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Measured Radio Frequency Emissions From

Prince
Homelink Transmitter
Model/PN: UN150/VB3117

Report No. 415031-916
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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 UN150. The transmitter operates (programs) in 286 to 418 MHz range. In the tests the transmitter was 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 in January and February, 1998, in the worst case of all the combinations tested, the transmitter in the worst case met the allowed limits for radiated emissions by 0.7 dB at the fundamental (p. 10) and by 0.9 dB at the harmonics (p. 9). Besides harmonics and presence of short "blips" when the VCO locks 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 cigarette pack sized universal garage door transmitter (UGDO) that will be installed as an OEM device in automobile sun visors. It is powered by automobile's 12 volts. The device 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 an another GDO, and is capable of storing up to three GDO information. It is is synthesizer based, 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.

This particular device has also a voice recorder and playback.

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

Prince Homelink Transmitter
Model/PN: UN150/VB3117
SN: FCC1(mod. for CW testing); SN: FCC3(std. unit)
FCC ID: CB2VB3117
CANADA: to be provided by IC

Two units were provided. One was custom modified for CW emission testing by soldering a jumper across couple pins on the micro and adding a programming access (connector) through which the DUT could be set to a desired frequency and attenuation setting with the provided control box. For the radiated emission tests, the DUT tested at 286, 310, and 418 MHz for three different attenuation settings at each frequency, representing 30%, 50%, and 80% duty factor transmissions. The attenuation constants were provided by Prince, the values that will be used in production units.

The other unit was unaltered. It was used for measurement of duty factors, bandwidths, etc., and verifying that, indeed, the devices operates as intended and does not accept frequencies in the 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 the final development stage of the product, Prince used the University of Michigan facilities to optimize the firmware and hardware "tweaking" of the device.

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 0.7 dB (p. 10).

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

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

$$K_E = ((12 \times 0.575) + (6 \times 3.875))\ \text{ms}/100\ \text{ms} = 0.3015 \text{ or } -10.4\ \text{dB}.$$

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

$$K_E = ((6 \times 0.575) + (12 \times 3.90))\ \text{ms}/100\ \text{ms} = 0.503 \text{ or } -6.0\ \text{dB}.$$

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

$$K_E = 18 \times 4.4275 \text{ ms}/100.0 \text{ ms} = 0.797 \text{ or } -2.0 \text{ dB}.$$

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 365 kHz for 50% modulation (Fig. 6.3(c)).

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, pulsed)

Supply Voltage	=	12.0 VDC
Current	=	170.0 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 286.5 MHz to 321.0 MHz and from 339.5 MHz to 391.0 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 the allowed amplitude limits.)

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Table 5.1. Highest Emissions Measured

Radiated Emissions — Prince HomeNote; 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	SBic	H	-19.5	Pk	18.0	23.3	71.8	73.9	**2.1**	flat 30% duty factor (meas. -10.4 dB)
2	286	SBic	V	-22.2	Pk	18.0	23.3	69.1	73.9	4.8	end ATTN: 31
3	572	SBic	H	-55.0	Pk	24.3	20.1	45.9	53.9	8.0	end
4	572	SBic	V	-57.9	Pk	24.3	20.1	43.0	53.9	10.9	end
5	858	SBic	H	-68.6	Pk	28.0	17.9	38.1	53.9	15.8	end
6	858	SBic	V	-56.1	Pk	28.0	17.9	50.6	53.9	**3.3**	end
7	1144	Horn	H	-56.6	Pk	20.2	28.1	32.1	53.9	21.8	side
8	1430	Horn	H	-61.1	Pk	21.2	28.3	28.5	53.9	25.5	flat
9	1716	Horn	H	-65.0	Pk	21.9	27.8	25.7	53.9	28.3	side, noise
10	2002	Horn	H	-64.0	Pk	22.5	26.6	28.5	53.9	25.4	max. all; noise floor
11	2288	Horn	H	-64.0	Pk	23.2	26.9	29.0	53.9	25.0	max. all; noise floor
12	2574	Horn	H	-64.0	Pk	24.0	26.6	30.0	53.9	23.9	max. all; noise floor
13	2860	Horn	H	-64.0	Pk	24.8	25.5	31.9	53.9	22.1	max. all; noise floor
14											
15	286	SBic	H	-24.0	Pk	18.0	23.3	71.7	73.9	**2.2**	flat 50% duty factor (meas. -6.0 dB)
16	286	SBic	V	-29.6	Pk	18.0	23.3	66.1	73.9	7.8	end ATTN: 22
17	572	SBic	H	-55.8	Pk	24.3	20.1	49.5	53.9	**4.4**	end
18	572	SBic	V	-59.0	Pk	24.3	20.1	46.3	53.9	7.6	end
19	858	SBic	H	-62.2	Pk	28.0	17.9	48.9	53.9	5.0	flat
20	858	SBic	V	-63.1	Pk	28.0	17.9	48.0	53.9	5.9	end
21	1144	Horn	H	-57.7	Pk	20.2	28.1	35.4	53.9	18.5	end
22	1430	Horn	H	-60.3	Pk	21.2	28.3	33.7	53.9	20.3	flat
23	1716	Horn	H	-63.7	Pk	21.9	27.8	31.4	53.9	22.6	flat
24	2002	Horn	H	-64.0	Pk	22.5	26.6	32.9	53.9	21.0	max. all; noise floor
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. 1/22 & 2/6/98; U of Mich.

