NRSC REPORT

NATIONAL RADIO SYSTEMS COMMITTEE

NRSC-R51
DAB Field Test Project
Antenna Characterization Report
July 9, 1996

(Submitted to NRSC/EIA/NAB Field Test Task Force)

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FOREWORD

NRSC-R51, DAB Field Test Project Antenna Characterization Report, presents the results of antenna characterization tests conducted by Ford Motor Company in support of digital radio system tests conducted jointly by the Electronics Industries Association (EIA) Subcommittee on Digital Audio Radio (DAR) and the NRSC Digital Audio Broadcasting (DAB) Subcommittee (now the DRB Subcommittee).

Seven different digital radio systems were involved in the joint EIA/NRSC test program—three FM in-band/on-channel (IBOC) systems, one FM in-band/adjacent channel (IBAC) system, one AM IBOC system, the Eureka-147 DAB system (operating at L-band), and a satellite system (operating at S-band). The FM and AM band systems were the only ones considered by the NRSC and consequently the L-band and S-band antenna test results are not included in NRSC-R51. The NRSC chairman at the time of the submission of NRSC-R-51 was Charles Morgan.

The NRSC is jointly sponsored by the Consumer Electronics Association and the National Association of Broadcasters. It serves as an industry-wide standards-setting body for technical aspects of terrestrial over-the-air radio broadcasting systems in the United States.

DAB FIELD TEST PROJECT ANTENNA CHARACTERIZATION REPORT

submitted to:

NRSC/EIA/NAB Field Test Task Force

July 9, 1996

prepared by:
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Audio Subsystems Engineering
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DAB FIELD TEST PROJECT ANTENNA CHARACTERIZATION REPORT
for the EIA and NAB

Introduction

As part of the EIA/NAB Field-Testing Task Group, the Automotive Components Division of Ford Motor Company has recently conducted characterization testing of the various antenna systems which will be used for the DAB testing in San Francisco area. A copy of the project proposal can be found in *Appendix A*. This report describes the test methodologies used, analysis of the test data, and suggests conclusions based on the measurements.

VHF (Terrestrial)

Tests Conducted

The specific characterization testing consisted of the following measurements:

	EIA/NAB VHF Test Antenna	**1995 Taurus Power Antenna (ref. only)**
Gain/Directionality: Vertical Polarization	X	X
Gain/Directionality: Horizontal Polarization	X	X
Gain/Directionality: Right-Circular Polarization	X	X
Gain/Directionality: "Off-the-Air" Signals	X	X
Output Impedance	X	X
Signal Fading vs. Height	X	-

The gain/directionality measurements were performed at an outdoor, ground-plane antenna test range. These measurements were taken on a rotating turntable with the antenna's ground plane fixtured 4 feet above ground level.

The Vertical, Horizontal, and Right Circular Polarization (RCP) measurements utilized a laboratory generated test signal to illuminate the EIA/NAB VHF Test Antenna; the resulting data was post-processed to normalize the measurements to a reference 1/2 wave dipole. The results are presented in polar-plot form showing relative gain as a function of azimuthal position in *Appendix B*.

The "Off-the-Air" measurements utilized ambient broadcast signals to provide a relative indication of the performance. Again, the data is normalized to a reference 1/2 wave dipole and presented in polar-plot format in *Appendix C*.

The Output Impedance was measured using a network analyzer; the measurements were taken at the end of the coaxial cable supplied with the test antenna. The data is presented in Smith Chart and Voltage Standing Wave Ration (VSWR) format normalized to 50 ohms in *Appendix D*.

Multipath Test Description:

An objective quantification of FM Signal Fading vs. Height is difficult to perform in a laboratory (or antenna test range) environment. The inherent difficulty is illuminating the receiving antenna-under-test with an appropriate combination of time-varying, multiple wavefronts representative of those experienced under mobile reception conditions. Even if this were practical, the results would likely prompt speculation into the correlation between the measurement results and actual field-conditions. To avoid these issues, a "real-world" characterization approach was selected which utilized ambient, off-the-air FM broadcast signals.

Using a fiberglass supporting structure, the EIA/NAB VHF Test Antenna was fixtured at the end of a 5' x 12' trailer. Three different fiberglass structures were fabricated at heights of 2', 5' and 8'. By utilizing the various fixtures, it was possible to mount the EIA/NAB VHF Test Antenna at different levels above ground. Since the trailer bed was (approx.) 2' above ground, testing was conducted with the antenna at aggregate heights of 4', 7' and 10' above ground level.

The trailer was towed by the Ford Econoline E350 Test Van. The output of the EIA/NAB VHF Test Antenna was connected to a Rohde & Schwarz ESVP receiver; an external A/D board in the test van computer sampled the analog signal level output at 8" distance increments. Calibration and control software was written to correlate the DC voltage measurements to the corresponding received signal strength levels.

The received signal-level measurements were taken from EIA/NAB VHF Test Antenna as the vehicle was driven along different test routes. (The intent was to determine/quantify the Fading vs. Height-Above-Ground under different environmental conditions). The test routes consisted of the following areas:

1. **Dearborn area:**

Specific Route:	Hubbard Drive => Southfield Freeway service drive => Ford Road => Mercury Drive => Executive Plaza Drive.
Route length:	10,300 ft. (approx.)

Environment: Suburban office area with heavy traffic.

2. **Downtown Detroit area:**

Specific Route: Atwater Street -> St. Antione Street -> Jefferson Ave -> Ripolle Street.

Route length: 6,200 ft. (approx.)

Environment: Downtown urban area tall buildings and heavy traffic.

The received signal-level measurements from three local FM broadcast stations were measured along each route. The stations used for the measurements were 95.5 Mhz. (WKQI), 101.9 Mhz. (WDET), and 103.5 Mhz. (WMUZ). The criteria used to select these specific stations included:

a. Utilize commercial (i.e., non-educational) FM radio stations.

b. Utilize stations with operating frequencies in different portions of the FM band.

c. Utilize stations with transmitting towers located in different directions relative to the measurement locations.

To minimize the total measurement time-span, all three radio stations were measured at a given antenna height at the Dearborn test location. The antenna height was then changed and the measurements repeated This process continued until data was collected at the Dearborn location at the 4', 7', and 10' levels.

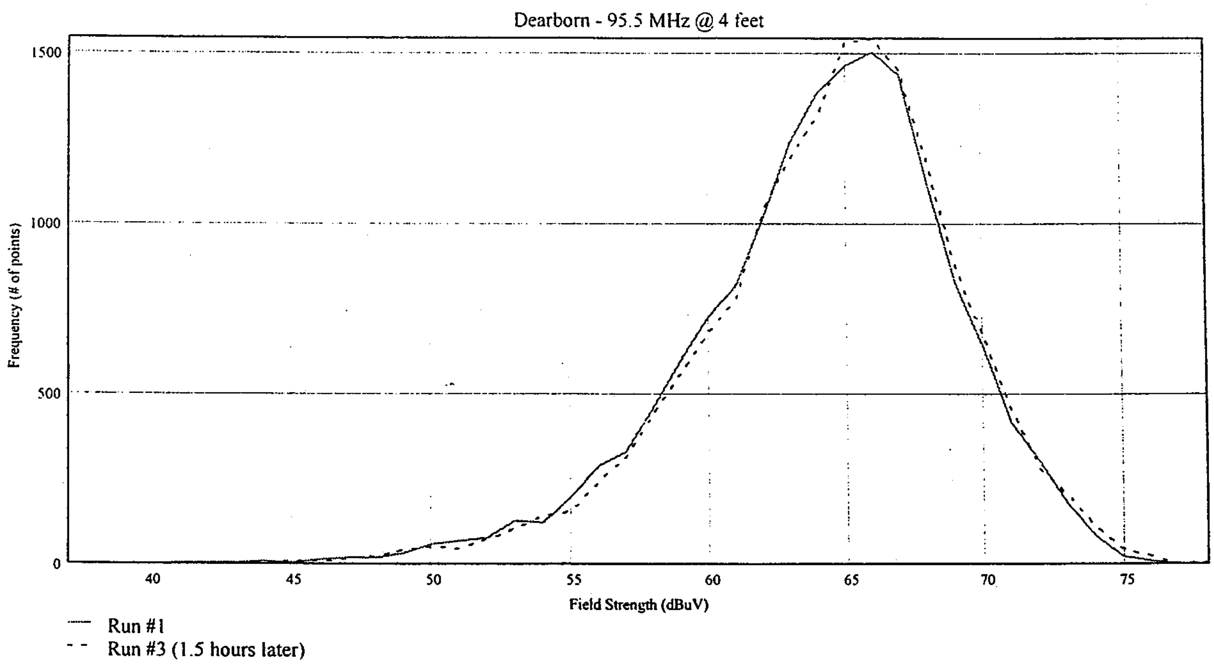
The same measurement procedure was later used to collect data at the Downtown Detroit test location.

Data Collection and Post Processing:

The Signal-Level vs. Distance data was post-processed to determine to fading probability distribution at the different locations. The raw data versus time can be found in *Appendix E.* Every test route and radio station was measured twice at each antenna height to insure repeatability. Probability distribution functions of each location's multiple runs can be seen in *Appendix F.*

Each data point from an individual measurement was grouped into a 1 dB. "bin". After assigning all the measurement data points, the total number of data points in each "bin" was counted and plotted. The Mean and Standard Deviation of the fading was then compared as a function of antenna height for each measurement. These can be found in *Appedix G.*

The measurement process repeatability was determined by re-measuring the 95.5 Mhz. station on the Dearborn test route at two different times (approx. 1.5 hours apart). The results are shown below:



Conclusions

The following are conclusions based on the measurement results:

1. The repeatability of the process used to measure signal fading vs. height has been demonstrated; temporal signal variations due to changing atmospheric propagation conditions did not significantly affect the measurement results.

2. Statistical differences in the signal fading characteristics have been observed with the EIA/NAB VHF Test Antenna mounted at different heights above ground. The magnitude of the differences varied somewhat as a function of the environment.

Throughout the test areas, changing the antenna height from 10' to 4' above ground resulted in an average Mean gain change of -4.8 dB. Additionally, the Standard Deviation increased by .5 dB.

AM (Terrestrial)

Tests Conducted

The specific characterization testing consisted of the following measurements:

	EIA/NAB AM Test Antenna	**1995 Taurus Power Antenna (ref. only)**
Gain / Directionality: "Off-the-Air" Signals	X	X

The "Off-the-Air" measurements utilized ambient broadcast signals to provide a relative indication of the performance of the antenna under test. The data is presented in the form of raw power (dBm) into the spectrum analyzer. All measurement were made with an active buffer amplifier, which presented the antenna with a 22 kOhm impedance, and matched to 50 Ohms at the spectrum analyzer. The AM IBOC antenna was tested with and without an additional 6 feet of RG-58 cable added to allow location of the buffer amplifier below the groundplane. During the testing, the AM IBOC antenna was mounted on the roof of an E150 van, to more closely correlate the mounting during the DAB testing. Polar plots of this data can be found in *Appendix H.*

Conclusions

The following are conclusions based on the measured results:

1. Comparing the results from the antenna under test with 6 feet of added cable (reasonable amount for a real application) to the 1995 Taurus, it can be seen that the AM IBOC antenna had an average gain 2 dB above the Taurus. This is consistent with the fact that the antenna under test was centered on the roof of a van, and was slightly longer that a standard vehicle whip antenna.

L-BAND (Terrestrial)

Tests Conducted

The DRRI Systems L-Band antenna (s/n 1001) was measured at an outdoor antenna test range. The raw data results can be found in *Appendix I.* All results were obtained by illuminating the antenna under test with a spin-linear transmit antenna. Gain measurement were first taken in the X-Z and Y-Z planes, then gain and ellipicity measurements were taken at elevations of 0, 20, and 40 degrees from horizon. All results are available in both polar and rectangular form.

Initially, a reference dipole was measured on the range, to provide a common reference point for all the data. A 0 dBi point is derived, and then marked on all subsequent plots.

The L-Band antenna was measured with the amplifier in-line and powered, at 1.468 GHz.

Conclusions

It can be seen from the data that the maximum gain appears to be approximately +27 dBi at an elevation of 30 degrees. The patterns are symmetrical at the various elevation cuts, and the deep nulls in the axial ratio indicate a vertically polarized antenna, as expected.

S-BAND (Satellite)

Tests Conducted

The Seavey Engineering Associates S-Band antenna model 9413-800 (s/n 001) was measured at an outdoor antenna test range. The raw data results can be found in *Appendix J.* All results were obtained by illuminating the antenna under test with a spin-linear transmit antenna. Gain measurement were first taken in the X-Z and Y-Z planes, then gain and ellipicity measurements were taken at elevations of 10, 25, 30, 50, and 80 degrees from horizon. All results are available in both polar and rectangular form.

Initially, a reference dipole was measured on the range, to provide a common reference point for all the data. A 0 dBi point is derived, and then marked on all subsequent plots.
The S-Band antenna was measured without ampliers or filters, at 2.01, 2.05, and 2.09 GHz

Conclusions

It can be seen from the data that the maximum gain appears to be approximately +5, +4, and +3 dBiL at an elevation of 25 degrees at the three frequencies. The patterns are symmetrical at the various elevation cuts, and the reduced nulls in the axial ratio indicate a circularly polarized antenna, as expected. The differences in gain (3 - 4 dB) between the Ford results and the Seavey Engineering results may be accounted for via the differences in illumination techniques (linear vs. circular).

APPENDIX A

DAR Field Test Project

Antenna Characterization Proposal

DAR Field Test Project Antenna Characterization

I. VHF (Terrestrial)

A. Antenna Description

1. 30" monopole on a 60" diameter groundplane. Antenna may be fed by a 50 Ω coaxial cable and located on a mounting plate affixed to the top of the test van.

B. Polarization

1. Lab testing may be conducted with a transmitted vertically polarized, horizontally polarized, and right hand circularly polarized continuous wave, created by a pair of crossed log-periodic dipole arrays, fed by a 90° phase shift hybrid. Transmit antenna is approximately 150 feet from the antenna under test, and is located 20 feet off the ground.
2. Field testing (multi-path) environment may be conducted using off the air FM broadcast signals, which are nominally right hand circular off the transmitting tower.

C. Gain

1. Measured with respect to a calibrated dipole, with the antenna under test located on the vehicle. Gain measured at 21 distinct frequencies from 87.9 MHz to 107.9 MHz. Data reported at each frequency may include Area Mean Gain (dB(dipole)), Standard Deviation (dB), and Minimum/Maximum Ratio (dB).

D. Radiation Pattern (azimuth)

1. Measured in 1 degree increments at each of the 21 test frequencies, and reported in the form of polar plots.

E. Impedance

1. Measured on the vehicle, at the end of the cable, before the signal enters the first device (attenuator/splitter) of the RF test bed. Results can be presented in the form of Complex Impedance (Smith Chart), Voltage Standing Wave Ratio, and Mismatch.

F. Multi-path Fading vs. Height

1. Traverse multi-path routes with antenna at various heights. Antenna under test may be located on a trailer with a lift mechanism. Test limits may be bounded by nominal passenger vehicle installation height at the lowest, and test van installation height at the highest.
2. Collect field strength (dBμV/m) vs. distance. Measurements are taken every 8 inches (approximately) and data runs may extend from 1000 to 10000 feet. Test routes may be repeated with antenna under test at various heights.
3. Use statistical analysis to quantify the effect of height
   a) Comparison of field strength temporal data. Results can be plotted together to indicate gross correlation of the data, and to show any problems with the tests (equipment failures, loss of transmit material).
   b) Comparison of field strength probability density function. Data may be grouped in 1 dBμV/m cells, and multiple runs plotted together for comparison. Means and standard deviations of the various runs may be calculated.
   c) Calculation of maximum deviation (as a percentage of total data points) vs. field strength. Data may also be presented as an average maximum deviation for an entire test.
4. To be reviewed by NRSC/EIA/NAB and proponents

II. L-Band (Terrestrial) - 1.468 GHz

A. Antenna Description

1. Radome enclosed w/ LNA. Antenna may be fed by a 50 Ω coaxial cable and located on a mounting plate affixed to the top of the test van.

- B. Polarization
  1. Lab testing may be conducted using a dipole with a 3 foot parabolic reflector, with spin linear polarization.
- C. Gain
  1. Measured with respect to a calibrated dipole over a ground plane
- D. Radiation Pattern (azimuth and elevation)
  1. Azimuth radiation pattern cuts may be taken at elevations of 0, 20, and 40 degrees over the horizon. Nominal gain and ellipticity may also be reported at these orientations
  2. Elevation cuts may be taken in the XZ and YZ planes
- E. Multi-path Fading vs. Height
  1. Characteristic will not be measured
     - a) Lack of availability of representative environment
     - b) Minimal vehicular affect @ top of mounting plate

III. S-Band (Satellite) - 2.01 GHz to 2.09 GHz

- A. Antenna Description
  1. Bi-filar spiral monopole, pylon
- B. Polarization
  1. Lab testing may be conducted using a dipole with a 3 foot parabolic reflector, with spin linear polarization.
- C. Gain
  1. Measured with respect to a calibrated dipole over a ground plane
- D. Radiation Pattern (azimuth and elevation)
  1. Azimuth radiation pattern cuts may be taken at elevations of 10, 30, 50, and 80 degrees over the horizon, at 3 distinct frequencies spaced 40 MHz apart. Nominal gain and ellipticity may also be reported at these orientations
  2. Elevation cuts may be taken in the XZ and YZ planes at all three frequencies. Maximum gain at zenith and 10 dB beamwidths may also be reported at these orientations.
- E. Multi-path Fading vs. Height
  1. Characteristic will not be measured
     - a) Lack of availability of representative environment
     - b) Minimal vehicular affect @ top of mounting plate

IV. Required Hardware

- A. Spectrum Analyzer / Receiver
  1. Rhode & Schwarz ESVP
  2. Anritsu MS2601A
- B. Transmitter / Tracking Generator
  1. Anritsu MH680B
- C. Transmit Antennas
  1. Log-periodic dipole array (VHF)
  2. 3' parabolic dish with dipole (L-band)
  3. 3' parabolic dish with dipole (S-band)
- D. Calibrated Antennas
  1. Dipoles over ground planes
- E. Network Analyzer
  1. HP8753C (to 6 GHz)
- F. Towable Trailer and Hitch
- G. Adjustable Lift Mechanism

V. Testing Locations

- A. JEF (outdoor antenna range)
- B. Dearborn / Detroit (urban multi-path environment)

C. NASA LeRC (urban multi-path environment)

VI. Concerns / Issues

A. Average Power vs. Selective Fading

1. Function of receiver bandwidth

B. Diversity Implementation

1. Not to be tested

C. Timing

APPENDIX B

VHF Antenna Gain Characterization Using Lab-generated Test Signal
1995 Taurus Power Antenna
and
EIA/NAB VHF Test Antenna

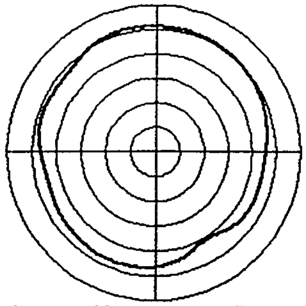
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....09:47:43 PATTERN.....001

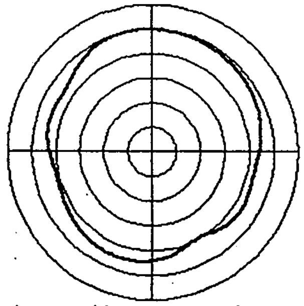
REF = 10dBd FRONT=0 10 dB/DIV

87.9 MHz



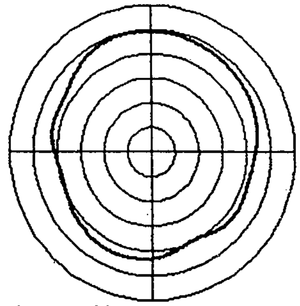
Area Mean = -2
Std dB Dev= 2.7
M/M Ratio = 10.3

89.5 MHz



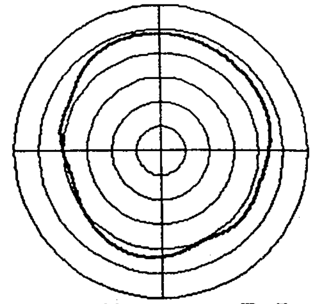
Area Mean = -4
Std dB Dev= 3.1
M/M Ratio = 9.9

90.3 MHz



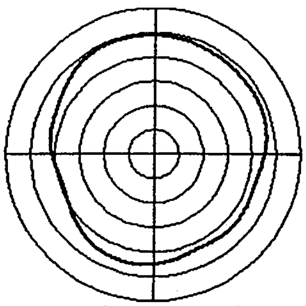
Area Mean = -4.8
Std dB Dev= 3.1
M/M Ratio = 9.9

91.3 MHz



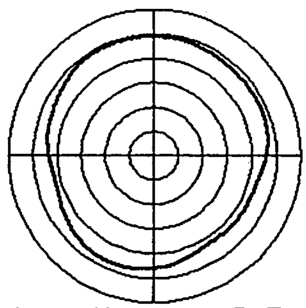
Area Mean = -5.3
Std dB Dev= 3
M/M Ratio = 10.4

92.1 MHz



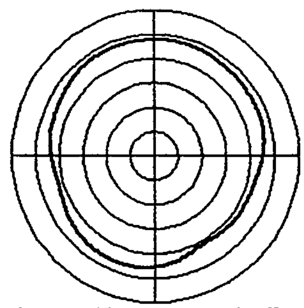
Area Mean = -4.2
Std dB Dev= 2.9
M/M Ratio = 10.1

93.5 MHz



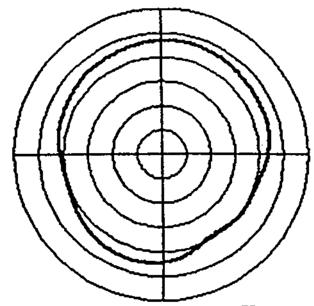
Area Mean = -3.5
Std dB Dev= 2.3
M/M Ratio = 7

94.3 MHz



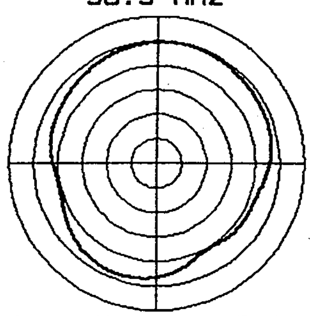
Area Mean = -4.3
Std dB Dev= 2
M/M Ratio = 6.3

95.1 MHz



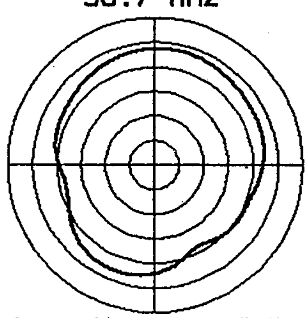
Area Mean = -5.8
Std dB Dev= 2.3
M/M Ratio = 8.1

95.9 MHz



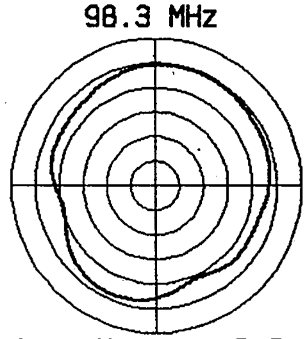
Area Mean = -3.6
Std dB Dev= 2.9
M/M Ratio = 9.3

96.7 MHz



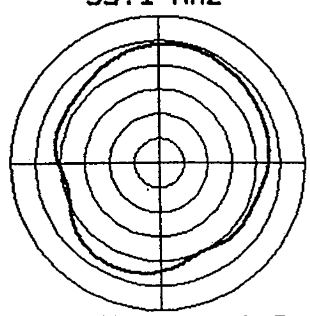
Area Mean = -5.7
Std dB Dev= 3.2
M/M Ratio = 10.5

98.3 MHz



Area Mean = -3.6
Std dB Dev= 2.8
M/M Ratio = 10.4

99.1 MHz



Area Mean = -4.9
Std dB Dev= 2.9
M/M Ratio = 10.6

Mean of Ind. Area Means...-4.1 dBd
Std dB Dev of Area Means.. 1.1 dB

Mean of Ind. MM Ratios.... 10.1 dB
Std dB Dev of M/M Ratios.. 1.5 dB
Mean of Ind Std dB Dev's.. 2.7 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...VERTICAL
Range..........150 Ft.

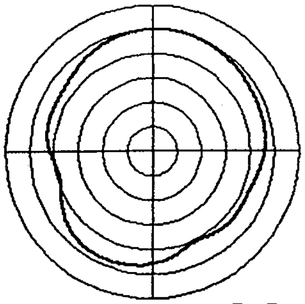
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....09:47:43   PATTERN.....001

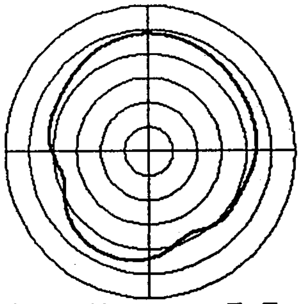
REF = 10dBd   FRONT=0   10 dB/DIV

99.9 MHz



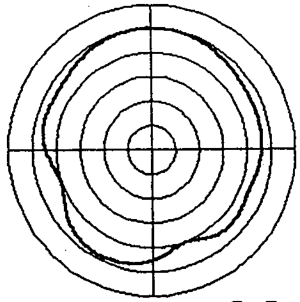
Area Mean = -3.6
Std dB Dev= 3.1
M/M Ratio = 11.3

100.7 MHz



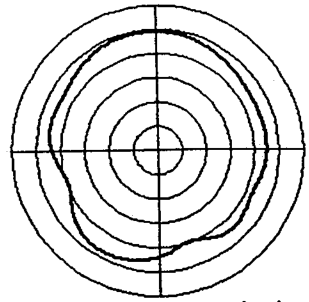
Area Mean = -5.5
Std dB Dev= 3.1
M/M Ratio = 11.2

102.3 MHz



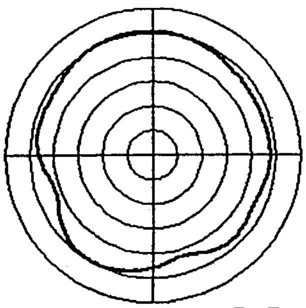
Area Mean = -3.3
Std dB Dev= 2.6
M/M Ratio = 10.1

103.3 MHz



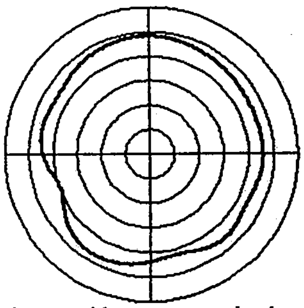
Area Mean = -4.4
Std dB Dev= 2.5
M/M Ratio = 9.8

103.9 MHz



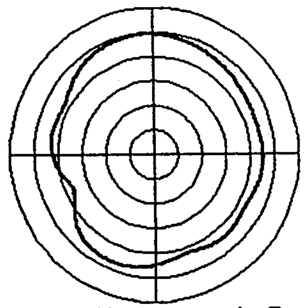
Area Mean = -2.2
Std dB Dev= 2.2
M/M Ratio = 9.1

104.9 MHz



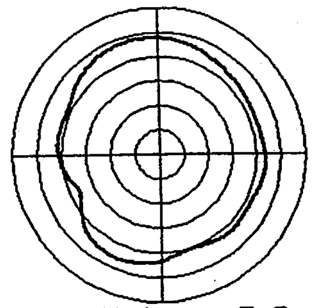
Area Mean = -4.4
Std dB Dev= 2
M/M Ratio = 8.9

106.3 MHz



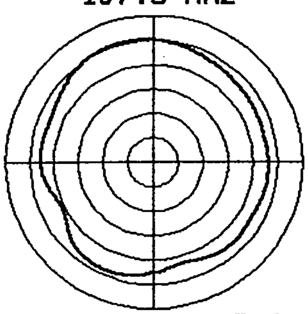
Area Mean = -4.6
Std dB Dev= 2.9
M/M Ratio = 12.8

106.9 MHz



Area Mean = -5.9
Std dB Dev= 2.7
M/M Ratio = 12.1

107.9 MHz



Area Mean = -3.1
Std dB Dev= 2.2
M/M Ratio = 9.5

Mean of Ind. Area Means...-4.1 dBd
Std dB Dev of Area Means.. 1.1 dB

Mean of Ind. MM Ratios.... 10.1 dB
Std dB Dev of M/M Ratios.. 1.5 dB
Mean of Ind Std dB Dev's.. 2.7 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...VERTICAL
Range..........150 Ft.

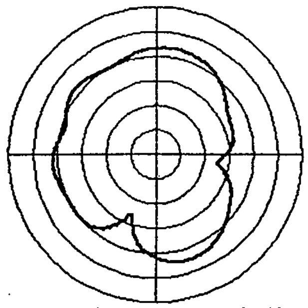
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....09:52:40   PATTERN.....002

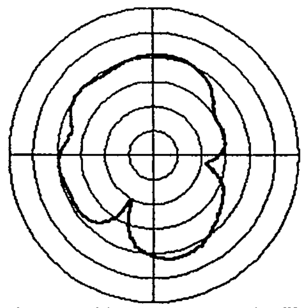
REF = 10dBd   FRONT=0   10 dB/DIV

87.9 MHz



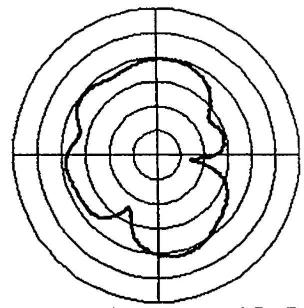
Area Mean = -9.5
Std dB Dev= 5
M/M Ratio = 19.5

89.5 MHz



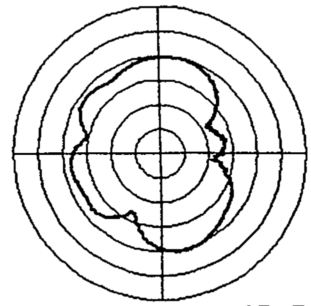
Area Mean = -11.7
Std dB Dev= 5.3
M/M Ratio = 23.2

90.3 MHz



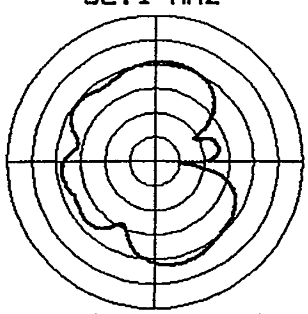
Area Mean = -12.9
Std dB Dev= 5.7
M/M Ratio = 27.7

91.3 MHz



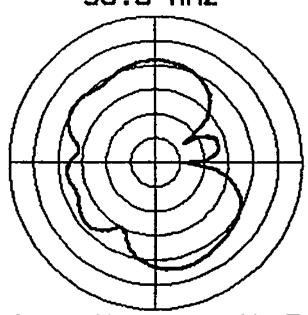
Area Mean = -13.6
Std dB Dev= 5.2
M/M Ratio = 19.1

92.1 MHz



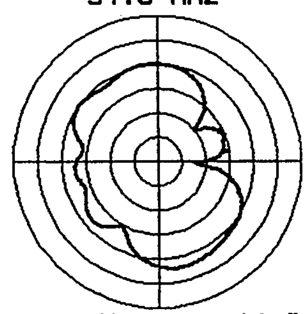
Area Mean = -11.9
Std dB Dev= 6.8
M/M Ratio = 33.2

93.5 MHz



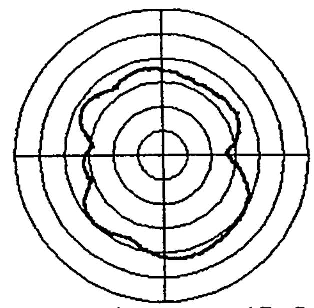
Area Mean = -10.7
Std dB Dev= 7.3
M/M Ratio = 33.3

94.3 MHz



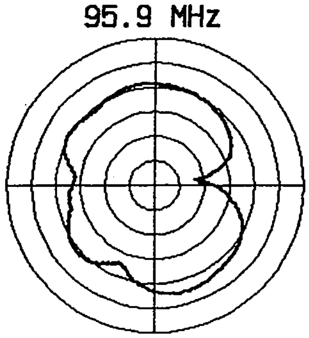
Area Mean = -11.3
Std dB Dev= 6.7
M/M Ratio = 29.7

95.1 MHz



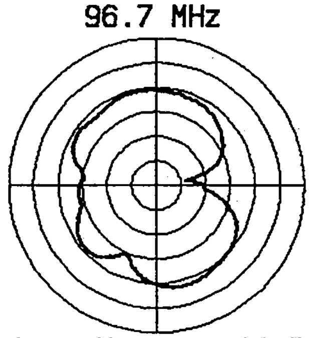
Area Mean = -12.2
Std dB Dev= 4.4
M/M Ratio = 17

95.9 MHz



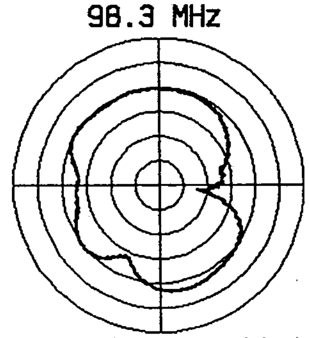
Area Mean = -10
Std dB Dev= 5.6
M/M Ratio = 28.8

96.7 MHz



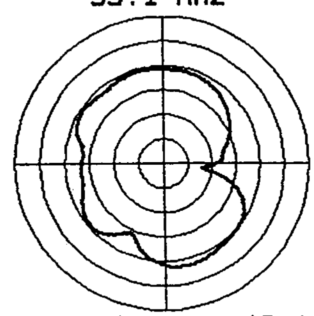
Area Mean = -12.6
Std dB Dev= 6.4
M/M Ratio = 30.3

98.3 MHz



Area Mean = -11.1
Std dB Dev= 5.5
M/M Ratio = 28.1

99.1 MHz



Area Mean = -12.1
Std dB Dev= 5.6
M/M Ratio = 27.3

Mean of Ind. Area Means...-12 dBd
Std dB Dev of Area Means.. 1.5 dB

Mean of Ind. MM Ratios.... 27 dB
Std dB Dev of M/M Ratios.. 6.1 dB
Mean of Ind Std dB Dev's.. 5.4 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...HORIZONTAL
Range..........150 Ft.

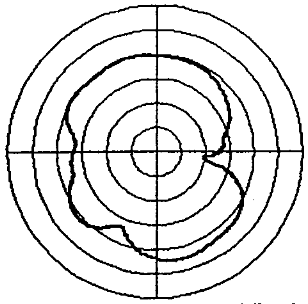
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....09:52:40 PATTERN.....002

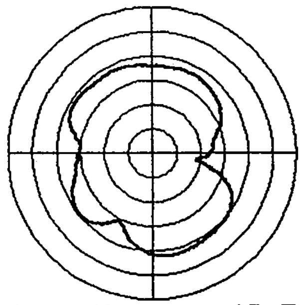
REF = 10dBd FRONT=0 10 dB/DIV

99.9 MHz



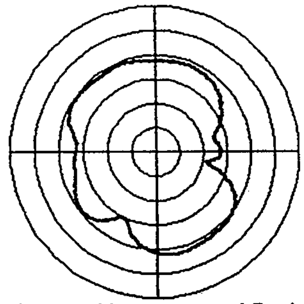
Area Mean = -10.1
Std dB Dev= 5.5
M/M Ratio = 25.6

100.7 MHz



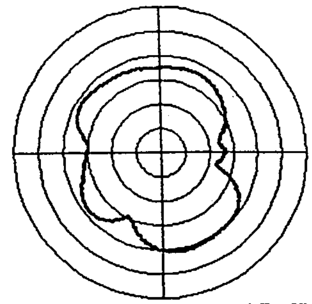
Area Mean = -12.5
Std dB Dev= 5.3
M/M Ratio = 24

102.3 MHz



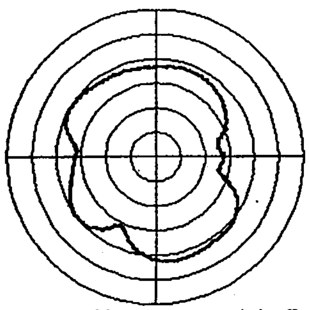
Area Mean = -12.1
Std dB Dev= 5
M/M Ratio = 21

103.3 MHz



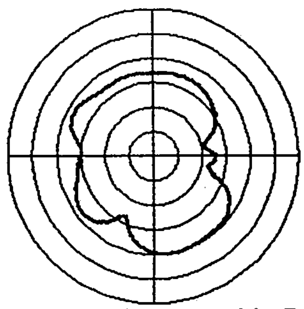
Area Mean = -13.5
Std dB Dev= 4.8
M/M Ratio = 18.4

103.9 MHz



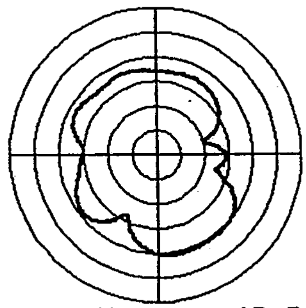
Area Mean = -11.9
Std dB Dev= 4.7
M/M Ratio = 17.7

104.9 MHz



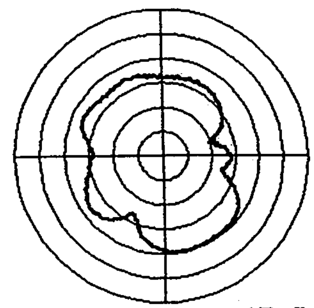
Area Mean = -14.6
Std dB Dev= 4.9
M/M Ratio = 19.9

106.3 MHz



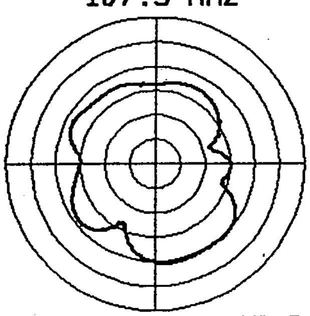
Area Mean = -13.6
Std dB Dev= 5
M/M Ratio = 21.3

106.9 MHz



Area Mean = -15.3
Std dB Dev= 4.7
M/M Ratio = 20.2

107.9 MHz



Area Mean = -13.8
Std dB Dev= 4.6
M/M Ratio = 18.9

Mean of Ind. Area Means...-12 dBd
Std dB Dev of Area Means.. 1.5 dB

Mean of Ind. MM Ratios.... 27 dB
Std dB Dev of M/M Ratios.. 6.1 dB
Mean of Ind Std dB Dev's.. 5.4 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...HORIZONTAL
Range..........150 Ft.

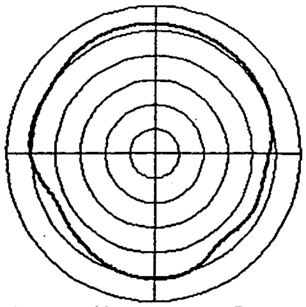
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....09:57:39   PATTERN.....003

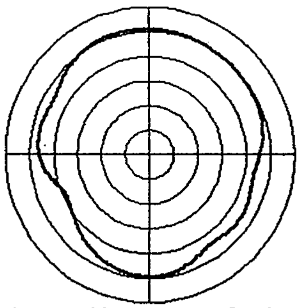
REF = 10dBd   FRONT=0   10 dB/DIV

87.9 MHz



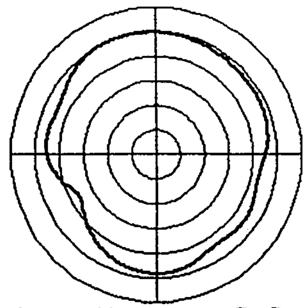
Area Mean = 0
Std dB Dev= 2.7
M/M Ratio = 8.8

89.5 MHz



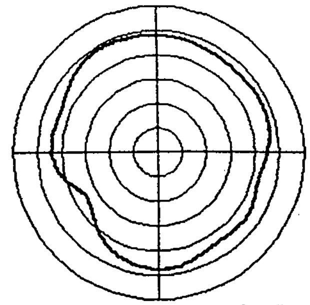
Area Mean = -2.1
Std dB Dev= 3.3
M/M Ratio = 12.7

90.3 MHz



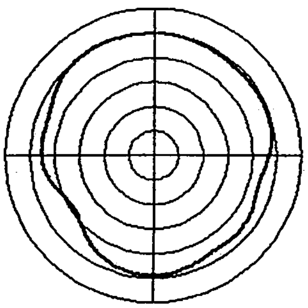
Area Mean = -3.2
Std dB Dev= 3.4
M/M Ratio = 14

91.3 MHz



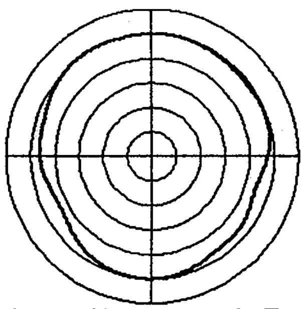
Area Mean = -4.2
Std dB Dev= 3.4
M/M Ratio = 13.9

92.1 MHz



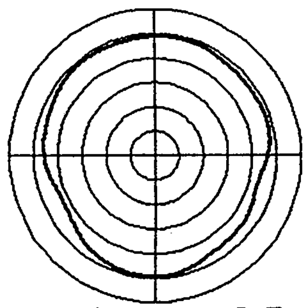
Area Mean = -2.4
Std dB Dev= 3
M/M Ratio = 11.7

93.5 MHz



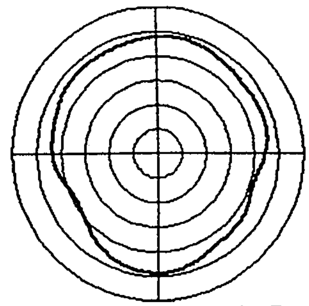
Area Mean = -1.7
Std dB Dev= 2.1
M/M Ratio = 7.4

94.3 MHz



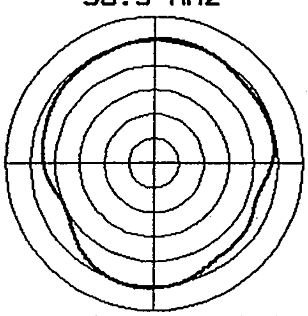
Area Mean = -2.7
Std dB Dev= 2
M/M Ratio = 7.7

95.1 MHz



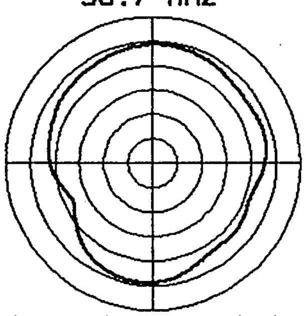
Area Mean = -4.2
Std dB Dev= 2.6
M/M Ratio = 10.6

95.9 MHz



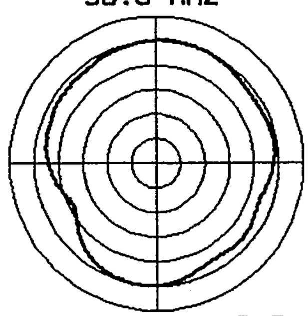
Area Mean = -1.7
Std dB Dev= 3
M/M Ratio = 11.5

96.7 MHz



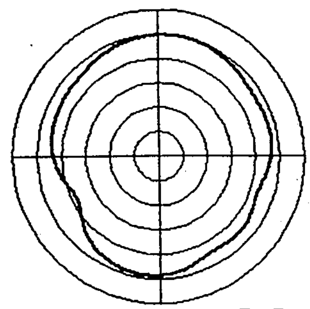
Area Mean = -4.1
Std dB Dev= 3.2
M/M Ratio = 13.1

98.3 MHz



Area Mean = -2.3
Std dB Dev= 3
M/M Ratio = 12.5

99.1 MHz



Area Mean = -3.3
Std dB Dev= 2.9
M/M Ratio = 12.2

Mean of Ind. Area Means...-2.6 dBd
Std dB Dev of Area Means.. 1.1 dB

Mean of Ind. MM Ratios.... 12.9 dB
Std dB Dev of M/M Ratios.. 2.4 dB
Mean of Ind Std dB Dev's.. 2.9 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...RIGHT CIRCULAR
Range..........150 Ft.

