

## Test Report for Unlicensed Low Power Transmitter

### Description of device: LPL radio (see below) operating in 902-928 MHz ISM Band

The Sensus **Model AR5002** is a handheld portable PC ruggedized for industrial and commercial applications. The Handheld PC has a Type II PCMCIA slot in which an RF Transceiver card is installed at factory. The PCMCIA RF card connects to a separate dielectric antenna which is mounted internally to the AR5002 expansion pod via coaxial cable. It is not visible from the outside.

The AR5002 has two RF transceivers, one is known as the RIU (Radio Interrogate Unit) and the other is known as the **LPL (low Power Link)**. The AR5001 has only the LPL radio, the components for the RIU radio are not installed on the circuit board.

The AR5002 RIU transmitter operates under Part 101 of the Rules but is exempt from certification per 101.139(e) because output peak output power is less than 250mW.

**FCC Applicable Rule Parts:** 15.205, 15.207, 15.249

**Applicant:** Sensus Metering Systems Inc.  
450 N. Gallatin Avenue  
P.O. Box 487  
Uniontown, PA 15401

### FCC ID: KCHAR5002

Brand name: Sensus Metering Systems  
Model Nos.: AR5001, AR5002

**IC: 2220A-AR5002**

## TEST REQUIREMENTS

The referenced device is subject to certification under Part 2 of FCC Rules. The specific emissions limits and test requirements are found in Part 15 of FCC Rules. In addition to the device specific requirements listed in 15.249 (re-printed below), the following Part 15 requirements are universal to all unlicensed transmitters and would also apply:

- 15.19 Labeling requirements
- 15.20 Accessories
- 15.21 Information to user
- 15.31 Measurement standards
- 15.33 Frequency range of measurements
- 15.35 Measurement detector functions and bandwidths
- 15.109 Radiated Emissions (unintentional radiators)

- 15.203 Antenna requirement
- 15.204 External radio frequency power amplifiers and antenna modifications.
- 15.205 Restricted bands of operation.
- 15.207 Conducted limits
- 15.209 Radiated emission limits, general requirements.

## REVISION INFORMATION AND ATTESTATION OF RESULTS

Report No: 06PR034LPLTX

<b>REV No.</b>	<b>Description</b>	<b>Revised By:</b>	<b>Date</b>
-	Original Submission	T. Cokenias	2 June 06

Test Requirement: FCC Part 15  
Manufacturer: Sensus Metering Systems  
FCC ID: KCHAR5002  
Brand name: Sensus Metering Systems  
Model Nos.: AR5001, AR5002  
IC: 2220A-AR5002

FCC ID: KCHAR5002 meets all FCC requirements for a device of this type.

THOMAS N. COKENIAS 2 June 2006

J. M. Aben

## EMC and Radio Regulatory Consultant Agent for Sensus Metering Systems

**15.205 Restricted bands of operation.**

Only spurious emissions are permitted in any of the frequency bands listed below: The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209.

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
10.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	
13.36 - 13.41			

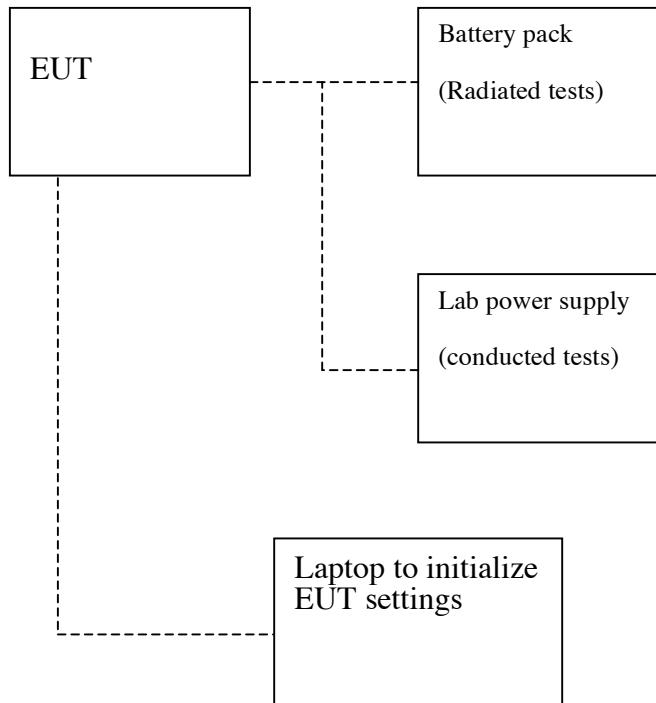
**15.109 Radiated emission limits, general requirements.**

Except as provided elsewhere in this paragraph the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength uV/m	Measurement distance, m
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

\*\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz.