Table 5.1(Cont.). Highest Emissions Measured

Radiated Emissions — Prince HomeNote; 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	SBic	H	-27.2	Pk	18.0	23.3	72.5	73.9	**1.4**	flat 80% duty factor (meas. -2.0 dB)
2	286	SBic	V	-32.9	Pk	18.0	23.3	66.8	73.9	7.1	end ATTN: 10
3	572	SBic	H	-58.2	Pk	24.3	20.1	51.1	53.9	2.8	end
4	572	SBic	V	-60.9	Pk	24.3	20.1	48.4	53.9	5.5	flat
5	858	SBic	H	-62.8	Pk	28.0	17.9	52.3	53.9	**1.6**	end
6	858	SBic	V	-67.2	Pk	28.0	17.9	47.9	53.9	6.0	flat
7	1144	Horn	H	-57.4	Pk	20.2	28.1	39.7	53.9	14.2	side
8	1430	Horn	H	-60.1	Pk	21.2	28.3	37.9	53.9	16.1	side
9	1716	Horn	H	-64.0	Pk	21.9	27.8	35.1	53.9	18.9	max all; noise floor
10	2002	Horn	H	-64.0	Pk	22.5	26.6	36.9	53.9	17.0	max all; noise floor
11	2288	Horn	H	-64.0	Pk	23.2	26.9	37.4	53.9	16.6	max. all; noise floor
12	2574	Horn	H	-64.0	Pk	24.0	26.6	38.4	53.9	15.5	max. all; noise floor
13	2860	Horn	H	-64.0	Pk	24.8	25.5	40.3	53.9	13.7	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. 1/22 & 2/6/98; U of Mich.

Table 5.2. Highest Emissions Measured

Radiated Emissions — Prince HomeNote; 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	SBic	H	-18.6	Pk	18.8	23.0	73.8	75.3	**1.5**	flat 30% duty factor (meas. -10.4 dB)
2	310	SBic	V	-23.4	Pk	18.8	23.0	69.0	75.3	6.3	side ATTN: 31
3	620	SBic	H	-57.8	Pk	25.1	19.6	44.2	55.3	11.1	flat
4	620	SBic	V	-62.5	Pk	25.1	19.6	39.5	55.3	15.8	side
5	930	SBic	H	-53.6	Pk	28.7	17.3	54.4	55.3	**0.9**	flat
6	930	SBic	V	-57.1	Pk	28.7	17.3	50.9	55.3	4.4	side
7	1240	Horn	H	-52.0	Pk	20.4	28.0	37.0	54.0	17.0	flat
8	1550	Horn	H	-61.1	Pk	21.5	28.2	28.8	54.0	25.3	side
9	1860	Horn	H	-62.6	Pk	22.1	28.3	27.8	55.3	27.5	end
10	2170	Horn	H	-64.0	Pk	22.8	27.1	28.3	55.3	27.0	max. all; noise floor
11	2480	Horn	H	-64.0	Pk	23.8	26.5	29.9	55.3	25.4	max. all; noise floor
12	2790	Horn	H	-64.0	Pk	24.5	25.6	31.5	54.0	22.5	max. all; noise floor
13	3100	Horn	H	-64.0	Pk	25.8	25.1	33.4	55.3	22.0	max. all; noise floor
14											
15	310	SBic	H	-23.4	Pk	18.8	23.0	73.4	75.3	**1.9**	flat 50% duty factor (meas. -6.0 dB)
16	310	SBic	V	-32.3	Pk	18.8	23.0	64.5	75.3	10.8	end ATTN: 16
17	620	SBic	H	-63.4	Pk	25.1	19.6	43.0	55.3	12.3	flat
18	620	SBic	V	-65.0	Pk	25.1	19.6	41.4	55.3	13.9	end
19	930	SBic	H	-63	Pk	28.7	17.3	49.4	55.3	**5.9**	flat
20	930	SBic	V	-65.9	Pk	28.7	17.3	46.5	55.3	8.8	side
21	1240	Horn	H	-53.3	Pk	20.4	28.0	40.1	54.0	13.9	side
22	1550	Horn	H	-59.7	Pk	21.5	28.2	34.6	54.0	19.5	side
23	1860	Horn	H	-62.5	Pk	22.1	28.3	32.3	55.3	23.1	flat
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	-64.0	Pk	25.8	25.1	37.8	55.3	17.6	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. 1/21,22 & 2/6/98; U of Mich.

