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Measured Radio Frequency Emissions
From

Prince Homelink Transmitter Model WJ

Report No. 415031-907
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EXHIBIT F

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U of Mich file 415031-907

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Summary

Tests for compliance with FCC Regulations, subject to Part 15, Subpart C, were performed on Prince Homelink (Universal Garage Door Opener) Transmitter, Model WJ. The transmitter operates (programs) in 286 to 418 MHz range. In the tests the transmitters were trained to three frequencies (286 MHz, 310 MHz, and 418 MHz) and three different codes (30%, 50%, and 80% duty factors) at each frequency.

In testing performed during October, 1997 through February, 1998, in the worst case of the all combinations tested, the transmitters tested in the worst case met the allowed limits for radiated emissions by 0.3 dB at the fundamental (p. 8) and by 0.5 dB at the harmonics (p. 8). Besides harmonics and presence of short "blips" when locking the VCO is locked to the required frequency, there were no other significant spurious emissions found.

The conductive emission tests do not apply, since the device is powered from a 12V automobile system.

1. Introduction

The Prince Homelink transmitter was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989. 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 attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland. (FCC file 31040/SIT)

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)		Hewlett-Packard 8593A SN: 3107A01358	July 1997/HP
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E SN: 3107A01131	June 1997/HP
Spectrum Analyzer (0.1-1500 MHz)	X	Hewlett-Packard 182T/8558B SN: 1529A01114/543592	August 1996/U of M Rad Lab
Preamplifier (5-1000MHz)	X	Watkins-Johnson A11 -1 plus A25-1S	May 1996/U of M Rad Lab
Preamplifier (5-4000 MHz)	X	Avantek	Nov. 1992/ U of M Rad Lab
Power Meter		Hewlett-Packard 432A	August 1989/U of M Rad Lab
w/ Thermistor		Hewlett-Packard 478A	August 1989/U of M Rad Lab
Broadband Bicone (20-200 MHz)	X	University of Michigan	July 1988/U of M Rad Lab
Broadband Bicone (200-1000 MHz)	X	University of Michigan	June 1996/U of M Rad Lab
Dipole Antenna Set (25-1000 MHz)	X	University of Michigan	June 1996/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	February 1991/U of M Rad Lab
LISN Box		University of Michigan	May 1994/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 7.5 x 5 x 2 inch size intrument package with an LCD display that contains a garage door opener, a compass, and a whole bunch of other convenience devices. It is an OEM device that typically is installed in automobile console and is powered by 12 VDC. Here we address only the transmitter. This transmitter differs from a standard Garage Door Opener (GDO) in that it does not have a fixed frequency and code, but rather learns and repeats the frequency and code from another GDO, up to three GDOs. The DUT uses a 4.0 MHz crystal frequency reference and operates over 286 to 418 MHz. The forbidden bands are "blocked out" by software. Depending on the frequency and the duty factor of the GDO that is being learned, the DUT attenuates the emissions in software using predetermined attenuation settings.

The DUT was designed and manufactured by Prince, One Prince Center, Holland, Michigan 49423. It is identified as:

Prince Homelink Transmitter
Model/PN: WJ/VA5591
SN: FCCWJ1(mod. for testing); SN: FCCWJ2(std. unit)
FCC ID: CB2VA5591
CANADA: to be provided by IC

Two units were provided. One was custom modified for emission testing by adding a programming access (connector) through which (with the provided control box) the DUT could be set to desired frequency, and attenuation setting. A CW operation was obtained by soldering a jumper across one of the button switches. The same unit could also be operated in a normal mode and was taught for 30%, 50%, and 80% duty factor modulation at 310 MHz. For the radiated emission tests, the DUTs was set to CW, and tested at 286, 310, and 418 MHz for three different attenuation settings at each frequency, representing different duty factor transmissions. The attenuation values were provided by Prince, the same values that will be used in production units.

The other unit was unaltered and was used for photographs and verification that, indeed, the devices operates as intended and does not accept frequencies in Restricted Bands.

3.1 EMI Relevant Modifications

There were no modifications made to the DUT by this laboratory after submission for final testing. However, during development of the product, Prince used the University of Michigan facilities to optimize the firmware and some component values for the transmitter.

4. Emission Limits

4.1 Radiated Emission Limits

The DUT tested falls under the category of an Intentional Radiators and the Digital Devices, subject to Subpart C, Section 15.231; and Subpart B, Section 15.109 (transmitter generated signals excluded); and Subpart A, Section 15.33. The applicable testing frequencies with corresponding emission limits are given in Tables 4.1 and 4.2 below. As a digital device, the DUT is considered as a Class B device.

Table 4.1. Radiated Emission Limits (Ref: 15.231(b), 15.205(a)) -- Transmitter.

Frequency (MHz)	Fundamental Ave. E_{lim} (3m)		Spurious** Ave. E_{lim} (3m)	
	(μV/m)	dB (μV/m)	(μV/m)	dB (μV/m)
260.0-470.0	3750-12500*		375-1250	
322-335.4 399.9-410 608-614	Restricted Bands		200	46.0
960-1240 1300-1427 1435-1626.5 1660-1710 1718.9-1722.2 2200-2300	Restricted Bands		500	54.0

* Linear interpolation, formula: E = -7083 + 41.67*f (MHz)
** Measure up to tenth harmonic; 120 kHz BW up to 1 GHz, 1 MHz BW above 1 GHz

Table 4.2. Radiated Emission Limits (Ref: 15.33, 15.35, 15.109) -- Digital, Class B

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

4.2 Conductive Emission Limits

The conductive emission limits and tests do not apply here, since the DUT is powered from automotive 12 VDC system.

5. Radiated Emission Tests and Results

5.1 Anechonic Chamber Measurements

To familiarize with the radiated emission behavior of the DUT, the DUT was first studied and measured in a shielded anechonic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with a turntable, an antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed. In testing for radiated emissions, the transmitter modified for continuous emissions was used. It was placed in a styrofoam block to facilitate its orientation on any of its three major axis, i. e., flat down, on its side, or on its end.

