

IEEE p802.4L**Through-the Air Physical Media, Radio****Retail measurement results**

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The attached charts¹ are impulse responses measured at a department store in a mall near Atlanta.

The charts are the decorrelated waveforms of a 255 bit M-sequence. The chip time is 40 ns and the equivalent baseband bandwidth of the receiver was 25 MHz. This gives an approximately 40 ns delay resolution.

Each chart is marked with a distance and attenuation value relative to the attenuation at 1 meter distance. The reference chart (not shown) was taken at 10 feet (3.3 meters) and the 1 meter attenuation is taken as 10.4 dB less than that at the measured distance of 3.3 meters.

The computed rms delay spread does not have any correction for the 40 ns resolution. Actual delay spreads are less than that measured.

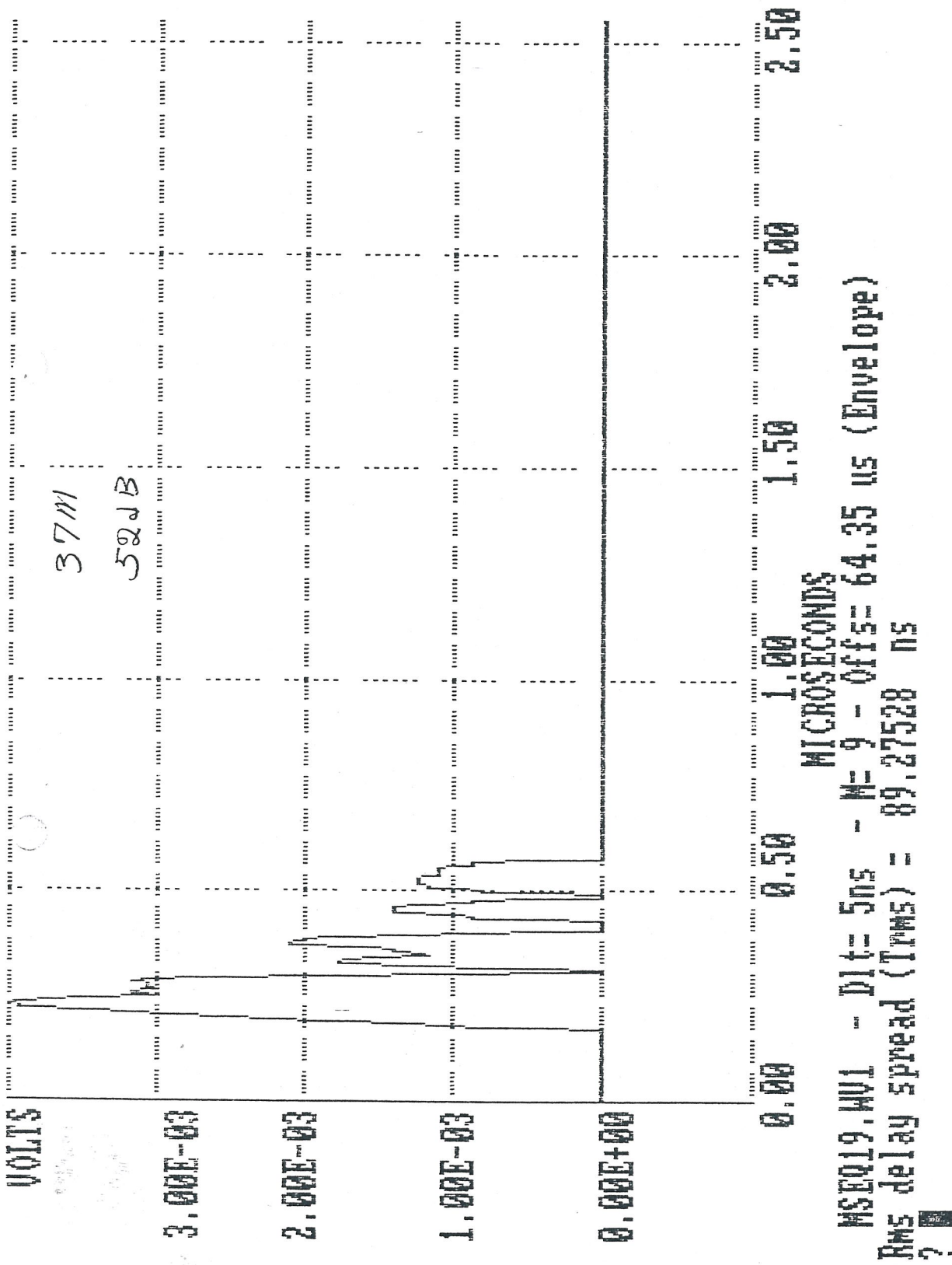
MSEQ08 is marked "between floors". One end of the path was near an elevator opening. All of the other paths were confined to a single floor.