Table 5.2(Cont.). Highest Emissions Measured

Radiated Emissions — Prince HomeNote; 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	SBic	H	-27.1	Pk	18.8	22.2	74.6	75.3	**0.7**	flat 80% duty factor (meas. -2.0 dB)
2	310	SBic	V	-38.8	Pk	18.8	22.2	62.9	75.3	12.4	end ATTN: 7
3	620	SBic	H	-63.0	Pk	25.1	22.2	45.0	55.3	**10.3**	side
4	620	SBic	V	-66.0	Pk	25.1	22.2	42.0	55.3	13.3	end
5	927	SBic	H	-69.7	Pk	26.1	22.2	39.3	55.3	16.0	flat
6	927	SBic	V	-65.1	Pk	26.1	22.2	43.9	55.3	11.4	end
7	1240	Horn	H	-53.8	Pk	20.4	28.0	43.7	54.0	10.3	side
8	1550	Horn	H	-60.6	Pk	21.5	28.2	37.8	54.0	16.3	side
9	1860	Horn	H	-63.2	Pk	22.1	28.3	35.7	55.3	19.7	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. 1/21,22 & 2/6/98; U of Mich.

Table 5.3. Highest Emissions Measured

Radiated Emissions — Prince HomeNote; 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	SBic	H	-25.9	Pk	21.1	22.0	69.2	80.3	**11.1**	flat 30% duty factor (meas. -10.4 dB)
2	418	SBic	V	-29.7	Pk	21.1	22.0	65.4	80.3	14.9	end ATTN: 31
3	836	SBic	H	-67.2	Pk	27.7	18.4	38.1	60.3	22.2	flat
4	836	SBic	V	-66.3	Pk	27.7	18.4	39.0	60.3	21.3	side
5	1254	Horn	H	-45.3	Pk	20.5	28.1	43.1	60.3	17.2	flat
6	1672	Horn	H	-51.2	Pk	21.5	28.1	38.2	54.0	**15.8**	flat
7	2090	Horn	H	-56.9	Pk	22.7	26.8	35.0	60.3	25.3	flat
8	2508	Horn	H	-59.2	Pk	24.0	26.5	34.3	60.3	26.0	end
9	2926	Horn	H	-64.0	Pk	25.1	25.2	31.9	60.3	28.4	max. all; noise floor
10	3344	Horn	H	-64.0	Pk	26.5	24.7	33.8	54.0	20.2	max. all; noise floor
11	3762	Horn	H	-64.0	Pk	27.7	24.3	35.4	54.0	18.6	max. all; noise floor
12	4180	Horn	H	-64.0	Pk	28.9	20.7	40.2	54.0	13.8	max. all; noise floor
13											
14	418	SBic	H	-25.9	Pk	21.1	22.0	74.2	80.3	**6.1**	flat 50% duty factor (meas. -6.0 dB)
15	418	SBic	V	-29.7	Pk	21.1	22.0	70.4	80.3	9.9	side ATTN: 31
16	836	SBic	H	-67.2	Pk	27.7	18.4	43.1	60.3	17.2	flat
17	836	SBic	V	-66.3	Pk	27.7	18.4	44.0	60.3	16.3	side
18	1254	Horn	H	-45.3	Pk	20.5	28.1	48.1	60.3	12.2	flat
19	1672	Horn	H	-51.2	Pk	21.5	28.1	43.2	54.0	10.8	flat
20	2090	Horn	H	-56.9	Pk	22.7	26.8	40.0	60.3	20.3	flat
21	2508	Horn	H	-59.2	Pk	24.0	26.5	39.3	60.3	21.0	flat
22	2926	Horn	H	-64.0	Pk	25.1	25.2	36.9	60.3	23.4	max. all; noise floor
23	3344	Horn	H	-64.0	Pk	26.5	24.7	38.8	54.0	15.2	max. all; noise floor
24	3762	Horn	H	-64.0	Pk	27.7	24.3	40.4	54.0	13.6	max. all; noise floor
25	4180	Horn	H	-64.0	Pk	28.9	20.7	45.2	54.0	**8.8**	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. 1/21 & 2/6/98; U of Mich.

Table 5.3(Cont.). Highest Emissions Measured

Radiated Emissions											Prince HomeNote; 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	SBic	H	-27.1	Pk	21.1	22.0	77.1	80.3	**3.2**	flat 80% duty factor (meas. -2.0 dB)
2	418	SBic	V	-33.2	Pk	21.1	22.0	71.0	80.3	9.3	side ATTN: 27
3	836	SBic	H	-63.9	Pk	27.7	18.4	50.5	60.3	9.8	flat
4	836	SBic	V	-67.7	Pk	27.7	18.4	46.7	60.3	13.6	side
5	1254	Horn	H	-45.8	Pk	20.5	28.1	51.7	60.3	8.6	side
6	1672	Horn	H	-50.1	Pk	21.5	28.1	48.4	54.0	**5.6**	flat
7	2090	Horn	H	-55.6	Pk	22.7	26.8	45.4	60.3	14.9	flat
8	2508	Horn	H	-57.2	Pk	24.0	26.5	45.4	60.3	14.9	end
9	2926	Horn	H	-64.0	Pk	25.1	25.2	41.0	60.3	19.3	max. all; noise floor
10	3344	Horn	H	-64.0	Pk	26.5	24.7	42.9	54.0	11.1	max. all; noise floor
11	3762	Horn	H	-64.0	Pk	27.7	24.3	44.5	54.0	9.5	max. all; noise floor
12	4180	Horn	H	-64.0	Pk	28.9	20.7	49.3	54.0	4.7	max. all; noise floor
13											
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							
#	Line Side	Line Side	Det. Used	Vtest dBµV	Vlim dBµV	Pass dB	Comments
1							
2							
3							
4				Not Applicable			
5							

Meas. 1/21 & 2/6/98; U of Mich.

