FSS-4180-LP Antenna Data

The Datron FSS-4180-LP antenna will be used in addition to the Melco antenna type. Operation of this antenna will comply with all technical specifications and requirements of the attached Technical Description. The specific antenna data is contained in Table 1:

Specification Antenna Data
Transmit Frequency: 14000 – 14500 MHz
Receive Frequency: 11700 – 12200 MHz
G/T Greater than 12 dB/k at 11.7 GHz from 10 – 90 degrees elevation
Transmit Gain: 34 dBi
Receive Gain: 31.9 dBi
EIRP Capable of greater than 45 dBW, a maximum of 40.99 dBW will be used during this operation
Antenna Size 18 inches x 13.5 inches (see figure 1)
Beam Width Transmit: 3.6 x 2.7 degrees nominal
Beam Width Receive: 4.4 x 3.3 degrees nominal
Polarization Transmit: Orthogonal Steered Linearly H/V
Polarization Receive: Steered linearly H/V (polarization automatically steered)
Velocity Azimuth: 1000 deg/s
Velocity Elevation: 1000 deg/s
Velocity Pol: 1000 deg/s
Acceleration Azimuth: 600 deg/s^2
Acceleration Elevation: 2000 deg/s^2

Acceleration Pol: 2000 deg/s^2
Coverage Azimuth: Continuous
Elevation: -5 to 90 degrees
Cross-Pol: +/- 165 degrees
Pointing Error Less than 1 dB (approximately .9 degrees)

Table 1

Figure 1

A single Datron FSS-4180-LP antenna may be operated independently using power, bandwidth and EIRP levels indicated in Table 2, and will comply with the International Bureau off-axis EIRP spectral density restrictions as demonstrated by the 2-degree showing, which documents the worst case (E-Plane) density. Additionally, when operating in a network configuration, the overall Boeing system will use the same network control system with the Datron FSS-4180-LP antenna as it does with the Melco antenna described in the technical description. This system controls the aggregate off-axis EIRP density towards the GSO which may result from simultaneous transmissions within the network, thus ensuring that the stated off-axis EIRP limits are met. The Datron antenna characteristics will be fully taken into account in controlling network operations, and as a result, there will be no increased potential for interference (e.g., increase in aggregate off-axis EIRP above stated limits). A RADHAZ Study and Antenna Range Report are also provided for the FSS-4180-LP.

Band GHz	Emission	Input Watts	Max EIRP	Max EIRP Density dBW/4KHz
14 – 14.5	3M40G7W	4 Watts	40.02 dBW	10.09 dBW/4KHz
14 – 14.5	6M75G7W	5 Watts	40.99 dBW	8.72 dBW/4KHz
14 – 14.5	11M9G7D	5 Watts	40.99 dBW	6.26 dBW/4KHz
14 – 14.5	20M0G7D	5 Watts	40.99 dBW	4.00 dBW/4KHz
14 – 14.5	24M3G7D	5 Watts	40.99 dBW	3.15 dBW/4KHz
14 – 14.5	29M5G7D	5 Watts	40.99 dBW	2.31 dBW/4KHz
14 – 14.5	32M4G7D	5 Watts	40.99 dBW	1.91 dBW/4KHz

Table 2

Two Degree Showing for FSS-4180-LP, 4 watts input at 3.4M bandwidth (Worst Case)

Routinely Licensed Input power density (dBW/4 kHz)	-14	Digital
Maximum antenna Gain (dBi) @ 14.25 GHz	34	
Max EIRP density (dBW/4 kHz) for proposed Earth Station	10.09	
Non-routinely sized antenna input Power density (dBW/4 kHz)	-23.91	

Value of Theta (degrees)	25.209(a)(1) Co-Pol Gain	Off-Axis EIRP Density under Routine Licensing	Non-Routinely sized Antenna Off-Axis Gain (dBi)	Max off-axis EIRP Density of non-routinely sized antenna (dBW/4kHz)	Margin
1.25	26.6	12.6	34	10.09	2.49
1.3	26.2	12.2	33.5	9.59	2.56
1.4	25.3	11.3	33	9.09	2.26
1.5	24.6	10.6	32.5	8.59	2.01
1.6	23.9	9.9	32	8.09	1.81
1.7	23.2	9.2	31.5	7.59	1.65
1.8	22.6	8.6	31.0	7.09	1.53
1.9	22.0	8.0	30.0	6.09	1.94
2	21.5	7.5	29.0	5.09	2.38
2.1	20.9	6.9	28.5	4.59	2.35
2.2	20.4	6.4	28.0	4.09	2.35
2.3	20.0	6.0	27.0	3.09	2.87
2.4	19.5	5.5	25.5	1.59	3.90
2.5	19.1	5.1	24.0	0.09	4.96
2.6	18.6	4.6	23.0	-0.91	5.54
2.7	18.2	4.2	22.0	-1.91	6.13
2.8	17.8	3.8	21.0	-2.91	6.73
2.9	17.4	3.4	20.0	-3.91	7.35
3	17.1	3.1	18.0	-5.91	8.98
3.5	15.4	1.4	16.5	-7.41	8.81
4	13.9	-0.1	14.0	-9.91	9.86
4.5	12.7	-1.3	13.0	-10.91	9.58
5	11.5	-2.5	12.5	-11.41	8.94
5.5	10.5	-3.5	12.0	-11.91	8.40
6	9.5	-4.5	11.3	-12.66	8.21
6.5	8.7	-5.3	10.5	-13.41	8.09
7	7.9	-6.1	10.0	-13.91	7.78
7.1	8.0	-6.0	9.7	-14.21	8.21
8	8.0	-6.0	9.0	-14.91	8.91
9.2	8.0	-6.0	8.0	-15.91	9.91
10	7.0	-7.0	7.5	-16.41	9.41
11	6.0	-8.0	7.0	-16.91	8.88
12	5.0	-9.0	6.0	-17.91	8.93
15	2.6	-11.4	4.0	-19.91	8.51
20	-0.5	-14.5	1.0	-22.91	8.38
25	-2.9	-16.9	-1.0	-24.91	7.96
30	-4.9	-18.9	-3.0	-26.91	7.98
35	-6.6	-20.6	-4.0	-27.91	7.31
40	-8.1	-22.1	-7.0	-30.91	8.86
48	-10.0	-24.0	-10.0	-33.91	9.88

Two Degree Showing for FSS-4180-LP, 4 watts input at 3.4M bandwidth (Worst Case)

50	-10.0	-24.0	-10.0	-33.91	9.91
60	-10.0	-24.0	-10.0	-33.91	9.91
70	-10.0	-24.0	-10.0	-33.91	9.91
80	-10.0	-24.0	-10.0	-33.91	9.91
90	-10.0	-24.0	-10.0	-33.91	9.91
100	-10.0	-24.0	-10.0	-33.91	9.91
120	-10.0	-24.0	-10.0	-33.91	9.91
140	-10.0	-24.0	-10.0	-33.91	9.91
160	-10.0	-24.0	-10.0	-33.91	9.91
180	-10.0	-24.0	-10.0	-33.91	9.91

Minimum Margin 1.53

Analysis of Non-Ionizing Radiation for a Datron model FSS-4180-LP

This report presents an analysis of the non-ionizing radiation levels for a DATRON FSS-4180-LP. The calculations used in this analysis were derived from and comply with the procedures outlined in the Federal Communication Commission, Office of Engineering and Technology Bulletin Number 65, which establishes guidelines for human exposure to Radio Frequency Electromagnetic Fields. Bulletin 65 defines exposure levels in two separate categories, the General Population/Uncontrolled Areas limits, and the Occupational/Controlled Area limits. The Maximum Permissible Exposure (MPE) limit of the General Population/Uncontrolled Area is defined in Table (1), and represents a maximum exposure limit averaged over a 30 minute period. The MPE limit of the Occupational/Controlled Area is defined in Table (2), and represents a maximum exposure limit averaged over a 6 minute period. The purpose of this report is to provide an analysis of the earth station power flux densities, and to compare those levels to the specified MPE's. This report provides predicted density levels in the near field, far field, transition region, main reflector surface area, area between the main reflector and sub reflector or feed assembly, as well as the area between the antenna edge and ground.

MPE Limits for General Population/Uncontrolled Area

Frequency Range (MHz)	***Power Density (mW/cm^2)***
1500 – 100,000	1.0

Table 1

MPE Limits for Occupational/Controlled Area

Frequency Range (MHz)	***Power Density (mW/cm^2)***
1500 – 100,000	5.0

Table 2

FSS-4180-LP

Table 3 contains formulas, equations and parameters that were used in determining the Power Flux Density levels for the Datron FSS-4180-LP:

Data Type	Data Symbol	Data Formula	Data Value	Unit of Measure
Power Input	P	Input	5	W
Antenna Size	D_1 x D_2	Input	.46 x .34	M
Antenna Area	A	$A = (\Pi D_1 D_2) \div 4$	.12	M^2
Subreflector Size	Sub	Input	7	cm
Subreflector Area	A_{sub}	$A_{sub} = (\Pi Sub^2) \div 4$	38.48	cm^2
Gain dBi	G_{dbi}	Input	34	dBi
Gain Factor	G	$G = 10^{Gdbi/10}$	2511.89	Gain Factor
Frequency	f	Input	14250	MHz
Wavelength	λ	$299.79 / f$	0.021038	Meters
Aperture Efficiency	η	$\eta = [(G\lambda^2) \div (4\Pi)] \div A$	.70	n/a
Pi	Π	Input	3.14159	Numeric
Constant	M/Sec	Input	299,792,458	Numeric
Conversion W to mW	mW	mW = $W \times 1000$	n/a	n/a
Conversion M to cm	cm	cm = $M \times 100$	n/a	n/a
Conversion M^2 to cm^2	cm^2	$cm^2 = M^2 \times 10000$	n/a	n/a
Conversion W/M^2 to mW/cm^2	mW/cm^2	$mW/cm^2 = W / M^2 \div 10$	n/a	n/a

Table 3

1. Far Field Analysis

The distance to the far field can be calculated using the following formula:

$$R_{ff} = \frac{0.6D^2}{\lambda} = \quad 4.56 \text{ Meters}$$

The power density in the far field can be calculated using the following formula. Note: this formula requires the use of power in milliwatts and far field distance in centimeters, or requires a post calculation conversion from W/M^2:

$$S_{ff} = \frac{PG}{4\Pi R_{ff}^2} = \quad 4.800 \text{ mW/cm}^2$$

2. Near Field Analysis

The extent of the Near Field region can be calculated using the following formula:

$$R_{nf} = \frac{D^2}{4\lambda} = \quad 1.90 \text{ Meters}$$

The power density of the near field can be calculated using the following formula. Note: this formula requires the use of power in milliwatts and diameter in centimeters, or requires a post calculation conversion from W/M^2:

$$S_{nf} = \frac{16\eta P}{\Pi D^2} = \quad 11.205 \text{ mW/cm}^2$$

3. Transition Region Analysis

The transition region extends from the end of the near field out to the beginning of the far field. The power density in the transition region decreases inversely with distance from the antenna, while power density in the far-field decreases inversely with the square of the distance. However the power density in the transition region will not exceed the density in the near field, and can be calculated for any point in the transition region (R), using the following formula. Note: This formula requires the use of distance in centimeters, or requires a post calculation conversion from W/M^2.

$$S_t = \frac{S_{nf} R_{nf}}{R} = \quad 11.205 \text{ mW/cm}^2$$

4. Main Reflector Surface Area Analysis

The maximum power density at the antenna surface area can be calculated using the following formula. Note: this formula requires the use of Power in milliwatts and Area in centimeters squared, or requires a post calculation conversion from W/M^2.

$$S_{surface} = \frac{4P}{A} = \quad 15.915 \text{ mW/cm}^2$$

5. Subreflector Area Analysis

The area between the sub reflector and main reflector presents a potential hazard, with the highest density being located at the sub reflector area. The power density at the sub reflector can be calculated using the following formula. Note: this formula requires the use of Power in milliwatts and Area in centimeters squared, or requires a post calculation conversion from W/M^2.

$$Sub_{surface} = \frac{4P}{A_{sub}} = 519.690 \text{ mW/cm}^2$$

6. Power Density between Reflector and Top of Aircraft Analysis

The power density between the reflector and the top of the aircraft can be calculated using the following formula. Note: this formula requires the use of Power in milliwatts and Area in centimeters squared, or requires a post calculation conversion from W/M^2.

$$S_{ground} = \frac{P}{A} = 3.979 \text{ mW/cm}^2$$

Tables 4 and 5 present a summary of the radiation hazard findings on the Datron FSS-4180-LP terminal for both the General Population/Uncontrolled Area, as well as the Occupational/Controlled area environments.