In the chamber we studied and recorded all the emissions using a bicone antenna up to 300 MHz and a ridged horn antenna above 200 MHz. The measurements made in the chamber below 1 GHz are used for pre-test evaluation only. The measurements made above 1 GHz are used in pre-test evaluation and in the final compliance assessment. We note that for the horn antenna, the antenna pattern is more directive and hence the measurement is essentially that of free space (no ground reflection). Consequently it is not essential to measure the DUT for both antenna polarizations, as long as the DUT is measured on all three of its major axis. In the chamber we also recorded the spectrum and modulation characteristics of the carrier. These data are presented in subsequent sections. We also note that in scanning from 30 MHz to 4.2 GHz using bicone and the ridge horn antennas, there were no other significant spurious emissions observed.

5.2 Outdoor Measurements

After the chamber measurements, the emissions were re-measured on the outdoor 3-meter site at fundamental and harmonics up to 1 GHz using tuned dipoles and/or the high frequency bicone.

Figure 5.1 shows the DUT placed flat on the open-site table.

5.3 Computations and Results

To convert the dBm measured on the spectrum analyzer to dB(μV/m), we use expression

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

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
K_E = pulse operation correction factor, dB (see Sec. 6.1)

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 Tables 5.1 through 5.3. There we see that the DUT meets the limit by 0.3 dB (p. 8).

6. Other Measurements and Computations

6.1 Correction For Pulse Operation

As agreed previous between FCC and Prince, the DUT was pre-taught signals of 30, 50, and 80% duty factors. The pre-programmed emitted wave shape was measured and these obtained duty factors were used in the computations for compliance. The measurements were made at the center frequency, 310 MHz. Figures 6.1(a) through 6.1(c) show the measured wave shapes from which the duty factors were computed. They are

<u>30% duty factor</u> The code consists of bursts of 12 narrow and six wide pulsed, which gives max occupied time in 100 ms window. Thus,

$$K_E = ((12 \text{ x } 0.560) + (6 \text{ x } 3.3.90)) \text{ ms/100 ms} = 0.283 \text{ or } -11.0 \text{ dB.}$$

<u>50% duty factor</u> The code consists of bursts of six narrow and 12 wide pulsed, which gives max occupied time in 100 ms window. Thus,

$$K_E = ((6 \text{ x } 0.56) + (12 \text{ x } 3.89)) \text{ ms/100 ms} = 0..500 \text{ or } -6.0 \text{ dB.}$$

80% duty factor The code consists of bursts of 18 pulses 4.40 ms wide, which gives max occupied time in 100 ms window. Thus,

$$K_E = 18 \times 4.48 \text{ ms}/100.0 \text{ ms} = 0.806 \text{ or } -1.9 \text{ dB}.$$

6.2 Emission Spectrum
Using the ridge-horn antenna and DUT placed in its aperture, emission spectrum was recorded and is shown in Figure 6.2.

6.3 Bandwidth of the Emission Spectrum
The measured spectrum of the signal is shown in Figure 6.3. The measurements were made at 310 MHz for 30, 50, and 80% duty factor modulations. At 310 MHz the allowed (-20 dB, 0.25%) bandwidth is 775 kHz. From the plots we see that, in the worst case, the -20 dB bandwidth is 355 kHz for 30% modulation (Fig. 6.3(a)).

6.4 Effect of Supply Voltage Variation
The DUT has been designed to be powered from automotive 12 V battery. For this test, a laboratory variable power supply was used and relative radiated field was measured at the fundamental, as the voltage was varied from 5 to 18 volts. The emission variation is shown in Figure 6.4.

6.5 Input Voltage and Current (310 MHz, CW)

Supply Voltage	=	12.0 VDC
Current	=	54.0 mADC

6.6 Verification of Non-operation in Restricted Bands
The DUT has been designed to learn and operate over 286 to 418 MHz frequency range. It also has been programmed to stay out of the Restricted Bands. In the operating range of the DUT, the bands are 240.0 - 285.0 MHz, 322.0 - 335.4 MHz, and 399.9 - 410.0 MHz.

For this the Prince provided a modulator that together with a CW signal generaror could generate any frequency encoded signal to teach the DUT from 240.0 to 440.0 MHz. It learned (repeated) frequencies from 287.0 MHz to 320.0 MHz and from 339.5 MHz to 390.0 MHz. We were not able to train the DUT to frequencies above 410 MHz, even though the device is "specified" to do so up to 418. In any case, no frequency was learned in the Restricted Bands. (Also there were no spurious emissions in the Restricted Bands that exceeded allowed amplitude limits.)

Table 5.1. Highest Emissions Measured

Radiated Emissions — UGDO WJ; 286 MHz

#	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	286	Dip	H	-24.4	Pk	18.2	22.2	67.6	73.9	**6.3**	flat 30% duty factor (meas. --11.0 dB)
2	286	Dip	V	-25.2	Pk	18.2	22.2	66.8	73.9	7.1	side ATTN: 31
3	572	Dip	H	-53.7	Pk	24.3	19.0	47.6	53.9	6.3	flat
4	572	Dip	V	-57.6	Pk	24.3	19.0	43.7	53.9	10.2	side
5	858	Dip	H	-58.0	Pk	28.0	16.8	49.2	53.9	**4.7**	flat
6	858	Dip	V	-63.5	Pk	28.0	16.8	43.7	53.9	10.2	side
7	1144	Horn	H	-49.1	Pk	20.2	28.1	39.0	53.9	14.9	flat
8	1430	Horn	H	-52.6	Pk	21.2	28.3	36.4	53.9	17.6	flat
9	1716	Horn	H	-52.5	Pk	21.9	27.8	37.6	53.9	16.4	end
10	2002	Horn	H	-59.0	Pk	22.5	26.6	32.9	53.9	21.0	flat
11	2288	Horn	H	-65.1	Pk	23.2	26.9	27.3	53.9	26.6	max. all; noise floor
12	2574	Horn	H	-66.5	Pk	24.0	26.6	26.9	53.9	27.0	max. all; noise floor
13	2860	Horn	H	-66.6	Pk	24.8	25.5	28.7	53.9	25.3	max. all; noise floor
14											
15	286	Dip	H	-23.8	Pk	18.2	22.9	72.5	73.9	**1.4**	end 50% duty factor (meas. -6.0 dB)
16	286	Dip	V	-24.9	Pk	18.2	22.9	71.4	73.9	2.5	end ATTN: 28
17	572	Dip	H	-58.3	Pk	24.3	19.7	47.3	53.9	6.6	flat
18	572	Dip	V	-57.7	Pk	24.3	19.7	47.9	53.9	6.0	side
19	858	Dip	H	-59.5	Pk	28.0	17.5	52.0	53.9	**1.9**	flat
20	858	Dip	V	-63.2	Pk	28.0	17.5	48.3	53.9	5.6	side
21	1144	Horn	H	-46.6	Pk	20.2	28.1	46.5	53.9	7.4	flat
22	1430	Horn	H	-57.3	Pk	21.2	28.3	36.7	53.9	17.3	side
23	1716	Horn	H	-52.4	Pk	21.9	27.8	42.7	53.9	11.3	end
24	2002	Horn	H	-59.9	Pk	22.5	26.6	37.0	53.9	16.9	end
25	2288	Horn	H	-64.0	Pk	23.2	26.9	33.4	53.9	20.6	max. all; noise floor
26	2574	Horn	H	-64.0	Pk	24.0	26.6	34.4	53.9	19.5	max. all; noise floor
27	2860	Horn	H	-64.0	Pk	24.8	25.5	36.3	53.9	17.7	max. all; noise floor
28											
29											
30											

