FCC part 15 testing for Grayhill Inc. Model: WM09STDB-0001

FCC ID: NMA-WM09STDB0001
731 conf # **EA173502**

- REMITTANCE ID NUMBER: **582457**
- AUTHORIZATION NUMBER: **145746**

GRANTEE: Grayhill Inc.
561 Hillgrove Avenue
LaGrange, IL 60525-5997
FRN: 0004277307

TEST SITE: Grayhill Inc.
561 Hillgrove Avenue
LaGrange, IL 60525-5997

&

Radiometrics Midwest Corp.
12 E. Devonwood
Romeoville, IL 60446

FINAL TEST DATE: September 6th 2004
REPORT DATE: September 10th 2004
TEST ENGINEERS: Chris Anderson & Joe Strzelecki

Table of Contents

List of Tested Antenna Configurations

For the purpose of calculating max EIRP we will assume cable loss = 0dB and the device transmit power 23.5dBm the antenna port.

Antenna Type	Mfg	Mfg PN	Gryahill PN	Gain (dBd)	Gain (dBi)	EIRP (dBm)
Yagi	Maxrad	BMOY8905	WL-ANT-Y9A	9	11.51	35.01
Yagi	LM	BYSS-090-09-01	WL-ANT-Y9LA	9	11.51	35.01
Patch	LM	BPAS85-090-08-11SW	WL-ANT-P9LA	8	10.51	34.01
Patch	Maxrad	MP8068	WLHH1434-1	7.9	10.41	33.91
Omni	Maxrad	MFB9157	WL-ANT-MN7A	7	9.51	33.01
Omni	Maxrad	MFB9153	WLHH1230-1	3	5.51	29.01
Whip	Maxrad	MEXE902	WL-ANT-W9MA	0	2.51	26.01
Whip	Grayhill ¼ Wave	WLHH1457-1	WLHH1457-1	-2.5	0.01	23.51
PCB Dipole	Centurion	Revie PRO	01HH5222-2	0	2.51	26.01

The Omni and Patch antennas were selected as being worst case examples of these antenna types. Other antennas tested were to get a good spread of data.

Test Setup Description

All tests were performed with the radio mounted on an interface board that converted the native 3.3V CMOS serial signals to RS-232 level signals to interface with a laptop computer used to control the radio. The laptop was attached to configure the radio for each test, then removed from the test setup. Power was supplied by a 9V CUI wall mounted transformer.

Test Summary

FCC Section(s)	Test Requirements	Compliance(Yes/No)
15.107(a)	AC Power Line Conducted Emissions Measurements	Yes
15.247(a)(1) & 15.247(a)(2)	Provisions for Frequency Hopping	Yes
15.247(b)	Peak Output Power	Yes
15.247(b)(5), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	Band-Edge and RF Conducted Spurious Emissions at the Antenna Terminal	Yes
15.247(c), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes

Conducted AC Emission Scan §15.207(a)

Grayhill Inc. has it's own conducted emissions test setup accredited by A2LA to ISO17025. The lab is also registered to ISO9001 by BVQI. Figure 1 shows the AC conducted emissions sweep with a PC generating transmit traffic to exercise the radio.

