4.3 Antenna Power Conduction Limits
Ref: 15.111(a). 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 remeasured 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 a laboratory power supply at 13.5 VDC. A 315 MHz CW signal was injected (radiated) from a nearby signal generator using a short wire antenna. The DUT was taped onto 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). Figure 5.3 shows the DUT on the test table; figure 5.4 shows the overview of the OATS with the DUT on the test table.

The emissions from digital circuitry were measured on the Open Site 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

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

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 5.0 dB.

5.4 Conducted Emission Tests
These tests do not apply, since the DUT is powered from an automotive 12 VDC source.

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 12 VDC power. Using a spectrum analyzer, relative radiated emissions were recorded at the "fundamental" (315 MHz) as voltage was varied from 6 to 18.0 VDC. Figure 6.2 shows the emission variation.

6.3 Operating Voltage and Current

V = 12.5 VDC
I = 3.0 mADC

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Table 5.1 Highest Emissions Measured

Radiated Emission - RF — TRW/Ford RX; FCC

#	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	314.7	Dip	H	-73.9	Pk	18.9	20.8	31.2	46.0	14.8	flat
2	314.7	Dip	H	-74.2	Pk	18.9	20.8	30.9	46.0	15.1	side
3	314.7	Dip	H	-72.4	Pk	18.9	20.8	32.7	46.0	13.3	end
4	314.7	Dip	V	-76.1	Pk	18.9	20.8	29.0	46.0	17.0	flat
5	314.7	Dip	V	-75.9	Pk	18.9	20.8	29.2	46.0	16.8	side
6	314.7	Dip	V	-76.2	Pk	18.9	20.8	28.9	46.0	17.1	end
7	629.3	Dip	V/H	-84.9	Pk	25.2	17.5	29.8	46.0	16.2	max. of all, noise; 30 kHz BW
8	944.0	Dip	V/H	-84.7	Pk	28.9	15.1	36.1	46.0	9.9	max. of all, noise; 30 kHz BW
9	1258.5	Horn	H	-60.0	Pk	20.4	28.0	39.4	54.0	14.6	max. of all
10	1573.2	Horn	H	-58.0	Pk	21.4	28.0	42.4	54.0	11.6	max. of all
11	1887.8	Horn	H	-52.0	Pk	22.2	28.2	49.0	54.0	**5.0**	max. of all *worst case
12											
13											
14											
15											
16											
17											
18											

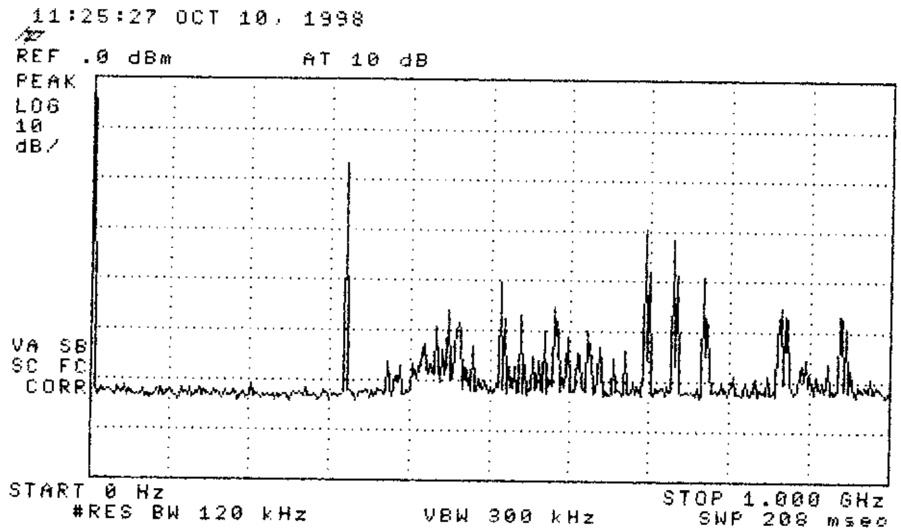
Radiated Emission - Digital (Class B)

#											
1											
2											
3	Digital Emissions more than 20 dB below Class B limits										
4											
5											
6											
7											
8											
9											
10											
11											
12											

Conducted Emissions

#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1							
2	Not applicable						
3							

Meas. 9/25, 10/10/98; U of Mich.