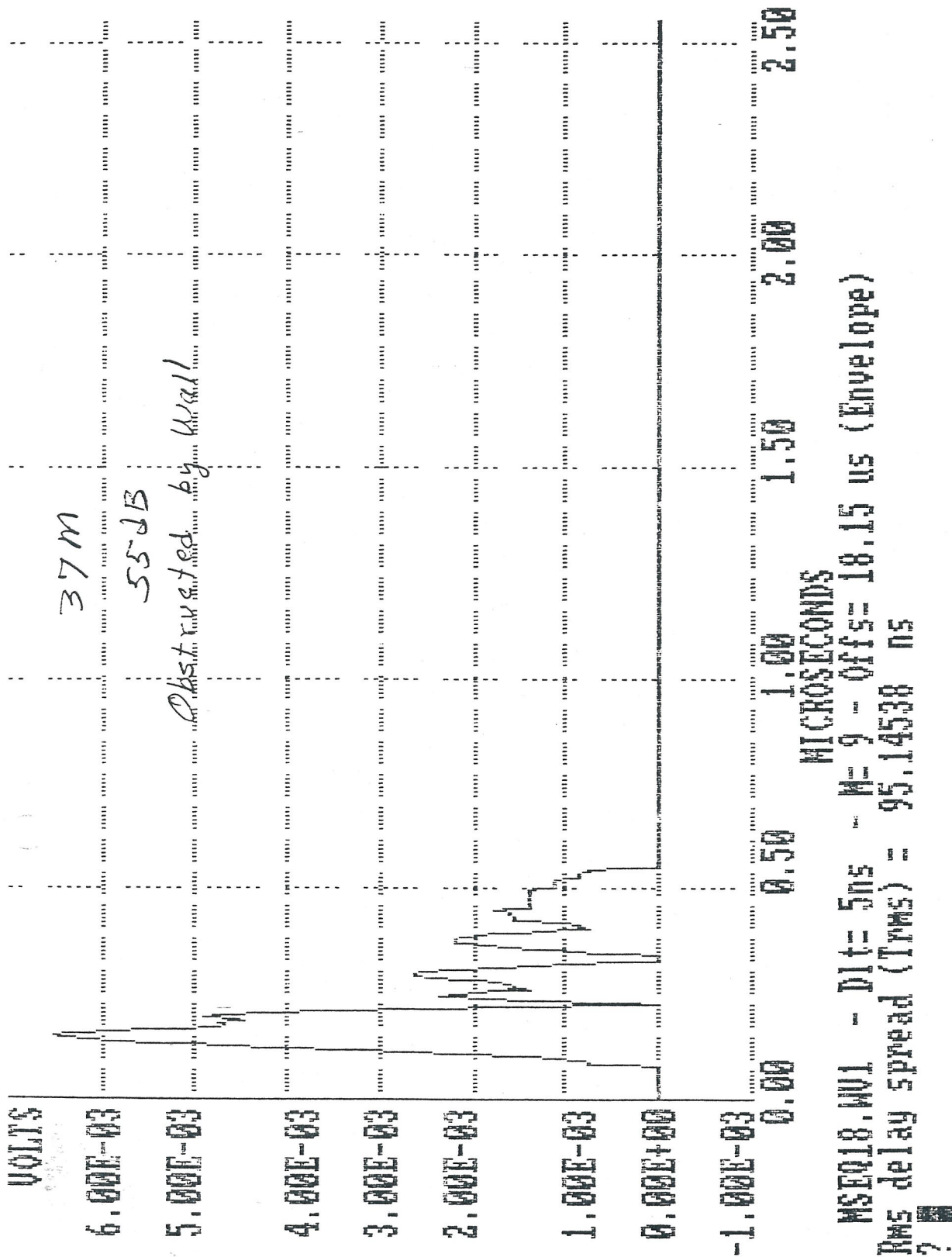
Refer to the charts for further attributes.

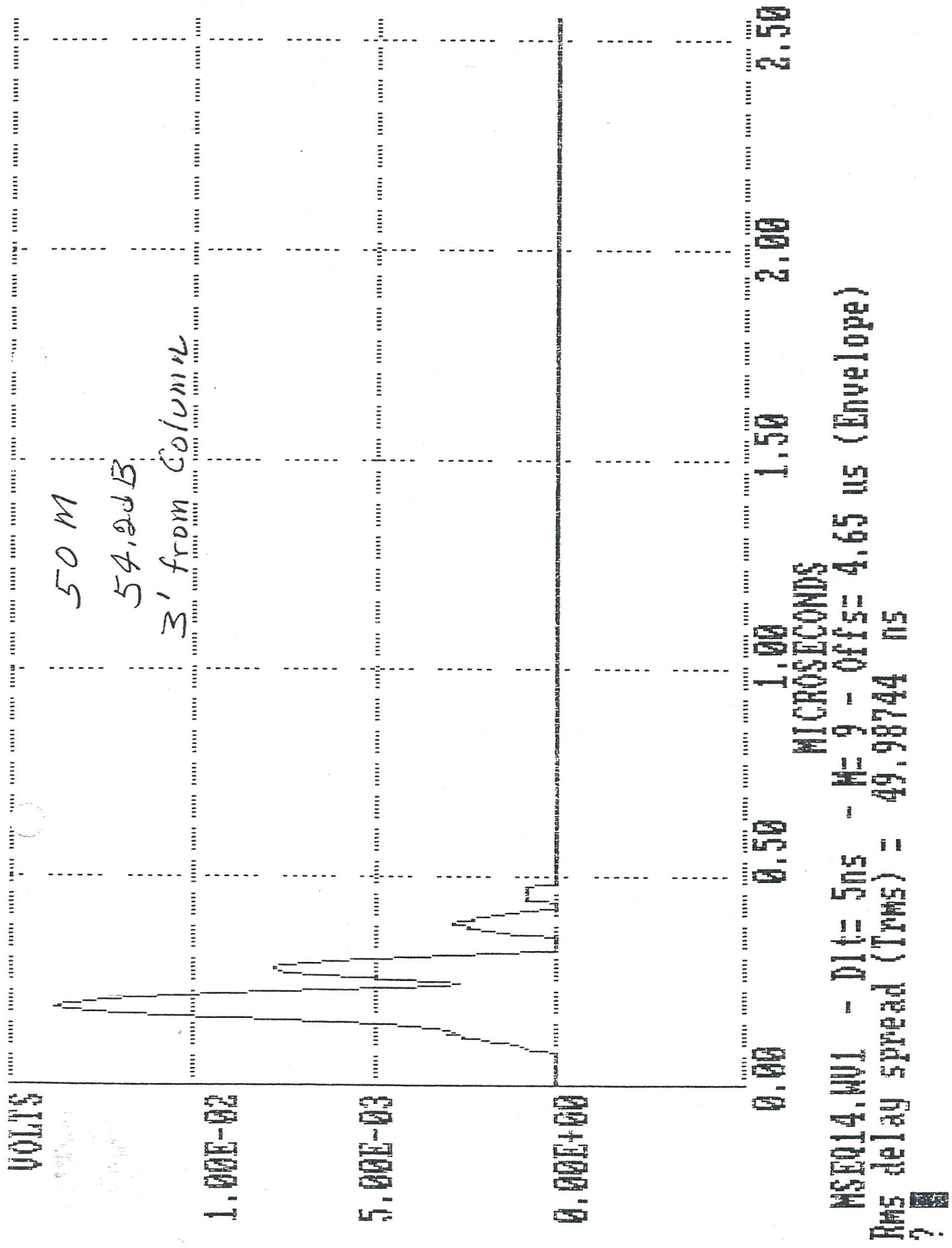
The result of an analysis is provided as follows