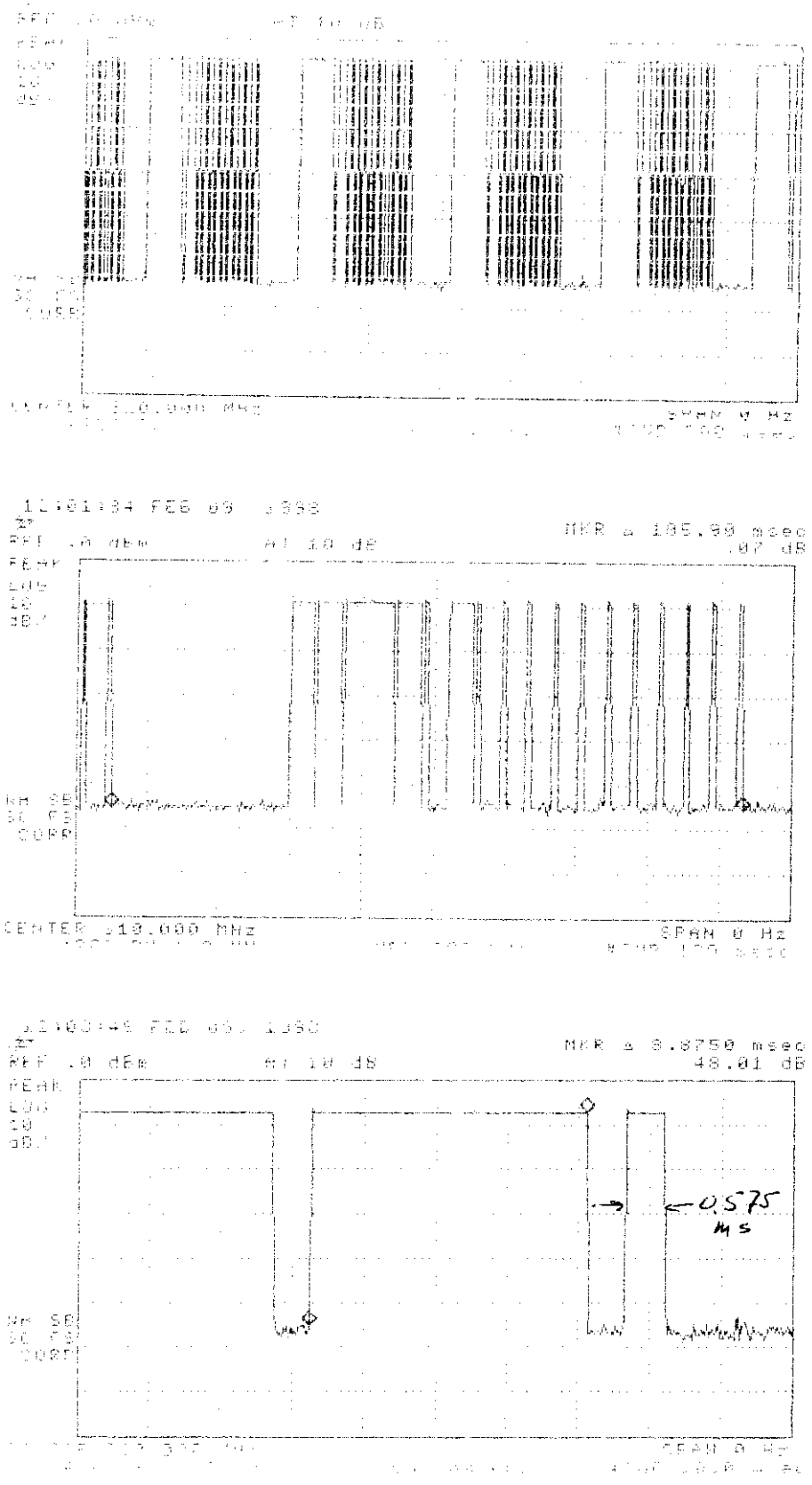

Figure 6.1(a). Transmissions modulation characteristics: (top) complete transmission, (center) expanded word, (bottom) expanded bits. (310 MHz, 30% duty fac.)

