwidth set to 120 kHz measurements made less than 1 GHz and 1 MHz for measurements made greater than or equal to 1 GHz. The results for less than 1 GHz are shown in Table 6.

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TABLE 6. RADIATED EMISSIONS DATA (Digital Device & Receiver)

CLASS B

Test Date: October 4, 2006

UST Project: 06-0204 Customer: Axonn LLC Product: STAMP

Radiated Emissions										
						Client:	Axon	n LLC		
	Project:	06-0204		Class:	В	Model:	STAMP			
Frequency	Test Data	AF	Test	AF+CA-	Results	Limits	Margin	PK = n		
			Data	AMP						
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	(dB)	/ QP		

No emissions seen within 20 dB of the FCC Limit.

Tester Signature: Lustin Thompson

.2.11 Power Line Conducted Emissions for Digital Device and Receiver FCC Section 15.107

Not Applicable, EUT battery Powered