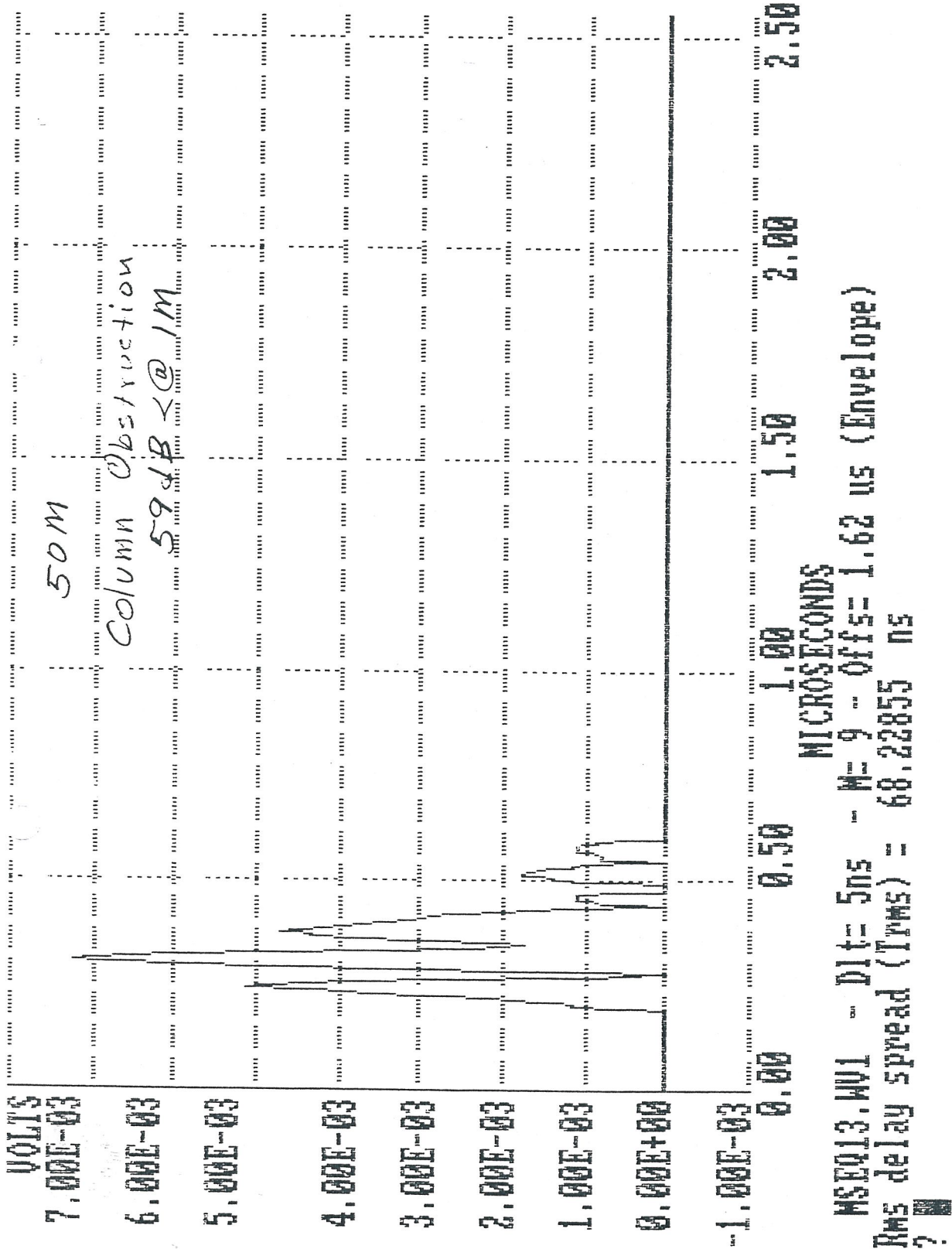
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Interference levels in the 915 MHz band.	page 16

