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Measured Radio Noise Emission (FCC Part 15, Subpart B) From

Ensure Technologies XyLock Lock (Receiver and PC Peripheral) Model: XCLK-1

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Summary
Tests for compliance with FCC Regulations, subject to Part 15, Subpart B, and with Industry Canada Regulations subject to RSS-210, were performed on the Ensure Technologies XyLock Lock (Receiver and PC Peripheral), Model: XC-2.
Model: XCLK-1.

In testing performed on February 27, 2001, the system tested met the specifications for radiated emissions by 4.5 dB (see p. 8) and met the specifications for conducted emissions by 12.0 dB (see p. 9).

1. Introduction

Ensure Technologies XyLock Lock (Receiver and PC Peripheral), Model: XCLK-1, 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 Reg. No: 91050) 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	December 2000/UM
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E SN: 3107A01131	December 2000/HP
Spectrum Analyzer (0.1-1500 MHz)		Hewlett-Packard 182T/8558B SN: 1529A01114/543592	December 2000/UM
Preamplifier (5-1000MHz)	X	Watkins-Johnson A11 -1 plus A25-1S	December 2000/UM
Preamplifier (5-4000 MHz)	X	Avantek	Oct. 1999/ U of M Rad Lab
Broadband Bicone (20-200 MHz)	X	University of Michigan	June 1999/U of M Rad Lab
Broadband Bicone (200-1000 MHz)	X	University of Michigan	June 1999/U of M Rad Lab
Dipole Antenna Set (25-1000 MHz)	X	University of Michigan	June 2000/UM
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C SN: 992	June 2000/UM
Active Loop Antenna (0.090-30MHz)		EMCO 6502 SN: 2855	December 1999/UM
Active Rod (30Hz-50 MHz)		EMCO 3301B SN: 3223	December 1999/UM
Ridge-horn Antenna (0.5-5 GHz)	X	University of Michigan	March 1999/U of M Rad Lab
S-Band Std. Gain Horn		S/A, Model SGH-2.6	Manufacturer, NRL design
C-Band Std. Gain Horn	X	University of Michigan	Manufacturer, NRL design
XN-Band Std. Gain Horn		University of Michigan	Manufacturer, NRL design
X-Band Std. Gain Horn		S/A, Model 12-8.2	Manufacturer, NRL design
LISN Box		University of Michigan	Dec. 2000/U of M Rad Lab
Signal Generator (0.1-2060 MHz)		Hewlett-Packard 8657B	January 2000/Uof M Rad Lab

3. Configuration of Equipment Under Test

The DUT is a 905 MHz receiver that is attached to a (PC) computer and locks the computer when control signals from the transmitter are not received. It is also subject to regulations as a computer peripheral, Class B. The receiver is superhet design, LO 915.7 MHz.

The DUT was designed and manufactured by Ensure Technologies, Inc., 3526 W. Liberty, Suite 100, Ann Arbor, MI 48103-9013.

Figure 3.1 is a block diagram of the system tested. Each component is identified in Table 3.1. In Figure 3.2, the upper photograph shows the layout of the DUT on the test table for conductive emissions, the center photo shows the layout for the radiated emissions on the outdoor 3m site, and the lower photo shows the inter connecting cable arrangement.

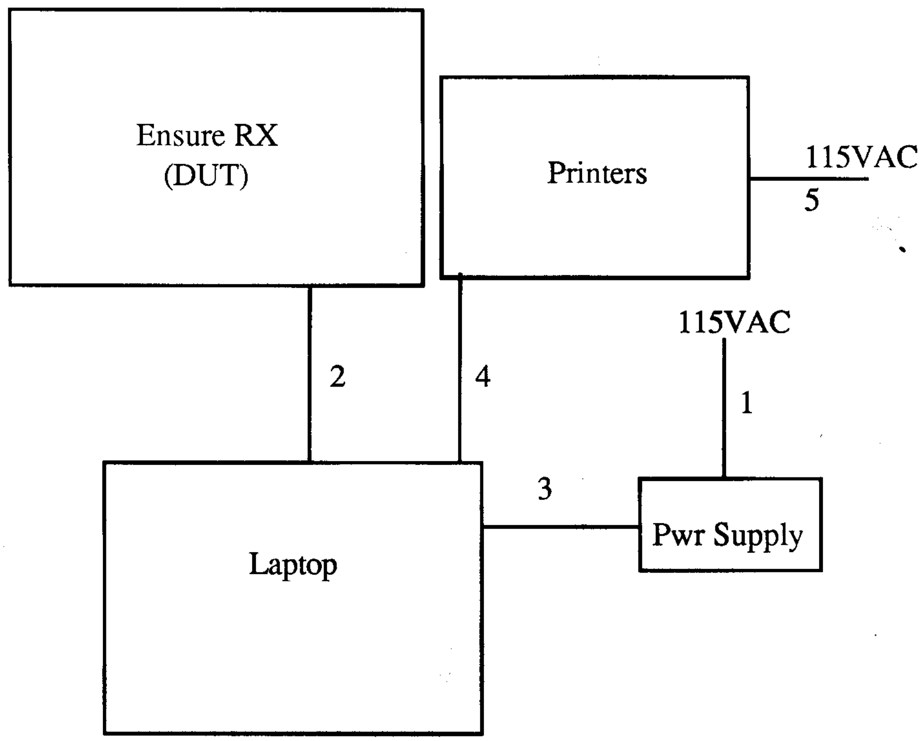


Figure 3.1. Block diagram and connection of equipment for the test.

Table 3.1. Identification of Equipment.

Description, Model	Serial No, FCC ID
DUT : Ensure Receiver, Model: XCLK-1	SN: 1198 FCC ID: NW5LKA (pending)
Computer: Gateway Solo, Model: 9100	SN: BC398321909 FCC ID: DOC
Power Supply: Gateway, Model: PA-1480-19Q	SN: AC299332607 FCC ID:
Printer: Epson, Model: MX-80III	SN: 331187 FCC ID: BKMK9A8P001A

Cables:
(1) attached to power supply
(2) attached to DUT
(3) attached to power supply
(4) 2m, parallel, shielded
(5) 2m, shielded

3.1 Modifications Made During Pre-test
None

3.2 EMI control devices noticed during testing
None

4. Emission Limits

The DUT tested falls under Part 15, Subpart B, "Unintentional Radiators". 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 at 3 m distance (Ref: 15.33, 15.35, 15.109 IC: RSS-210, 7.3).

Freq.	Class A		Class B	
MHz	(μV/m)	dB(μV/m)	(μV/m)	dB(μV/m)
30-88	270	48.5	100	40.0
88-216	450	53.0	150	43.5
219-960	630	55.9	200	46.0
960-	900	59.0	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 Limit

Table 4.2. Conducted emission limits (15.107, IC: RSS-210, 6.6).