### Test Set-up Diagram



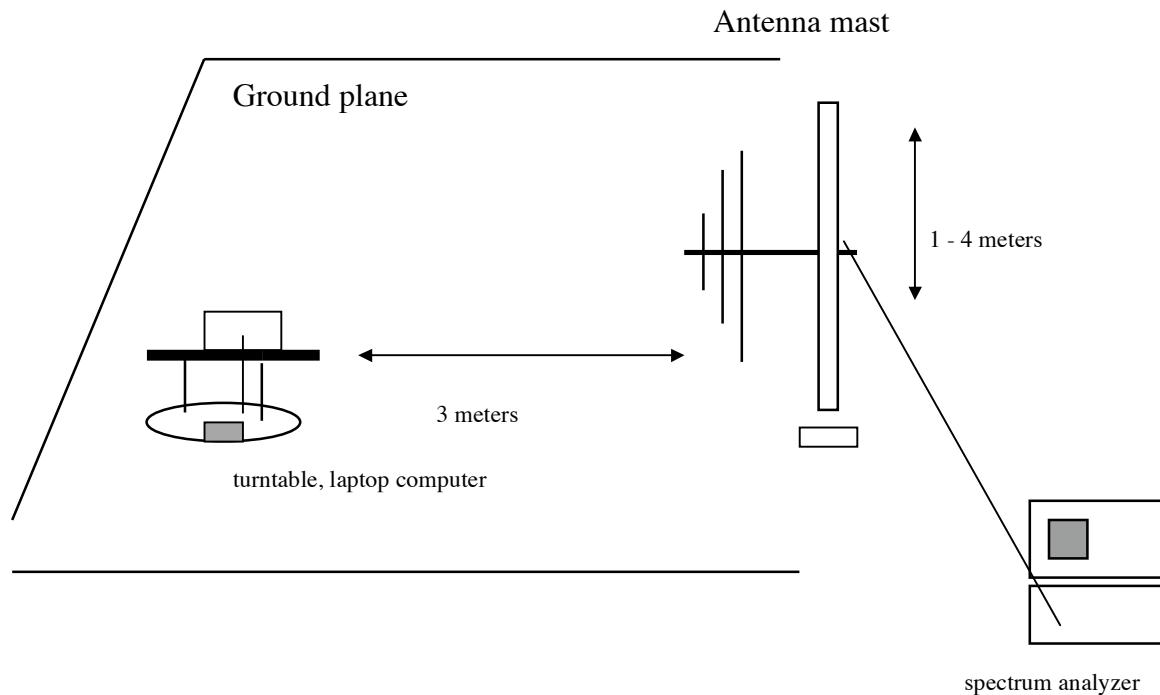
TEST EQUIPMENT LIST				
Name of Equipment	Manufacturer	Model No.	Serial No.	Due Date
Antenna, Horn 1 ~ 18 GHz	ETS	3117	29301	4/22/06
Preamplifier, 1 ~ 26.5 GHz	Agilent / HP	8449B	3008A00369	8/17/06
Spectrum Analyzer 3 Hz ~ 44 GHz 1.5 GHz HPF	Agilent / HP MicroTronics	E4446A	US42510266 002	10/19/06

**15.249 Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz, and 24.0 - 24.25 GHz.**

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following table. Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209, whichever is the lesser attenuation.

Fundamental Frequency	Field Strength, fundamental emission at 3 meters	Field Strength, harmonics and spurious emissions at 3m
<b>902-928 MHz</b>	<b>50,000 uV/m (94 dBuV/m)</b>	<b>500 uV/m (54 dBuV/m)</b>
2400 - 2483.5 MHz	50,000 uV/m (94 dBuV/m)	500 uV/m (54 dBuV/m)
5725-5875 MHz	50,000 uV/m (94 dBuV/m)	500 uV/m (54 dBuV/m)
24.0 - 24.25 GHz	250,000uV/m (104 dBuV/m)	2500 uV/m (68 dBuV/m)

**15.205, 15.209, 15.249 Radiated Emissions  
Radiated Test Set-up, 30 - 1000 MHz**



**Test Procedures, 30 -1000 MHz**

The EUT was set to normal operating conditions (constantly transmitting). Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4.