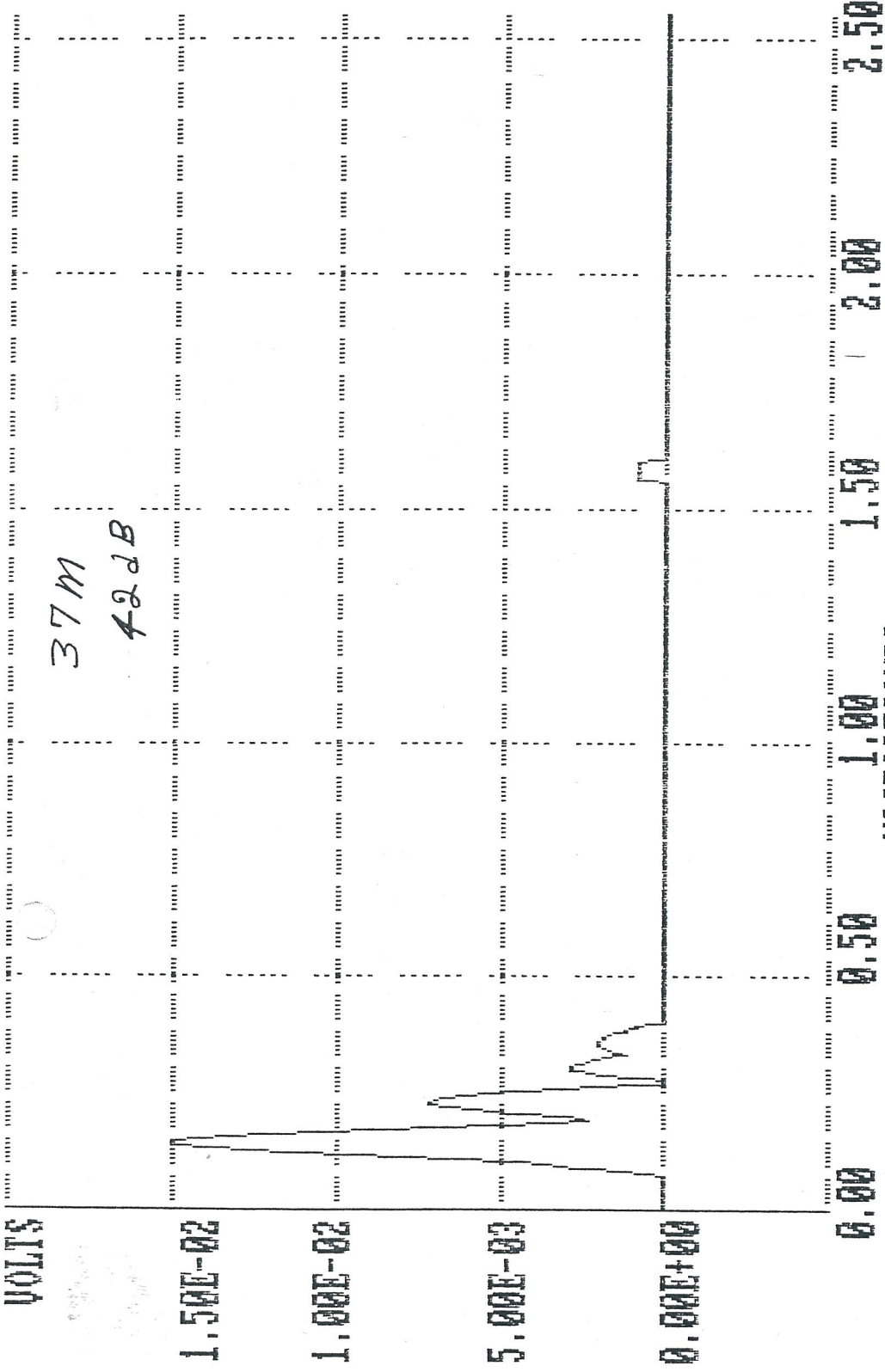
¹These charts were submitted to the IEEE p802.4L meeting held 5-7 November 1989 in Fort Lauderdale, FL. The temporary number was F.4L/8.



