Input-Output Inc.
2888Transceiver

FCC ID: MCV-FSU101
Model No.: FSU101
FCC Rule Parts: 2, 90

General Overview
A description of the theory of operation and product configuration is found in an attachment to this application and report.

SPECIFICATIONS

Transmitter	
TX operating frequency:	217.0125 MHz (ch.1) – 219.9875 MHz (ch.16)
TX output power:	2 watts nominal, 1.42 watts measured
Modulation:	FSK Modulation is internally generated and limited
Power requirements:	7.2 VDC, approx. 2 A maximum current draw
Antenna connector:	TNC- type
Frequency Tolerance	.0001 , ±219 Hz -30 to +50 C 85%-115% supply voltage at 25C
Test Dates:	8,9, 15 August 2006

Test Site

All tests reported here were performed at Compliance Certification Services.
Conducted and radiated emissions were performed using test equipment with calibration traceable to NIST, and following test procedures accepted by the industry.

THOMAS N. COKENIAS
Consultant, EMC&Radio Type Approvals
Agent for Input-Output Inc.

FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Part 2.

2.1033(c)1 Applicant: Input-Output Inc.
601 North Glenville, Suite 115
Richardson, TX 75081

2.1033(c)2 FCC ID: MCV-FSU101

2.1033(c)4,5 Emission type and Frequency range

Modulation: FSK from internal source
Emission designator: **9K62F1D**

2.1033(c) 6 Range of Operating Power

2 watts peak (33.0 dBm)

2.1033(c) 7 Maximum Power Rating

31.52 dBm measured = 1.42 watts

Maximum allowed per 90.259(a): 2 watts

2.1033(c) 13 Description of Modulation System

4000 bps FSK digital, from internal source.

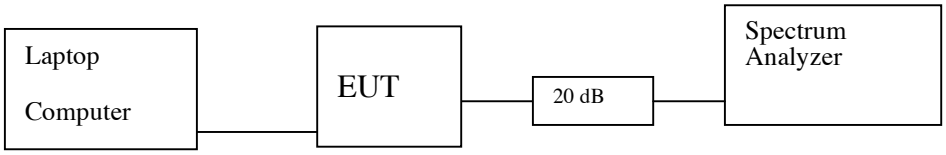
2.1033(c) 14 Test Data per 2.1046 – 2.1057

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**Cal Due**
EMI Receiver, 9 kHz ~ 2.9 GHz	Agilent / HP	8542E	3942A00286	2/4/07
RF Filter Section	Agilent / HP	85420E	3705A00256	2/4/07
Antenna, Bilog 30 MHz ~ 2 Ghz	Sunol Sciences	JB1	A121003	9/3/06
Spectrum analyzer	HP	8593EM	CCS T32	7/26/08
Digital Multimeter (voltmeter)	Fluke	26III	CCS3	1/3/07

2.1046 RF Output Power Measurements
Requirement/Limit: 90.259(a)5

Test set-up:

Figure 1



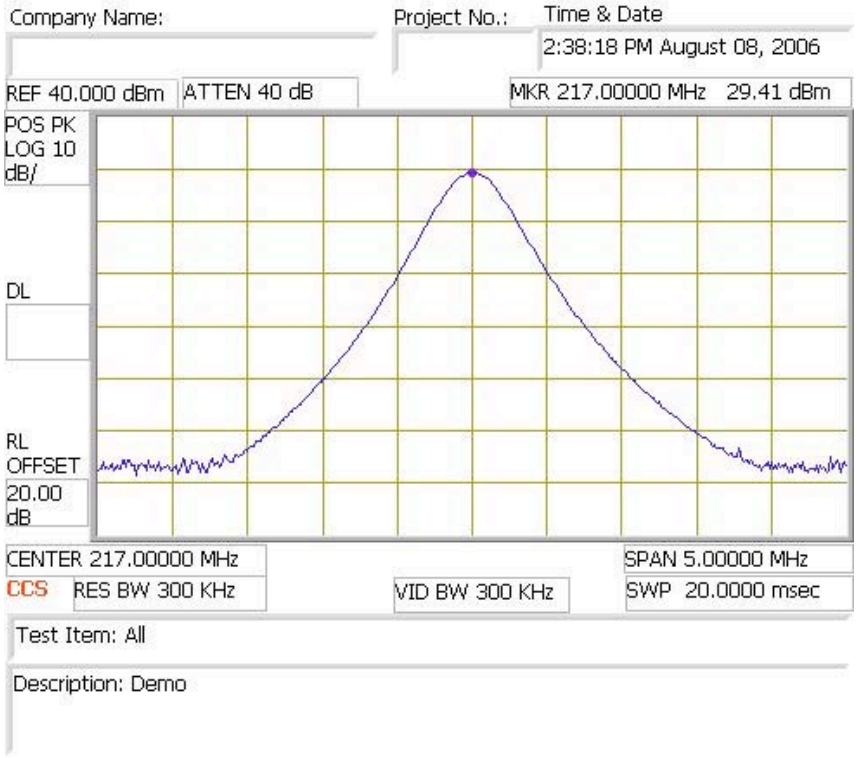
Test Procedures

1. Set the transmitter to produce maximum modulated power at the desired frequency
2. Set analyzer RBW and VBW to 300 kHz, much greater than 99% BW
3. Read PEAK output power

Test Results

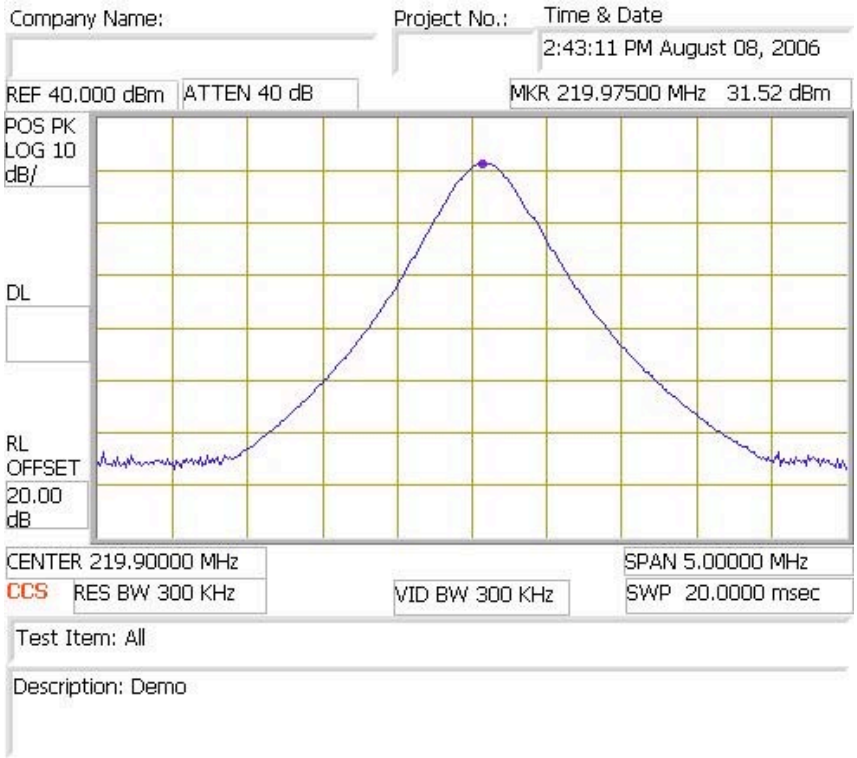
Maximum output power 31.52 dBm = 1.42 watts. Refer to spectrum analyzer plots below.