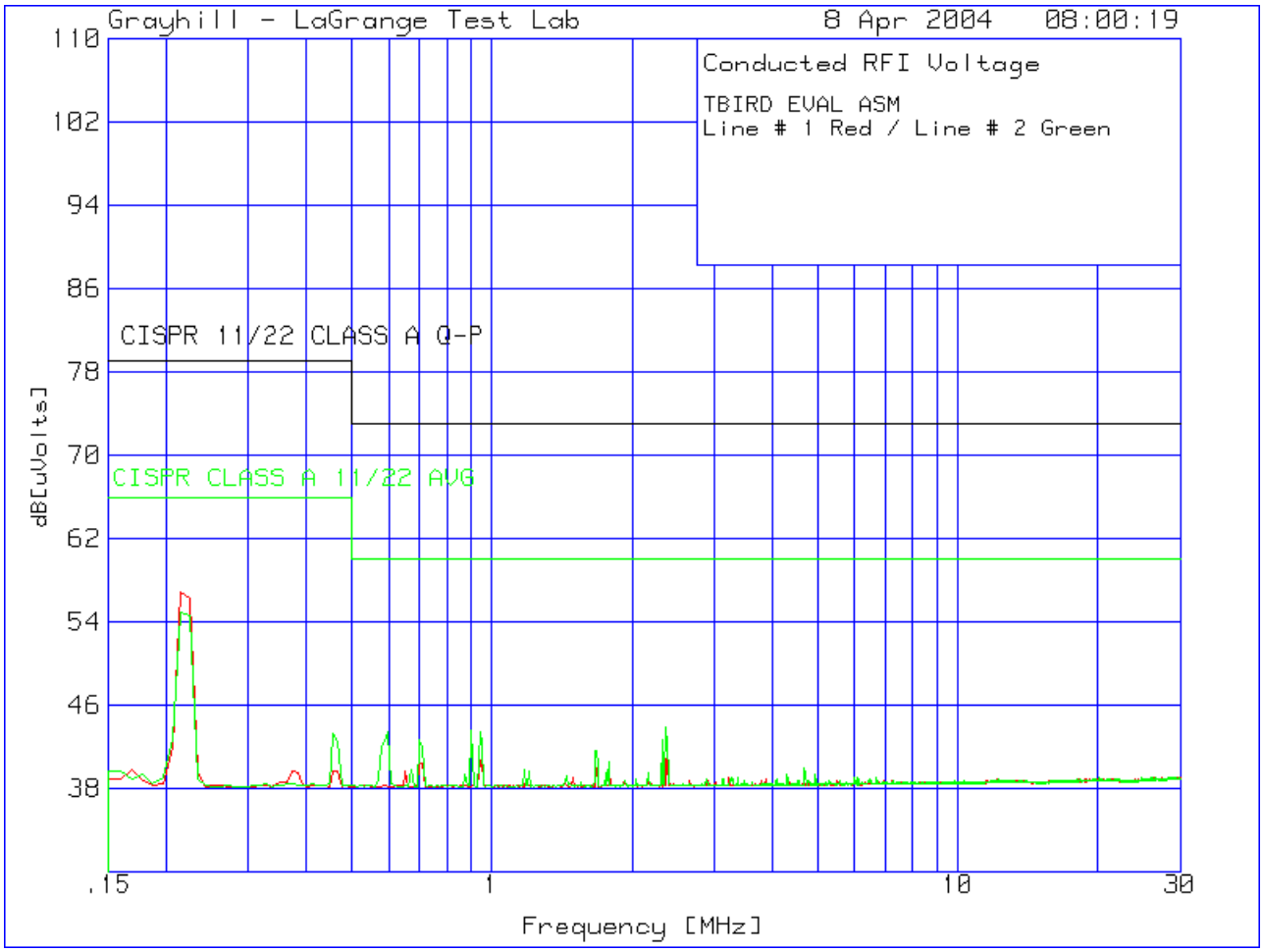

Figure 1 Conducted Emissions

Provisions for Frequency Hopping

Carrier Frequency Separation:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

1. Span = wide enough to capture the peaks of two adjacent channels
2. RBW = 1% of the span
3. VBW > RBW
4. Sweep = Auto
5. Detector = peak
6. Trace = max hold

Figure 2 shows 2 complete and 2 partial modulated signals. The markers have been set at the same point on each modulated signal and as the picture shows, the channels are 393kHz apart.

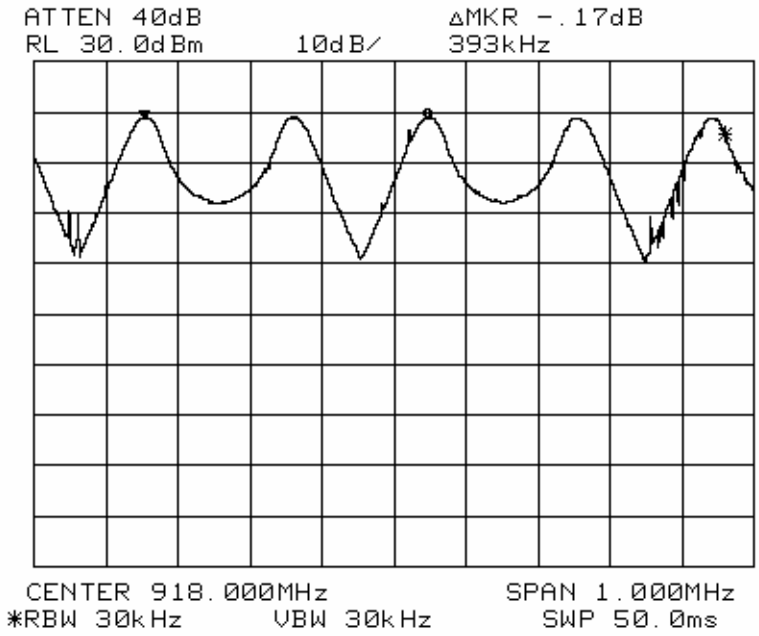

Figure 2 Channel Spacing

Number of hopping frequencies:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