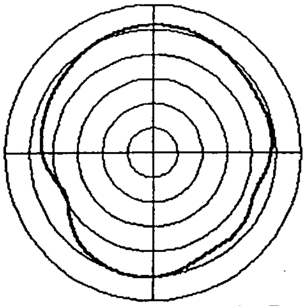
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....09:57:39   PATTERN.....003

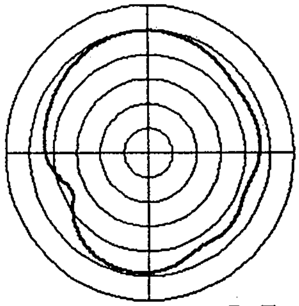
REF = 10dBd   FRONT=0   10 dB/DIV

99.9 MHz



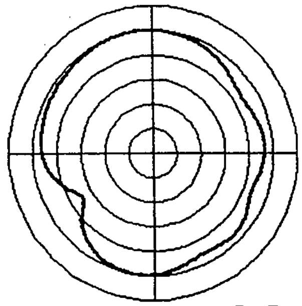
Area Mean = -1.6
Std dB Dev= 3.2
M/M Ratio = 13

100.7 MHz



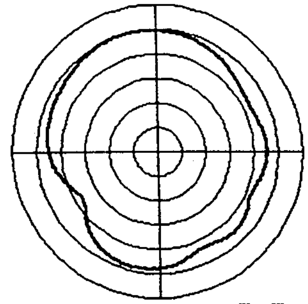
Area Mean = -3.5
Std dB Dev= 3.2
M/M Ratio = 14

102.3 MHz



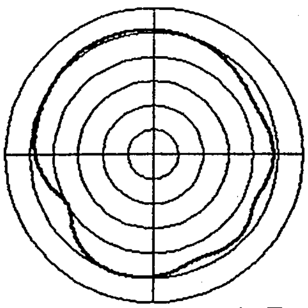
Area Mean = -2.8
Std dB Dev= 3.4
M/M Ratio = 15.8

103.3 MHz



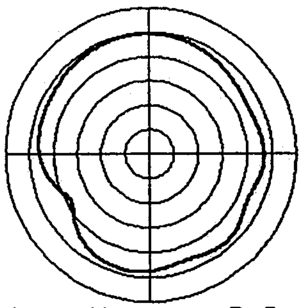
Area Mean = -3.7
Std dB Dev= 3
M/M Ratio = 12.9

103.9 MHz



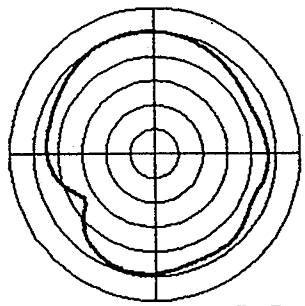
Area Mean = -1.5
Std dB Dev= 2.7
M/M Ratio = 11.7

104.9 MHz



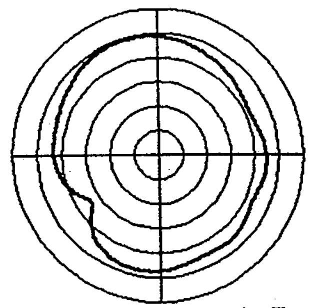
Area Mean = -3.2
Std dB Dev= 2.5
M/M Ratio = 11.7

106.3 MHz



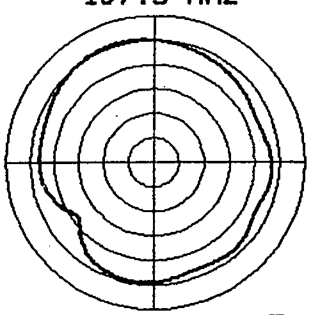
Area Mean = -2.8
Std dB Dev= 3.4
M/M Ratio = 16.3

106.9 MHz



Area Mean = -4.5
Std dB Dev= 3.2
M/M Ratio = 14.9

107.9 MHz



Area Mean = -2.5
Std dB Dev= 2.7
M/M Ratio = 13.4

Mean of Ind. Area Means...-2.6 dBd
Std dB Dev of Area Means.. 1.1 dB

Mean of Ind. MM Ratios.... 12.9 dB
Std dB Dev of M/M Ratios.. 2.4 dB
Mean of Ind Std dB Dev's.. 2.9 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...RIGHT CIRCULAR
Range..........150 Ft.

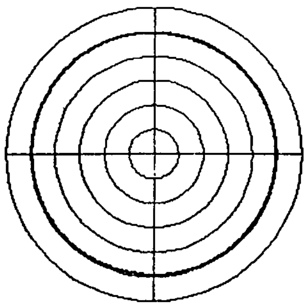
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10:40:45 PATTERN.....006

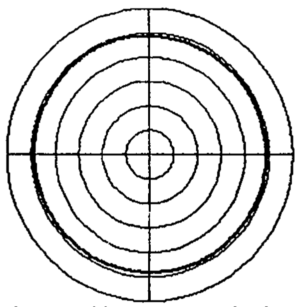
REF = 10dBd FRONT=0 10 dB/DIV

87.9 MHz



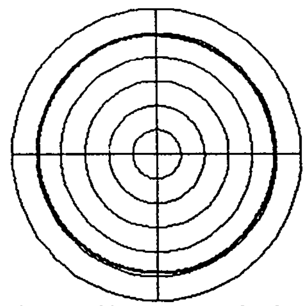
Area Mean = -.5
Std dB Dev= .2
M/M Ratio = .7

89.5 MHz



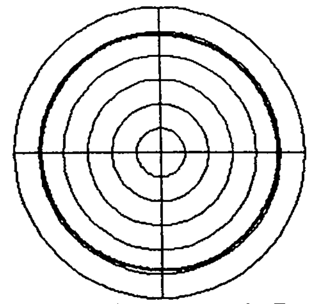
Area Mean = -1.4
Std dB Dev= .2
M/M Ratio = 1

90.3 MHz



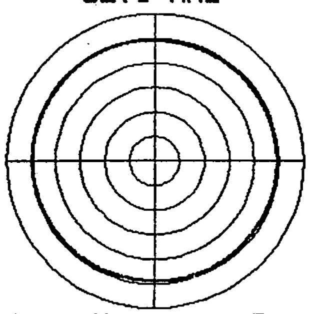
Area Mean = -1.1
Std dB Dev= .2
M/M Ratio = 1

91.3 MHz



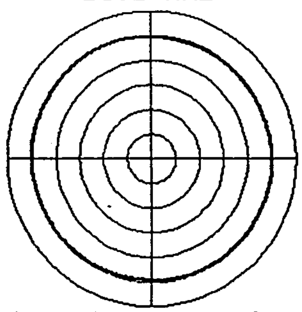
Area Mean = -1.2
Std dB Dev= .2
M/M Ratio = 1

92.1 MHz



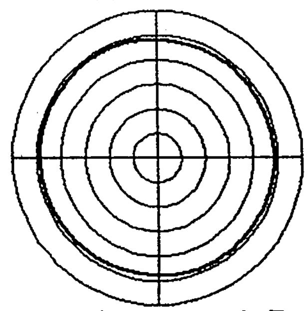
Area Mean = -.8
Std dB Dev= .2
M/M Ratio = .9

93.5 MHz



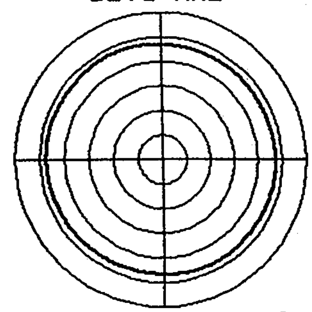
Area Mean = -.3
Std dB Dev= .2
M/M Ratio = 1.1

94.3 MHz



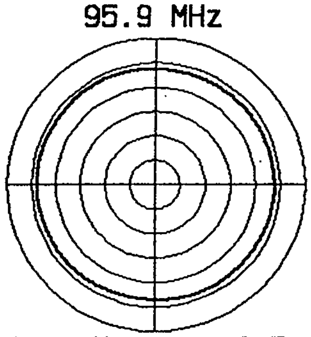
Area Mean = -1.7
Std dB Dev= .3
M/M Ratio = 1.1

95.1 MHz



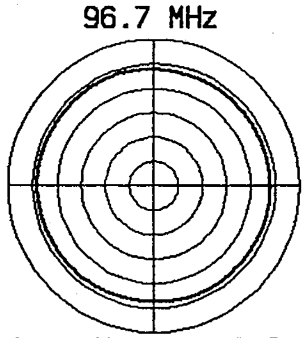
Area Mean = -2.9
Std dB Dev= .2
M/M Ratio = 1.1

95.9 MHz



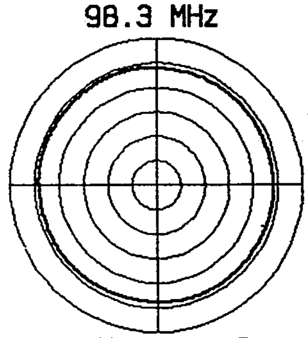
Area Mean = -2.5
Std dB Dev= .2
M/M Ratio = .9

96.7 MHz



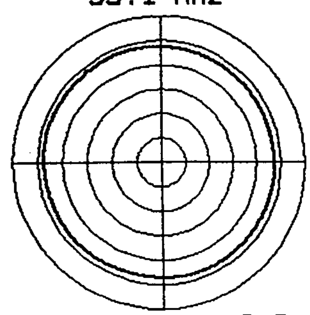
Area Mean = -2.2
Std dB Dev= .2
M/M Ratio = .9

98.3 MHz



Area Mean = -2
Std dB Dev= .2
M/M Ratio = 1

99.1 MHz



Area Mean = -2.6
Std dB Dev= .2
M/M Ratio = .8

Mean of Ind. Area Means...-1.9 dBd
Std dB Dev of Area Means.. 1 dB

Mean of Ind. MM Ratios.... 1 dB
Std dB Dev of M/M Ratios.. .2 dB
Mean of Ind Std dB Dev's.. .2 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number...... FM IBOC
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...VERTICAL
Range..........150 Ft.

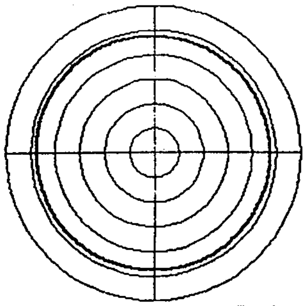
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10:40:45 PATTERN.....006

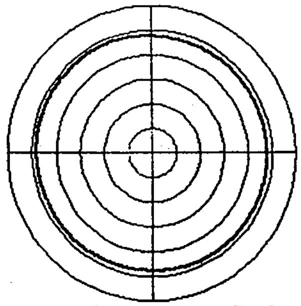
REF = 10dBd FRONT=0 10 dB/DIV

99.9 MHz



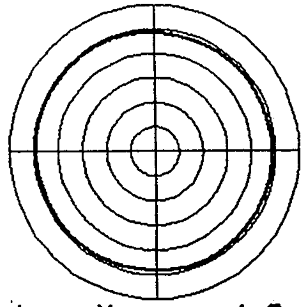
Area Mean = -2.4
Std dB Dev= .2
M/M Ratio = .8

100.7 MHz



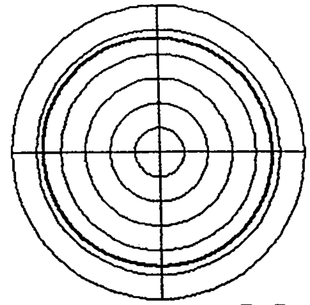
Area Mean = -2.1
Std dB Dev= .2
M/M Ratio = 1

102.3 MHz



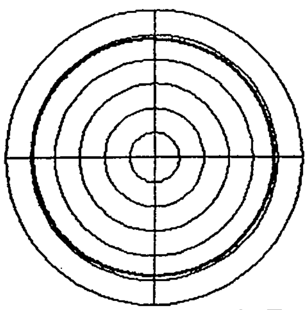
Area Mean = -1.3
Std dB Dev= .3
M/M Ratio = 1.2

103.3 MHz



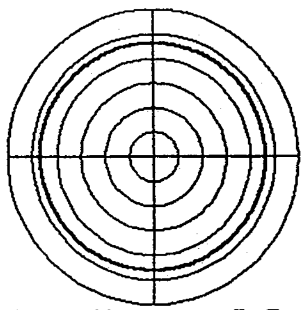
Area Mean = -3.2
Std dB Dev= .2
M/M Ratio = 1.2

103.9 MHz



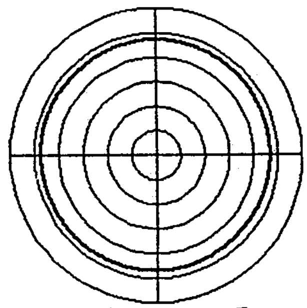
Area Mean = -1.5
Std dB Dev= .3
M/M Ratio = 1.4

104.9 MHz



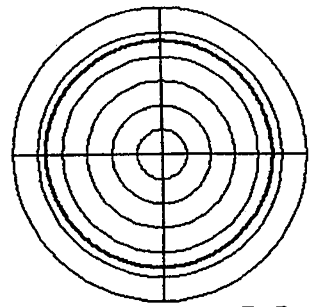
Area Mean = -3.6
Std dB Dev= .2
M/M Ratio = .9

106.3 MHz



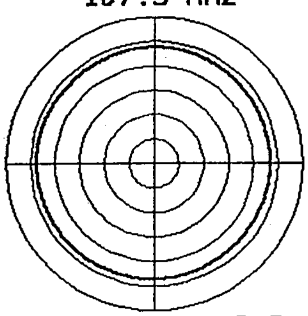
Area Mean = -3
Std dB Dev= .2
M/M Ratio = .8

106.9 MHz



Area Mean = -3.8
Std dB Dev= .2
M/M Ratio = .9

107.9 MHz



Area Mean = -2.8
Std dB Dev= .2
M/M Ratio = .9

Mean of Ind. Area Means...-1.9 dBd
Std dB Dev of Area Means.. 1 dB

Mean of Ind. MM Ratios.... 1 dB
Std dB Dev of M/M Ratios.. .2 dB
Mean of Ind Std dB Dev's.. .2 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number......
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...VERTICAL
Range..........150 Ft.

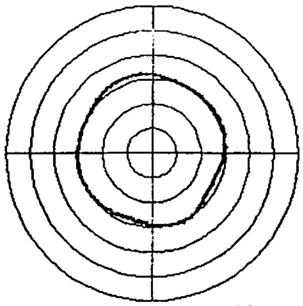
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....10: 45: 19   PATTERN.:...007

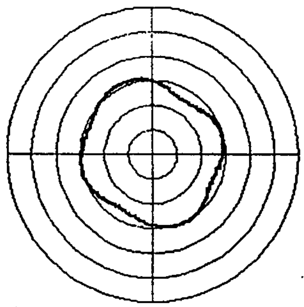
REF = 10dBd   FRONT=0   10 dB/DIV

87.9 MHz



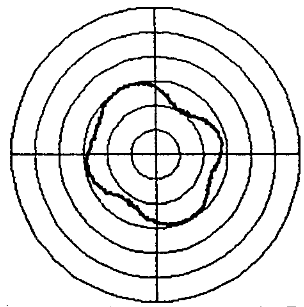
Area Mean = -19.9
Std dB Dev= 1.2
M/M Ratio = 4.8

89.5 MHz



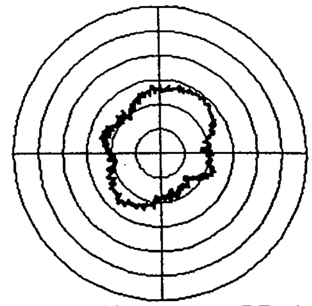
Area Mean = -21.1
Std dB Dev= 1.7
M/M Ratio = 6.3

90.3 MHz



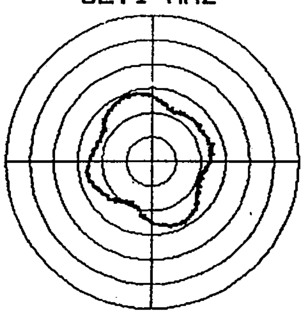
Area Mean = -22.9
Std dB Dev= 2.7
M/M Ratio = 10.6

91.3 MHz



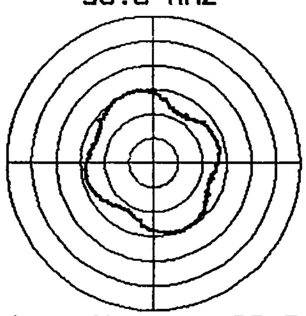
Area Mean = -26.4
Std dB Dev= 3.6
M/M Ratio = 14.7

92.1 MHz



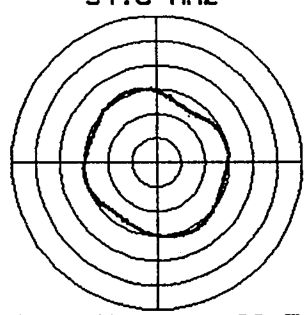
Area Mean = -25.1
Std dB Dev= 2.4
M/M Ratio = 10.1

93.5 MHz



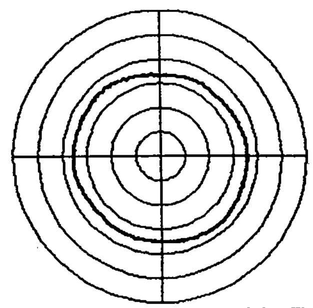
Area Mean = -22.9
Std dB Dev= 2.3
M/M Ratio = 8.4

94.3 MHz



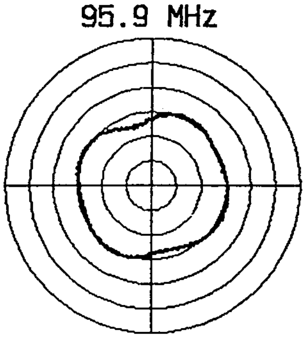
Area Mean = -20.7
Std dB Dev= 1.8
M/M Ratio = 7.4

95.1 MHz



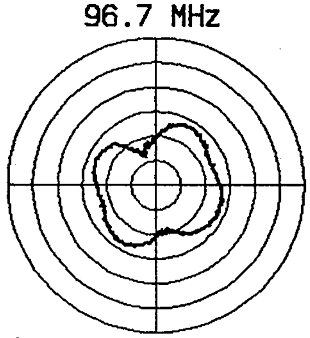
Area Mean = -14.7
Std dB Dev= 1
M/M Ratio = 4.1

95.9 MHz



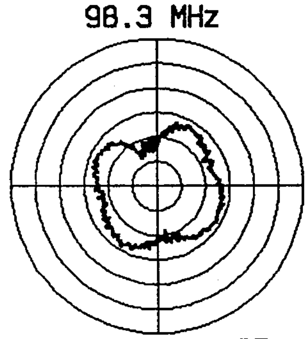
Area Mean = -20.4
Std dB Dev= 1.7
M/M Ratio = 8

96.7 MHz



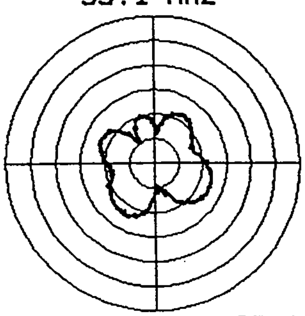
Area Mean = -25.2
Std dB Dev= 3.7
M/M Ratio = 16.3

98.3 MHz



Area Mean = -25
Std dB Dev= 3.4
M/M Ratio = 16.1

99.1 MHz



Area Mean = -29.1
Std dB Dev= 4
M/M Ratio = 16.1

Mean of Ind. Area Means...-23 dBd
Std dB Dev of Area Means.. 4.9 dB

Mean of Ind. MM Ratios.... 15.7 dB
Std dB Dev of M/M Ratios.. 5.8 dB
Mean of Ind Std dB Dev's.. 3 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number......
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...HORIZONTAL
Range..........150 Ft.

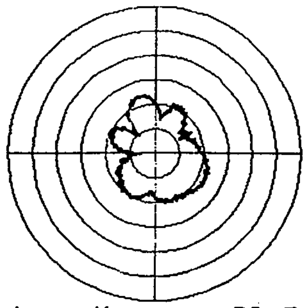
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10: 45: 19 PATTERN.....007

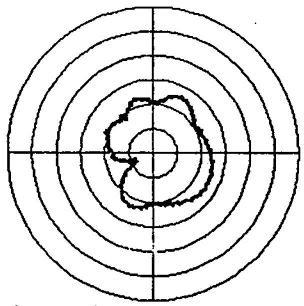
REF = 10dBd FRONT=0 10 dB/DIV

99.9 MHz



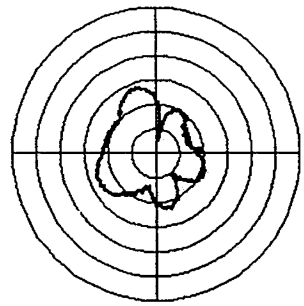
Area Mean = -30.6
Std dB Dev= 3.7
M/M Ratio = 18

100.7 MHz



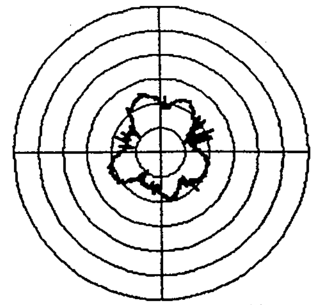
Area Mean = -27.7
Std dB Dev= 4.1
M/M Ratio = 18.8

102.3 MHz



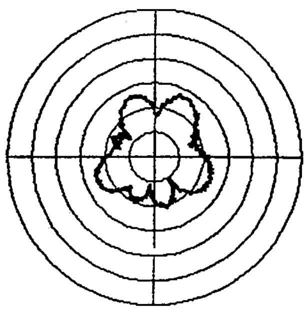
Area Mean = -28.3
Std dB Dev= 4.4
M/M Ratio = 22.6

103.3 MHz



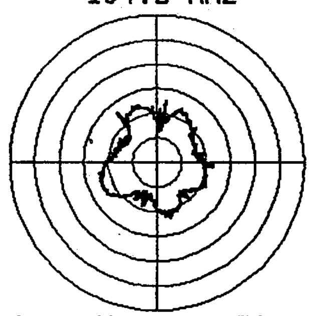
Area Mean = -30.9
Std dB Dev= 3.6
M/M Ratio = 15.2

103.9 MHz



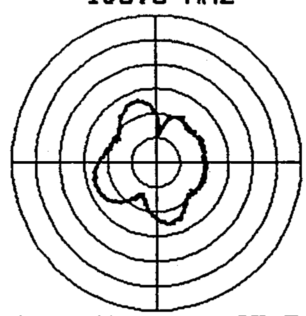
Area Mean = -28.2
Std dB Dev= 3.8
M/M Ratio = 16.1

104.9 MHz



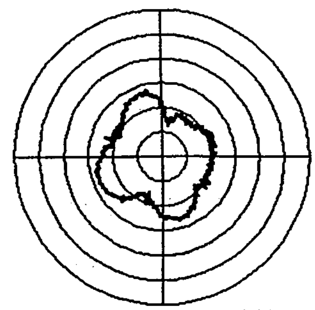
Area Mean = -30
Std dB Dev= 3
M/M Ratio = 12.7

106.3 MHz



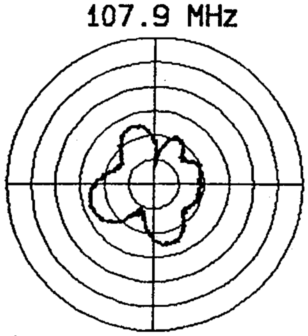
Area Mean = -27.7
Std dB Dev= 3.2
M/M Ratio = 15

106.9 MHz



Area Mean = -27
Std dB Dev= 3.5
M/M Ratio = 14.6

107.9 MHz



Area Mean = -28.5
Std dB Dev= 4.3
M/M Ratio = 20

Mean of Ind. Area Means...-23 dBd
Std dB Dev of Area Means.. 4.9 dB

Mean of Ind. MM Ratios.... 15.7 dB
Std dB Dev of M/M Ratios.. 5.8 dB
Mean of Ind Std dB Dev's.. 3 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number......
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...HORIZONTAL
Range..........150 Ft.

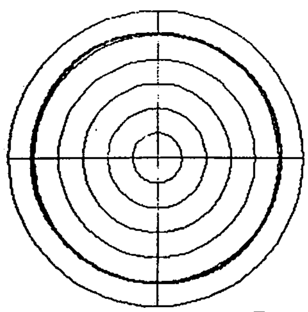
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10:49:45 PATTERN.....008

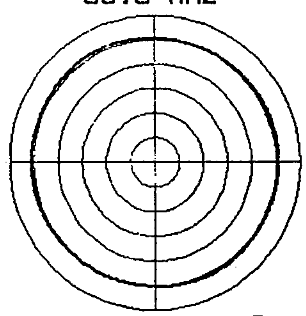
REF = 10dBd FRONT=0 10 dB/DIV

87.9 MHz



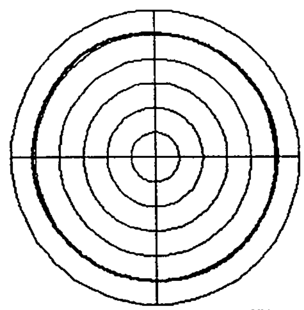
Area Mean = .9
Std dB Dev= .3
M/M Ratio = 1

89.5 MHz



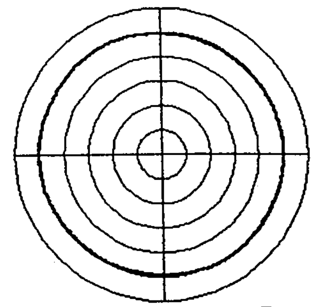
Area Mean = .8
Std dB Dev= .3
M/M Ratio = 1.1

90.3 MHz



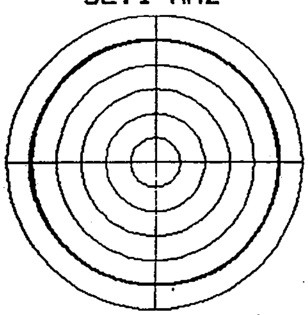
Area Mean = .7
Std dB Dev= .3
M/M Ratio = 1.2

91.3 MHz



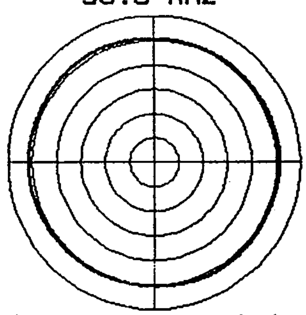
Area Mean = -.3
Std dB Dev= .3
M/M Ratio = 1.2

92.1 MHz



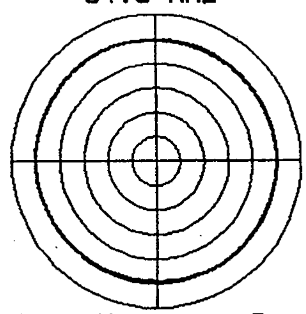
Area Mean = .4
Std dB Dev= .3
M/M Ratio = 1

93.5 MHz



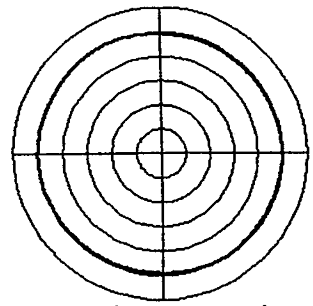
Area Mean = 1.1
Std dB Dev= .3
M/M Ratio = 1.2

94.3 MHz



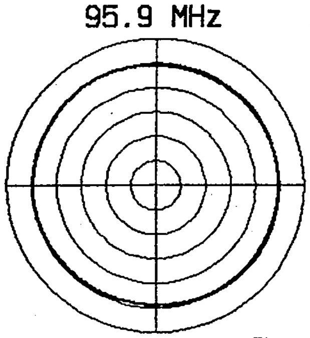
Area Mean = -.3
Std dB Dev= .3
M/M Ratio = 1.2

95.1 MHz



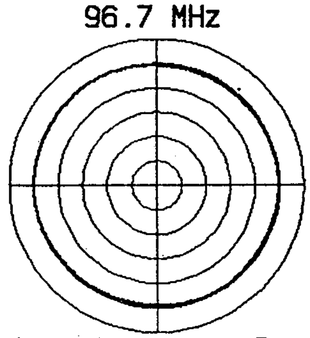
Area Mean = -.4
Std dB Dev= .3
M/M Ratio = 1.3

95.9 MHz



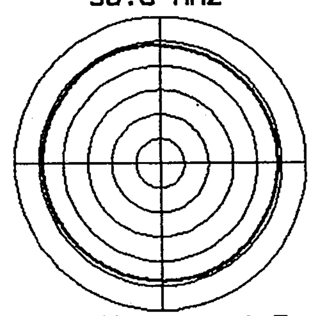
Area Mean = -.7
Std dB Dev= .3
M/M Ratio = 1.1

96.7 MHz



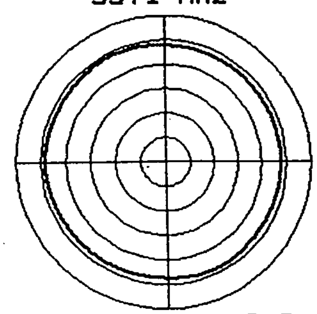
Area Mean = -.6
Std dB Dev= .3
M/M Ratio = 1.2

98.3 MHz



Area Mean = -1.7
Std dB Dev= .3
M/M Ratio = 1.1

99.1 MHz



Area Mean = -2.2
Std dB Dev= .2
M/M Ratio = .9

Mean of Ind. Area Means...-.8 dBd
Std dB Dev of Area Means.. 1.4 dB

Mean of Ind. MM Ratios.... 1.2 dB
Std dB Dev of M/M Ratios.. .2 dB
Mean of Ind Std dB Dev's.. .3 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number......
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...RIGHT CIRCULAR
Range..........150 Ft.

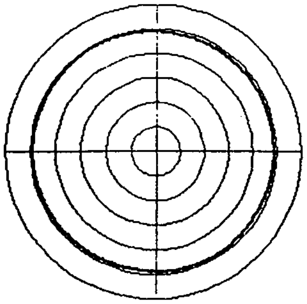
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10:49:45 PATTERN.....008

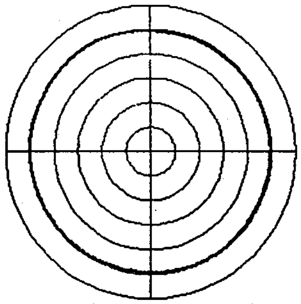
REF = 10dBd FRONT=0 10 dB/DIV

99.9 MHz



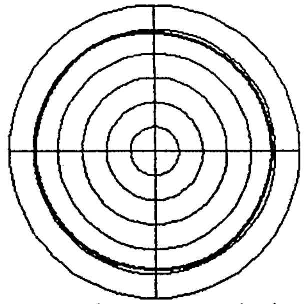
Area Mean = -1.2
Std dB Dev= .2
M/M Ratio = .8

100.7 MHz



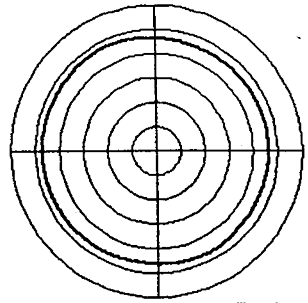
Area Mean = -.4
Std dB Dev= .2
M/M Ratio = .8

102.3 MHz



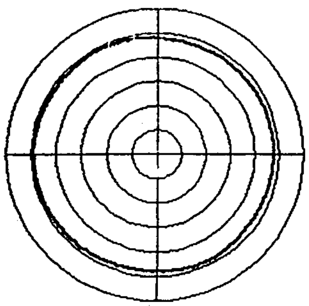
Area Mean = -1.4
Std dB Dev= .3
M/M Ratio = 1.2

103.3 MHz



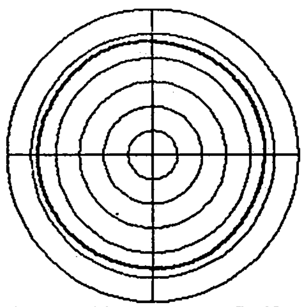
Area Mean = -3.4
Std dB Dev= .3
M/M Ratio = 1.3

103.9 MHz



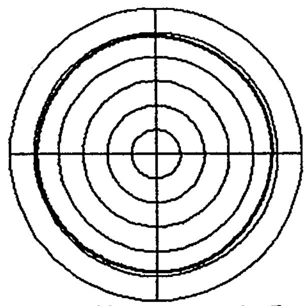
Area Mean = -1.8
Std dB Dev= .4
M/M Ratio = 1.6

104.9 MHz



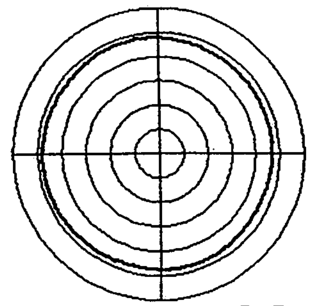
Area Mean = -3.5
Std dB Dev= .3
M/M Ratio = 1.5

106.3 MHz



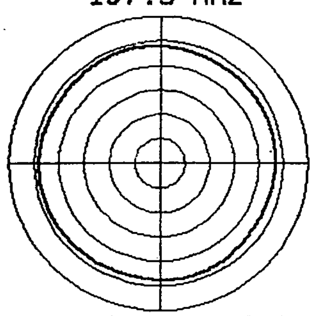
Area Mean = -1.8
Std dB Dev= .3
M/M Ratio = 1.2

106.9 MHz



Area Mean = -2.6
Std dB Dev= .3
M/M Ratio = 1.5

107.9 MHz



Area Mean = -2.6
Std dB Dev= .4
M/M Ratio = 1.6

Mean of Ind. Area Means...-.8 dBd
Std dB Dev of Area Means.. 1.4 dB

Mean of Ind. MM Ratios.... 1.2 dB
Std dB Dev of M/M Ratios.. .2 dB
Mean of Ind Std dB Dev's.. .3 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number......
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......LAB SIGNAL
Transmit Ant...JEF 50-1000 MHz XLP
Height.........20 Ft.

Mfg./Model.....Anritsu MH680B
Polarization...RIGHT CIRCULAR
Range..........150 Ft.

APPENDIX C

VHF Antenna Gain Characterization Using "Off-air" Signals

1995 Taurus Power Antenna

and

EIA/NAB VHF Test Antenna

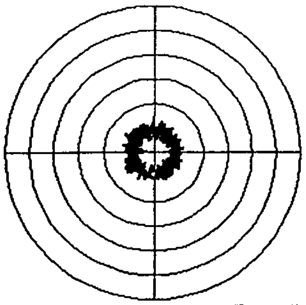
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....10:02:36   PATTERN.....004

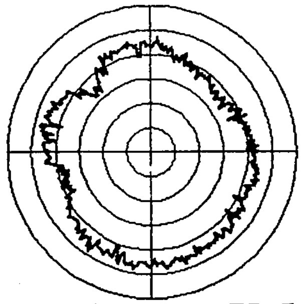
REF = -40dBm   FRONT=0   10 dB/DIV

88.1 MHz



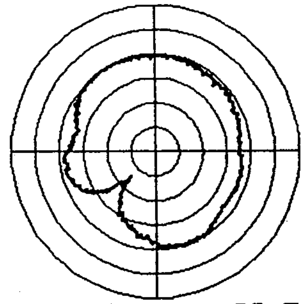
Area Mean = -90.7
Std dB Dev= 1.8
M/M Ratio = 10.2

89.1 MHz



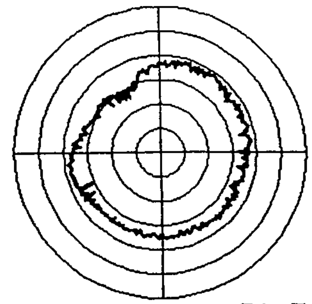
Area Mean = -56.9
Std dB Dev= 3.8
M/M Ratio = 16.8

89.9 MHz



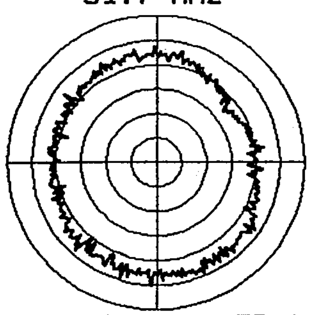
Area Mean = -62.7
Std dB Dev= 4.4
M/M Ratio = 26

90.9 MHz



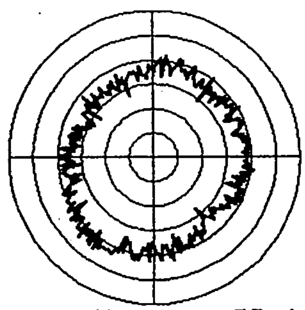
Area Mean = -64.7
Std dB Dev= 2.7
M/M Ratio = 13

91.7 MHz



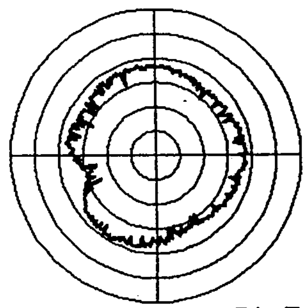
Area Mean = -56.4
Std dB Dev= 3.2
M/M Ratio = 16.7

93.1 MHz



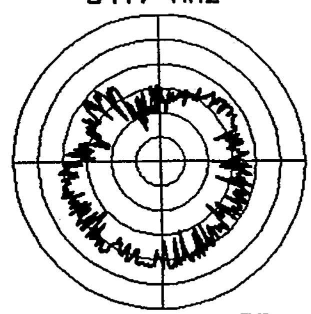
Area Mean = -62.4
Std dB Dev= 3.6
M/M Ratio = 18.5

93.9 MHz



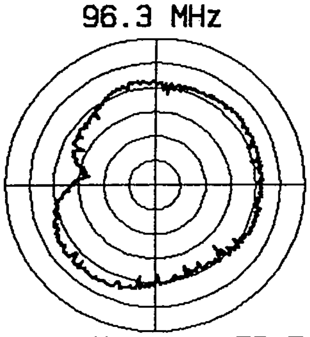
Area Mean = -64.7
Std dB Dev= 2.5
M/M Ratio = 14.2

94.7 MHz



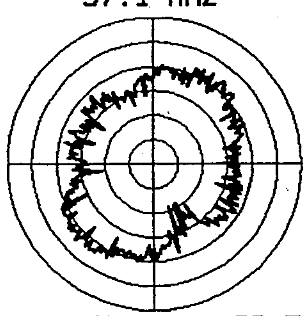
Area Mean = -63
Std dB Dev= 6.8
M/M Ratio = 30

96.3 MHz



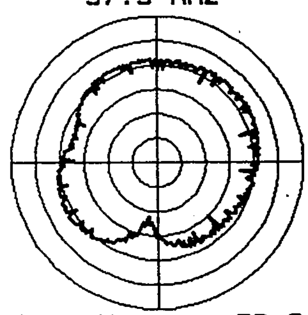
Area Mean = -58.5
Std dB Dev= 3.9
M/M Ratio = 19.2

97.1 MHz



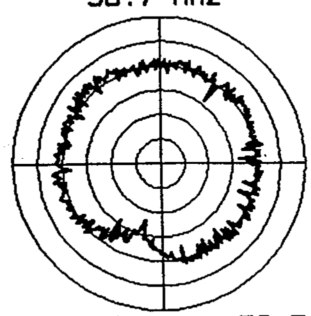
Area Mean = -62.7
Std dB Dev= 5.4
M/M Ratio = 26.6

97.9 MHz



Area Mean = -59.9
Std dB Dev= 4.3
M/M Ratio = 21.5

98.7 MHz



Area Mean = -59.5
Std dB Dev= 3.4
M/M Ratio = 19.7

Mean of Ind. Area Means...-59.1 dBm
Std dB Dev of Area Means.. 8.2 dB

Mean of Ind. MM Ratios.... 24 dB
Std dB Dev of M/M Ratios.. 8 dB
Mean of Ind Std dB Dev's.. 3.8 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......AIR SIGNAL
Transmit Ant...N/A
Height.........N/A

Mfg./Model.....N/A
Polarization...N/A
Range..........N/A

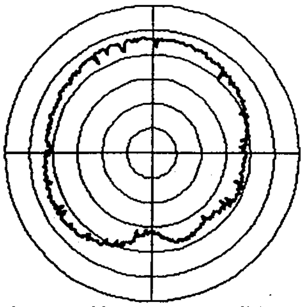
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10:02:36 PATTERN.....004

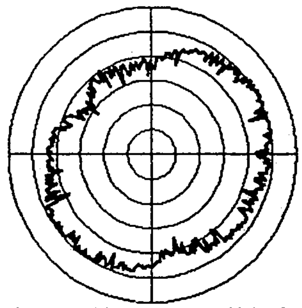
REF = -40dBm FRONT=0 10 dB/DIV

100.3 MHz



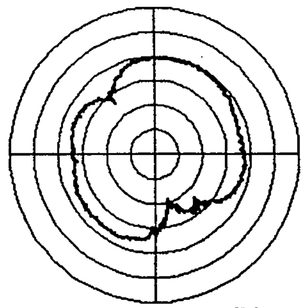
Area Mean = -57.2
Std dB Dev= 4.2
M/M Ratio = 15.1

101.1 MHz



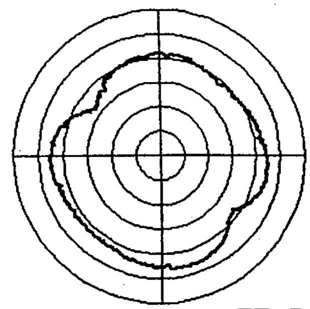
Area Mean = -54.3
Std dB Dev= 5.6
M/M Ratio = 23.4

101.9 MHz



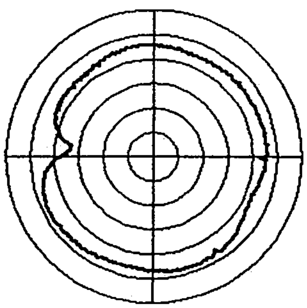
Area Mean = -64
Std dB Dev= 4.4
M/M Ratio = 21

102.9 MHz



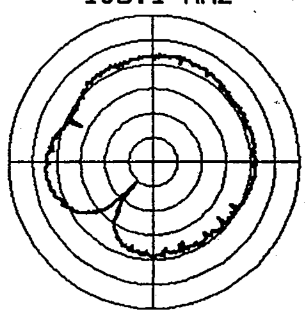
Area Mean = -57.3
Std dB Dev= 3.2
M/M Ratio = 14.2

103.5 MHz



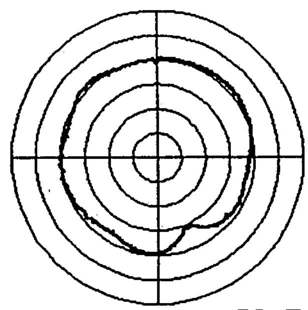
Area Mean = -54.5
Std dB Dev= 2.7
M/M Ratio = 15.1

105.1 MHz



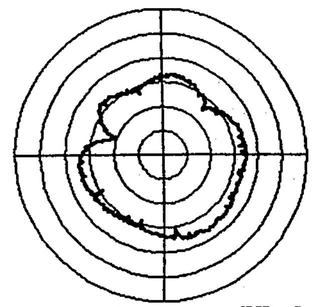
Area Mean = -59
Std dB Dev= 4.7
M/M Ratio = 33.3

105.9 MHz



Area Mean = -60.7
Std dB Dev= 2.2
M/M Ratio = 10.9

107.1 MHz



Area Mean = -67.2
Std dB Dev= 3
M/M Ratio = 16.2

Mean of Ind. Area Means...-59.1 dBm
Std dB Dev of Area Means.. 8.2 dB

Mean of Ind. MM Ratios.... 24 dB
Std dB Dev of M/M Ratios.. 8 dB
Mean of Ind Std dB Dev's.. 3.8 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP
Comments.......NONE

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......AIR SIGNAL
Transmit Ant...N/A
Height.........N/A

Mfg./Model.....N/A
Polarization...N/A
Range..........N/A

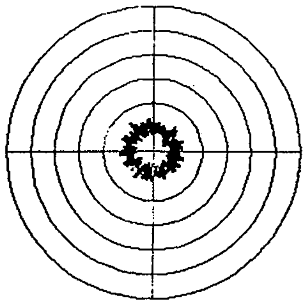
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....10:54:33   PATTERN.....009

