

Test report no. : 20082015

Item tested : GEOSPACE SEISMIC RECORDER (GSR)

Type of equipment : IEEE 802.15.4, 2.4GHz

FCC ID : WAOGSR

Client : Oyo Geospace Corporation

FCC Part 15.247
Digital Transmission System

RSS-210 Issue 7 & RSS Gen Issue 2
Low Power Licence-Exempt
Radiocommunication Devices

17 June 2008

Authorized by : _____



Wayne Langston

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1 GENERAL INFORMATION

1.1 Test Lab Information

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Montgomery, Texas 77316

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Fax : Fax (281) 337-7217

E-mail: wayne.langston@waynelangstoninc.com

NVLAP # : 200021-0

1.2 Client Information

Name : Oyo Geospace Corporation

Address : 7007 Pinemont
Houston, TX 77040

Telephone : 713-986-4444

Fax : 713-986-4448

E-mail: rjames@oyogeospace.com

1.3 Manufacturer

Same as client

2 Test Information

2.1 Test Item

Name :	Geospace Seismic Recorder (GSR)
FCC ID :	WAOGSR
Model/version :	GSR
Serial number :	Not Stated
Hardware identity and/or version:	Not Stated
Software identity and/or version :	10.09
Frequency Range :	2405 - 2480 MHz
Tunable Bands :	1
Number of Channels :	16 ¹
Operating Modes :	TX & RX
Type of Modulation :	O-QPSK
Emissions Designator :	G1D
User Frequency Adjustment :	None, Software controlled
Rated Output Power :	2 mW (3 dBm)
Type of Power Supply :	12 V DC
Antenna Connector :	Integral antenna only
Antenna Diversity Supported :	None

1) 16 channels in use.

Theory of Operation

The Geospace Seismic Recorder (GSR) is a stand alone seismic acquisition system. The unit consists of;

- a power conditioning circuits to convert the battery voltage to the various voltages need within the GRS,
- a signal conditioning and digitizing circuit,
- a non-volatile memory to store the digitized data,
- a GPS radio receiver and processing circuit,
- an IEEE® 802.15.4-compliant transceiver that operates in the 2.4 GHz ISM frequency band,
- a microprocessor to oversee all of these functions.

A typical survey might utilize several thousand GSRs placed on a 50m grid with geophone sensors connected to the analog inputs of the GSRs. The GSRs amplify, condition and digitize the input from the geophones. The digital data is stored in non-volatile memory for the duration of the survey. When the survey is complete, the GSR is taken to a computer station with proprietary hardware and software which is used to recover the data in the GSR non-volatile memory. The data from all of the GSRs in the survey are then merged into a much larger data set that is then processed with the intention of creating a 3

dimensional image of the earth's subsurface.

Given that the GSR may be left to record data for several days to several weeks, it is important that the user be able to monitor the health of the unit during seismic data acquisition. The 2.4 GHz radio allows a GSR to communicate with other GSRs or Laptop mounted radios in order to report the status or health of the unit.

2.2 Test Environment

2.2.1 Normal test condition

Temperature: 20 - 26 °C

Relative humidity: 20 - 40 %

Normal test voltage: 12 V DC

2.3 Test Period

Item received date: 15 May 2008

Test period : from 15 May 2008 to 17 June 2008



3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Oyo Geospace Corporation

Model No: GSR

All measurements are traceable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15.247.

Radiated tests were conducted in accordance with ANSI C63.4-2003. The radiated tests were made in a semi-anechoic chamber at measuring distances of 1 and 3 meters.

■ New Submission

Class II Permissive Change

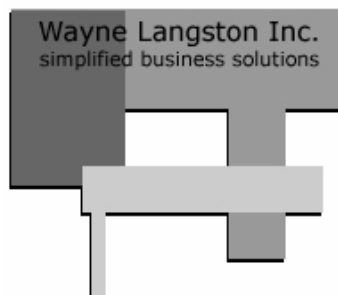
DTS Equipment Code

■ Production Unit

Pre-production Unit

Family Listing

**THIS TEST REPORT RELATES ONLY TO THE ITEM (S) TESTED.
Deviation from, additions to, or exclusions from the test specifications are described in
"Summary of Test Data"**



TESTED BY: Wayne Langston Date: June 17, 2008

3.2 Test Summary

Name of test	FCC Part 15 reference	RSS210 Issue 7 & RSS Gen Issue 2	Result
Supply voltage variations	15.31 (e)	8 (RSS-GEN)	N/A ²
Number of operating frequencies	15.31 (m)	A8.1	Complies
Power-line Conducted Emissions (Receiver)	15.107(a)	7.2.2 (RSS-GEN)	ref. 15.207(a)
Radiated Emissions limits (receiver)	15.109(a)	6 (RSS-GEN)	ref. 15.209(a)
Antenna requirement	15.203	7.1.4 (RSS-GEN)	Complies ¹
Radiated emissions limits for restricted bands	15.205(a)		Complies
Power Line Conducted Emissions	15.207(a)	7.2.2 (RSS-GEN)	N/A ²
Radiated emission limits	15.209(a)	A8.5	Complies
Bandwidth	15.247(a)(2)	A8.2	Complies
Peak Power Output	15.247(b)(3)	A8.4	Complies
Power Spectral Density	15.247(d)	A8.2	Complies
Out-of-band emissions (Antenna Conducted)	15.247(c)	A8.5	Complies ¹
Out-of-band emissions (Radiated)	15.247(c)	A8.5	Complies
Lower band edge radiated emission	15.247(c)	A8.5	Complies
Upper band edge radiated emission	15.247(c)	A8.5	Complies

¹ Integral antenna only . For testing purpose MPX connector was provided.