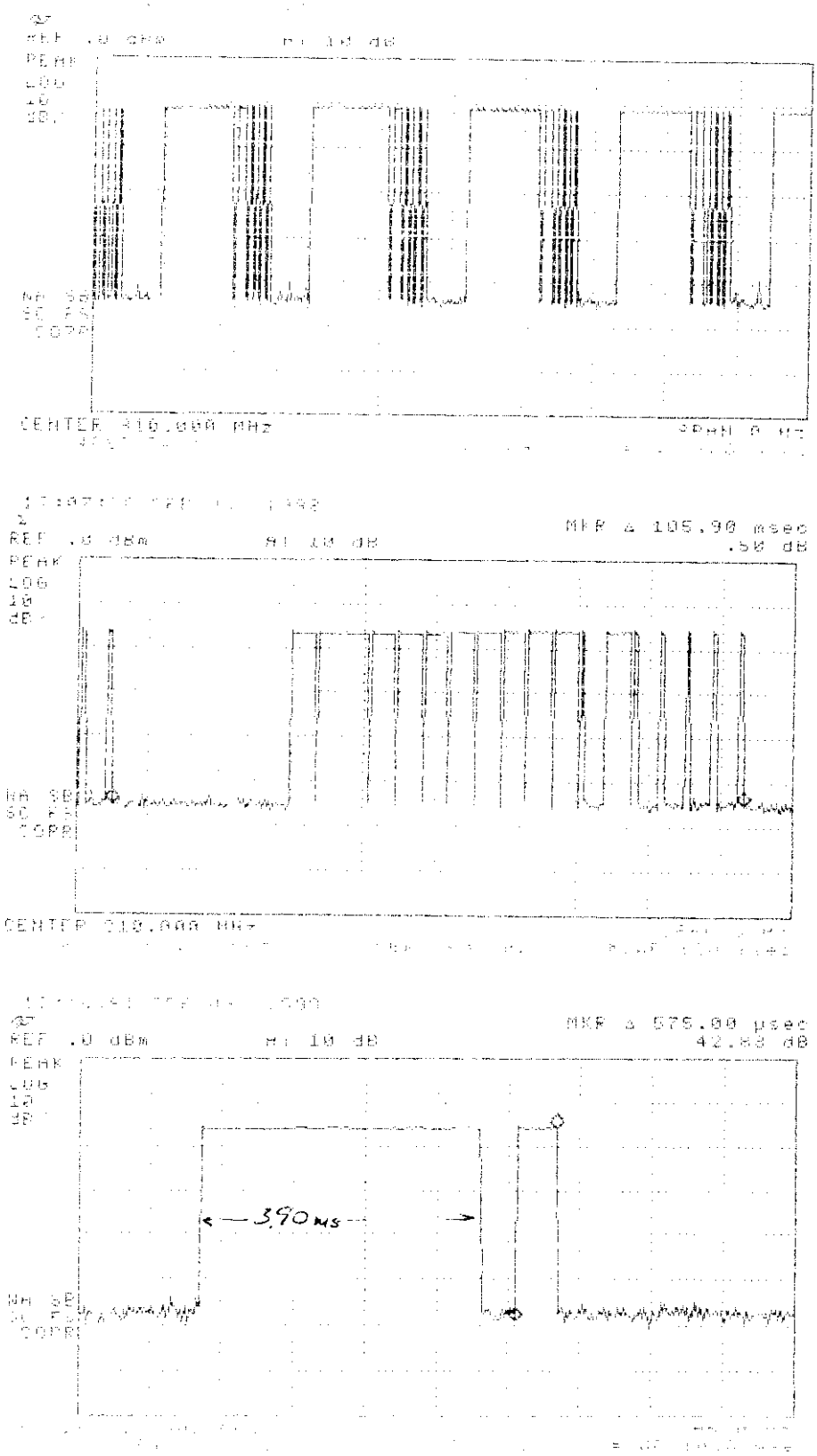

Figure 6.1(b). Transmissions modulation characteristics: (top) complete transmission, (center) expanded word, (bottom) expanded bits. (310 MHz, 50% duty fac.)