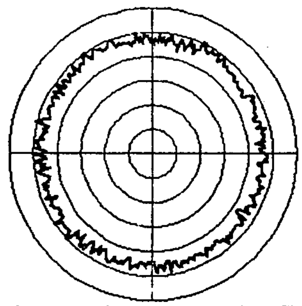
REF = -40dBm   FRONT=0   10 dB/DIV

88.1 MHz



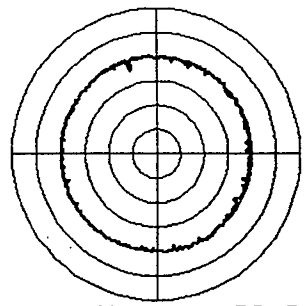
Area Mean = -90.5
Std dB Dev= 1.7
M/M Ratio = 9.1

89.1 MHz



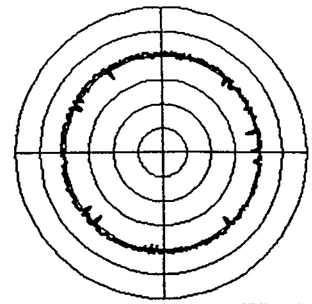
Area Mean = -53.3
Std dB Dev= 1.5
M/M Ratio = 8

89.9 MHz



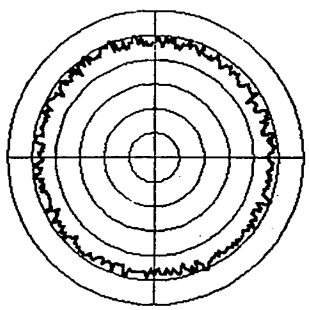
Area Mean = -60.3
Std dB Dev= .6
M/M Ratio = 5.1

90.9 MHz



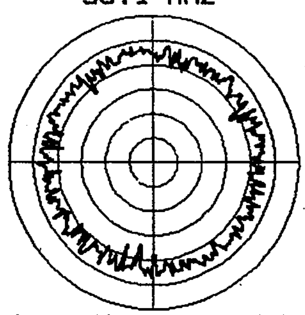
Area Mean = -59.1
Std dB Dev= .9
M/M Ratio = 6

91.7 MHz



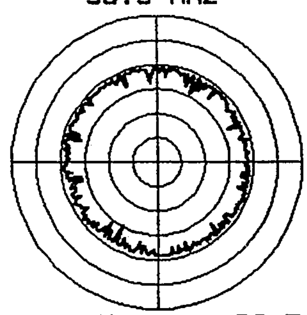
Area Mean = -52.6
Std dB Dev= 1.3
M/M Ratio = 6.7

93.1 MHz



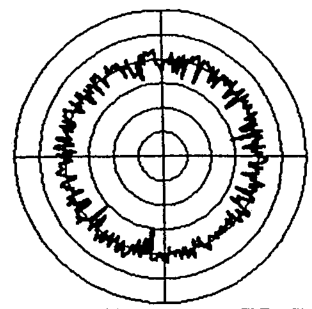
Area Mean = -55.7
Std dB Dev= 2.4
M/M Ratio = 13.2

93.9 MHz



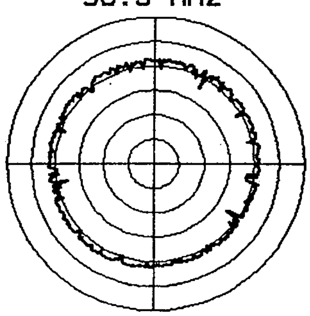
Area Mean = -62.7
Std dB Dev= 1.5
M/M Ratio = 9.4

94.7 MHz



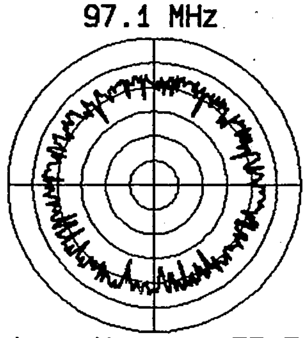
Area Mean = -59.6
Std dB Dev= 2.9
M/M Ratio = 14.6

96.3 MHz



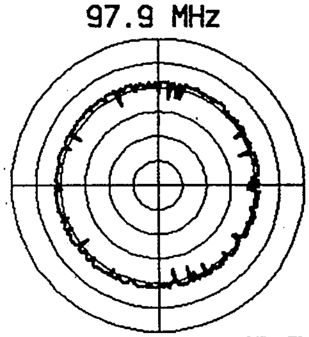
Area Mean = -58.3
Std dB Dev= 1.2
M/M Ratio = 7.9

97.1 MHz



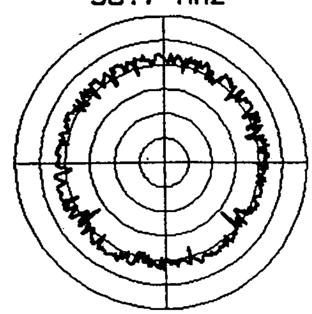
Area Mean = -57.5
Std dB Dev= 2.8
M/M Ratio = 14.1

97.9 MHz



Area Mean = -58.7
Std dB Dev= 1.3
M/M Ratio = 7.7

98.7 MHz



Area Mean = -57.9
Std dB Dev= 2.1
M/M Ratio = 12.8

Mean of Ind. Area Means...-57.1 dBm
Std dB Dev of Area Means.. 8.4 dB

Mean of Ind. MM Ratios.... 9.4 dB
Std dB Dev of M/M Ratios.. 4 dB
Mean of Ind Std dB Dev's.. 1.3 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number......
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......AIR SIGNAL
Transmit Ant...N/A
Height.........N/A

Mfg./Model.....N/A
Polarization...N/A
Range.........N/A

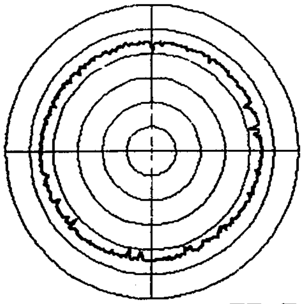
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10:54:33 PATTERN.....009

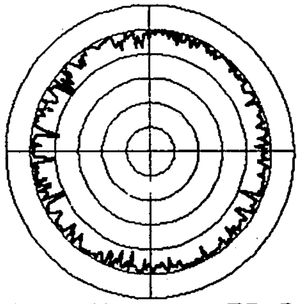
REF = -40dBm FRONT=0 10 dB/DIV

100.3 MHz



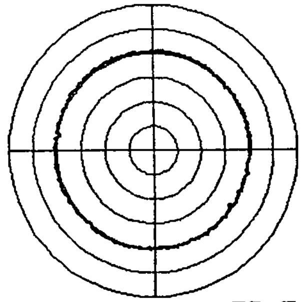
Area Mean = -55.5
Std dB Dev= .8
M/M Ratio = 5.3

101.1 MHz



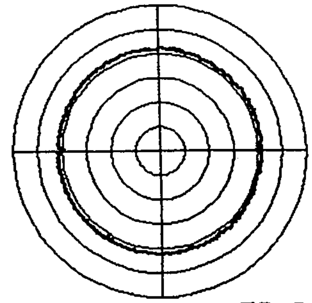
Area Mean = -52.2
Std dB Dev= 2.1
M/M Ratio = 10.9

101.9 MHz



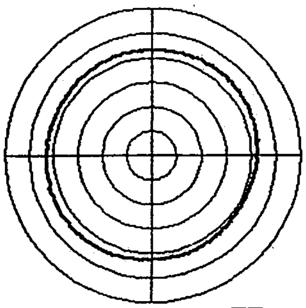
Area Mean = -59.5
Std dB Dev= .4
M/M Ratio = 2.9

102.9 MHz



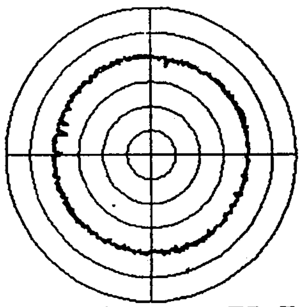
Area Mean = -58.2
Std dB Dev= .5
M/M Ratio = 3.6

103.5 MHz



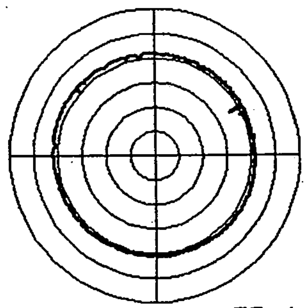
Area Mean = -57
Std dB Dev= .6
M/M Ratio = 2.6

105.1 MHz



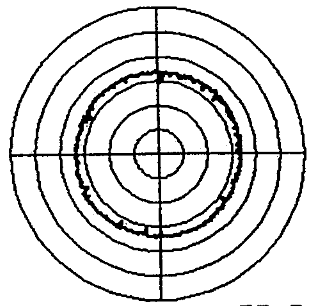
Area Mean = -59.7
Std dB Dev= .8
M/M Ratio = 5.9

105.9 MHz



Area Mean = -58.4
Std dB Dev= .5
M/M Ratio = 6.4

107.1 MHz



Area Mean = -66.3
Std dB Dev= .7
M/M Ratio = 5.4

Mean of Ind. Area Means...-57.1 dBm
Std dB Dev of Area Means.. 8.4 dB

Mean of Ind. MM Ratios.... 9.4 dB
Std dB Dev of M/M Ratios.. 4 dB
Mean of Ind Std dB Dev's.. 1.3 dB

UNIT TESTED....
Mfg./Model.....
Antenna Type...1/4 WAVE MONOPOLE
Comments.......FIXTURED ON 5 FT. SQUARE GROUND PLANE

ID Number......
Ant. Location..ON 4 FT. FOAM BLOCKS

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 100 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

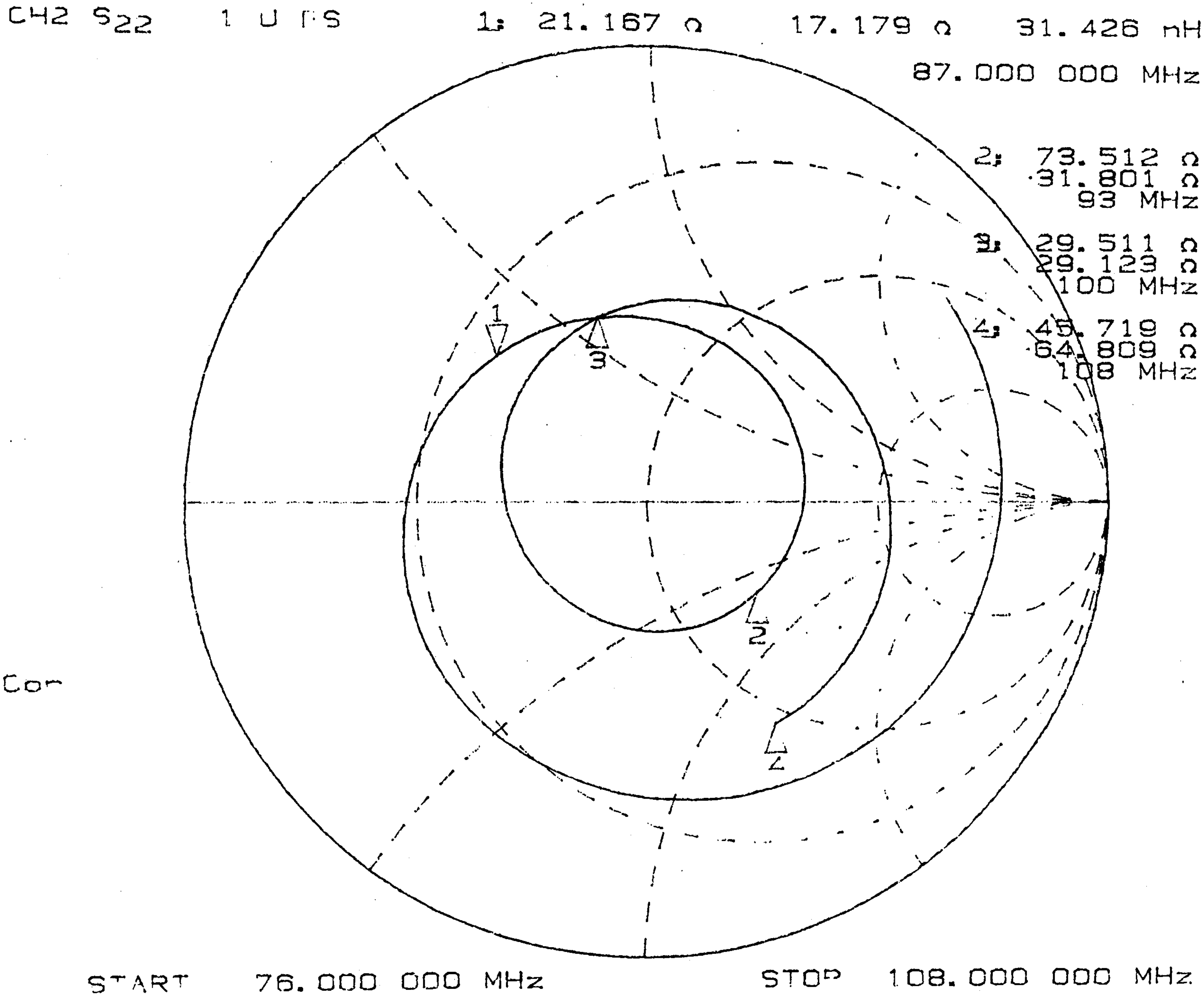
RF SOURCE......AIR SIGNAL
Transmit Ant...N/A
Height.........N/A

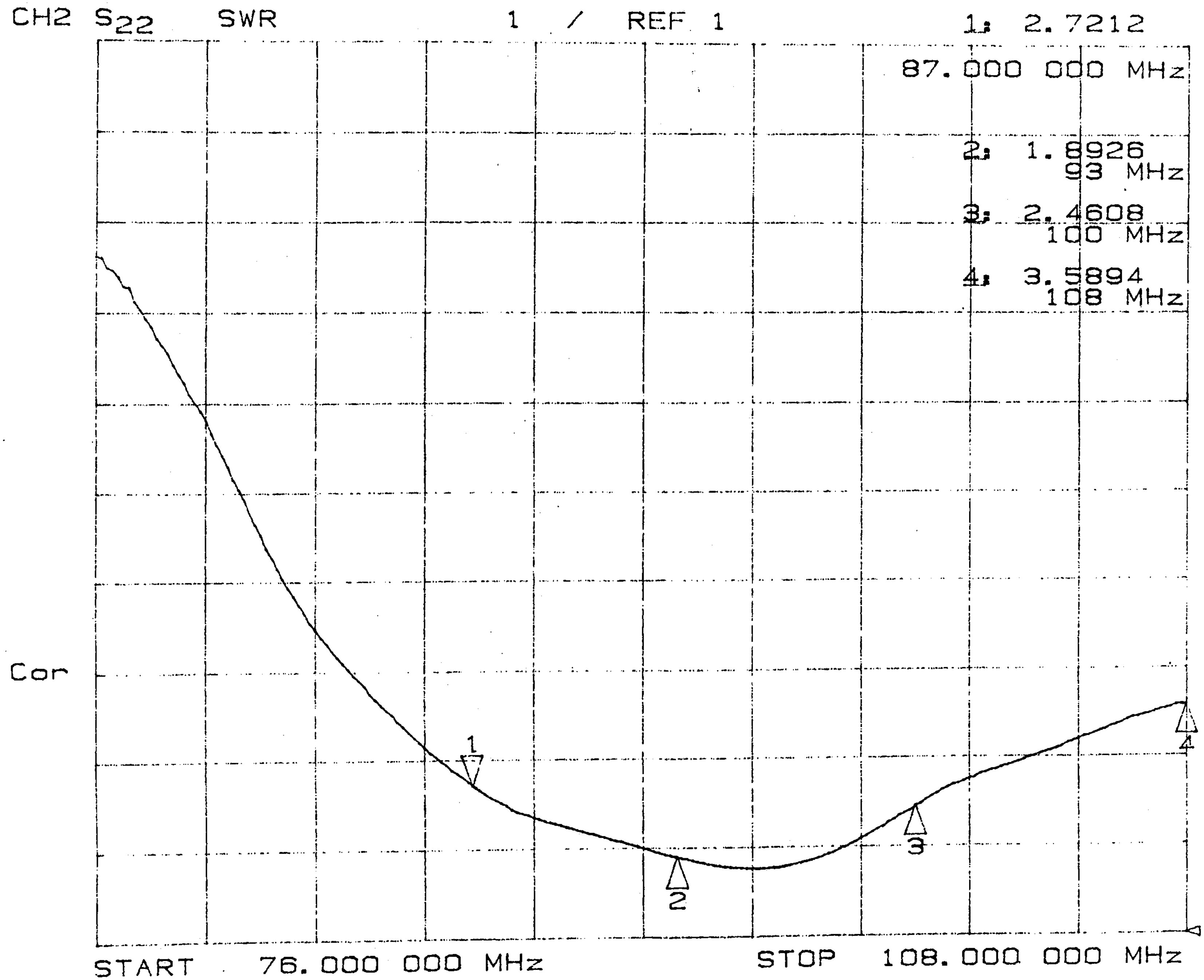
Mfg./Model.....N/A
Polarization...N/A
Range..........N/A

APPENDIX D

VHF Antenna Characterization - Output Impedance

EIA/NAB VHF Test Antenna


CH2 S22 1 U FS
1: 21.167 Ω 17.179 Ω 31.426 nH
87.000 000 MHz
2: 73.512 Ω
-31.801 Ω
93 MHz
3: 29.511 Ω
29.123 Ω
100 MHz
4: 45.719 Ω
-64.809 Ω
108 MHz
1
2
3
4
Cor
START 76.000 000 MHz
STOP 108.000 000 MHz


CH2 S_{22} SWR 1 / REF 1
1: 2.7212
87.000 000 MHz
2: 1.8926
93 MHz
3: 2.4608
100 MHz
4: 3.5894
108 MHz
Cor
1
2
3
4
START 76.000 000 MHz
STOP 108.000 000 MHz

APPENDIX E

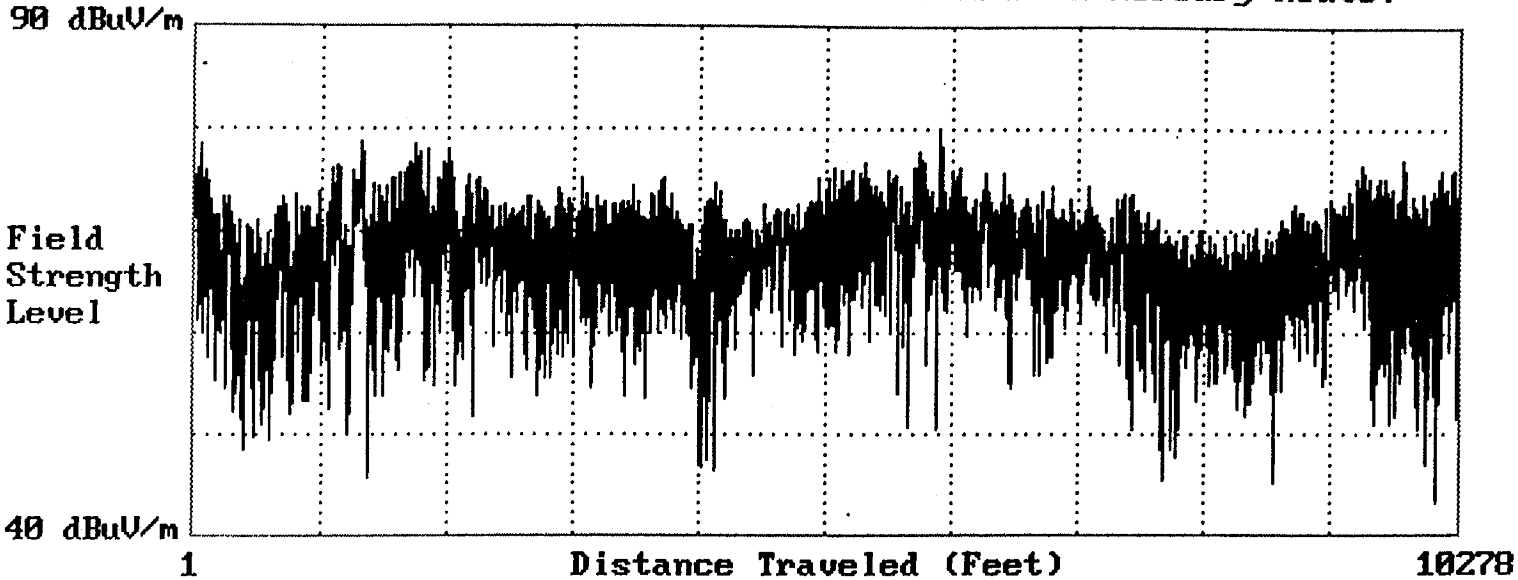
VHF Antenna Characterization - Fading vs. Antenna Height (Data)

EIA/NAB VHF Test Antenna

Filename: c:\eia\0955_1.dat
Date: 03-01-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 95.5
Time: 17:06:09
Field-Strength vs. Distance

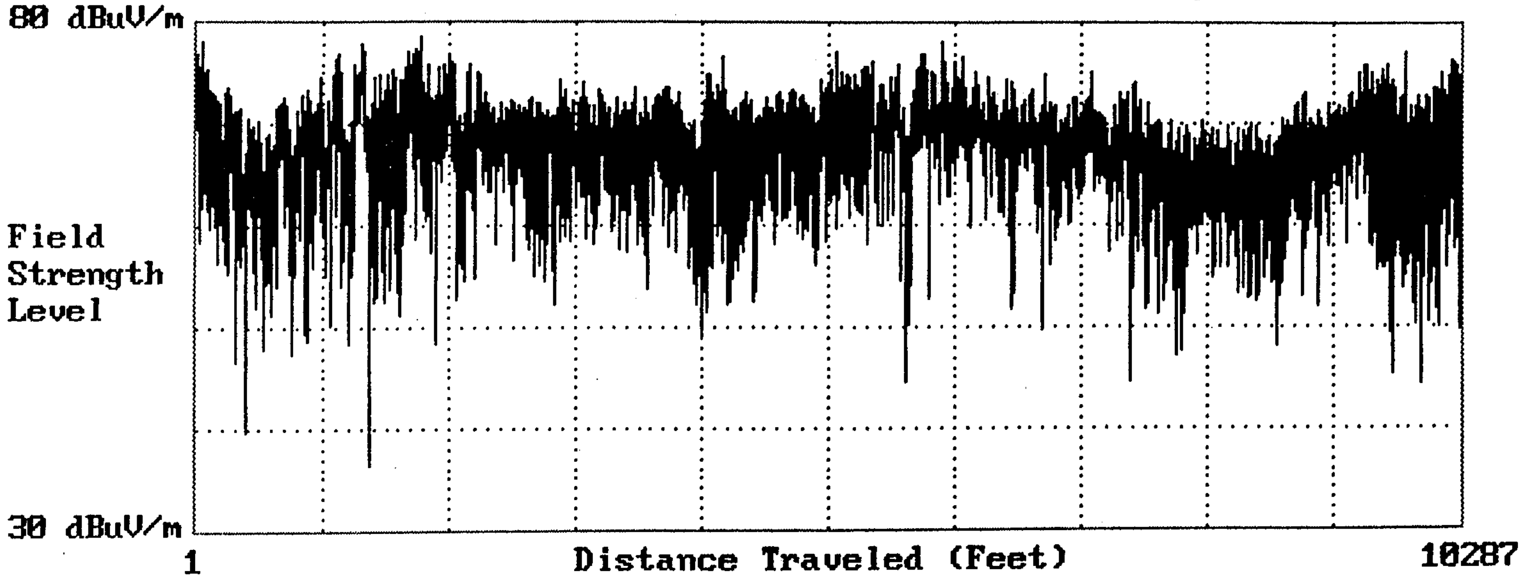
95.5 Mhz. on 5' frame; Hubbard-Southfld-Ford-Mercury Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (D) DOS Shell, (R) Return
(F) Plot Another File

Filename: c:\eia\0955_2.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 5' frame; Hubbard-Southfld-Ford-Mercury Route.

Freq. (Mhz.): 95.5
Time: 17:19:40
Field-Strength vs. Distance

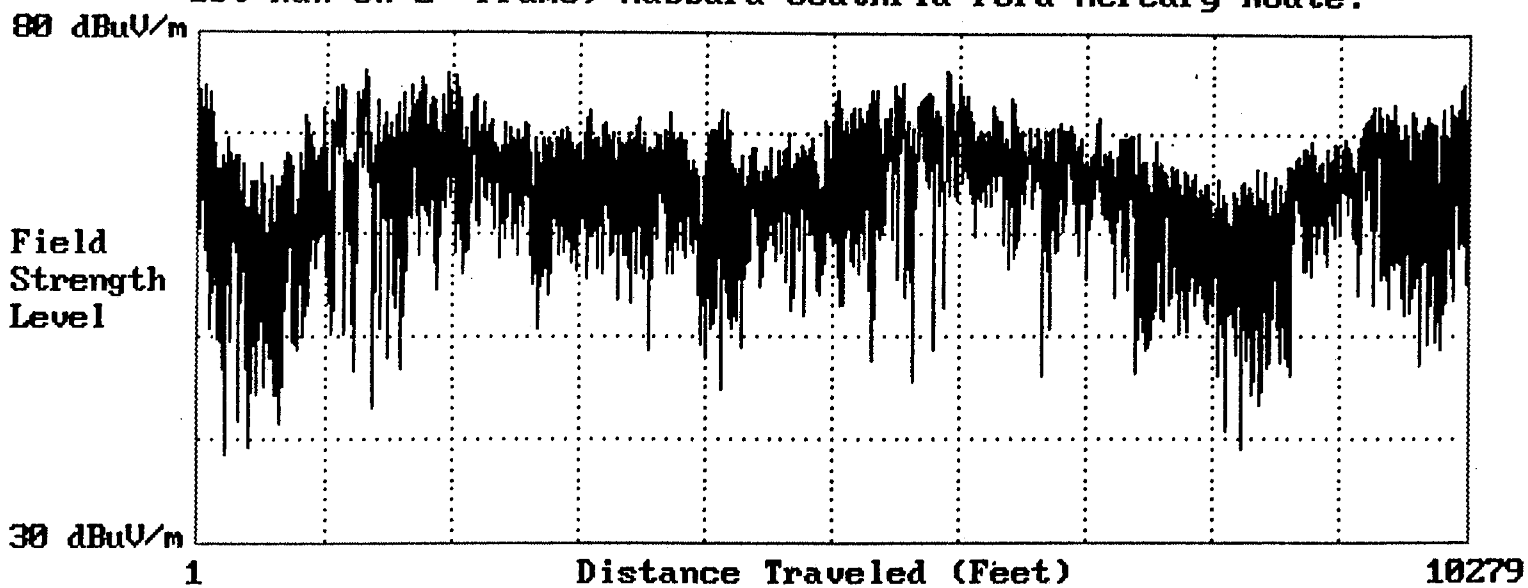


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_3.dat
Date: 03-01-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 95.5
Time: 18:27:46
Field-Strength vs. Distance

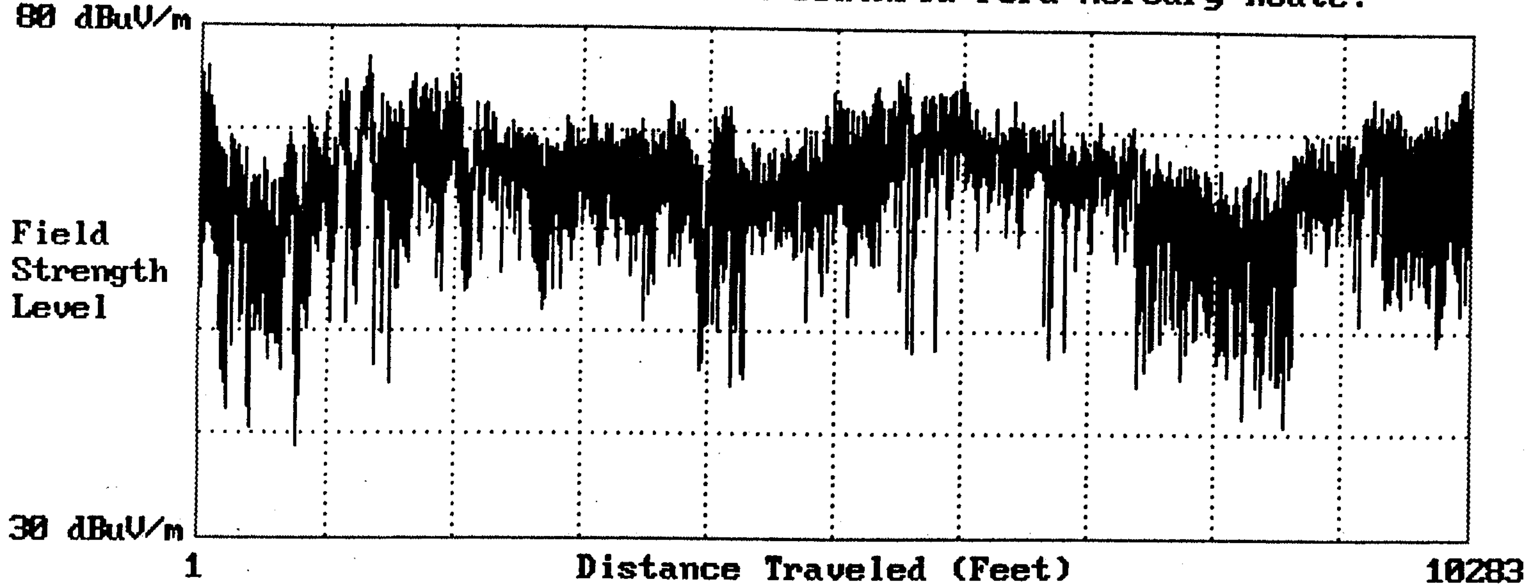
1st Run on 2' frame; Hubbard-Southfld-Ford-Mercury Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_4.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 2' frame; Hubbard-Southfld-Ford-Mercury Route.

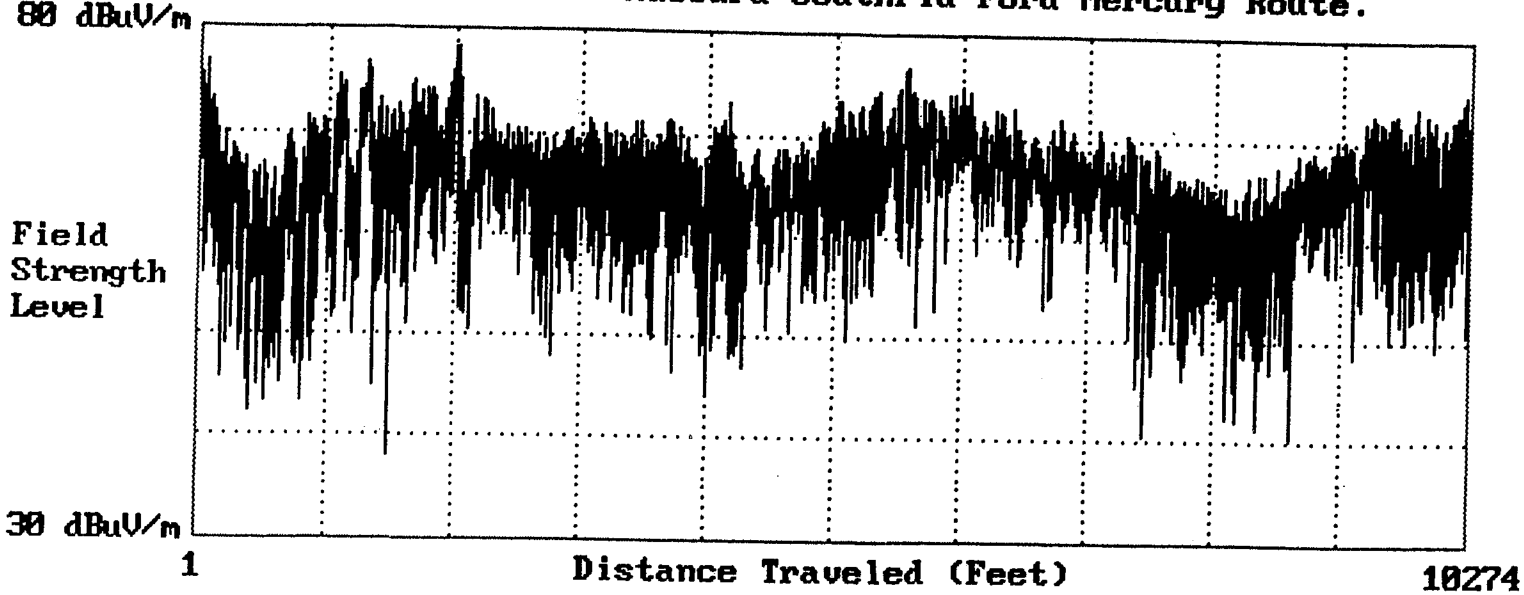
Freq. (Mhz.): 95.5
Time: 18:37:10
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_5.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
3rd Run on 2' frame; Hubbard-Southfld-Ford-Mercury Route.

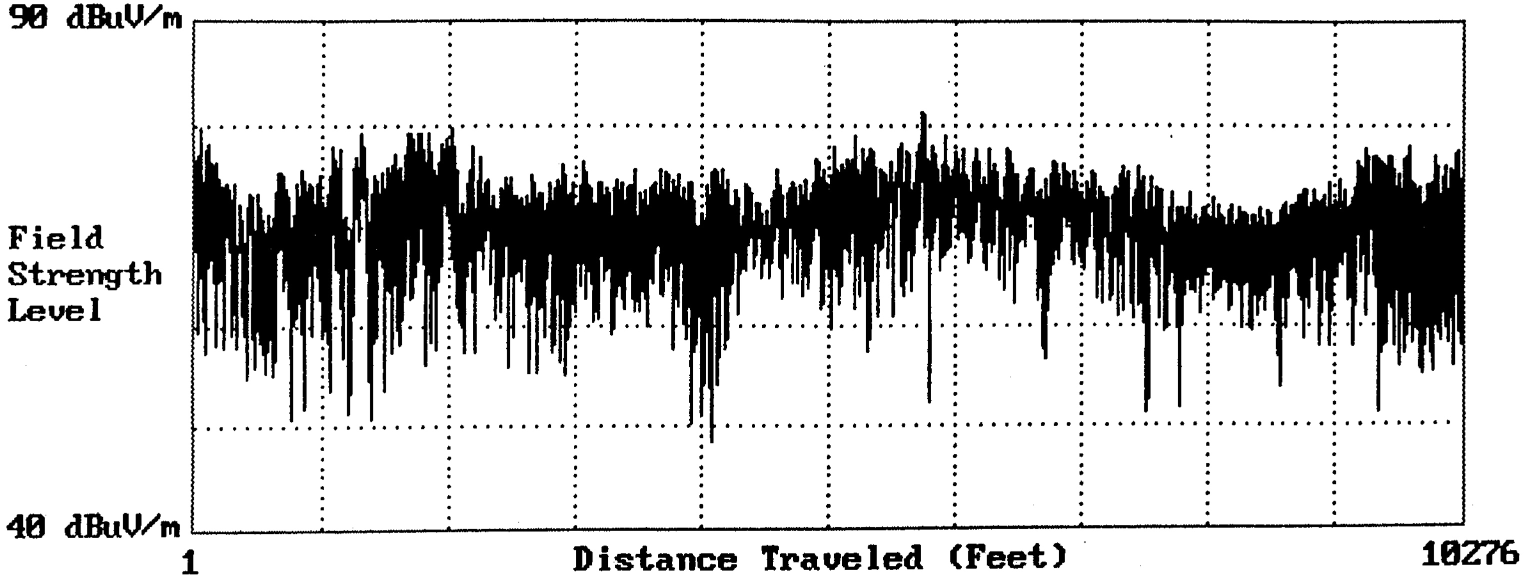
Freq. (Mhz.): 95.5
Time: 20:02:41
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_6.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
1st Run on 8' frame; Hubbard-Southfld-Ford-Mercury Route.

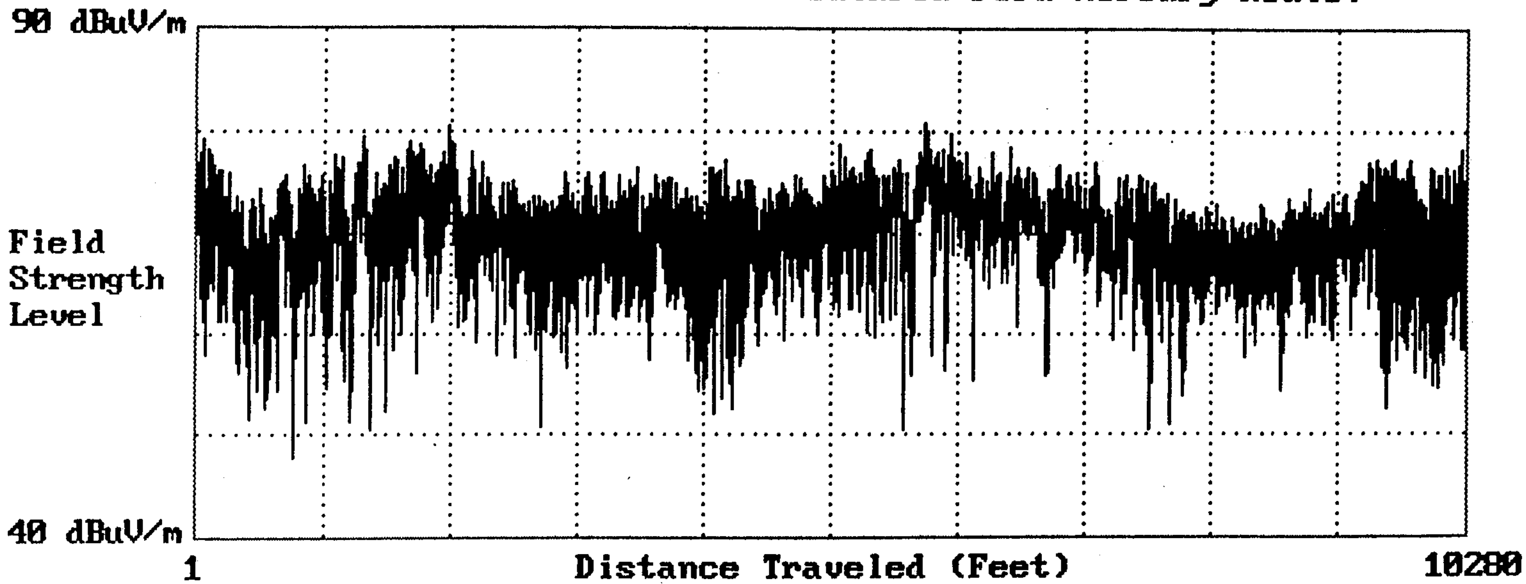
Freq. (Mhz.): 95.5
Time: 21:42:27
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

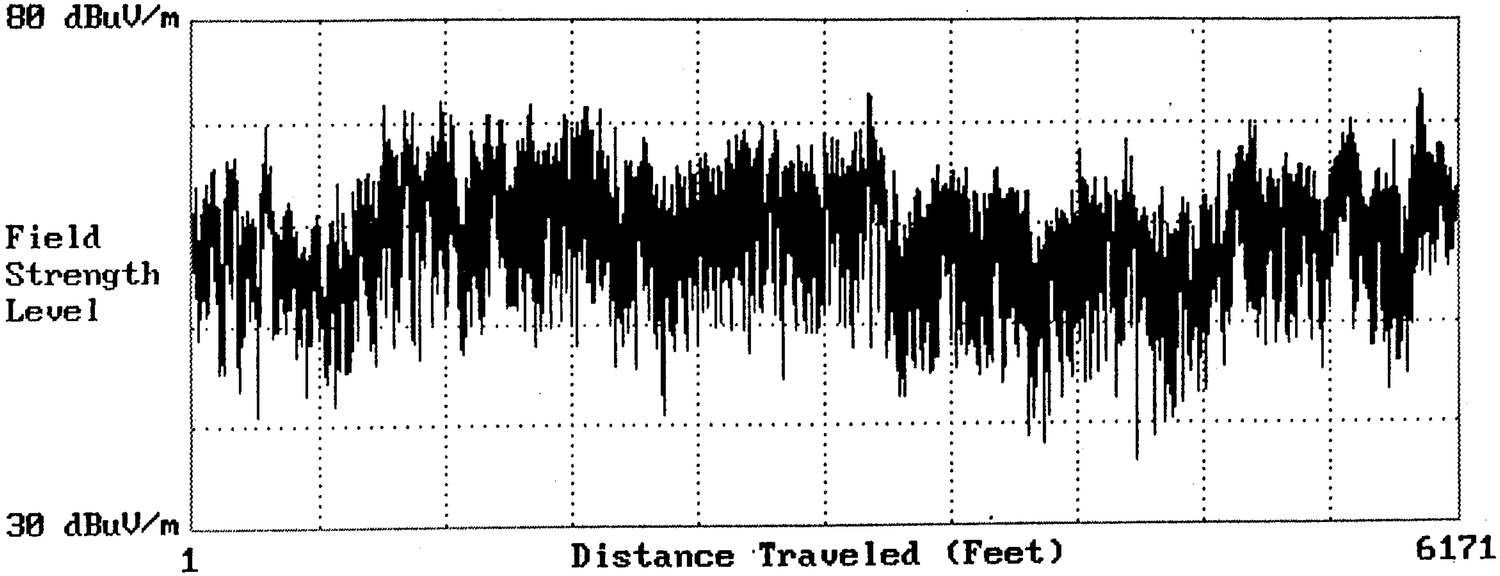
Filename: c:\eia\0955_7.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 8' frame; Hubbard-Southfld-Ford-Mercury Route.

Freq. (Mhz.): 95.5
Time: 21:55:12
Field-Strength vs. Distance



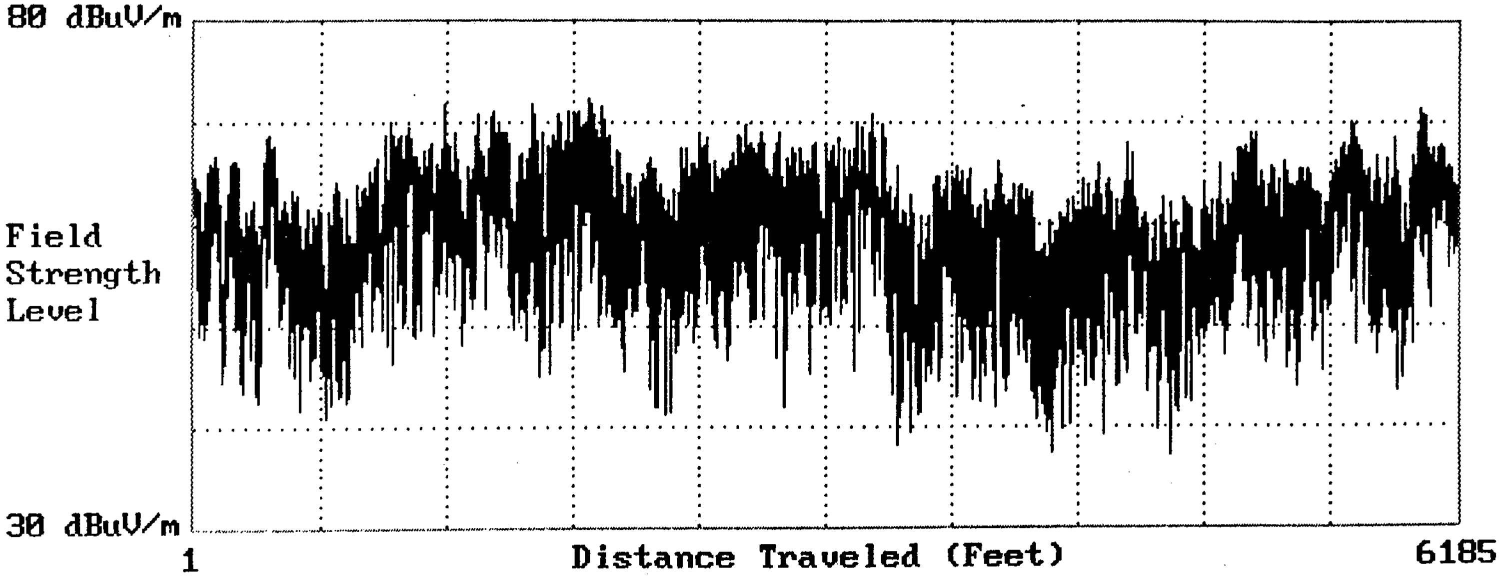
(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_8.dat Freq. (Mhz.): 95.5
Date: 03-04-1996 Time: 16:39:17
Ant. Factor (dB.): 0 Field-Strength vs. Distance
1st Run on 8' frame; Atwater-St. Antione-Jefferson Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (D) DOS Shell, (R) Return
(F) Plot Another File

Filename: c:\eia\0955_9.dat
Freq. (Mhz.): 95.5
Date: 03-04-1996
Time: 16:50:46
Ant. Factor (dB.): 0
Field-Strength vs. Distance
2nd Run on 8' frame; Atwater-St. Antione-Jefferson Route.