Conducted Emissions

#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1							
2							
3							
4				Not Applicable			
5							

Meas. 10/17,11/13,12/3/97; U of Mich.

Table 5.1(Cont.). Highest Emissions Measured

Radiated Emissions											UGDO WJ; 286 MHz
#	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	286	Dip	H	-27.2	Pk	18.2	22.5	73.6	73.9	**0.3**	end 80% duty factor (meas. -1.9 dB)
2	286	Dip	V	-30.7	Pk	18.2	22.5	70.1	73.9	3.8	flat ATTN: 16
3	572	Dip	H	-65.2	Pk	24.3	19.3	44.9	53.9	9.0	end
4	572	Dip	V	-61.9	Pk	24.3	19.3	48.2	53.9	5.7	side
5	858	Dip	H	-62.6	Pk	28.0	17.1	53.4	53.9	**0.5**	flat
6	858	Dip	V	-65.6	Pk	28.0	17.1	50.4	53.9	3.5	end
7	1144	Horn	H	-48.1	Pk	20.2	28.1	49.1	53.9	4.8	flat
8	1430	Horn	H	-59	Pk	21.2	28.3	39.1	53.9	14.9	end
9	1716	Horn	H	-52.4	Pk	21.9	27.8	46.8	53.9	7.2	end
10	2002	Horn	H	-59.3	Pk	22.5	26.6	41.7	53.9	12.2	end
11	2288	Horn	H	-66.7	Pk	23.2	26.9	34.8	53.9	19.2	max. all; noise floor
12	2574	Horn	H	-67.1	Pk	24.0	26.6	35.4	53.9	18.5	max. all; noise floor
13	2860	Horn	H	-66.7	Pk	24.8	25.5	37.7	53.9	16.3	max. all; noise floor
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29		Digital emissions are more than 20 dB below FCC Class B limit.									
30											

Conducted Emissions							
#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1							
2							
3							
4				Not Applicable			
5							

Meas. 10/17,11/13,12/3/97; U of Mich.

Table 5.2. Highest Emissions Measured

Radiated Emissions											UGDO WJ; 310 MHz
#	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	310	Dip	H	-24.4	Pk	18.8	22.1	68.3	75.3	7.0	flat 30% duty factor (meas. -11.0 dB)
2	310	Dip	V	-27.1	Pk	18.8	22.1	65.6	75.3	9.7	side ATTN: 31
3	620	Dip	H	-51.6	Pk	25.1	18.7	50.8	55.3	**4.6**	flat
4	620	Dip	V	-65.4	Pk	25.1	18.7	37.0	55.3	18.4	side
5	927	Dip	H	-59.1	Pk	26.1	16.4	46.6	55.3	8.8	flat
6	927	Dip	V	-58.8	Pk	26.1	16.4	46.9	55.3	**8.5**	side
7	1240	Horn	H	-51.6	Pk	20.4	28.0	36.8	54.0	17.2	flat
8	1550	Horn	H	-44.8	Pk	21.5	28.2	44.5	54.0	9.6	side
9	1860	Horn	H	-50.2	Pk	22.1	28.3	39.6	55.3	15.8	end
10	2170	Horn	H	-64.0	Pk	22.8	27.1	27.7	55.3	27.6	max. all; noise floor
11	2480	Horn	H	-64.0	Pk	23.8	26.5	29.3	55.3	26.0	max. all; noise floor
12	2790	Horn	H	-64.0	Pk	24.5	25.6	30.9	54.0	23.1	max. all; noise floor
13	3100	Horn	H	-64.0	Pk	25.8	25.1	32.8	55.3	22.6	max. all; noise floor
14											
15	310	Dip	H	-24.7	Pk	18.8	22.1	73.0	75.3	**2.3**	flat 50% duty factor (meas. -6.0 dB)
16	310	Dip	V	-26.9	Pk	18.8	22.1	70.8	75.3	4.5	end ATTN: 25
17	620	Dip	H	-56.2	Pk	25.1	18.7	51.2	55.3	4.2	flat
18	620	Dip	V	-64.1	Pk	25.1	18.7	43.3	55.3	12.1	end
19	930	Dip	H	-59.3	Pk	26.1	16.4	51.4	55.3	**3.9**	flat
20	930	Dip	V	-60.7	Pk	26.1	16.4	50.0	55.3	5.3	side
21	1240	Horn	H	-51.4	Pk	20.4	28.0	42.0	54.0	12.0	flat
22	1550	Horn	H	-49.1	Pk	21.5	28.2	45.2	54.0	8.9	side
23	1860	Horn	H	-49.0	Pk	22.1	28.3	45.8	55.3	9.6	end
24	2170	Horn	H	-64.0	Pk	22.8	27.1	32.7	55.3	22.6	max. all; noise floor
25	2480	Horn	H	-64.0	Pk	23.8	26.5	34.3	55.3	21.0	max. all; noise floor
26	2790	Horn	H	-64.0	Pk	24.5	25.6	35.9	54.0	18.1	max. all; noise floor
27	3100	Horn	H	-67.1	Pk	25.8	25.1	34.7	55.3	20.6	max. all; noise floor
28											
29											
30											

Conducted Emissions							
#	Freq. MHz	Line Side	Det. Used	Vtest dBµV	Vlim dBµV	Pass dB	Comments
1							
2							
3							
4				Not Applicable			
5							

Meas. 10/17,11/13,12/3/97; U of Mich.