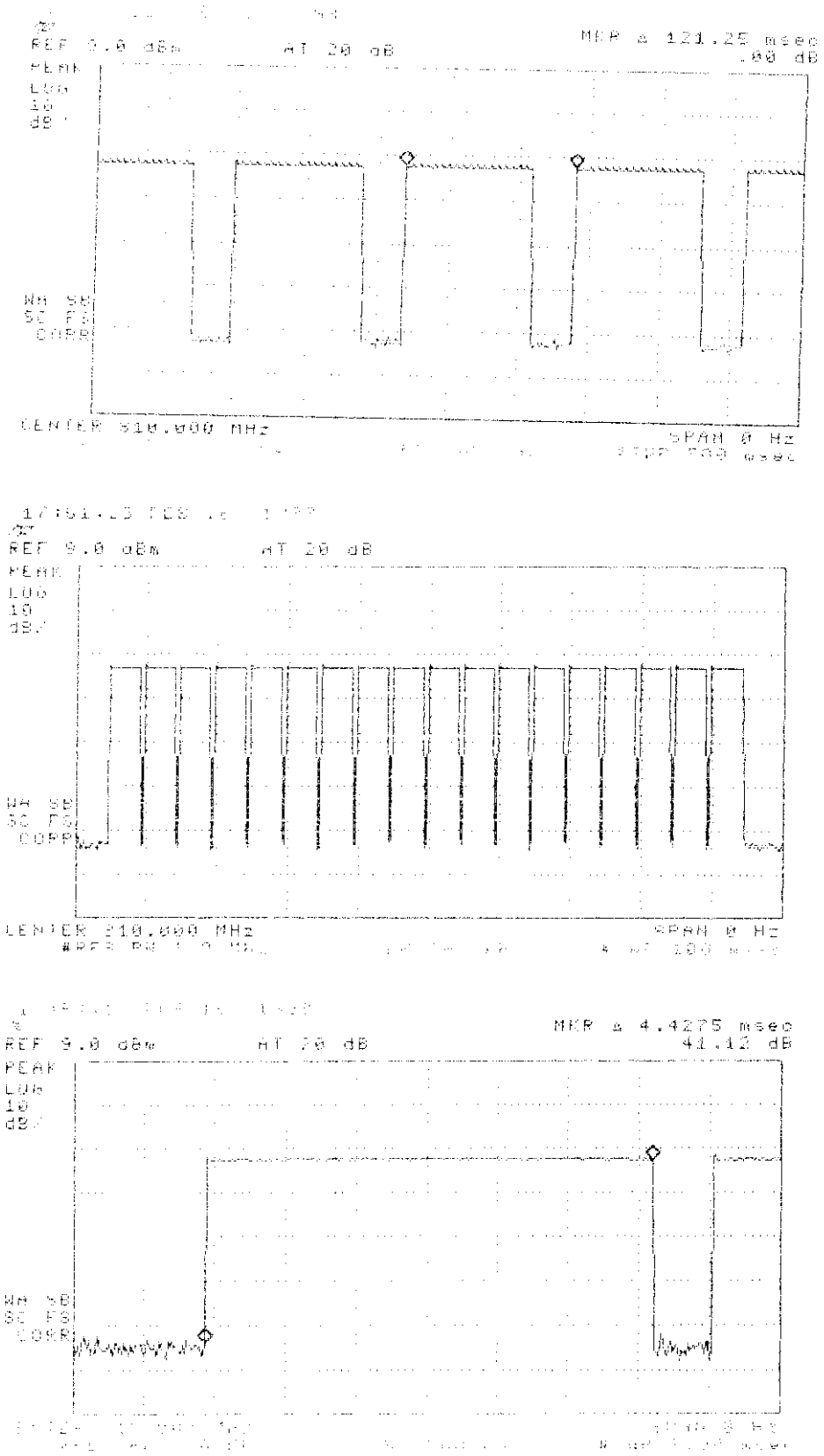

Figure 6.1(c). Transmissions modulation characteristics: (top) complete transmission, (center) expanded word, (bottom) expanded bits. (310 MHz, 80% duty fac.)

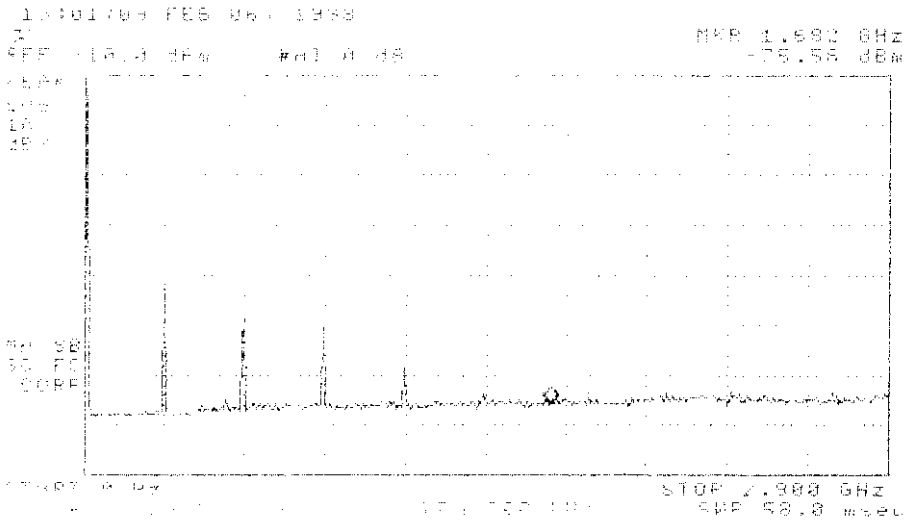

Figure 6.2(a). Emission spectrum of the DUT (286 MHz, CW).
The amplitudes are only indicative (not calibrated).

