SECTION VI

The Effects of Ambient HF Power Densities on HF CATV Systems

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"THE EVALUATION OF INGRESS AND EGRESS

PROBLEMS IN THE C.A.T.V. SUB LOW FREQUENCY SPECTRUM"

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6.0 INTRODUCTION

The level of ingress received on a CATV system is related to the level of HF fields in the vicinity of the system. If the HF field strength at a certain frequency and the effective shielding of the CATV system are known, the level of ingress on the system and the effects of that ingress are easily predicted. Maximum ambient HF field strengths are used for this analysis.

Similarly the level of egress from a CATV system is related to the signal levels carried on the system. If these signal levels and the effective shielding are known, the field strength radiated by the system is easily predicted. The effects of radiation from the system are analyzed using minimum ambient HF field strengths.

6.1 FIELD TESTS

Signal levels in the HF band were measured as described in Appendix 6.1. Test results indicated a large variation in signal level in the HF band.

No design level of field strength could be established from these results. However, results of many other studies have indicated maximum and minimum field strengths expected in urban environments. These field strengths are used in Sections 6.2 and 6.3 to calculate "expected" ingress and egress levels.

6.2 EXPECTED INGRESS LEVELS

Three grades for radio environment immunity have been established for electronic devices by the Department of Communications.* For the HF band, the three grades are unlikely to experience performance degradation due to the field intensities shown in Table 6.1.

Table 6.1

HF Radio Environment Immunity Grades

Grade	Field Strength (v/m)
1	1
2	3
3	10

Given the field strength, and ingress level which can be tolerated, the necessary shielding of the CATV system can be calculated using:

$$Wr = \frac{E^2 \lambda^2 gd}{480 \pi^2}$$

Where Wr = Power received (W)
E = Field strength (v/m)
λ = Wavelength (m)
gd = gain of receiving antenna (CATV system)

$$\text{Gain(dB;)} = 10 \log_{10} gd$$
$$\text{Shielding(dB;)} = -10 \log_{10} gd$$
$$\text{and Power Received - PR(dBm)} = 30 + 10 \log_{10} Wr$$

The necessary shielding for the three grades of radio environment immunity at 5MHz and at 30MHz are shown in Fig. 6.1.

*Electromagnetic Compatibility Advisory Bulletin

Immunity of Electrical/Electronic Equipment Intended to Operate in the Canadian Radio Environment (0.014 - 10,000MHz) Release Date: Sept.1,1977