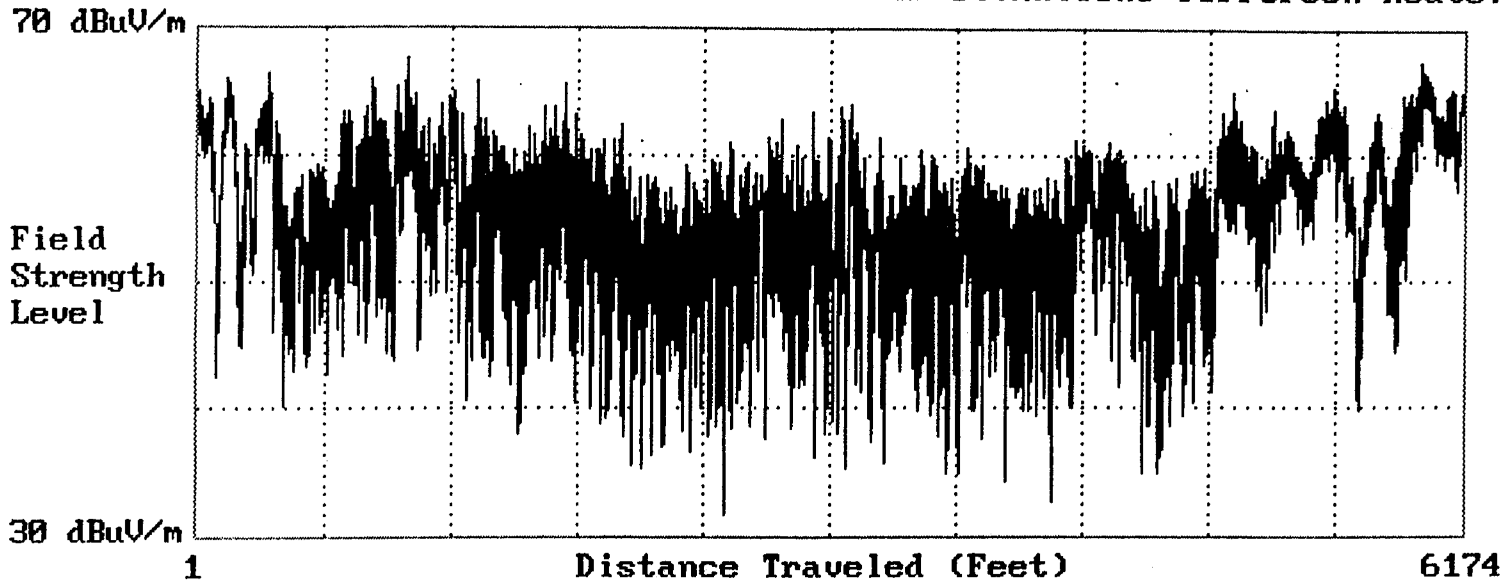


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (D) DOS Shell, (R) Return
(F) Plot Another File

Filename: c:\eia\0955_10.dat
Date: 03-04-1996
Ant. Factor (dB.): 0

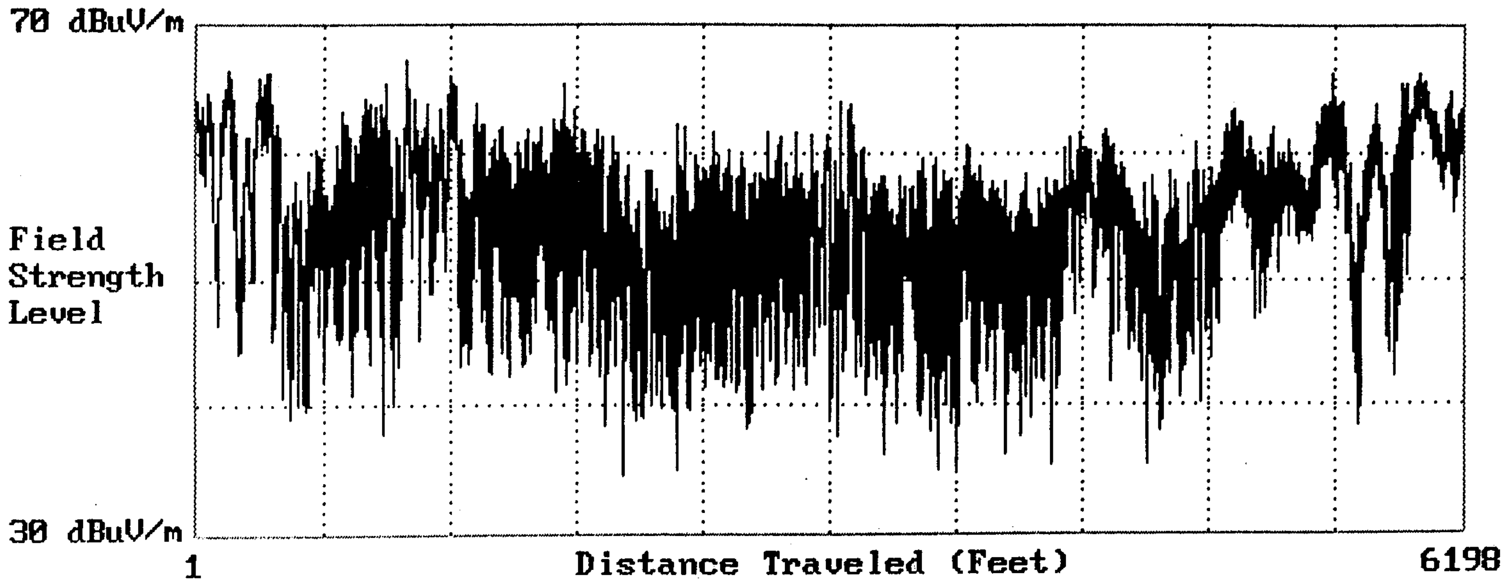
Freq. (Mhz.): 95.5
Time: 17:45:33
Field-Strength vs. Distance

1st Run w/ Test Van Antenna; Atwater-St.Antione-Jefferson Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

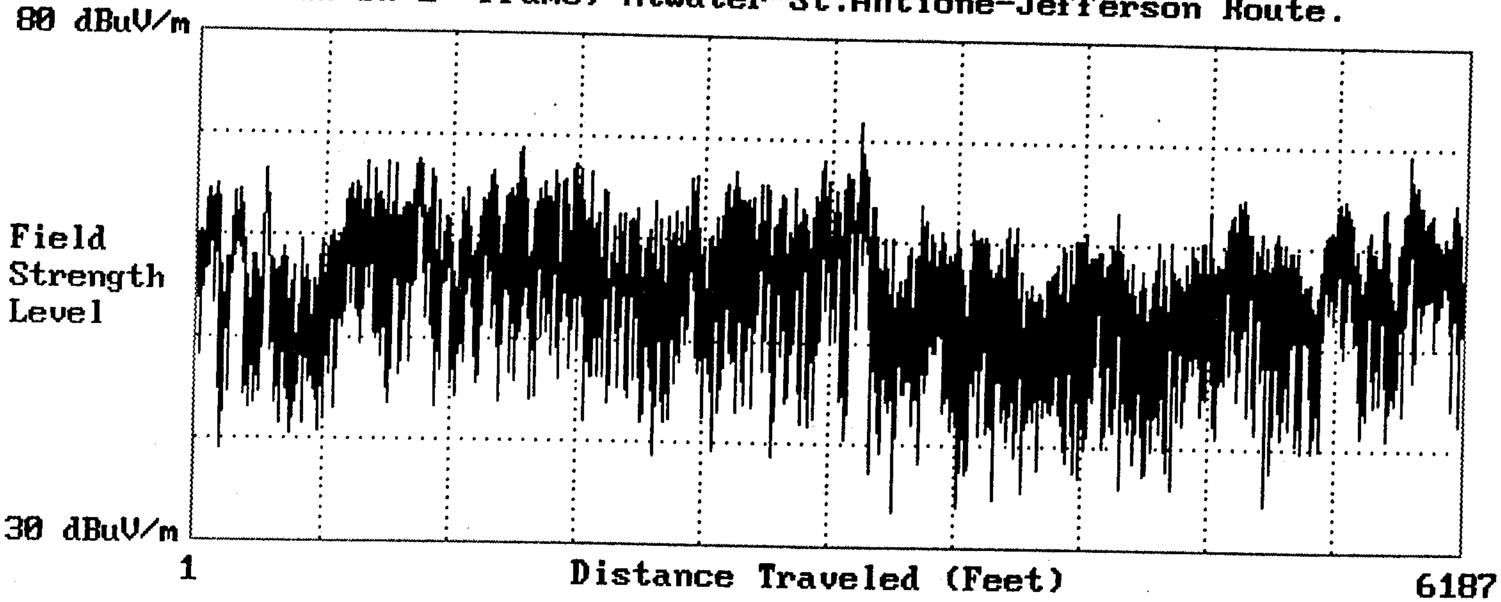
Filename: c:\eia\0955_11.dat　　　　Freq. (Mhz.): 95.5
Date: 03-04-1996　　　　Time: 17:53:45
Ant. Factor (dB.): 0　　　　Field-Strength vs. Distance
2nd Run w/ Test Van Antenna; Atwater-St.Antione-Jefferson Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_12.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run on 2' frame; Atwater-St.Antione-Jefferson Route.

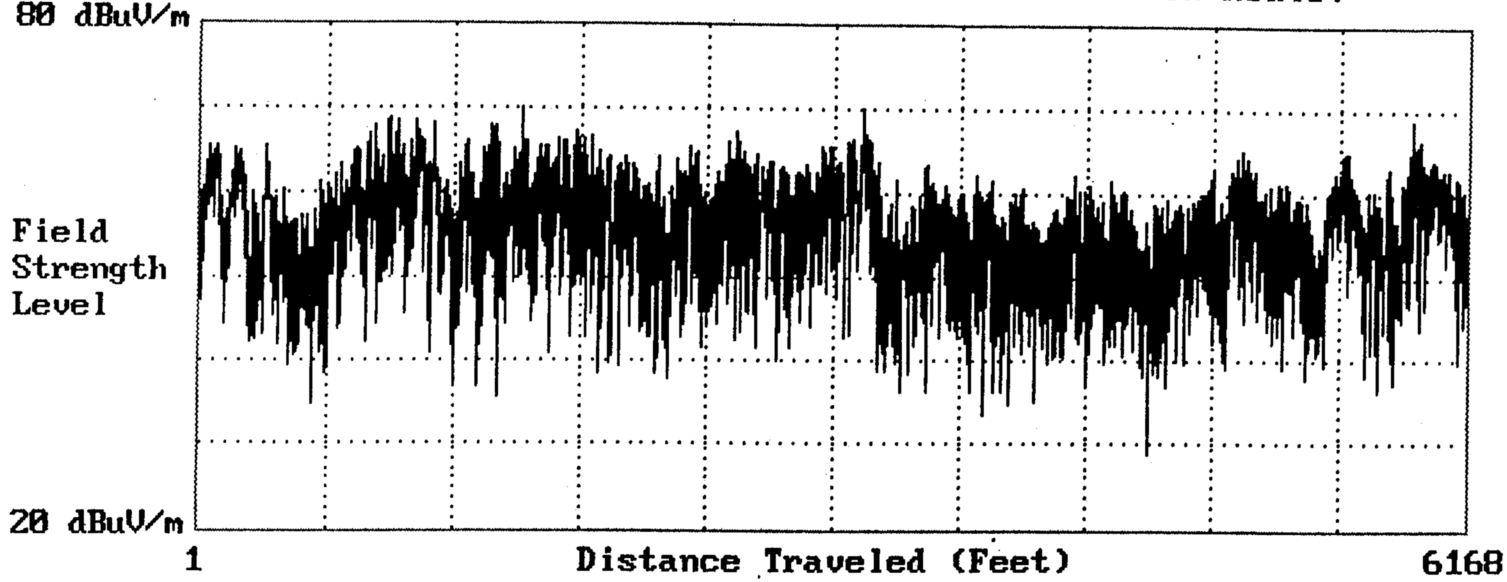
Freq. (Mhz.): 95.5
Time: 18:55:54
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_13.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
2nd Run on 2' frame; Atwater-St.Antione-Jefferson Route.

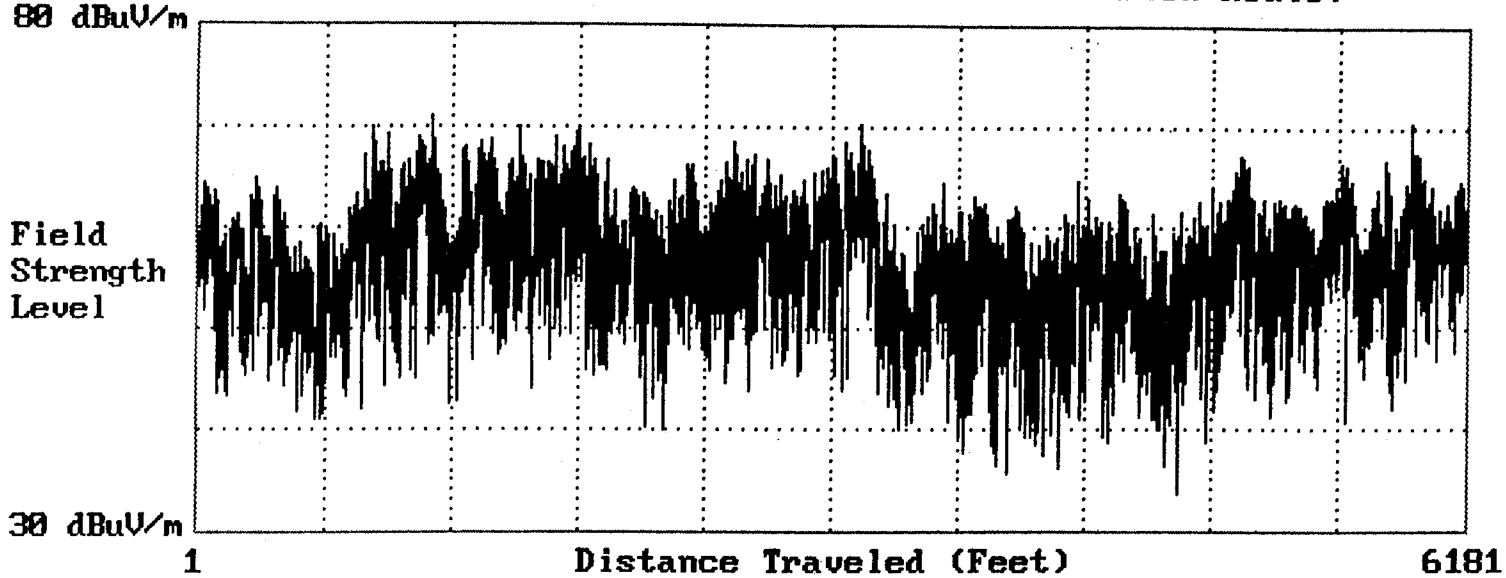
Freq. (Mhz.): 95.5
Time: 19:03:46
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_14.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run on 5' frame; Atwater-St.Antione-Jefferson Route.

Freq. (Mhz.): 95.5
Time: 20:01:21
Field-Strength vs. Distance

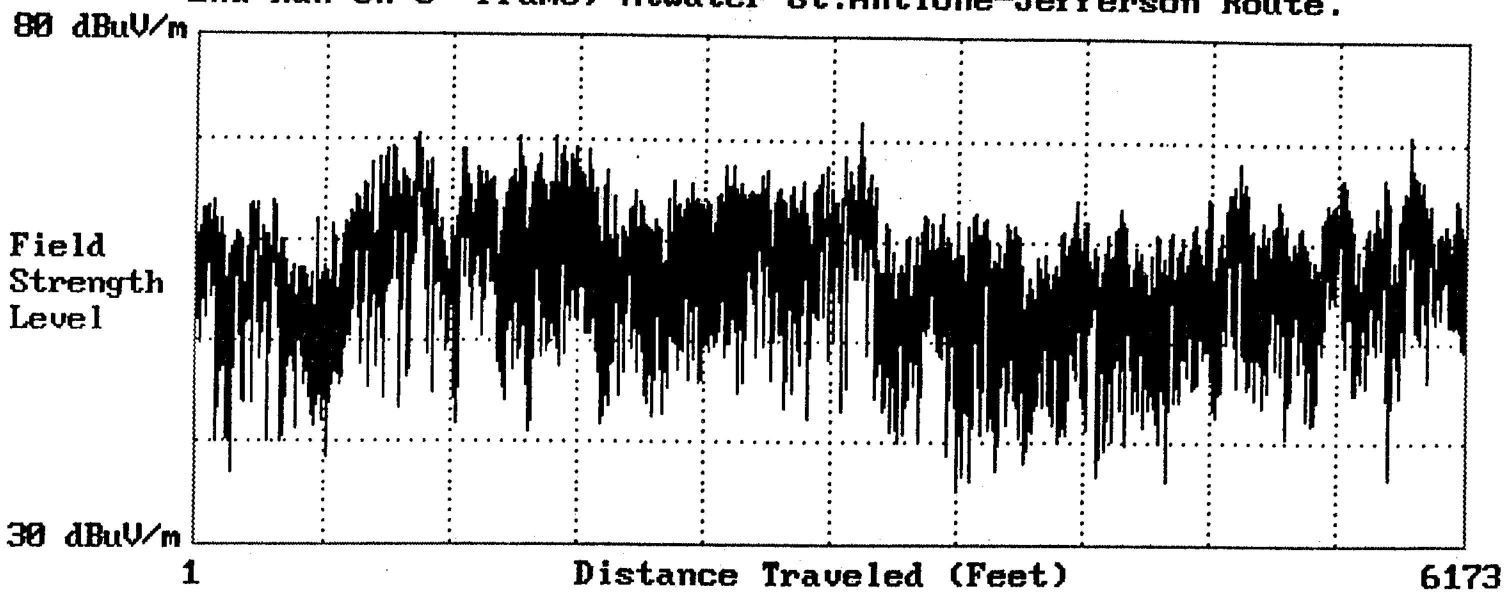


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\0955_15.dat
Date: 03-04-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 95.5
Time: 20:08:38
Field-Strength vs. Distance

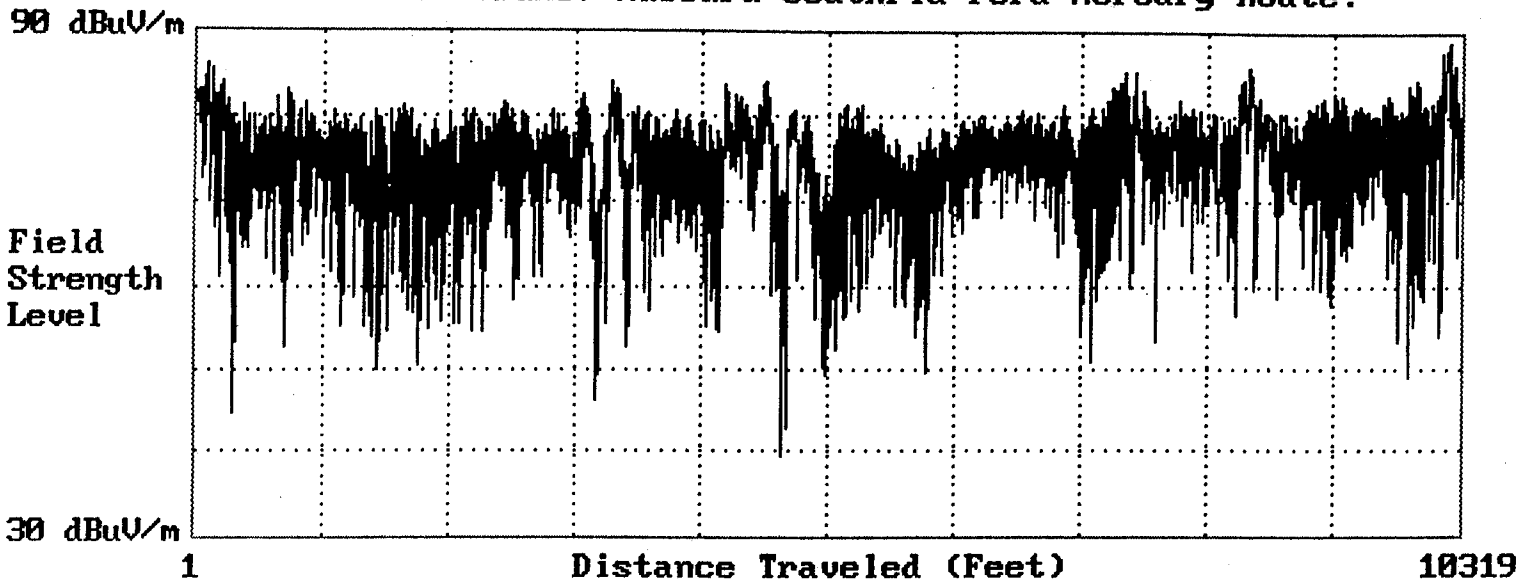
2nd Run on 5' frame; Atwater-St.Antione-Jefferson Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_1.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
1st Run on 5' frame; Hubbard-Southfld-Ford-Mercury Route.

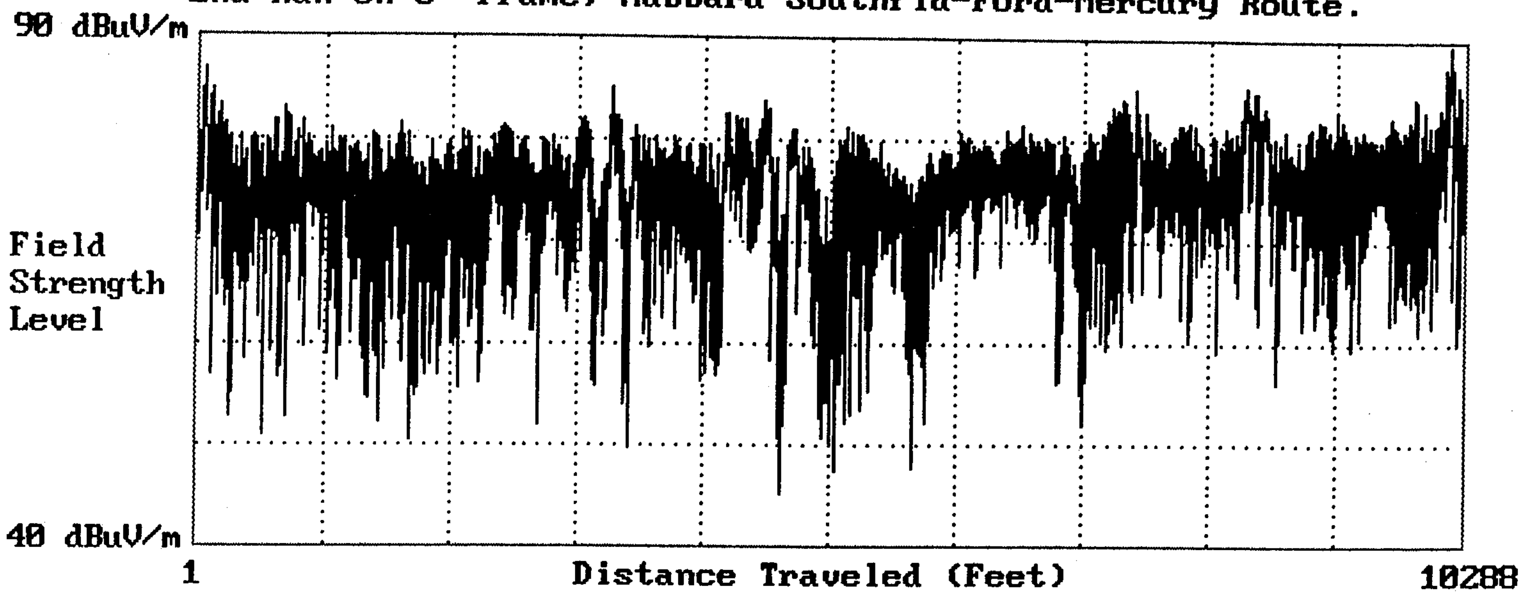
Freq. (Mhz.): 101.9
Time: 17:35:09
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_2.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 5' frame; Hubbard-Southfld-Ford-Mercury Route.

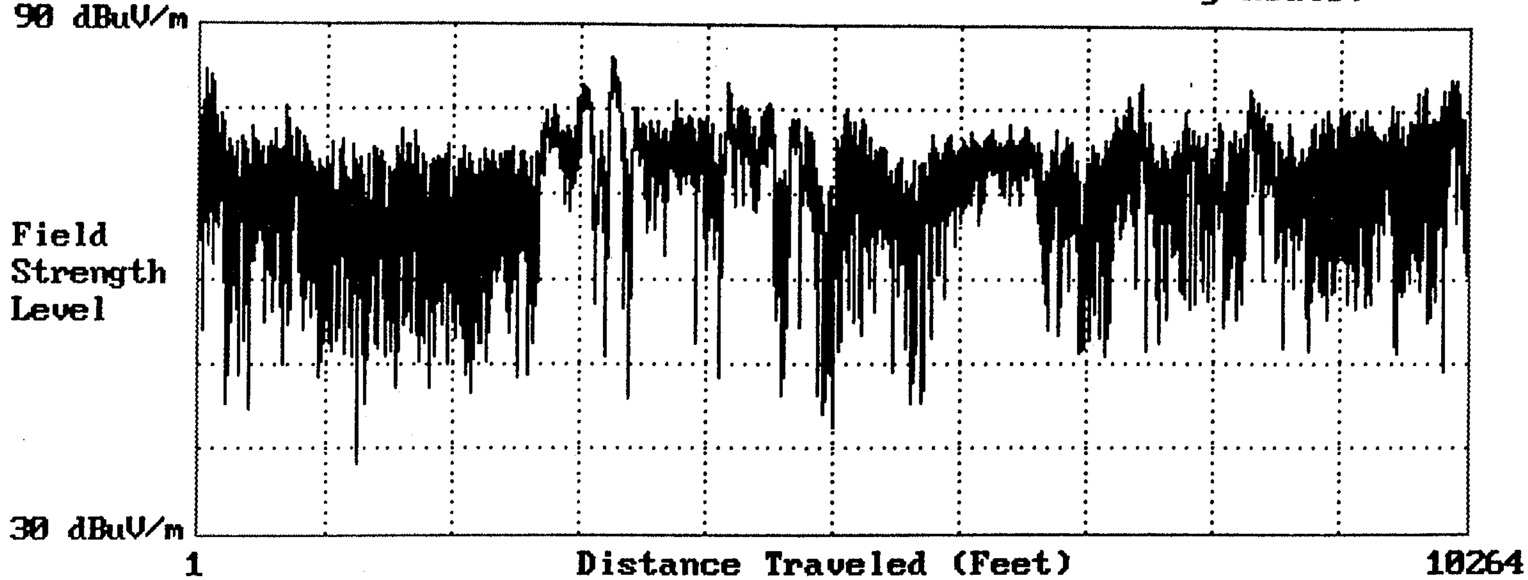
Freq. (Mhz.): 101.9
Time: 17:44:09
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_3.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
1st Run on 2' frame; Hubbard-Southfld-Ford-Mercury Route.

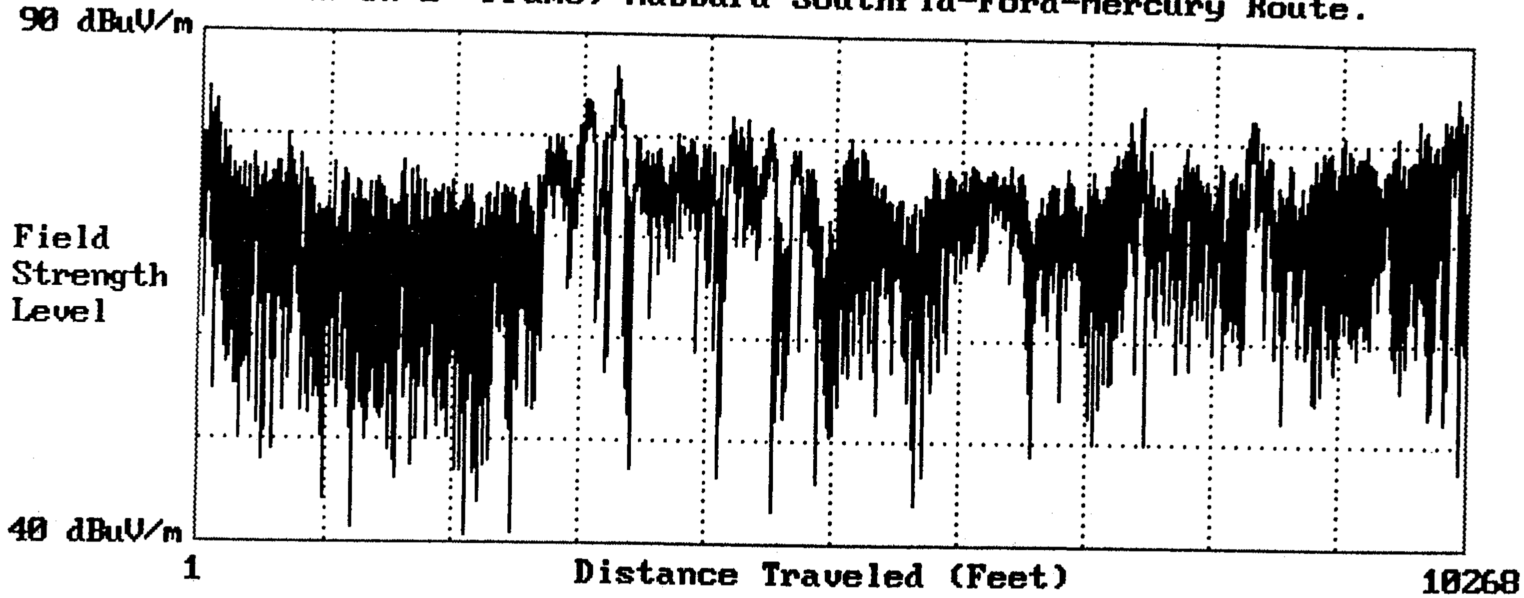
Freq. (Mhz.): 101.9
Time: 18:46:50
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_4.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 2' frame; Hubbard-Southfld-Ford-Mercury Route.

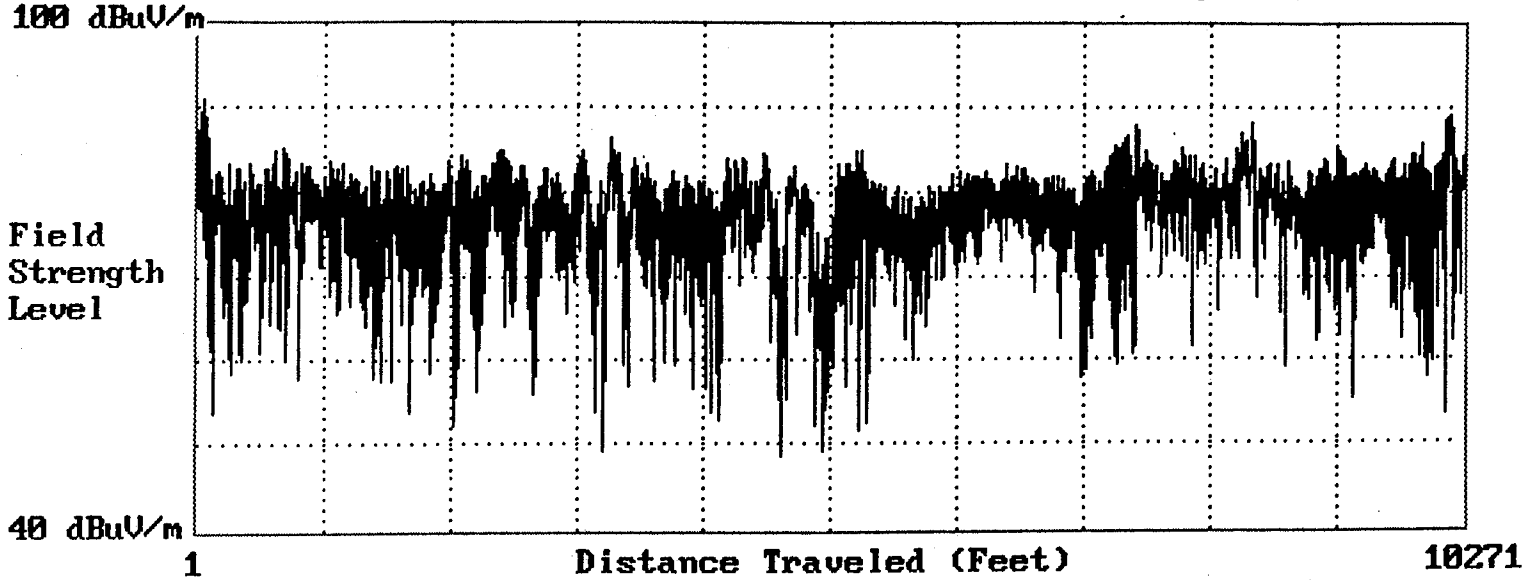
Freq. (Mhz.): 101.9
Time: 18:56:32
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_5.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
1st Run on 8' frame; Hubbard-Southfld-Ford-Mercury Route.

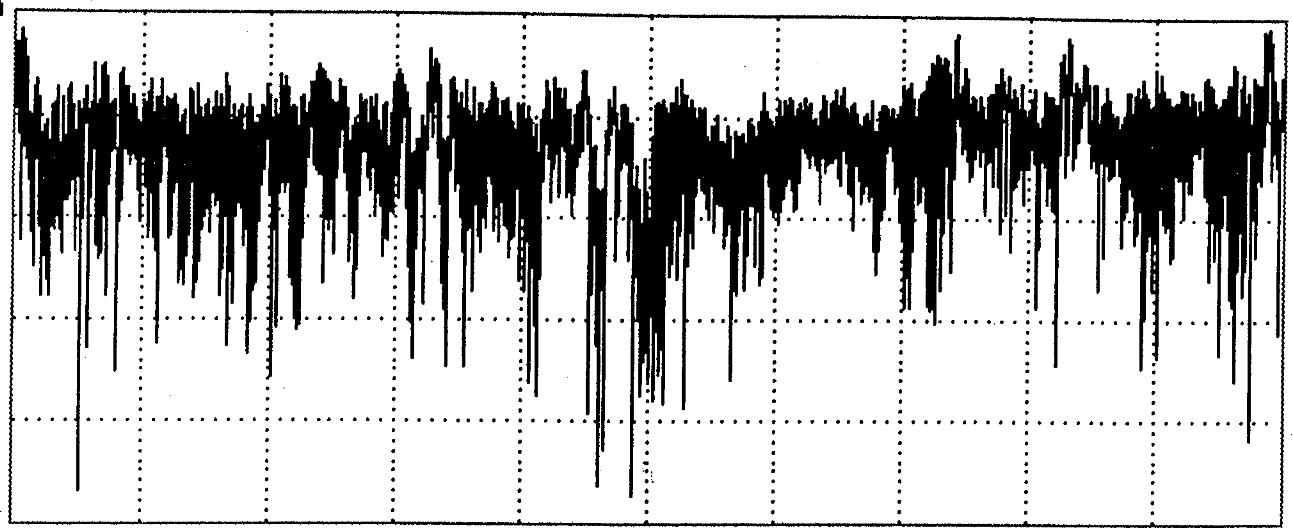
Freq. (Mhz.): 101.9
Time: 22:05:30
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_6.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 8' frame; Hubbard-Southfld-Ford-Mercury Route.

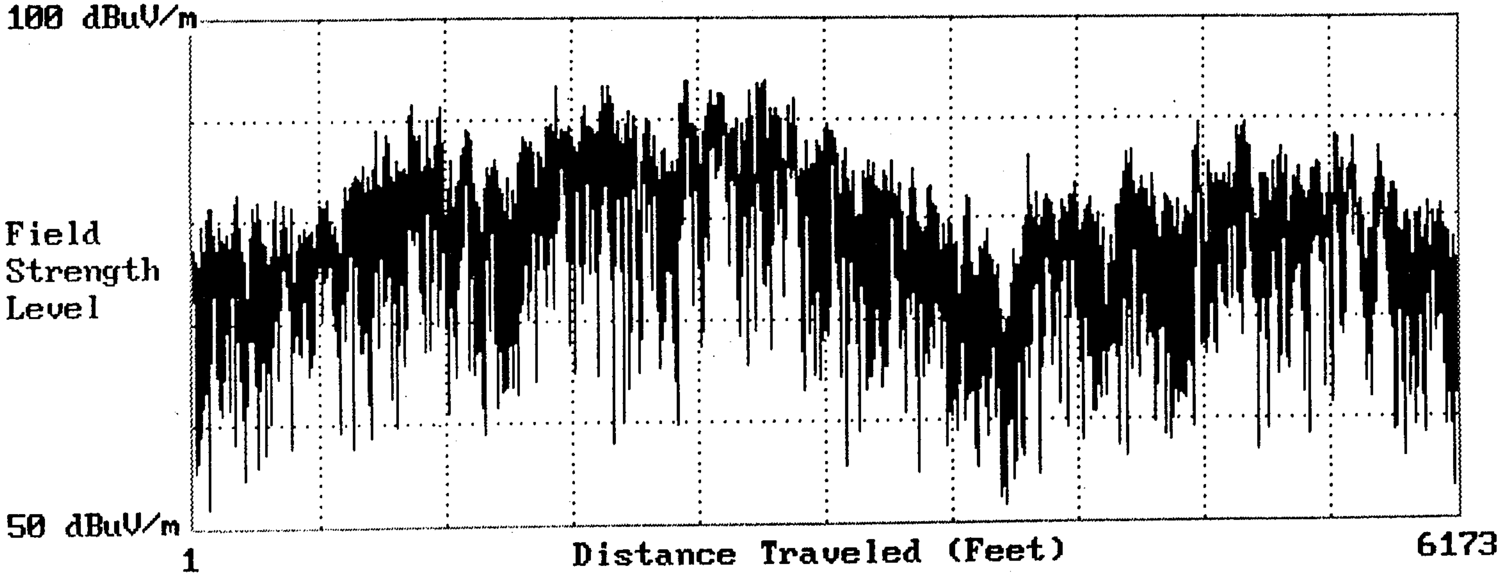
Freq. (Mhz.): 101.9
Time: 22:16:27
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

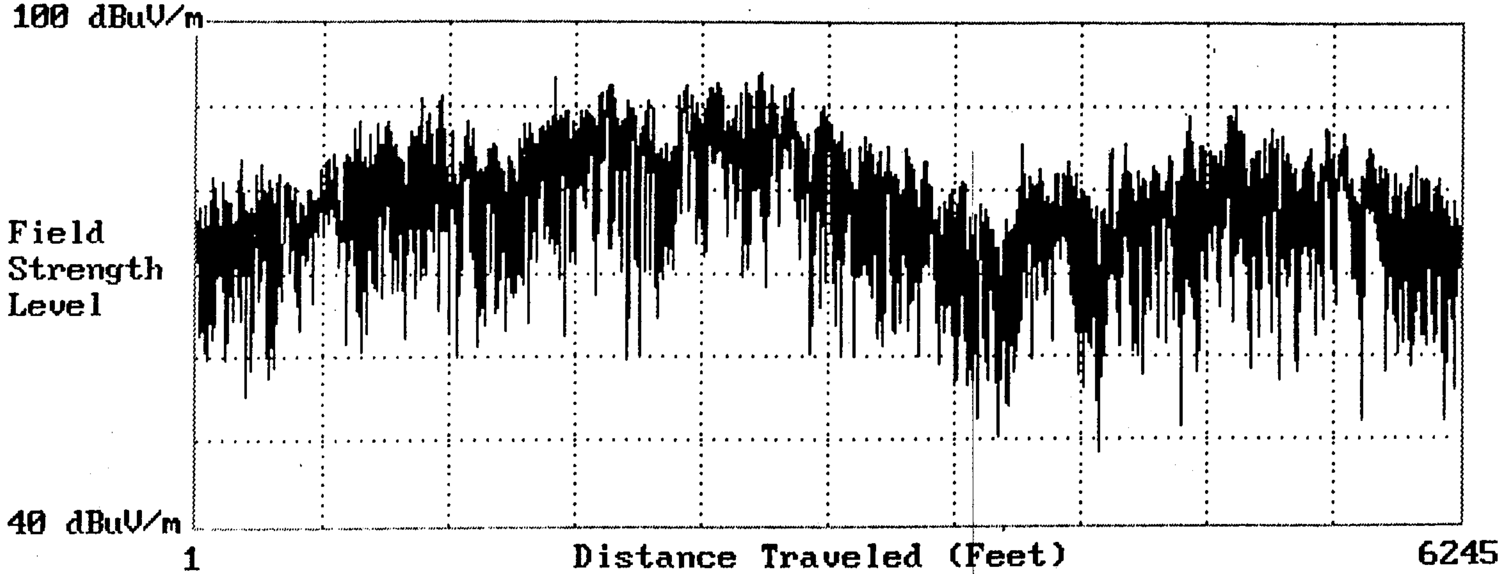
Filename: c:\eia\1019_7.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run on 8' frame; Atwater-St.Antione-Jefferson Route.

Freq. (Mhz.): 101.9
Time: 17:03:57
Field-Strength vs. Distance



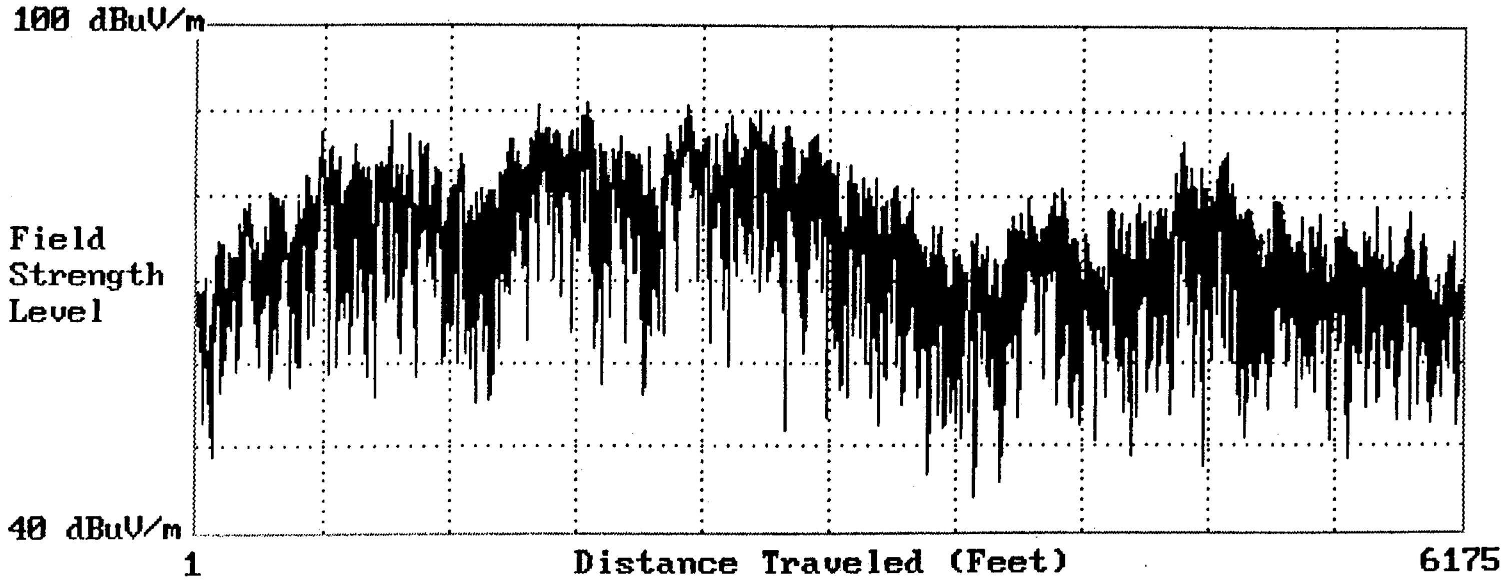
(X) Rescale X-Axis, (Y) Rescale Y-Axis, (D) DOS Shell, (R) Return
(F) Plot Another File

Filename: c:\eia\1019_8.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
Freq. (Mhz.): 101.9
Time: 17:11:00
Field-Strength vs. Distance
2nd Run on 8' frame; Atwater-St.Antione-Jefferson Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (D) DOS Shell, (R) Return
(F) Plot Another File

Filename: c:\eia\1019_9.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
Freq. (Mhz.): 101.9
Time: 18:01:49
Field-Strength vs. Distance
1st Run w/ Test Van Antenna; Atwater-St.Antione-Jefferson Route.