MPE Limits for General Population/Uncontrolled Area

Area	Range Meters	Power Density (mW/cm^2)	Finding
Far Field	4.56	4.800 mW/cm^2	Potential Hazard
Near Field	1.90	11.205 mW/cm^2	Potential Hazard
Transition Region	1.90 – 4.56	11.205 mW/cm^2	Potential Hazard
Main Reflector Surface	N/A	15.915 mW/cm^2	Potential Hazard
Sub-reflector Surface	N/A	519.690 mW/cm^2	Potential Hazard
Area between Reflector and Top of Aircraft	N/A	3.979 mW/cm^2	Potential Hazard

Table 4

MPE Limits for Occupational/Controlled Area

Area	*Range Meters*	*Power Density (mW/cm^2)*	*Finding*
Far Field	4.56	4.800 mW/cm^2	Meets FCC Requirement
Near Field	1.90	11.205 mW/cm^2	Potential Hazard
Transition Region	1.90 – 4.56	11.205 mW/cm^2	Potential Hazard
Main Reflector Surface	N/A	15.915 mW/cm^2	Potential Hazard
Sub-reflector Surface	N/A	519.690 mW/cm^2	Potential Hazard
Area between Reflector and Top of Aircraft	N/A	3.979 mW/cm^2	Meets FCC Requirement

Table 5

Based on the above finding there is a potential hazard of radio frequency exposure with use of the FSS-4180-LP. In order to mitigate the risk of these hazards, while on the ground this terminal will only be operated in a controlled area. Also the antenna is located on the top of the aircraft, which is approximately 13 feet (4 meters). Additionally, the unit will be shut down prior to performing maintenance in any of the occupational hazard areas.

Antenna Range Test Report
Datron FSS-4180-LP

OPTIM 18 " ANTENNA
46000-05

10/25/04

H-PLANE OPTIM ANT PATTERNS **EL ROLL AUT 90 DEG**

								SIDELOBE		3dB BW
PATTERN #	FREQ GHz	AUT PORT	BORESITE	AUT POL	AXIS	PLANE	TEST DESC	LEFT (dB)	RIGHT (dB)	DEG
OPTIM2.021	10.95	WR-75	VERT	HOR	EL	H-PLANE	+/- 180 DEG PATTERN	-13.89	-14.2	3.68
OPTIM2.022	11.31	WR-75	VERT	HOR	EL	H-PLANE	+/- 180 DEG PATTERN	-13.63	-14.01	3.63
OPTIM2.023	11.67	WR-75	VERT	HOR	EL	H-PLANE	+/- 180 DEG PATTERN	-13.57	-14.08	3.51
OPTIM2.024	12.03	WR-75	VERT	HOR	EL	H-PLANE	+/- 180 DEG PATTERN	-13.44	-13.82	3.37
OPTIM2.025	12.39	WR-75	VERT	HOR	EL	H-PLANE	+/- 180 DEG PATTERN	-15.35	-15.67	3.46
OPTIM2.026	12.75	WR-75	VERT	HOR	EL	H-PLANE	+/- 180 DEG PATTERN	-15.61	-16.18	3.37
OPTIM2.027	13.5	WR-62	VERT	VERT	AZ	H-PLANE	+/- 180 DEG PATTERN	-17.07	-16.94	3.27
OPTIM2.028	13.84	WR-62	VERT	VERT	AZ	H-PLANE	+/- 180 DEG PATTERN	-18.15	-17.96	3.32
OPTIM2.029	14.16	WR-62	VERT	VERT	AZ	H-PLANE	+/- 180 DEG PATTERN	-18.79	-18.41	3.34
OPTIM2.030	14.5	WR-62	VERT	VERT	AZ	H-PLANE	+/- 180 DEG PATTERN	-20.96	-20.76	3.21

E-PLANE OPTIM ANT PATTERNS **EL ROLL AUT 90 DEG**

								SIDELOBE		3dB BW
PATTERN #	FREQ GHz	AUT PORT	BORESITE	AUT POL	AXIS	PLANE	TEST DESC	LEFT (dB)	RIGHT (dB)	DEG
OPTIM2.031	10.95	WR-75	HOR	HOR	AZ	E-PLANE	+/- 180 DEG PATTERN	-20.13	-20.06	3.93
OPTIM2.032	11.31	WR-75	HOR	HOR	AZ	E-PLANE	+/- 180 DEG PATTERN	-21.21	-20.96	3.87
OPTIM2.033	11.67	WR-75	HOR	HOR	AZ	E-PLANE	+/- 180 DEG PATTERN	-19.49	-19.51	3.68
OPTIM2.034	12.03	WR-75	HOR	HOR	AZ	E-PLANE	+/- 180 DEG PATTERN	-20.57	-20.51	3.63
OPTIM2.035	12.39	WR-75	HOR	HOR	AZ	E-PLANE	+/- 180 DEG PATTERN	-19.94	-19.81	3.59
OPTIM2.036	12.75	WR-75	HOR	HOR	AZ	E-PLANE	+/- 180 DEG PATTERN	-19.17	-19.36	3.48
OPTIM2.037	13.5	WR-62	HOR	VERT	EL	E-PLANE	+/- 180 DEG PATTERN	-17.58	-19.05	3.25
OPTIM2.038	13.84	WR-62	HOR	VERT	EL	E-PLANE	+/- 180 DEG PATTERN	-16.82	-17.39	3.19
OPTIM2.039	14.16	WR-62	HOR	VERT	EL	E-PLANE	+/- 180 DEG PATTERN	-16.24	-17.26	3.09
OPTIM2.040	14.5	WR-62	HOR	VERT	EL	E-PLANE	+/- 180 DEG PATTERN	-14.97	-15.54	2.96

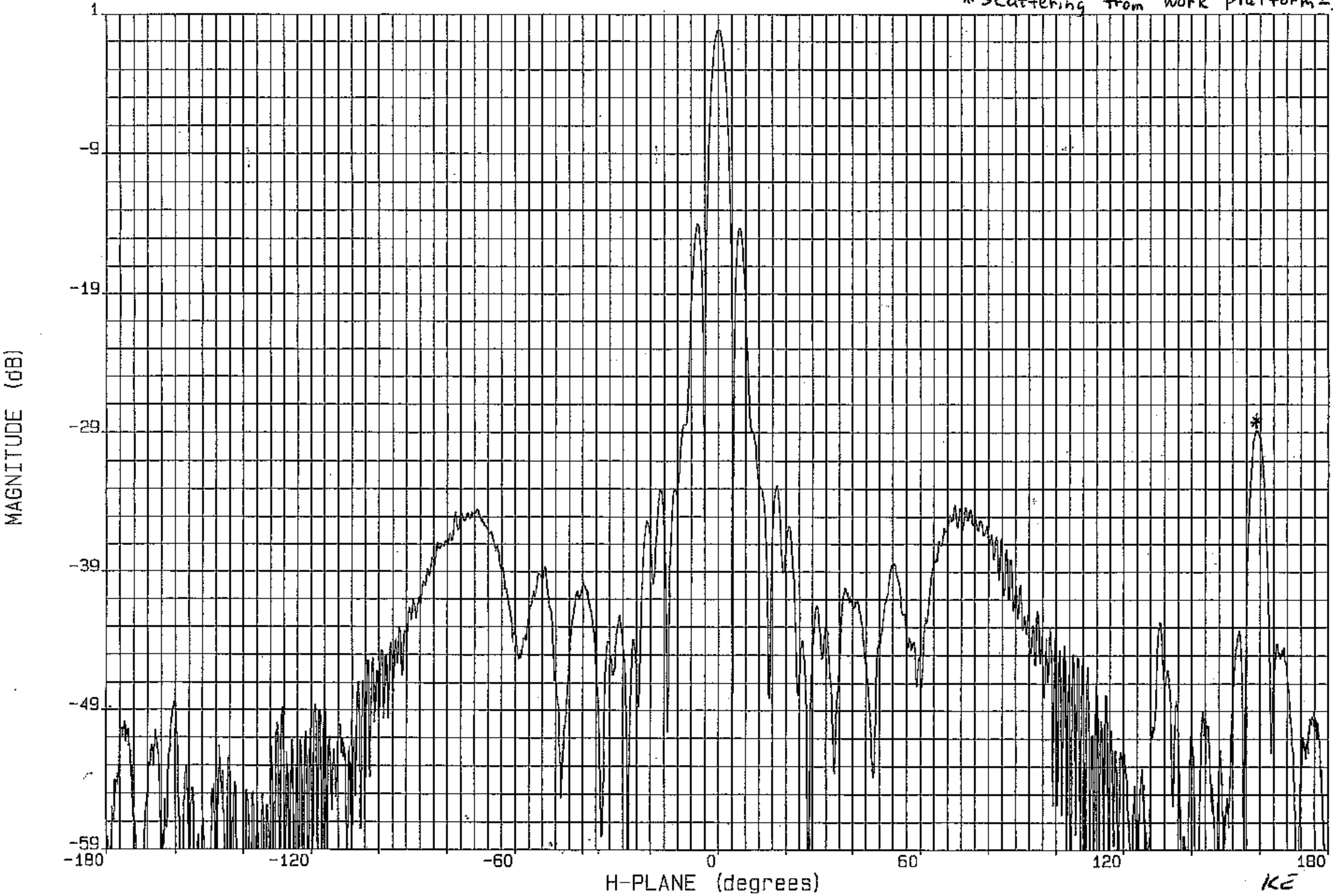
ICE

46000, 18"OPTIM ANT, WR-75,
FILENAME: OPTIM2.021
FREQ: 10.950 GHz
POLARIZATION: HOR-EL
B = 0.00 Degrees

10/25/04 11:35:38

PLOT: Channel 1
Data:

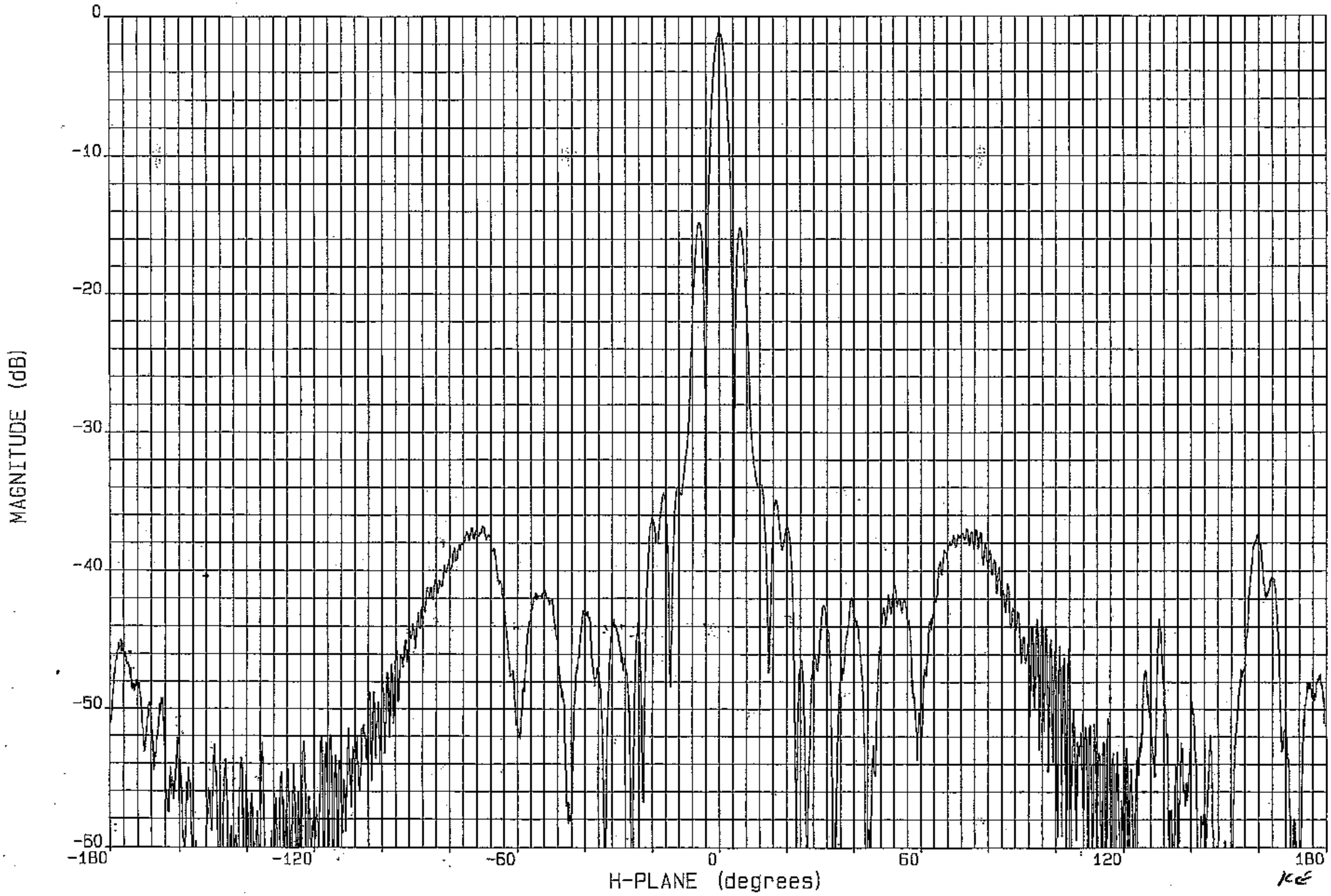
*Scattering from work platform – KE



46000, 18"OPTIM ANT, WR-75,
FILENAME: OPTIM2.022
FREQ: 11.310 GHz
POLARIZATION: HOR-EL
B = 0.00 Degrees

10/25/04 11: 42: 16

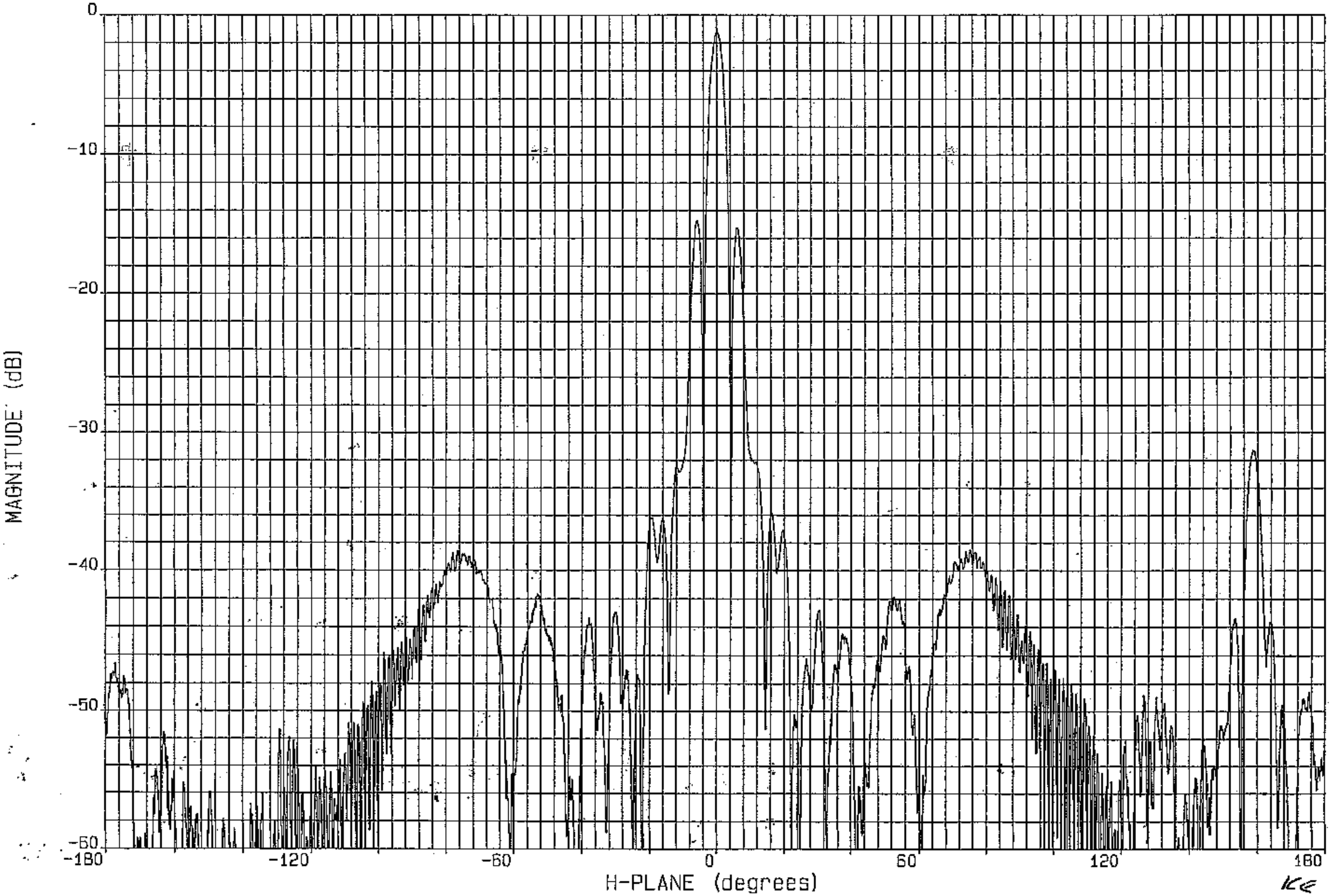
PLOT: Channel 1
Data: ———



46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.023
FREQ: 11.670 GHz
POLARIZATION: HOR-EL
B = 0.00 Degrees

10/25/04 11:46:19

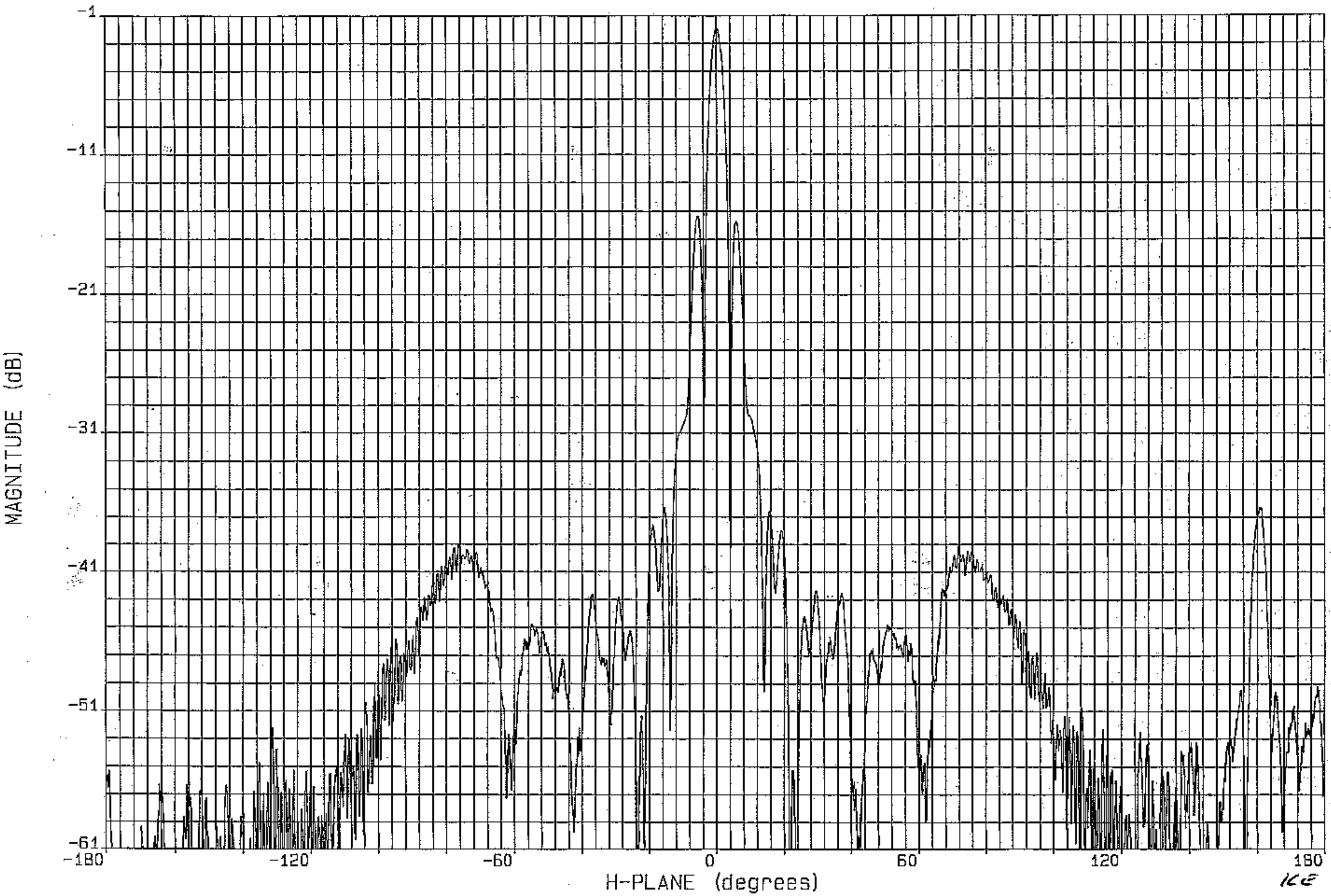
PLOT: Channel 1
Data:

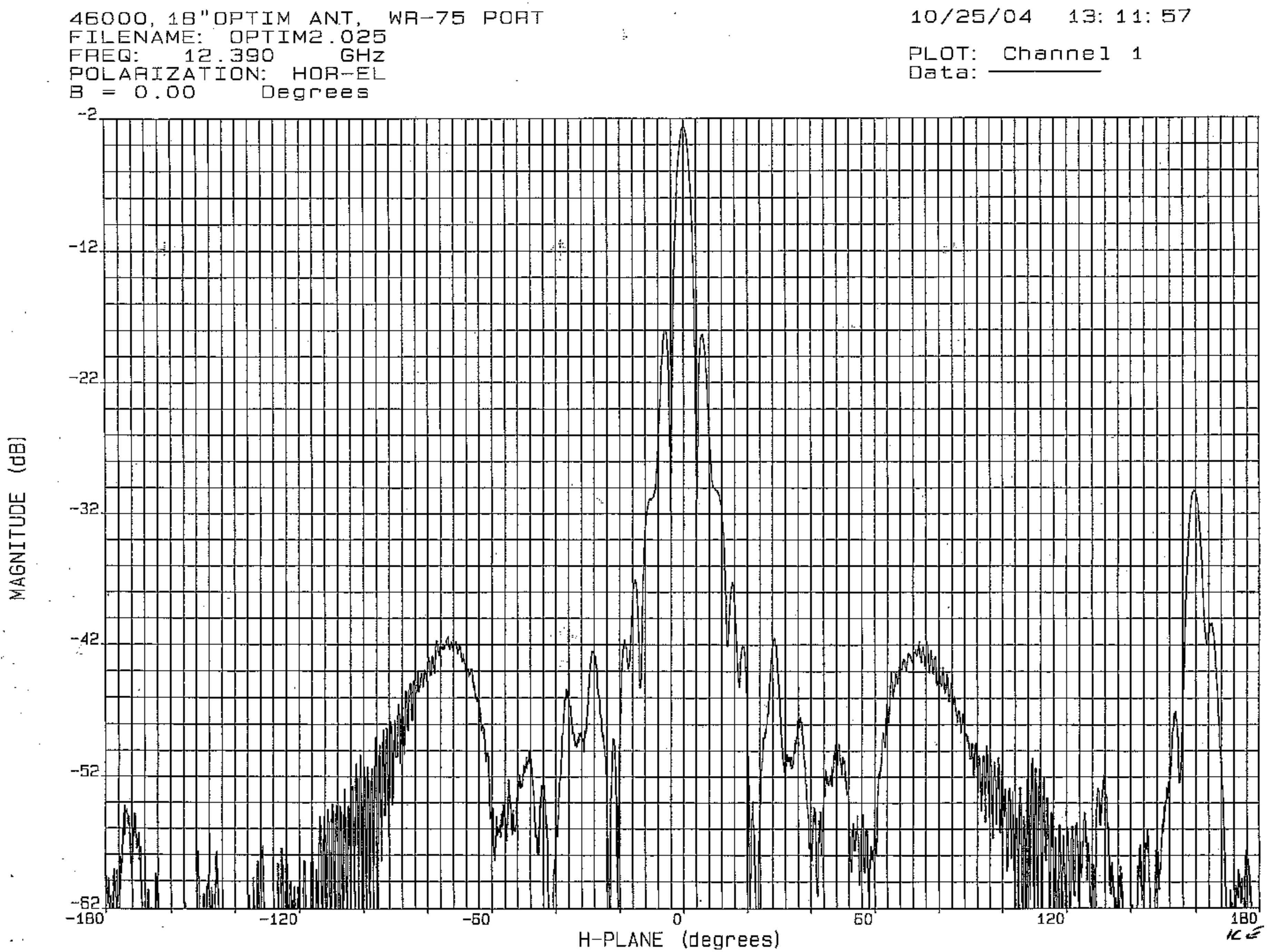


46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.024
FREQ: 12.030 GHz
POLARIZATION: HOR-EL
B = 0.00 Degrees

10/25/04 11:52:25

PLOT: Channel 1
Data: ———

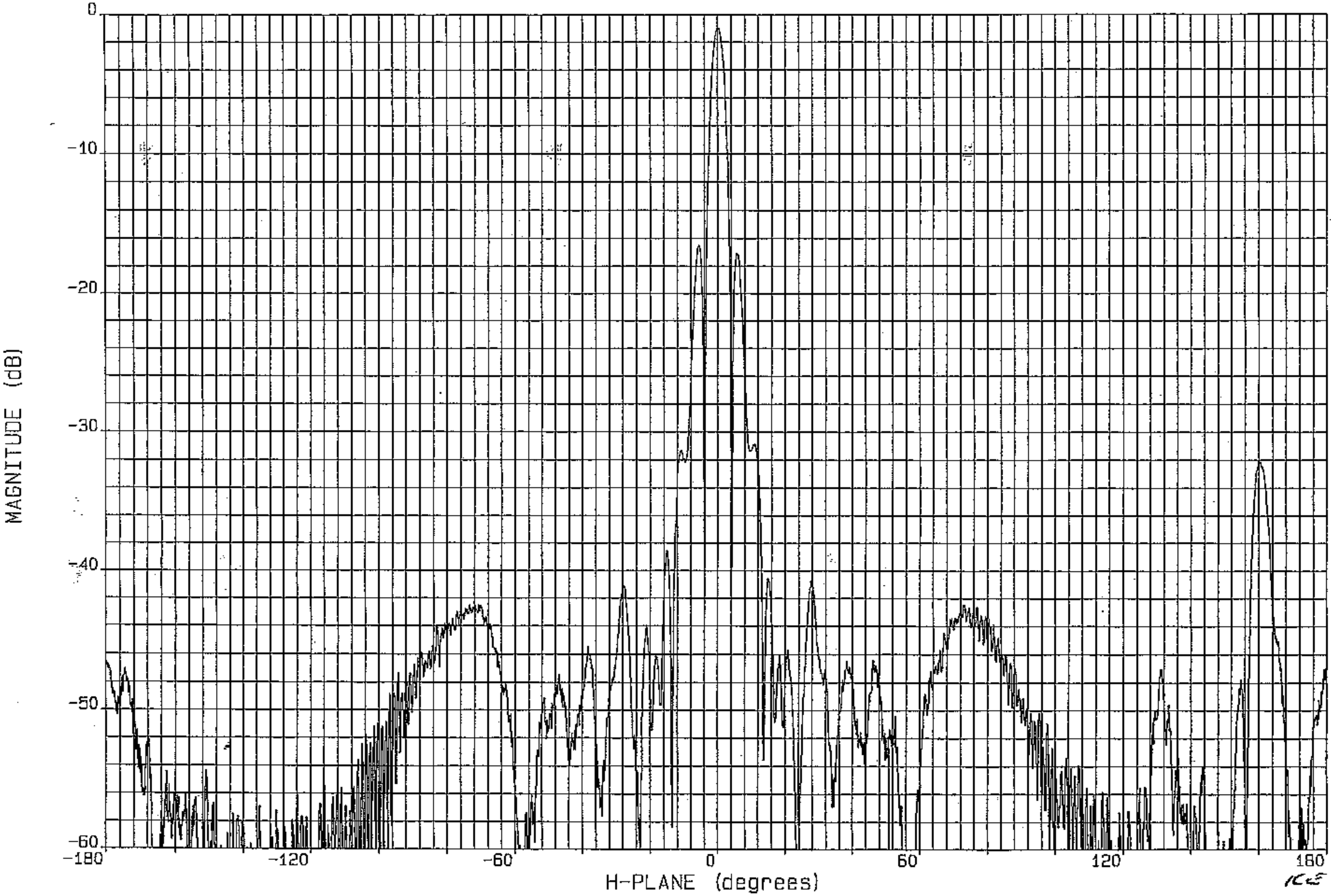



46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.025
FREQ: 12.390 GHz
POLARIZATION: HOR-EL
B = 0.00 Degrees
10/25/04 13: 11: 57
PLOT: Channel 1
Data:
MAGNITUDE (dB)
-2
-12
-22
-32
-42
-52
-62
-180
-120
-60
0
60
120
180
H-PLANE (degrees)

46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.026
FREQ: 12.750 GHz
POLARIZATION: HOR-EL
B = 0.00 Degrees

10/25/04 13:17:21

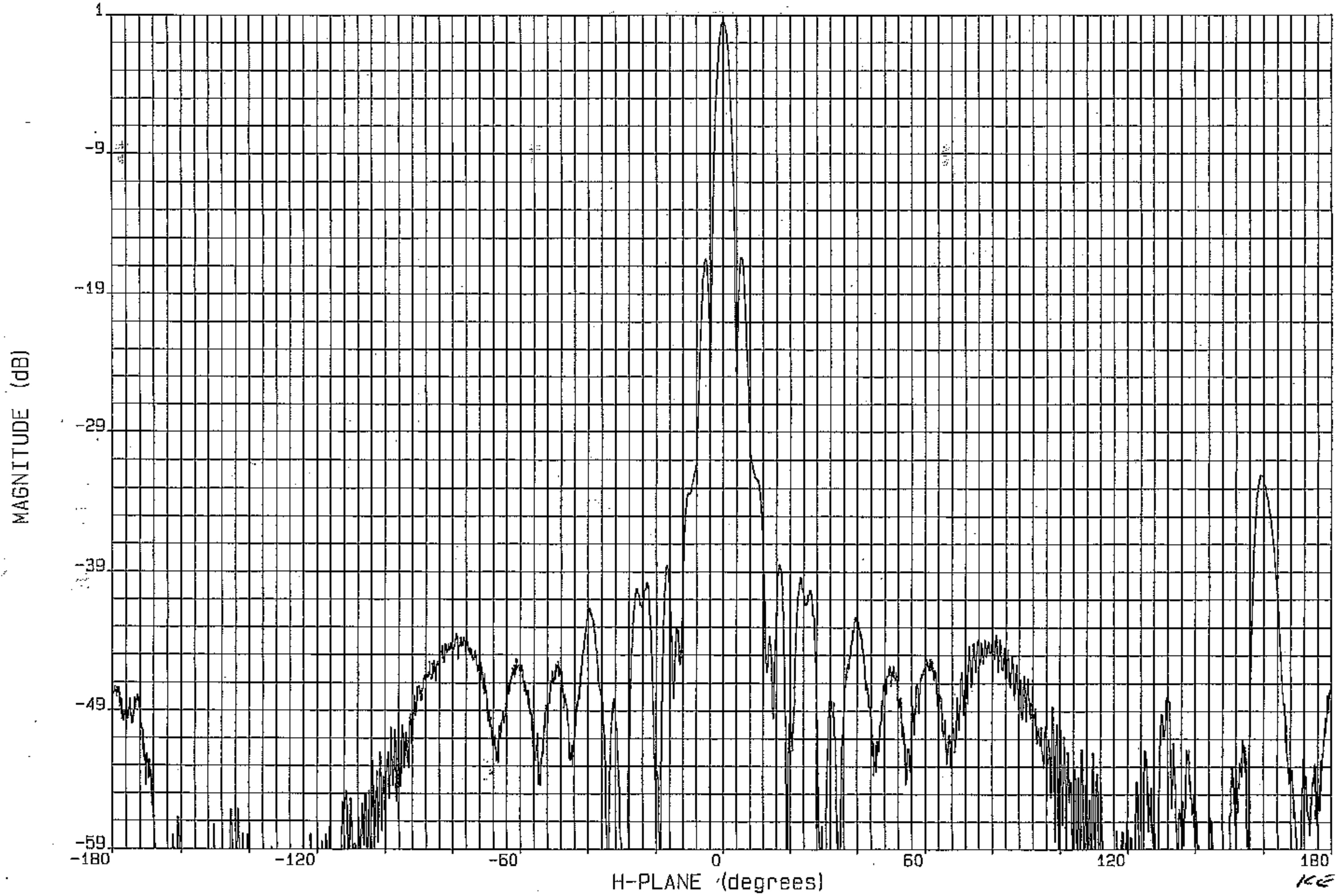
PLOT: Channel 1
Data: ———



46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.027
FREQ: 13.500 GHz
POLARIZATION: VERT-AZ
B = 0.00 Degrees