**In-band Test Results (Fundamental Frequencies L,M, H channels)**



**COMPLIANCE**  
Certification Services

06U10062  
06U10062B  
03/30/06 11:53 AM

FCC, VCCI, CISPR, CE, AUSTEL, NZ  
UL, CSA, TUV, BSMI, DHHS, NVLAP

561F MONTEREY ROAD, SAN JOSE, CA 95037-9001  
PHONE: (408) 463-0885 FAX: (408) 463-0888

A-Site  B-Site  C-Site  F-Site  6 Worst Dat  Descending

Freq. (MHz)	Reading (dBuV)	AF (dB)	Closs (dB)	Pre-amp (dB)	Level (dBuV/m)	Limit FCC_B (dB)	Margin (dB)	Pol (H/V)	Az (Deg)	Height (Meter)	Mark (P/Q/A)
High Ch. Up position											
927.69	59.16	20.78	7.84	0.00	87.78	46.00	41.78	3mV	0.00	2.50	P
927.69	55.74	20.78	7.84	0.00	84.36	46.00	38.36	3mH	90.00	1.00	P
High Ch. Lay down position											
927.69	62.41	20.78	7.84	0.00	91.03	46.00	45.03	3mH	90.00	1.00	P
927.69	60.60	20.78	7.84	0.00	89.22	46.00	43.22	3mV	0.00	1.50	P
Mid Ch. Up position											
914.85	61.57	20.71	7.78	0.00	90.06	46.00	44.06	3mV	0.00	1.50	P
914.85	52.84	20.71	7.78	0.00	81.33	46.00	35.33	3mH	90.00	3.50	P
Mid Ch. Lay down position											
914.85	56.74	20.71	7.78	0.00	85.23	46.00	39.23	3mH	90.00	4.00	P
914.85	65.16	20.71	7.78	0.00	93.65	46.00	47.65	3mV	0.00	1.00	P
Low Ch. Up position											
903.08	58.48	20.65	7.72	0.00	86.84	46.00	40.84	3mV	0.00	1.50	P
903.08	54.41	20.65	7.72	0.00	82.77	46.00	36.77	3mH	90.00	3.50	P
Low Ch. Lay down position											
903.08	55.48	20.65	7.72	0.00	83.84	46.00	37.84	3mH	90.00	4.00	P
903.08	62.11	20.65	7.72	0.00	90.47	46.00	44.47	3mV	0.00	1.50	P
Total data #: 12											
V.2b											

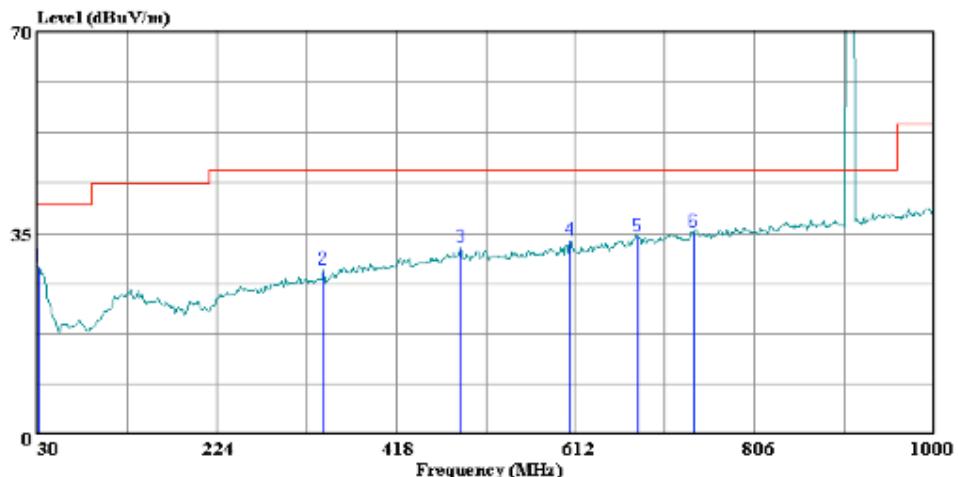
NOTE: Measurement system software was developed for FCC Part 15.109 test limits (unintentional radiators) and does not have provisions for modifying limit. For 15.249 devices operating in the 902-928 MHz range, radiated limit at fundamental emission is 50,000 uV/m = 94 dBuV/m at 3m (quasi peak detector). Fundamental emission peak readings are all below 94dBuV/m, readings for peak detector is equal to or greater than for quasi peak detector.