Channel 1 Output Power



Channel 11 Output Power

Channel 16 Output Power



Section 2.1047 Modulation Characteristics

Requirement/Limit: 90.210(c)

(c) *Emission Mask C*. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (f_d/5) dB;
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth:
At least 29 log (f_d^2 /11) dB or 50 dB, whichever is the lesser attenuation;
(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

Test set-up: Figure 1

Test Procedures

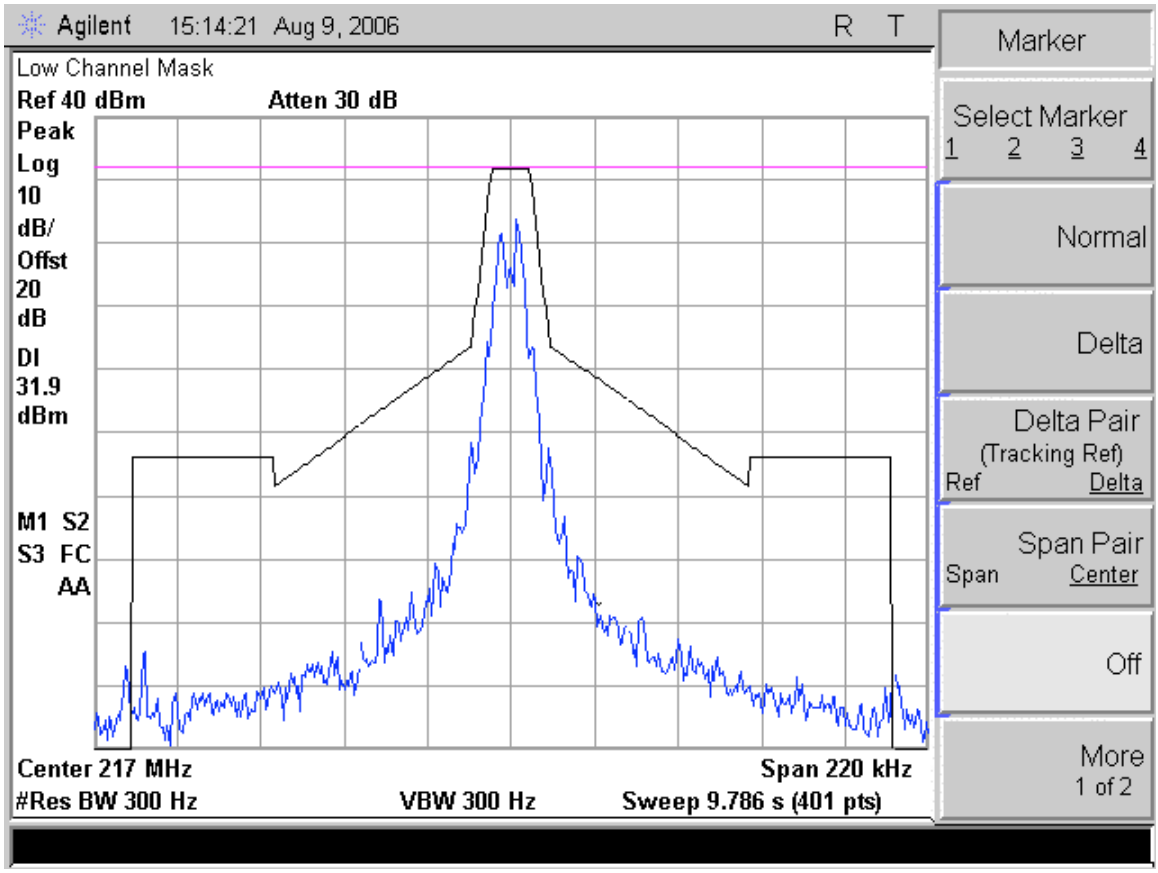
a. Set the transmitter to produce maximum modulated power at the desired frequency
b. Set RBW and VBW to required values and record emission masks.

Test Results

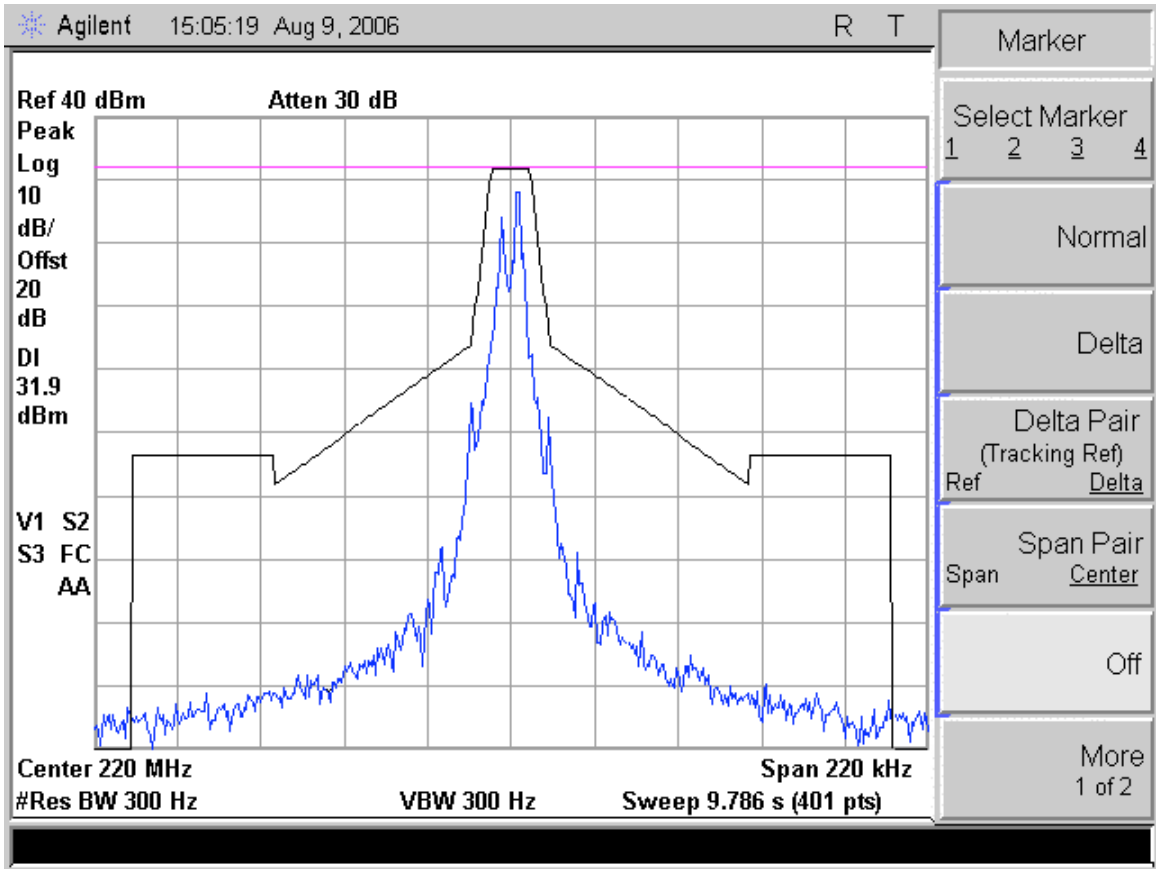
PASS. Refer to attached spectrum analyzer charts.