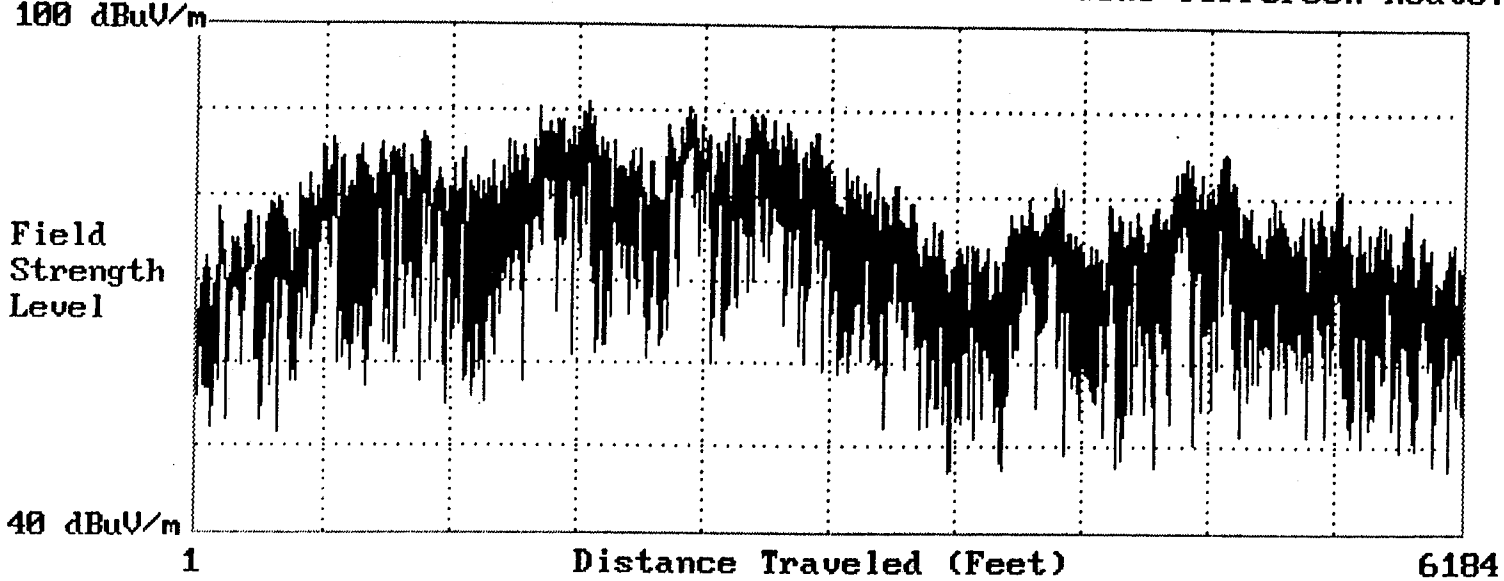


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_10.dat
Date: 03-04-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 101.9
Time: 18:09:54
Field-Strength vs. Distance

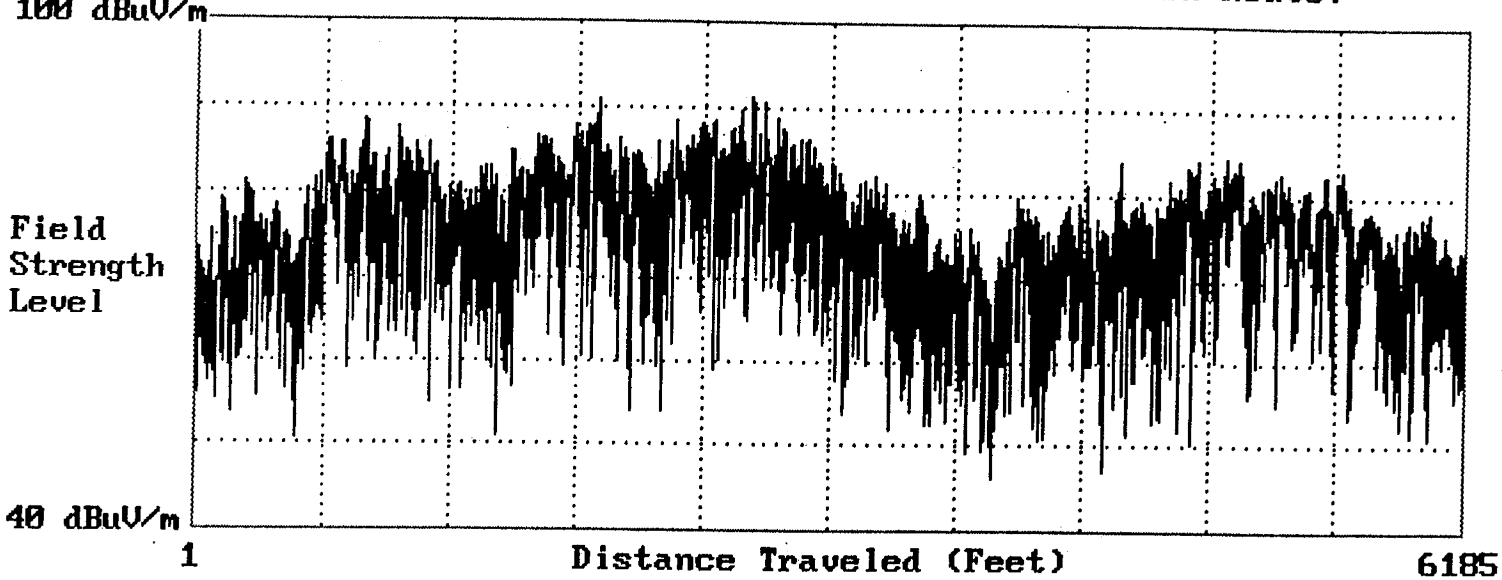
2nd Run w/ Test van Antenna; Atwater-St.Antione-Jefferson Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_11.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run on 2' frame; Atwater-St.Antione-Jefferson Route.

Freq. (Mhz.): 101.9
Time: 19:11:46
Field-Strength vs. Distance

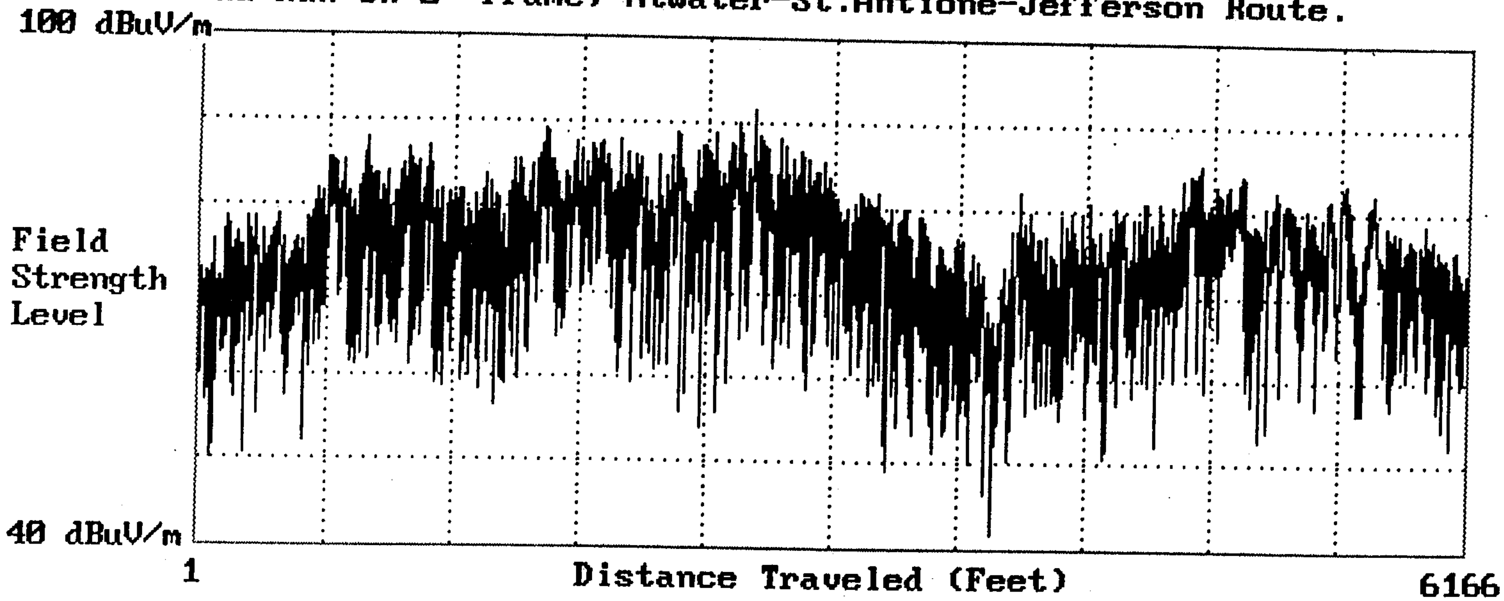


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_12.dat
Date: 03-04-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 101.9
Time: 19:18:32
Field-Strength vs. Distance

2nd Run on 2' frame; Atwater-St.Antione-Jefferson Route.

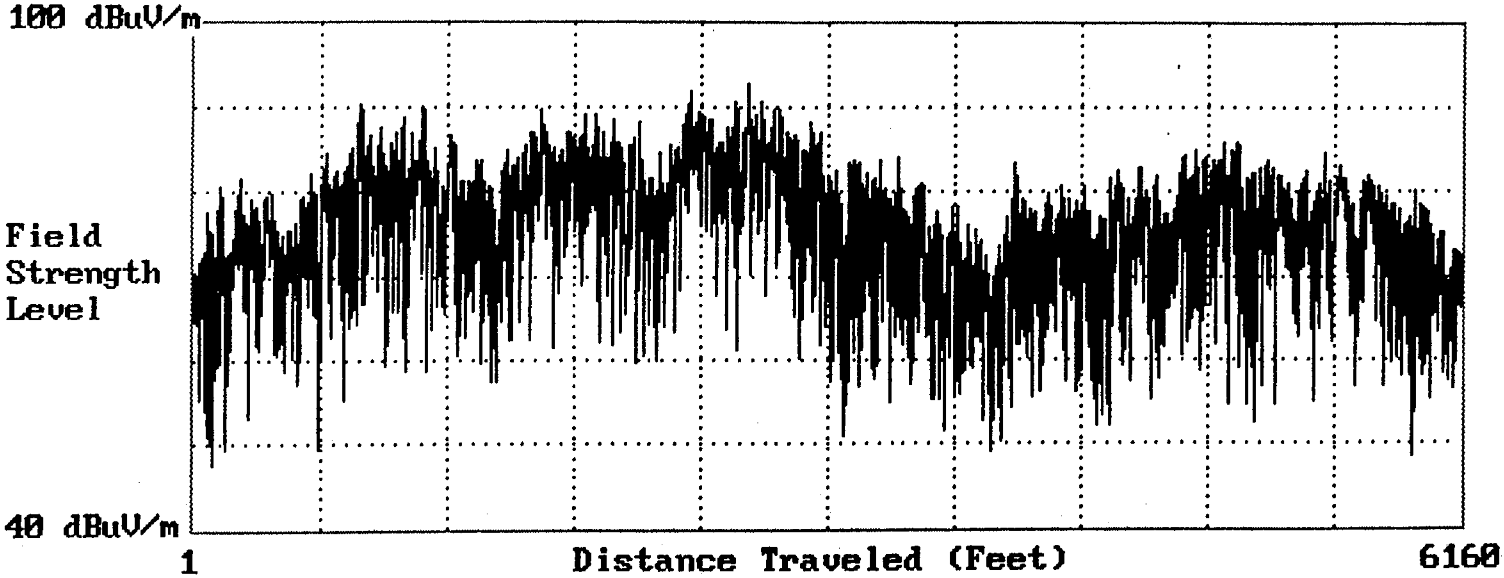


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_13.dat
Date: 03-04-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 101.9
Time: 20:15:51
Field-Strength vs. Distance

1st Run on 5' frame; Atwater-St.Antione-Jefferson Route.

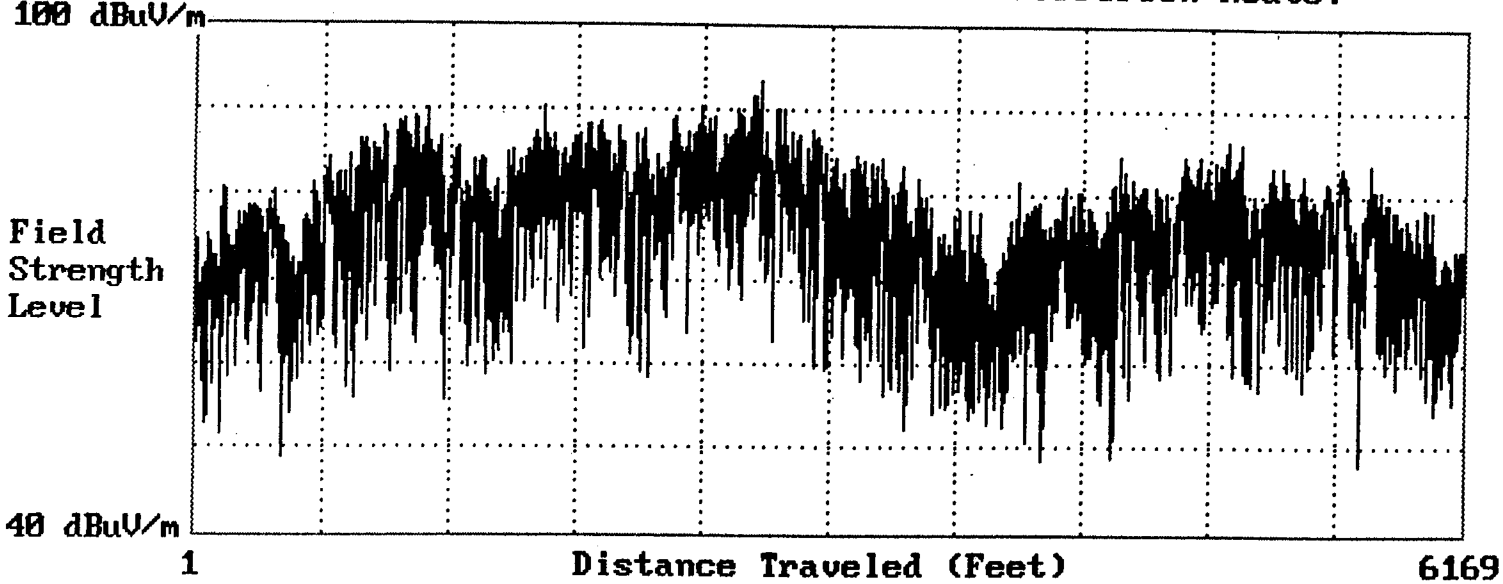


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1019_14.dat
Date: 03-04-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 101.9
Time: 20:23:25
Field-Strength vs. Distance

2nd Run on 5' frame; Atwater-St.Antione-Jefferson Route.

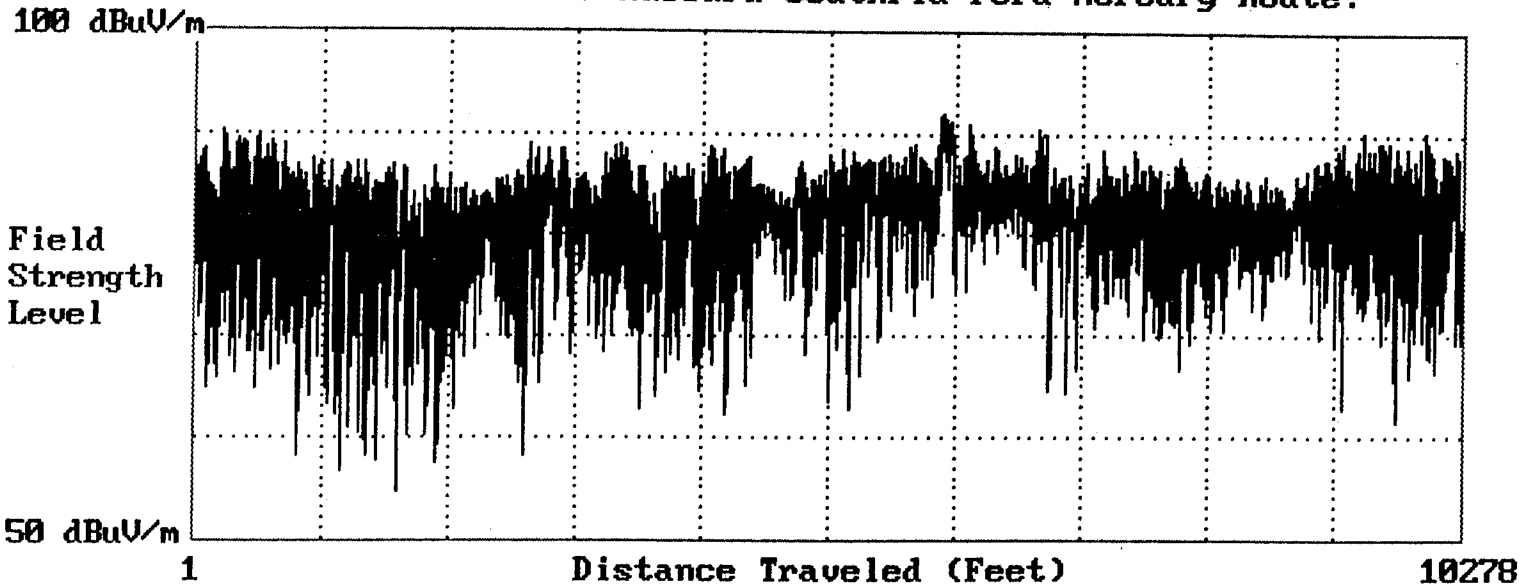


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_1.dat
Date: 03-01-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 103.5
Time: 17:53:34
Field-Strength vs. Distance

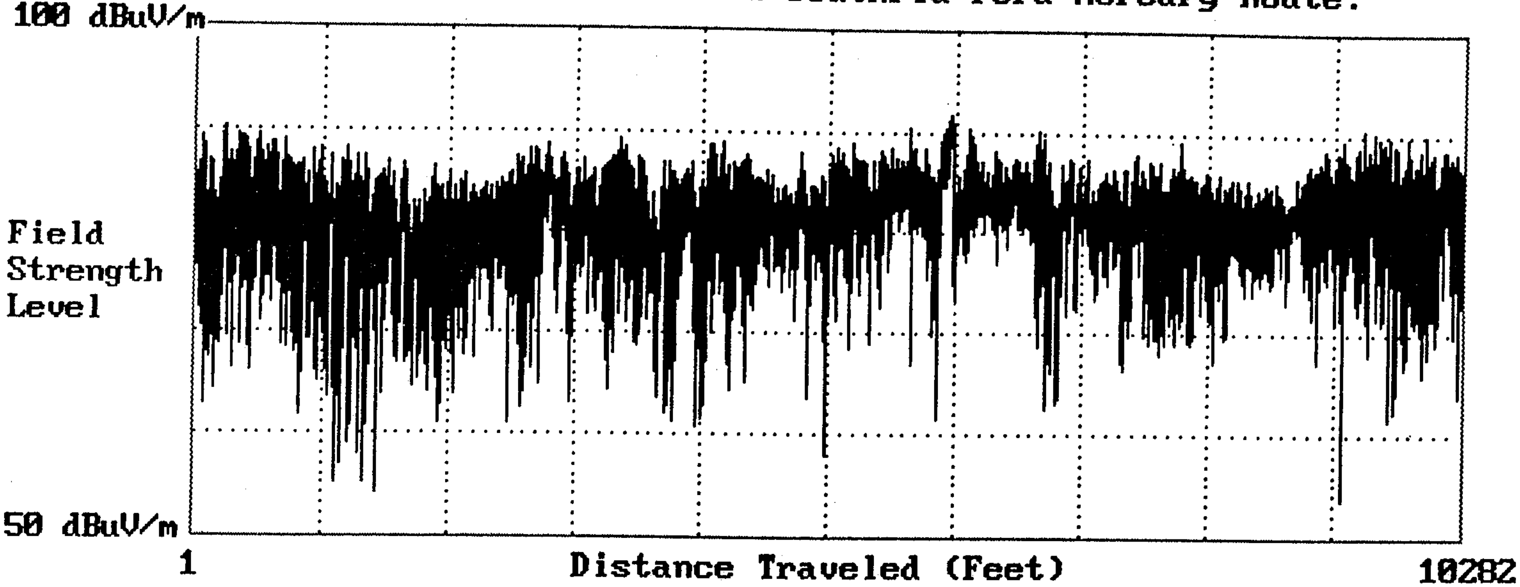
1st Run on 5' frame; Hubbard-Southfld-Ford-Mercury Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_2.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 5' frame; Hubbard-Southfld-Ford-Mercury Route.

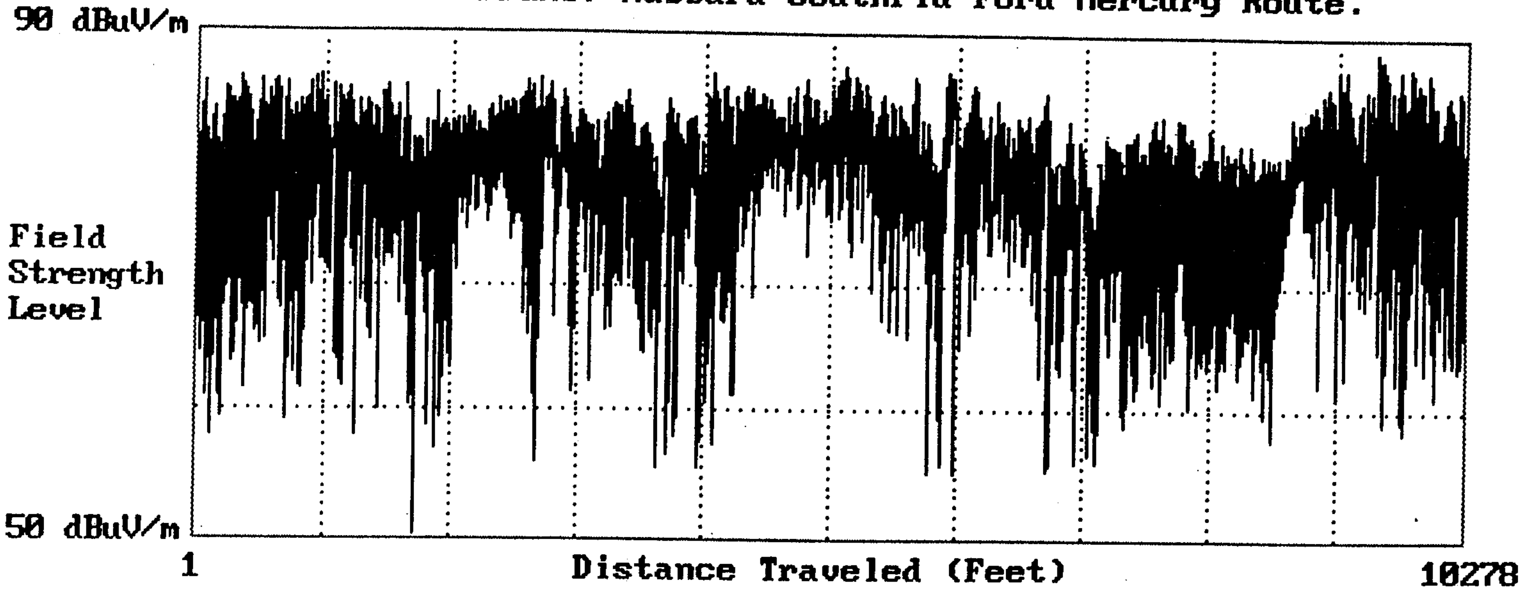
Freq. (Mhz.): 103.5
Time: 18:01:28
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_3.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
1st Run on 2' frame; Hubbard-Southfld-Ford-Mercury Route.

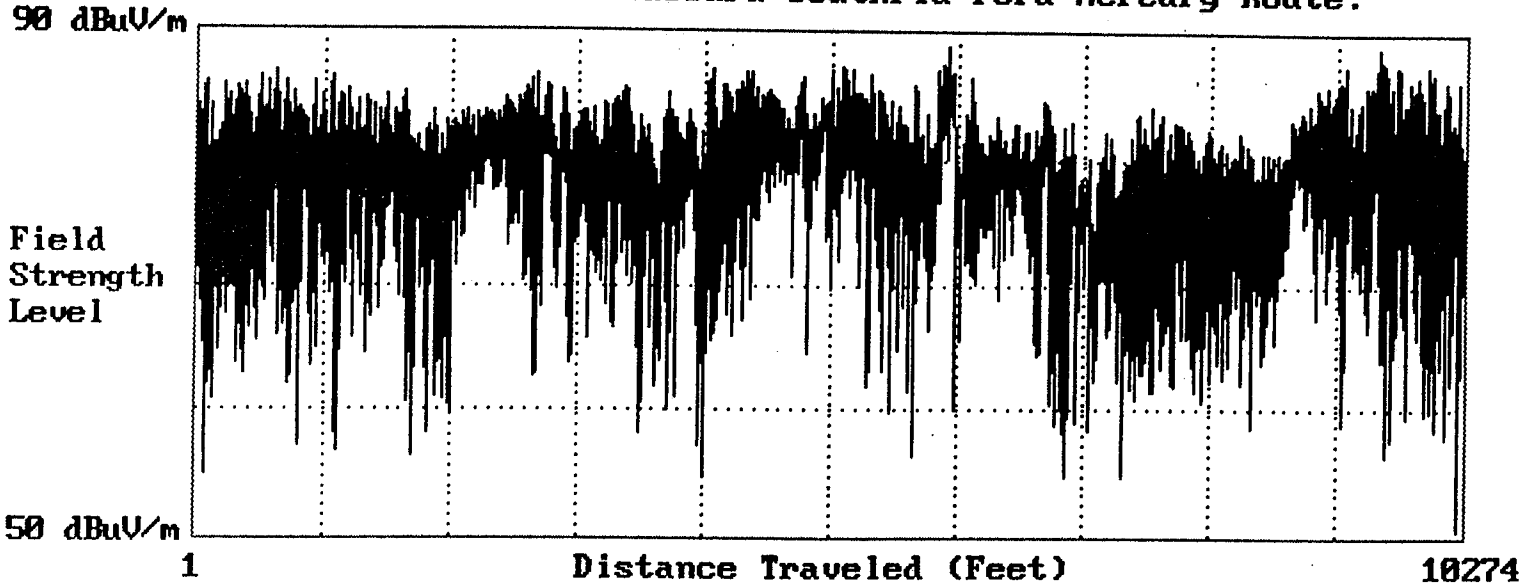
Freq. (Mhz.): 103.5
Time: 19:07:21
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_4.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 2' frame; Hubbard-Southfld-Ford-Mercury Route.

Freq. (Mhz.): 103.5
Time: 19:17:12
Field-Strength vs. Distance

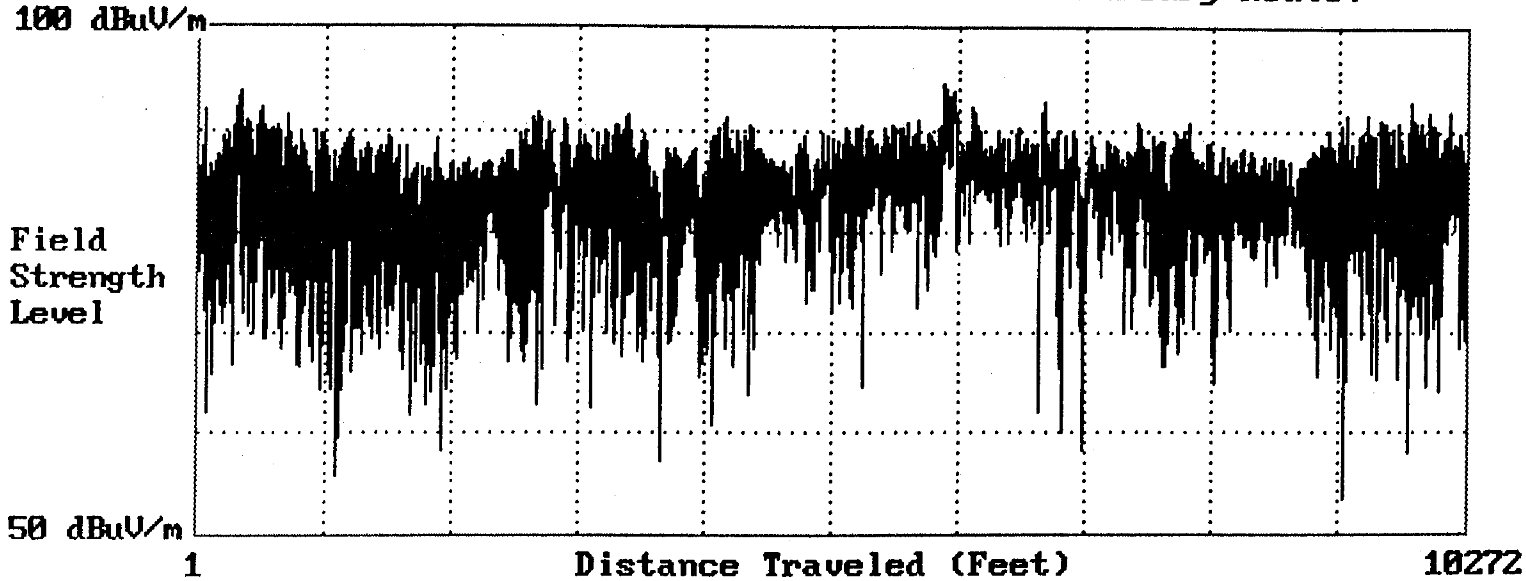


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_5.dat
Date: 03-01-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 103.5
Time: 22:25:42
Field-Strength vs. Distance

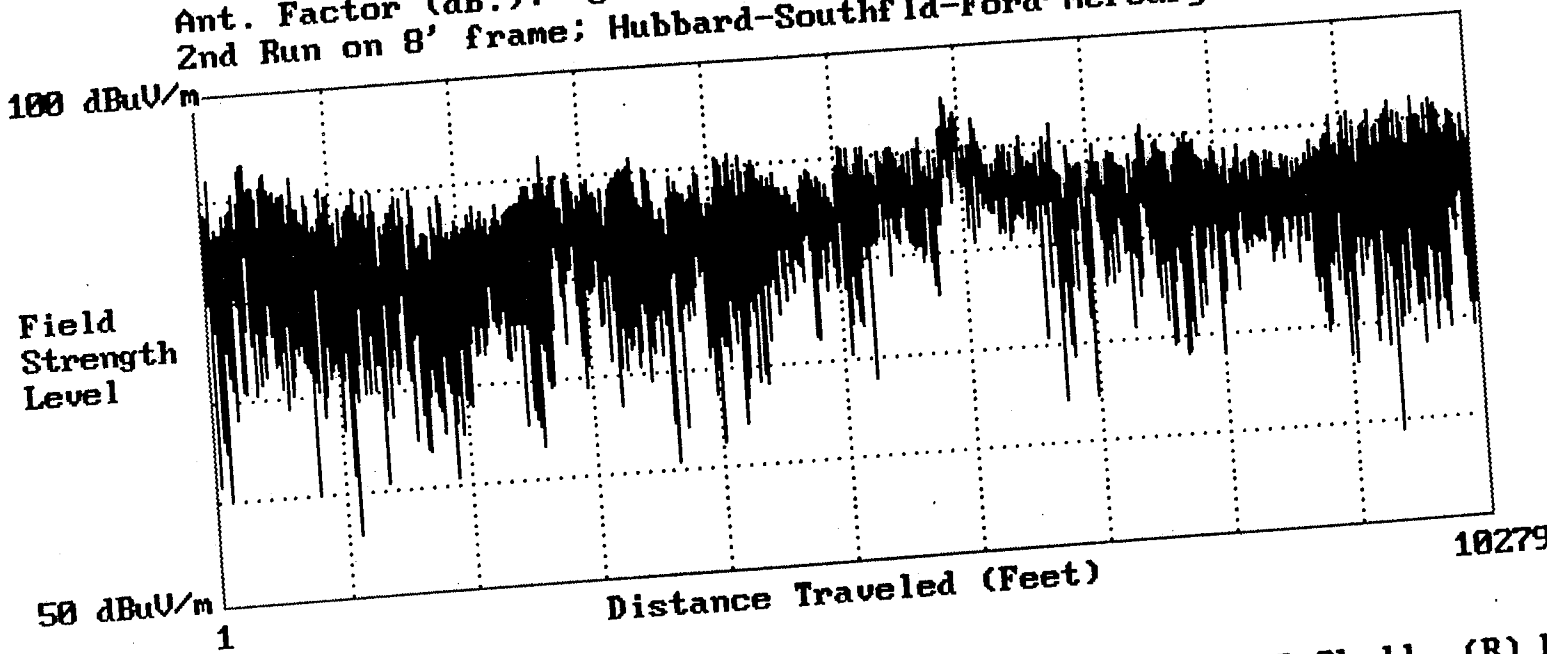
1st Run on 8' frame; Hubbard-Southfld-Ford-Mercury Route.



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_6.dat
Date: 03-01-1996
Ant. Factor (dB.): 0
2nd Run on 8' frame; Hubbard-Southfld-Ford-Mercury Route.

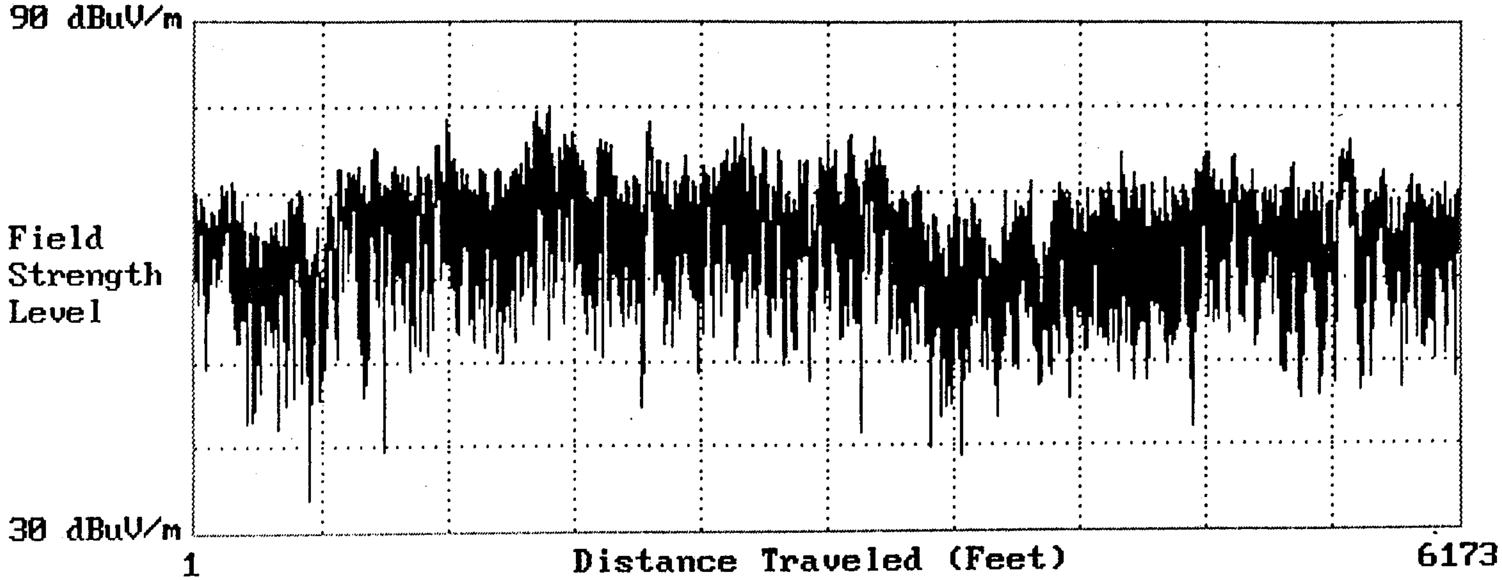
Freq. (Mhz.): 103.5
Time: 22:35:39
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_7.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run on 8' frame: Atwater-St.Antione-Jefferson Route.

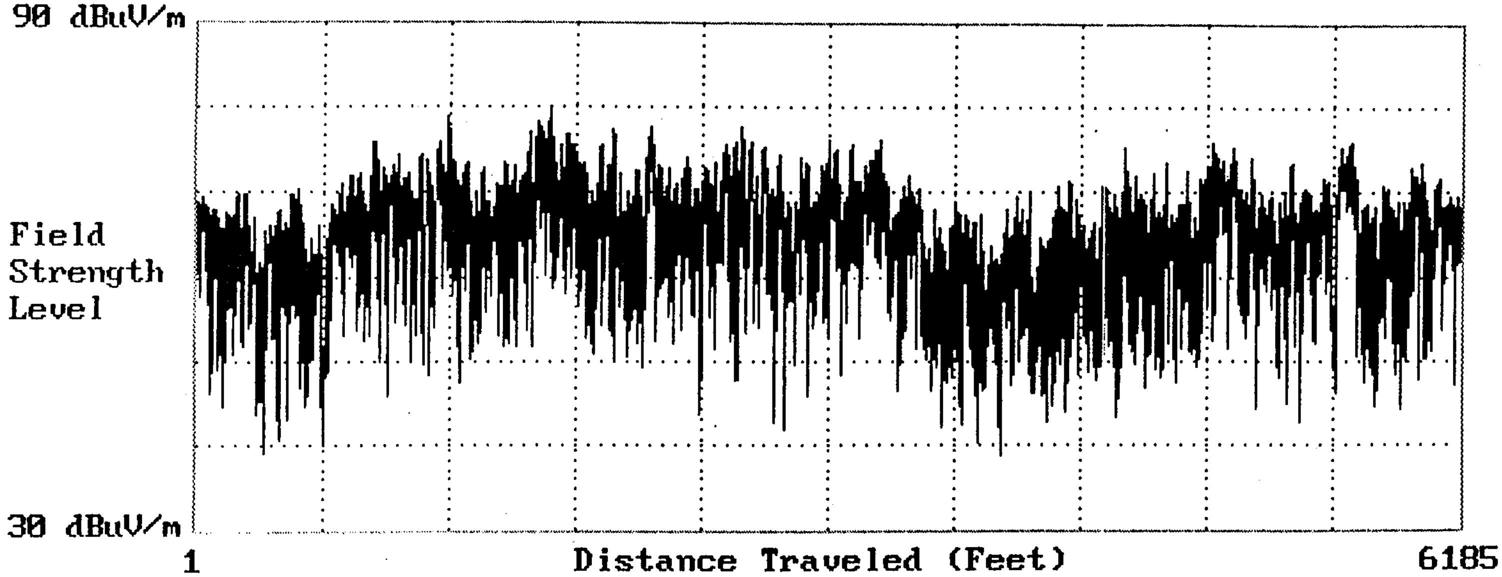
Freq. (Mhz.): 103.5
Time: 17:18:21
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (D) DOS Shell, (R) Return
(F) Plot Another File

Filename: c:\eia\1035_8.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
2nd Run on 8' frame; Atwater-St.Antione-Jefferson Route.

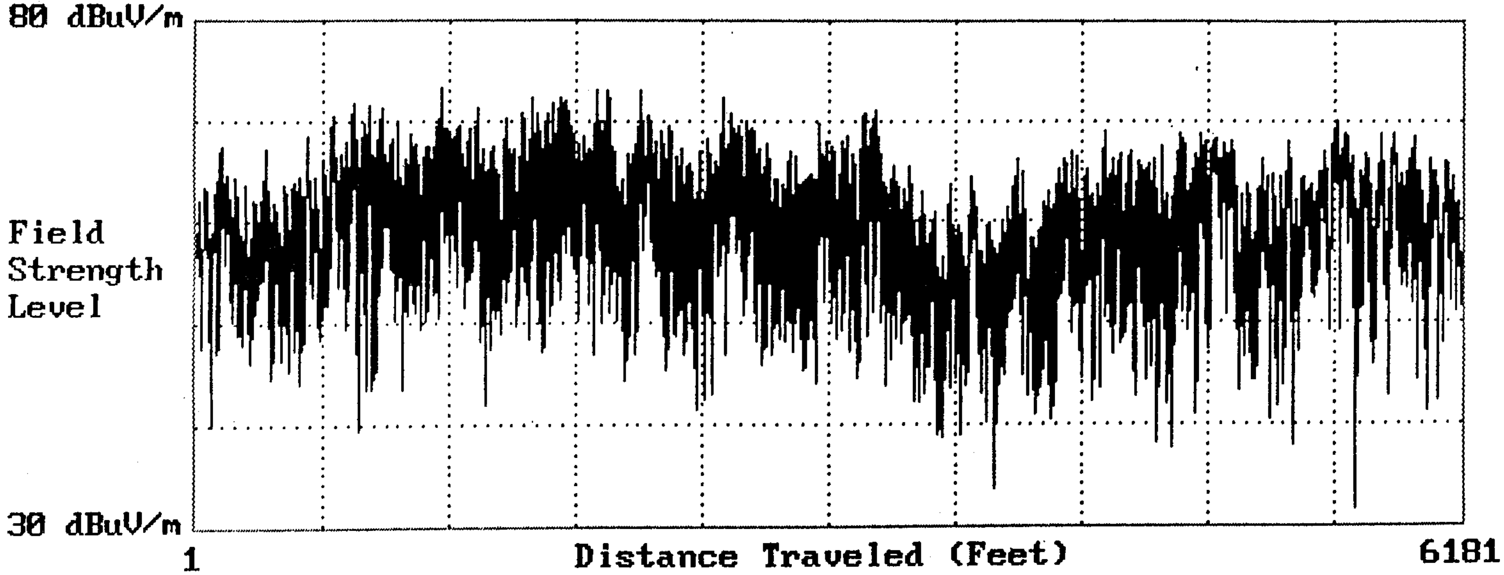
Freq. (Mhz.): 103.5
Time: 17:24:51
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_9.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run w/ Test Van Antenna; Atwater-St.Antione-Jefferson Route.