² The manufacturer specified voltage range is 12 V DC (Battery operated)

3.3 Description of modification for Modification Filing

Not applicable.

3.4

Comments

The laptop PC connects to the EUT via an Ethernet network hard wired connection. The laptop PC is used to select the channel and to instruct the Atmel AT86RF230 ZigBee radio IC to operate in a 100% continuous transmit mode. In this mode the IC transmits in every other way the same as in normal operation. The measurements are performed at channels near top Ch 26, near middle Ch 18 and near bottom Ch 11. The output level is set to maximum in the firmware. The EUT complies at these channels.

The laptop PC is powered off during the test. The laptop is a Panasonic, Toughbook model CF-74 . The laptop belongs to the manufacturer.

All measurements are done with a fully charged battery.

The radiated measurements are tested on three axis

Both ports of the EUT are populated during spurious emission measurements. (Port 1, External battery & Port 2, Geophone String)

A temporary antenna connector is used only for making conducted RF measurements for evaluation purposes.

3.5 Family List Rationale
Not Applicable.

4 TEST RESULTS

4.1 Power-line Conducted Emissions

Para. No.: 15.207 (a)

Test Performed By: -

Date of Test: -

Measurement procedure: ANSI C63.4-2003 using 50 uH/50 ohms LISN.

Test Results: N/A

Measurement Data: N/A

The tested EUT is battery operated.

4.2 Minimum 6 dB Bandwidth

Para. No.: 15.247 (a)(2)

Test Performed By: Wayne Langston

Date of Test: 02 June 2008

Test Results: Complies

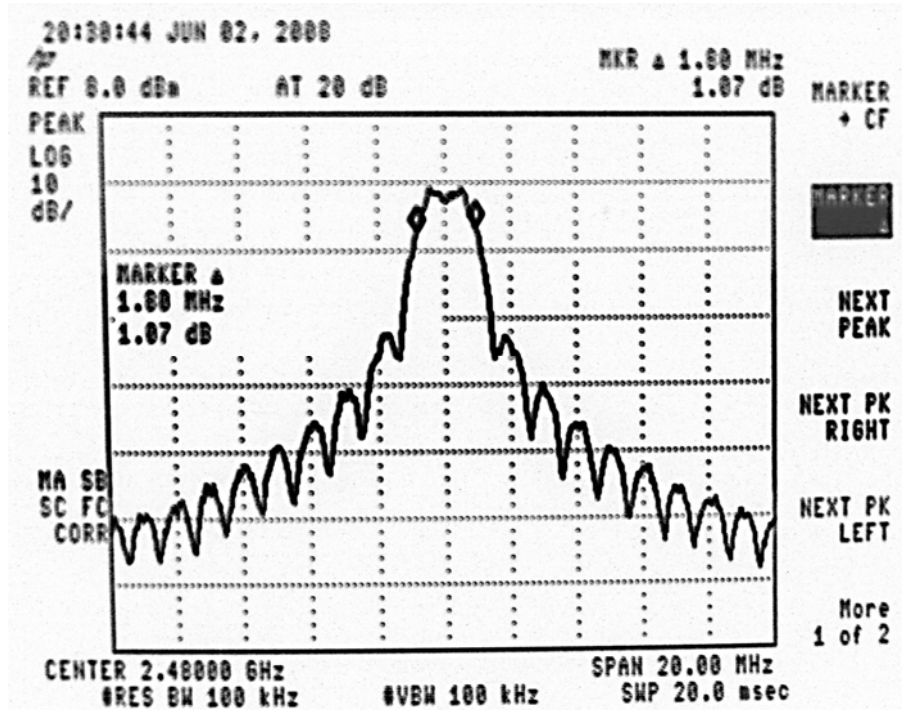
Measurement Data:

6 dB Bandwidth (MHz)		
Ch 11	Ch 18	Ch 26
2405MHz	2440MHz	2480MHz
1.60 MHz	1.70 MHz	1.80 MHz

A fully charged battery is used.

Requirements:

For Digital Transmission Systems in the 2400-2483.5 MHz band the minimum 6 dB bandwidth shall be at least 500 KHz.



CH26 - 6 dB bandwidth - 1.80MHz



4.3 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: Wayne Langston

Date of Test: 02 June 2008

Test Results: Complies

Measurement Data:

Maximum Conducted Peak Output Power Measured

RF channel		Ch 11	Ch 18	Ch 26
Measured value	(dBm)	-0.15	-0.04	+76
Corrected value for cable loss	(dBm)	0.68	0.79	1.59
Measured, Corrected Power	(mW)	1.17	1.20	1.44
Calculated Field Strength, Isotropic Ant, 1m	(dBµV/m)	105.45	105.56	106.35

Maximum field strength Measured @ 1m

RF channel		Ch 11	Ch 18	Ch 26
Measured value	(dBm)	- 31.63	- 30.28	- 31.17
Corrected value for cable loss	(dBm)	-30.80	-29.45	-30.34
Measured value in volts	(dBµV)	76.20	77.55	76..66
Measured, Corrected Field Strength	(dBµV/m)	107.24	108.59	107.70