**Out of Band emissions: Below 1 GHz – LOW Channel, Vertical**



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

Data#: 28 File#: EMI.EMI Date: 03-31-2006 Time: 13:47:16



(Audix ATC)

Trace: 27

Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator : William Zhuang  
Project # : 06U10062  
Company : Sensus / TomCokenias  
EUT : 902-928MHz + 952-956MHz Tranceiver  
Model No : Meter Transmitter  
S/N :  
Configuration : EUT stand alone  
Mode of operation: LPL Transmit, Low Ch. 903.08MHz  
Target of Test : FCC 15.247

Page: 1

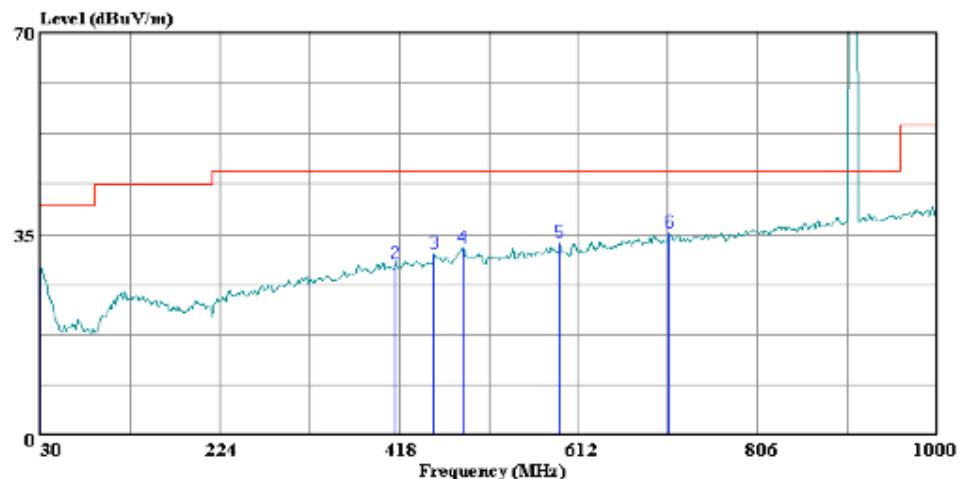
Freq	Read		Limit Line	Over Line	Remark
	MHz	dBuV	Level	dBuV/m	dBuV/m
		dB			
1	30.970	8.74	20.45	29.19	40.00 -10.81 Peak
2	339.430	12.06	16.61	28.67	46.00 -17.33 Peak
3	487.840	12.40	20.00	32.40	46.00 -13.60 Peak
4	606.180	12.00	21.63	33.63	46.00 -12.37 Peak
5	679.900	11.56	22.83	34.39	46.00 -11.61 Peak
6	740.040	11.30	23.71	35.01	46.00 -10.99 Peak

**Out of Band emissions: Below 1 GHz – LOW Channel, Horizontal**



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

Data#: 30 File#: EMI.EMI Date: 03-31-2006 Time: 13:53:54



(Audix ATC)  
Trace: 29 Ref Trace:

Condition: FCC CLASS-B HORIZONTAL  
Test Operator : William Zhuang  
Project # : 06U10062  
Company : Sensus / TomCokenias  
EUT : 902-928MHz + 952-956MHz Tranceiver  
Model No : Meter Transmitter  
S/N :  
Configuration : EUT stand alone  
Mode of operation: LPL Transmit, Low Ch. 903.08MHz  
Target of Test : FCC 15.247

Page: 1

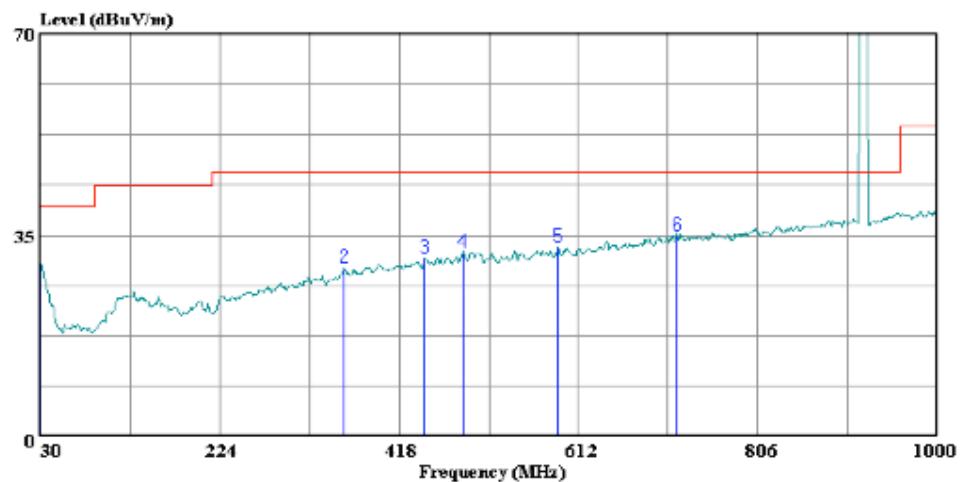
Freq	Read		Limit	Over	Remark
	Level	Factor			
MHz	dBuV	dB	dBuV/m	dBuV/m	dB
1	30.000	8.71	20.45	29.16	40.00 -10.84 Peak
2	414.120	11.50	18.40	29.90	46.00 -16.10 Peak
3	455.830	12.06	19.33	31.39	46.00 -14.61 Peak
4	486.870	12.59	19.97	32.56	46.00 -13.44 Peak
5	591.630	12.03	21.38	33.41	46.00 -12.59 Peak
6	710.940	11.82	23.26	35.08	46.00 -10.92 Peak