Freq. (Mhz.): 103.5
Time: 18:17:00
Field-Strength vs. Distance

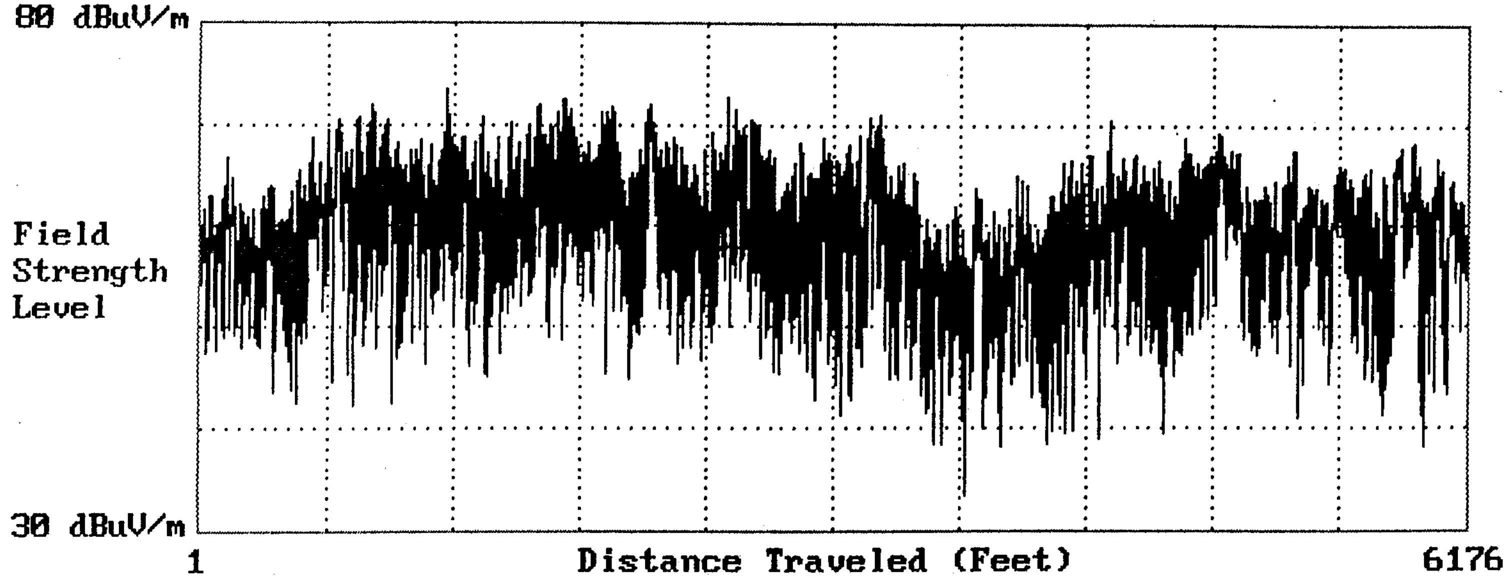


(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_10.dat
Date: 03-04-1996
Ant. Factor (dB.): 0

Freq. (Mhz.): 103.5
Time: 18:24:29
Field-Strength vs. Distance

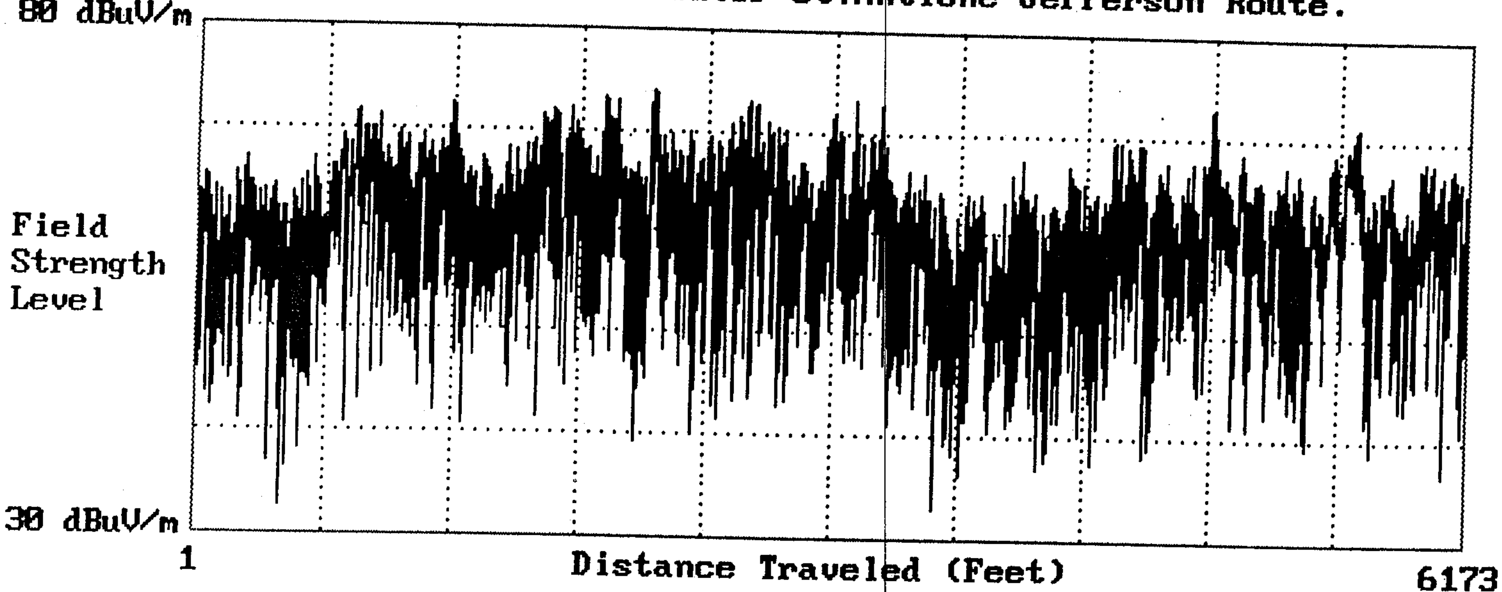
2nd Run w/ Test Van Antenna; Atwater-St.Antione-Jefferson Route.



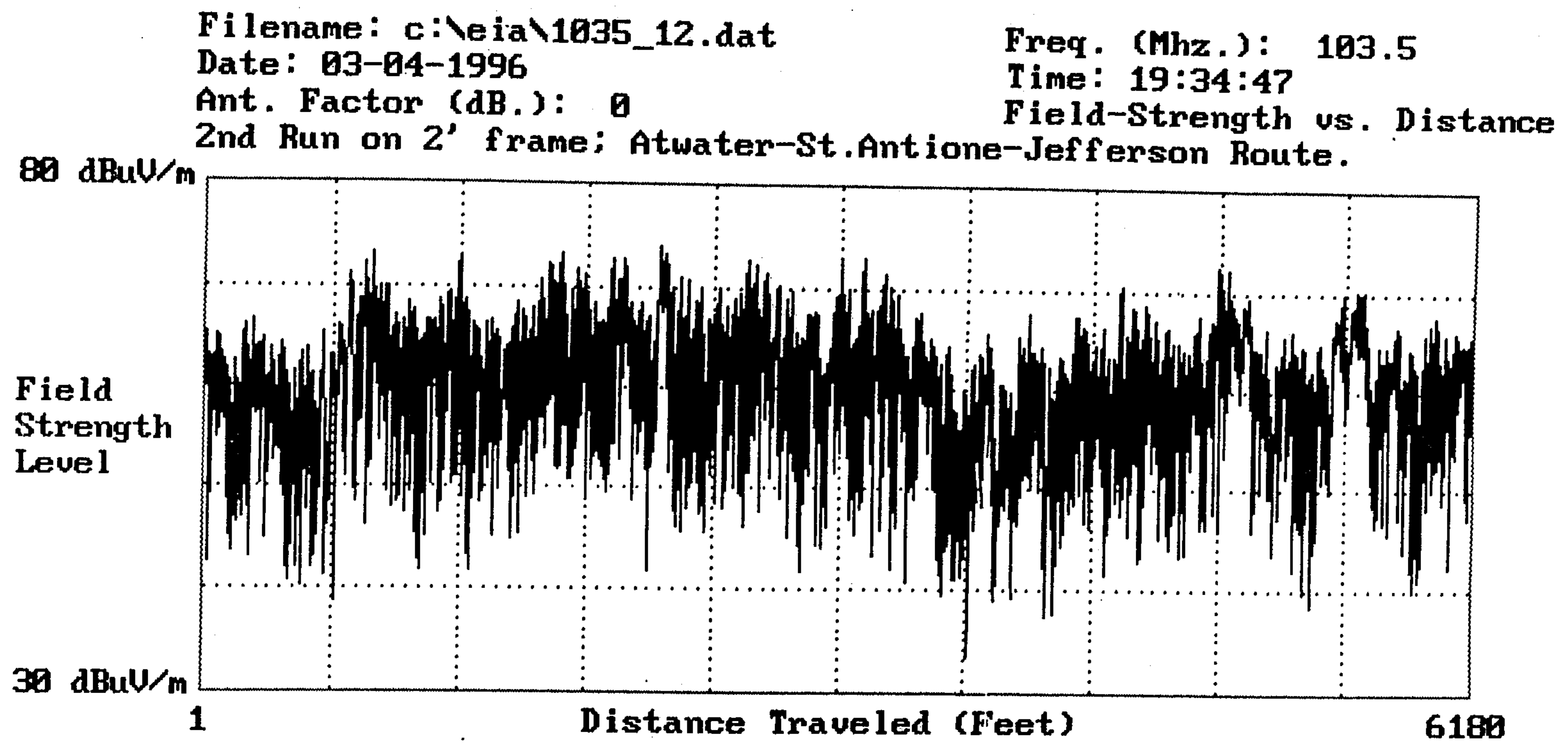
(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_11.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run on 2' frame; Atwater-St.Antione-Jefferson Route.

Freq. (Mhz.): 103.5
Time: 19:27:11
Field-Strength vs. Distance



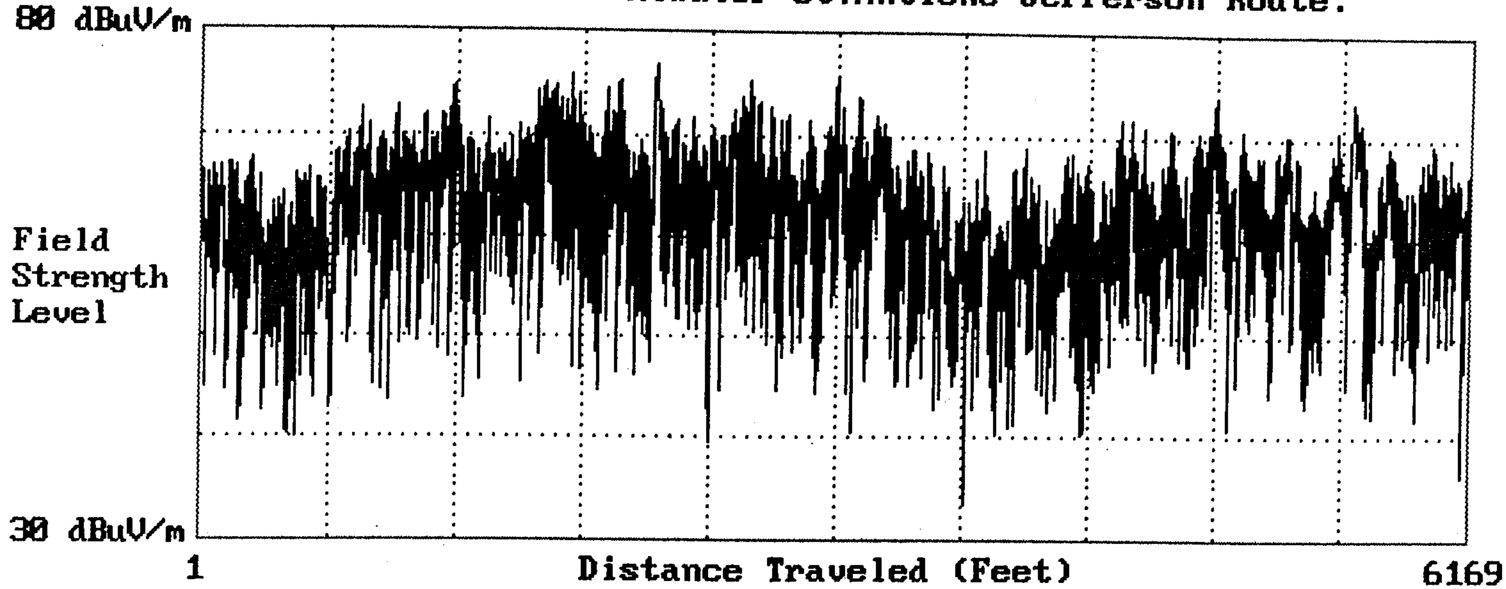
(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_13.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
1st Run on 5' frame; Atwater-St.Antione-Jefferson Route.

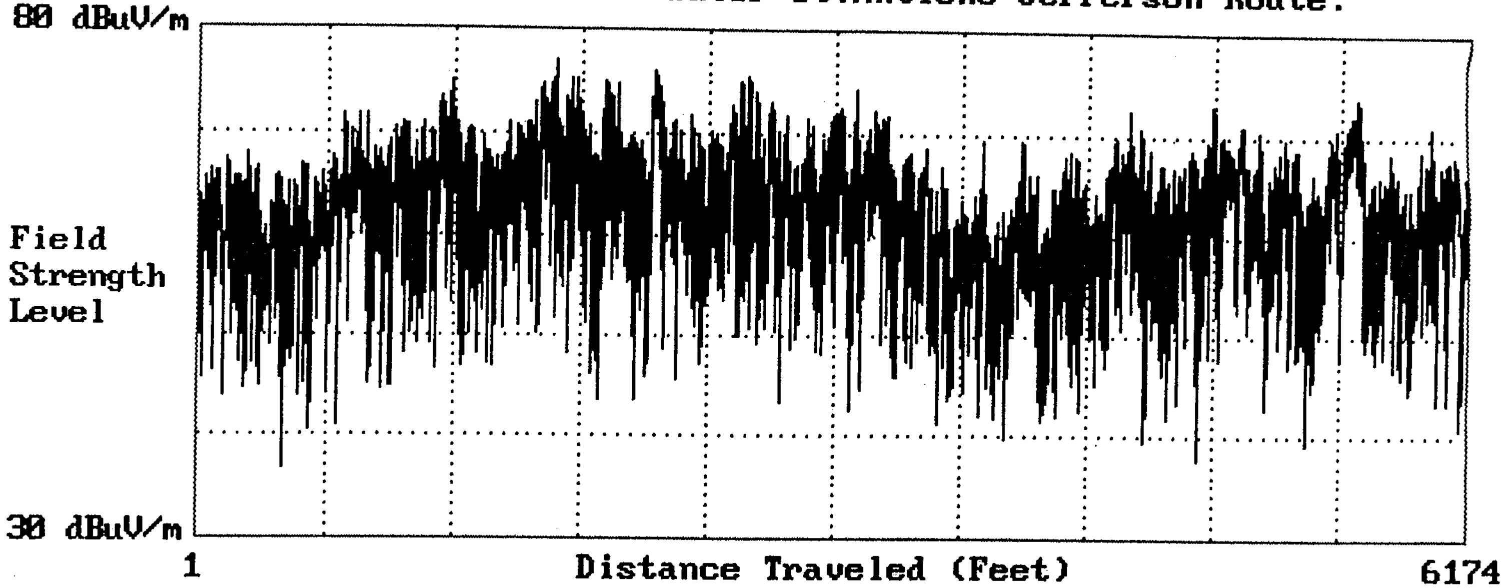
Freq. (Mhz.): 103.5
Time: 20:31:00
Field-Strength vs. Distance



(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

Filename: c:\eia\1035_14.dat
Date: 03-04-1996
Ant. Factor (dB.): 0
2nd Run on 5' frame; Atwater-St.Antione-Jefferson Route.

Freq. (Mhz.): 103.5
Time: 20:38:39
Field-Strength vs. Distance



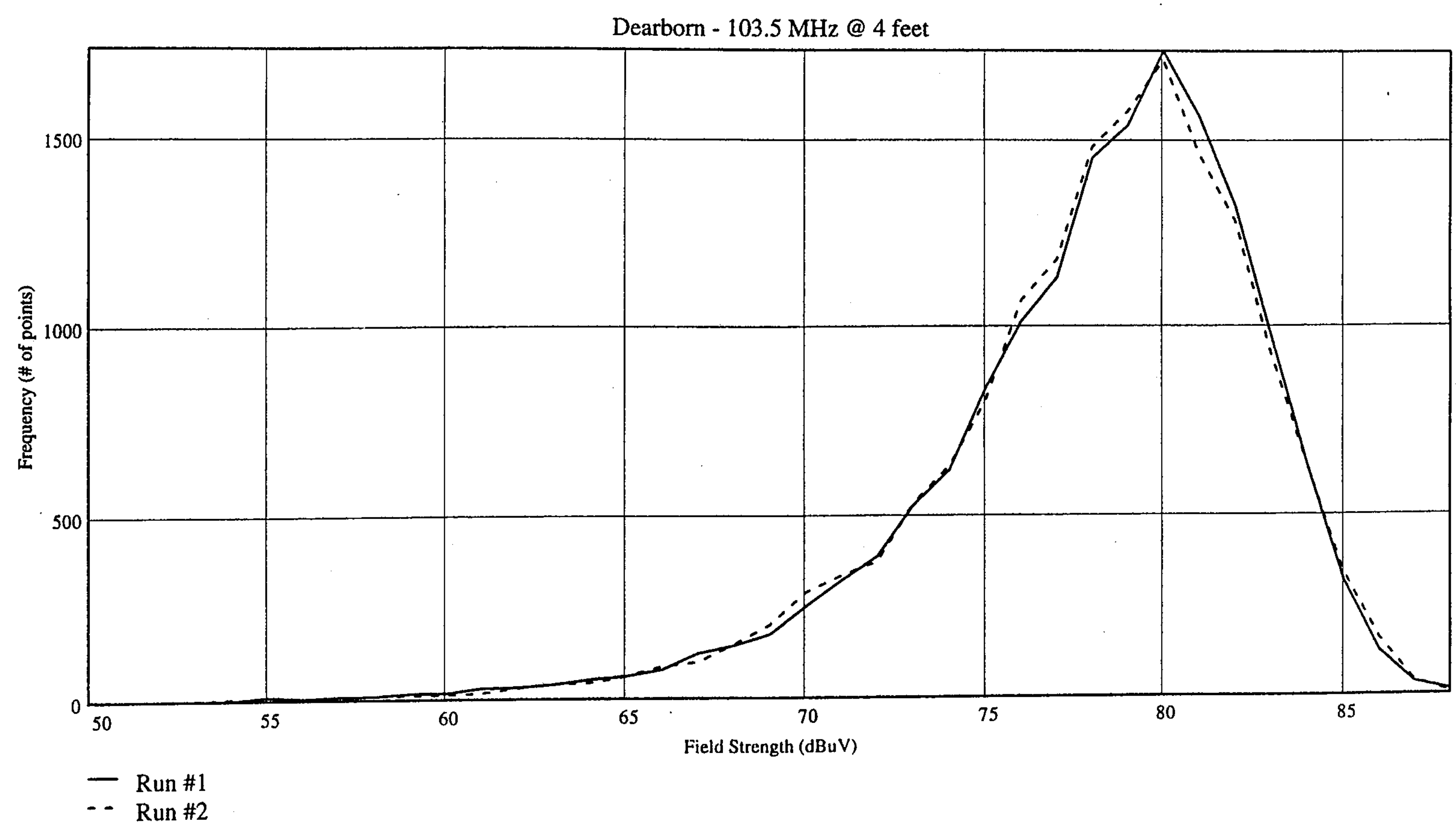
(X) Rescale X-Axis, (Y) Rescale Y-Axis, (S) Save Data, (D) DOS Shell, (R) Return

APPENDIX F

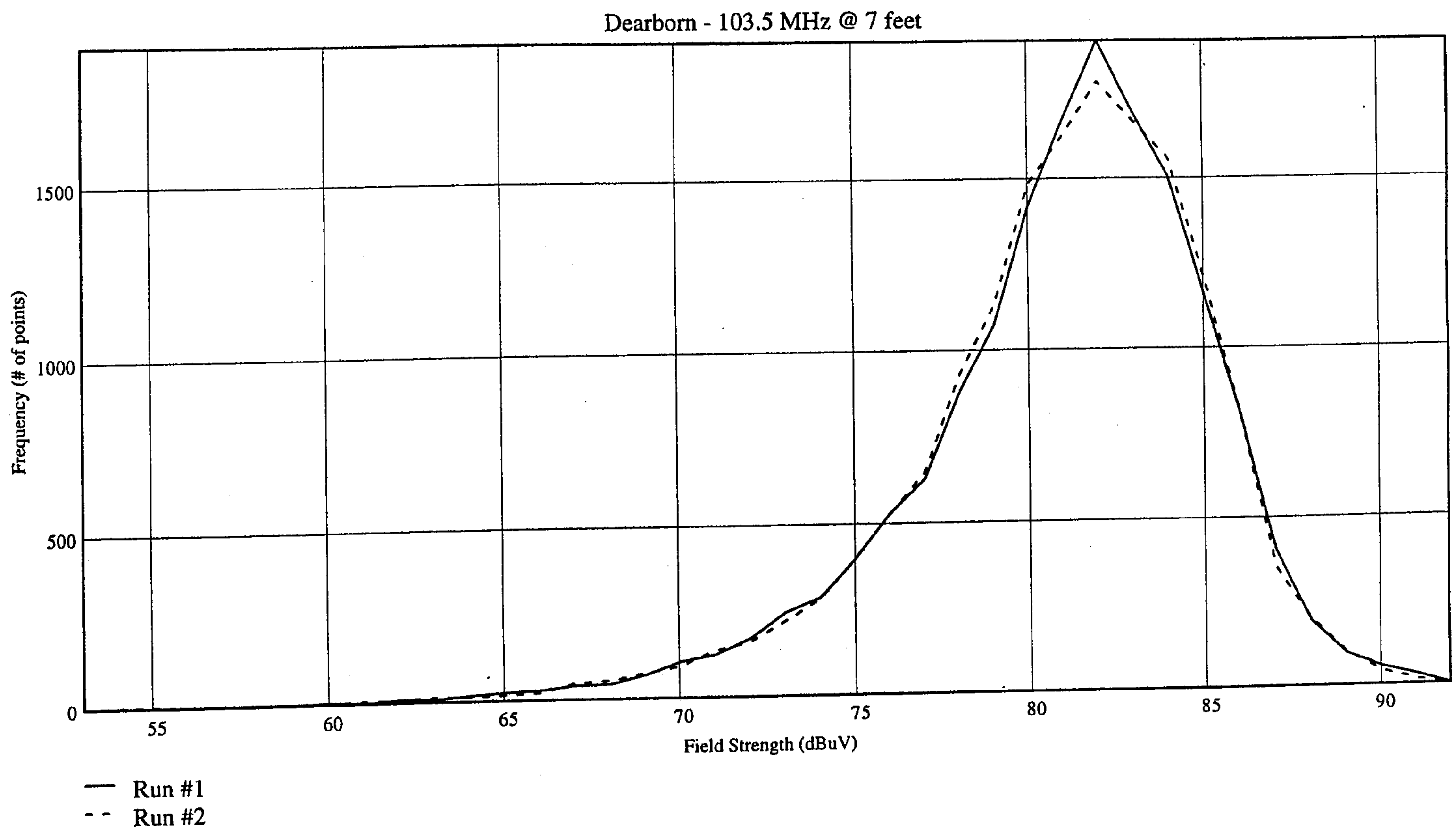
VHF Antenna Characterization - Fading vs. Antenna Height (Raw Statistics)