RF channel		Ch 11	Ch 18	Ch 26
Antenna gain	(dBi)	1.79	3.03	1.35

Conducted and radiated measurements both made through .5m of RG316. 0.83dB loss

Measurement Antenna Calibration: AF = 31.04 dB/m

Ideal Isotropic field strength $V/M = \text{sqrt}(377 P_{in}/4 \pi r^2)$

Detachable antenna? **NO**

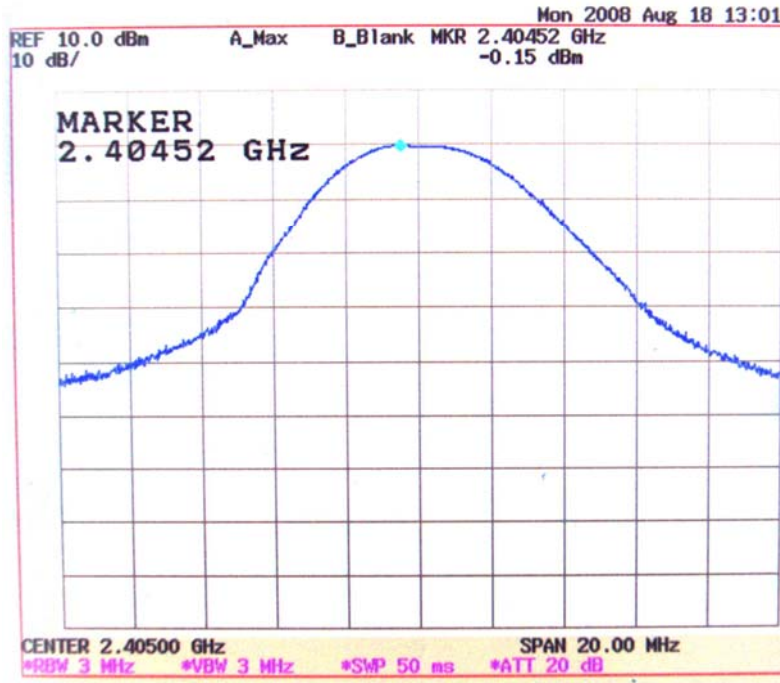
If detachable, is the antenna connector non-standard? **N/A**

Requirements:

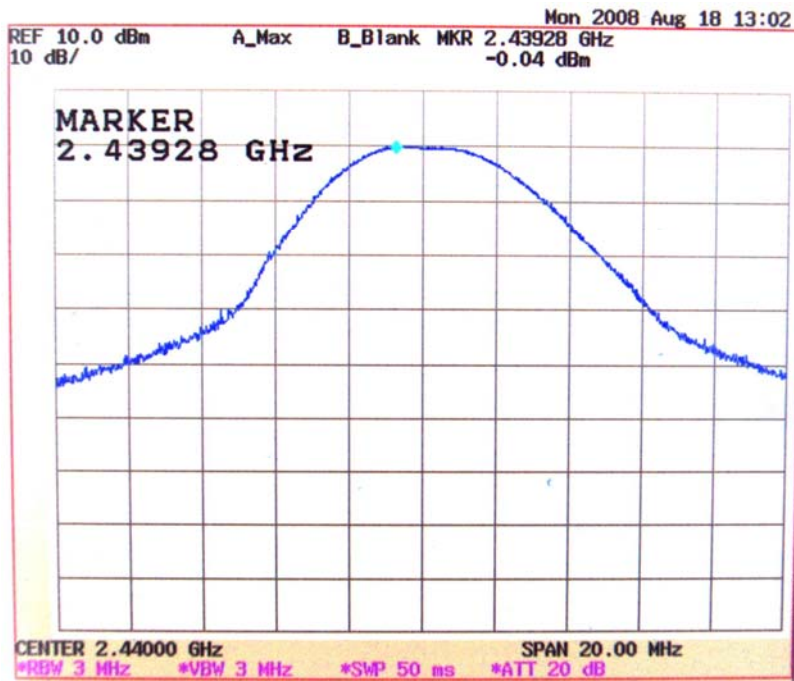
The maximum peak output power shall not exceed the following limits:

For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



Ch 11 - Conducted Peak Output Power



Ch 18 - Conducted Peak Output Power



Ch 26 - Conducted Peak Output Power

4.4 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: Wayne Langston **Date of Test: 17 June 2008**

Test Results: Complies

Measurement Data:

Lower Band-edge radiated measurements

Frequency	Power below nearest channel, dB	Limit	Margin
GHz	RF ch 11 DSS	dB	dB
2.4	39.22	-20	19.22

Band-edge field strength 2.4 GHz:

Marker Delta 100kHz RBW: 39.22dB

Peak Field Strength 107.24 - 39.22 = 68.02 dB μ V/m @ 1 m

Average Field Strength: 68.02 dBuV/m - 20 dB = 48.02 dB μ V/m

Upper Band-edge radiated measurements

Frequency	Power below nearest channel, dB	Limit	Margin
GHz	RF ch 26 DSS	dB	dB
2.4835	32.21	-20	12.21

Band-edge field strength 2.4835 GHz:

Marker Delta 100kHz RBW: 32.21dB

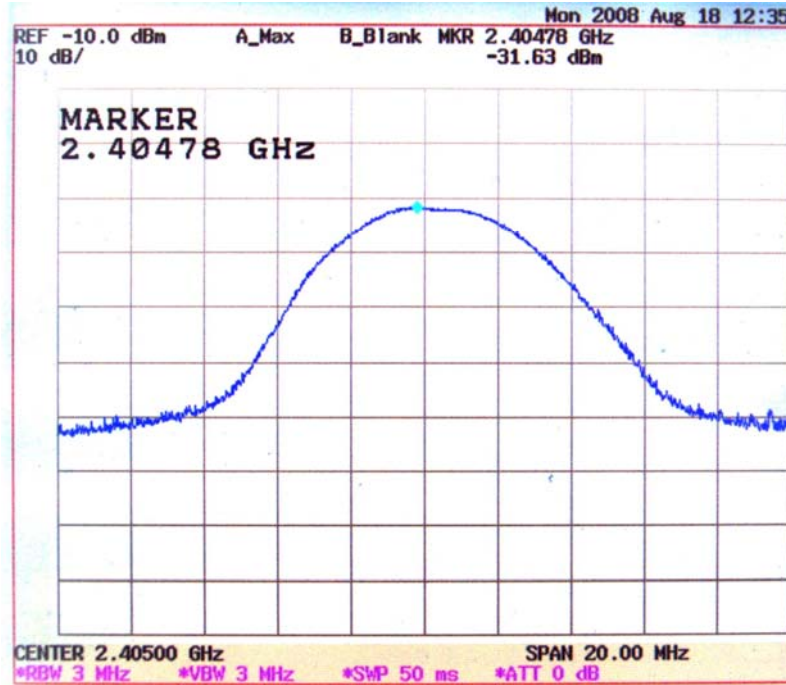
Peak Field Strength 107.70 - 32.21 = 75.49 dB μ V/m @ 1 m