1. Span = the frequency band of operation
2. RBW = 1% of the span
3. VBW > RBW
4. Sweep = Auto
5. Detector = peak
6. Trace = max hold

For this frequency plan, the 915MHz ISM band is cut up into 67 channels. The top and bottom channels are not used to avoid interference with adjacent bands. The hopset shown in Figure 3 is the default hopset as the radios are shipped. The hopset is the following channel, in this order:

30, 32, 19, 55, 10, 39, 46, 20, 54, 58, 64, 22, 7, 38, 1, 42, 41, 26, 40, 8, 24, 0, 33, 2, 45

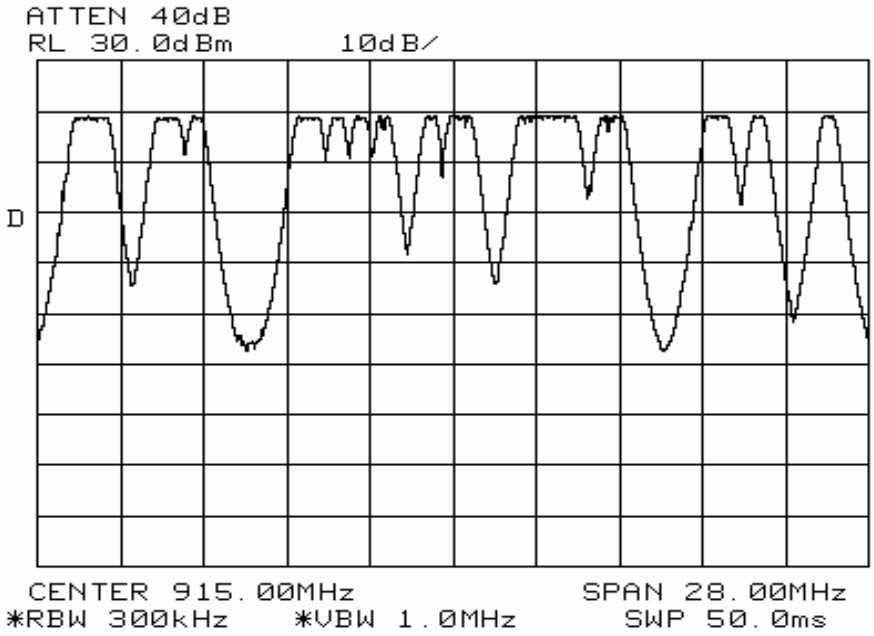

Figure 3 Number of Hop Channels

Time of Occupancy (Dwell Time):

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

1. Span = 0 Hz centered on a hopping channel
2. RBW = 1 MHz
3. VBW > RBW
4. Sweep = as necessary to capture the entire dwell time per hopping channel
5. Detector = peak
6. Trace = max hold

The max dwell time for this radio is dictated by the max packet size, which is fixed at 35 bytes. Shorter packets can happen but only 1 packet is allowed on a given channel, no matter what length the packet is. The image below shows the longest packet is on channel for 200ms. Each channel in the hopset is used only once each pass through the hopset. If the radio is presented with a continuous data stream, the worst case is that a 200ms packet is sent on each channel in the hopset, and the hopset is passed through twice the 10 second measurement period. This results in a max worst case of 400ms on each channel which ensures that the average time of occupancy is less than 400ms. Figure 4 shows the max dwell time for any given transmission.

