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Measured Radio Frequency Emissions From

Sonic Alert RX 315MHz
Model: DB100/DB200

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For:
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Summary

Tests for compliance with FCC Regulations Part 15, Subpart B, and with Industry Canada Regulations, RSS-210, were performed on Sonic Alert DB100 / DB200 Receiver(s). This device is subject to FCC Rules and Regulations as a Receiver. As a Digital Device it is exempt, but such measurements were made to assess the receiver's overall emissions.

In testing performed on April 21, May 25 and September 5, 2000, the DB200 model device tested in the worst case met the allowed FCC (Class B) specifications for radiated emissions by 6.4 dB and the DB100 model device (DB200 without the telephone line interface) passed FCC Class B radiated emissions by 12.7 dB (see p. 6). Both the DB200 and DB100 models met line conducted emissions, Class B, by 12.5 dB.

1. Introduction

Sonic Alert DB100 / DB200 Receiver was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989, and with Industry Canada RSS-210, Issue 2, dated February 14, 1998. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-1992 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC file 31040/SIT) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057).

2. Test Procedure and Equipment Used

The test equipment commonly used in our facility is listed in Table 2.1 below. The second column identifies the specific equipment used in these tests. The HP 8593E spectrum analyzer is used for primary amplitude and frequency reference.

Table 2.1. Test Equipment.

Test Instrument	Equipment Used	Manufacturer/Model	Cal. Date/By
Spectrum Analyzer (9kHz-22GHz)	X	Hewlett-Packard 8593A SN: 3107A01358	October 1999/UM
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E SN: 3107A01131	September 1999/HP
Spectrum Analyzer (0.1-1500 MHz)		Hewlett-Packard 182T/8558B SN: 1529A01114/543592	October 1999/U of M Rad Lab
Preamplifier (5-1000MHz)	X	Watkins-Johnson A11 -1 plus A25-1S	Oct. 1999/U of M Rad Lab
Preamplifier (5-4000 MHz)	X	Avantek	Nov. 1996/ U of M Rad Lab
Broadband Bicone (20-200 MHz)	X	University of Michigan	June 1996/U of M Rad Lab
Broadband Bicone (200-1000 MHz)		University of Michigan	June 1996/U of M Rad Lab
Dipole Antenna Set (25-1000 MHz)	X	University of Michigan	June 1997/U of M Rad Lab
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C SN: 992	June 1996/U of M Rad Lab
Active Loop Antenna (0.090-30MHz)		EMCO 6502 SN: 2855	December 1993/ EMCO
Active Rod (30Hz-50 MHz)		EMCO 3301B SN: 3223	December 1993/EMCO
Ridge-horn Antenna (0.5-5 GHz)	X	University of Michigan	March 1999/U of M Rad Lab
LISN Box		University of Michigan	Dec 1997/U of M Rad Lab
Signal Cables	X	Assorted	January 1993/U of M Rad Lab
X-Y Plotter		Hewlett-Packard 7046A	During Use/U of M Rad Lab
Signal Generator (0.1-990 MHz)	X	Hewlett-Packard 8656A	January 1990/U of M Rad Lab
Printer	X	Hewlett-Packard 2225A	August 1989/HP

3. Configuration and Identification of Device Under Test

The DUT is a 315.0 MHz superregenerative receiver, designed for home security applications. The device is powered from a 120 V ac outlet. It is housed in a plastic case approximately 6.5 by 3.5 by 1.0 inches. Antenna is internal. For testing, a 3 meter long section of telephone cord (Model DB200 only) and a AC wall outlet were used, with power wires routed away from the telephone wires (were applicable). In the digital section of the receiver, decoding, signal processing, etc. are performed by a micro timed by a 18.72 MHz ceramic resonator.

The DUT was designed and manufactured by RHK Technology Inc., 1050 East Maple Road, Troy, MI, 48083. It is identified as:

Sonic Alert DB100 / DB200 Receiver
Model: DB100
Model: DB200
FCC ID: OQYDB100R
CANADA: to be provided by IC

3.1 Modifications Made

The carrier current function in the device, as received, did not meet the FCC/IC specifications. Hence, such was physically depopulated from the PCB board in these models.

4. Emission Limits

For FCC the DUT falls under Part 15, Subpart B, "Unintentional Radiators". For Industry Canada the DUT falls under Receiver category and is subject to technical requirement of sections 7.1 to 7.4 in RSS-210. The pertinent test frequencies, with corresponding emission limits, are given in Tables 4.1 and 4.2 below.