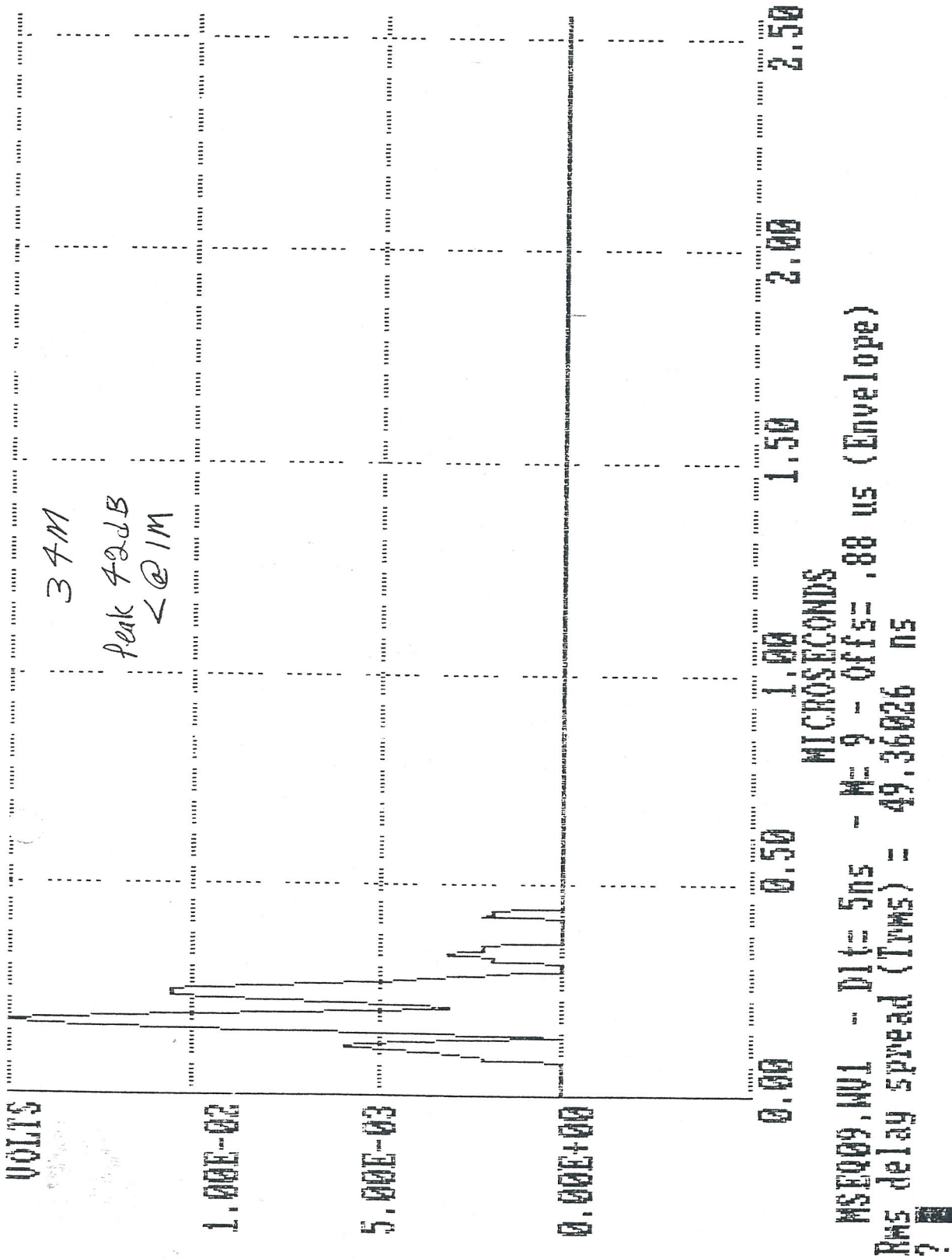


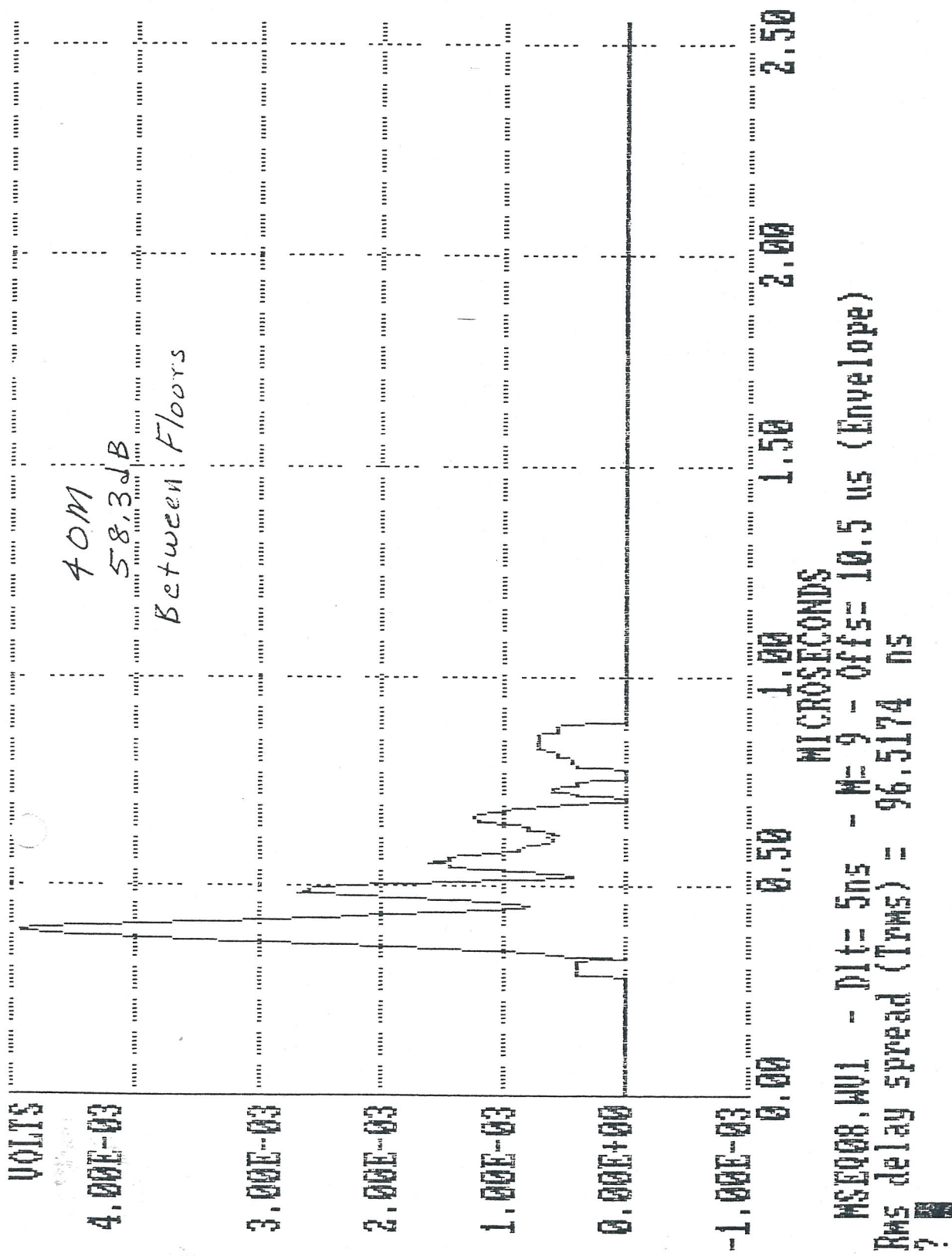


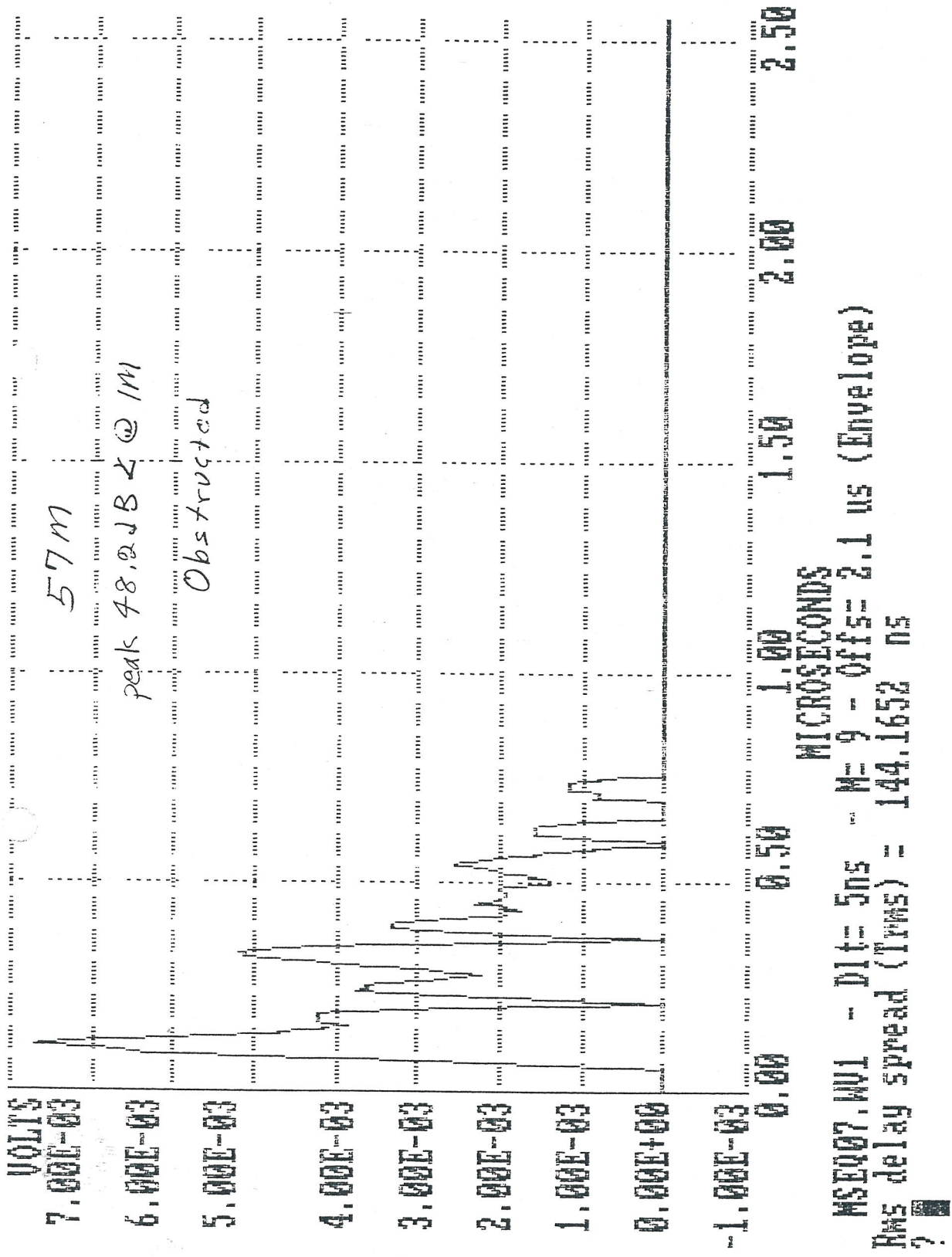