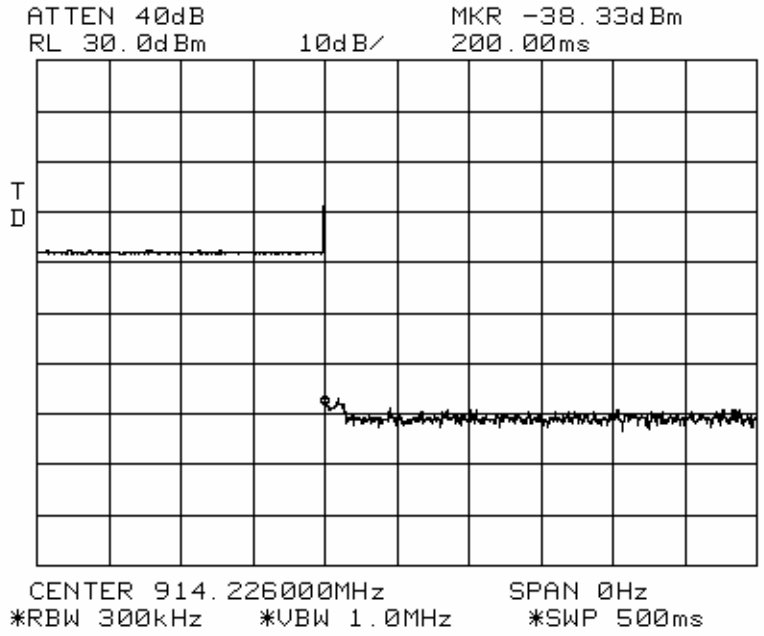

Figure 4 Channel Dwell Time

20 dB Bandwidth:

Use the spectrum analyzer setting as follows:

1. Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
2. RBW = 1% of the 20 dB bandwidth
3. VBW > RBW
4. Sweep = auto
5. Detector = peak
6. Trace = max hold
7. The transmitter shall be transmitting at its maximum data rate.
8. Allow the trace to stabilize.
9. Use the marker-to-peak function to set the marker to the peak of the emission.
10. Use the marker-delta function to measure 20 dB down on both sides of the emission.
11. The 20 dB BW is the delta reading in frequency between two markers.

For this image the max peak was at 18.50dBm at 914.901MHz. The 20dB points are then –1.50dBm. The spectrum analyzer resolution was such that it's adjacent sample points were at –2.33. Figure 5 shows the screen with the markers set to the –2.33dBm points, and this yields a BW of about 270kHz. It can be see from the span of 1MHz that the signal is down at lest 25dB by the 250kHz points.

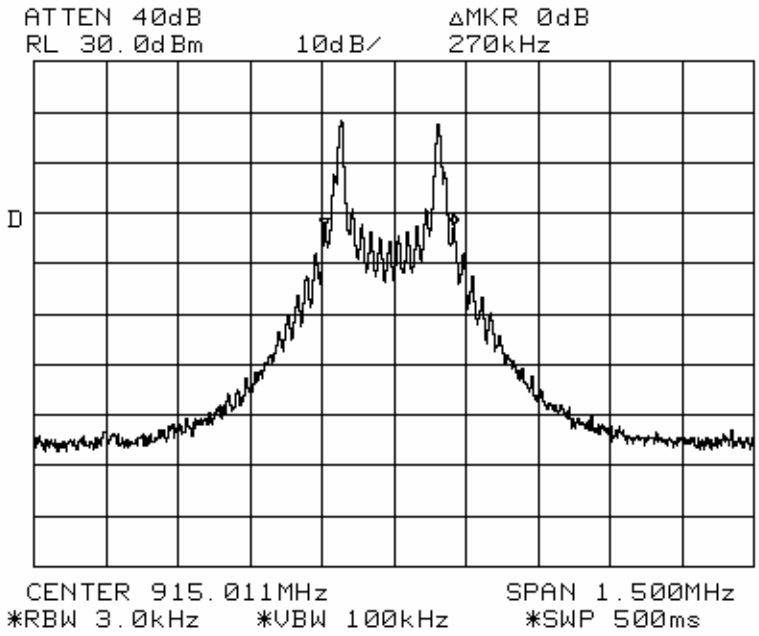

Figure 5 20dB Signal Bandwidth

Results

Test Description	FCC Specification	Measured Values	Comments
20 dB BW of the hopping channel	500 kHz maximum	270 kHz	Pass; see plots x to x
Channel Hopping Frequency Separation	Minimum of 25 kHz or 20dB BW whichever is greater.	393 kHz	Pass; see plot x for
Number hopping frequencies	At least 25 hopping frequencies	25 channels per set	Pass; see plot x to x
Average Time of Occupancy	No more than 0.4s in 10s avg	0.4s MAX in 10s	Pass; see plots x to x

Conducted Output Power Measurement §15.247(b)(1)

This test was performed with an Anritsu ML2407A power meter and Anritsu MA2481B power sensor with 10dB attenuator. The radio was placed in continuous transmit (100% duty cycle) mode for this test and no duty cycle compensation was used on the power meter. The internal cal standard was used to calibrate the sensor with the attenuator in place and thus remove it from the equation.