10/25/04 13:28:49

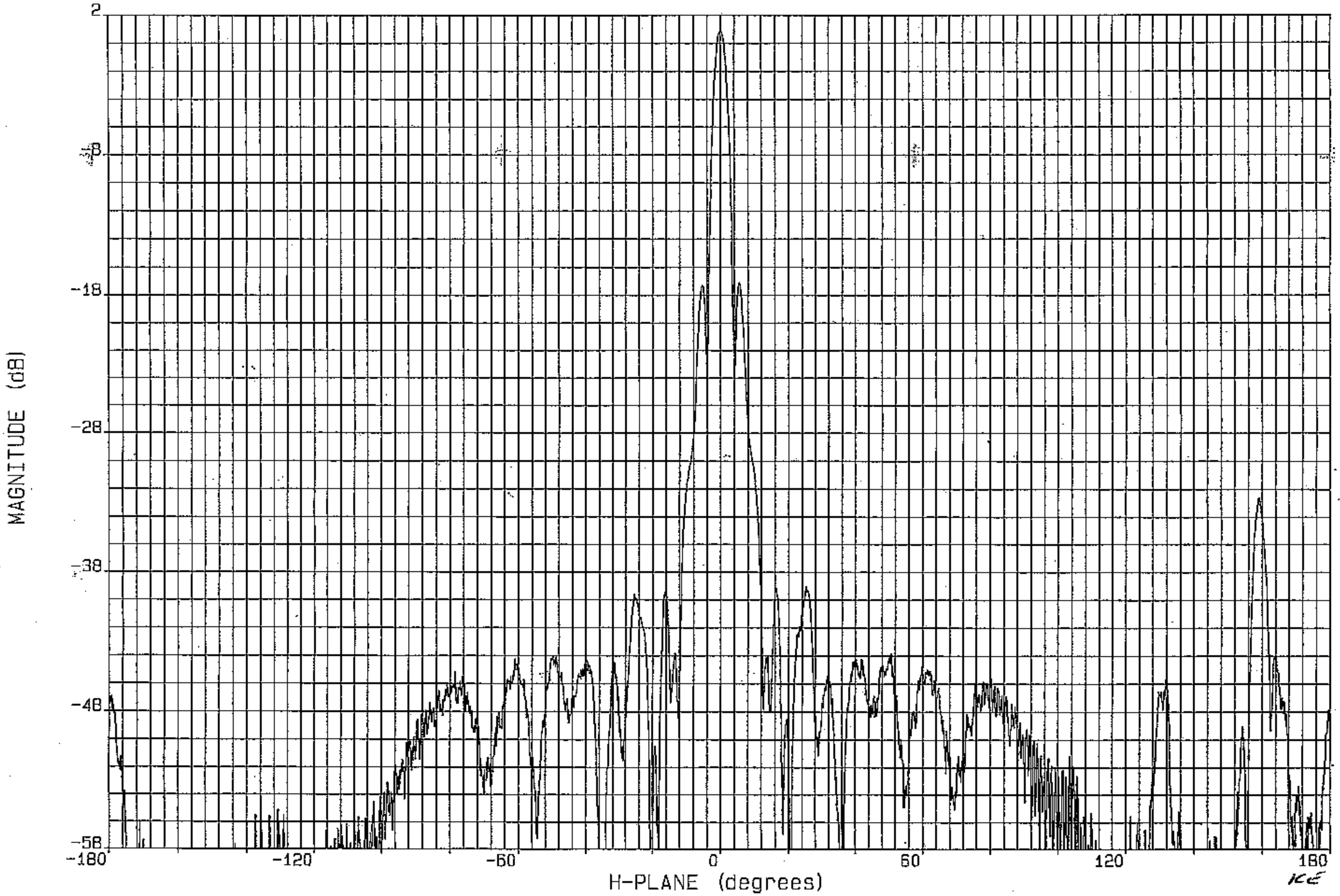
PLOT: Channel 1
Data: ———



46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.028
FREQ: 13.840 GHz
POLARIZATION: VERT-AZ
B = 0.00 Degrees

10/25/04 13: 33: 29

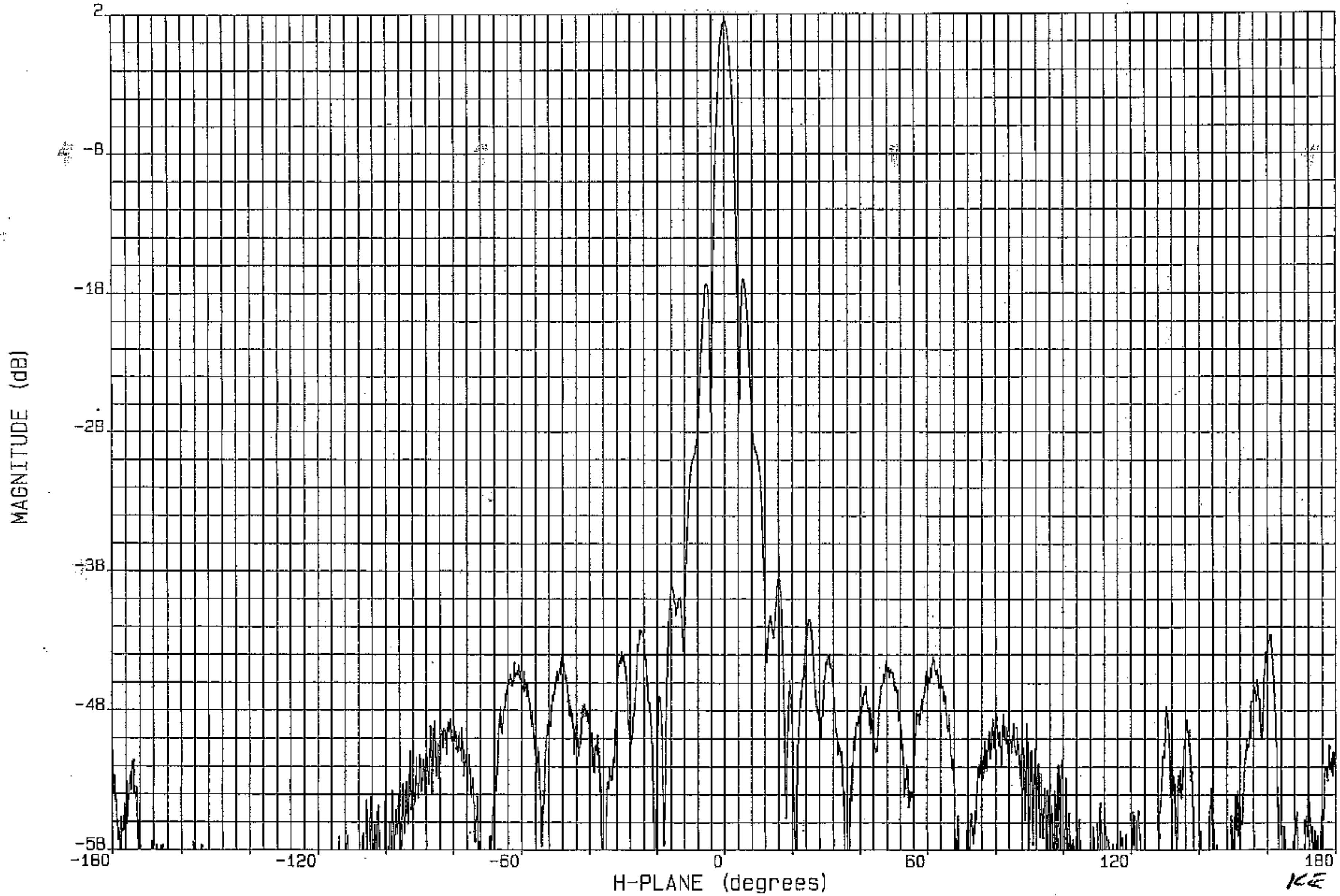
PLOT: Channel 1
Data: ———



46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.029
FREQ: 14.160 GHz
POLARIZATION: VERT-AZ
B = 0.00 Degrees

10/25/04 13: 40: 27

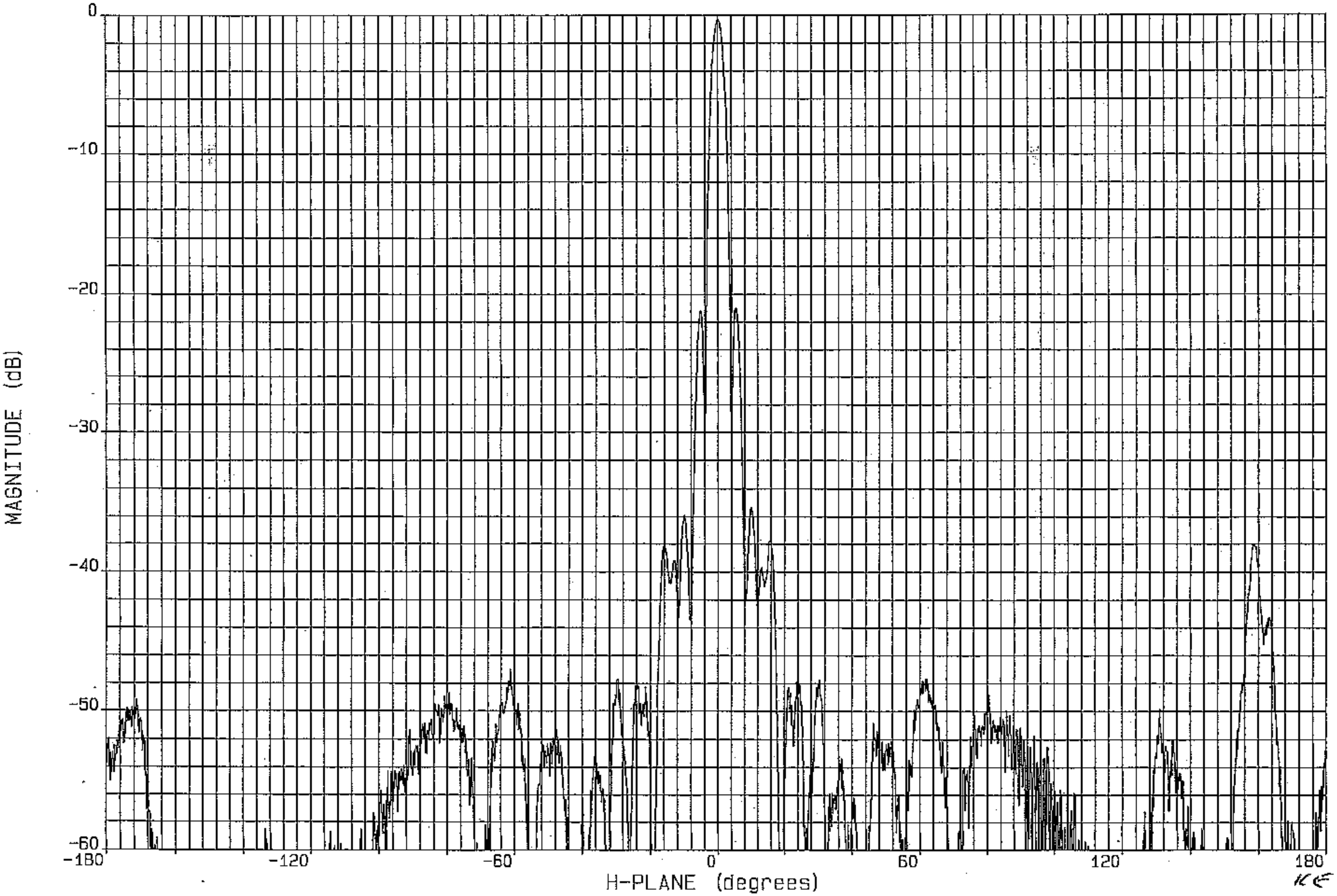
PLOT: Channel 1
Data: ________



46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.030
FREQ: 14.500 GHz
POLARIZATION: VERT-AZ
B = 0.00 Degrees