Table 5.2(Cont.). Highest Emissions Measured

						Radiated Emissions					UGDO LH; 310 MHz
#	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	310	Dip	H	-29.6	Pk	18.8	22.2	72.1	75.3	**3.2**	flat 80% duty factor (meas. -1.9 dB)
2	310	Dip	V	-33.3	Pk	18.8	22.2	68.4	75.3	6.9	end ATTN: 15
3	620	Dip	H	-67.1	Pk	25.1	22.2	40.9	55.3	14.4	side
4	620	Dip	V	-64.4	Pk	25.1	22.2	43.6	55.3	11.7	end
5	927	Dip	H	-61.8	Pk	26.1	22.2	47.2	55.3	8.1	flat
6	927	Dip	V	-63.2	Pk	26.1	22.2	45.8	55.3	9.5	end
7	1240	Horn	H	-51.1	Pk	20.4	28.0	46.4	54.0	7.6	side
8	1550	Horn	H	-51	Pk	21.5	28.2	47.4	54.0	6.7	side
9	1860	Horn	H	-50.0	Pk	22.1	28.3	48.9	55.3	**6.5**	end
10	2170	Horn	H	-64.0	Pk	22.8	27.1	36.8	55.3	18.5	max. all; noise floor
11	2480	Horn	H	-64.0	Pk	23.8	26.5	38.4	55.3	16.9	max. all; noise floor
12	2790	Horn	H	-64.0	Pk	24.5	25.6	40.0	54.0	14.0	max. all; noise floor
13	3100	Horn	H	-64.0	Pk	25.8	25.1	41.9	55.3	13.5	max. all; noise floor
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29		Digital emissions are more than 20 dB below FCC Class B limit.									
30											

			Conducted Emissions				
#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1							
2							
3							
4				Not Applicable			
5							

Meas. 10/17,11/13,12/3/97; U of Mich.

Table 5.3(Cont.). Highest Emissions Measured

Radiated Emissions

UGDO WJ; 418 MHz

#	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	418	Dip	H	-28.1	Pk	21.1	22.0	76.1	80.3	**4.2**	flat 80% duty factor (meas. -1.9 dB)
2	418	Dip	V	-28.9	Pk	21.1	22.0	75.3	80.3	5.0	side ATTN: 25
3	836	Dip	H	-73.4	Pk	27.7	18.4	41.0	60.3	19.3	flat
4	836	Dip	V	-71.4	Pk	27.7	18.4	43.0	60.3	17.3	side
5	1254	Horn	H	-40.3	Pk	20.5	28.1	57.2	60.3	3.1	side
6	1672	Horn	H	-46.8	Pk	21.5	28.1	51.7	54.0	**2.3**	flat
7	2090	Horn	H	-53.7	Pk	22.7	26.8	47.3	60.3	13.0	flat
8	2508	Horn	H	-59.2	Pk	24.0	26.5	43.4	60.3	16.9	end
9	2926	Horn	H	-63.0	Pk	25.1	25.2	42.0	60.3	18.3	max. all; noise floor
10	3344	Horn	H	-63.0	Pk	26.5	24.7	43.9	54.0	10.1	max. all; noise floor
11	3762	Horn	H	-63.0	Pk	27.7	24.3	45.5	54.0	8.5	max. all; noise floor
12	4180	Horn	H	-63.0	Pk	28.9	20.7	50.3	54.0	3.7	max. all; noise floor
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											max. all; noise floor
29		Digital emissions are more than 20 dB below FCC Class B limit.									max. all; noise floor
30											max. all; noise floor

Conducted Emissions

#	Line Side	Line Side	Det. Used	Vtest dBµV	Vlim dBµV	Pass dB	Comments
1							
2							
3							
4				Not Applicable			
5							

Meas. 10/17,11/13,12/3/97; U of Mich.

Table 5.3. Highest Emissions Measured

Radiated Emissions											UGDO WJ; 418 MHz
#	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	418	Dip	H	-24.3	Pk	21.1	22.0	70.8	80.3	**9.5**	flat 30% duty factor (meas. -11.0 dB)
2	418	Dip	V	-27.8	Pk	21.1	22.0	67.3	80.3	13.0	end ATTN: 31
3	836	Dip	H	-61.7	Pk	27.7	18.4	43.6	60.3	16.7	flat
4	836	Dip	V	-67.9	Pk	27.7	18.4	37.4	60.3	22.9	side
5	1254	Horn	H	-39.2	Pk	20.5	28.1	49.2	60.3	11.1	flat
6	1672	Horn	H	-46.4	Pk	21.5	28.1	43.0	54.0	**11.0**	flat
7	2090	Horn	H	-54.3	Pk	22.7	26.8	37.6	60.3	22.7	flat
8	2508	Horn	H	-53.9	Pk	24.0	26.5	39.6	60.3	20.7	end
9	2926	Horn	H	-63.0	Pk	25.1	25.2	32.9	60.3	27.4	max. all; noise floor
10	3344	Horn	H	-63.0	Pk	26.5	24.7	34.8	54.0	19.2	max. all; noise floor
11	3762	Horn	H	-63.0	Pk	27.7	24.3	36.4	54.0	17.6	max. all; noise floor
12	4180	Horn	H	-63.0	Pk	28.9	20.7	41.2	54.0	12.8	max. all; noise floor
13											
14	418	Dip	H	-24.3	Pk	21.1	22.0	75.8	80.3	**4.5**	flat 50% duty factor (meas. -6.0 dB)
15	418	Dip	V	-27.8	Pk	21.1	22.0	72.3	80.3	8.0	side ATTN: 31
16	836	Dip	H	-61.7	Pk	27.7	18.4	48.6	60.3	11.7	flat
17	836	Dip	V	-67.9	Pk	27.7	18.4	42.4	60.3	17.9	side
18	1254	Horn	H	-39.2	Pk	20.5	28.1	54.2	60.3	6.1	flat
19	1672	Horn	H	-46.4	Pk	21.5	28.1	48.0	54.0	**6.0**	flat
20	2090	Horn	H	-54.3	Pk	22.7	26.8	42.6	60.3	17.7	flat
21	2508	Horn	H	-53.9	Pk	24.0	26.5	44.6	60.3	15.7	flat
22	2926	Horn	H	-63.0	Pk	25.1	25.2	37.9	60.3	22.4	max. all; noise floor
23	3344	Horn	H	-63.0	Pk	26.5	24.7	39.8	54.0	14.2	max. all; noise floor
24	3762	Horn	H	-63.0	Pk	27.7	24.3	41.4	54.0	12.6	max. all; noise floor
25	4180	Horn	H	-63.0	Pk	28.9	20.7	46.2	54.0	7.8	max. all; noise floor
26											
27											
28											
29											
30											

Conducted Emissions							
#	Line Side	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1							
2							
3							
4				Not Applicable			
5							

Meas. 10/17,11/13,12/3/97; U of Mich.