Average Field Strength: 75.49 dBuV/m - 20 dB = 55.34 dB μ V/m

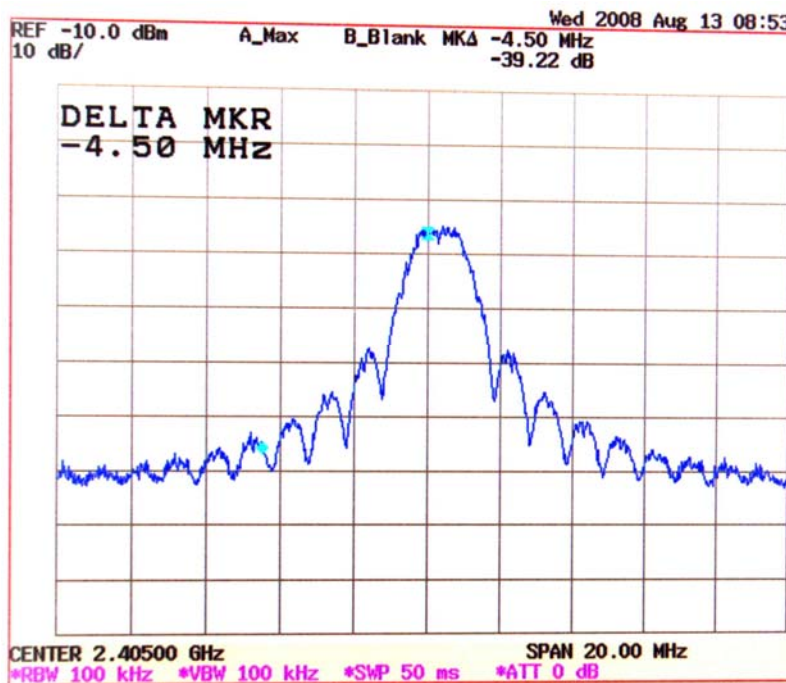
RF conducted emissions to 25 GHz

Maximum RF level outside operating band:

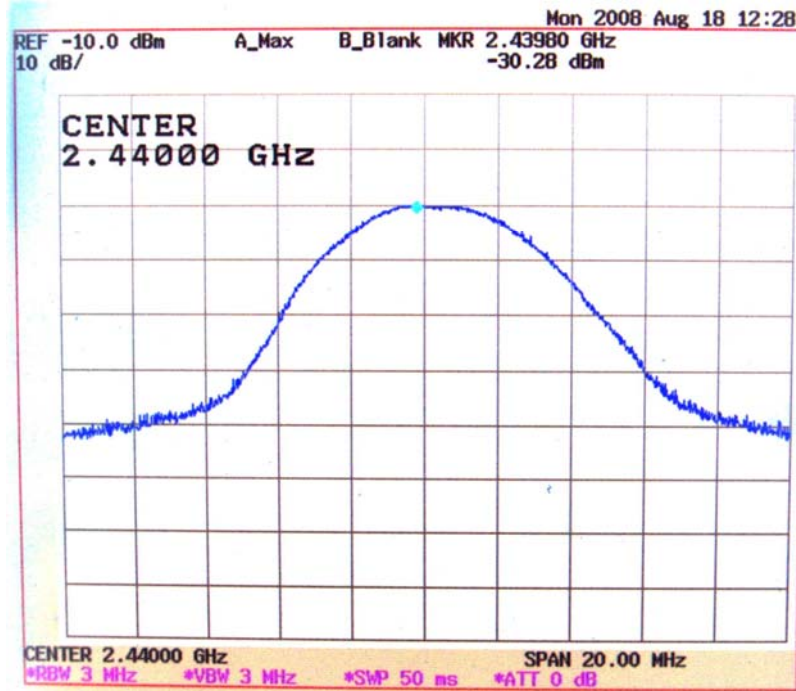
RF ch 11: 43 dB/C, margin > 20 dB
 RF ch 18: 43 dB/C, margin > 20 dB
 RF ch 26: 44 dB/C, margin > 20 dB