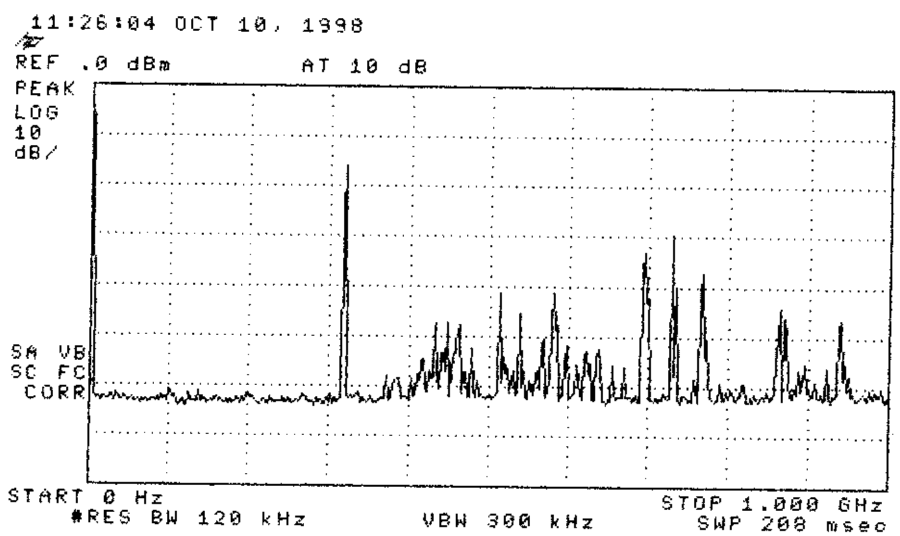
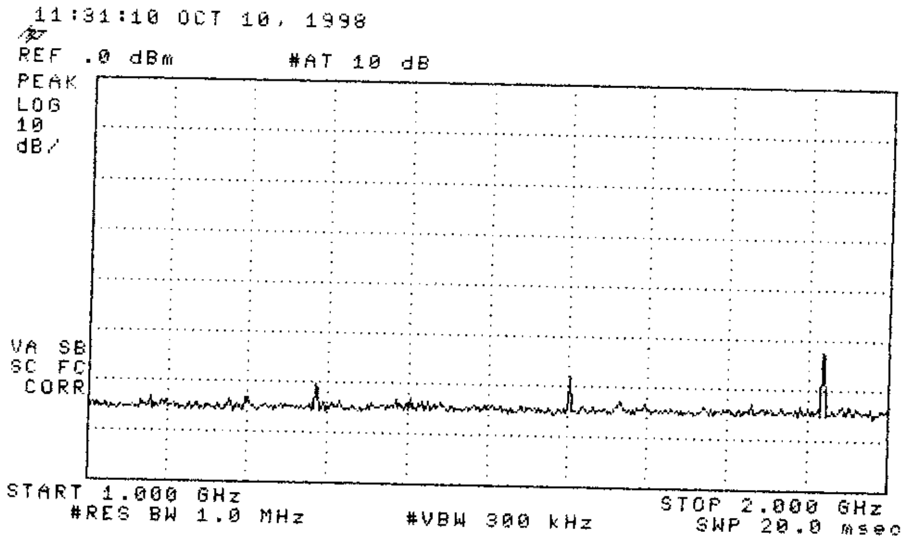


Figure 5.1. Emissions measured at 3 meters in anechoic chamber, 0-1000 MHz.
(top) Receiver plus ambient
(bottom) Ambient