Freq.	Class A		Class B	
MHz	μV	dBμV	μV	dBμV
0.45-1.705	1000	60.0	250	48.0
1.705-30.0	3000	69.6	250	48.0

Note: Quasi-Peak readings apply here (9 KHz BW)

5. Emission Tests

The preliminary radiated emissions are studied in our shielded anechoic chamber and the final ones are measured on the open field range. Before the tests, the operations of the DUT are discussed with the customer to assess the presence of potential emitters, such as the clock signals and ribbon cables that carry these signals.

The conductive emissions are also measured in the shielded chamber.

NOTE: Eventhough the FCC Rules specify that both the radiated and conductive emissions be measured using Quasi-Peak detection scheme, we normally use peak detection since the former is cumbersome to use with our instrumentation. In case the DUT fails to meet the limits, or the measurement is near the limit, the frequencies in question are remeasured using Quasi-Peak detection. We note that, since the peak detected signal is always higher or equal to the Quasi-Peak detected signal, the margin of compliance may be better, but not worse, than indicated in this report.

5.1 Anechoic Chamber Radiated Tests

To assess the radiated emissions, the system is first set up in the anechoic chamber on the test table as shown in Figure 3.1 and Figure 3.2. The emissions are studied on the spectrum analyzer using a bicone antenna at about 1.5 meters. During testing, the system is exercised by runningDisplay Mate Utilities program.

The pedestal table is rotated and the power and signal cables moved around to obtain the worst case situation. If it appears that the emissions are too high, the test is either terminated or on-site modifications are made at this time. If the latter is followed, the DUT is again exercised and evaluated. Once the emissions appear to meet the limits, the worst case situations and the dominant emissions are identified and the emission spectra recorded from 0 to 200 MHz for horizontal and vertical polarizations. At this time background spectra are also recorded. The spectrum above 200 MHz (to 1 GHz) is scanned (using a small 200 to 1000 MHz bicone antenna), and when any appreciable emissions are identified, these are recorded and/or plotted. See Plots 1 through 4. In this case, the spectrum was scanned to 5 GHz. The measurements 1 - 5 GHz taken in the chamber where used for compliance assessment.

5.2 Open Site Radiated Tests

On the outdoor range the DUT was set up the same way on the table as in the chamber (See Section 5.1) and the measurements repeated as was done in preliminary testing except now at 3 meter range. From the emissions observed in the anechoic chamber, the study of the recorded spectra on the indoor measured plots, and further outdoor observations on the spectrum analyzer, the dominant emissions were carefully scrutinized. At each of these frequencies the DUT was usually tested by scanning the analyzer at 1 or 2 MHz/div (120 KHz BW), rotating the DUT, moving cables, and changing the polarization and the height of the receiving antenna. The signal was then read off from the spectrum analyzer in dBm.

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

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

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

When the computed field strength is close to the limit (usually within 3 dB or so) those frequencies are remeasured, but in this case with the tuned dipoles. Quasi-Peak detection may also be used at this time. The results are entered in Table 5.1. Based on the results in the table, the radiated compliance criteria is deduced. In this case, the data show that the system met the radiated Class A limit with a 4.5 dB margin for the worst case indicated by bold value.

5.3 Conducted Tests

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 wall transformer. 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. Conducted measurments were made for Monitor only. The data are shown in Plots 5 through 8. 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 plot and summarized in Table 5.2. In the worst case, as indicated by bold value, the DUT meets the conducted Class A limit by 12.0 dB.

Table 5.1. Highest Radiated Emissions Measured

Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments
										Ensure RX; FCC B
47.0	Bic	H	-64.0	Pk	11.8	25.5	29.3	40.0	10.7	
47.0	Bic	V	-67.0	Pk	11.8	25.5	26.3	40.0	13.7	
74.0	Bic	H	-67.0	Pk	11.0	25.0	26.0	40.0	14.0	
74.0	Bic	V	-66.0	Pk	11.0	25.0	27.0	40.0	13.0	
79.0	Bic	H	-66.0	Pk	11.1	24.9	27.2	40.0	12.8	
115.1	Bic	H	-64.0	Pk	12.9	24.4	31.5	43.5	12.0	
119.5	Bic	H	-60.5	Pk	13.1	24.3	35.3	43.5	8.2	
143.5	Bic	H	-66.0	Pk	14.4	24.0	31.5	43.5	12.0	
164.0	Bic	V	-72.0	Pk	15.2	23.7	26.5	43.5	17.0	
167.6	Bic	H	-66.5	Pk	15.3	23.6	32.2	43.5	11.3	
202.0	Bic	H	-60.7	QP	15.9	23.2	39.0	43.5	**4.5**	
231.0	Bic	V	-76.0	Pk	16.6	22.8	24.8	46.0	21.2	
239.0	Bic	V	-71.0	Pk	17.0	22.7	30.3	46.0	15.7	
248.0	Bic	H	-66.0	Pk	17.7	22.6	36.1	46.0	9.9	
1170.0	Horn	H	-54.0	Pk	20.2	28.0	45.2	54.0	8.8	
1500.0	Horn	H	-57.0	Pk	21.3	28.1	43.2	54.0	10.8	
1800.0	Horn	H	-64.0	Pk	22.2	28.1	37.1	54.0	16.9	
RX LO emissions										
915.7	Dip	H	-86.5	Pk	28.6	16.2	32.9	46.0	13.1	DUT on end (on OATS)
915.7	Dip	V	-88.2	Pk	28.6	16.2	31.2	46.0	14.8	DUT flat (on OATS)
915.7	Horn	H	-47.6	Pk	20.0	48.4	31.0	46.0	15.0	measured indoors (for ref only)
1831.4	Horn	H	-68.6	Pk	22.8	28.1	33.1	54.0	20.9	max all
2747.1	Horn	H	-69.3	Pk	24.7	25.6	36.8	54.0	17.2	max all, noise
3662.8	Horn	H	-72.1	Pk	27.6	24.3	38.2	54.0	15.8	max all, noise
4578.5	Horn	H	-71.0	Pk	30.4	20.0	46.4	54.0	7.6	max all, noise

Meas. 2/27/01; U of Mich.