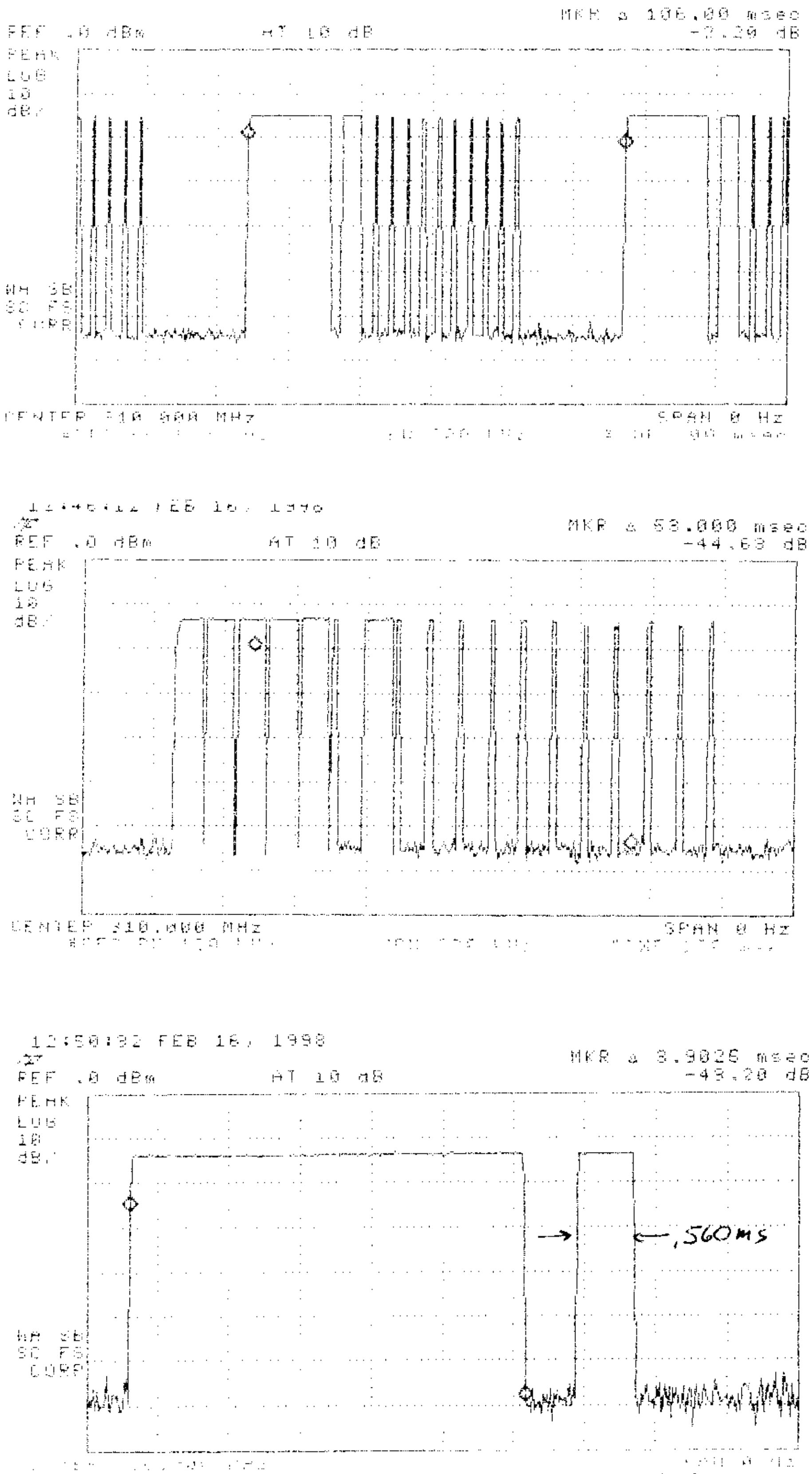

Figure 6.1(a). Transmissions modulation characteristics: (top) complete transmission, (center) expanded word, (bottom) expanded bits. (310 MHz, 30% duty fac.)