Emissions are shown with mask lines superimposed on spectrum analyzer charts.

Channel 1 Emissions Mask



Channel 16 Emissions Mask



Section 2.1049 Occupied Bandwidth
Requirement/Limit: 90.209(a)5

(5) Unless specified elsewhere, channel spacings and bandwidths that will be authorized in the following frequency bands are given in the following table.

Standard Channel Spacing/Bandwidth

Frequency band (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
216-2205	6.25	20/11.25/6 \5\

Test set-up: Figure 1

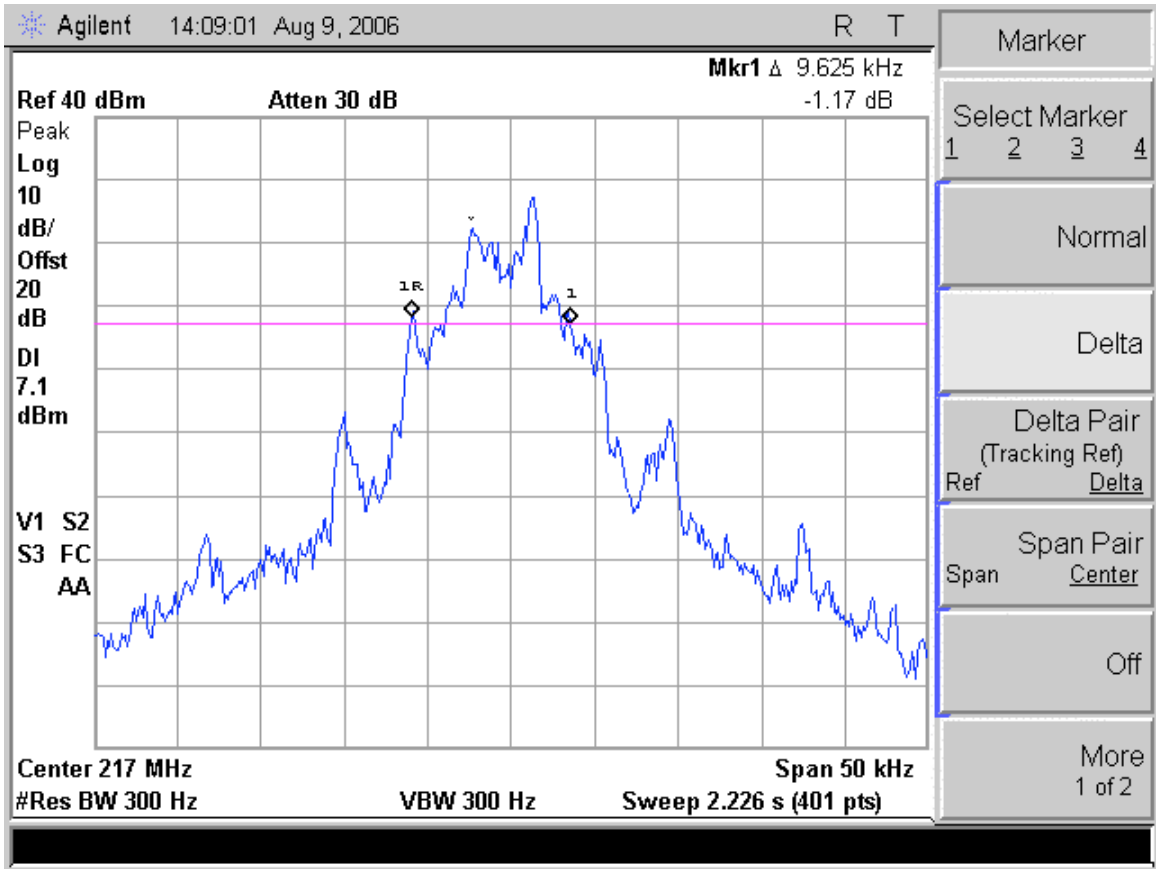
Test Procedures and Results:

-20 dBc ccupied bandwidth was measured manually.

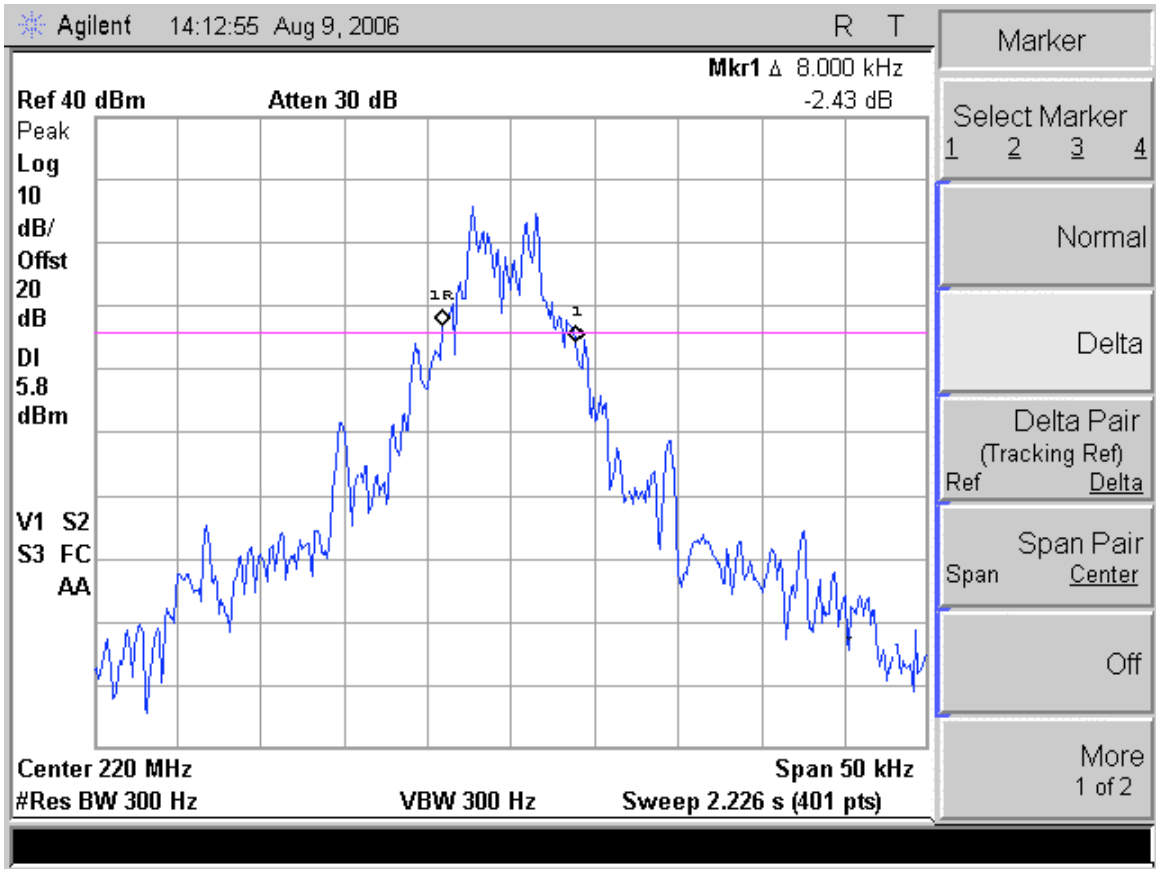
Test Results

Refer to spectrum analyzer plots below

Occupied Bandwidth, Channel 1



Occupied Bandwidth, Channel 16



Section 2.1051 Spurious and Harmonic Emissions at Antenna Terminals
Requirement/Limit: 90.210(c)3