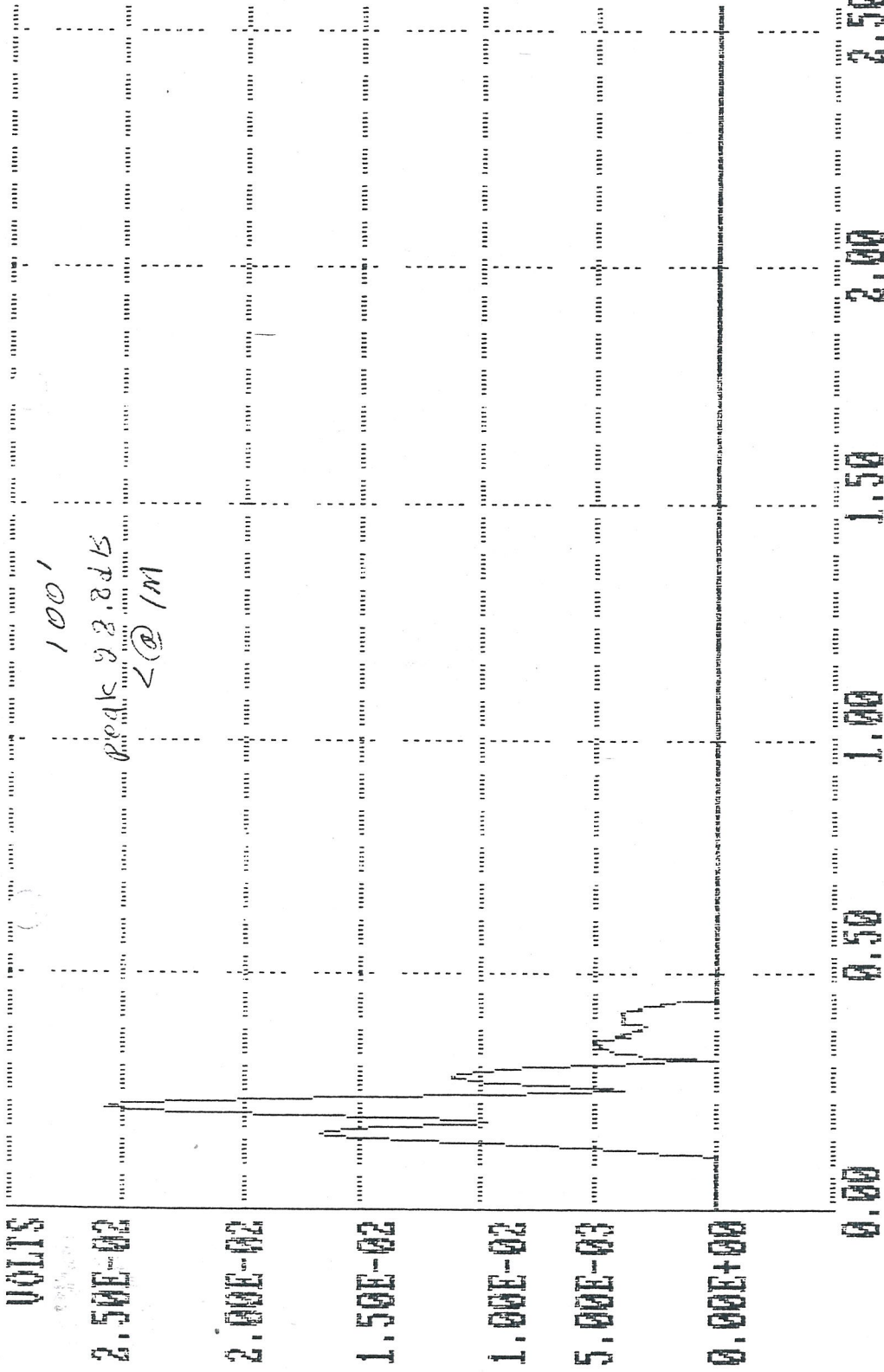


MSE010.MU1 - DIt= 5ns - M= 9 - Offs= .81 us (Envelope)
 Rms delay spread (Trms) = 86.16861 ns
 ?