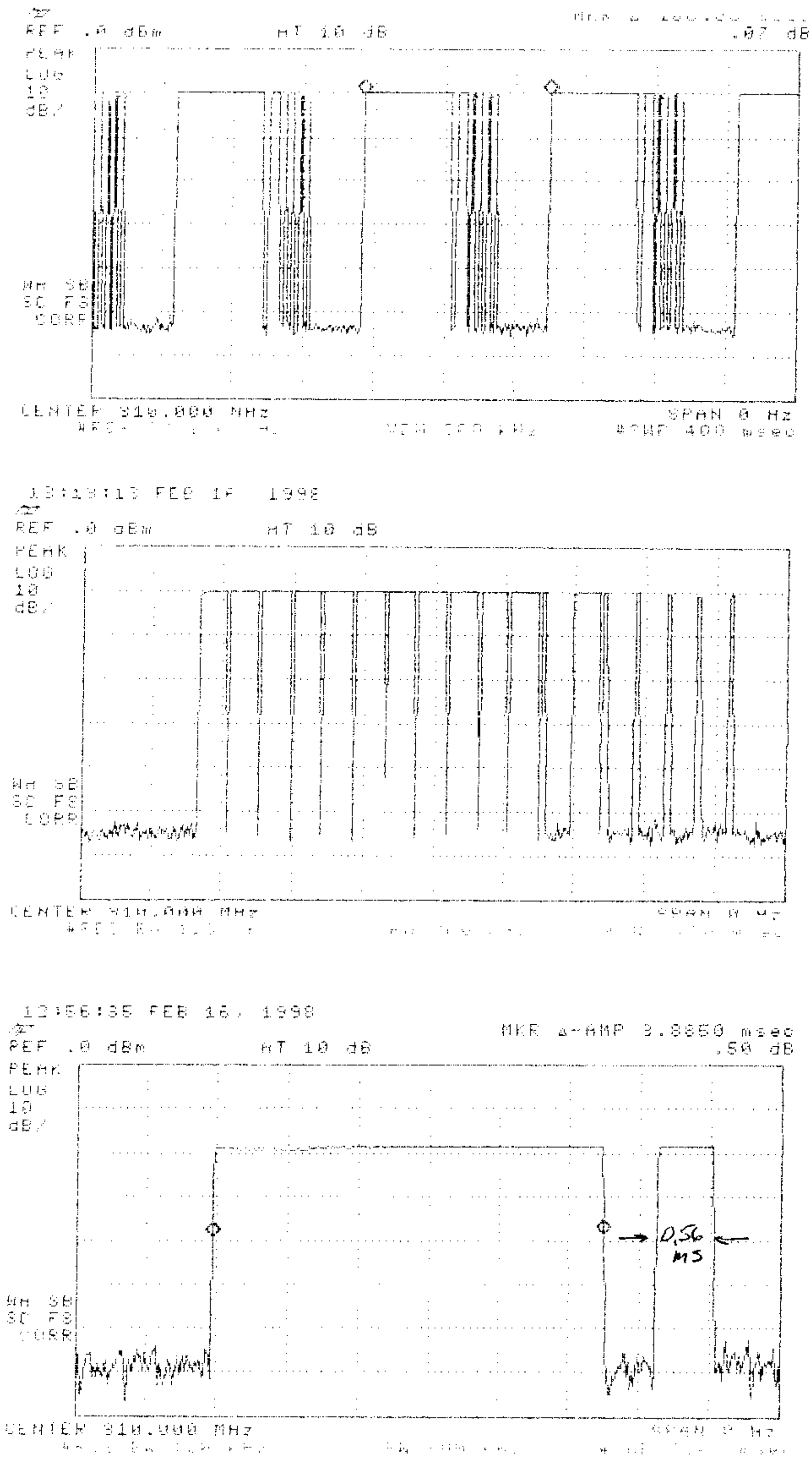

Figure 6.1(b). Transmissions modulation characteristics: (top) complete transmission, (center) expanded word, (bottom) expanded bits. (310 MHz, 50% duty fac.)

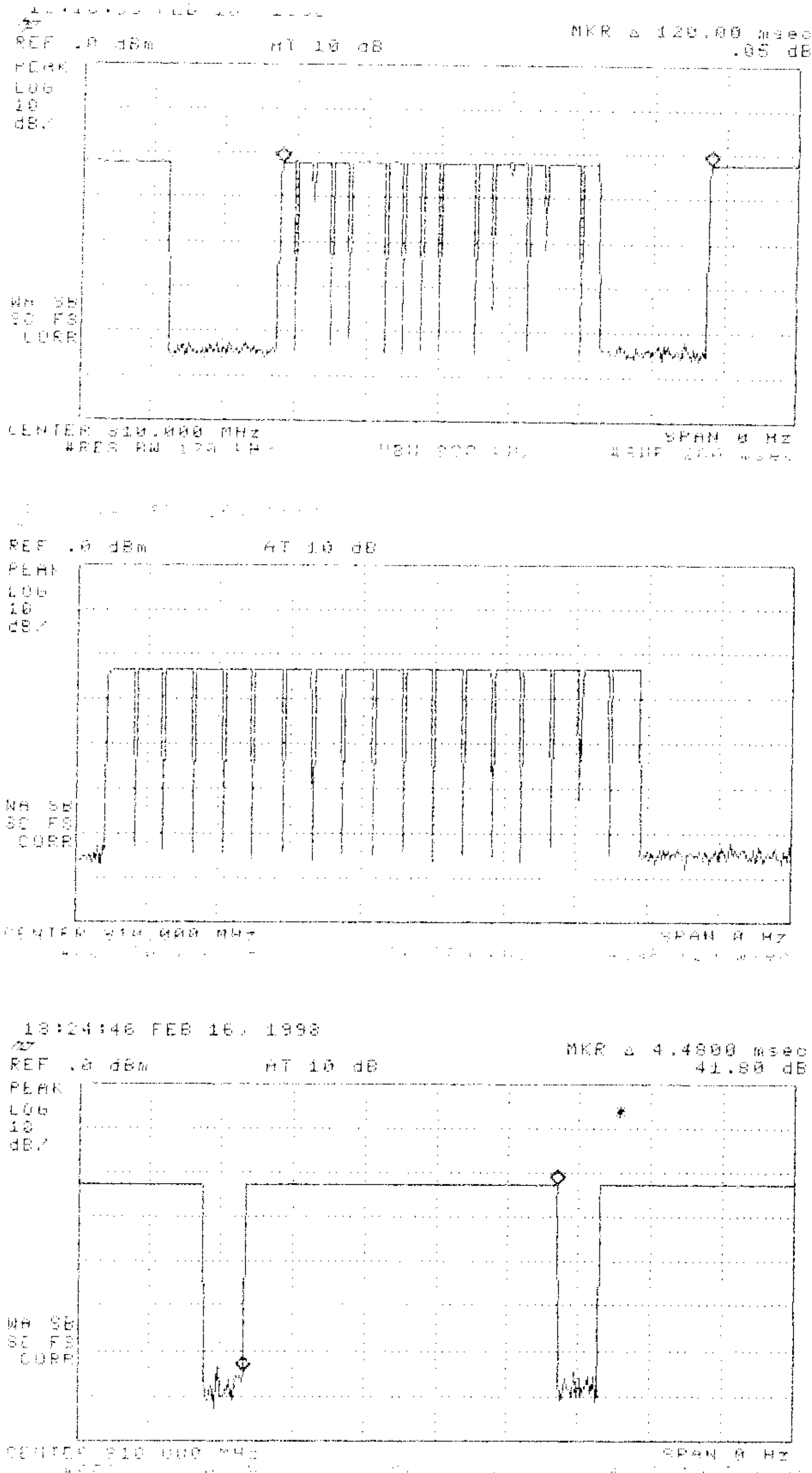

Figure 6.1(c). Transmissions modulation characteristics: (top) complete transmission, (center) expanded word, (bottom) expanded bits. (310 MHz, 80% duty fac.)