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

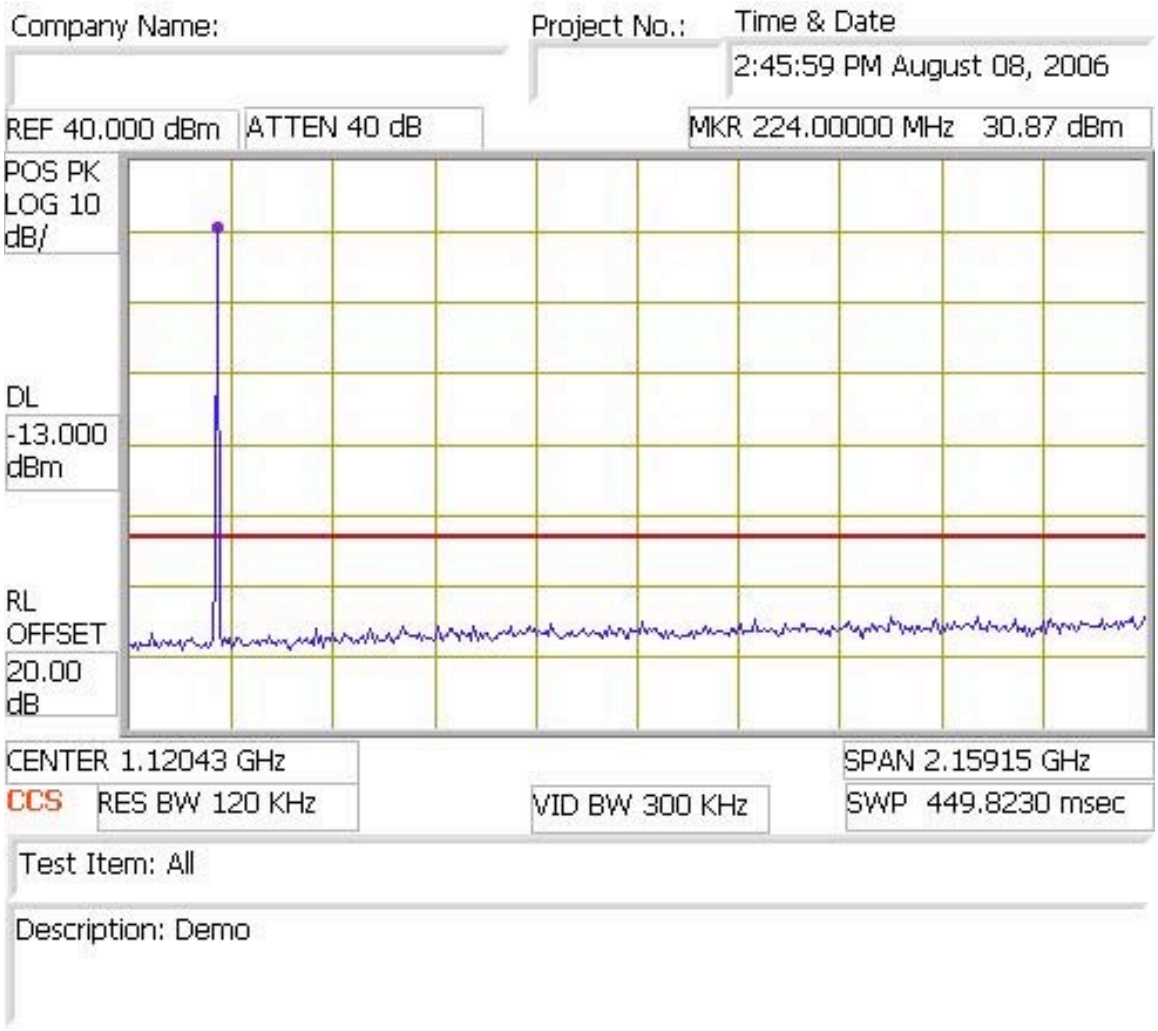
Test set-up:
Refer to Figure 3 above

Test Procedures
1. Record transmitter output spectrum from 1 MHz to 10th harmonic of TX output frequency
2. Plot spectrum analyzer output traces.