Table 5.2 Highest Conducted Emissions Measured

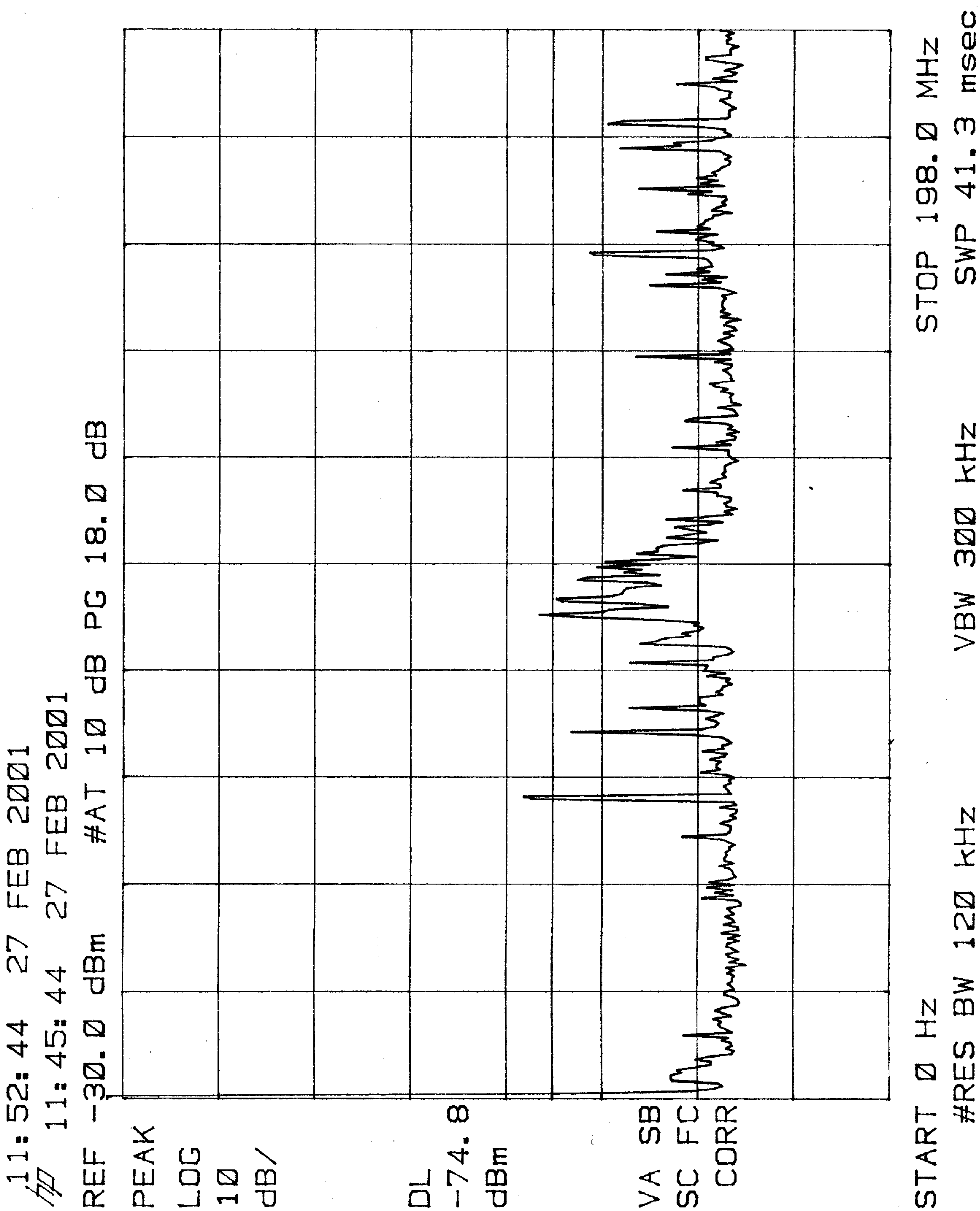
												Ensure RX; FCC B
	Freq.	Line	Peak Det., dBμV		Pass	QP Det., dBμV		Pass	Ave. Det., dBμV		Pass	
#	MHz	Side	Vtest	Vlim*	dB*	Vtest	Vlim	dB	Vtest	Vlim	dB	Comments
1	0.480	Lo	36.0	48.0	12.0		48.0					
2	0.770	Lo	36.0	48.0	12.0		48.0					
3	1.060	Lo	35.0	48.0	13.0		48.0					
4	1.35	Lo	35.0	48.0	13.0		48.0					
5	1.45	Lo	36.0	48.0	12.0		48.0					
6	1.64	Lo	36.0	48.0	12.0		48.0					
7	1.72	Lo	36.0	48.0	12.0		48.0					
8	1.82	Lo	33.0	48.0	15.0		48.0					
9	1.92	Lo	36.0	48.0	12.0		48.0					
10	3.50	Lo	36.0	48.0	12.0		48.0					
11	5.50	Lo	35.0	48.0	13.0		48.0					
12							48.0					
13							48.0					
14	0.480	Hi	32.0	48.0	16.0		48.0					
15	0.620	Hi	34.0	48.0	14.0		48.0					
16	0.750	Hi	34.0	48.0	14.0		48.0					
17	0.85	Hi	34.0	48.0	14.0		48.0					
18	1.05	Hi	34.0	48.0	14.0		48.0					
19	1.25	Hi	34.0	48.0	14.0		48.0					
20	1.46	Hi	35.0	48.0	13.0		48.0					
21	1.72	Hi	34.0	48.0	14.0		48.0					
22	1.92	Hi	34.0	48.0	14.0		48.0					
23	3.30	Hi	36.0	48.0	12.0		48.0					
24	6.20	Hi	35.0	48.0	13.0		48.0					
25												
26												
27												
28												
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												