EIA/NAB VHF Test Antenna

Temporal Comparison of Multiple Runs

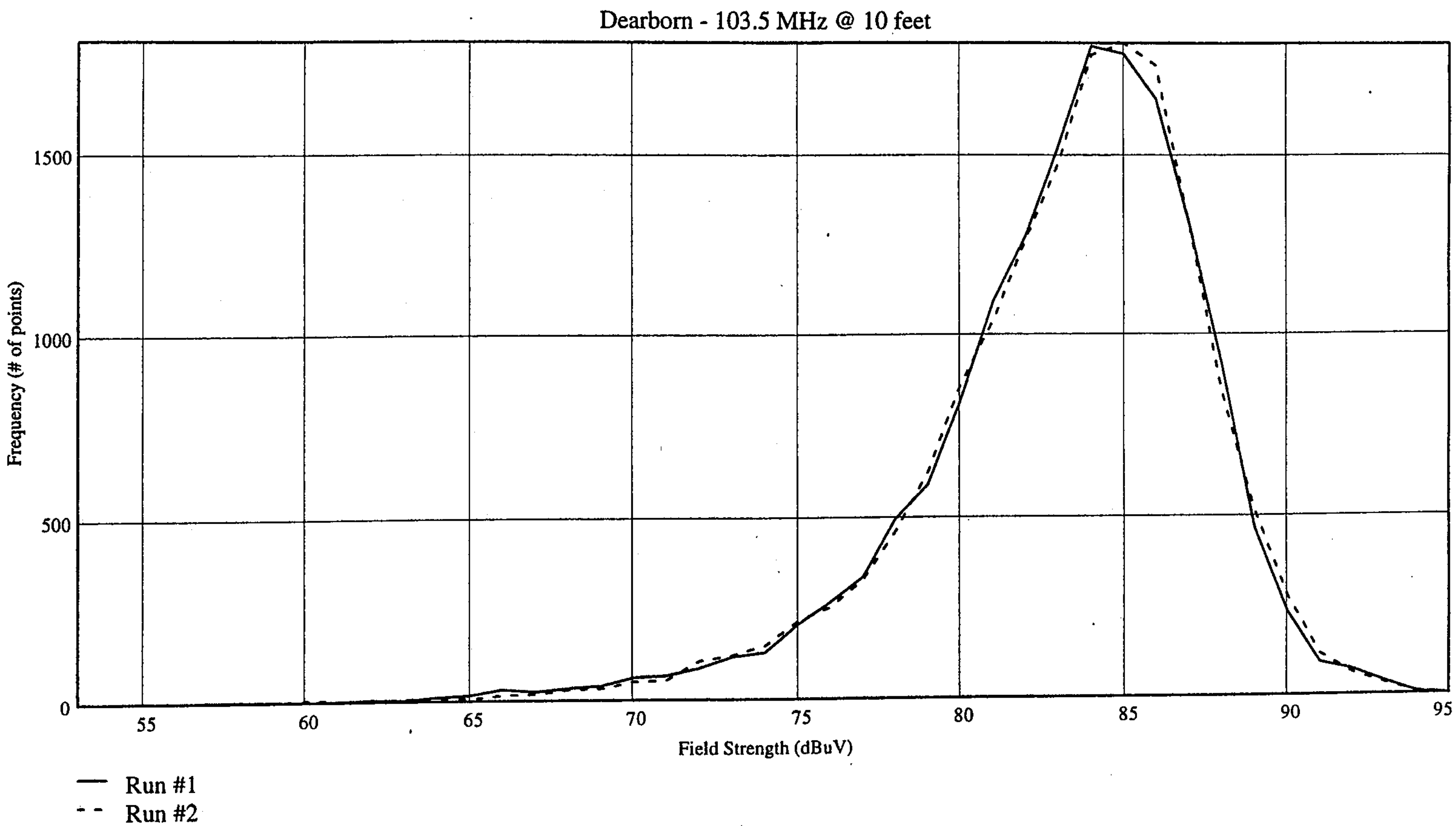


Temporal Comparison of Multiple Runs

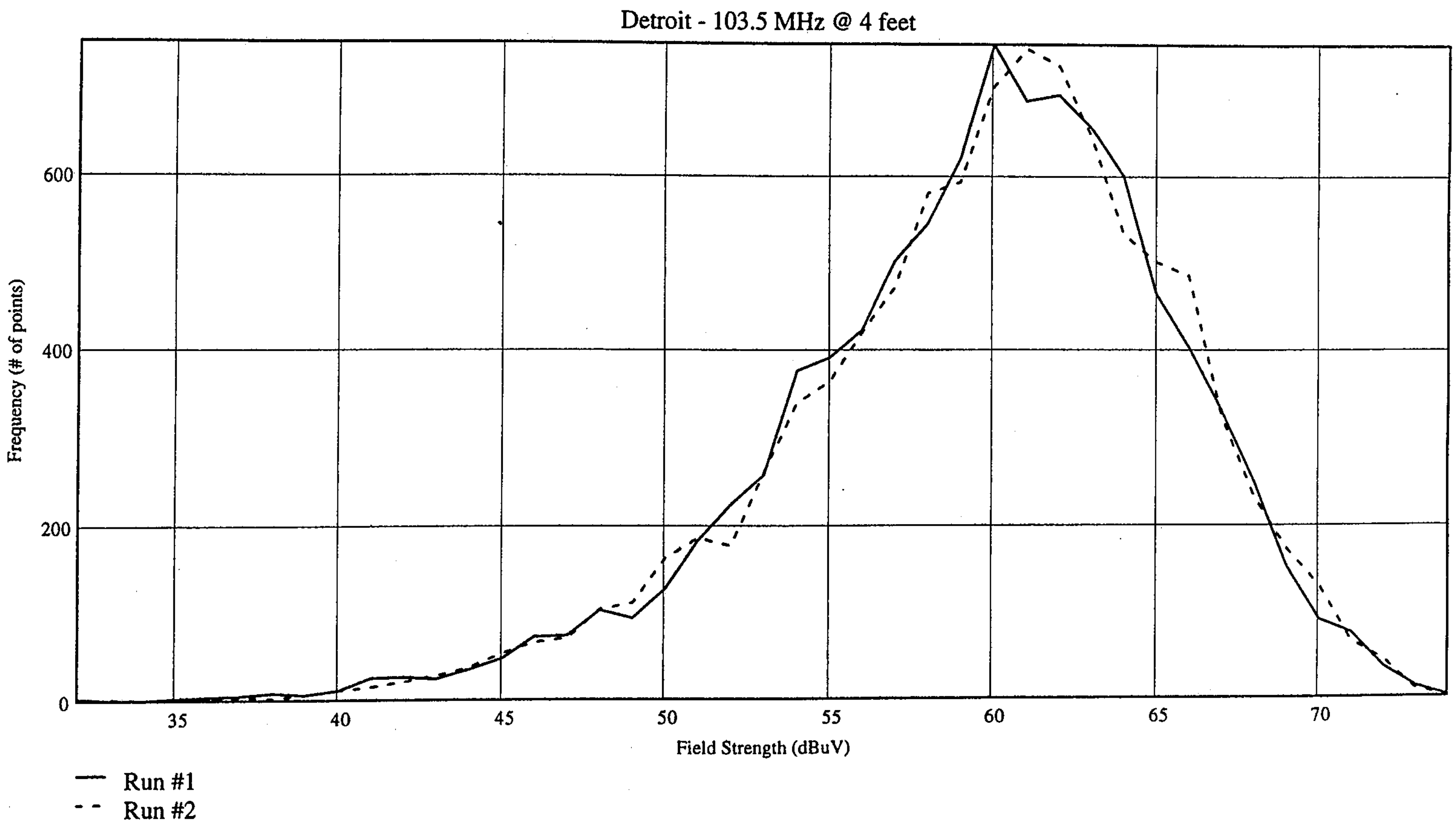


3

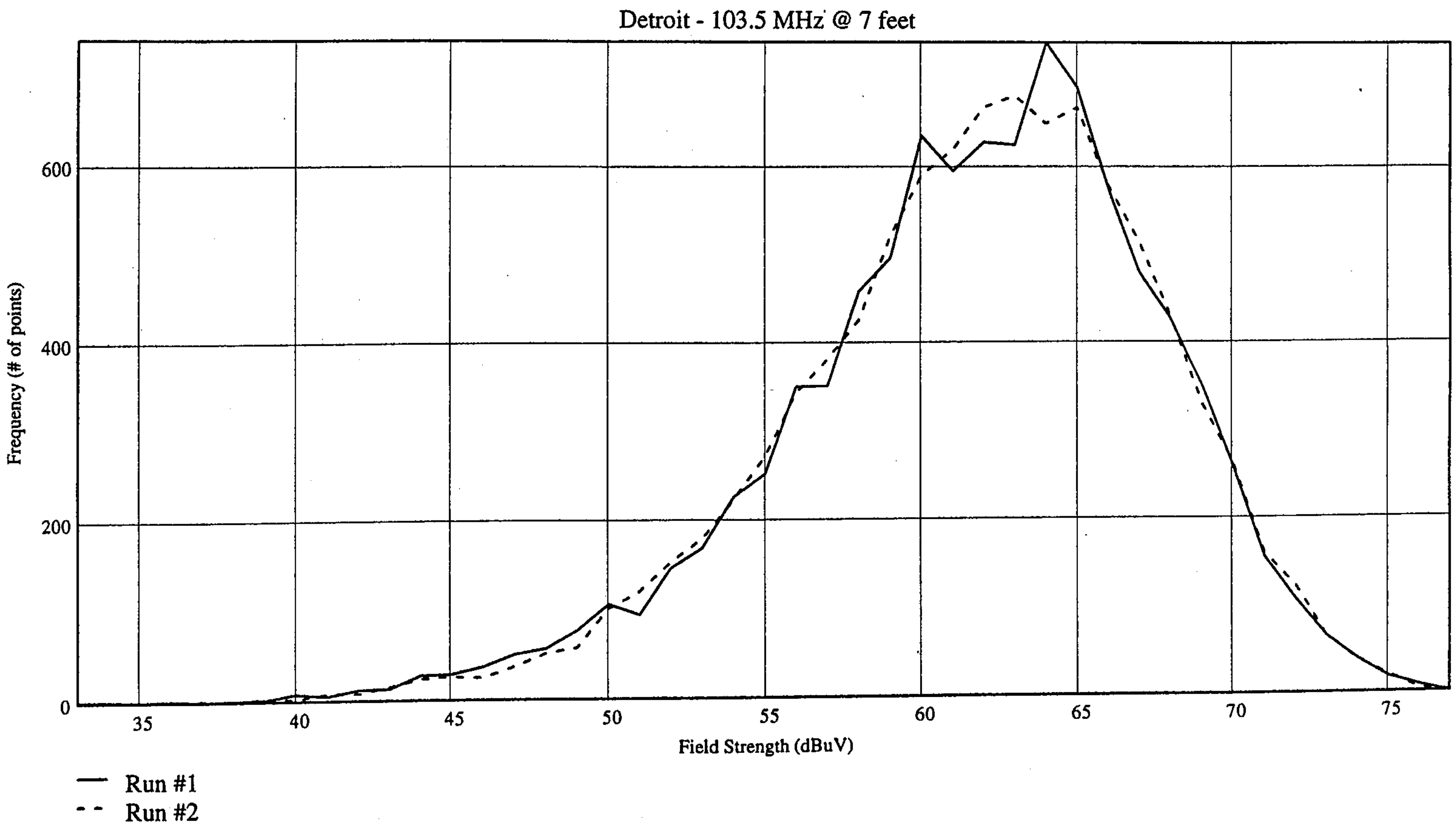
Temporal Comparison of Multiple Runs



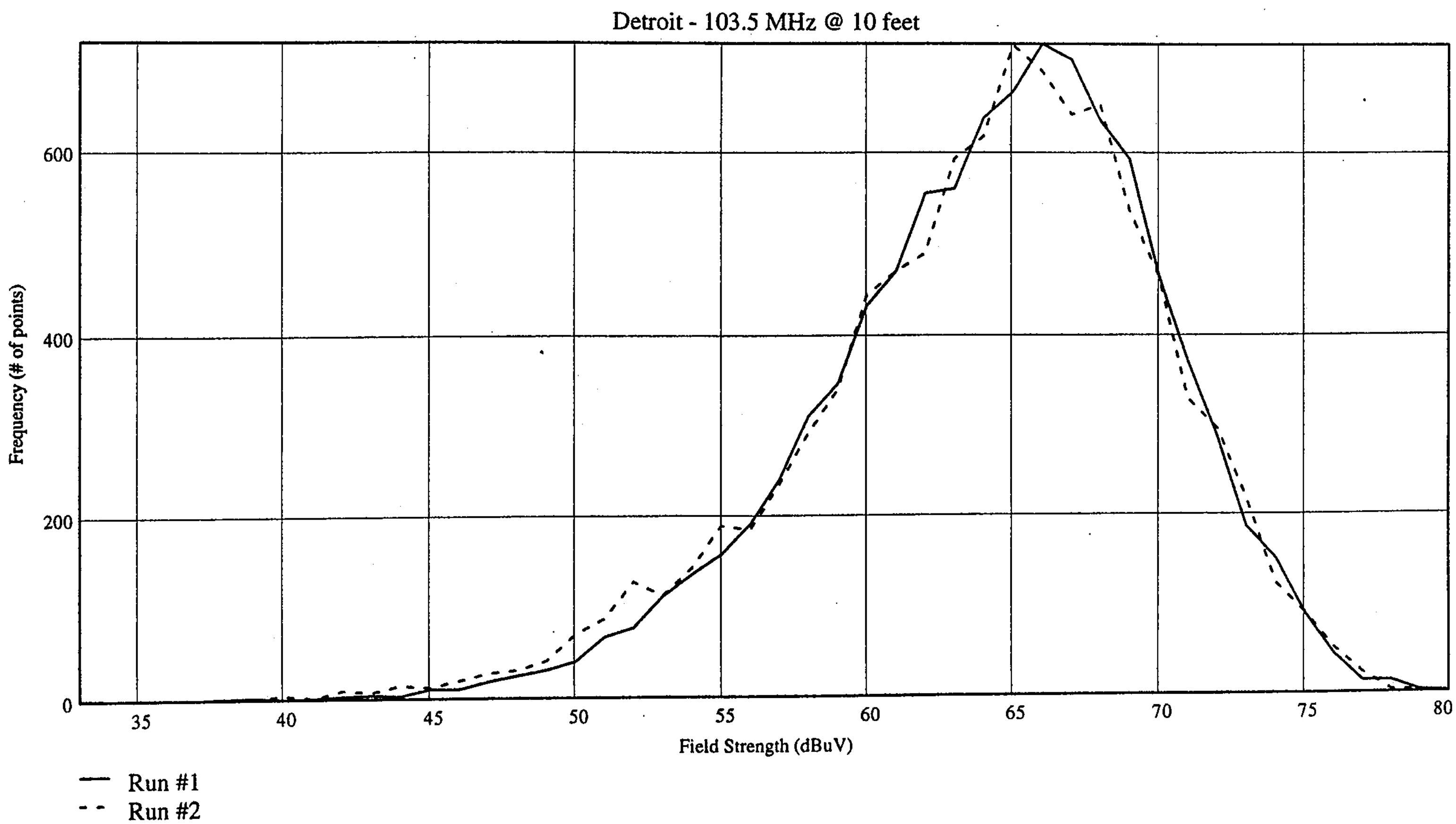
Temporal Comparison of Multiple Runs



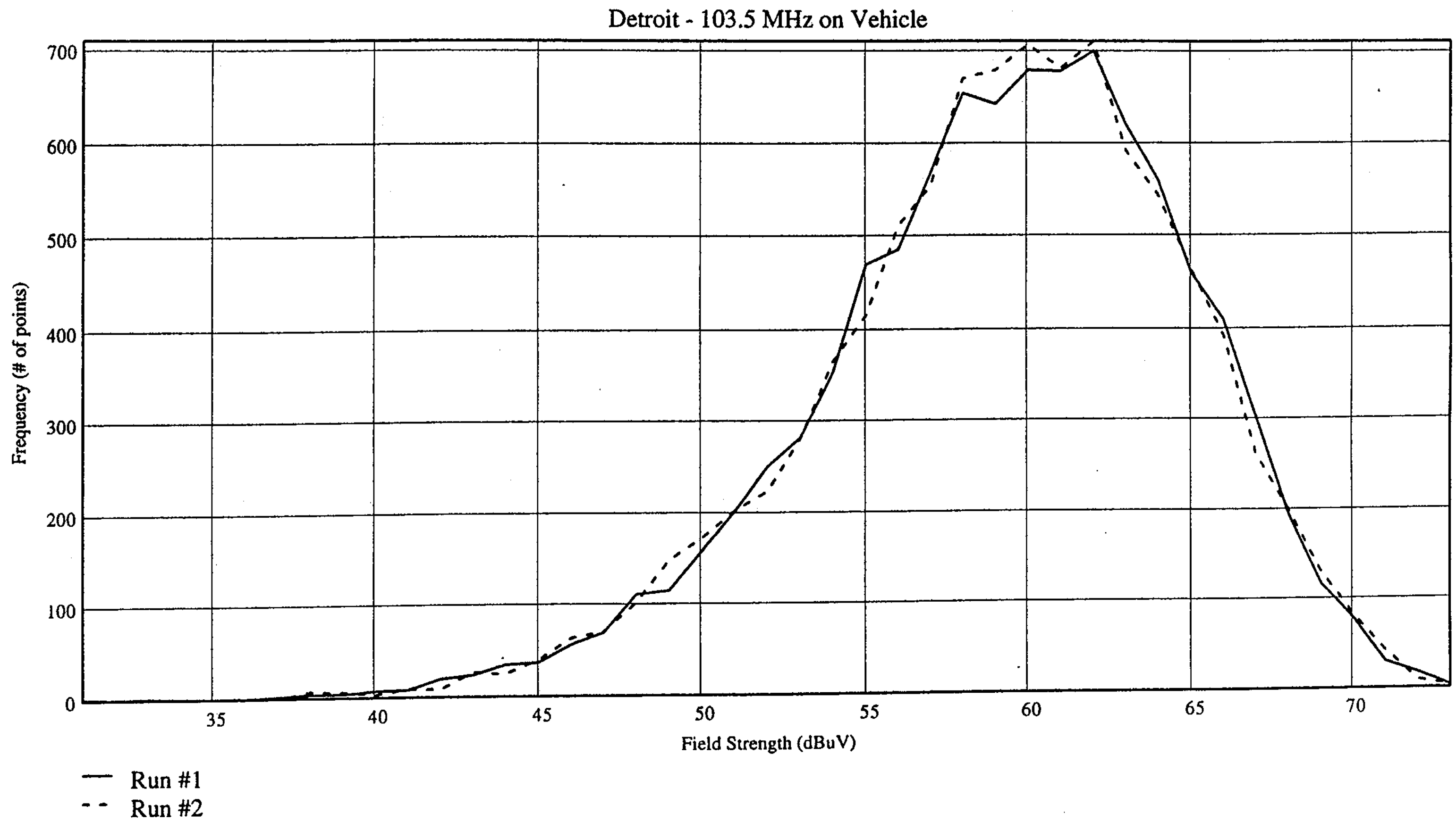
Temporal Comparison of Multiple Runs



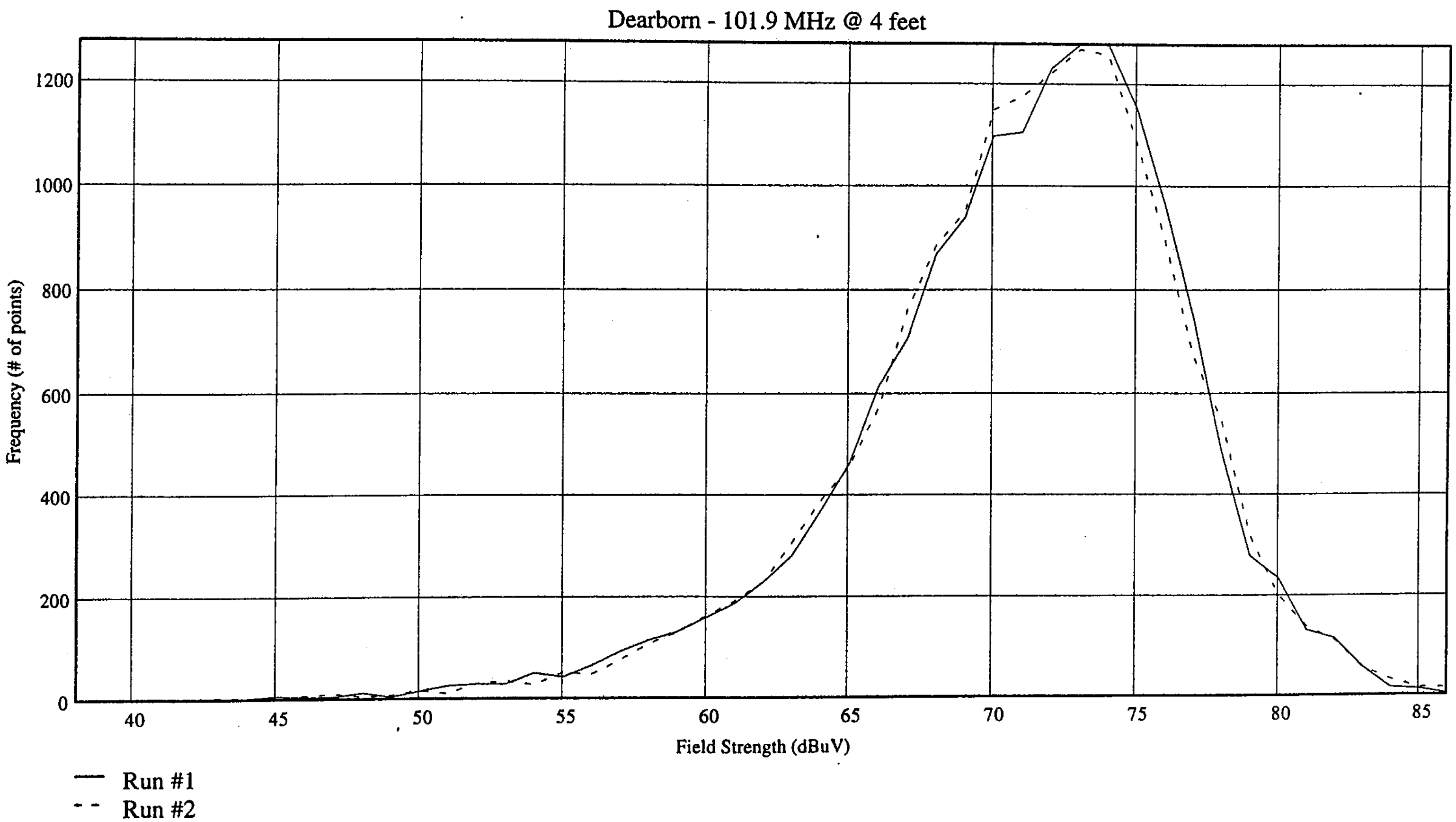
Temporal Comparison of Multiple Runs



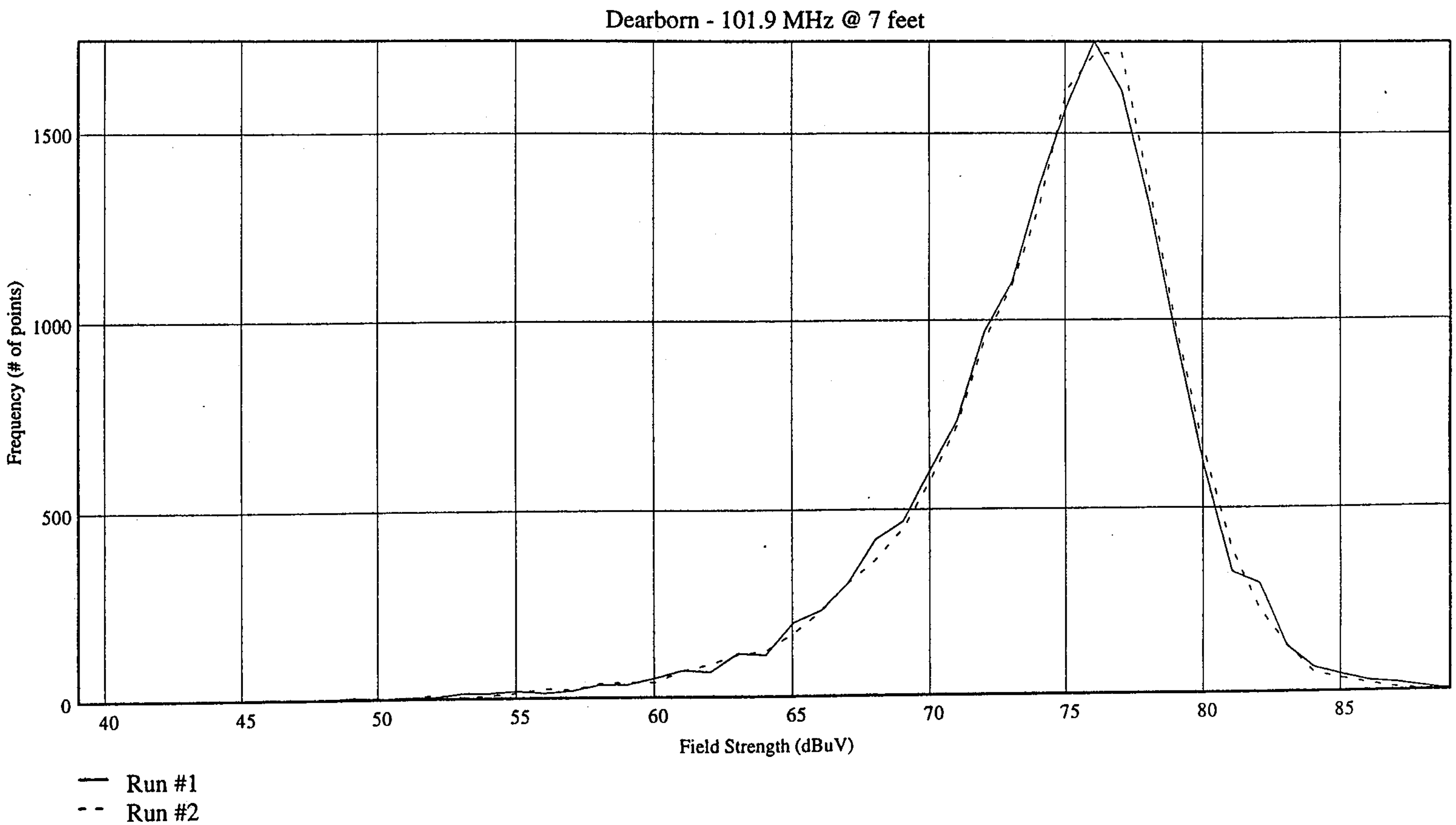
Temporal Comparison of Multiple Runs



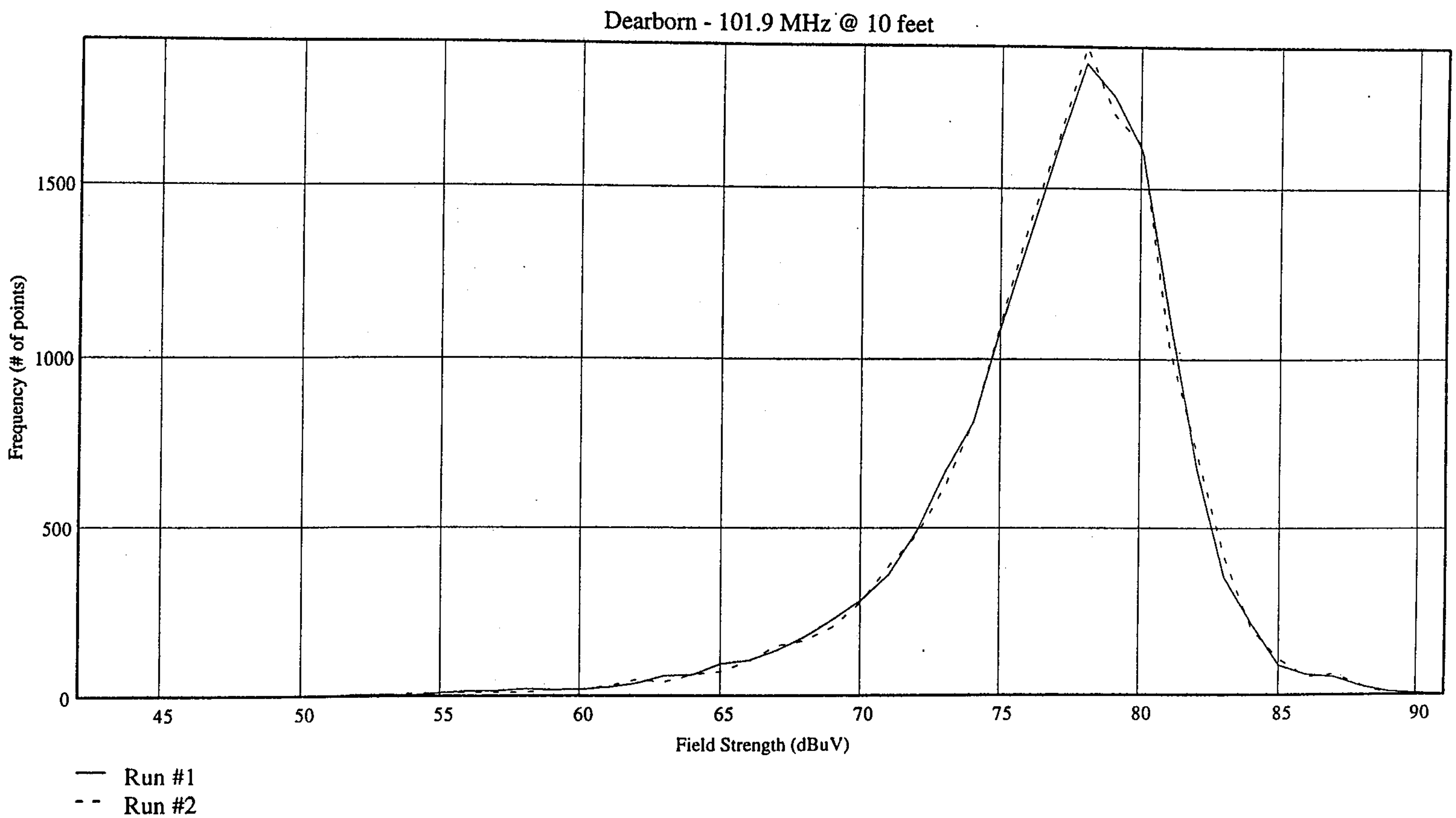
Temporal Comparison of Multiple Runs



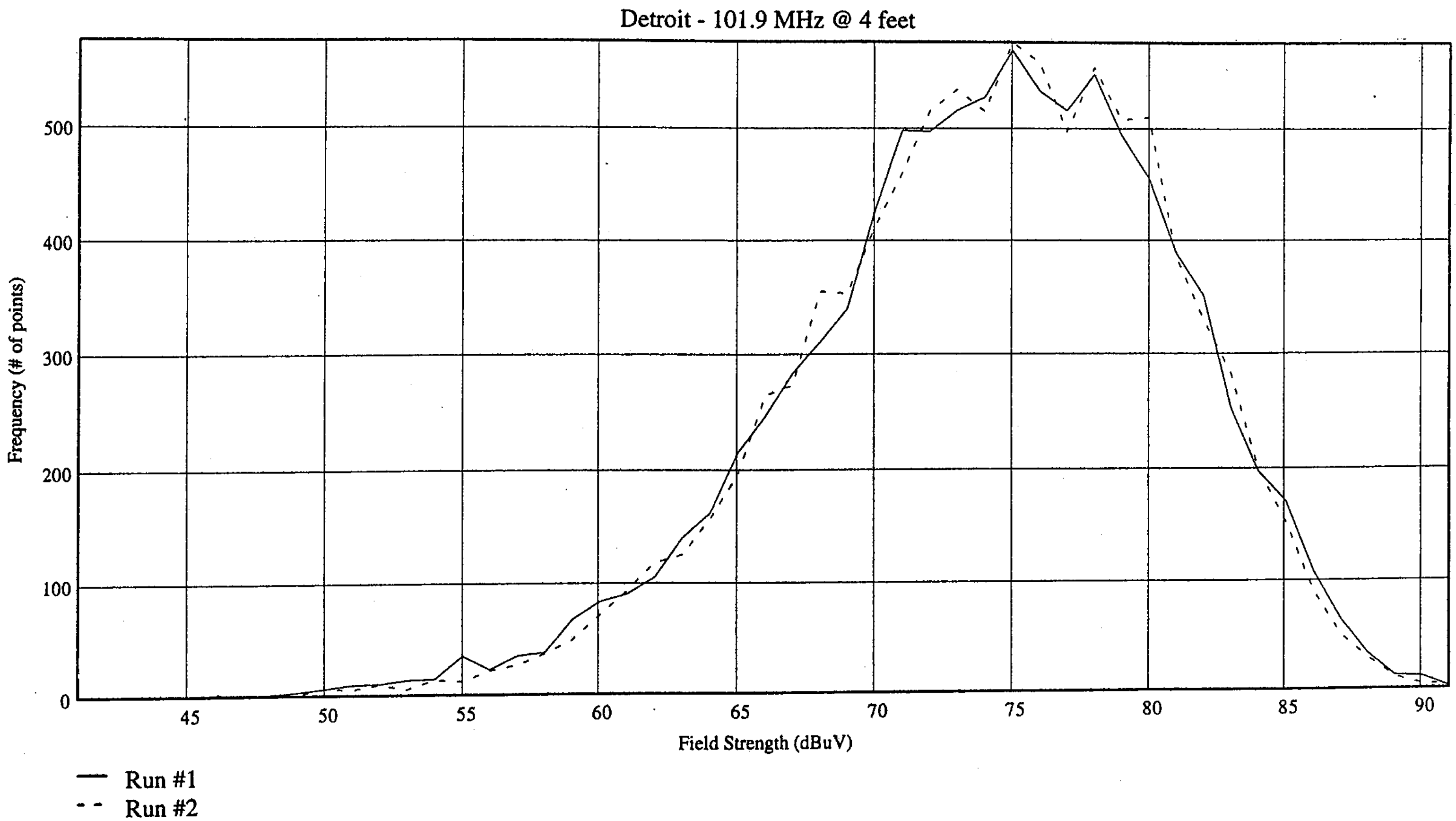
Temporal Comparison of Multiple Runs



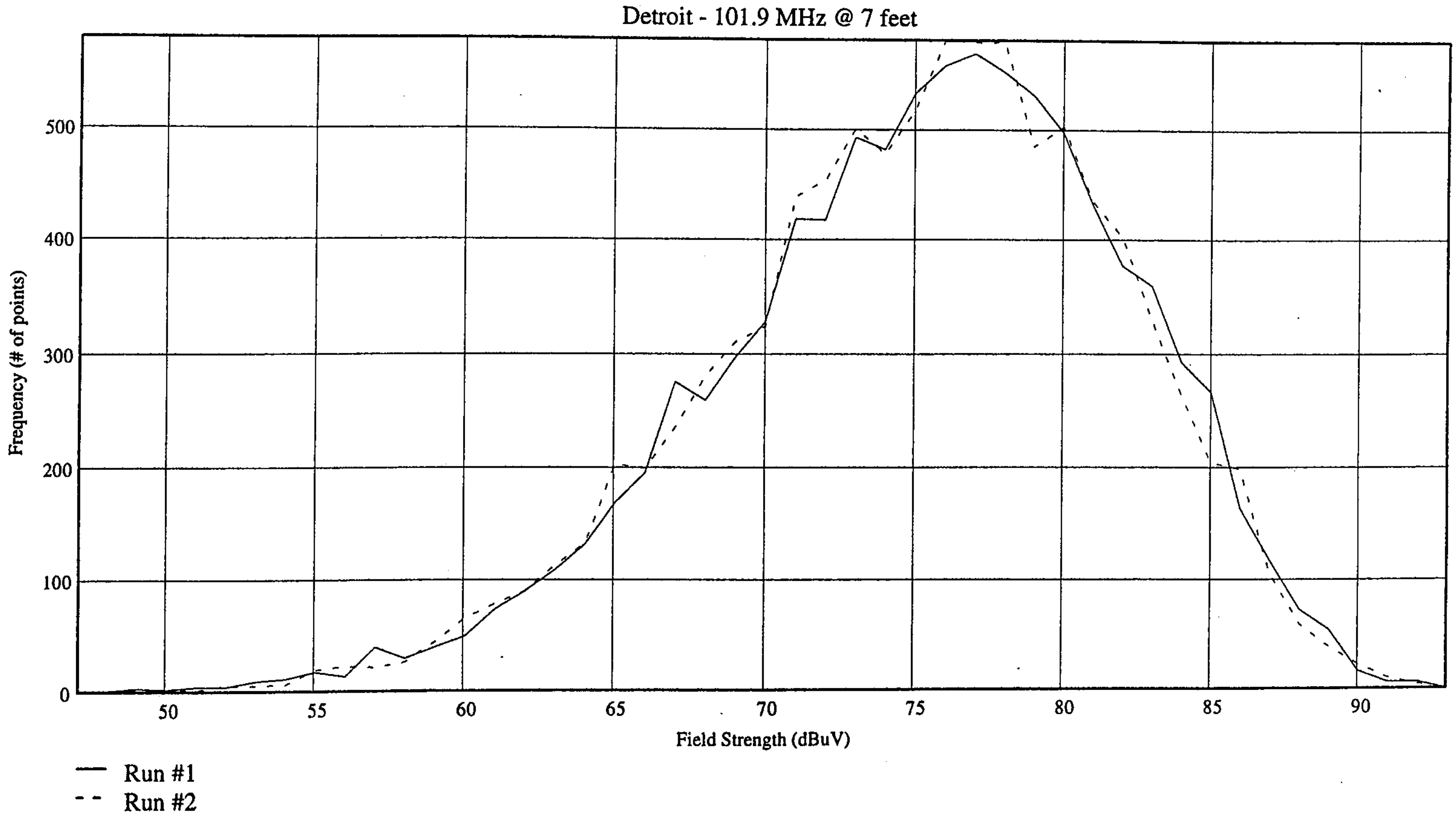
Temporal Comparison of Multiple Runs



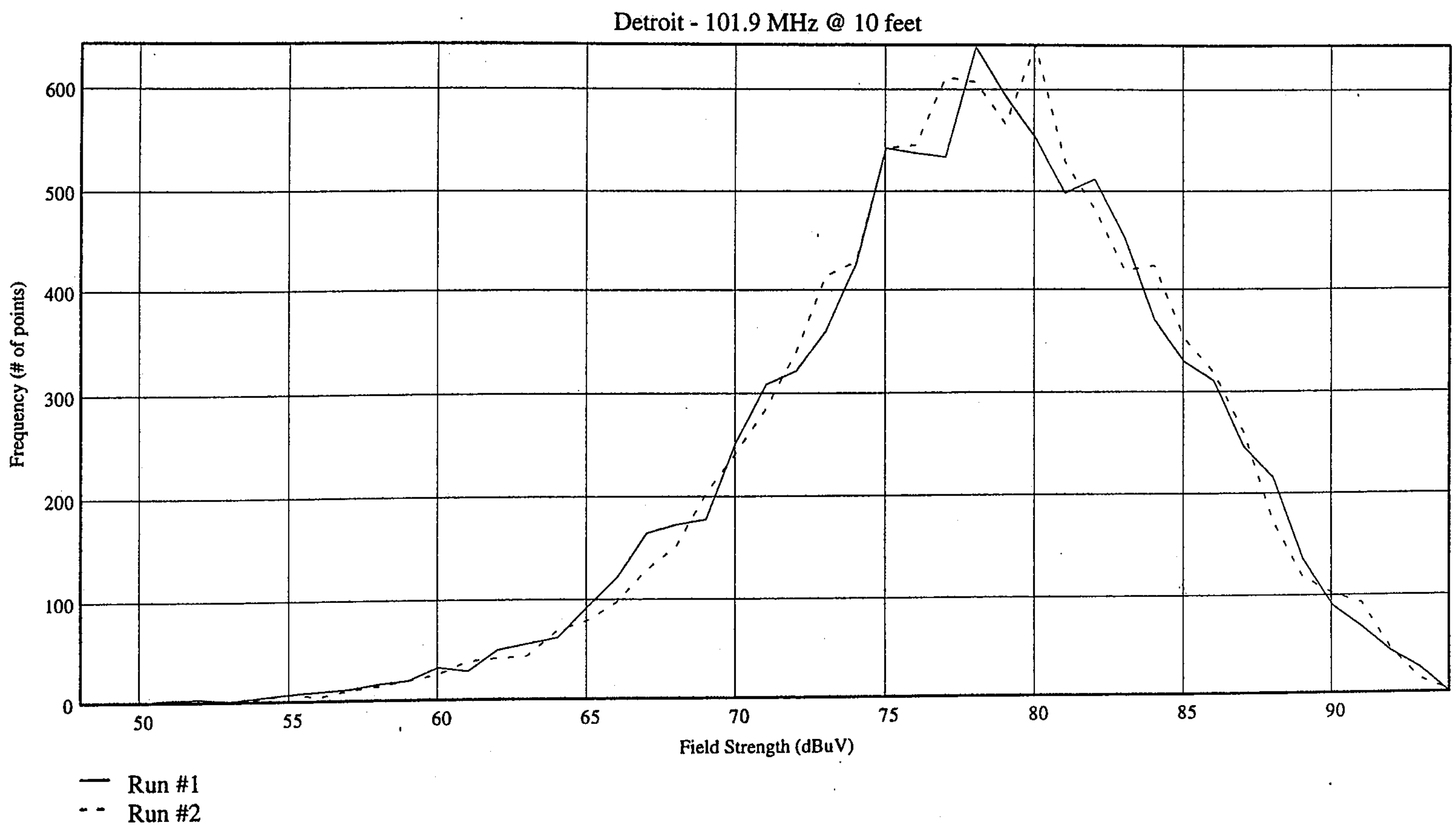
Temporal Comparison of Multiple Runs



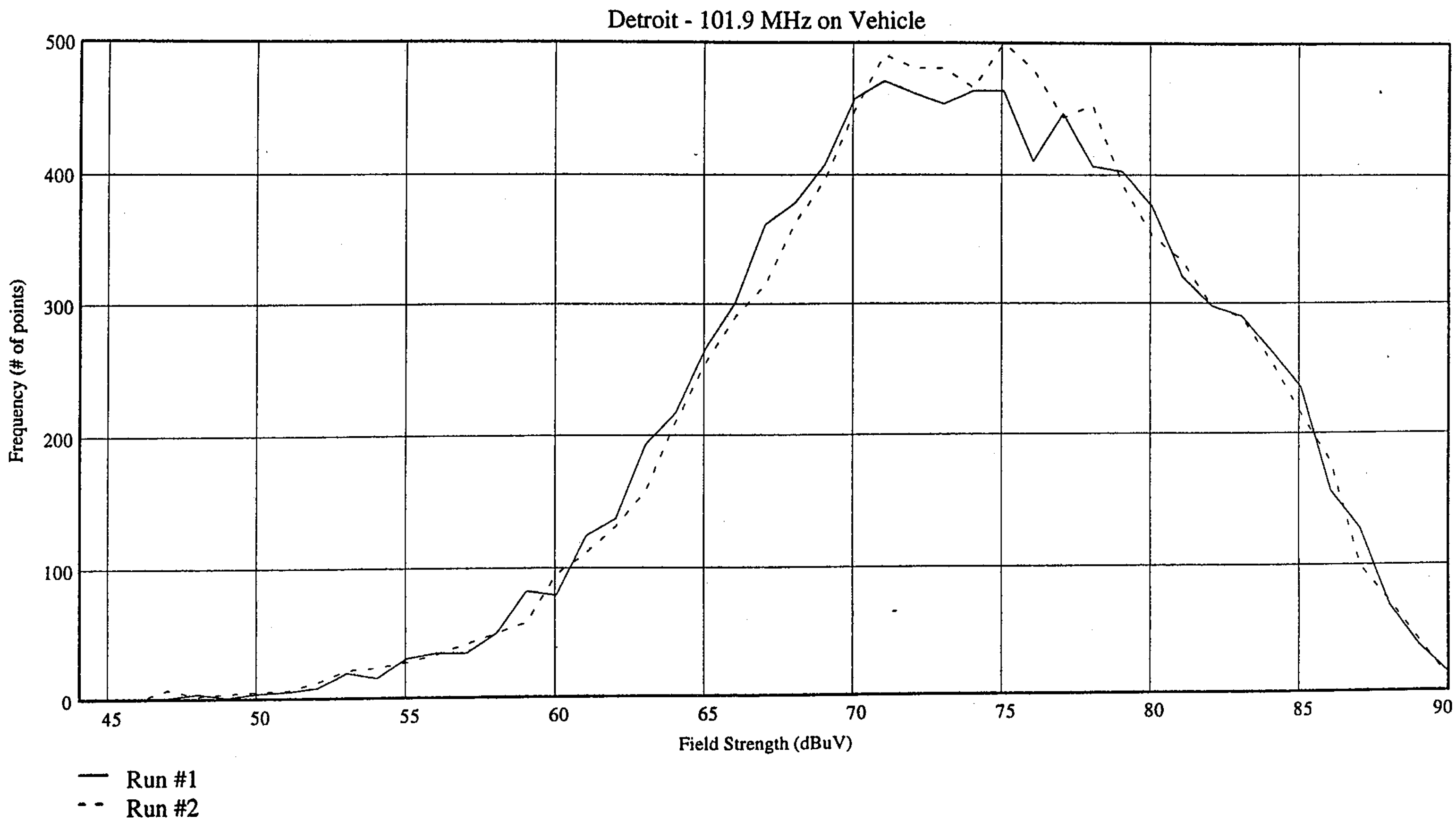
Temporal Comparison of Multiple Runs



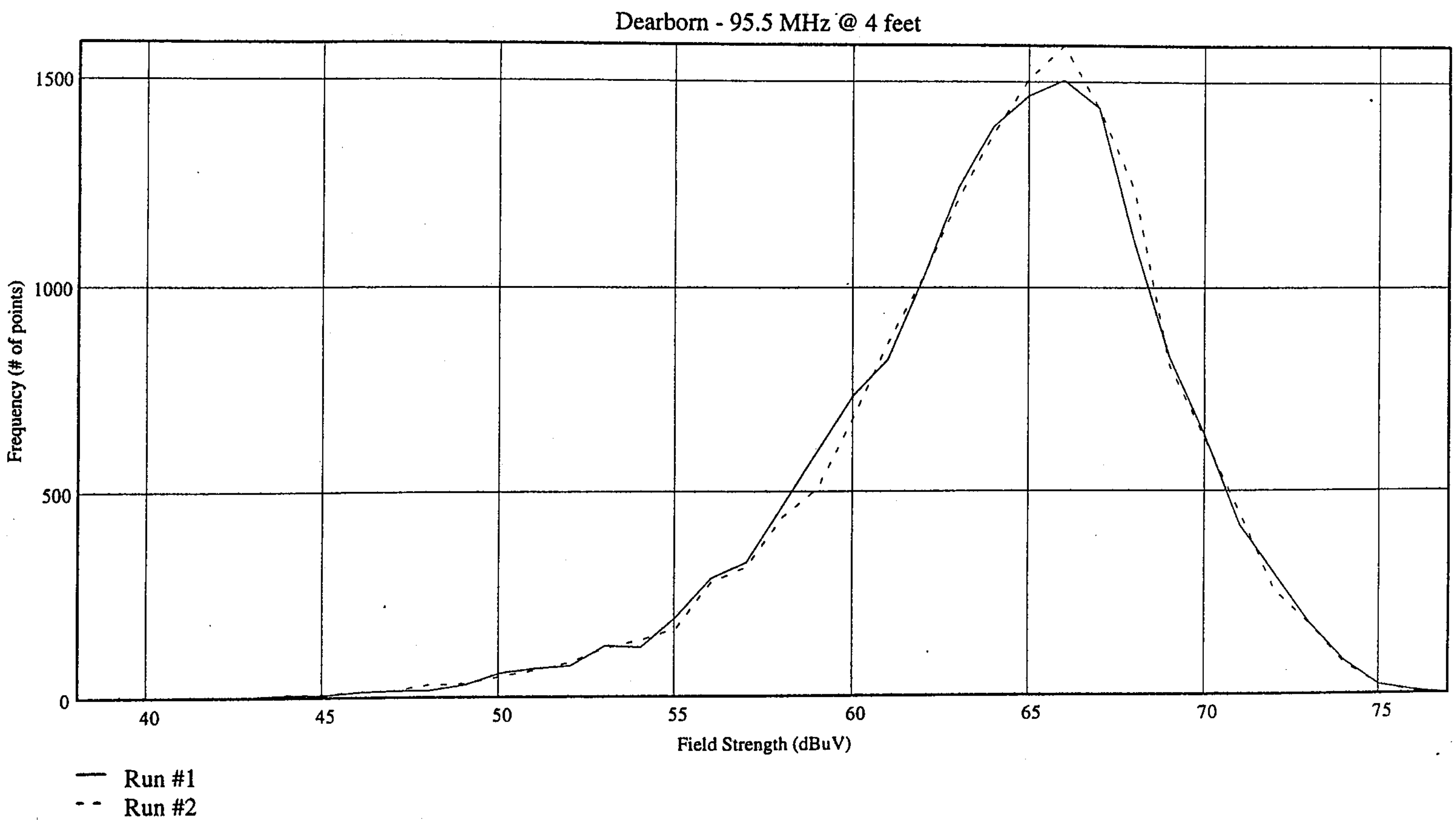
Temporal Comparison of Multiple Runs



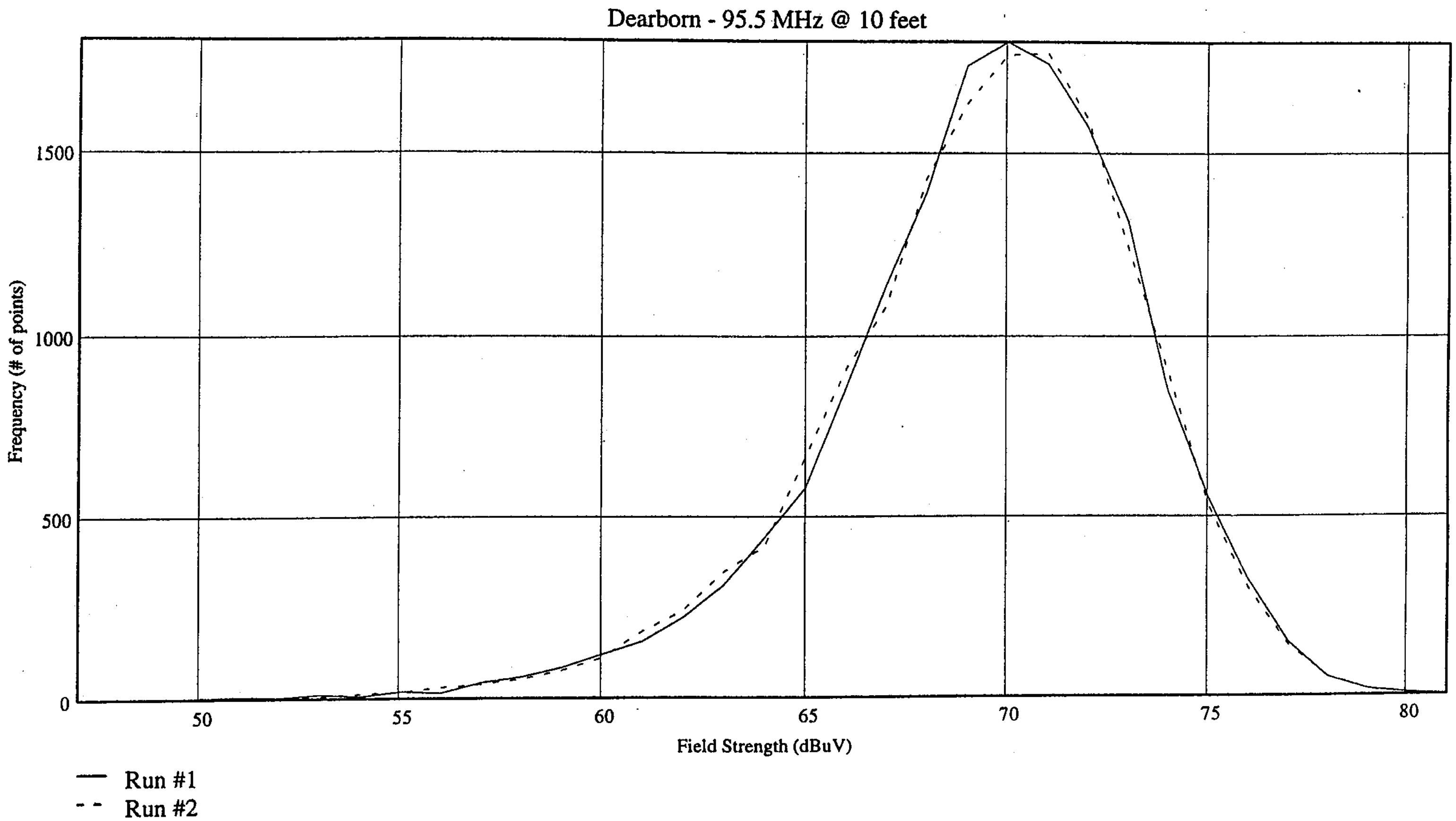
Temporal Comparison of Multiple Runs



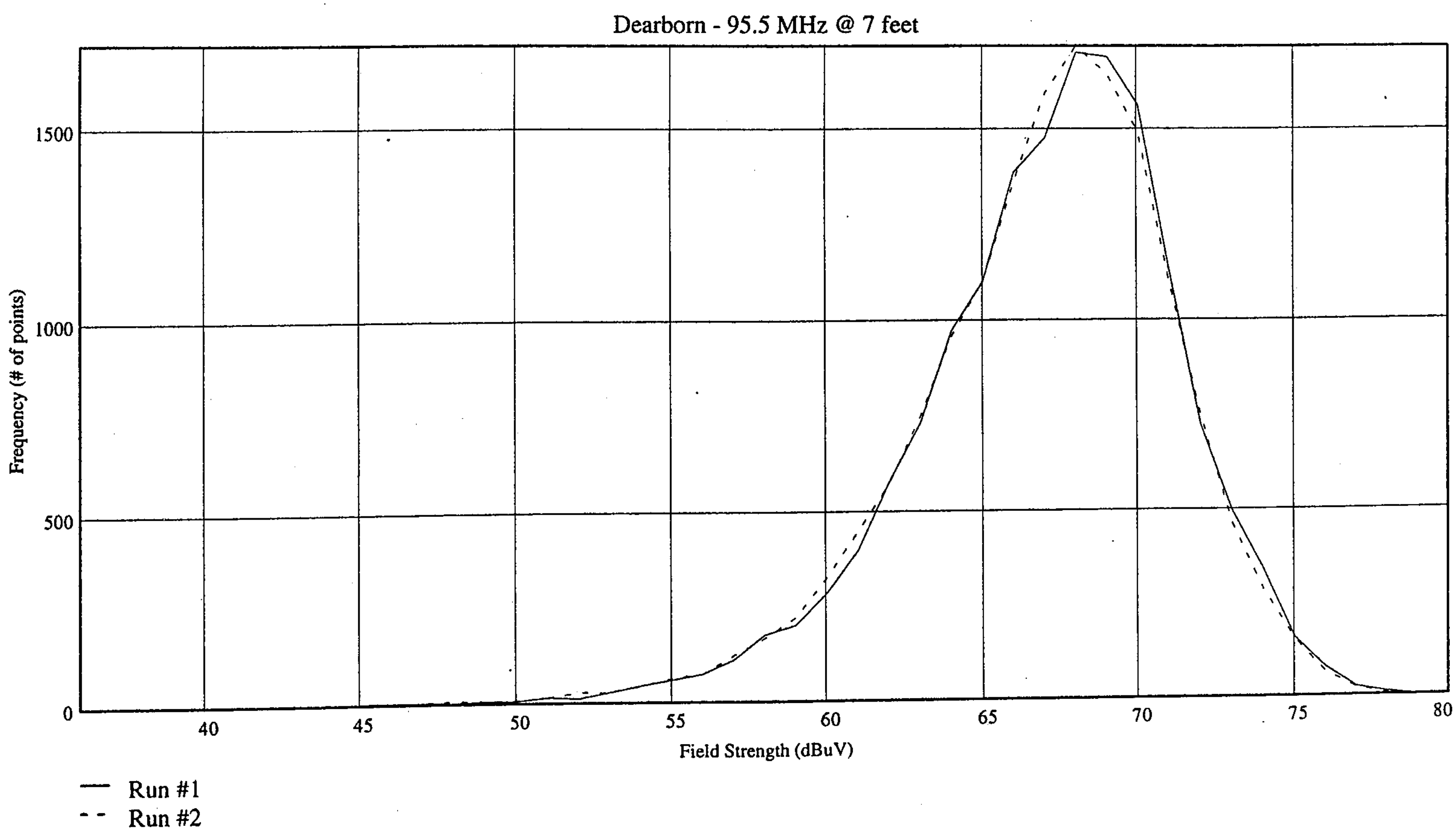
Temporal Comparison of Multiple Runs



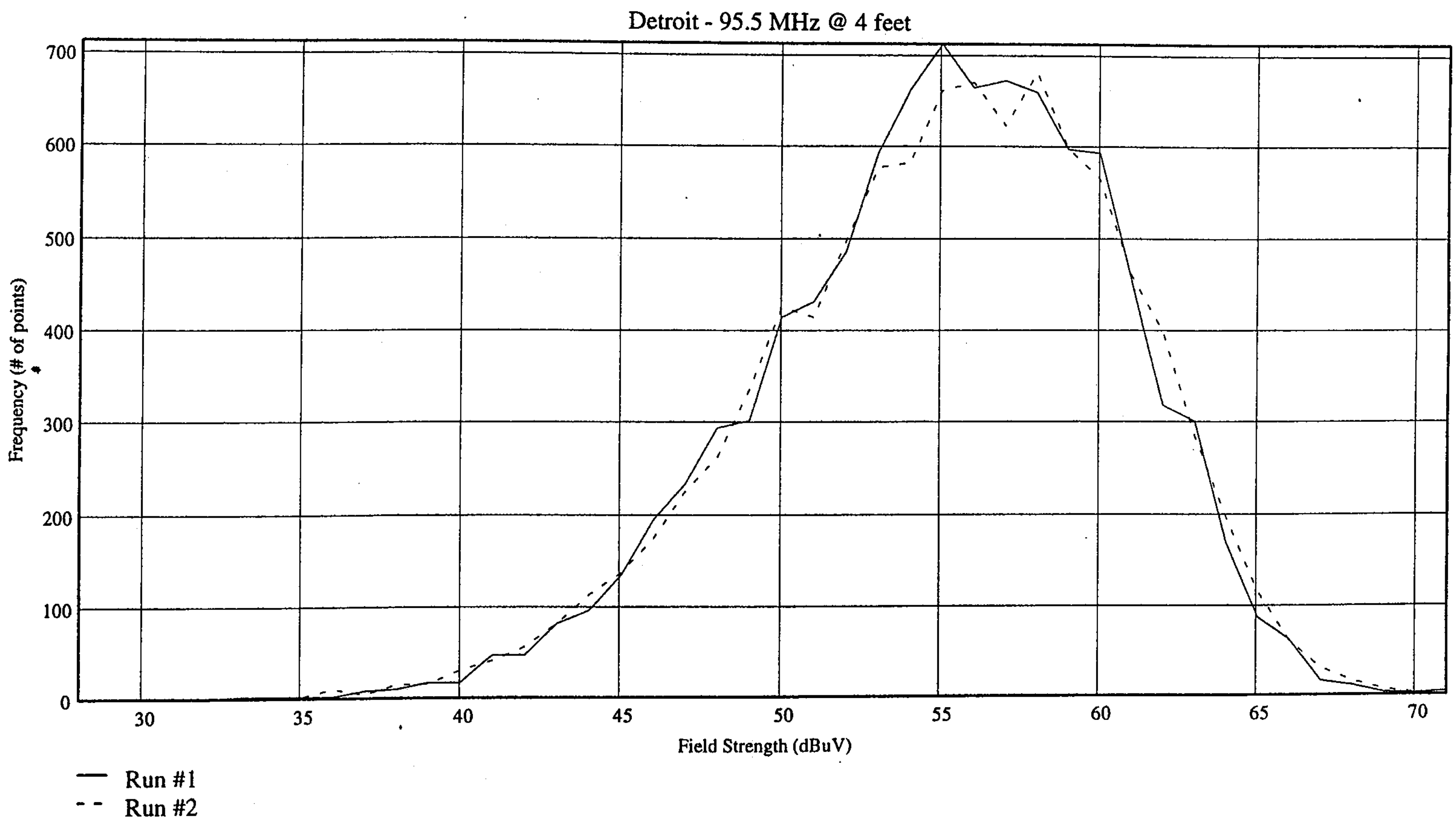
Temporal Comparison of Multiple Runs



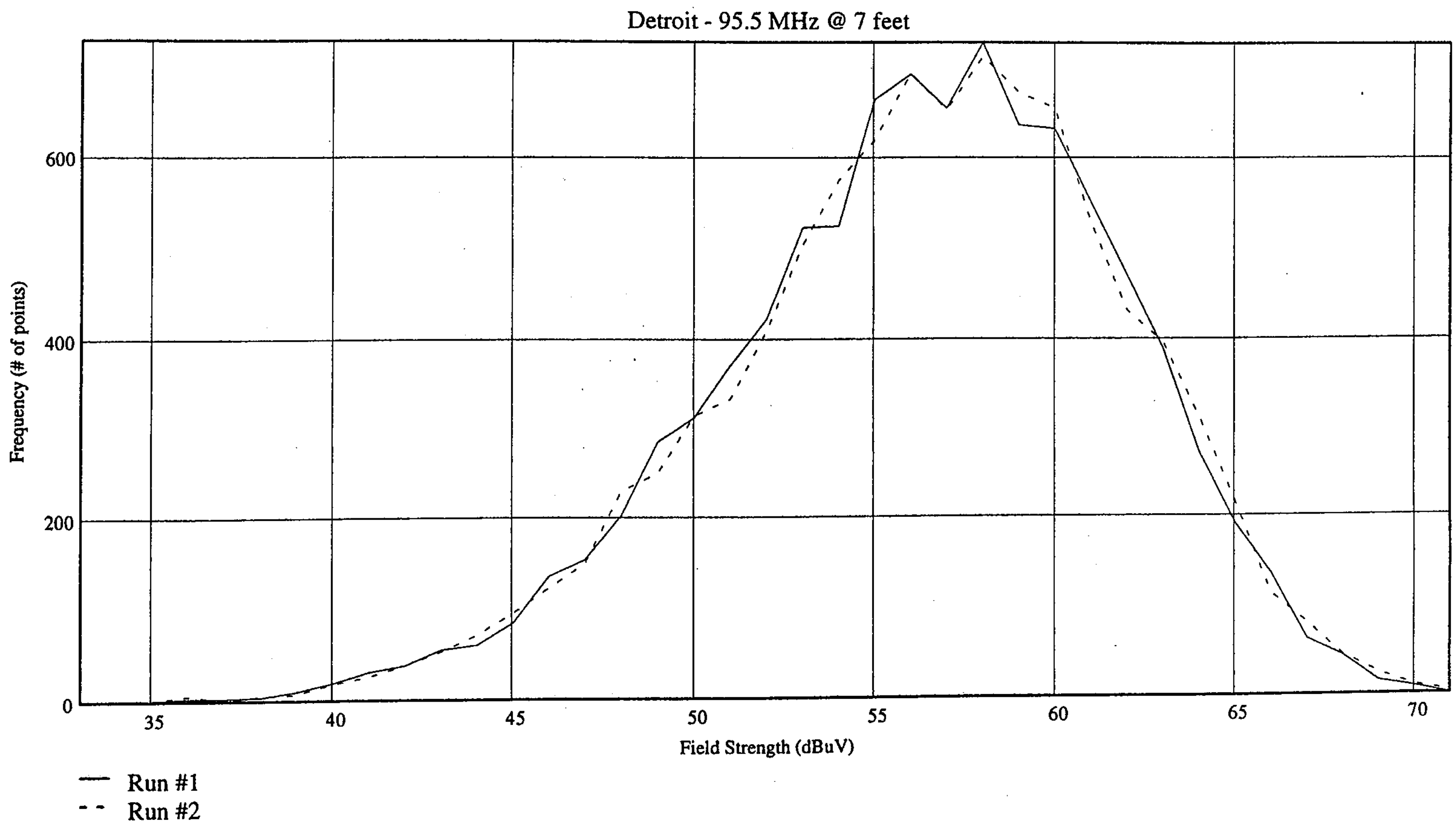
Temporal Comparison of Multiple Runs



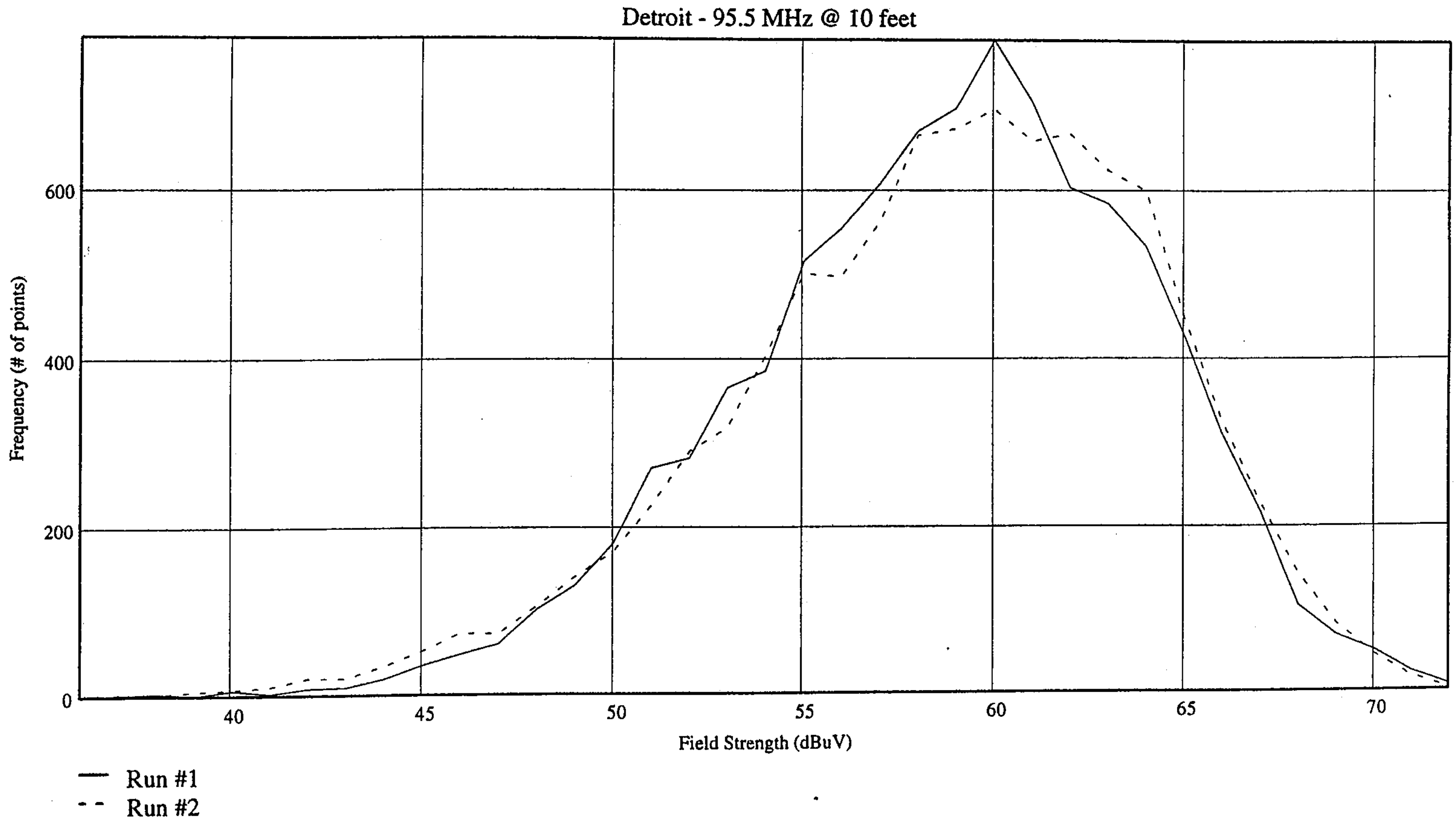
Temporal Comparison of Multiple Runs



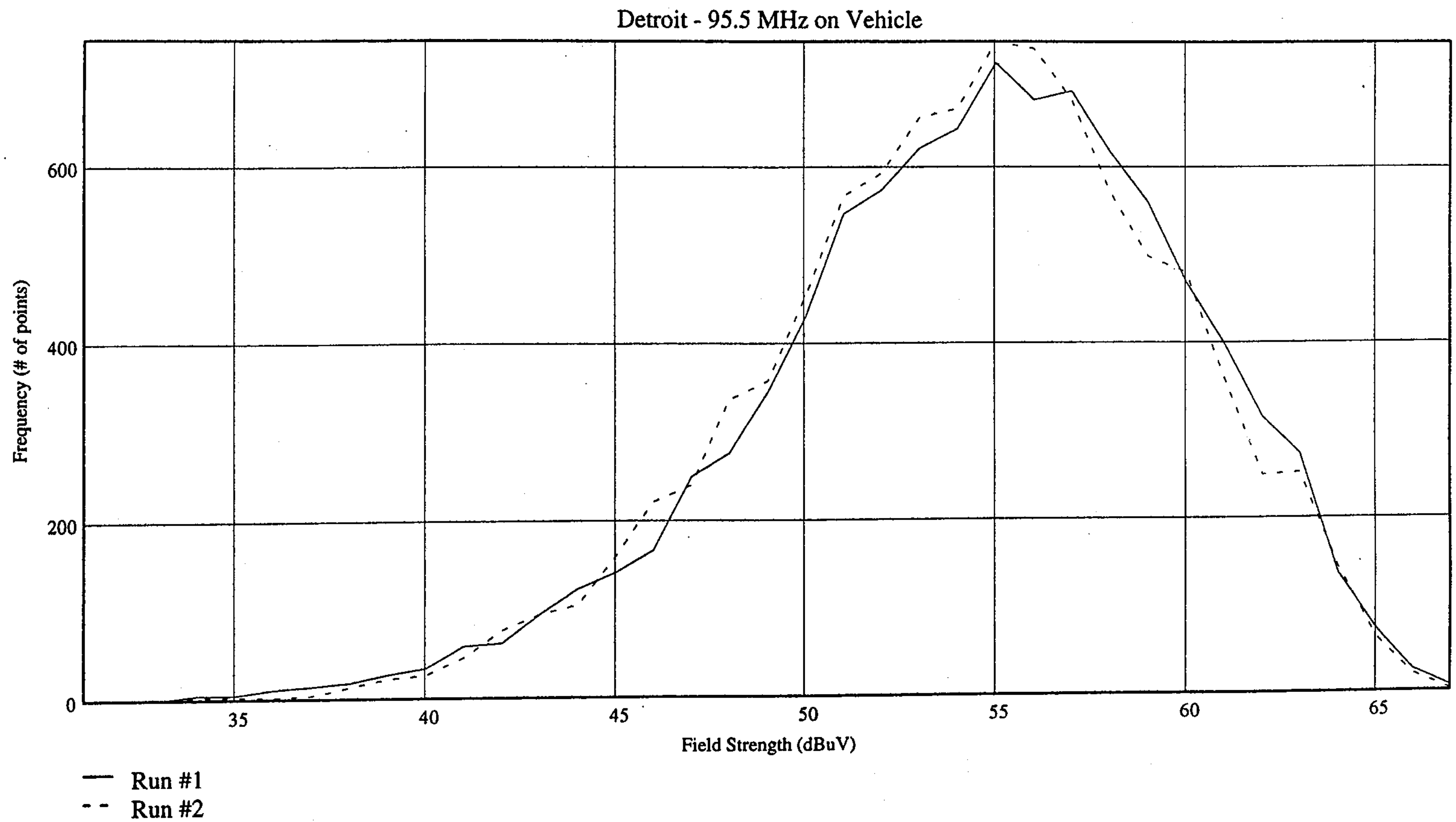
Temporal Comparison of Multiple Runs



Temporal Comparison of Multiple Runs



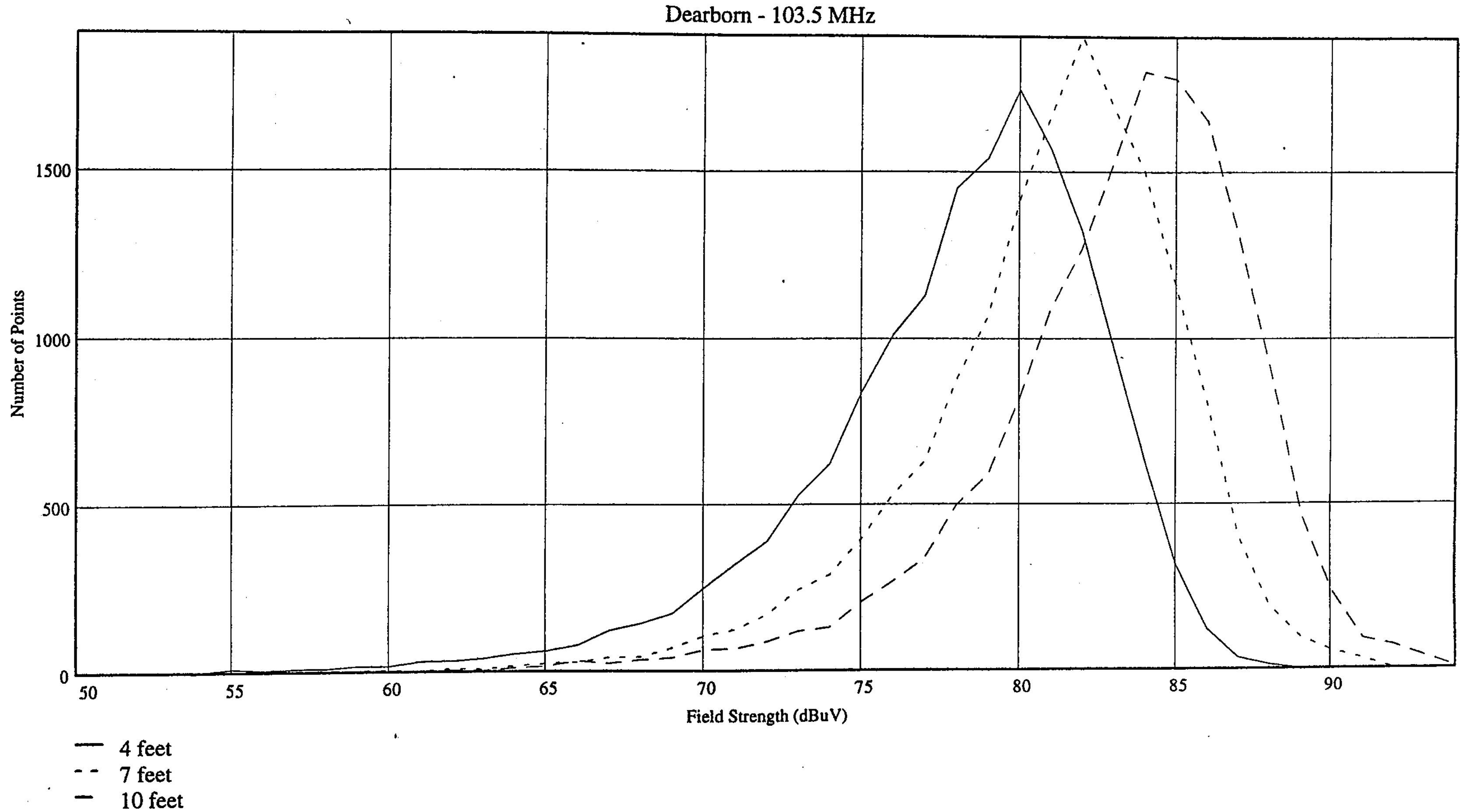
Temporal Comparison of Multiple Runs



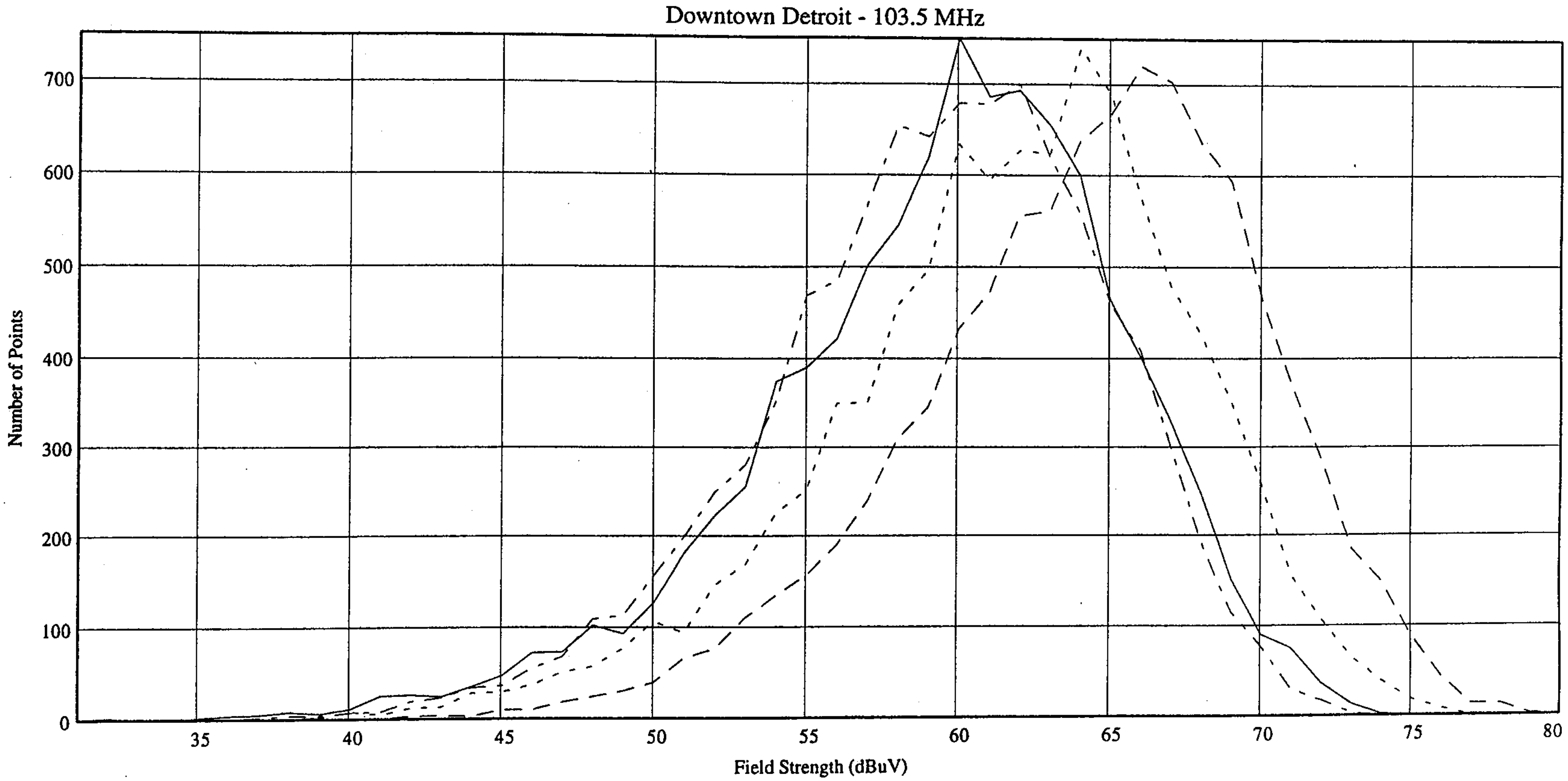
APPENDIX G

VHF Antenna Characterization - Fading vs. Antenna Height (Statistics vs. Height)

EIA/NAB VHF Test Antenna

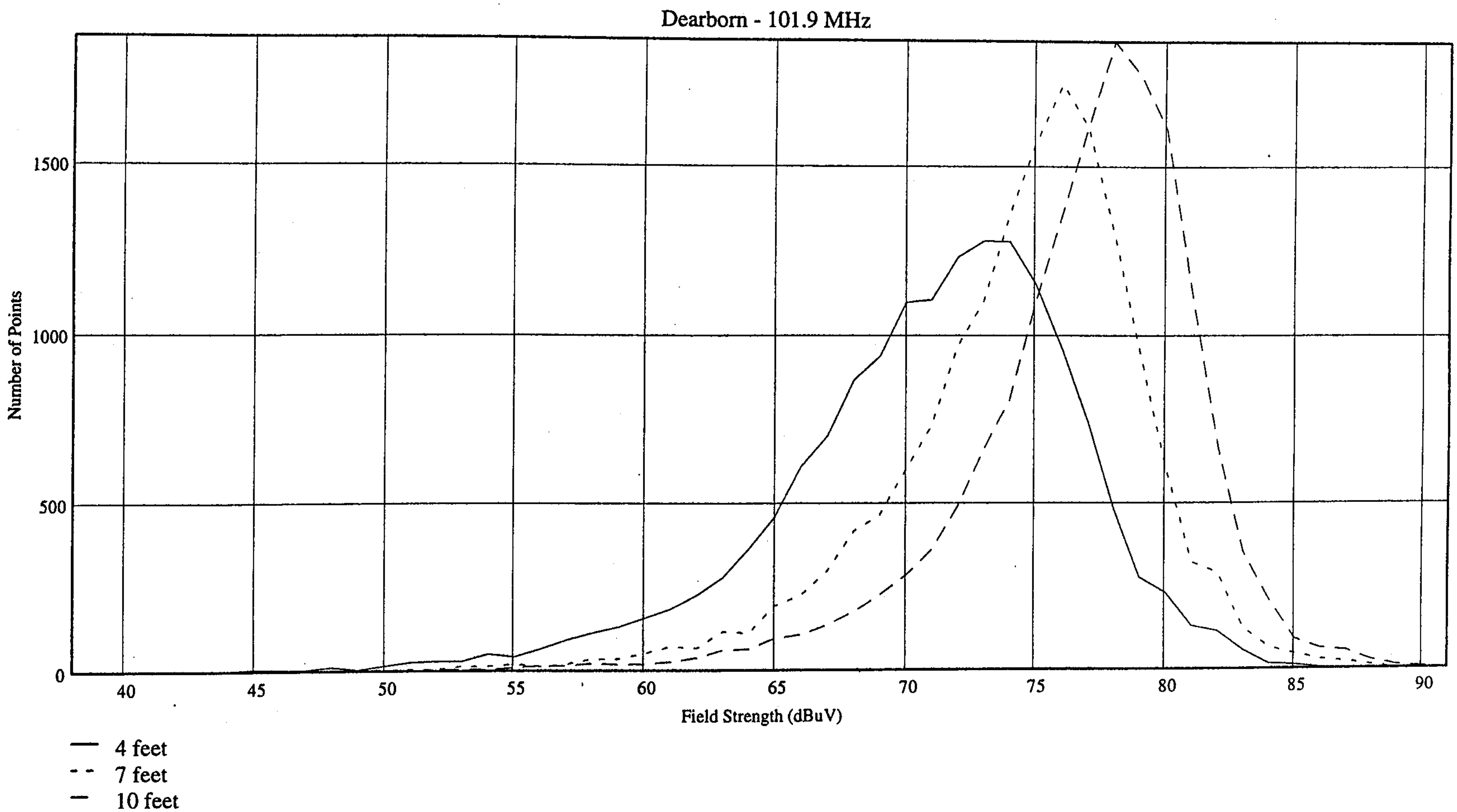


$$\mathrm{MEAN} = \begin{pmatrix} 78.012 \\ 80.9 \\ 83.146 \end{pmatrix} \qquad \mathrm{STDEV} = \begin{pmatrix} 4.591 \\ 4.199 \\ 4.293 \end{pmatrix}$$

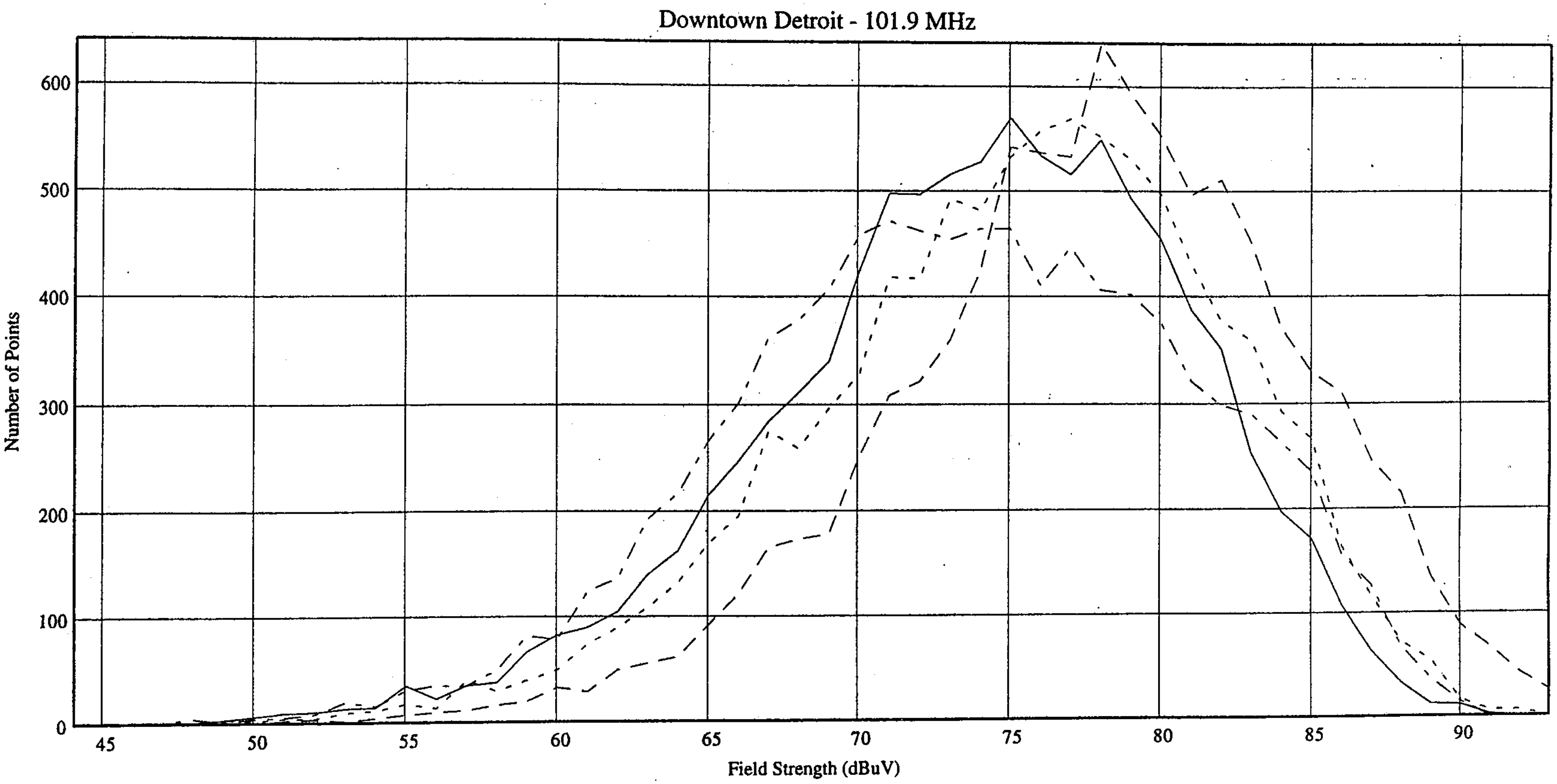


— 4 feet
- - 7 feet
— 10 feet
— van

$$\mathrm{MEAN} = \begin{bmatrix} 59.567 \\ 61.677 \\ 64.291 \\ 59.251 \end{bmatrix} \qquad \mathrm{STDEV} = \begin{bmatrix} 5.844 \\ 5.852 \\ 5.65 \\ 5.512 \end{bmatrix}$$

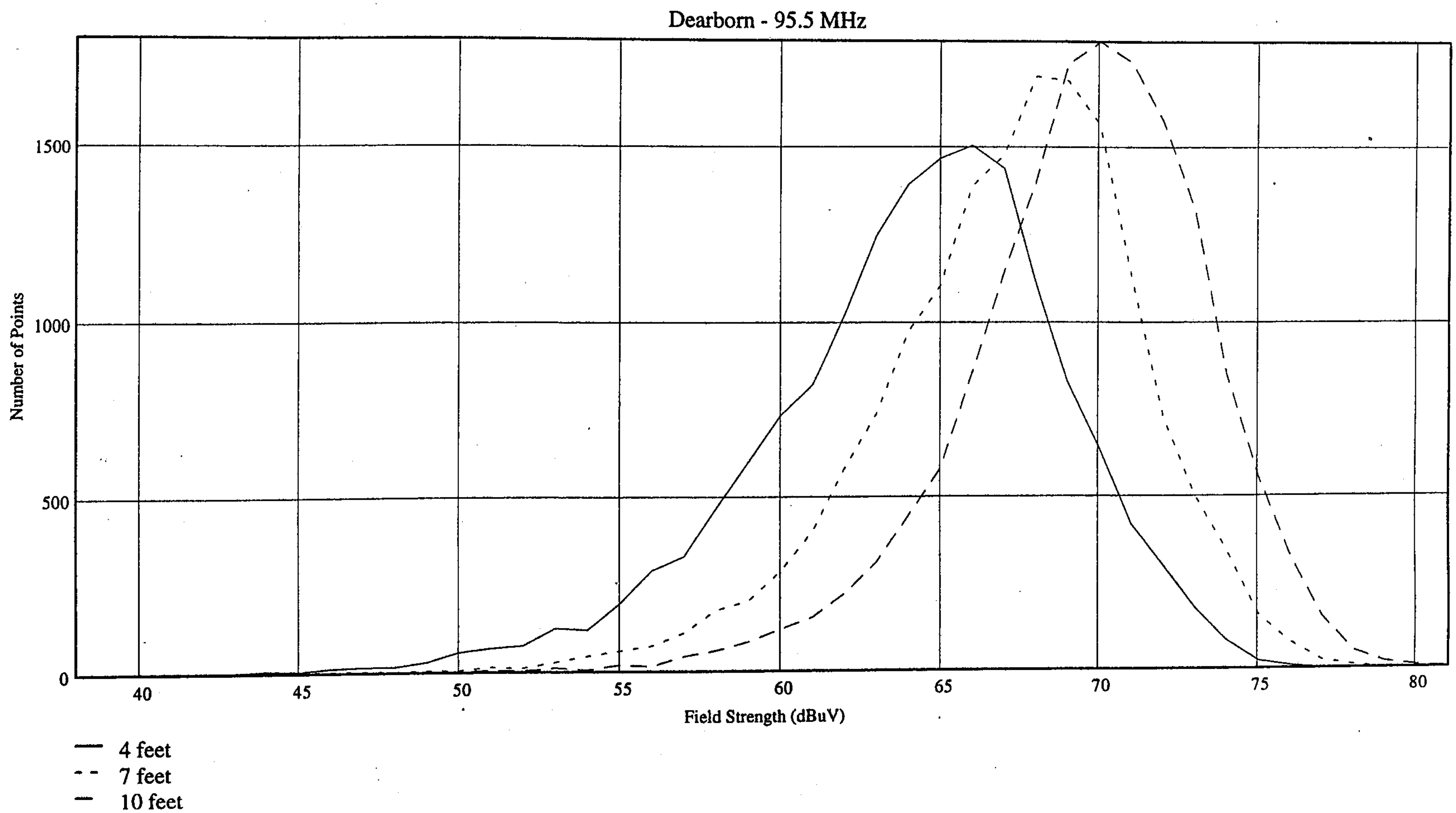


$$\text{MEAN} = \begin{pmatrix} 70.926 \\ 74.325 \\ 76.803 \end{pmatrix} \qquad \text{STDEV} = \begin{pmatrix} 5.576 \\ 4.829 \\ 4.511 \end{pmatrix}$$

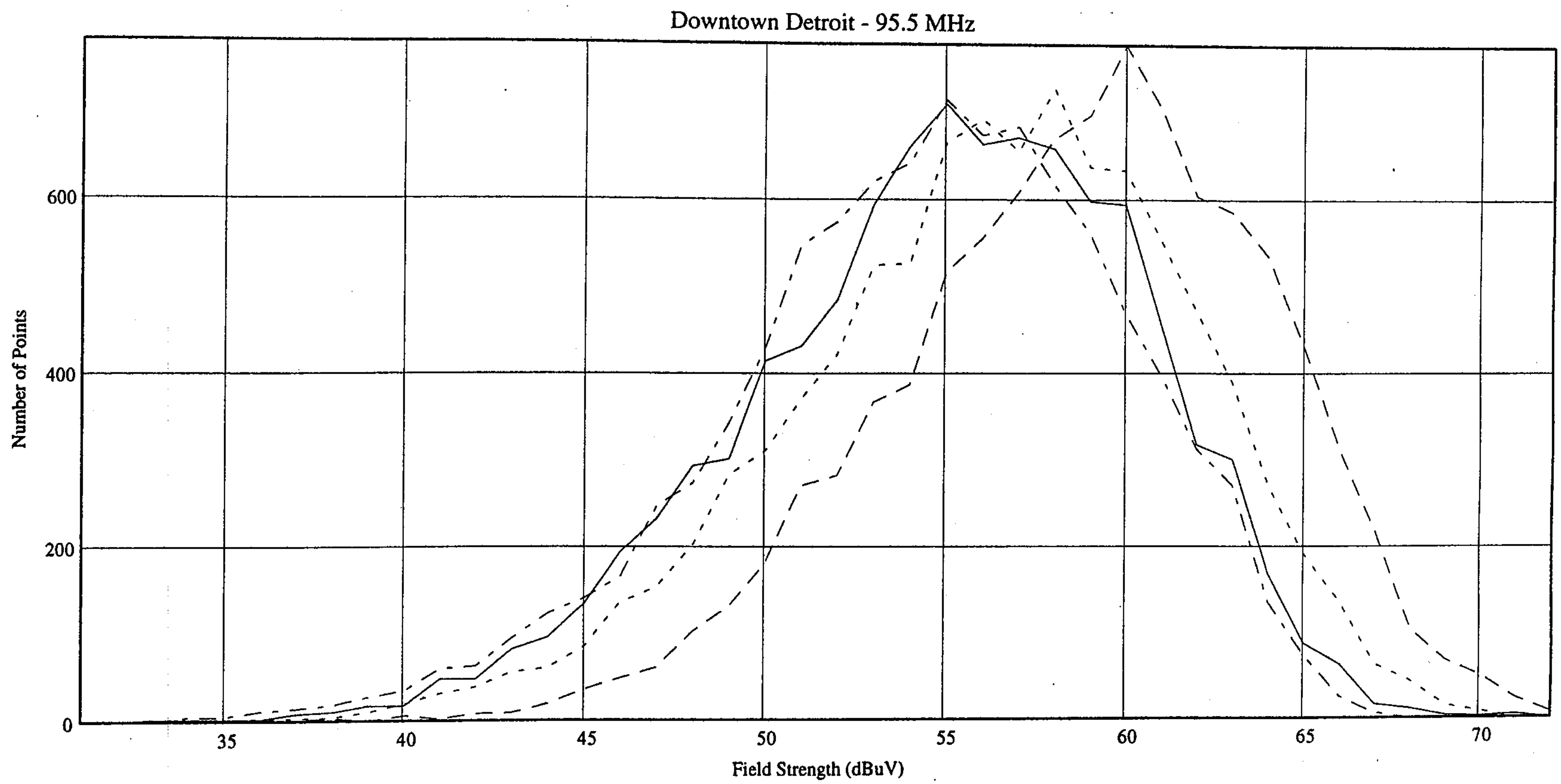


— 4 feet
- - 7 feet
— 10 feet
— van

$$\text{MEAN} = \begin{bmatrix} 73.98 \\ 75.272 \\ 77.744 \\ 73.594 \end{bmatrix} \qquad \text{STDEV} = \begin{bmatrix} 6.746 \\ 6.772 \\ 6.609 \\ 7.342 \end{bmatrix}$$



$$MEAN = \begin{pmatrix} 64.091 \\ 67.07 \\ 69.484 \end{pmatrix} \qquad STDEV = \begin{pmatrix} 4.711 \\ 4.141 \\ 3.81 \end{pmatrix}$$



- 4 feet
- 7 feet
- 10 feet
- van

$$MEAN = \begin{bmatrix} 55.004 \\ 56.267 \\ 58.724 \\ 54.429 \end{bmatrix} \qquad STDEV = \begin{bmatrix} 5.382 \\ 5.412 \\ 5.154 \\ 5.43 \end{bmatrix}$$

APPENDIX H

MF Antenna Gain Characterization Using "Off-air" Signals

1995 Taurus Power Antenna

and

EIA/NAB AM Test Antenna

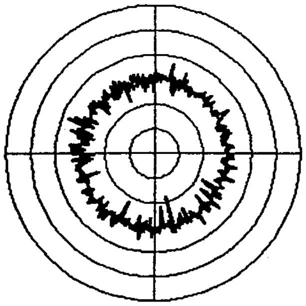
JEF Consultant, Inc.

Belleville, Michigan Phone: (313) 482-5505

DATE.....02-27-1996 TIME.....10:12:18 PATTERN.....005

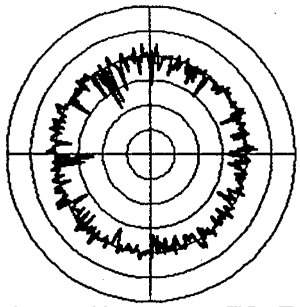
REF = -50dBm FRONT=0 10 dB/DIV

.56 MHz



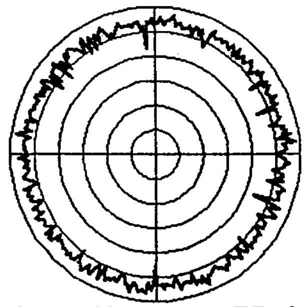
Area Mean = -79.8
Std dB Dev= 2.4
M/M Ratio = 18.2

.69 MHz



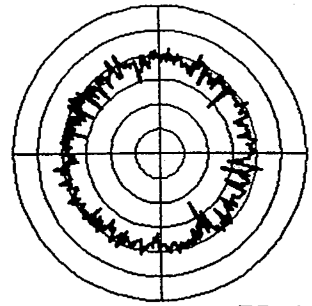
Area Mean = -70.7
Std dB Dev= 3.1
M/M Ratio = 22.5

.76 MHz



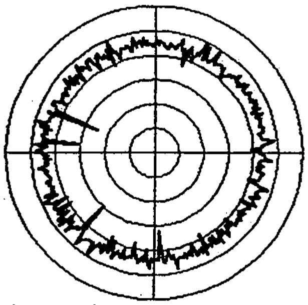
Area Mean = -56.4
Std dB Dev= 2.1
M/M Ratio = 15.5

.95 MHz



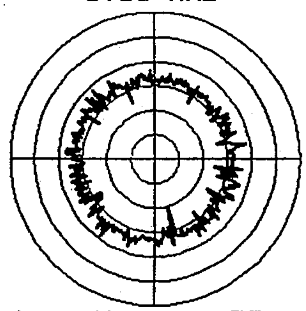
Area Mean = -72.1
Std dB Dev= 2.7
M/M Ratio = 19.6

.99 MHz



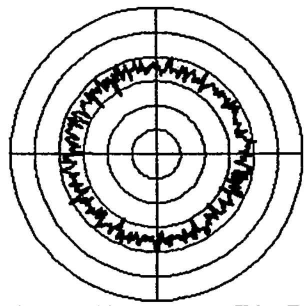
Area Mean = -65.6
Std dB Dev= 2.5
M/M Ratio = 24.9

1.31 MHz



Area Mean = -77.2
Std dB Dev= 2.2
M/M Ratio = 17.6

1.6 MHz



Area Mean = -74.2
Std dB Dev= 2.1
M/M Ratio = 14.3

Mean of Ind. Area Means...-64 dBm
Std dB Dev of Area Means.. 10.8 dB

Mean of Ind. MM Ratios.... 20.4 dB
Std dB Dev of M/M Ratios.. 4.1 dB