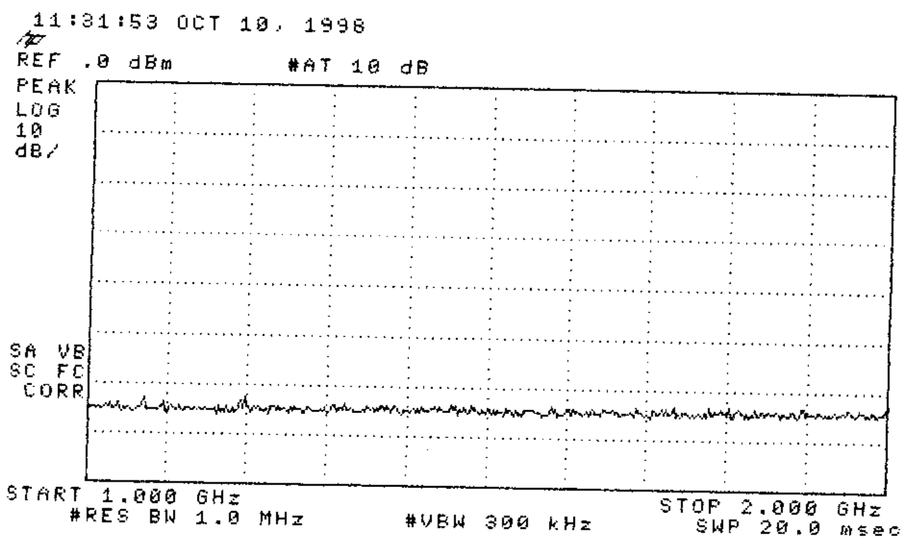


Figure 5.2. Emissions measured at 3 meters in anechoic chamber, 1000-2000 MHz.
(top) Receiver plus ambient
(bottom) Ambient

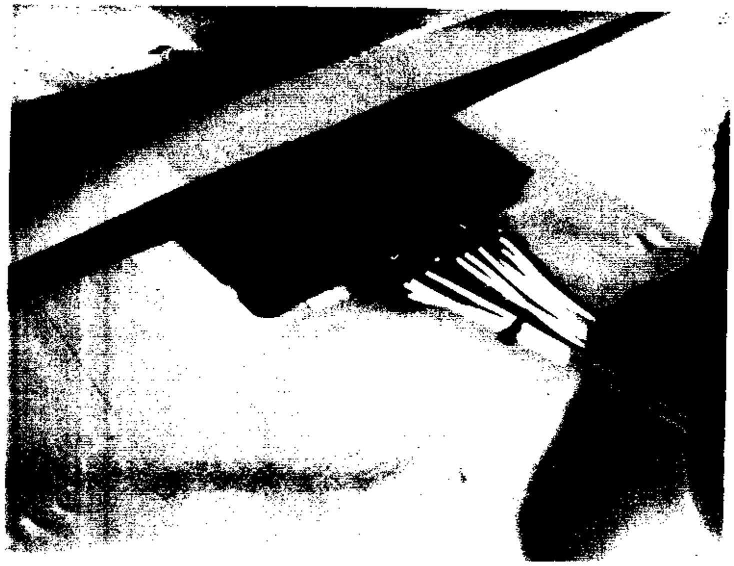


Figure 5.3. Close-up of the DUT on the open-site test table for worst case emissions at "fundamental".

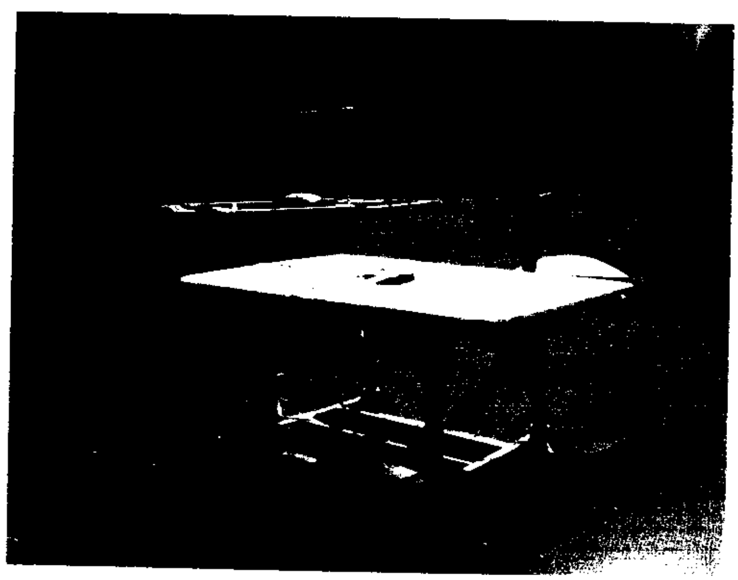


Figure 5.4. DUT on the OATS test table showing the overall view.