**Out of Band emissions: Below 1 GHz – MID Channel, Vertical**



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

Data#: 34 File#: EMI.EMI Date: 03-31-2006 Time: 14:10:27



(Audix ATC)  
Trace: 33 Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator : William Zhuang  
Project # : 06U10062  
Company : Sensus / TomCokenias  
EUT : 902-928MHz + 952-956MHz Tranceiver  
Model No : Meter Transmitter  
S/N :  
Configuration : EUT stand alone  
Mode of operation: LPL Transmit, Mid Ch. 914.85 MHz  
Target of Test : FCC 15.247

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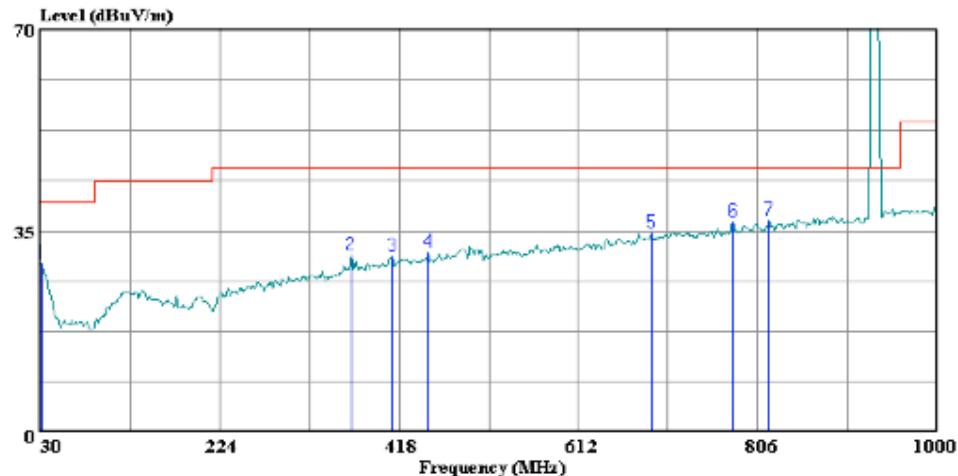
Freq	Read		Limit	Over	Remark
	Level	Factor			
MHz	dBuV	dB	dBuV/m	dBuV/m	dB
1	30.000	9.55	20.45	30.00	40.00 -10.00 Peak
2	358.830	12.27	17.12	29.39	46.00 -16.61 Peak
3	446.130	11.86	19.09	30.95	46.00 -15.05 Peak
4	486.870	11.97	19.97	31.95	46.00 -14.05 Peak
5	589.690	11.60	21.39	32.99	46.00 -13.01 Peak
6	718.700	11.53	23.42	34.95	46.00 -11.05 Peak

**Out of Band emissions: Below 1 GHz – HIGH Channel, Vertical**



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

Data#: 36 File#: EMI.EMI Date: 03-31-2006 Time: 14:21:48



(Audix ATC)

Trace: 35

Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator : William Zhuang  
Project # : 06U10062  
Company : Sensus / TomCokenias  
EUT : 902-928MHz + 952-956MHz Tranceiver  
Model No : Meter Transmitter  
S/N :  
Configuration : EUT stand alone  
Mode of operation: LPL Transmit, High Ch. 927.69 MHz  
Target of Test : FCC 15.247