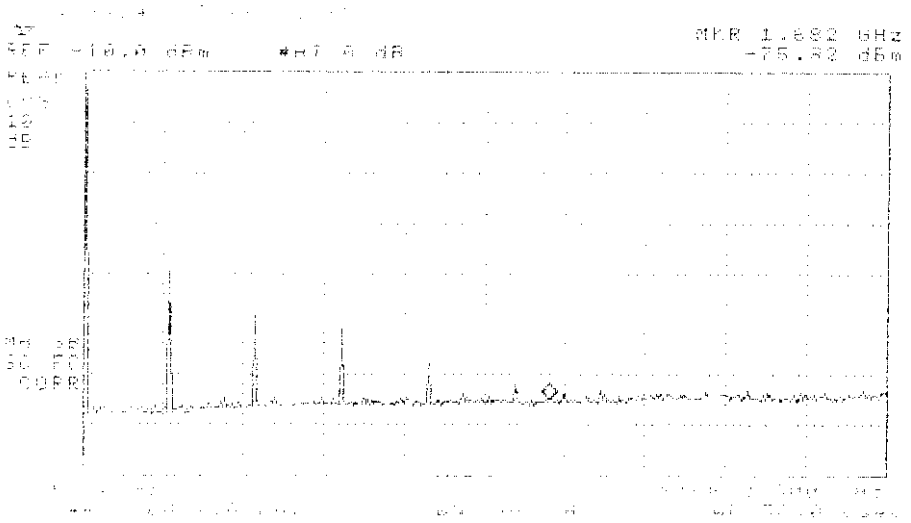

Figure 6.2(b). Emission spectrum of the DUT (310 MHz, CW).
The amplitudes are only indicative (not calibrated).

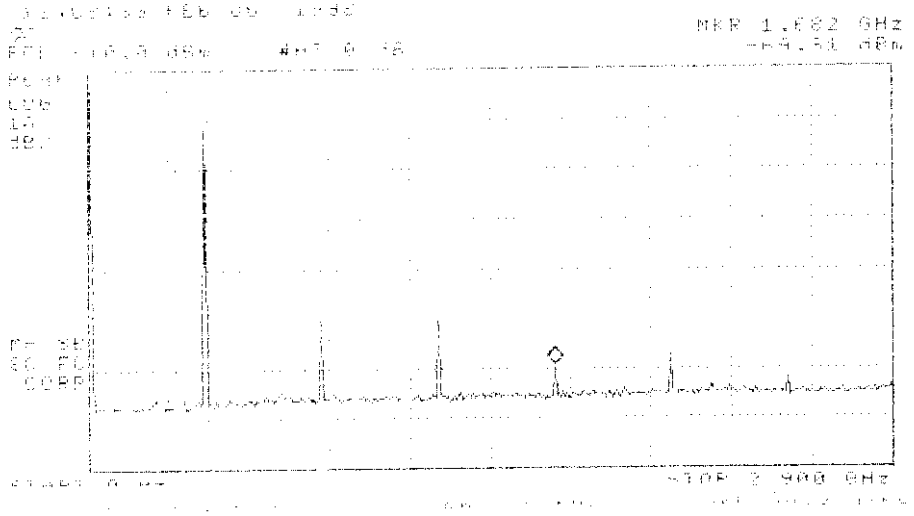

Figure 6.2(c). Emission spectrum of the DUT (418 MHz, CW).
The amplitudes are only indicative (not calibrated).

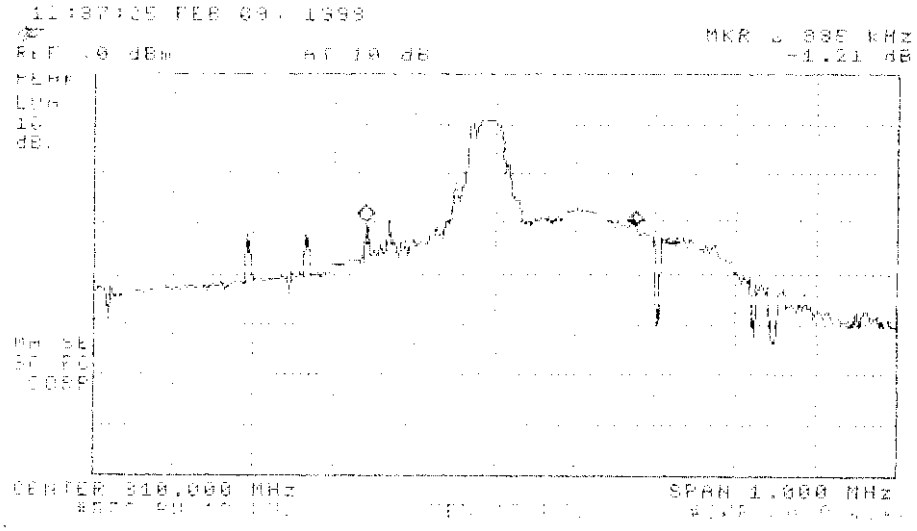

Figure 6.3(a). Measured bandwidth of the DUT
(Pulsed mode, 310 MHz, 30% duty fac.).