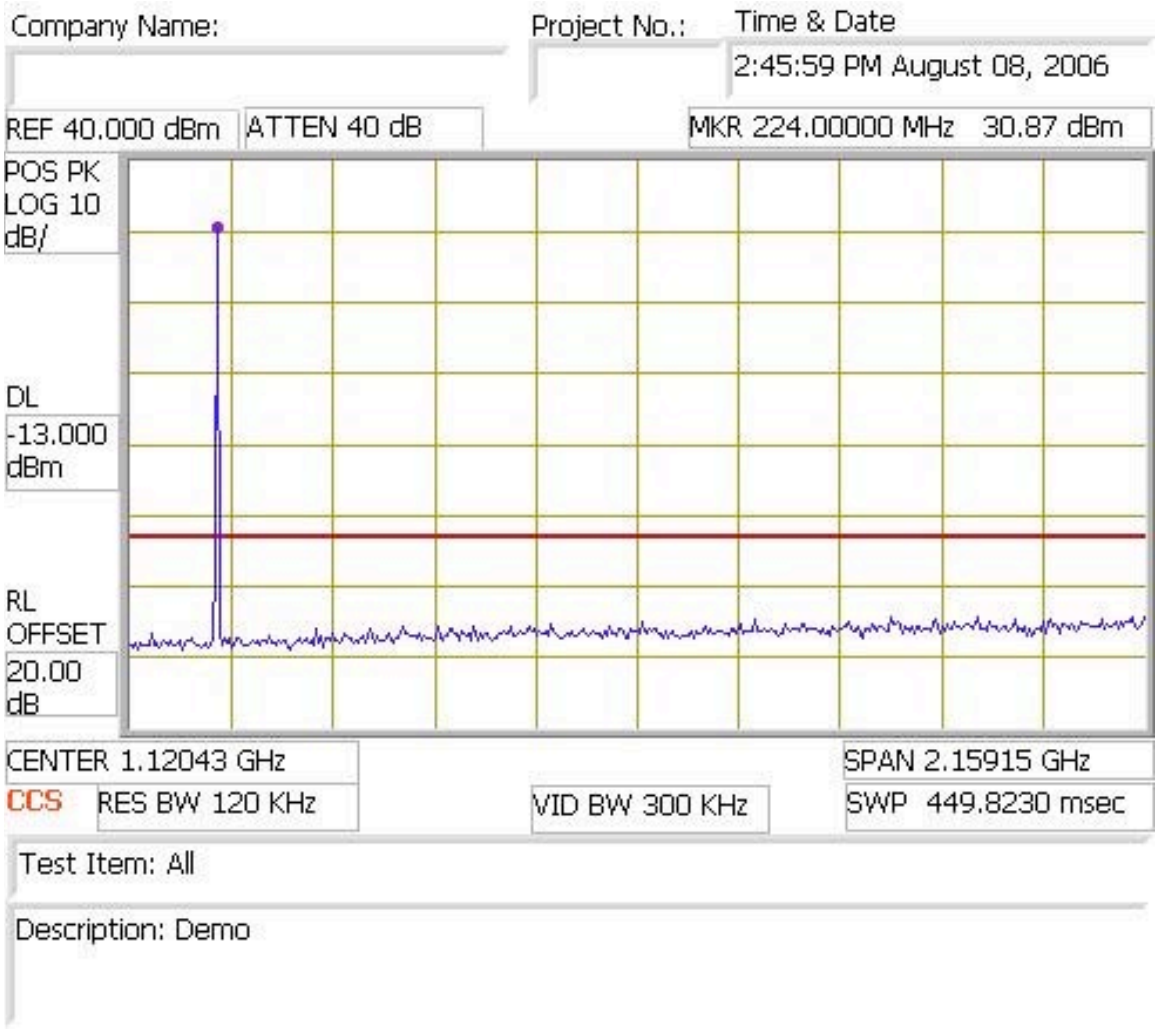
Test Results

PASS. Refer to data plots below.

Channel 1 Spurious emissions, antenna port



Channel 16 Spurious emissions, antenna port



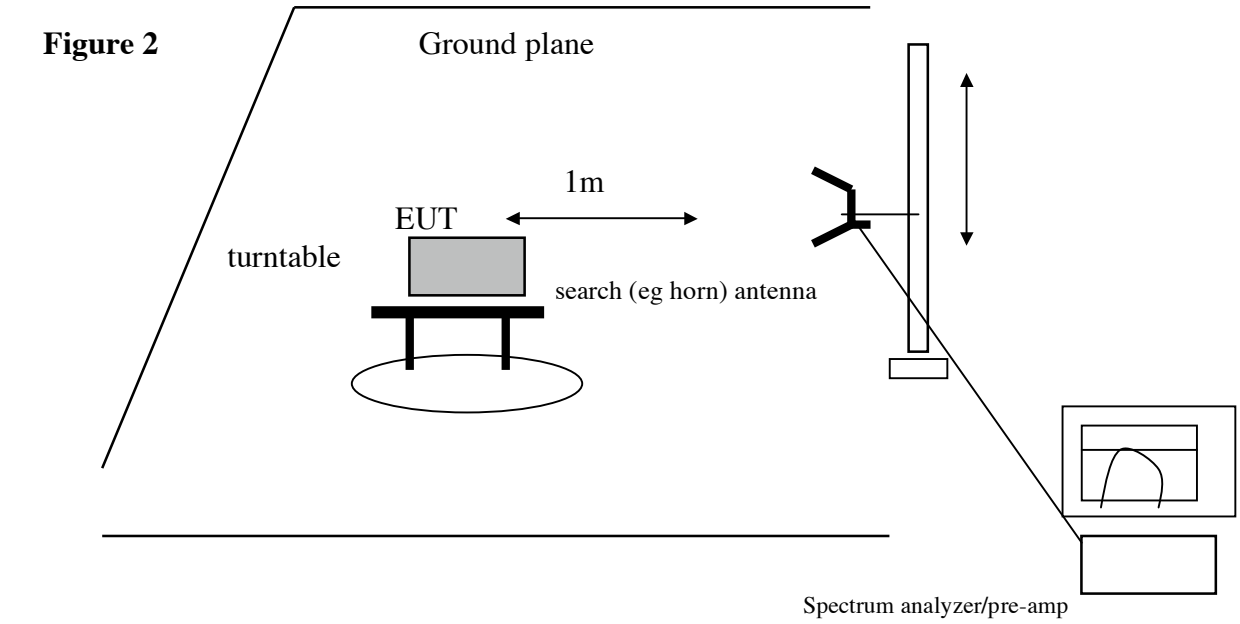
Section 2.1053 Field Strength of Spurious and Harmonic Radiation

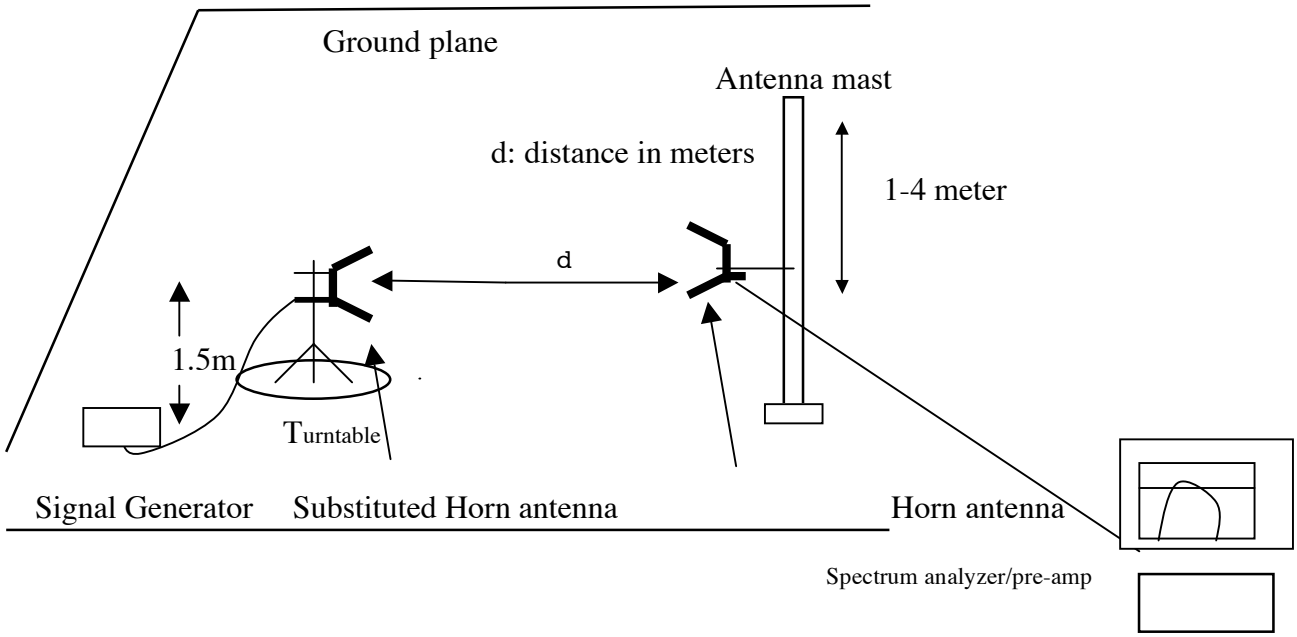
Requirement/Limit: 90.210(c)3

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

Test Set-Up

Figure 2





Minimum Requirement

-13 dBm ERP beyond 250% of authorized bandwidth

Test Method

The antenna output port of the EUT was terminated with a 50-ohm load. With the transmitter operating at full power, the EUT was rotated 360° and the search antenna was raised and lowered in both polarities, all in an attempt to maximize the levels of the received emission for each harmonic and spurious emission up to 10 fo.