10/25/04 13:45:26

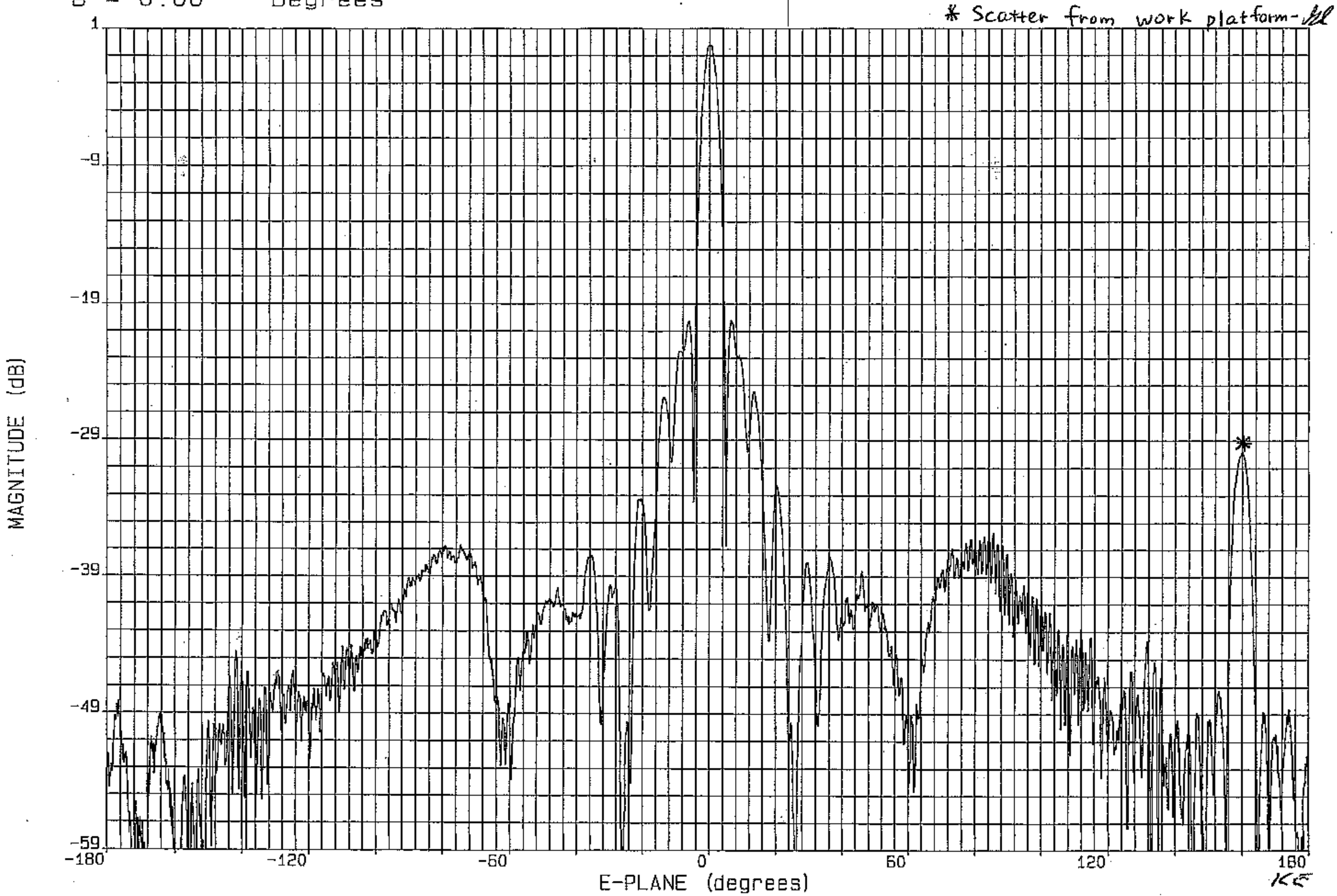
PLOT: Channel 1
Data: ______

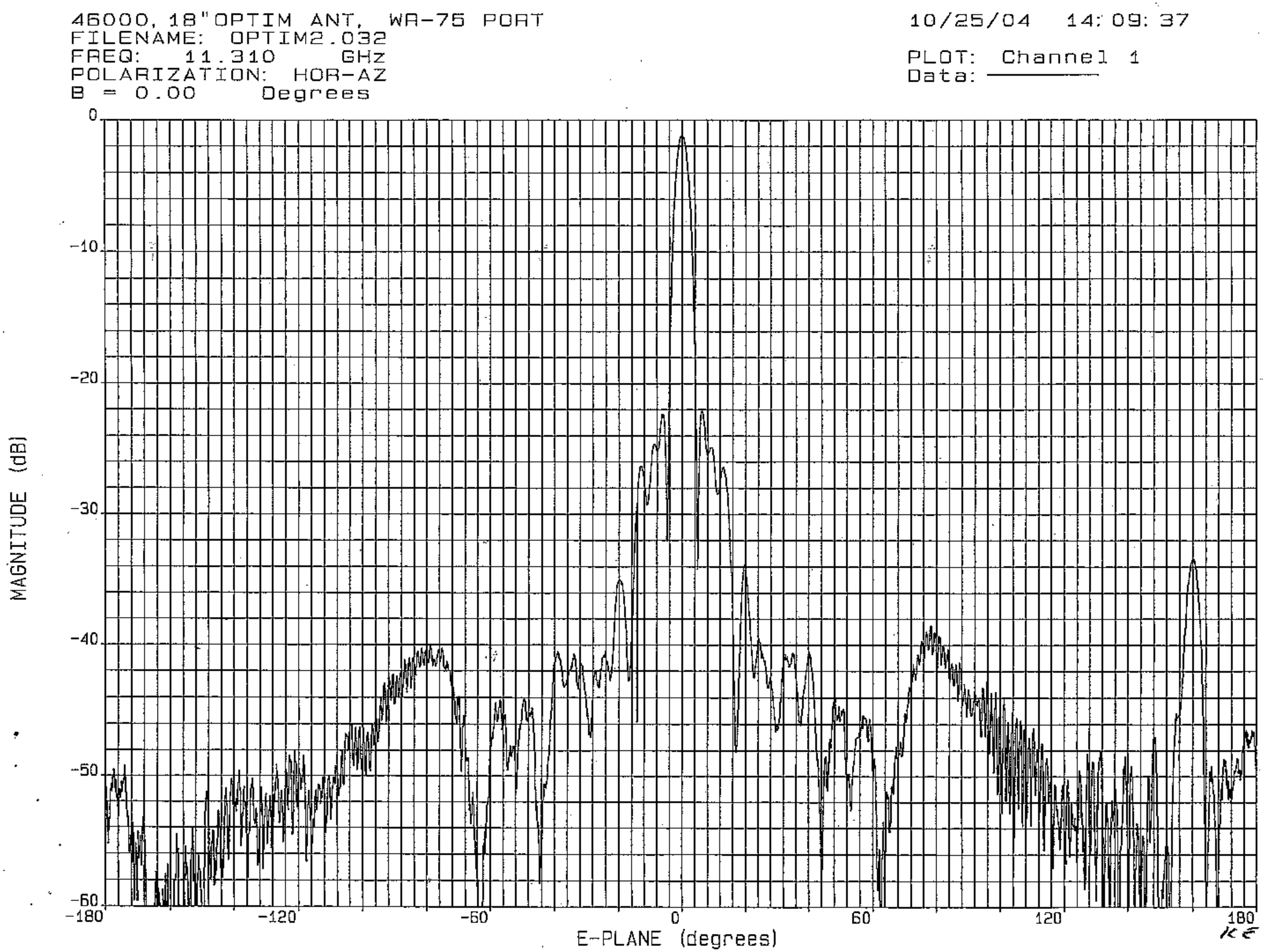


46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.031
FREQ: 10.950 GHz
POLARIZATION: HOR-AZ
B = 0.00 Degrees

10/25/04 14: 04: 24

PLOT: Channel 1
Data: ________

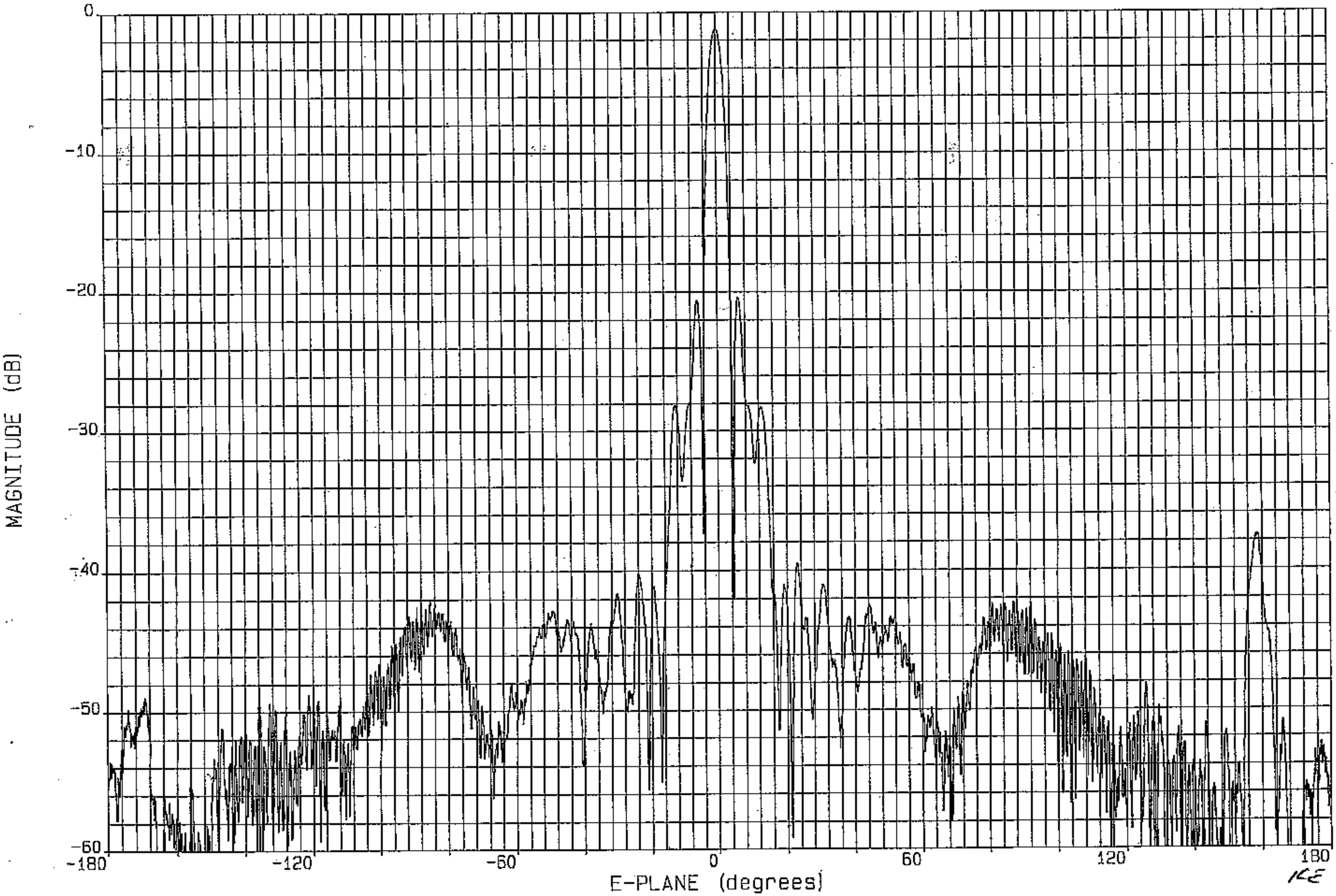



46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.032
FREQ: 11.310 GHz
POLARIZATION: HOR-AZ
B = 0.00 Degrees
10/25/04 14:09:37
PLOT: Channel 1
Data:
MAGNITUDE (dB)
0
-10
-20
-30
-40
-50
-60
-180
-120
-60
0
60
120
180
E-PLANE (degrees)
KE

46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.033
FREQ: 11.670 GHz
POLARIZATION: HOR-AZ
B = 0.00 Degrees