4.1 Radiated Emission Limits

Table 4.1. Radiated Emission Limits (FCC: 15.33, 15.35, 15.109; IC: RSS-210, 7.3).

Freq. (MHz)	E_{lim} (3m) μV/m	E_{lim} dB(μV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Quasi-Peak readings apply to 1000 MHz (120 kHz BW)
Average readings apply above 1000 MHz (1 MHz BW)

4.2 Conducted Emission Limits

Table 4.2. Conducted Emission Limits (FCC: 15.107; IC: RSS-210, 6.6).

Freq. (MHz)	μV	dB(μV)
0.450 - 1.705	250	48.0
1.705 - 30.0	250	48.0

Note: Quasi-Peak readings apply here

4.3 Antenna Power Conduction Limits
(FCC: 15.111(a); IC: RSS-210, 7.2). Pmax = 2 nW; for frequency range see Table 4.1.

5. Emission Tests and Results

NOTE: Even though the FCC and/or Industry Canada specify that both the radiated and conductive emissions be measured using the Quasi-Peak and/or average detection schemes, we normally use peak detection since especially the Quasi-Peak is cumbersome to use with our instrumentation. In case the measurement fails to meet the limits, or the measurement is near the limit, it is re-measured using appropriate detection. We note, that since the peak detected signal is always higher or equal to the Quasi-Peak or average detected signal, the margin of compliance may be better, but not worse, than indicated in this report. The type of detection used is indicated in the data table, Table 5.1.

5.1 Anechoic Chamber Radiated Emission Tests
To familiarize with the radiated emission behavior of the DUT, it was studied and measured in the shielded anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with turntable, antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

To study and test for radiated emissions, the DUT was powered by 120 V ac outlet. A 315 MHz CW signal was injected (radiated) from a nearby signal generator using a short wire antenna. The DUT was taped to a syrofoam block and placed on the test table on each of the three axis. At each orientation, the table was rotated to obtain maximum signal for vertical and horizontal emission polarizations. This sequence was repeated throughout the required frequency range.

In the chamber we studied and recorded all the emissions using a ridge-horn antenna, which covers 200 MHz to 5000 MHz, up to 2 GHz. In scanning from 30 MHz to 2.0 GHz, there were no spurious emissions observed other than the LO and injection signal (315 MHz), and the LO harmonics. Figures 5.1 and 5.2 show emissions measured 0-1000 MHz and 1000-2000 MHz, respectively. These measurements are made with a ridge-horn antenna at 3m, with spectrum analyzer in peak hold mode and the receiver rotated in all orientations. The measurements up to 1000 MHz (Fig. 5.1) are used for initial evaluation only, but those above 1000 MHz (Fig. 5.2) are used in final assessment for compliance.

5.2 Open Site Radiated Emission Tests
The DUT was then moved to the 3 meter Open Field Test Site where measurements were repeated up to 1000 MHz using a small bicone, or dipoles when the measurement is near the limit. The DUT was exercised as described in Sec. 5.1 above. The measurements were made with a spectrum analyzer using 120 kHz IF bandwidth and peak detection mode, and, when appropriate, using Quasi-Peak or average detection (see 5.0). The test set-up photographs are in Appendix (i.e., at end of this report).

The emissions from digital circuitry were measured using a standard bicone. These results are also presented in Table 5.1.

5.3 Computations and Results for Radiated Emissions
To convert the dBm's measured on the spectrum analyzer to dB(μV/m), we use expression

$$E_3(\mathrm{dB\mu V/m}) = 107 + P_R + K_A - K_G$$

where P_R = power recorded on spectrum analyzer, dB, measured at 3m
K_A = antenna factor, dB/m
K_G = pre-amplifier gain, including cable loss, dB

When presenting the data, at each frequency the highest measured emission under all of the possible orientations is given. Computations and results are given in Table 5.1. There we see that the DUT meets the limit by 6.4 dB.

5.4 Conducted Emission Limits
Power line conducted emission levels were measured in the anechoic chamber with the system placed on regulation test table (see figure 3.2a). The conducted emissions were measured from the DUT's built in wall plug. The system was exercised as described in Sec. 5.1. The conductive noise power was measured with spectrum analyzer and recorded in dBμV from 0-2 MHz and 0-30 MHz for both

the ungrounded (High) and the grounded (Low) power line conductors. The spectrum analyzer was set in 'peak hold' position to record the highest peak signals. Only when the DUT exceeds the limit or is near the limit, a Quasi-Peak detector is used (See 5.0).