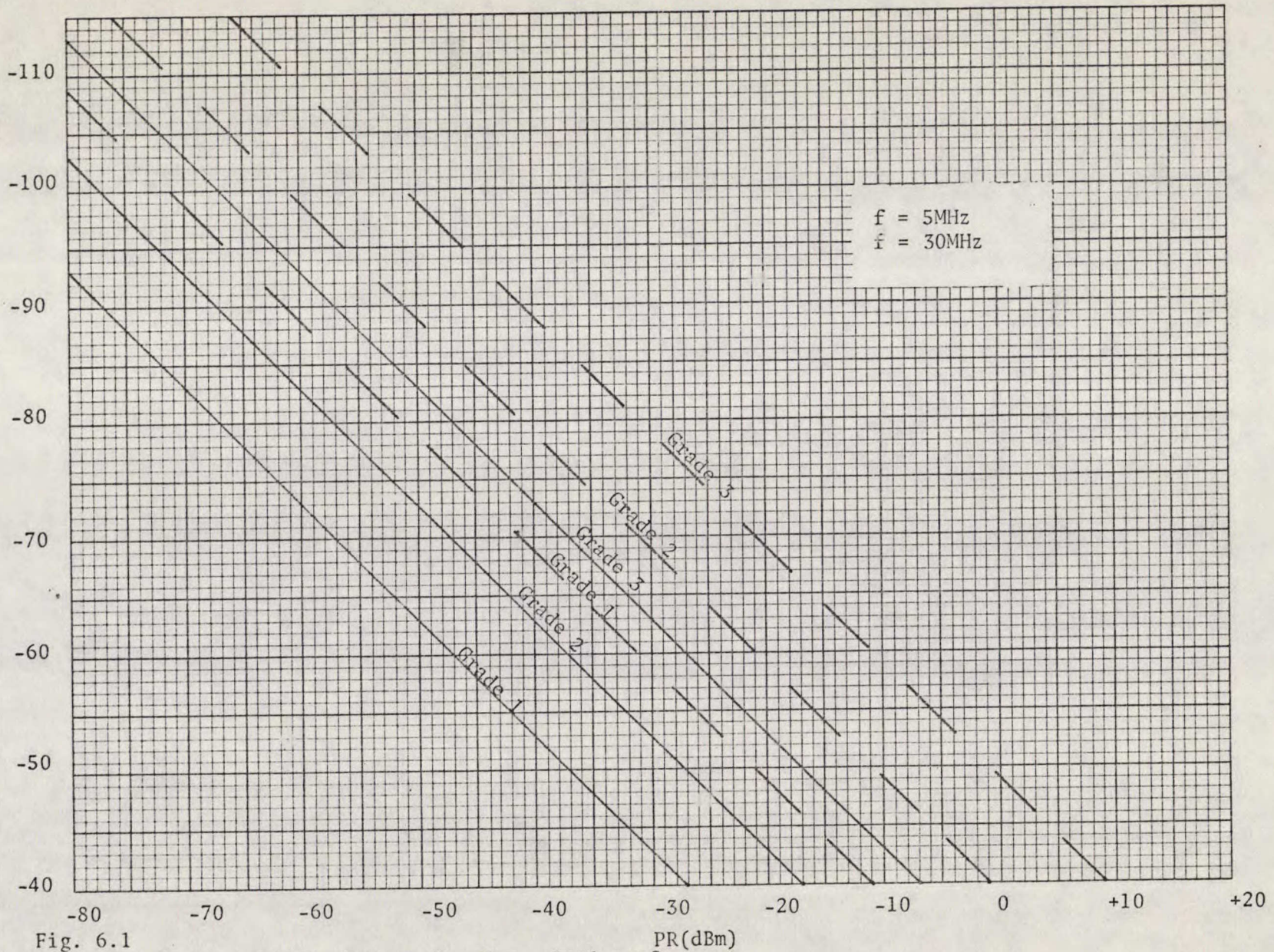


Fig. 6.1
Maximum gain of C.A.T.V. System for Three Grades of Radio Environment Immunity for a given Power Received

The field strengths shown in Table 6.1 are of a reasonable order of magnitude. A radiated field strength of 5 V/m in the 2.99 MHz to 29.99 MHz (HF) band is suggested by MIL-STD-461B Section RS 03 as a design standard. A design standard of HF field strength between 1 V/m and 10 V/m (i.e. +120 dBμV/m and +140dBμV/m) should be considered for C.A.T.V. systems.

Median values of HF field strengths are expected to be in the order of 0 to +10 dBμV/m/KHz*. This is significantly lower than the recommended "design" field strength for HF C.A.T.V. systems. Man-made noise sources have been found to create significantly higher field strengths than natural sources.

* Electromagnetic Interference and Compatibility
Volume 5 EMI Prediction and Analysis Techniques
William G. Duff and Donald R. J. White, 1972.

6.3 EXPECTED EGRESS LEVELS

Radiated field strengths from CATV systems may interfere with other communication systems. The maximum signal level in a CATV system is approximately 0dBm(10^{-3}W). The most severe egress problems will occur if the desired (non CATV) field strength is minimum. Minimum field strengths of about 0.001 V/m can be expected in the HF band.

The field strength radiated by the CATV system is described by

$$E = \frac{120\pi \ W_T \ g_2}{4\pi \ d^2}$$

Where E = Radiated field strength (v/m)
W_T = Transmitted Power (W)
g_2 = gain of CATV system
d = distance from CATV system(m)

If $W_T = 10^{-3}W$

$$E = \frac{3 \times 10^{-2} g_2}{d}$$

Gain(dBi) = $10 \log_{10} g_2$
Shielding(dBi) = $-10 \log_{10} g_2$
E(dBμV/m) = $20 \log_{10} E + 120$

For a given distance and maximum permissible indicated field strength the maximum permissible gain (i.e. minimum shielding) of the CATV system can be found from Fig. 6.2.