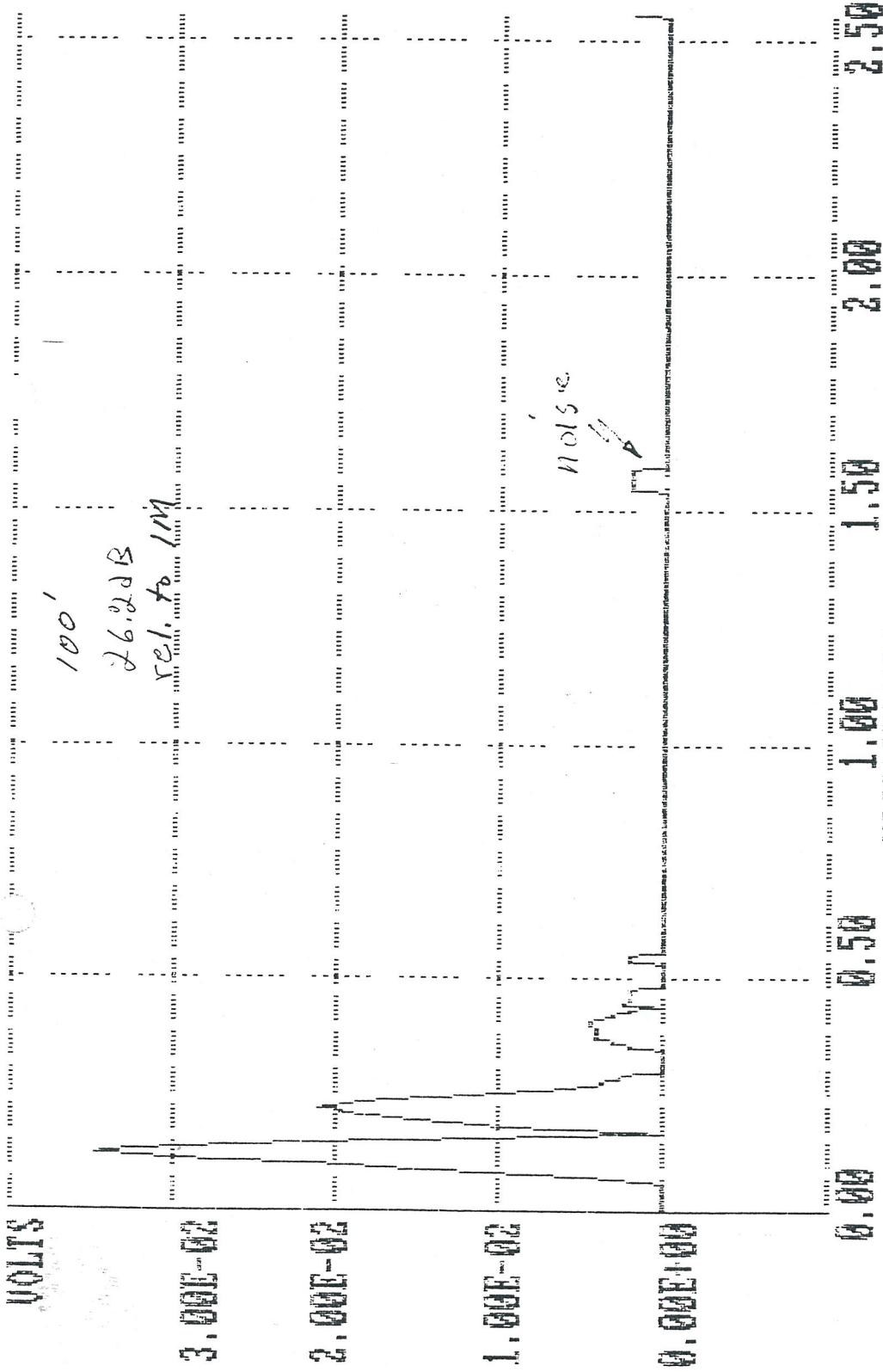




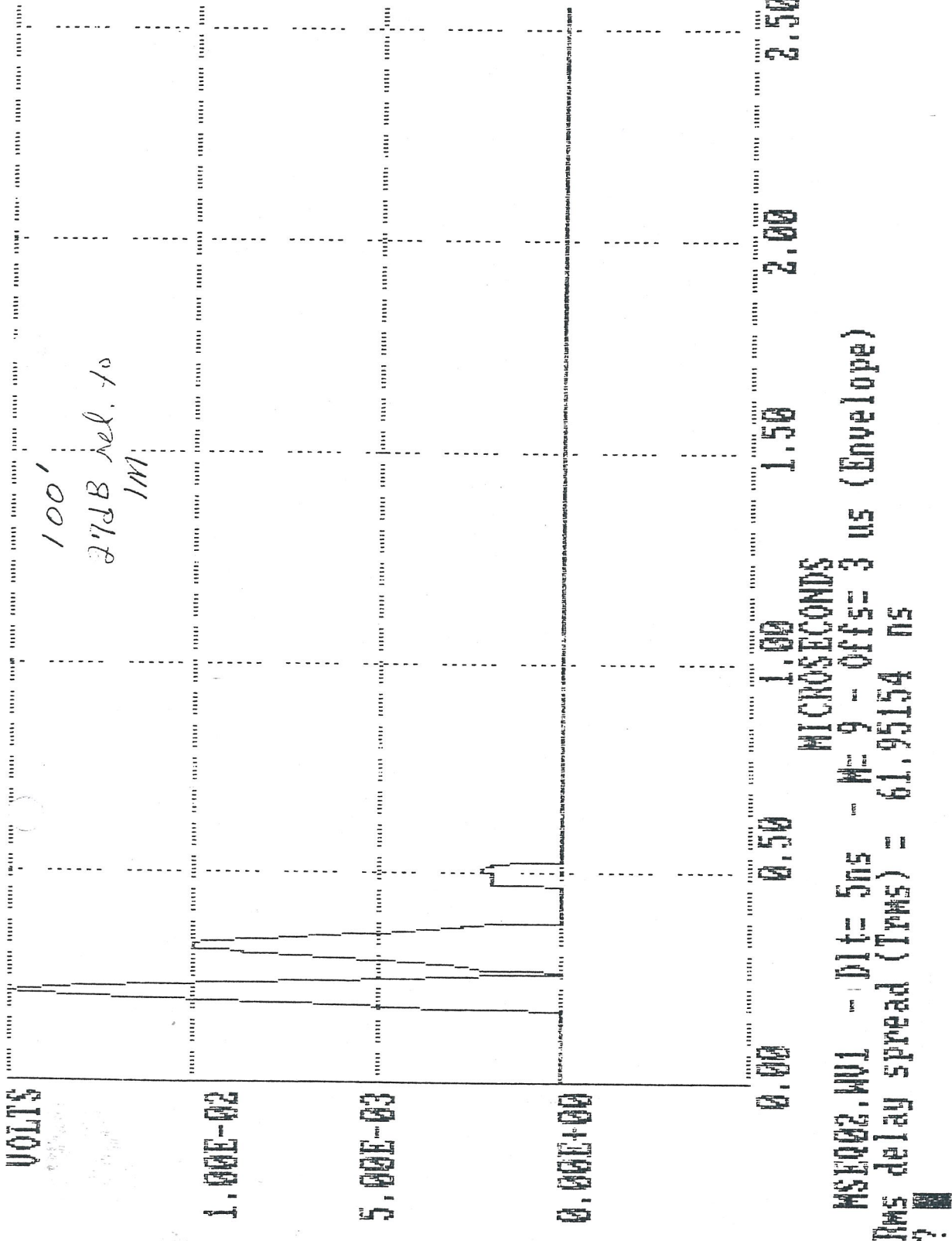




MS0004.WV1 - DIt= 5ns - N= 9 - Offs= .15 us (Envelope)
 RMS delay spread (Trms) = 50.86002 ns
 ?



MS0003.MV1 - D1t= 5ns - M= 9 - Offs= 1.03 us (Envelope)
 RMS delay spread (Trms) = 91.14362 ns
 ?



Attenuation profiles

Retail department store

Location	Frequency	6 db/octave to knee	Final slope	Deviation from regression line σ
	GHz	m	dB/octave	dB
Second floor	.915	10	10	4.5
Second floor	2.44	8	10.8	6.7
First floor	.915	13	12.6	5.1
First floor	2.44	7	10.5	6.3

Distances measured: 1 - 70 m

915 MHz Impulse Noise

Retail Terminal source (10 ft away)

Trigger Threshold	Triggers/sec	Total number of triggers
dBm	note 1	
-57 (50 mV-KII)	3.15	31
-51 (100 mV)	0.24	62

note 1 5.5 dB per decade count change

Necessary signal level (See document 89-20)

- 51 dBm wideband peak @ 0.24 / s (25 MHz LPF)
- 18 (+5.2 σ) rms (8MHz BW)/peak (25 MHz BW) 13 random samples
- 6 S/N @ 10 impulses/error
- +2 receiver allowance
- 73 dBm

-73 -- 68 (-73+ σ) dBm for $P_e \leq 2.4 \times 10^{-8}$

-79 -- 74 dBm for $P_e \leq 3.15 \times 10^{-7}$

(74 to 79 dB excess loss over 1 m at 600 mW)