Mean of Ind Std dB Dev's.. 2.4 dB

UNIT TESTED....'95 FORD
Mfg./Model.....TAURUS STATION WAGON
Antenna Type...POWER WHIP

ID Number......NORWOOD POOL CAR
Ant. Location..RIGHT FENDER

Comments.......AM DATA TAKEN WITH FORD BUFFER AMP POWERED W/POWER SUPPLY SET AT 9V

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 10 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......AIR SIGNAL
Transmit Ant...N/A
Height.........N/A

Mfg./Model.....N/A
Polarization...N/A
Range..........N/A

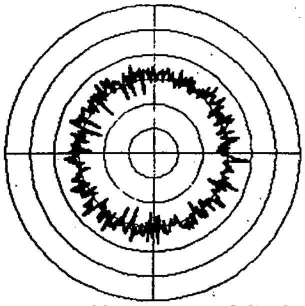
JEF Consultant, Inc.

Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....11:16:35   PATTERN.....010

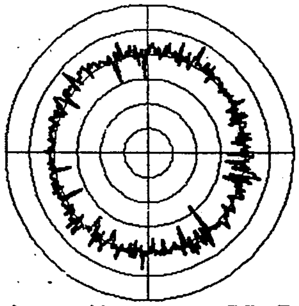
REF = -50dBm   FRONT=0   10 dB/DIV

.56 MHz



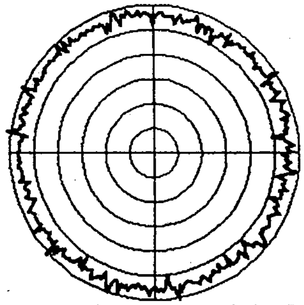
Area Mean = -78.3
Std dB Dev= 2.7
M/M Ratio = 17.3

.69 MHz



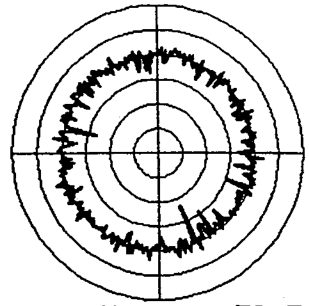
Area Mean = -68.8
Std dB Dev= 2.7
M/M Ratio = 20.3

.76 MHz



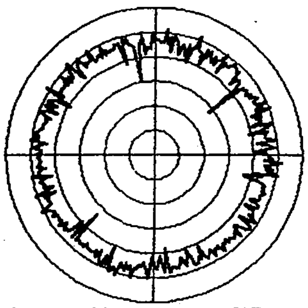
Area Mean = -54.2
Std dB Dev= 1.6
M/M Ratio = 11.1

.95 MHz



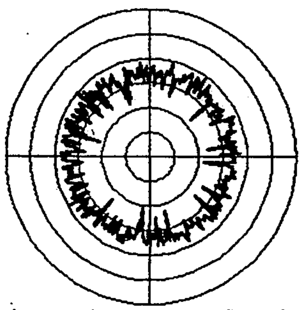
Area Mean = -70.5
Std dB Dev= 2.5
M/M Ratio = 20.2

.99 MHz



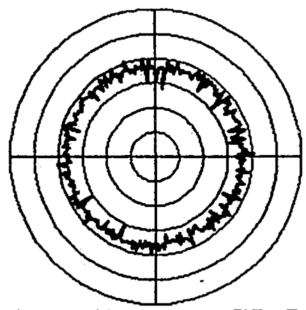
Area Mean = -63.7
Std dB Dev= 2.8
M/M Ratio = 23.7

1.31 MHz



Area Mean = -76.2
Std dB Dev= 3.2
M/M Ratio = 17.9

1.6 MHz



Area Mean = -73.6
Std dB Dev= 1.7
M/M Ratio = 12.9

Mean of Ind. Area Means...-61.9 dBm
Std dB Dev of Area Means.. 11.5 dB

Mean of Ind. MM Ratios.... 19.3 dB
Std dB Dev of M/M Ratios.. 4.7 dB
Mean of Ind Std dB Dev's.. 2.5 dB

UNIT TESTED....; 84 FORD
Mfg./Model.....E150 VAN
Antenna Type...MAG MOUNT WHIP

ID Number......AM IBOC
Ant. Location..CENTER OF ROOF

Comments.......AM DATA TAKEN W/FORD BUFFER AMP POWERED W/POWER SUPPLY SET AT 9V/6 FEE
T OF RG-58 CABLE ADDED

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 10 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......AIR SIGNAL
Transmit Ant...N/A

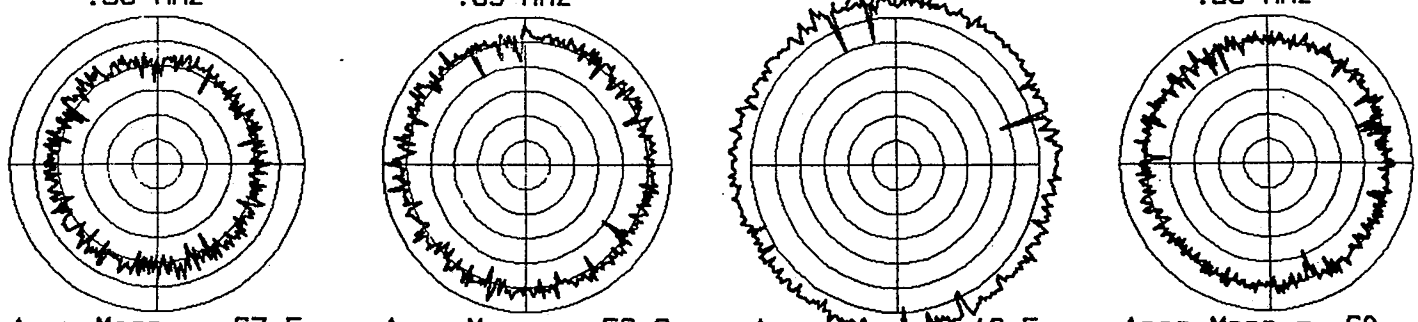
Mfg./Model.....N/A
Polarization...N/A

JEF Consultant, Inc.

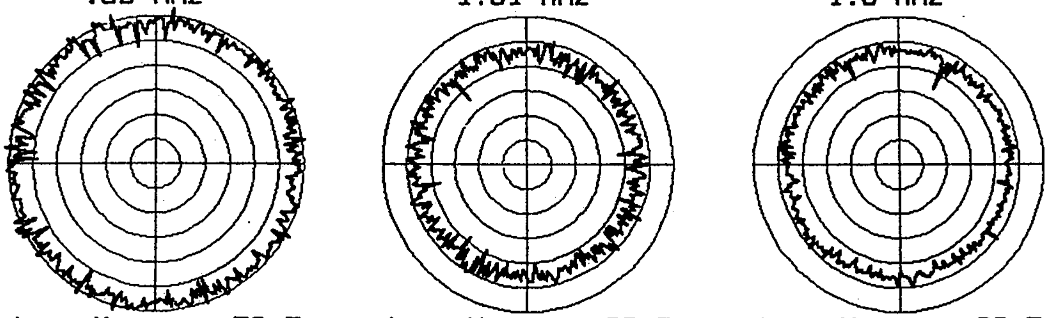
Belleville, Michigan   Phone: (313) 482-5505

DATE.....02-27-1996   TIME.....11:26:14   PATTERN.....011

REF = -50dBm   FRONT=0   10 dB/DIV



.56 MHz	.69 MHz	.76 MHz	.95 MHz
Area Mean = -67.5	Area Mean = -58.3	Area Mean = -43.5	Area Mean = -60
Std dB Dev= 2.7	Std dB Dev= 2.6	Std dB Dev= 2.4	Std dB Dev= 2.5
M/M Ratio = 15.7	M/M Ratio = 19.4	M/M Ratio = 25.1	M/M Ratio = 16.1



.99 MHz	1.31 MHz	1.6 MHz
Area Mean = -52.5	Area Mean = -63.9	Area Mean = -63.7
Std dB Dev= 2.4	Std dB Dev= 2.5	Std dB Dev= 1.6
M/M Ratio = 15.1	M/M Ratio = 16.3	M/M Ratio = 16.9

Mean of Ind. Area Means...-51.1 dBm
Std dB Dev of Area Means.. 11.4 dB

Mean of Ind. MM Ratios.... 19.4 dB
Std dB Dev of M/M Ratios.. 3.9 dB
Mean of Ind Std dB Dev's.. 2.4 dB

UNIT TESTED....; 84 FORD
Mfg./Model.....E150 VAN
Antenna Type...MAG MOUNT WHIP

ID Number......AM IBOC
Ant. Location..CENTER OF ROOF

Comments.......AM DATA TAKEN W/FORD BUFFER AMP POWERED W/POWER SUPPLY SET AT 9V/BUFFE R AMP ON ROOF

RF DETECTOR....SPECTRUM ANALYZER
Resolution BW.. 10 KHz

Mfg./Model.....Anritsu MS2601A
Detector Fn....Peak

RF SOURCE......AIR SIGNAL
Transmit Ant...N/A
Height.........N/A

Mfg./Model.....N/A
Polarization...N/A
Range..........N/A

NRSC Document Improvement Proposal

If in the review or use of this document a potential change appears needed for safety, health or technical reasons, please fill in the appropriate information below and email, mail or fax to:

National Radio Systems Committee
c/o Consumer Electronics Association
Technology & Standards Department
1919 S. Eads St.
Arlington, VA 22202
FAX: 703-907-4190
Email: standards@ce.org

DOCUMENT NO.	DOCUMENT TITLE:
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URGENCY OF CHANGE: _____ Immediate	_____ At next revision
PROBLEM AREA (ATTACH ADDITIONAL SHEETS IF NECESSARY): a. Clause Number and/or Drawing: b. Recommended Changes: c. Reason/Rationale for Recommendation:	
ADDITIONAL REMARKS:	
SIGNATURE:	DATE:

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Responsible Committee: ____________________

Co-chairmen: ____________________

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