**QP limit*

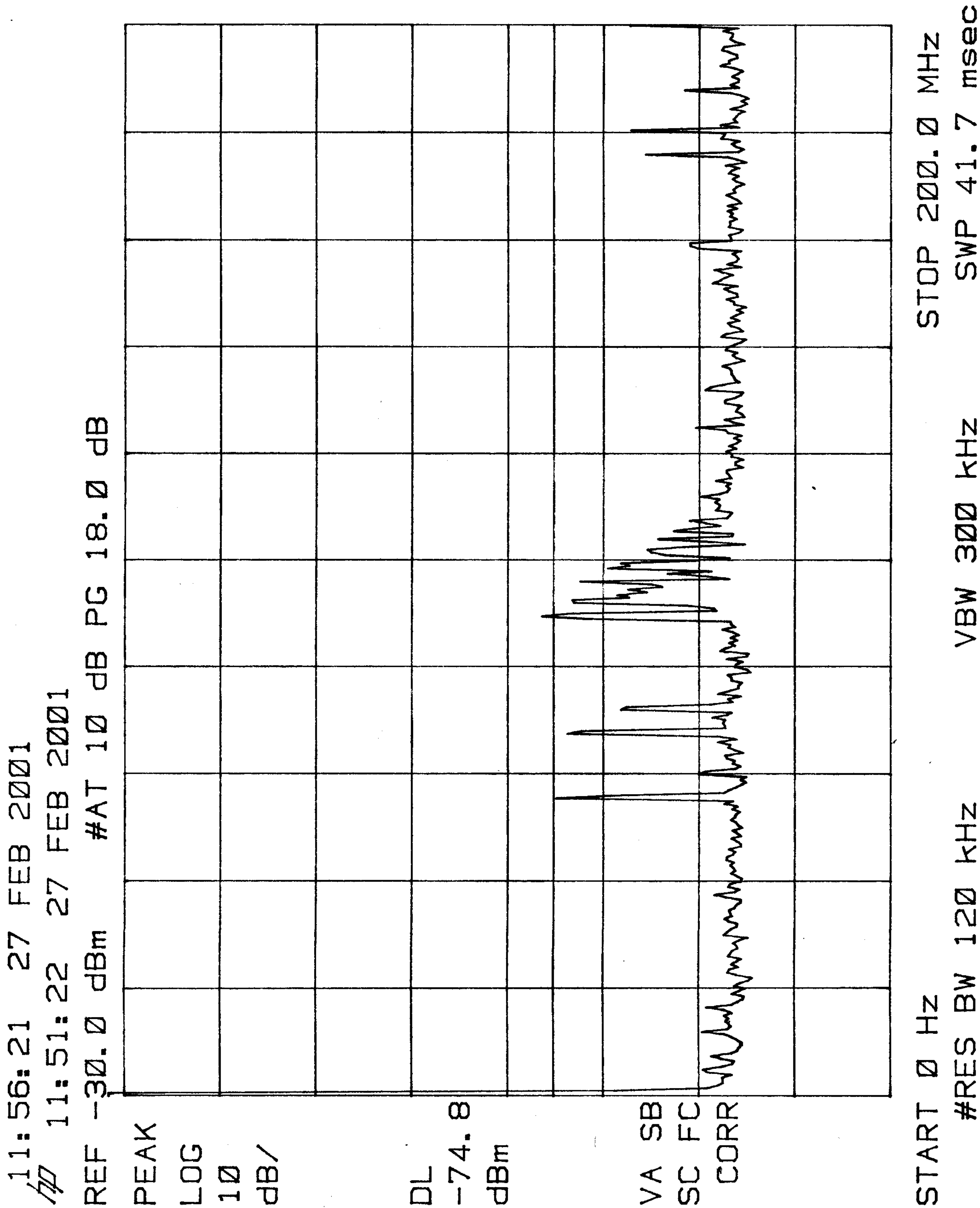
Meas. 2/27/01; U of Mich.

Since Vpeak >= Vqp, the Vqplim is met.

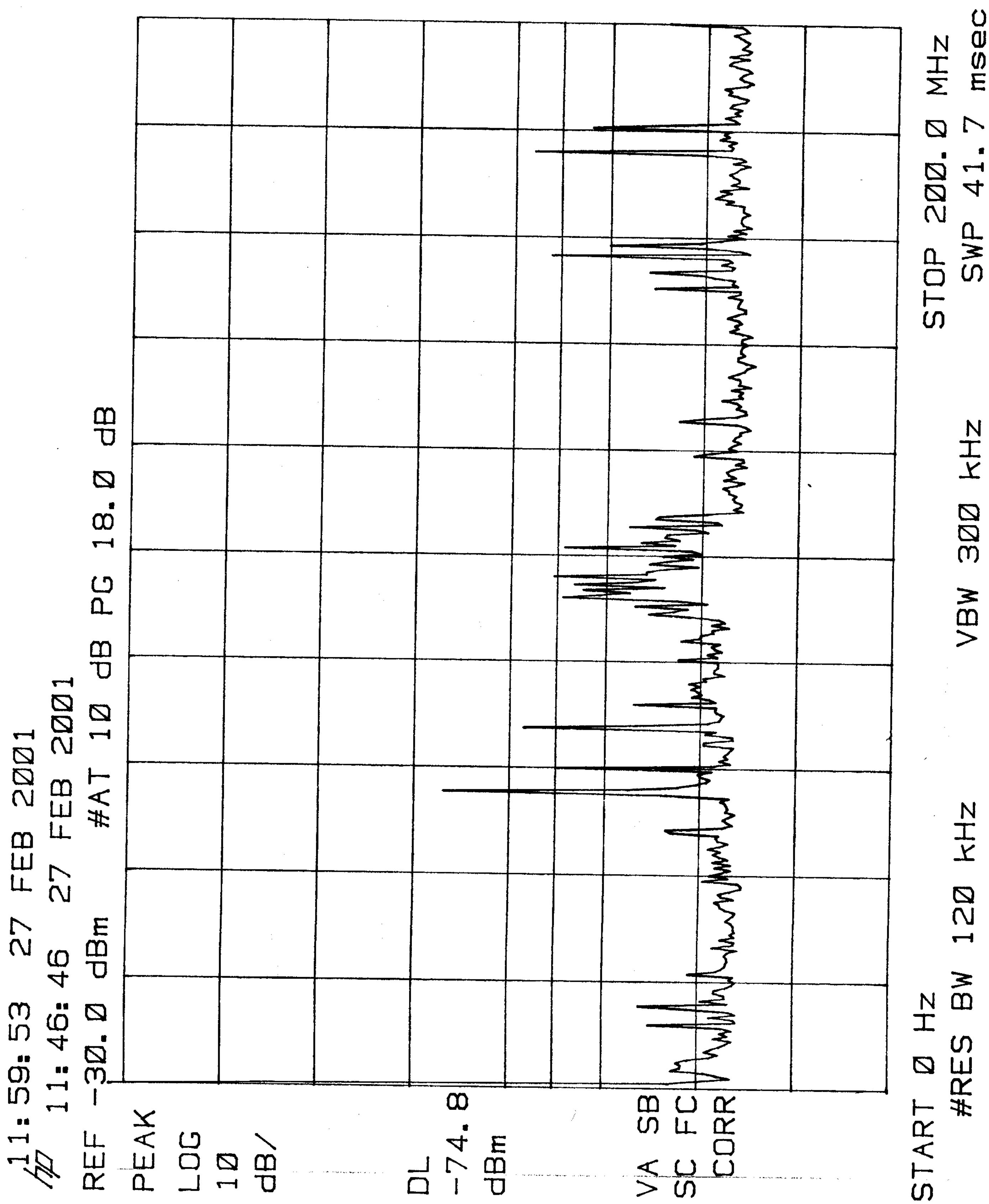
Plot 1a. Prescan Radiated Emission + Ambient (d=1.5 m), 0 - 200 MHz
Bicone, Horizontal, 120 kHz Bandwidth, Peak Detection