Note: The above does not take into account any S/N gain against impulse noise due to peak clipping. This clipping effect will give about a 6 dB gain resulting in 80 to 85 dB for the excess loss of the last line above.

Other sources - Less frequent than retail terminal.

2.44 GHz Impulse noise

Retail Terminal source (10 ft away)

Trigger Threshold	Triggers/sec	Total number of triggers
dBm		
-44 (10 mV-KII) 25 MHz LPBw	0.0284	47

Necessary signal level (See document 89-20)

-44 dBm	wideband peak @ 0.0284 / s (25 MHz LPF)
-21.8 (+5.2 dB σ)	rms (8MHz BW)/peak (25 MHz BW)
-6	S/N @ 10 impulses/error
<u>+2</u>	receiver allowance
-69.8 dBm	

-69.8 - - 64.7 (-69.8+ σ) dBm for $P_e \leq 2.8 \times 10^{-9}$

56.2 to 61.3 dB excess loss over 1 m @ 600 mW

Note: The above does not take into account any S/N gain against impulse noise due to peak clipping. This clipping effect will give about a 6 dB gain resulting in 62.3 to 67.3 dB for the excess loss of the last line above.

902 - 928 MHz Intereference levels

Department Store
Atlanta, GA

Location	Frequency	Level (into dipole antenna)
	MHz	dBm
Entrance, Both Levels	905.7	-50
	907.4	-54
	902.0	-70
	908.0	-70
	930.0	-63
Upper Level, Under Skylight	930	-50
	Others	<-72
Lower Level, Sporting Goods	930	-50
	All Others	<-72
Mobile Voice Transmitter	929.1 (second harmonic)	-56 @ 1 m