Page: 1

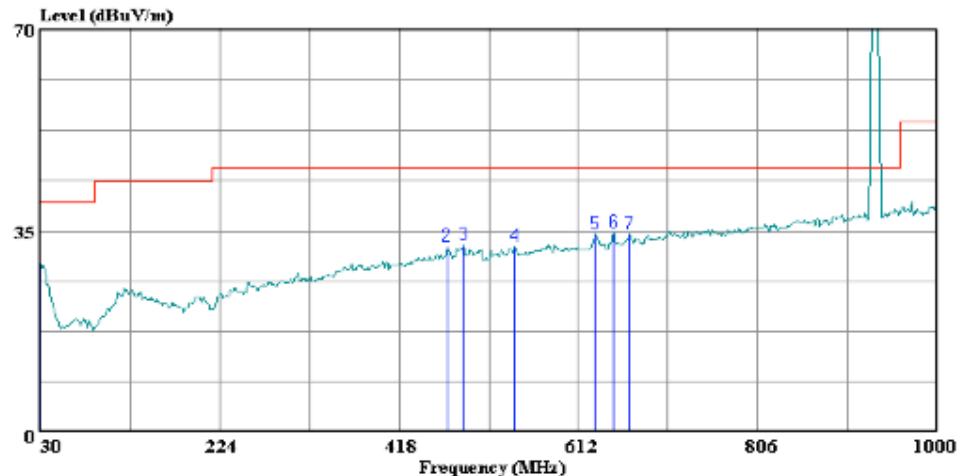
Freq	Read		Limit	Over	Remark
	MHz	dBuV			
			dBuV/m	dBuV/m	
1	30.970	8.78	20.45	29.23	40.00 -10.77 Peak
2	366.590	13.55	17.31	30.86	46.00 -15.14 Peak
3	410.240	12.17	18.31	30.48	46.00 -15.52 Peak
4	449.040	12.07	19.17	31.24	46.00 -14.76 Peak
5	691.540	11.69	22.96	34.65	46.00 -11.35 Peak
6	778.840	12.45	24.24	36.69	46.00 -9.31 Peak
7	817.640	11.97	24.83	36.80	46.00 -9.20 Peak

**Out of Band emissions: Below 1 GHz – HIGH Channel, Horizontal**



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

Data#: 38 File#: EMI.EMI Date: 03-31-2006 Time: 14:27:22



(Audix ATC)

Trace: 37

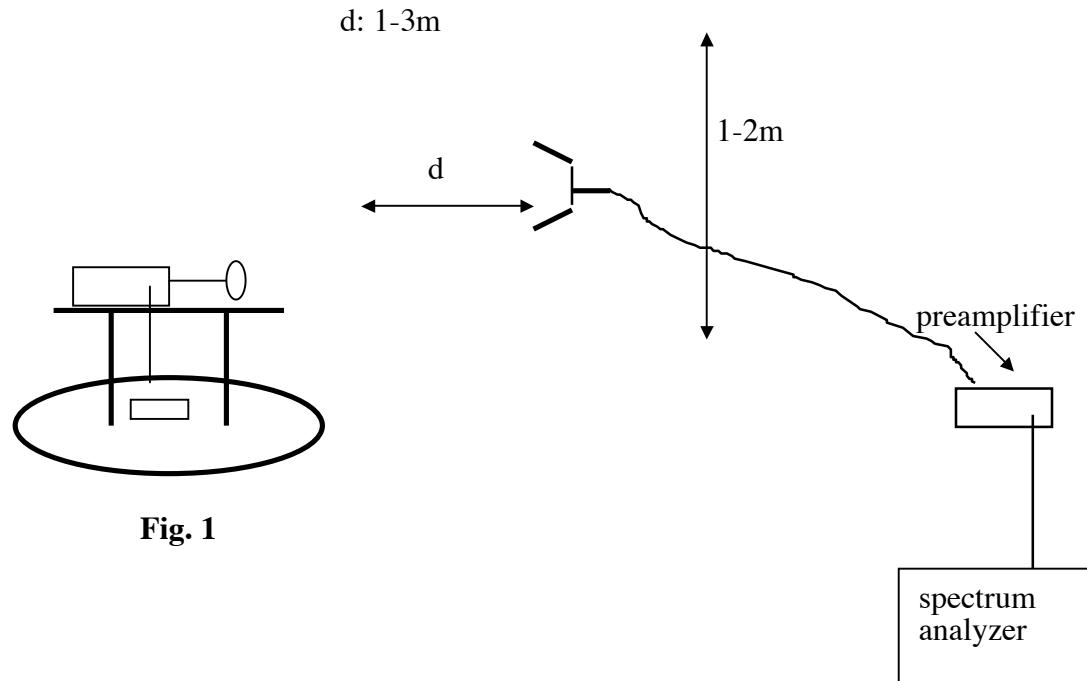
Ref Trace:

Condition: FCC CLASS-B HORIZONTAL  
Test Operator : William Zhuang  
Project # : 06U10062  
Company : Sensus / TomCokenias  
EUT : 902-928MHz + 952-956MHz Tranceiver  
Model No : Meter Transmitter  
S/N :  
Configuration : EUT stand alone  
Mode of operation: LPL Transmit, High Ch. 927.69 MHz  
Target of Test : FCC 15.247