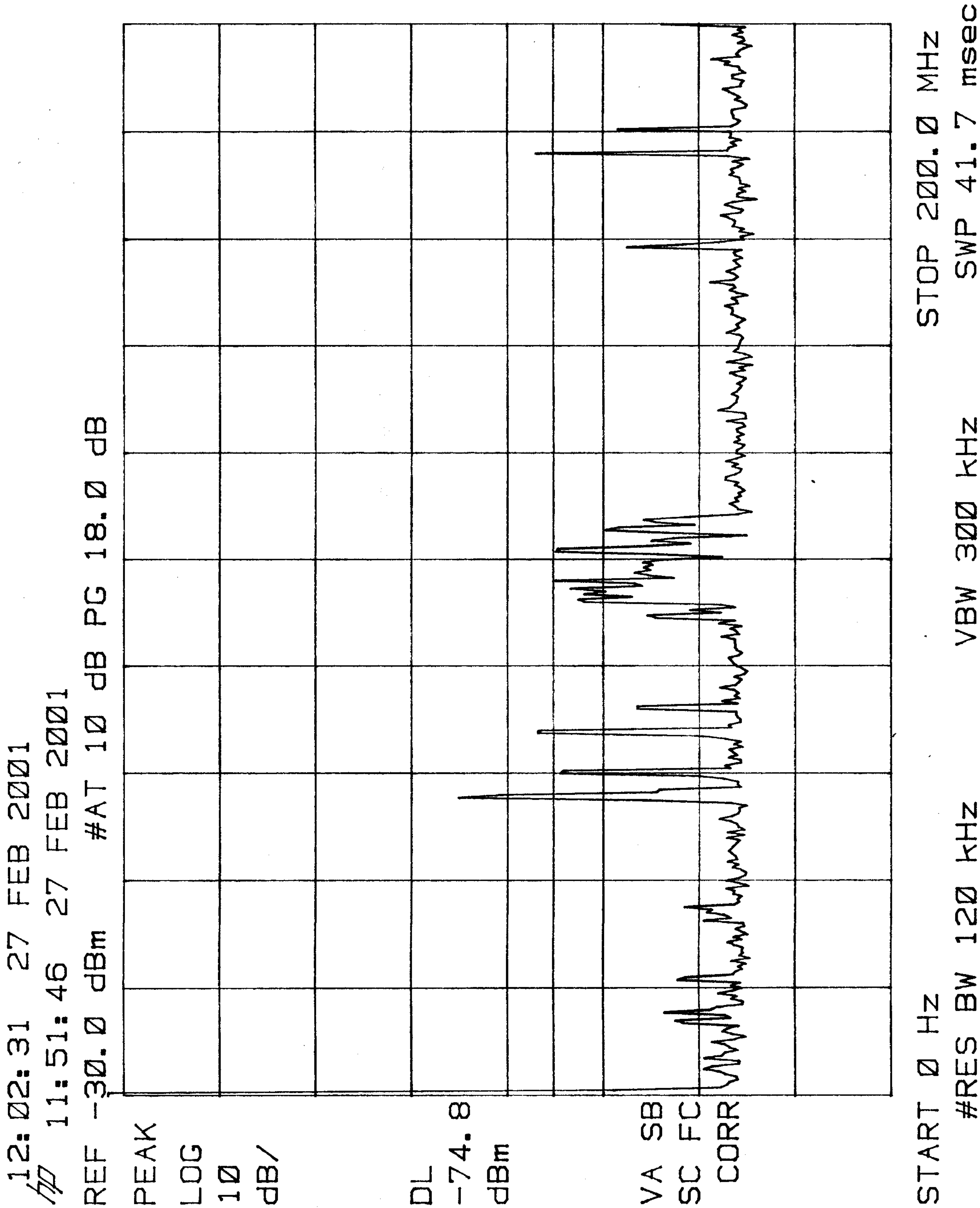
Plot 1b. Prescan Ambient Spectrum(d=1.5 m), 0 - 200 MHz
Bicone, Horizontal, 120 kHz Bandwidth, Peak Detection



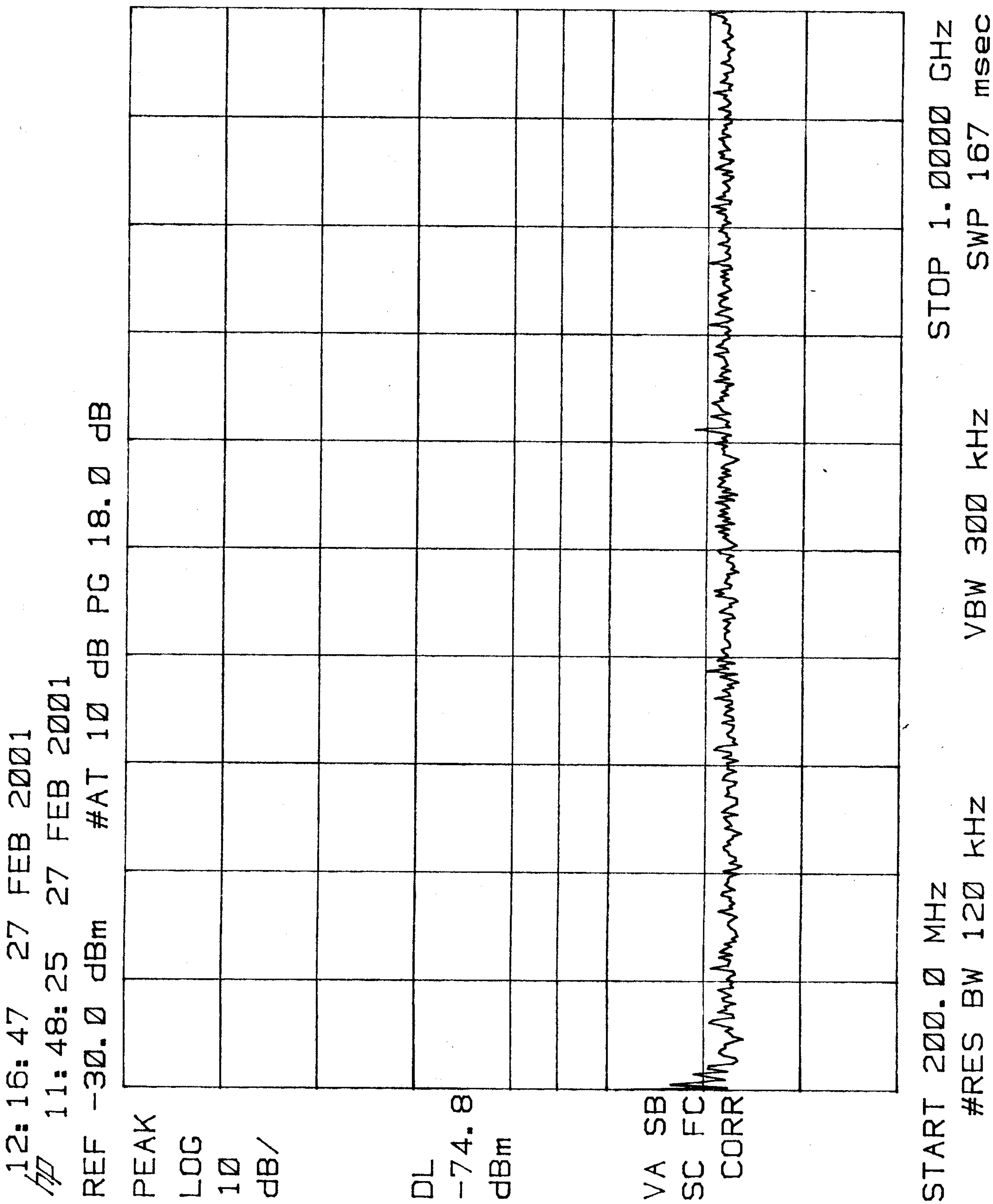
Plot 2a. Prescan Radiated Emission + Ambient (d=1.5 m), 0 - 200 MHz
Bicone, Vertical, 120 kHz Bandwidth, Peak Detection