The EUT was removed and was replaced by a substitution antenna connected via coax to a signal generator. The generator output was set to each emission frequency detected, the search antenna was raised and lowered, the turntable was rotated, and until the maximum emission level was obtained. The signal generator output level was adjusted to match the radiated emission level from the EUT. After correcting for substitution antenna factor and generator cable loss, output power level is compared to the limit.

Test Results

Pass. All emissions detected were at least 21.9 dB below limits. Refer to worst-case data below.

High Frequency Substitution Measurement
Compliance Certification Services, Morgan Hill 5m Chamber Site

Company: Input-output
Project #: 06U10476
Date: 08/08/2006
Test Engineer: Gordon Andrews
Configuration: EUT and laptop
Mode: Tx
Model Number: FSU 217-220 MHz Part 90 C Tranceiver

Test Equipment:

EMCO Horn 1-18GHz: T60; S/N: 2238 @3m

Horn >18GHz:

Limit: ERP

Hi Frequency Cables: (2 ft) ☐ (2 ~ 3 ft) ☑ (4 ~ 6 ft) ☐ (12 ft) ☑

Pre-amplifer 1-26GHz: T87 Miteq924342

Pre-amplifer:

f GHz	SA reading (dBuV/m)	Ant. Pol. (H/V)	SG reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)
Channel 1									
1.085	70.8	V	-48.0	1.4	5.1	2.9	-46.4	-13.0	-33.4
1.300	81.7	V	-37.1	1.5	5.8	3.7	-34.9	-13.0	-21.9
1.520	60.2	V	-58.6	1.5	6.6	4.5	-55.7	-13.0	-42.7
1.740	73.5	V	-45.4	1.6	7.4	5.2	-41.8	-13.0	-28.8
1.960	71.9	V	-47.0	1.7	8.2	6.0	-42.7	-13.0	-29.7
2.090	54.4	V	-64.4	1.8	8.5	6.4	-59.8	-13.0	-46.8
2.180	65.6	V	-53.2	1.8	8.7	6.6	-48.4	-13.0	-35.4
1.087	68.0	H	-50.1	1.4	5.1	2.9	-48.5	-13.0	-35.5
1.300	71.6	H	-46.5	1.5	5.8	3.7	-44.3	-13.0	-31.3
1.520	58.0	H	-60.1	1.5	6.6	4.5	-57.2	-13.0	-44.2
1.740	70.1	H	-48.1	1.6	7.4	5.2	-44.5	-13.0	-31.5
1.960	67.3	H	-50.9	1.7	8.2	6.0	-46.6	-13.0	-33.6
2.090	51.7	H	-66.9	1.8	8.5	6.4	-62.3	-13.0	-49.3
2.180	61.2	H	-57.4	1.8	8.7	6.6	-52.6	-13.0	-39.6
Channel 16									
1.100	71.1	V	-47.7	1.4	5.1	3.0	-46.1	-13.0	-33.1
1.324	79.2	V	-39.6	1.5	5.9	3.8	-37.3	-13.0	-24.3
1.770	68.7	V	-50.2	1.6	7.5	5.3	-46.5	-13.0	-33.5
1.990	66.1	V	-52.8	1.7	8.3	6.1	-48.4	-13.0	-35.4
1.100	70.9	H	-47.2	1.4	5.1	3.0	-45.5	-13.0	-32.5
1.324	75.3	H	-42.8	1.5	5.9	3.8	-40.5	-13.0	-27.5
1.770	69.4	H	-48.8	1.6	7.5	5.3	-45.1	-13.0	-32.1
1.990	65.8	H	-52.4	1.7	8.3	6.1	-48.0	-13.0	-35.0

Rev. 5.1.6

2.1055 Frequency Stability
Requirement/Limit: 90.213(a)

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as sp
following table.

Minimum Frequency Stability
[Parts per million (ppm)]

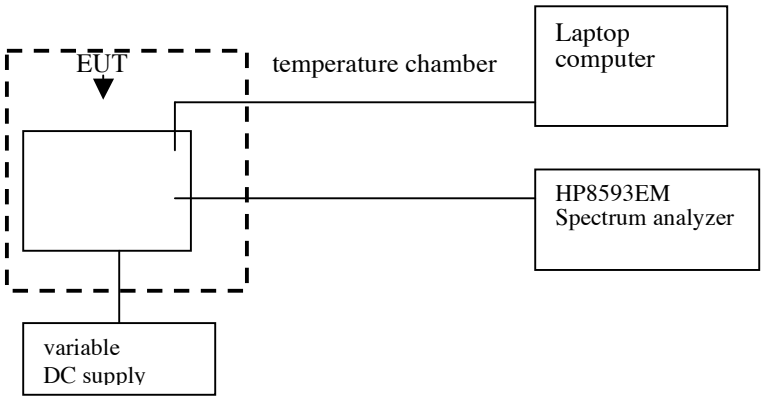
Frequency range (MHz)	Fixed base stations	Mobile stations: Over 2 watts output power	Mobile stations: 2 watts or less output power
216-220.....	1.0	----------	1.0

Frequency Tolerance : .0001% (1 part per million)
= ±217 Hz at 217.1250MHz
= ±219 Hz at 219.9875 MHz

Temperature Range: -30C to +50 C
Supply Voltage Range: 85% - 115% nominal 13.6 VDC (11.6 - 15.6 VDC)

Test Setup

Figure 3



Test Procedures

1. Spectrum analyzer center frequency was set to channel 1 operating frequency. Frequency was measured at +25C using spectrum analyzer marker function.
2. The transmitter was allowed to stabilize at every 10 degrees C from –30C to +50C and measurements were recorded at each temperature.

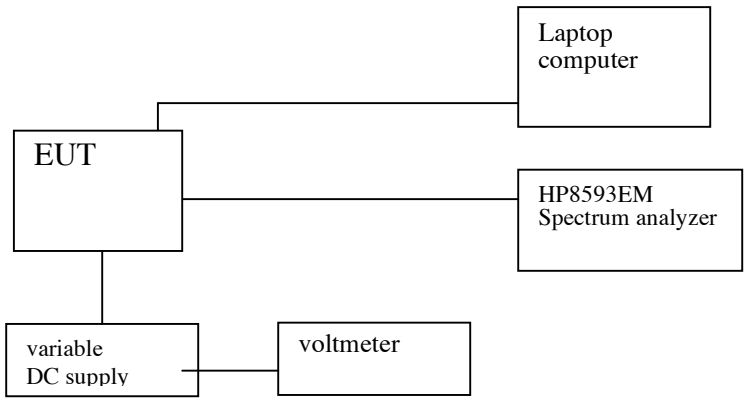
Test Results

Temp, ºC	Frequency	Delta, Hz
25	217.012501	+1
50	217.012409	-91
40	217.012533	-67
30	217.012509	+9
20	217.012512	+12
10	217.012535	+35
0	217.012481	-19
-10	217.012522	+22
-20	217.012514	+14
-30	217.012500	0

Operating Voltage v Frequency

Test Setup

Figure 4



Test Procedures

At 25C the power supply voltage was varied between 85% and 115% nominal.

Test Results

Supply Voltage, DC		Frequency	Delta
7.2	(Nominal)	217.012481	-19
8.28	(115%)	217.012478	-22
6.12	(85%)	217.012478	-22

15.109 Unintentional radiated

Receiver radiated emissions tests were performed concurrently with TX radiated emissions tests. No emissions were detected from receiver portion of the EUT.