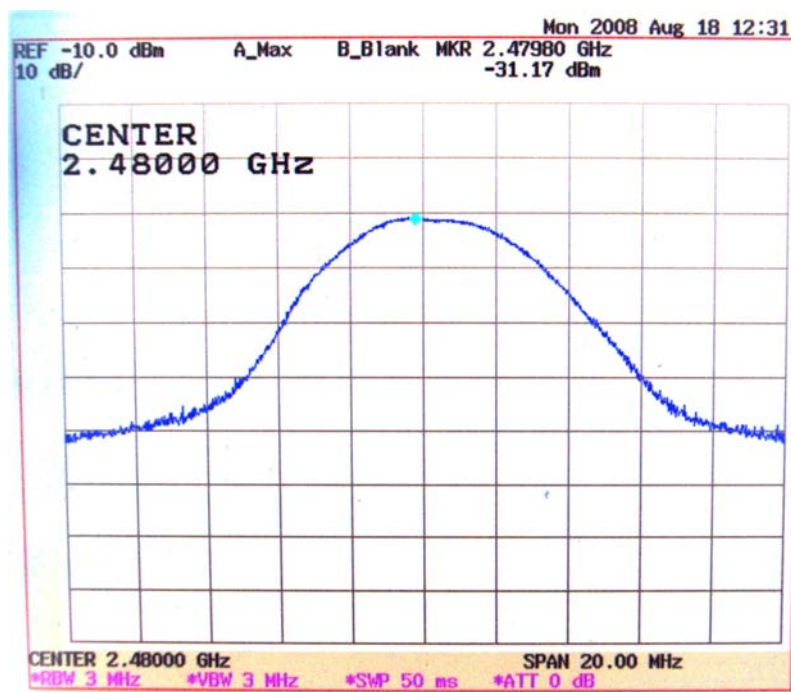
Ch11 - Lower-band - Field strength



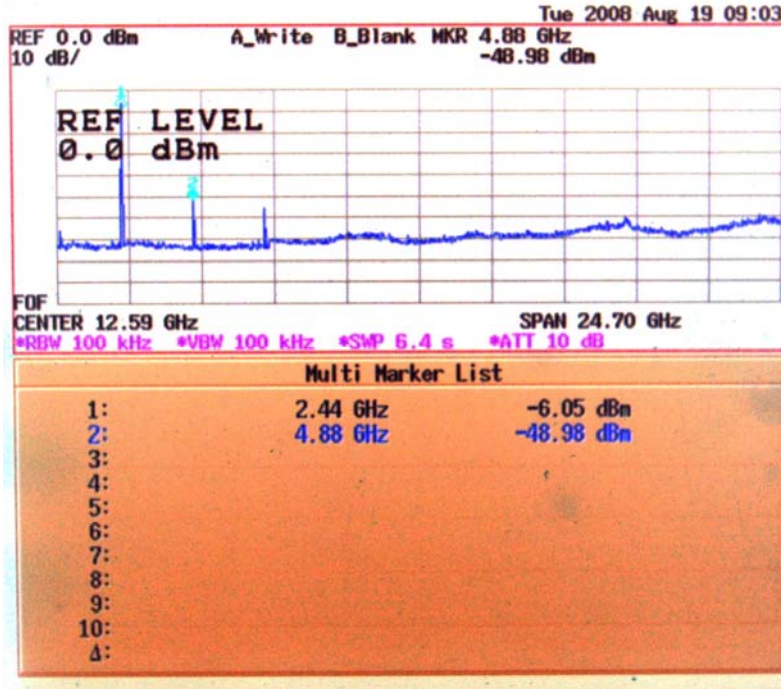
Ch11 - Lower-band-edge - Delta-marker



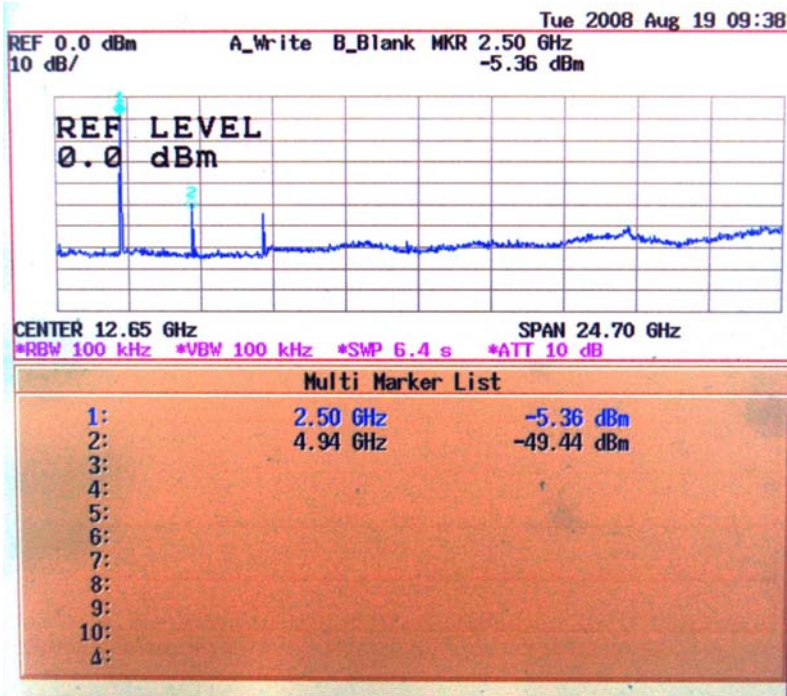
Ch18 - Mid-band - Field Strength



Ch26 - Upper-band - Field strength



Ch18 - Conducted Spurious - 300MHz to 25GHz



Ch26 - Conducted Spurious - 300MHz to 25GHz

Duty Cycle Calculations:

RF duty cycle: Calculation according to RF burst Para 15.35 (c)