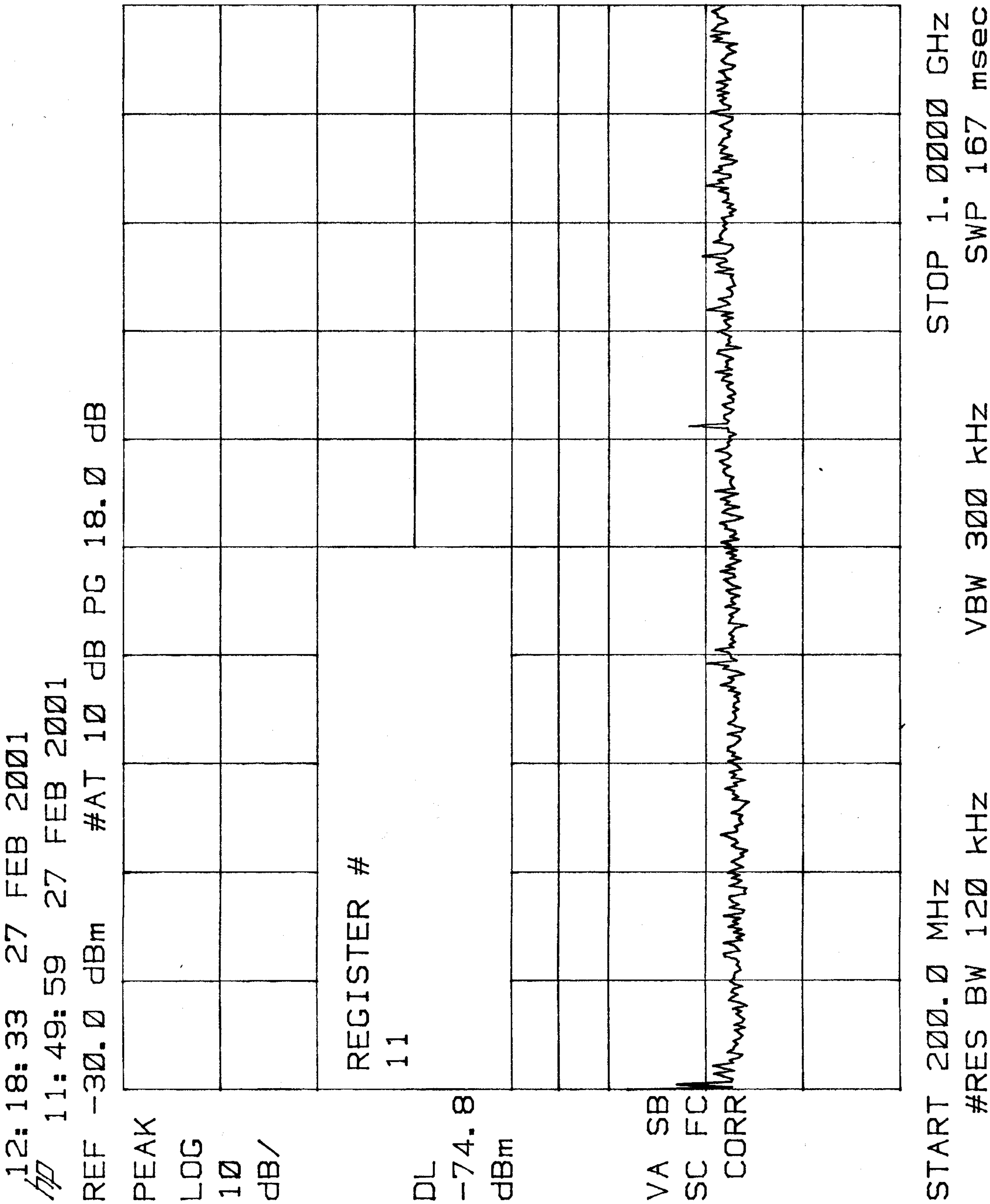
Plot 2b. Prescan Ambient Spectrum (d=1.5 m), 0 - 200 MHz
Bicone, Vertical, 120 kHz Bandwidth, Peak Detection