Data are then read off from the plots and summarized in Table 5.1. In the worst case, as indicated by bold value, the DUT meets the conducted Class B limit by 12.5 dB.

6. Other Measurements

6.1 Emission Spectrum Near Fundamental

Near operating frequency the emission spectrum is measured typically over 50 MHz span with and without injection signal. These data are taken with the DUT close to antenna and hence amplitudes are relative. The plots are shown in Figure 6.1.

6.2 Effect of Supply Voltage Variation

The DUT has been designed to operate from 120 VAC power. Using a spectrum analyzer, relative radiated emissions were recorded at the "fundamental" (315.0 MHz) as voltage was varied from 35.0 to 140.0 VAC. Figure 6.2 shows the emission variation.

6.3 Operating Voltage and Current

V = 110.0 VAC
I = 59.5 mA

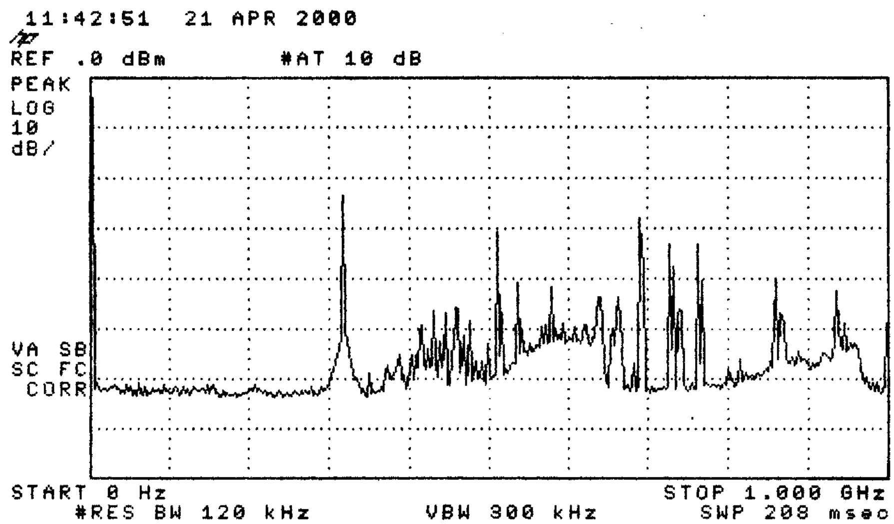
Table 5.1 Highest Emissions Measured

					Radiated Emission - RF				Sonic Alert DB200/DB100 RX; FCC/IC		
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	315.0	Dip	H	-66.0	Pk	18.9	20.3	39.6	46.0	**6.4**	side *worst case
2	315.0	Dip	V	-66.1	Pk	18.9	20.3	39.5	46.0	6.5	end
3	630.0	Dip	H	-90.8	Pk	25.2	16.9	24.5	46.0	21.5	end, noise
4	630.0	Dip	V	-91.0	Pk	25.2	16.9	24.3	46.0	21.7	side, noise
5	945.0	Dip	H	-87.3	Pk	28.9	14.5	34.1	46.0	11.9	flat
6	945.0	Dip	V	-89.5	Pk	28.9	14.5	31.9	46.0	14.1	end, noise
7	1260.0	Horn	H	-63.0	Pk	20.6	28.1	36.5	54.0	17.5	max of all
8	1491.0	Horn	H	-64.4	Pk	21.4	28.2	35.8	54.0	18.2	max of all
9	1575.0	Horn	H	-67.0	Pk	21.5	28.2	33.3	54.0	20.7	max of all
10	1890.0	Horn	H	-68.0	Pk	22.4	28.1	33.3	54.0	20.7	max of all, noise
11											
12	Worst case measurement for DB100										
13	315.0	Dip	H	-72.3	Pk	18.9	20.3	33.3	46.0	**12.7**	side *worst case
14											
15											
16											

					Radiated Emission - Digital (Class B)						
1											
2			Digital Emissions more than 20 dB below FCC Class B limits								
3											

				Conducted Emissions			
#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1	0.2	Hi	Pk.	27.0	46.0	19.0	
2	1.6	Hi	Pk.	29.3	46.0	16.7	
3	12.0	Hi	Pk.	22.5	46.0	23.5	
4	18.8	Hi	Pk.	33.5	46.0	**12.5**	* worst case
5	0.2	Low	Pk.	26.5	46.0	19.5	
6	1.6	Low	Pk.	23.9	46.0	22.1	
7	12.0	Low	Pk.	23.0	46.0	23.0	
8	18.8	Low	Pk.	30.0	46.0	16.0	
9							
10							
11							

Meas. 04/21/00, 05/25/00, 09/05/00; U of Mich.