Page: 1

Freq	Read		Limit	Over	Remark
	MHz	dBuV			
			dBuV/m	dBuV/m	
1	30.000	8.79	20.45	29.24	40.00 -10.76 Peak
2	470.380	12.69	19.65	32.34	46.00 -13.66 Peak
3	487.840	12.54	20.00	32.54	46.00 -13.46 Peak
4	543.130	11.55	20.79	32.34	46.00 -13.66 Peak
5	630.430	12.35	22.00	34.35	46.00 -11.65 Peak
6	649.830	12.39	22.35	34.74	46.00 -11.26 Peak
7	667.290	11.65	22.66	34.31	46.00 -11.69 Peak

**15.205, 15.209, 15.249 Radiated Emissions  
Test Set-up, 1-40 GHz**



**Fig. 1**

**Test Procedure**

The EUT was placed on a wooden turntable located 3m from the search antenna. The EUT was activated to transmit continuously. Radiated emissions from fundamental operating frequency to the 10<sup>th</sup> harmonic, for search antenna in both vertical and horizontal polarities.

**Test Results**

Data shows the EUT meets all radiated requirements specified in 15.205 and 15.249. For each antenna, radiated data points listed are the only ones detected within 20 dB of the limit. Refer to attached spread sheet and spectrum analyzer conducted output plot.

Receiver radiated emissions were also measured against the limits in 15.109 in the Rules. No emissions from the receiver were detected within 20 dB of the limits.

03/29/06 High Frequency Measurement Compliance Certification Services, Morgan Hill Open Field Site																												
Test Engr: William Zhuang Project #: 06U10062 Company: Sensus EUT Descrip.: 902-928MHz 15.249 Transceiver (LPL) + Part 101 120mW Transceiver 952-956MHz (RIU) FCC ID: KCHAR5002 Test Target: FCC 15.249 (LPL section of device) Mode Oper: Tx On																												
f	Measurement Frequency				Amp	Preamp Gain				Avg Lim		Average Field Strength Limit																
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters				Pk Lim	Peak Field Strength Limit				Avg Mar	Margin vs. Average Limit															
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m				Pk Mar	Margin vs. Peak Limit				Pk Mar	Margin vs. Peak Limit															
AF	Antenna Factor	Peak	Calculated Peak Field Strength																									
CL	Cable Loss	HPF	High Pass Filter																									
f	Dist	Read Pk	Read Avg	AF	CL	Amp	D Corr	Fltr	Peak	Avg	Pk Lim	Avg Lim	Pk Mar	Avg Mar	Notes	(V/H)												
GHz	(m)	dBuV	dBuV	dB/m	dB	dB	dB	dB	dBuV/m	dBuV/m	dBuV/m	dBuV/m	dB	dB	(V/H)													
Low Ch. 903.08MHz																												
1.806	3.0	51.3	47.3	30.9	2.6	-37.1	0.0	0.3	47.9	43.9	74.0	54.0	-26.1	-10.1	V, Up position													
2.709	3.0	44.2	32.4	32.1	2.9	-36.1	0.0	0.6	43.7	31.9	74.0	54.0	-30.3	-22.2	V, Up position													
1.806	3.0	50.9	46.4	30.9	2.6	-37.1	0.0	0.3	47.5	43.0	74.0	54.0	-26.5	-11.0	H, Up position													
2.709	3.0	44.4	31.7	32.1	2.9	-36.1	0.0	0.6	43.8	31.2	74.0	54.0	-30.2	-22.8	H, Up position													
1.806	3.0	48.2	41.8	30.9	2.6	-37.1	0.0	0.3	44.8	38.4	74.0	54.0	-29.2	-15.6	V, lay down position													
2.709	3.0	43.6	31.8	32.1	2.9	-36.1	0.0	0.6	43.1	31.2	74.0	54.0	-30.9	-22.8	V, lay down position													
1.806	3.0	46.7	38.4	30.9	2.6	-37.1	0.0	0.3	43.3	35.0	74.0	54.0	-30.7	-19.0	H, lay down position													
2.709	3.0	44.1	32.1	32.1	2.9	-36.1	0.0	0.6	43.6	31.5	74.0	54.0	-30.4	-22.5	H, lay down position													
Mid Ch. 914.85MHz																												
1.830	3.0	47.3	36.0	31.0	2.6	-37.1	0.0	0.3	44.0	32.8	74.0	54.0	-30.0	-21.2	V, Lay down position													
2.745	3.0	54.7	54.7	32.2	2.9	-44.4	0.0	0.6	46.1	46.1	74.0	54.0	-27.9	-7.9	V, Lay down position													
1.830	3.0	46.0	34.6	31.0	2.6	-37.1	0.0	0.3	42.8	31.3	74.0	54.0	-31.2	-22.7	H, Lay down position													
2.745	3.0	54.7	54.7	32.2	2.9	-44.4	0.0	0.6	46.1	46.1	74.0	54.0	-27.9	-7.9	H, Lay down position													
1.830	3.0	47.1	37.7	31.0	2.6	-37.1	0.0	0.3	43.9	34.4	74.0	54.0	-30.1	-19.6	V, Up position													
1.830	3.0	45.9	36.0	31.0	2.6	-37.1	0.0	0.3	42.7	32.7	74.0	54.0	-31.3	-21.3	H, Up position													
High Ch. 927.69MHz																												
1.855	3.0	46.2	33.6	31.1	2.6	-37.1	0.0	0.3	43.1	30.5	74.0	54.0	-30.9	-23.5	V, Lay down position													
2.783	3.0	43.2	30.6	32.1	3.0	-36.1	0.0	0.6	42.8	30.2	74.0	54.0	-31.2	-23.8	V, Lay down position													
1.855	3.0	45.7	33.5	31.1	2.6	-37.1	0.0	0.3	42.6	30.4	74.0	54.0	-31.4	-23.6	H, Lay down position													
2.783	3.0	43.0	30.6	32.1	3.0	-36.1	0.0	0.6	42.6	30.2	74.0	54.0	-31.4	-23.8	H, Lay down position													
1.855	3.0	46.1	33.4	31.1	2.6	-37.1	0.0	0.3	43.0	30.3	74.0	54.0	-31.0	-23.7	V, Up position													
2.783	3.0	43.8	30.6	32.1	3.0	-36.1	0.0	0.6	43.5	30.2	74.0	54.0	-30.5	-23.8	V, Up position													
1.855	3.0	45.7	34.2	31.1	2.6	-37.1	0.0	0.3	42.6	31.1	74.0	54.0	-31.4	-22.9	H, Up position													
2.783	3.0	43.4	31.6	32.1	3.0	-36.1	0.0	0.6	43.0	31.2	74.0	54.0	-31.0	-22.8	H, Up position													