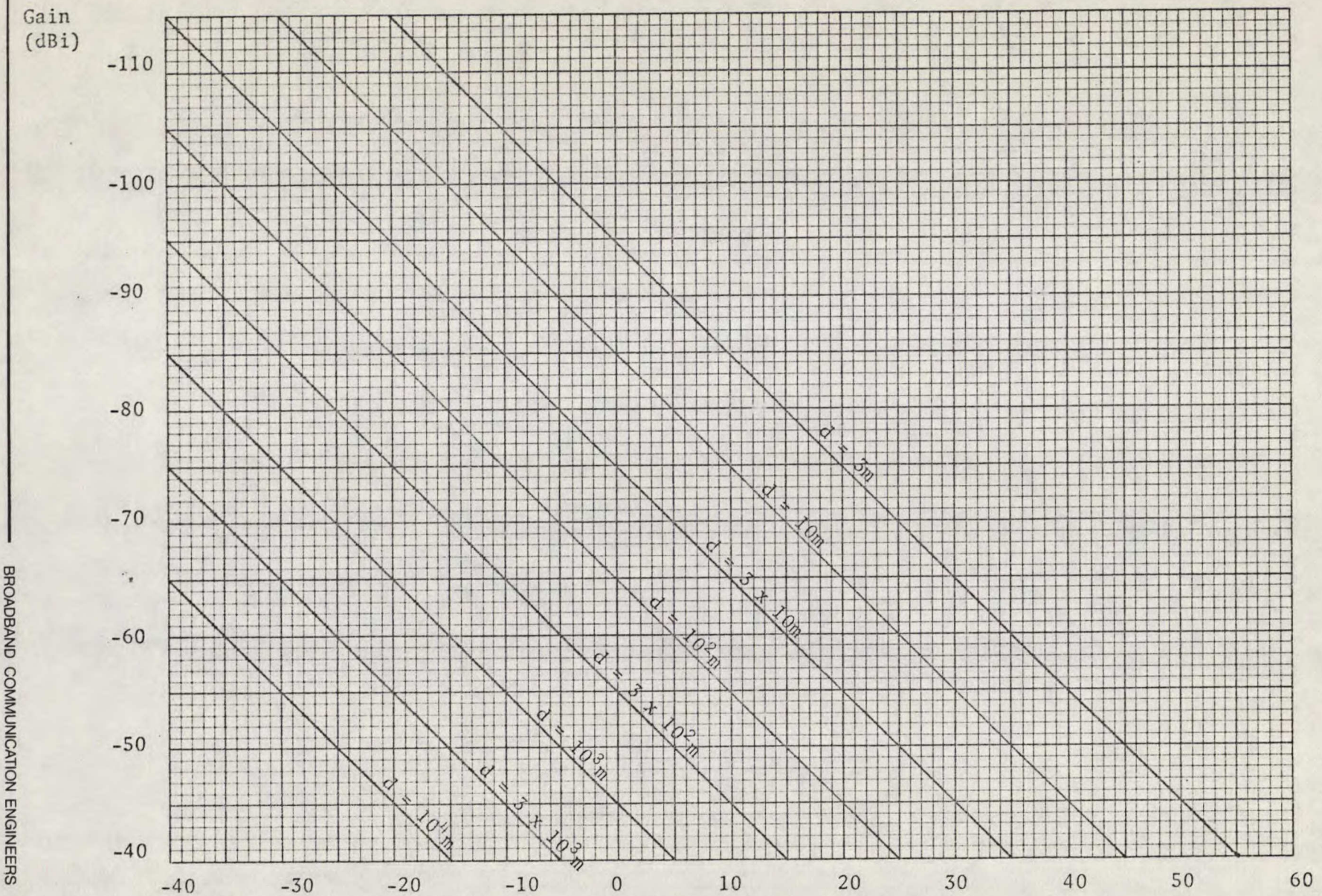


Fig. 6.2 Maximum gain of C.A.T.V. System for various distances for a given Field Strength

APPENDIX 6.1

Test Procedure for Measuring HF Signal Levels

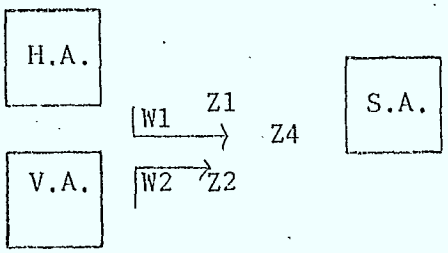
To measure HF signal levels, an HF antenna and spectrum analyzer is used to measure peak levels.

TEST EQUIPMENT

Manufacture	Model No.	Serial No.	Quantity	Description	Reference Designation
Hewlett-Packard	8553L/8552B		1	Spectrum Analyzer	S.A.
Hewlett-Packard	140B	908-00237	1	Oscilloscope	
Hustler	40 Meter Mobile Mount (7MHz)		1	Vertical Antenna	V.A.
Cablesystems Eng.	10MHz	Dipole	1	Horizontal Antenna	H.A.

CONNECTORS AND CABLES FOR DENSITY MEASUREMENT

Amphenol	PL-259 (50Ω)	1	Cable Connector	Z 1
Amphenol	RG-58ν (50Ω)	14 ft.	Coaxial Cable	W 1
Amphenol	RG-59ν (21 - 1159) 75Ω	50 ft.	Coaxial Cable	W 2
Sterling	F-59 (75Ω)	1	Cable Connector	Z 2
Amphenol	31-4321 (50Ω)	1	BNC Connector	Z 4



NOTE: Only one antenna will be hooked up at a time. Connect the equipment as shown in the figure.

PROCEDURE

With the use of the Horizontal Dipole Antenna (H.A.) or the Vertical Antenna (V.A.) hooked to the Spectrum Analyzer the levels of signals are measured in the H.F. Band.

1. Hook either the Horizontal or Vertical Antenna to the Spectrum Analyzer RF input. (Z4)
2. Sweep across the Band of Frequency.
3. Record Signal Levels at Frequencies of interest.

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