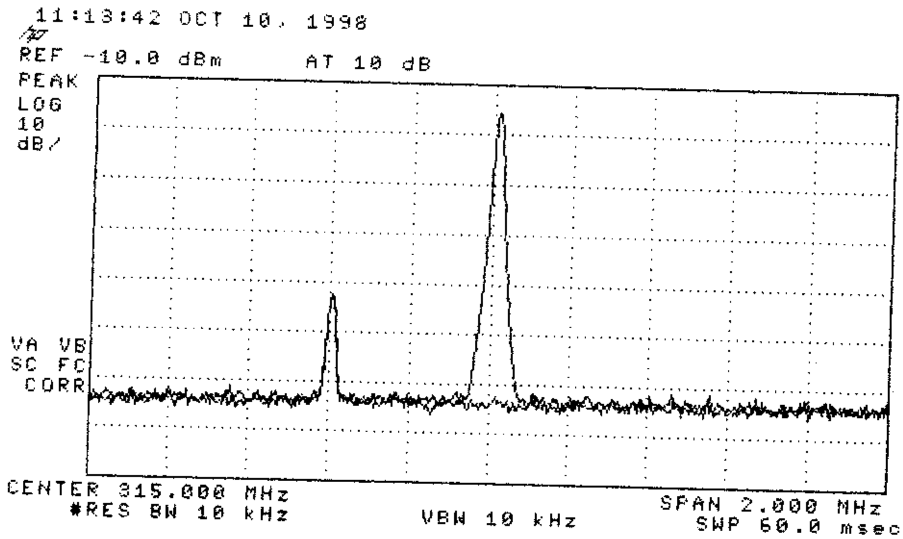


Figure 6.1. Relative receiver emissions in stand-by and "locked-in" modes. The final emission measurements were made with the receiver in "locked-in" mode.

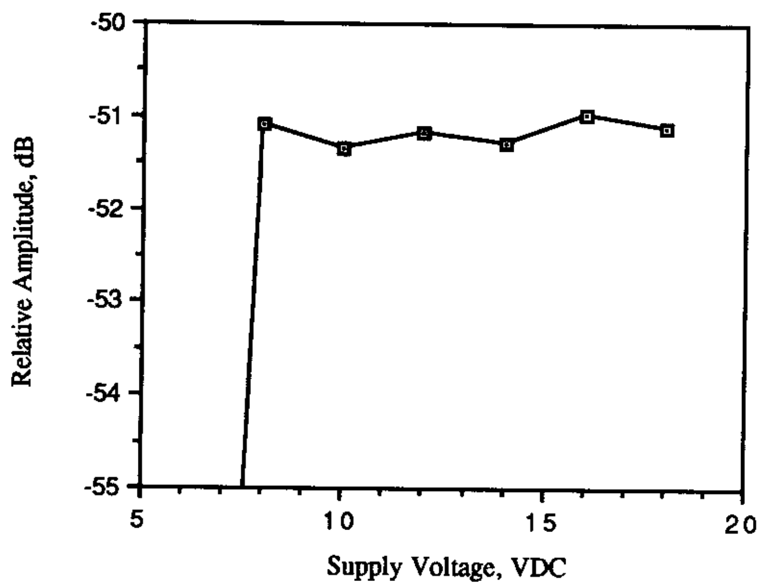


Figure 6.2. Relative emission at "fundamental" vs. supply voltage.

GENERAL DESCRIPTION

The equipment for which certification is being requested is a super-heterodyne receiver. When used with its associated key fob transmitter, it can be used to remotely lock and unlock the doors of the automobile in which it is installed. The receiver is installed during the assembly of the vehicle and the transmitter/receiver set is sold as an option when the vehicle is purchased.

PRINCIPLES OF CIRCUIT OPERATION

The receiver portion of the remote lock control system is incorporated into the wiring system of an automobile and is powered by the vehicle's 12V battery. The receiver operates in three modes: sleep, active, and program mode. Upon receipt of a valid code, the receiver leaves the sleep mode and activates the desired loads (door lock motors, etc.). In the program mode, the receiver is able to learn the security code of any four rolling code transmitters. After this, the receiver will respond only to the transmitters it is programmed to.

The R.F. portion of the receiver is super-heterodyne in design and is tuned to 315MHz. The received data signal is demodulated and fed into a microcontroller which "wakes up" the rest of the receiver's circuitry. The microcontroller contains EEPROM that can store four 32 bit security codes. The microcontroller compares the received data to the previously stored security codes. When a valid code is received the microcontroller will activate the appropriate outputs.