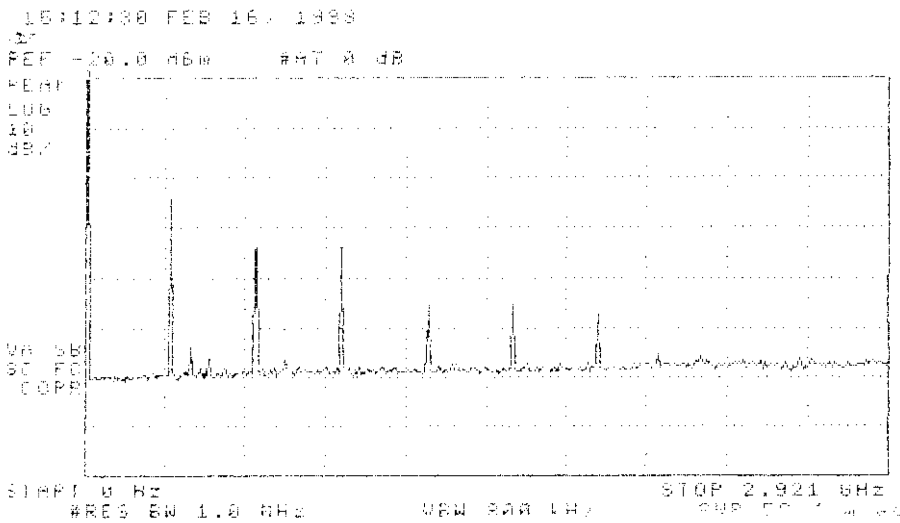

Figure 6.2(a). Emission spectrum of the DUT (286 MHz, CW).
The amplitudes are only indicative (not calibrated).

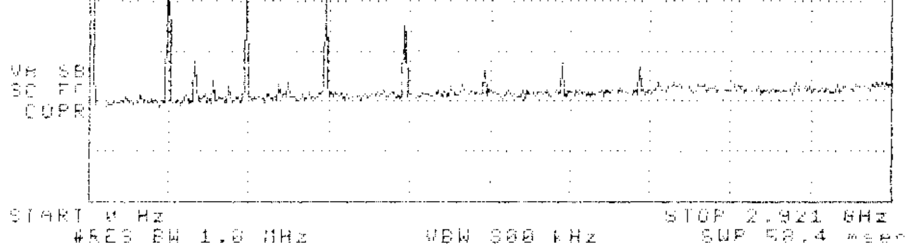

Figure 6.2(b). Emission spectrum of the DUT (310 MHz, CW).
The amplitudes are only indicative (not calibrated).

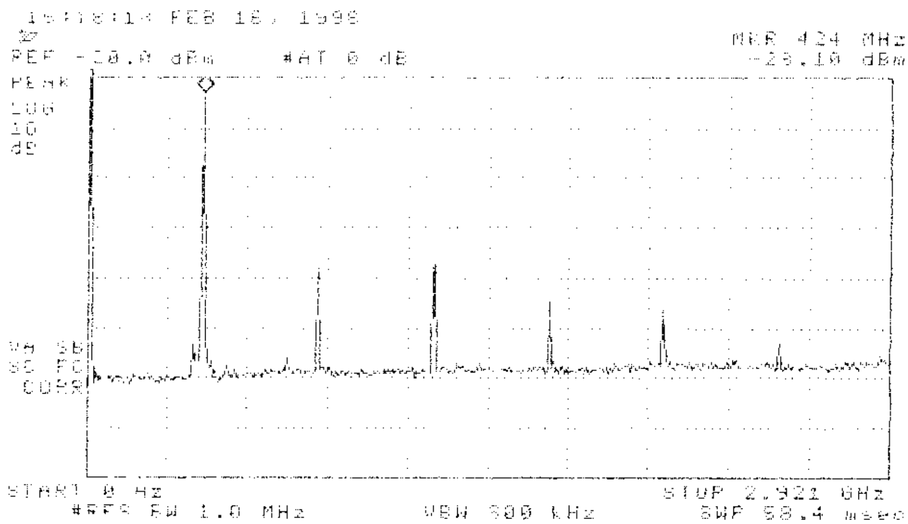

Figure 6.2(c). Emission spectrum of the DUT (418 MHz, CW).
The amplitudes are only indicative (not calibrated).

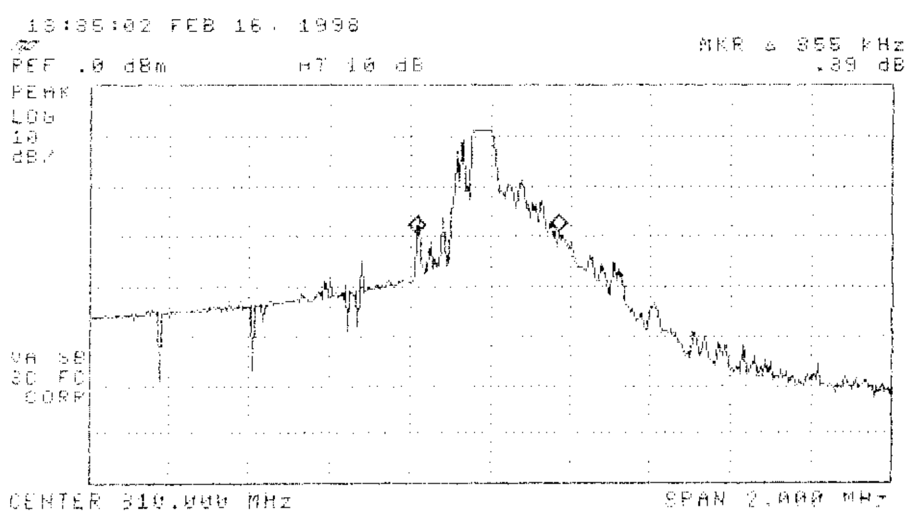

Figure 6.3(a). Measured bandwidth of the DUT
(Pulsed mode, 310 MHz, 30% duty fac.).