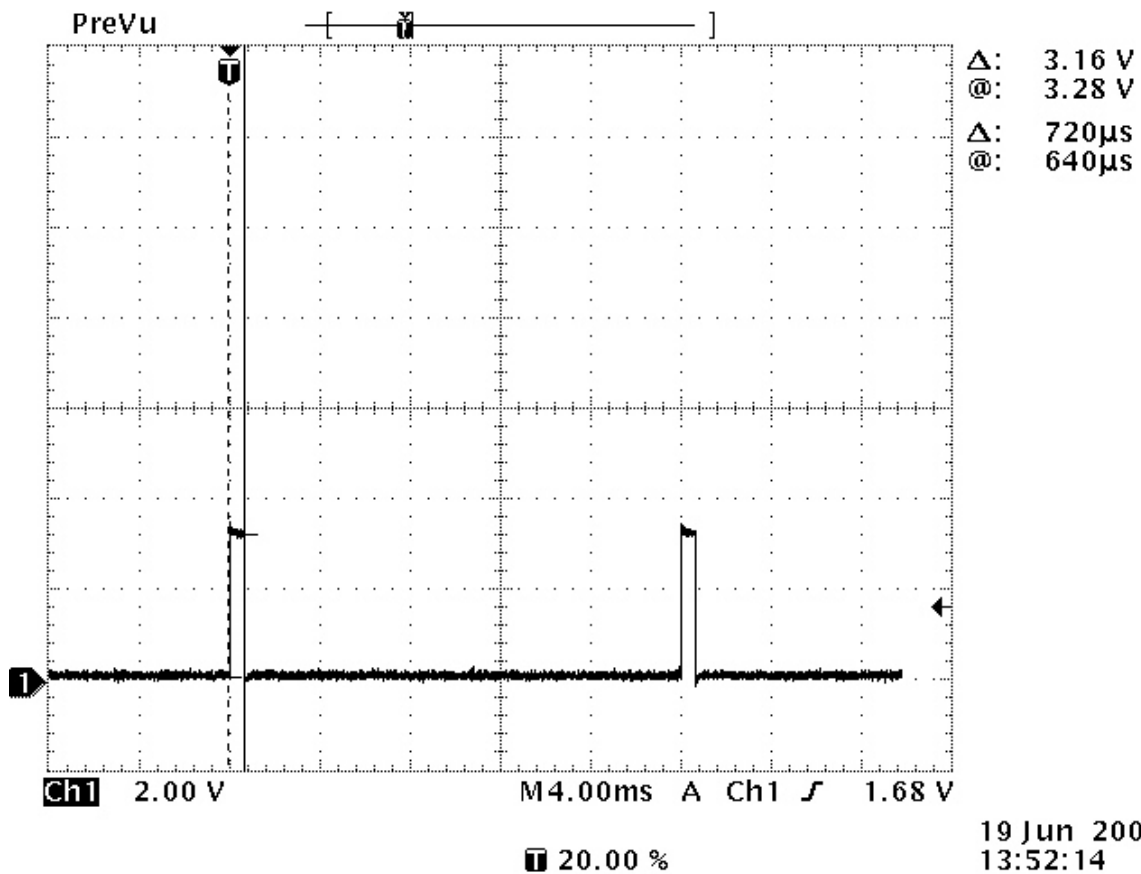
$$-20 \cdot \log(0.72\text{ms}/19.28\text{ms}) = 28.55 \text{ dB}$$

Maximum duty cycle according to Para 15.35 (b): 20 dB

This value is used to calculate average field strength above 1 GHz from the measured Peak value.

DC ON = 0.72ms
DC OFF = 19.28ms

The transmit busy pin on the microprocessor is recorded. This signal is set when the processor sends a transmit command to the radio IC and cleared when the radio IC responds with transmit complete. The EUT software limits this to the maximum duty cycle.



Transmit Duty Cycle Hi = Transmit

Radiated Emissions, 1-25 GHz, peak

1 - 25 GHz measured at 1 m. No radiated spurious emissions detected above 8 GHz.

Radiated Emission 1 - 25 GHz, Peak Measured with Peak Detector

Freq	RF Channel	Distance Corr Factor	Antenna Factor	Duty Cycle Corr Factor	Measured Signal	Preamp Corr Factor	Corrected Field Strength, Peak, 3m	Down From Carrier	Limit 15.35b	Margin
GHz	11 - 26	dB	dB/m	-	dBm	dB	dBuV/m	dB/C	dBuV/m	dB
2.405	11	-9.54	31.04	-	-28.30	0	101.18	N/A		
2.440	18	-9.54	31.04	-	-28.97	0	100.51	N/A		
2.480	26	-9.54	31.04	-	-28.10	0	101.38	N/A		
4.809	11	-9.54	38.0	-	-69.03	-10	57.41	43.77	74	16.59
4.889	18	-9.54	38.0	-	-70.3	-10	56.14	44.37	74	17.86
4.958	26	-9.54	38.0	-	-70.55	-10	55.89	45.49	74	18.11
7.216	11	-9.54	41.5	-	-82.08	-10	47.86	53.32	74	26.14
7.333	18	-9.54	41.5	-	-85.77	-10	44.17	56.34	74	29.83
7.438	26	-9.54	41.5	-	-75.13	-10	54.81	46.57	74	19.19
8 - 25	11,18,26				None detected			-	-	-

Calculated Average Values from Peak Detector

Freq	RF Channel	Distance Corr Factor	Antenna Factor	Duty Cycle Corr Factor	Measured Signal	Preamp Corr Factor	Corrected Field Strength, Peak, 3m	Down From Carrier	Limit 15.209a	Margin
GHz	11 - 26	dB	dB/m	dB	dBm	dB	dBuV/m	dB/C	dBuV/m	dB
2.405	11	-9.54	31.04	-20	-28.30	0	81.18	N/A		
2.440	18	-9.54	31.04	-20	-28.97	0	80.51	N/A		
2.480	26	-9.54	31.04	-20	-28.10	0	81.38	N/A		
4.809	11	-9.54	38.0	-20	-69.03	-10	37.41	43.77	54	16.59
4.889	18	-9.54	38.0	-20	-70.3	-10	36.14	44.37	54	17.86
4.958	26	-9.54	38.0	-20	-70.55	-10	35.89	45.49	54	18.11
7.216	11	-9.54	41.5	-20	-82.08	-10	27.86	53.32	54	26.14
7.333	18	-9.54	41.5	-20	-85.77	-10	24.17	56.34	54	29.83
7.438	26	-9.54	41.5	-20	-75.13	-10	34.81	46.57	54	19.19
8 - 25	11,18,26				None detected			-	-	-

Connection from antenna to analyzer 14' RG8, .98dB loss

Radiated emissions 30 - 1000 MHz.