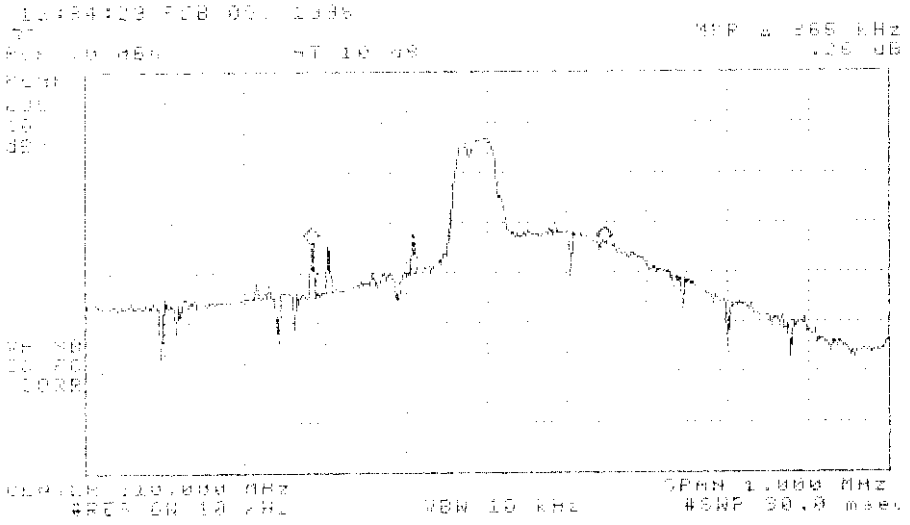

Figure 6.3(b). Measured bandwidth of the DUT
(Pulsed mode, 310 MHz, 50% duty fac.).

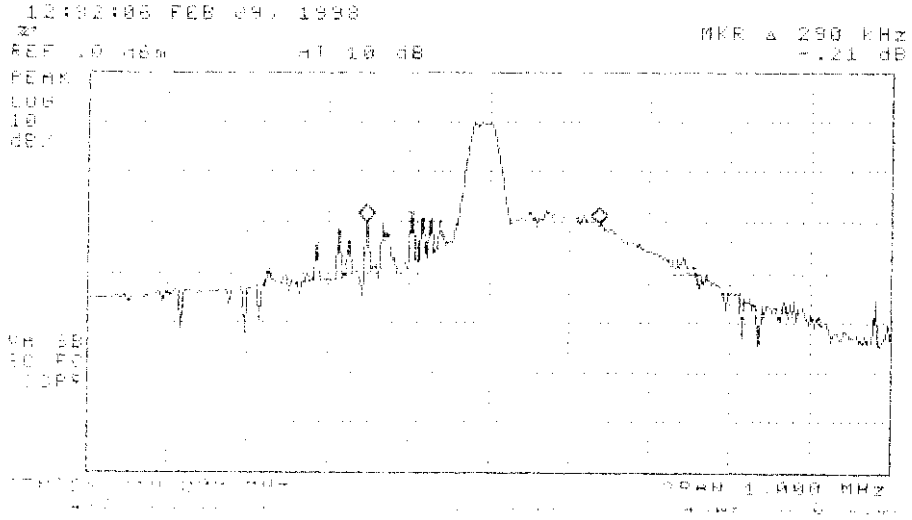

Figure 6.3(c). Measured bandwidth of the DUT
(Pulsed mode, 310 MHz, 80% duty fac.).

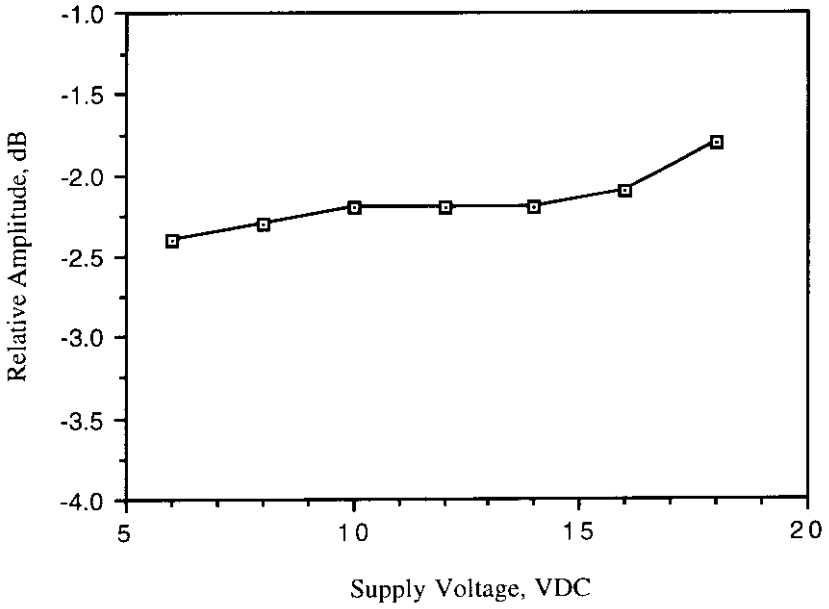

Figure 6.4. Relative emission vs. supply voltage. (310 MHz, pulsed 30%)