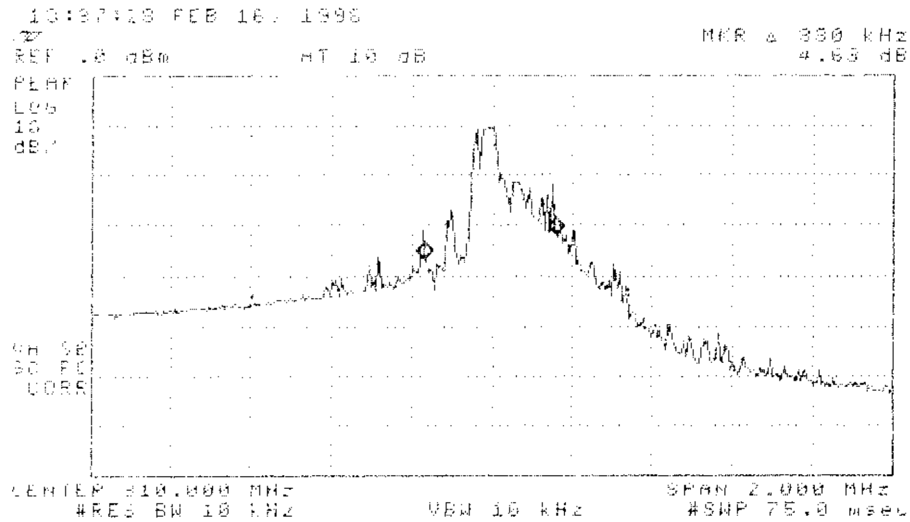

Figure 6.3(b). Measured bandwidth of the DUT
(Pulsed mode, 310 MHz, 50% duty fac.).

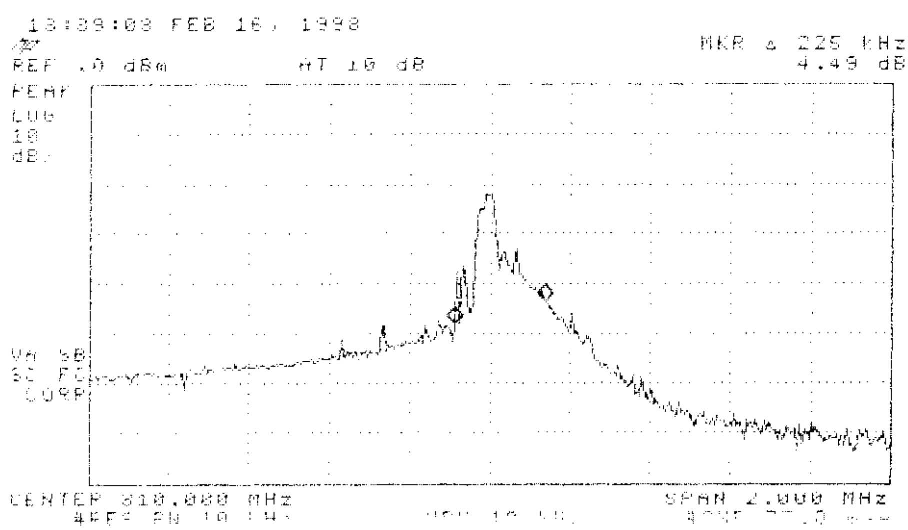

Figure 6.3(c). Measured bandwidth of the DUT
(Pulsed mode, 310 MHz, 80% duty fac.).

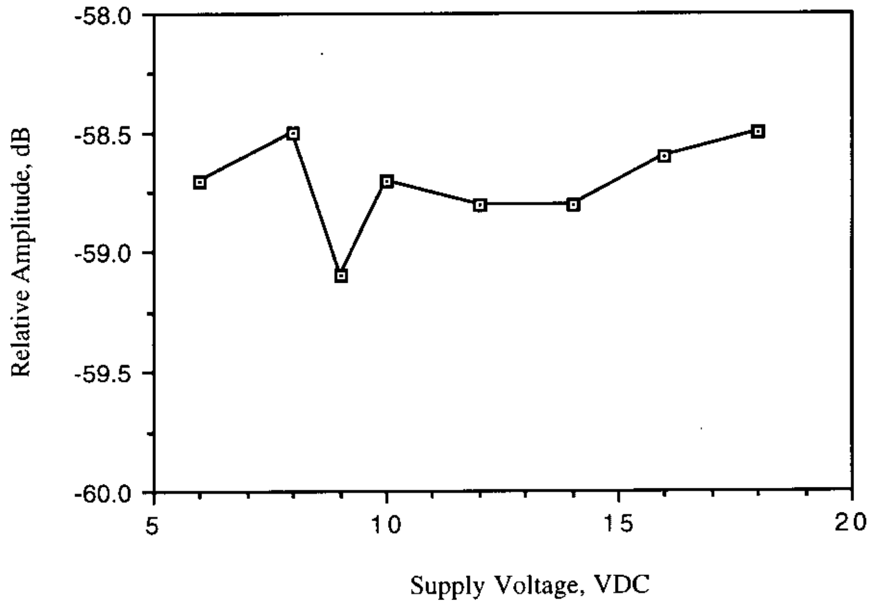

Figure 6.4. Relative emission vs. supply voltage. (310 MHz, CW)

WJ Electronic Vehicle Information Center with Homelink® Module Description of Operation

The WJ module consists of two basic sections. The Vehicle Information Center section, and the Homelink® section.

The Vehicle Information Center section provides data to the user via a VFD display such as Compass Heading, Outside Temperature, Trip Information, door ajar information, distance to service, and low coolant warning messages. There are seven switches on board, four of which allow the user to change Vehicle Information Center modes of operation, and three others which allow the user to select Homelink® operation. The Vehicle Information Center micro-processor then powers up the Homelink® section, and communicates to the Homelink® microprocessor which channel has been selected.

The 'training' operation is performed by scanning the legal frequencies with a single conversion superheterodyne receiver, looking for valid garage door opener bit code formats. The Homelink® shall not train or transmit to carrier frequencies in the bands 240 MHz - 285 MHz, 322 MHz - 335 MHz, or 400 MHz - 410 MHz.

In addition to being frequency and data format adaptive the Homelink's ® transmitter is also RF amplitude adaptive. A 5 bit (up to 32 settings) attenuator, which is controlled by a microcontroller algorithm, is calibrated at three specific duty factor settings an the FCC test site: 30%, 50% and 80%. Constants derived from the calibration sequence, which control the algorithm, are stored in the ROM of the microcontroller. During the training sequence, the duty factor of the incoming bit code format is evaluated by the microcontroller determining the greatest amount of on-time In a 1OOmS window. The attenuator is then computed by the microcontroller according to the calibrated algorithm; the algorithm will always round to the next higher attenuator setting (i.e. more attentions)

After the training sequence the frequency bit code format and attenuator setting is stored in non-volatile memory (NVM) and retrieved on subsequent power ups. A Phase Locked Loop' (PLL) is then programmed by the microcontroller to set the RF carrier frequency to that which was stored in the NVM. The attenuator is also programmed to what is stored in the NVM. The PLL voltage controlled oscillator (VCO) is then modulated with the appropriate bit code information from the NVM.

EXHIBIT 6

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