10/25/04 14: 17: 05

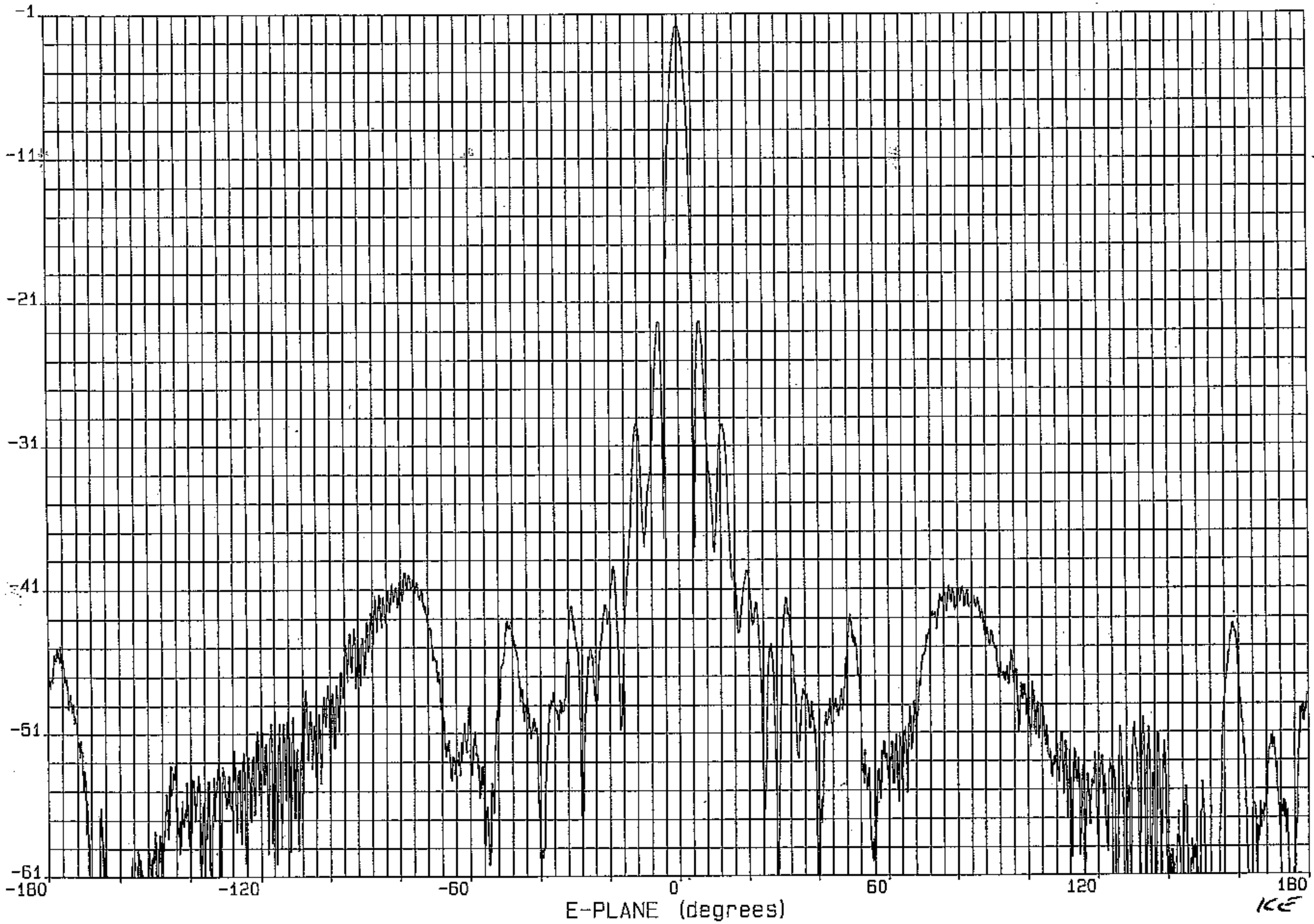
PLOT: Channel 1
Data: ________



46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.034
FREQ: 12.030 GHz
POLARIZATION: HOR-AZ
B = 0.00 Degrees

10/25/04 14:21:13

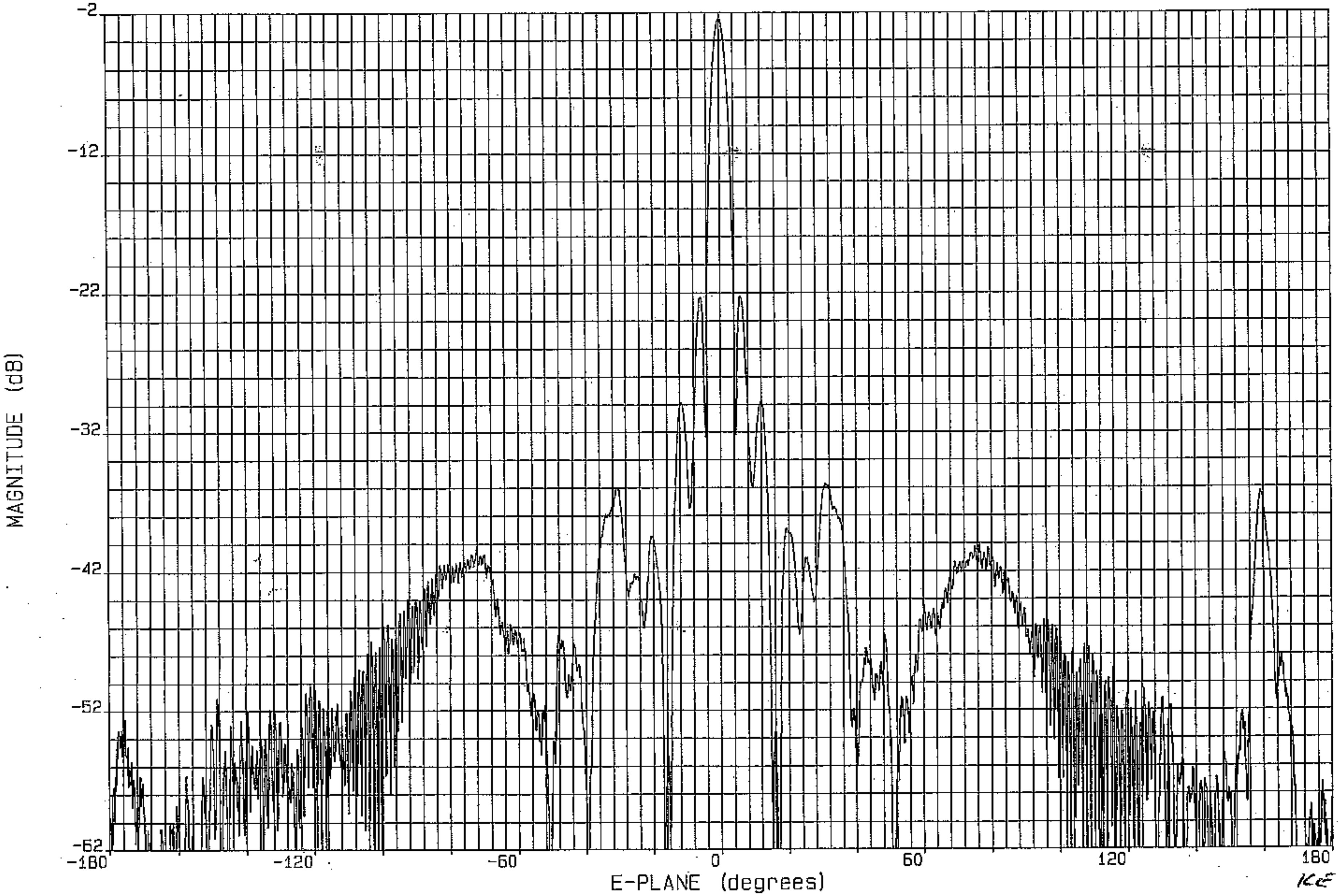
PLOT: Channel 1
Data: ———

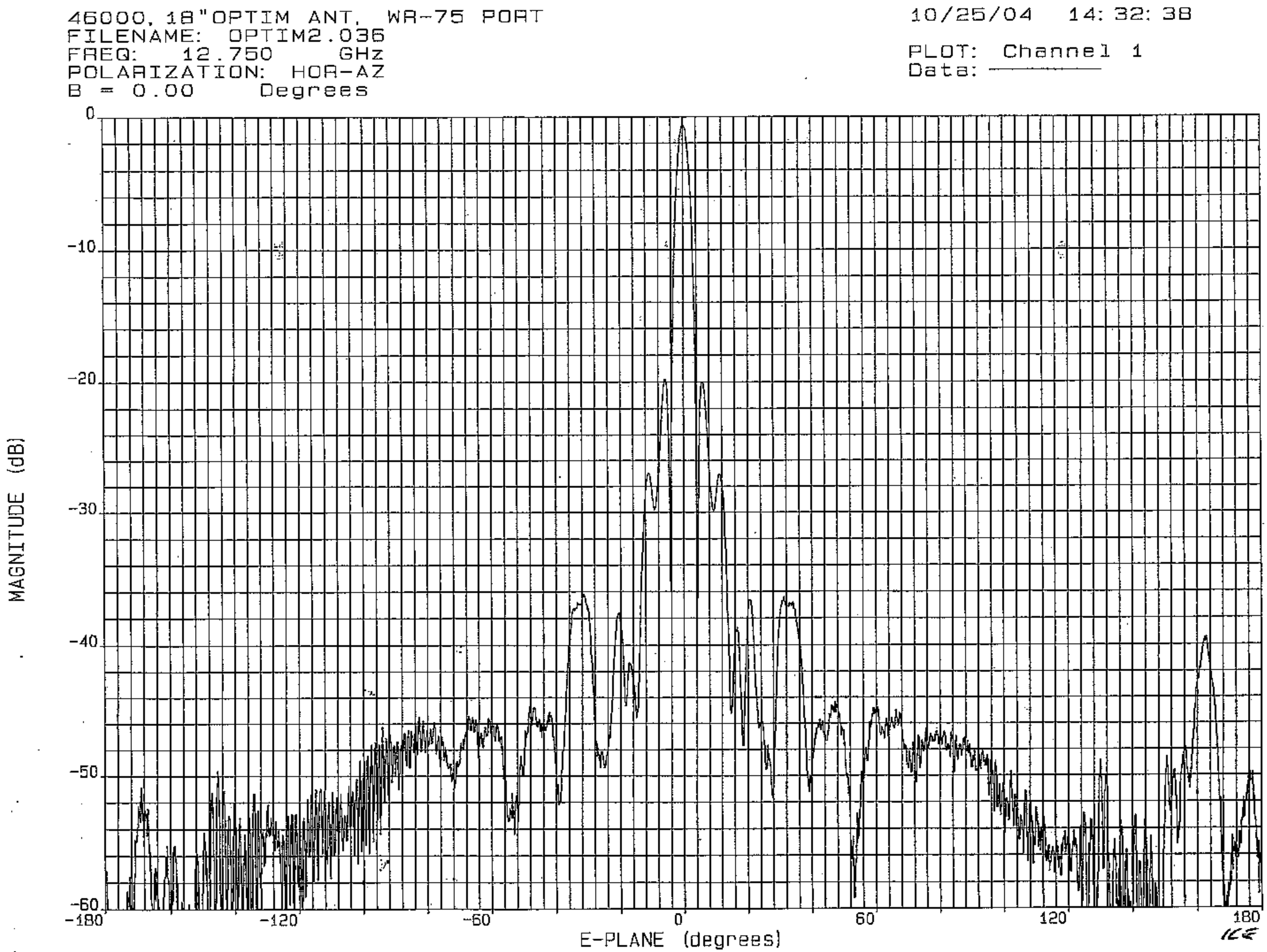


46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.035
FREQ: 12.390 GHz
POLARIZATION: HOR-AZ
B = 0.00 Degrees