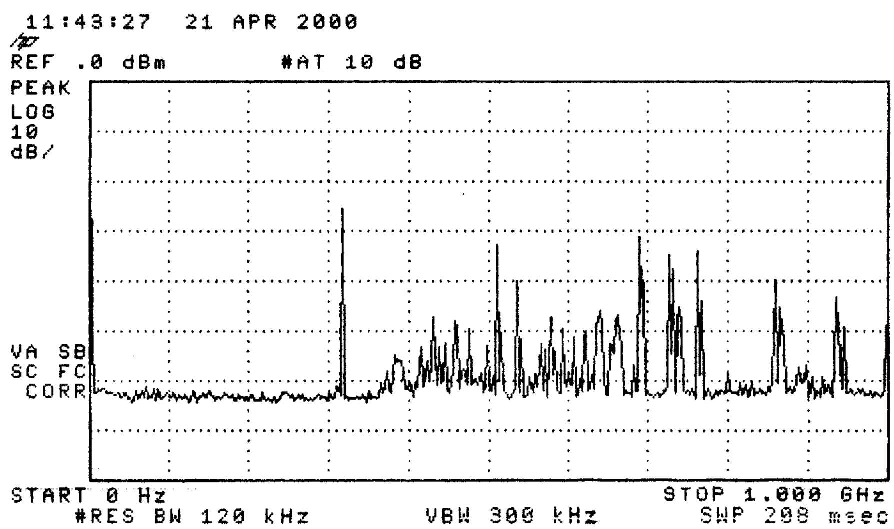
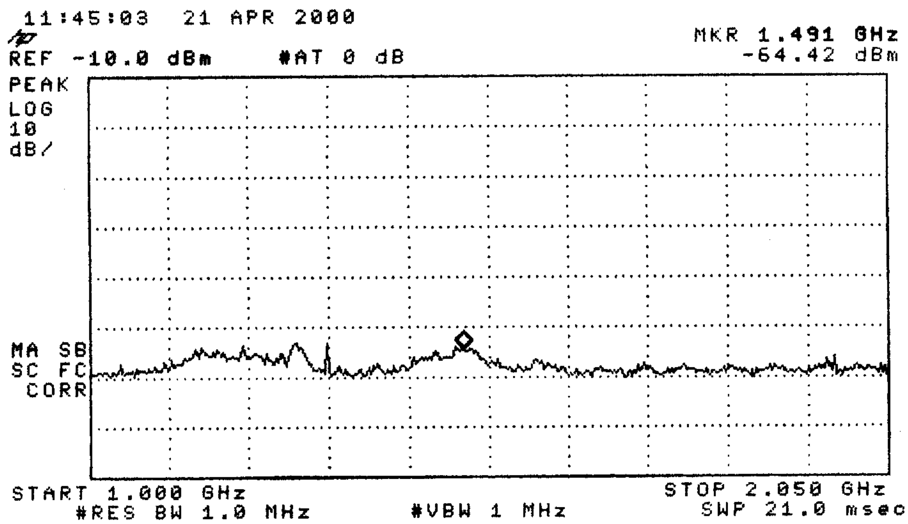


Figure 5.1. Emissions measured at 3 meters in anechoic chamber, 0-1000 MHz.
(top) Receiver plus ambient
(bottom) Ambient