Emissions from the digital portion of the EUT were tested to class A limits as the EUT is not sold or used in residences.

Test Set-up

Figure 2.

Test Procedures

The EUT was placed on a turntable located in a 5m anechoic chamber. The EUT was tested twice, once with the transmitter ON, the second time with the transmitter off but with the rest of the circuitry active (digital board, GPS receiver, and Bluetooth module).

EUT emissions were maximized by raising the search antenna 1-4 m in both horizontal and vertical polarities, and by rotating the turntable through a full 360 degrees.

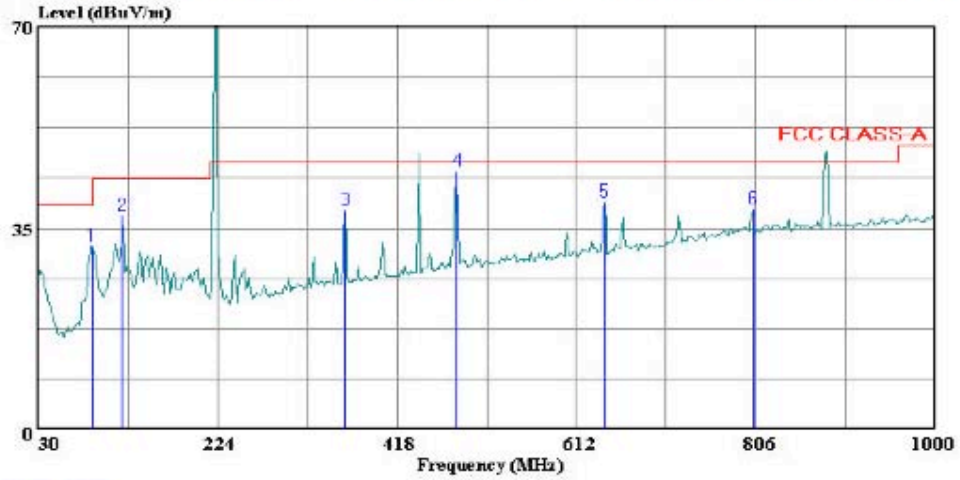
Test Results

Test plots and tabulated data are presented below for both test conditions, transmitter ON and transmitter OFF. The EUT meets class a limits for both conditions of operation.

Transmitter ON (Vertical)

561F Monterey Road
Morgan Hill, CA 95037
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 6 File#: Input-output FSU.emiDate: 08-08-2006 Time: 12:05:19



(Audix ATC)

Trace: 5 Ref Trace:

Condition: FCC CLASS-A VERTICAL
Test Operator: : Gordon Andrews
Company: : Input-Output
Project #: : 06U10476
Configuration: : EUT with laptop on floor
Mode of Operation: Tx
: FSU 217-220 MHz Transceiver

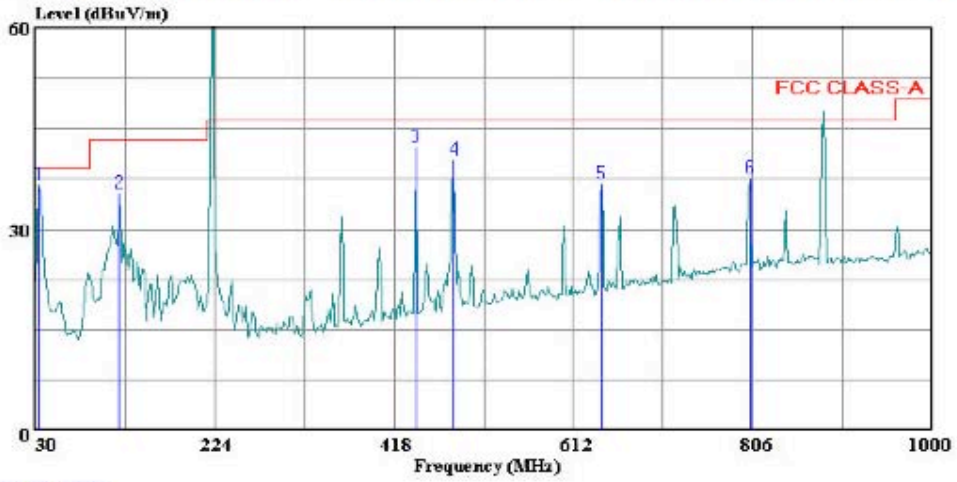
Page: 1

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	88.200	23.18	8.56	31.74	43.50	-11.76	Peak
2	121.180	21.83	15.16	36.99	43.50	-6.51	Peak
3	361.740	20.76	17.20	37.96	46.40	-8.44	Peak
4	482.990	24.87	19.89	44.76	46.40	-1.64	Peak
5	643.040	17.32	22.23	39.55	46.40	-6.85	Peak
6	803.090	13.77	24.59	38.36	46.40	-8.04	Peak

Transmitter ON (Horizontal)

561F Monterey Road
Morgan Hill, CA 95037
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 4 File#: Input-output FSU.emiDate: 08-08-2006 Time: 11:48:19



(Audix ATC)

Trace: 3 Ref Trace:

Condition: FCC CLASS-A VERTICAL
Test Operator: : Gordon Andrews
Company: : Input-Output
Project #: : 06U10476
Configuration: : EUT with laptop on floor
Mode of Operation: Tx
: FSU 217-220 MHz Transceiver

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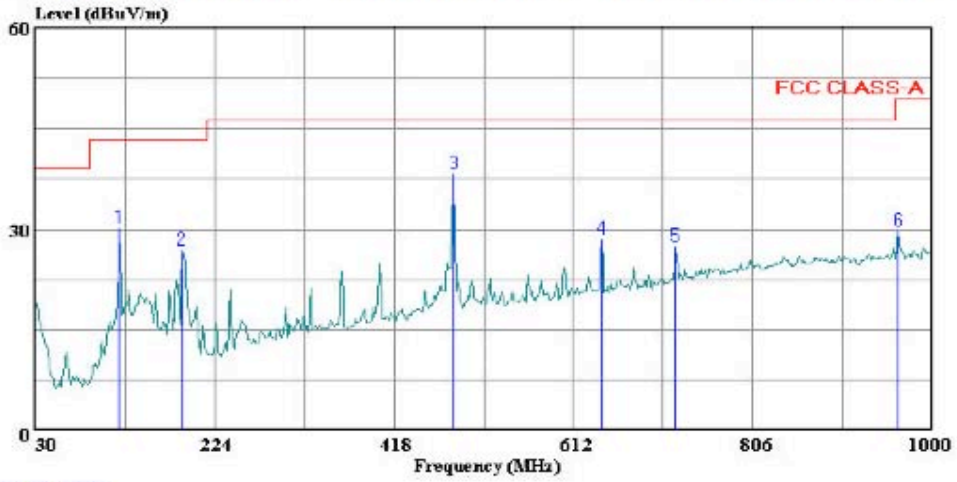
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	33.880	17.45	19.05	36.50	39.00	-2.50	Peak
2	121.180	20.09	15.16	35.25	43.50	-8.25	Peak
3	441.280	23.16	19.02	42.18	46.40	-4.22	Peak
4	482.990	20.35	19.89	40.24	46.40	-6.16	Peak
5	643.040	14.56	22.23	36.79	46.40	-9.61	Peak
6	803.090	12.95	24.59	37.54	46.40	-8.86	Peak