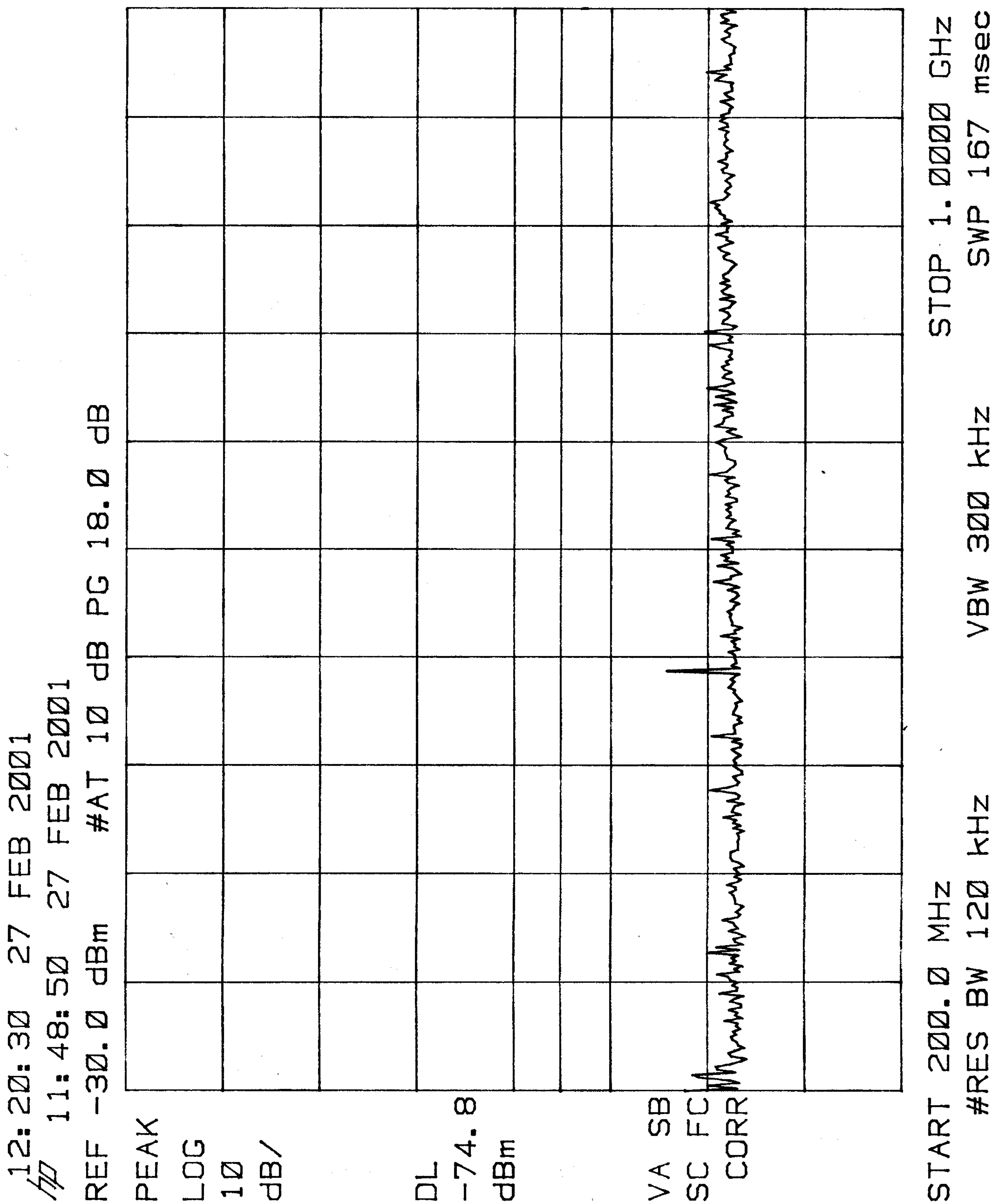
Plot 3a. Prescan Radiated Emission + Ambient (d=1.5 m), 200 - 1000 MHz
Bicone, Horizontal, 120 kHz Bandwidth, Peak Detection



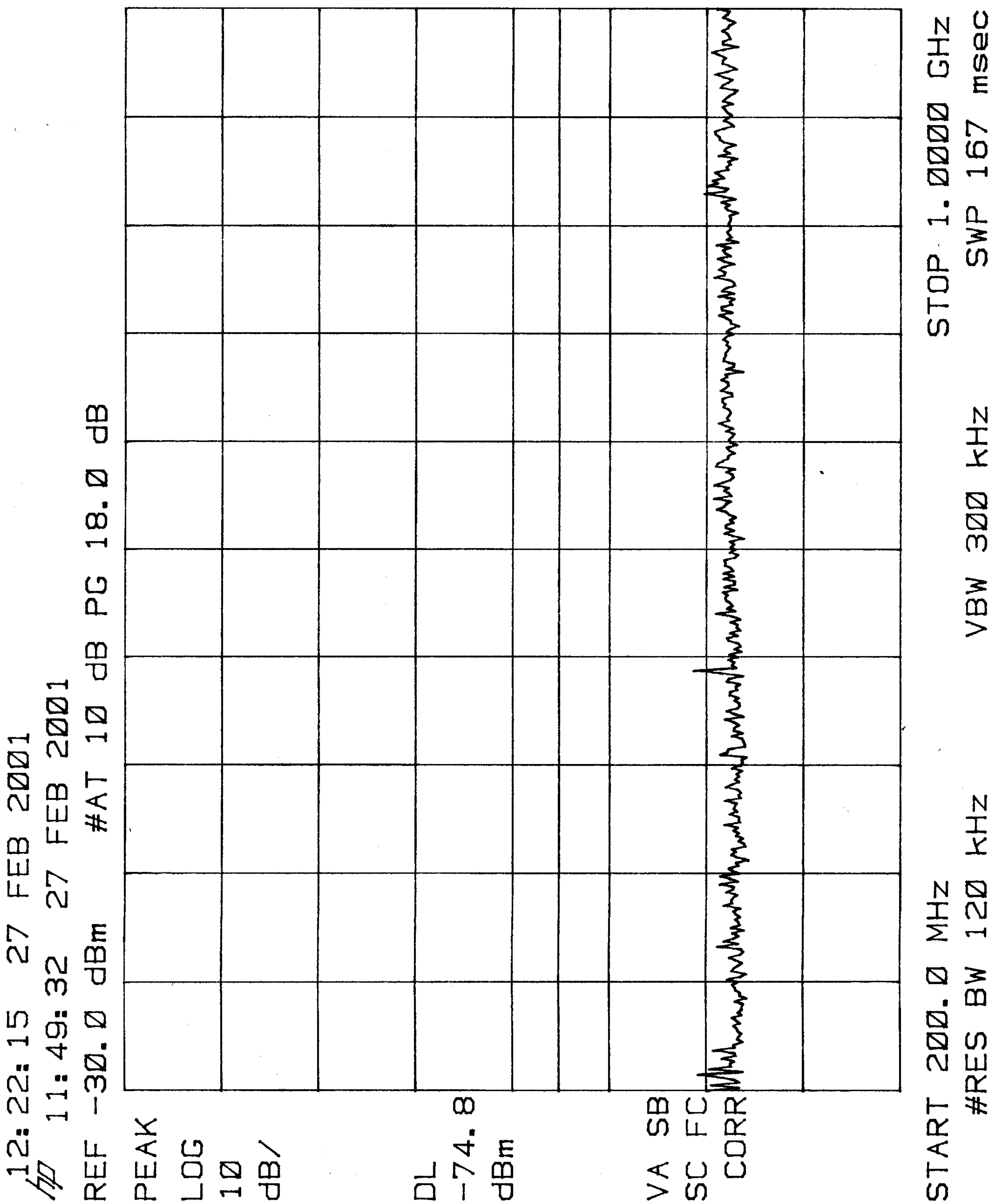
Plot 3b. Prescan Ambient Spectrum(d=1.5 m), 200 - 1000 MHz
Bicone, Horizontal, 120 kHz Bandwidth, Peak Detection