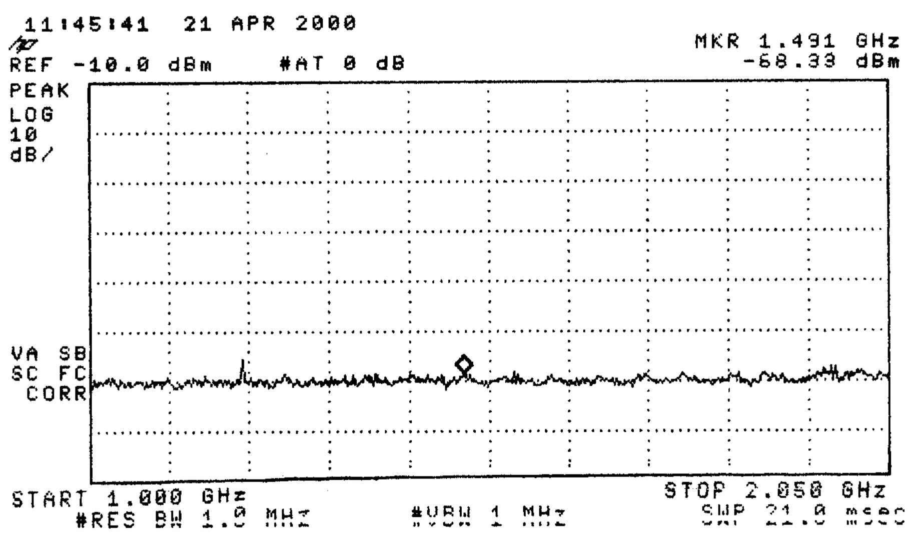


Figure 5.2. Emissions measured at 3 meters in anechoic chamber, 1000-2000 MHz.
(top) Receiver plus ambient
(bottom) Ambient

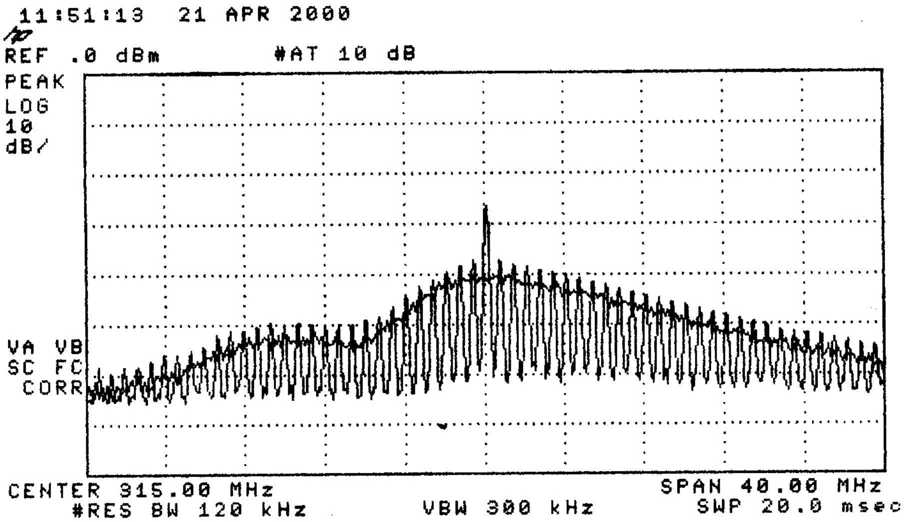


Figure 6.1. Relative receiver emissions in stand-by and "locked-in" modes. The final emission measurements were made with the receiver in "locked-in" mode.

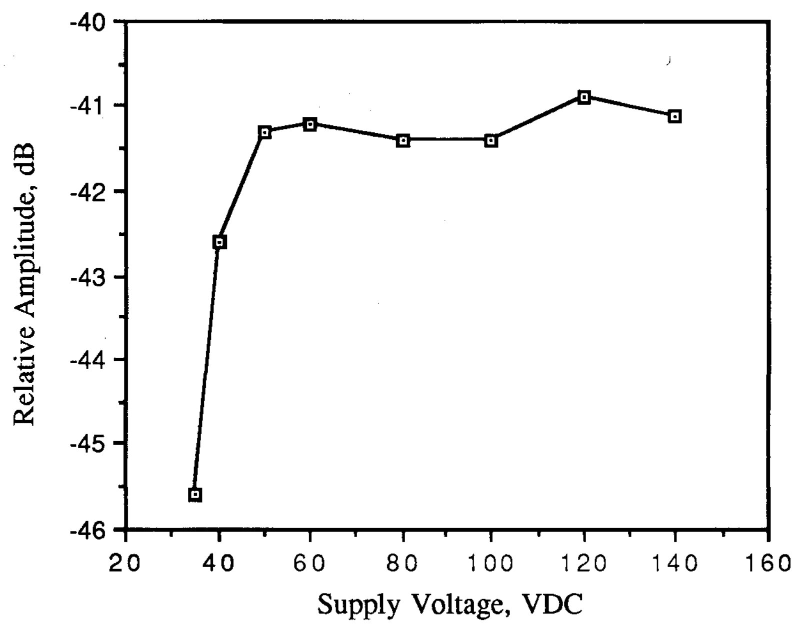


Figure 6.2. Relative emission at "fundamental" vs. supply voltage.