Test Site Radiated Emission

Freq. (MHz)	Level (dBuV)	A _F /C _L (dB)	H _A (M) Hor/Ver	Rotation □°	Field Strength Results (dBuV/m)	Comments Margin
36.8	12.0	15.2	3.0 mH	45	27.2	
68.1	18.0	10.8	3.0 mH	100	28.8	
70.4	12.2	10.8	3.0 mH	100	23.0	
72.2	13.2	10.8	3.0 mH	180	24.0	
74.5	13.6	10.8	2.5 mH	180	24.4	
36.2	4.0	15.2	1 mV	100	19.2	
37.5	10.2	10.8	1 mV	100	21.0	
69.8	12.1	10.8	1 mV	200	22.9	
109.0	17.1	17.2	1 mV	90	34.3	
160.0	15.0	17.8	1 mV	0	32.8	
162.1	14.0	18.1	1 mV	0	32.1	
657.1	3.0	37.7	1 mV	45	40.7	

The EUT was tested at the WLI test facility at 3 meter

Limits

The eut complies with class B requirements at 5.7 dB under class B at 109.0 Mhz.

Class B limit at 3 meters

Millivolts	Frequency	dBmV
100	30-88	40
150	88-216	43.5
200	216-960	46
500	960<	54

4.5 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: Wayne Langston

Date of Test: 17 June 2008

Test Results: Passed

Measured and Calculated Data:

Measured Conducted Values:

Ch11 - Lower Channel:

PSD = - 15.55 dBm margin 23.55 dB

Ch19 - Middle Channel:

PSD = - 16.55 dBm margin 24.55 dB

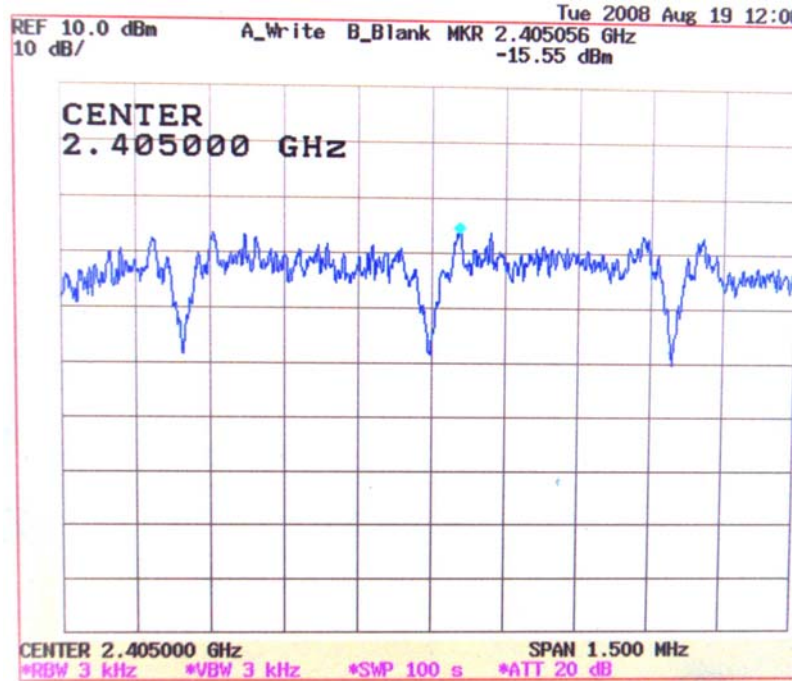
Ch 26 - Upper Channel:``

PSD = - 16.44 dBm margin 24.44 dB

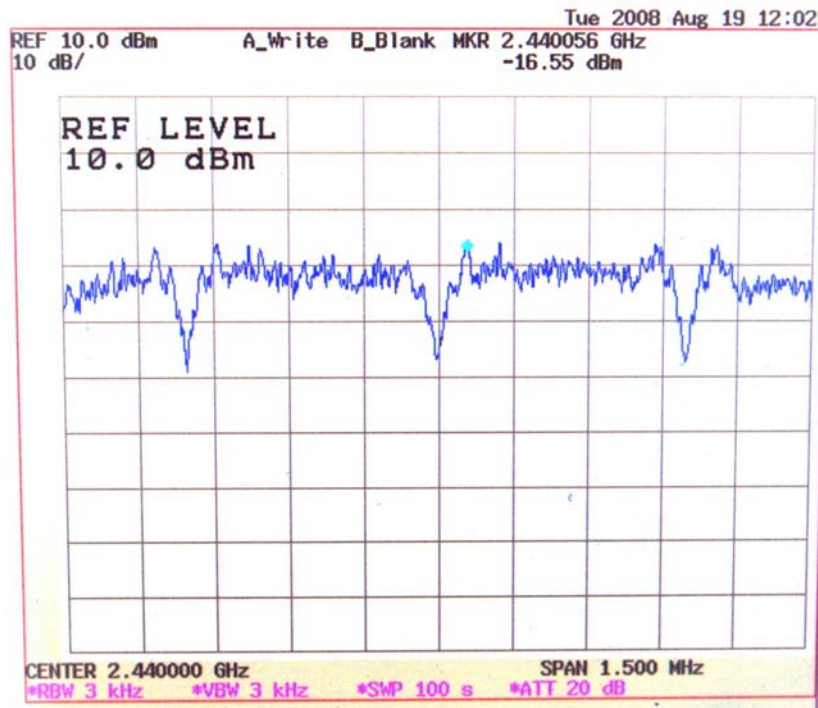
Requirements:

The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3kHz band

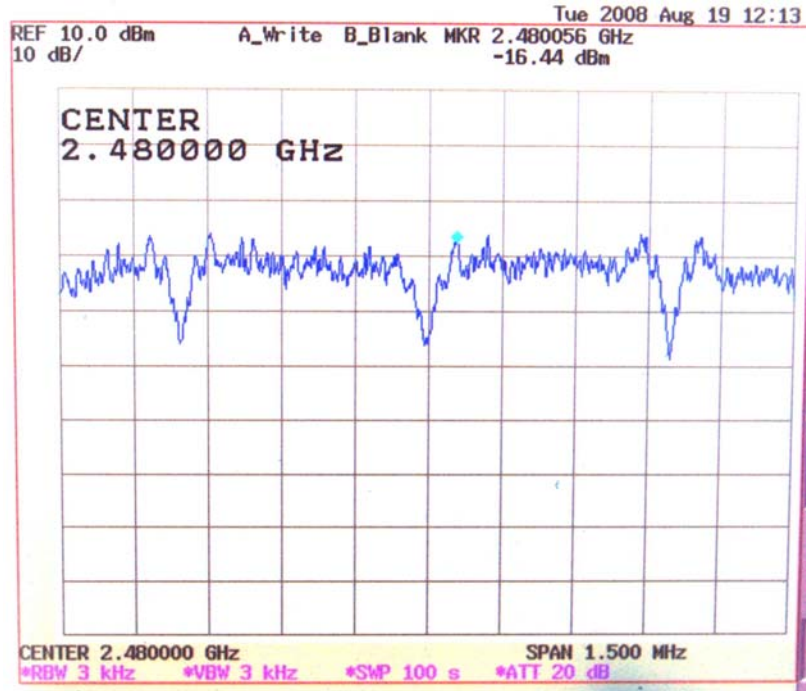
No requirements for Frequency Hopping Systems.



Ch11 - Power Density - Conducted measurement



Ch18 - Power Density - Conducted measurement



Ch26 - Power Density - Conducted measurement

5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

TEST: Check One:	Test Type: Check One	End Results: Check One
FCC (Part 15) <input type="checkbox"/>	Radiated <input checked="" type="checkbox"/>	Pass <input checked="" type="checkbox"/>
EN550 11/Cispr 11 <input checked="" type="checkbox"/>	Conducted <input type="checkbox"/>	Fails <input type="checkbox"/>
Immunity: IEC 801 <input type="checkbox"/>	Both <input type="checkbox"/>	
Other (please define):		

EUT Model Name/No.	Name : <u>GSR</u>		
EUT Description	See Client Brochure		
Software	Client Provided if any		
EUT Classification	Class "A" <input type="checkbox"/>	Class "B" <input checked="" type="checkbox"/>	

Test Equipment/Model #	Serial #	Cal Date
<input type="checkbox"/> AH Systems/SAS-200/S12	303	08/07
<input type="checkbox"/> Compliance Design/Lisn		08/07
<input type="checkbox"/> Rhode & Schwarz ESVP	879691/09	Daily
<input type="checkbox"/> Hewlett Packard 8591E	3501A03599	08/07
<input type="checkbox"/> Hewlett Packard 8640B	1532A03642	08/07
<input type="checkbox"/> Rhode & Schwarz/ESH3	872318/03	08/07
<input type="checkbox"/> Polard/ESH3-Z2	N/A	08/07
<input type="checkbox"/> Polard/HFH2-Z2	N/A	08/07
<input type="checkbox"/> Electro-Metrics/ESA-1000	307	08/07
<input type="checkbox"/> TEM Chamber/None	None	Per IEC 801-3
<input type="checkbox"/> Mini-Circuits Power Amp/None	100102	08/07
<input type="checkbox"/> Mini-Circuits/AFL-1000LN	10093	08/07
<input type="checkbox"/> Mini-Circuits/CAT-3(3dB,500Ohm Pad)	None	08/07
<input type="checkbox"/> HP Oscilloscope/54600A	3134A04619	08/07
<input type="checkbox"/> Mini-Circuits 50 dB Pad/NTRM 50	10018	None Required
<input type="checkbox"/> Schaffner NSG433		08/07
<input type="checkbox"/> Schaffner NSG1046		08/07
<input type="checkbox"/> Hewlett-Packard 8568B & 85650A		08/07
<input checked="" type="checkbox"/> Hewlett-Packard 8569B		08/07
<input checked="" type="checkbox"/> Hewlett-Packard 8594E	13750U03609	05/08
<input checked="" type="checkbox"/> Mini circuit ZX60-6013E		08/07
<input checked="" type="checkbox"/> Advantest R3272	42390011	07/08
<input checked="" type="checkbox"/> Electro Metrics EM6952	763	08/07
<input type="checkbox"/> Electro-Metrics Biconical	BIA 3432	08/07
<input type="checkbox"/> Roberts Tuned Dipoles Std	N/A	Per ANSI Ref. Std.
<input type="checkbox"/> Rhode & Schwarz	HL023	08/07

6.0 System set up

Radiated Test Photos