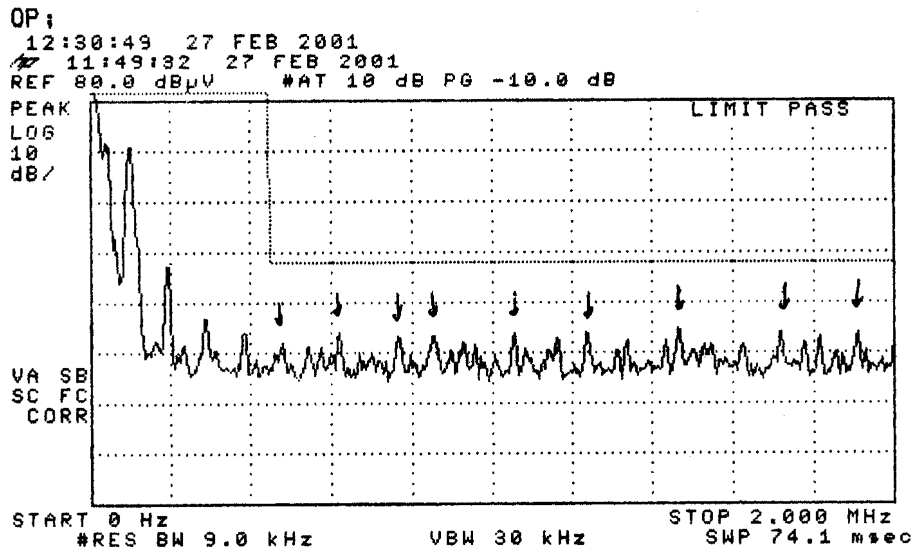


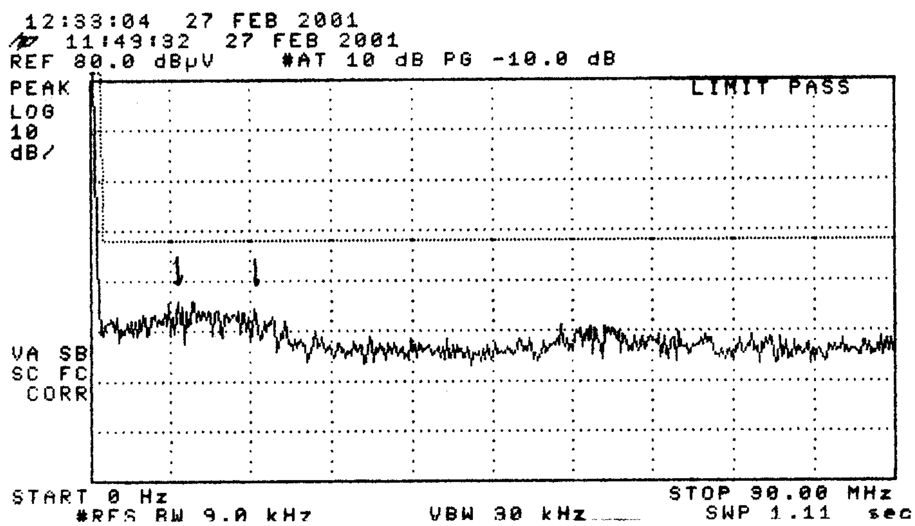
Plot 4a. Prescan Radiated Emission + Ambient (d=1.5 m), 200 - 1000 MHz
Bicone, Vertical, 120 kHz Bandwidth, Peak Detection



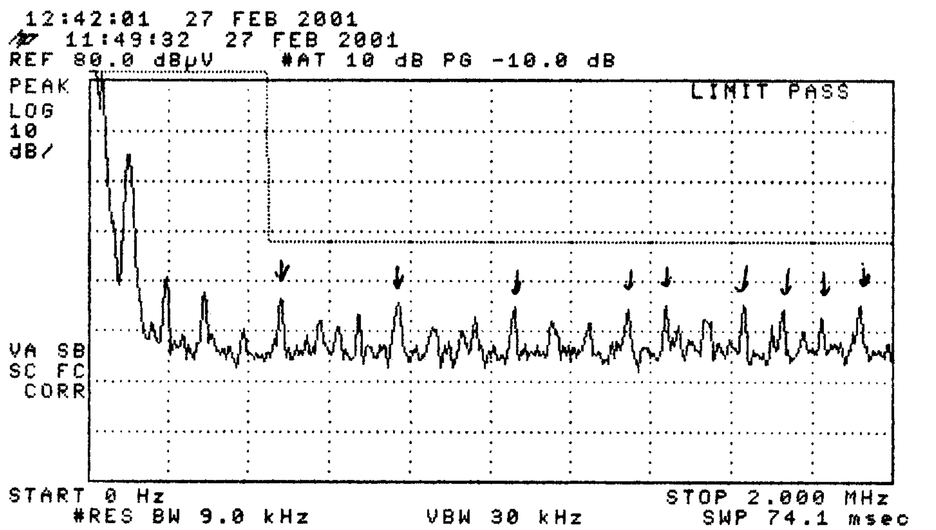
Plot 4b. Prescan Ambient Spectrum (d=1.5 m), 200 - 1000 MHz
Bicone, Vertical, 120 kHz Bandwidth, Peak Detection

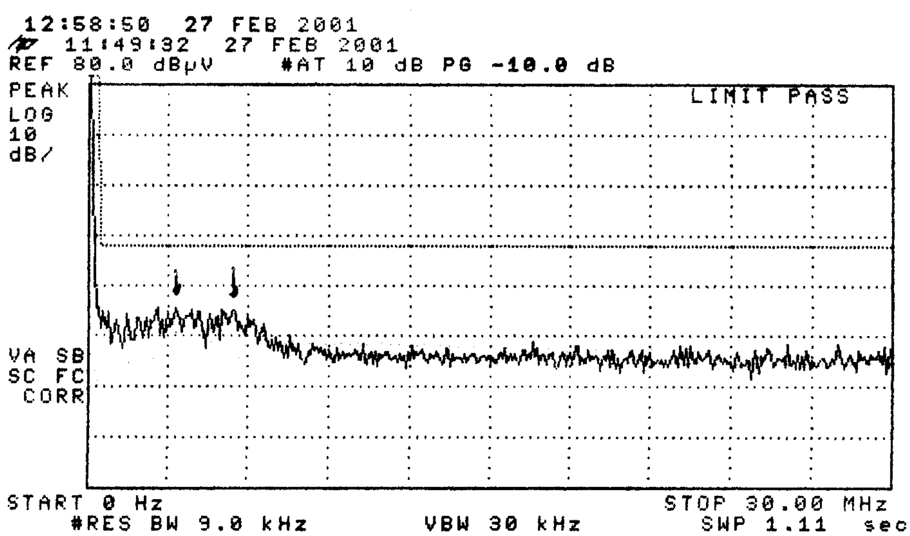






Plot 5. (Top) Conducted Emissions; High Side, 0-2.0 MHz.
Plot 6. (Bottom) Conducted Emissions; High Side, 0-30 MHz.
(LISN, 9 KHz Bandwidth, Peak Detection)





Plot 7. (Top) Conducted Emissions,; Low Side, 0-2.0 MHz.
Plot 8. (Bottom) Conducted Emissions; Low Side, 0-30 MHz.
(LISN, 9 KHz Bandwidth, Peak Detection)