902.395173MHz	22.68dBm
914.999614MHz	23.12dBm
927.604055MHz	23.41dBm

The radio does not have a means for the user to control transmit power. The circuit design includes a series T attenuator which was used to set the transmit power to less than 23.5dBm.

Conducted Spurious Emissions

Part 15.247(4)(c) states that emissions in any 100kHz bandwidth must be at least 20dBc. Figure 6 and Figure 7 show conducted emissions around the transmit signal, with the highest out of band emission down 32dBc.

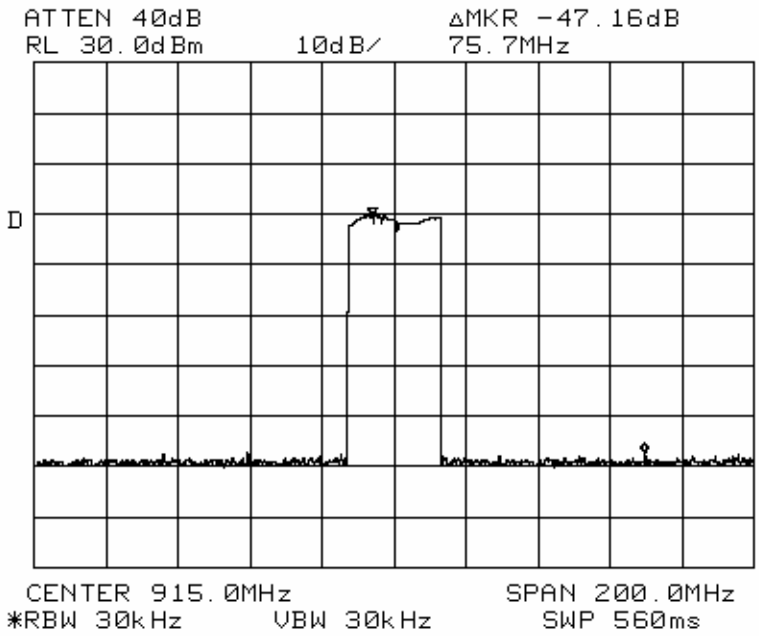

Figure 6 Conducted Emissions

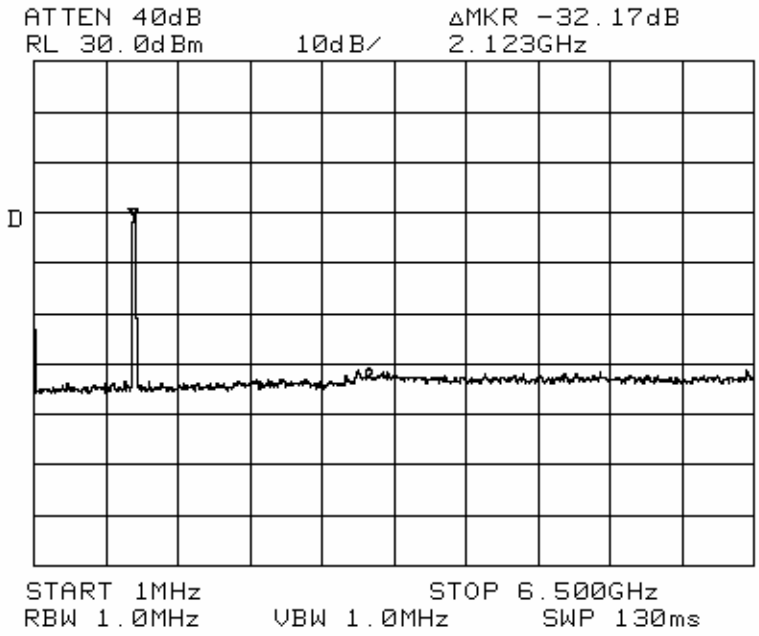

Figure 7 Conducted Emissions

Radiated Emissions in Restricted Bands 30MHz – 10GHz §15.247(c), 15.209(a)

Part 15.247(4)(c) states that emissions in any 100kHz bandwidth must be at least 20dBc, or if in a restricted band as defined by 15.205, to the level required by 15.209. The following captures are radiated measurements.

See separate document from Radiometrics.