### Radiated Emissions Test Set-up Photograph

EUT Vertical

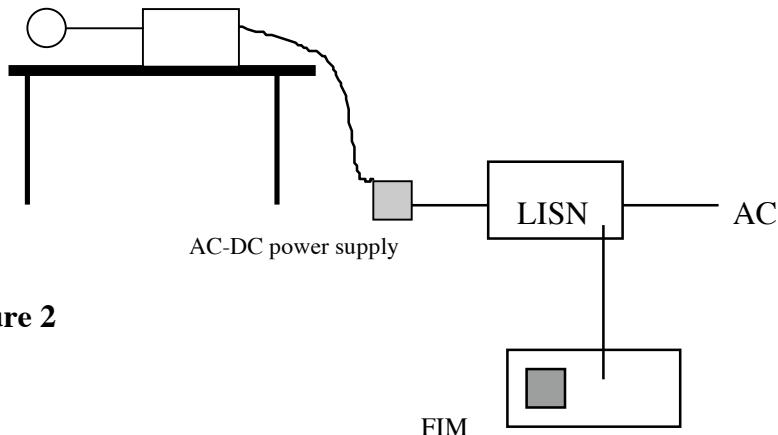


EUT Horizontal



**AC Line Conducted Emissions**  
**Test Requirement: 15.107, 15.207**

**Test Set-up**



**Figure 2**

**Test Procedure**

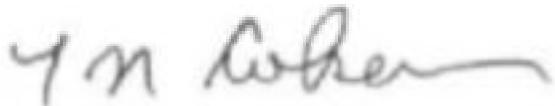
1. The EUT was placed on a wooden table 40 cm from a vertical ground plane and approximately 80 cm above the horizontal ground plane on the floor. The EUT was set to transmit in normally.
2. Line conducted data was recorded for both NEUTRAL and HOT lines.

**Test Results**

NOT PERFORMED. EUT is battery operated only

### **Human Hazard RF Exposure Considerations**

FCC requirements concerning measuring and reporting human RF exposure hazards are found in section 1.1307 and 2.1091 of the Rules. There are no requirements for measurement or reporting RF exposure hazard potential for 902-928 MHz devices operating under 15.249; per the referenced rules, this type of equipment is categorically exempt from having to meet the requirements because the RF power output is only a fraction of a milliwatts.



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