Transmitter OFF, worst case (Vertical)

561F Monterey Road
Morgan Hill, CA 95037
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 11 File#: Input-output FSU.emiDate: 08-24-2006 Time: 16:49:16



(Audix ATC)

Trace: 7 Ref Trace:

Condition: FCC CLASS-A VERTICAL
Test Operator: : Gordon Andrews
Company: : Input-Output
Project #: : 06U10476
Configuration: : EUT with laptop on floor
Mode of Operation: Rx
: FSU 217-220 MHz Transceiver

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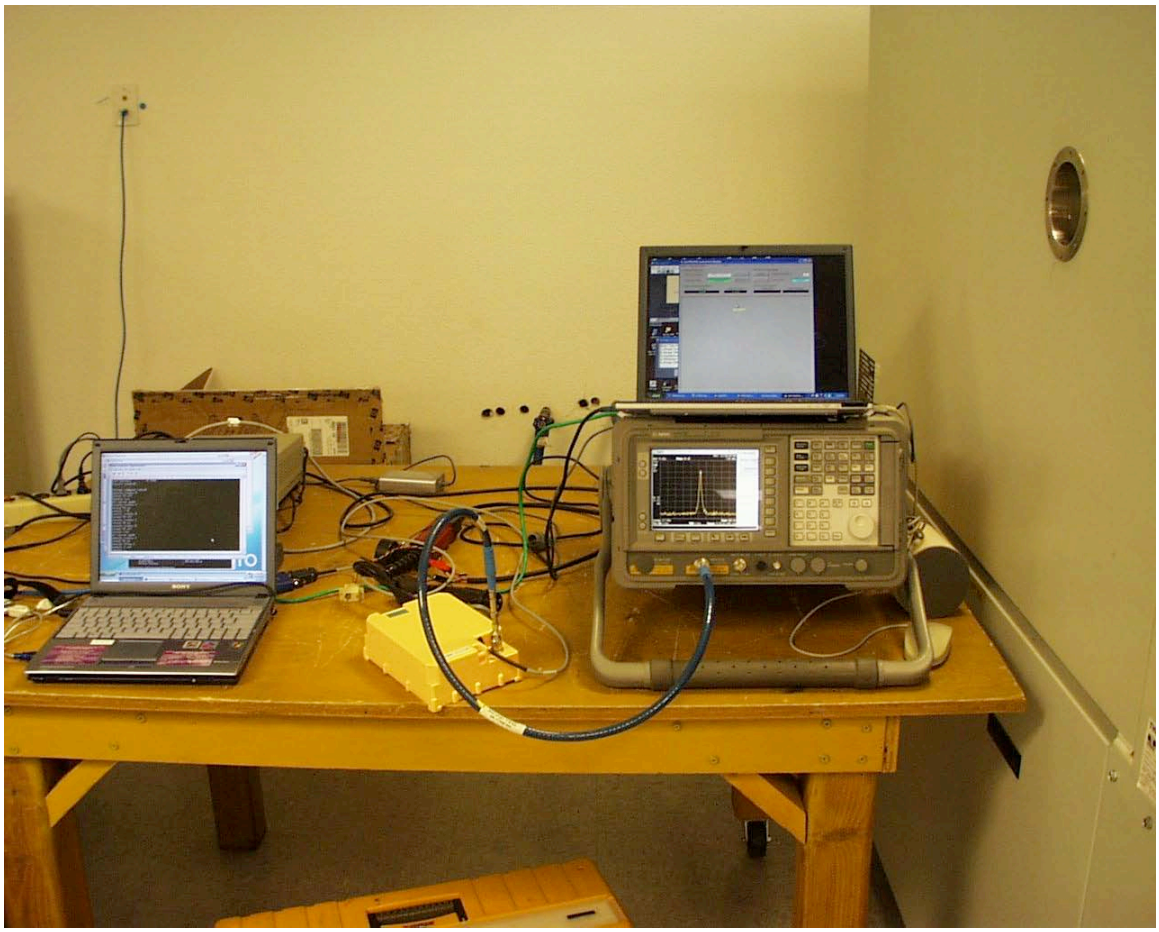
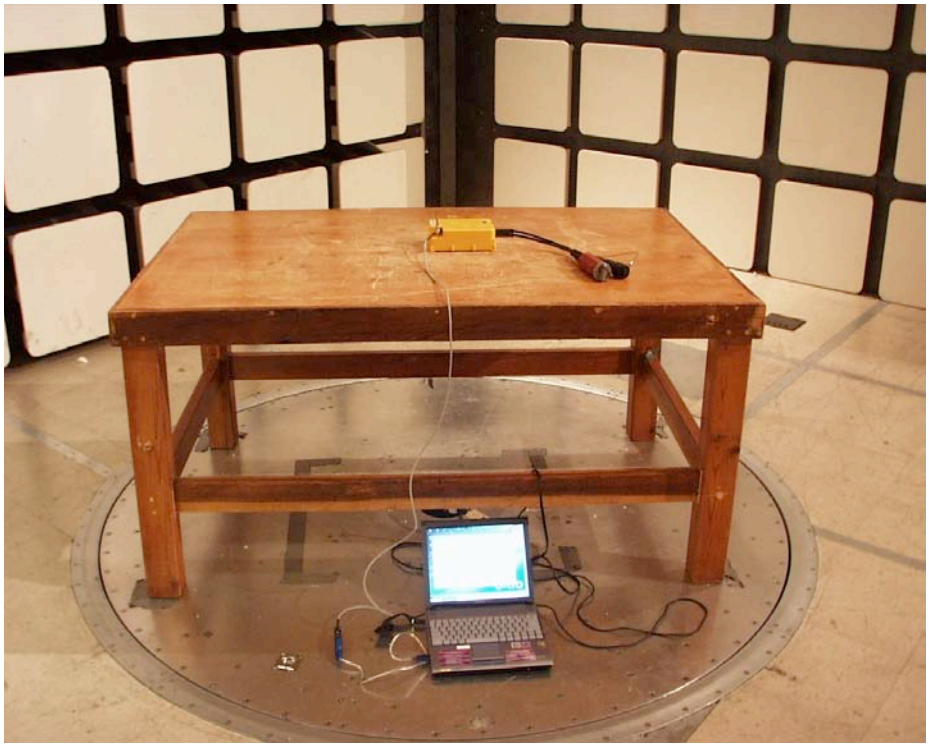
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	121.180	15.01	15.16	30.17	43.50	-13.33	Peak
2	189.080	13.77	12.93	26.70	43.50	-16.80	Peak
3	482.990	18.37	19.89	38.26	46.40	-8.14	Peak
4	643.040	6.20	22.23	28.43	46.40	-17.97	Peak
5	722.580	3.96	23.50	27.46	46.40	-18.94	Peak
6	963.140	3.18	26.61	29.79	49.50	-19.71	Peak

Test Set-up Photographs

Antenna port conducted emissions



Radiated emissions



Frequency Stability Test (Frequency v Temperature)

Frequency Stability (Frequency v Operating Voltage)