10/25/04 14: 26: 11

PLOT: Channel 1
Data: ————

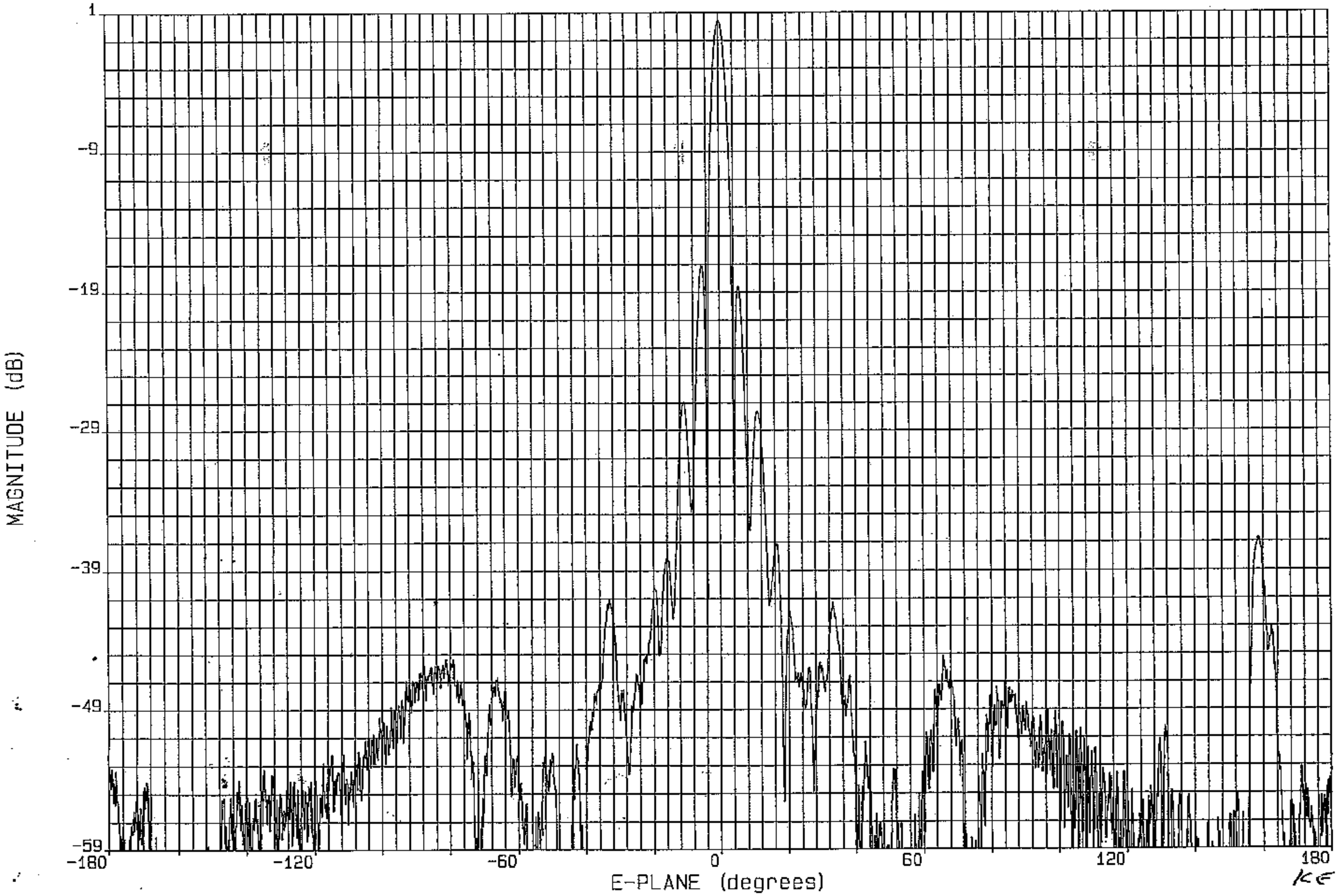



46000, 18"OPTIM ANT, WR-75 PORT
FILENAME: OPTIM2.036
FREQ: 12.750 GHz
POLARIZATION: HOR-AZ
B = 0.00 Degrees
10/25/04 14:32:38
PLOT: Channel 1
Data:
MAGNITUDE (dB)
0
-10
-20
-30
-40
-50
-60
-180
-120
-60
0
60
120
180
E-PLANE (degrees)
ICE

46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.037
FREQ: 13.500 GHz
POLARIZATION: VERT-EL
B = 0.00 Degrees

10/25/04 14: 43: 32

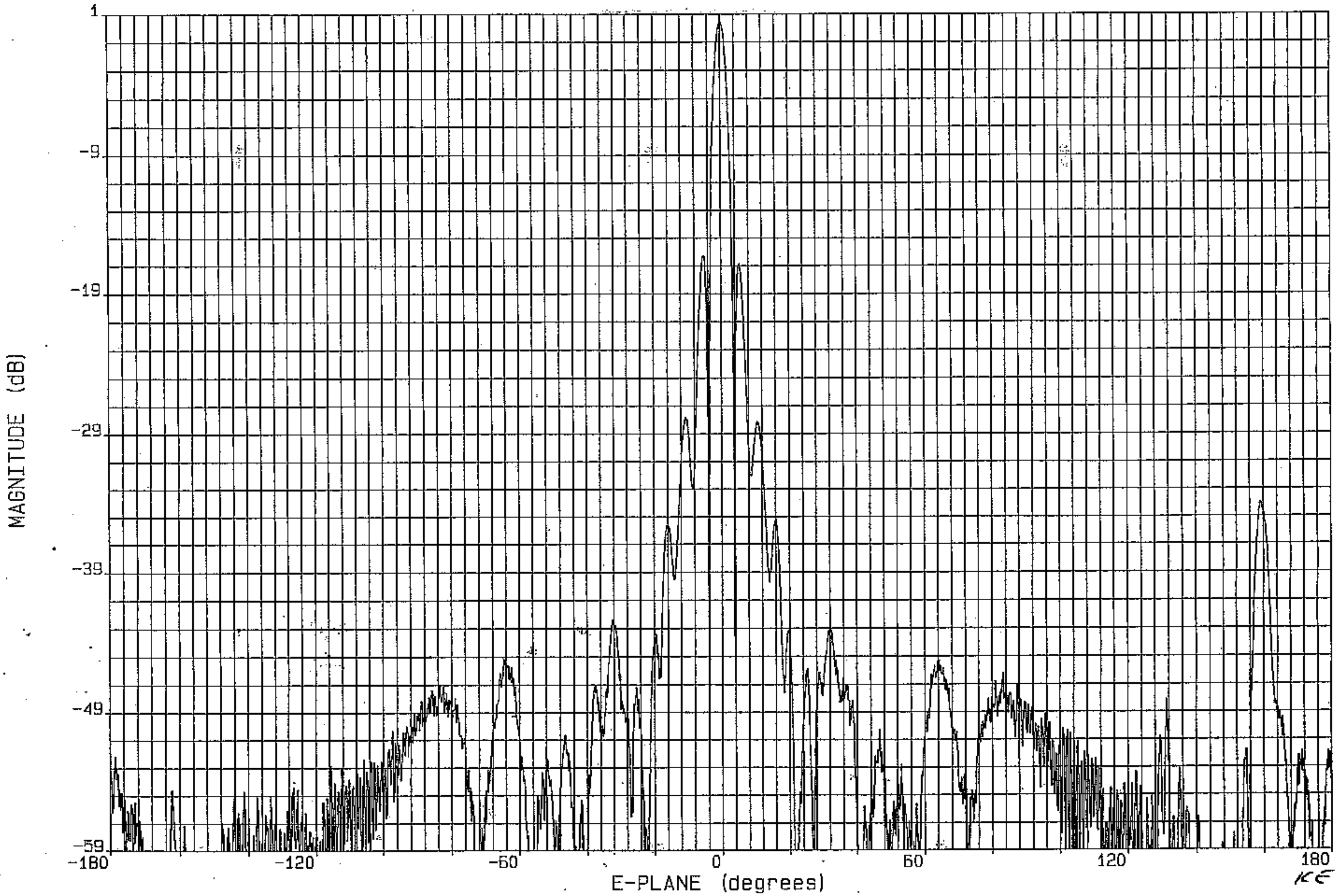
PLOT: Channel 1
Data: ————



46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.038
FREQ: 13.840 GHz
POLARIZATION: VERT-EL
B = 0.00 Degrees

10/25/04 14: 48: 48

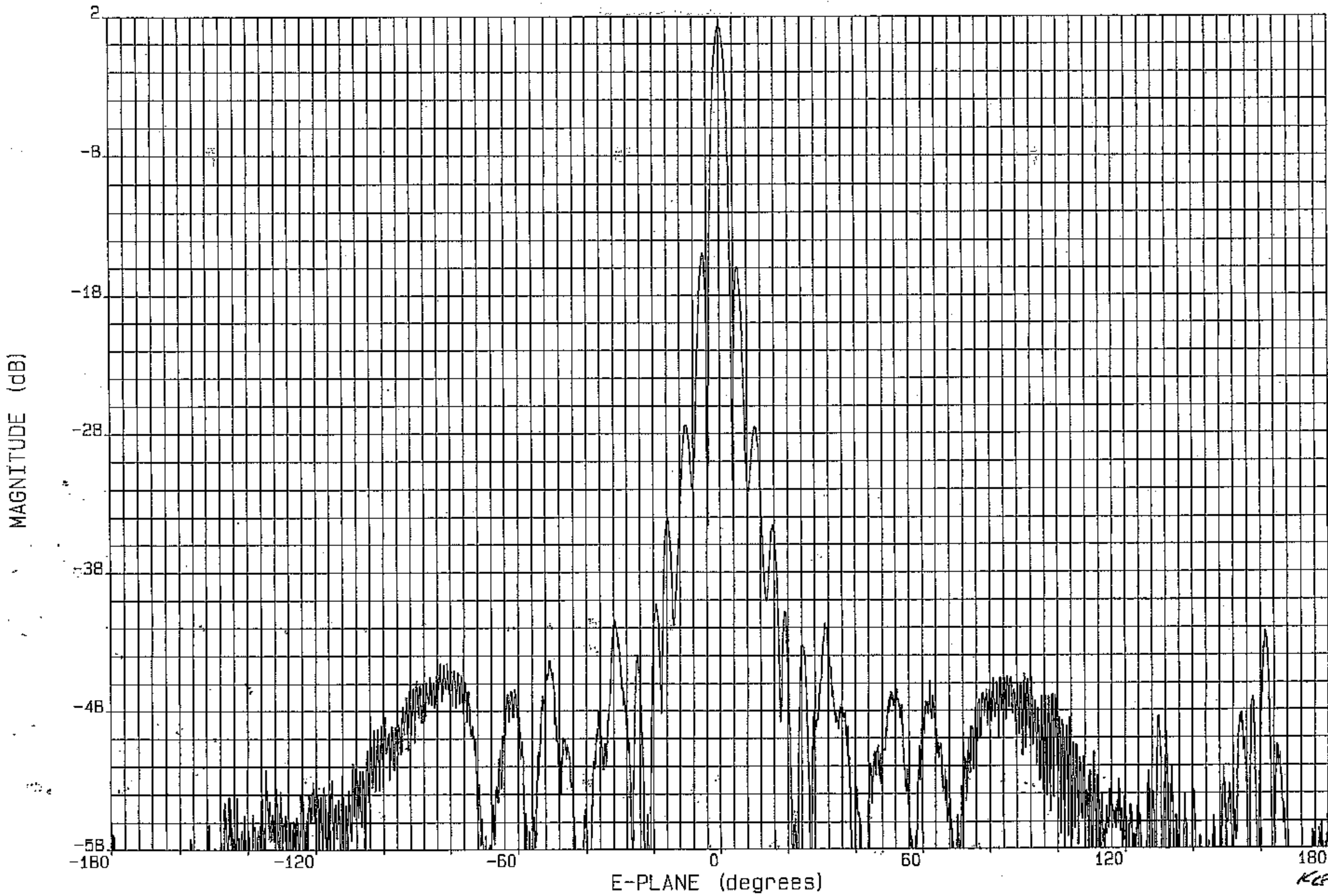
PLOT: Channel 1
Data: ——



46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.039
FREQ: 14.160 GHz
POLARIZATION: VERT-EL
B = 0.00 Degrees

10/25/04 14: 52: 52

PLOT: Channel 1
Data:



46000, 18"OPTIM ANT, WR-62 PORT
FILENAME: OPTIM2.040
FREQ: 14.500 GHz
POLARIZATION: VERT-EL
B = 0.00 Degrees

10/25/04 14:57:41

PLOT: Channel 1
Data: ————