MICROWAVE ANTENNAS

KS-15676 HORN-REFLECTOR AND WAVEGUIDE SYSTEM

DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section contains equipment data, transmission characteristics, and other information pertaining to the KS-15676 L8, L9, and L14 horn-reflector antennas and associated circular waveguide.

1.02 This section is reissued to include information pertaining to the L14 horn reflector and L15 modification kit and to supplement and revise transmission characteristics and equipment information.

1.03 The KS-15676 horn-reflector antenna is designed for use with the microwave equipment of the TD-2, TD-3, TH, TJ, TL-2, and TM-1 radio relay systems. It may be used either as a transmitting or a receiving antenna or, with a suitable isolating network, one antenna may be used for both transmitting and receiving. This antenna provides high forward gain, and good side and rear lobe suppression. It is, therefore, especially useful on long paths or in situations requiring good directivity and shielding.

1.04 The antenna is designed for operation within the 3700 MHz to 4200 MHz, the 5925 MHz to 6425 MHz, and the 10,700 MHz to 11,700 MHz common carrier bands. Both vertically and horizontally polarized signals may be employed.

1.05 The L14 antenna is designed to resist an overpressure of 2 psi, which may result from the detonation of a nuclear weapon, and is intended for use at hardened stations.

1.06 The L8 and L9 antennas may be converted to L14 antennas by installing the L15 modification kit. This may be accomplished without removing the antenna from service as described in Section 402-421-220.

2. INTRODUCTION

2.01 The KS-15676 L8, L9, and L14 horn-reflector antennas consist of an electromagnetic horn which illuminates a sector of a very large paraboloidal reflector whose focal point is at the apex or feed point of the horn. The paraboloidal reflector converts the spherical wave front emanating from the feed horn to a plane or uniphase wave front at the antenna aperture, thus insuring maximum gain and minimum side lobe radiation.

2.02 The antenna is fed with 2.812-inch ID circular waveguide with TE°_{11}- dominant mode transmission of both vertically and horizontally polarized signals. This allows alternate polarization of adjacent broadband radio channels. As a result, more efficient use is made of the frequency spectrum.

2.03 The antenna has a projected aperture area of 64.57 square feet.

3. EQUIPMENT FEATURES

3.01 Figures 12 and 13 in Section 402-421-201 show the complete antenna assembly and its associated subassemblies. The basic antenna, furnished as a KS-15676 L8, L9, or L14 antenna, includes the following subassemblies:

L2 Weather Cover

L5 Mounting Frame

L7 Sealing Kit

L11 Mounting Clamps (4)

The following additional associated subassemblies are ordered and furnished as required:

L3 Feed Horn

L4 Mounting Base

L10 Repair Kit

L12 Azimuth Adjusting Tool

L13 Tilt Adjusting Tool

L15 Hardening Modification Kit

3.02 The L8 and L9 antennas are constructed of aluminum alloy sheets. The sides are reinforced by extruded stiffeners, and the reflector by longitudinal spars and horizontal ribs. The L8 and L9 horn-reflector antennas are identical except that the L8 antenna is shipped to the erection site knocked down and packed in four boxes, and the L9 antenna is factory-assembled and pressure-tested. The L14 antenna consists of a L9 antenna with an additional "skin" of 0.062-inch thick aluminum sheets added to the side, front, and rear panels to give the additional strength required to resist blast overpressures of 2 psi. The L14 antenna is factory assembled and pressure tested and is intended for use at hardened stations.

3.03 The antenna aperture is protected from the weather by a L2 weather cover consisting of a 4-ply, polyester-impregnated, glass fiber fabric laminate, 0.040-inch thick. Additional plies are added along the edges and to the corners to give the window sufficient strength to withstand wind loads of 100 pounds per square foot.

3.04 The small end of the horn-reflector assembly terminates in an 11.592-inch-square aperture to which a L3 feed horn is attached. This feed horn is a precision aluminum alloy casting about 21 inches long. The internal contour tapers down in a gradual hyperbolic transformation from the 11.592-inch-square aperture, which matches the large horn, to a 2.812-inch diameter that matches the circular waveguide.

3.05 The L4 circular mounting base may be installed without regard to the final aiming of the antenna. The antenna is placed on the mounting base, aligned roughly in the desired direction, and clamped down. Final aiming is accomplished by orientation according to the procedure described in Sections 402-421-206, 402-421-207, or 402-421-208.

3.06 The antenna will normally be mounted on a tower with the horn in a vertical position. The L5 mounting frame assembly provides for a minimum adjustment of the antenna of ±5 degrees in azimuth and ±3 degrees in elevation. The mounting frame assembly is arranged for anchoring to the L4 circular mounting base with four L11 mounting clamps. The antenna is secured in its tilt (elevation) position with eight locking screws.

3.07 All antenna seams are sealed with the sealer strip assembly which consists of a conducting rubber compound in combination with a woven wire mesh. Though primarily a weather seal, the conducting rubber also provides an important secondary protection against microwave leakage. The sealer strip assembly is a part of the L7 Sealing Kit.

3.08 The KS-15676 L10 repair kit is for use in making simple repairs of perforations such as bullet holes, etc, in the aluminum skin and the weather cover. The material furnished with each kit can be used to make a number of repairs, depending upon the size and nature of the damage. Instructions for the use of this kit can be found in Section 402-421-501.

3.09 The KS-15676 L11 mounting clamp, four of which are required for each KS-15676 L8, L9, or L14 antenna, is designed for use with the L12 azimuth adjusting tool when making orientation adjustments as well as for final antenna lockdown.

3.10 The KS-15676 L12 azimuth adjusting tool is used with the L11 mounting clamp for making initial and final orientation adjustments.

3.11 The KS-15676 L13 tilt adjusting tool is designed for adjusting the tilt or elevation of the antenna during orientation.

3.12 The KS-15676 L15 modification kit consists of material and hardware necessary to harden (improve the blast resistance) the KS-15676 L8 or L9 horn-reflector antenna in the field.

3.13 The KS-15676 L17 azimuth adjusting tool is used with the L11 mounting clamp for making initial and final orientation adjustments. The L17 tool differs from the L12 tool in that the adjustment is accomplished by a ratchet assembly rather than an open end wrench.

4. TRANSMISSION CHARACTERISTICS

A. Gain

4.01 The gain of the antenna with respect to an isotropic radiator (point source) is as follows:

FREQ, MHz	POLARIZATION	MIDBAND GAIN, DB
3950	Vertical	39.6
	Horizontal	39.4
6175	Vertical	43.2
	Horizontal	43.0
11,200	Vertical	48.0
	Horizontal	47.4

Representative gain-versus frequency characteristic graphs are shown in Figure 1.

B. Horizontal Directivity

4.02 The shape of the main lobe in the horizontal plane, with vertical and horizontal polarization, is shown in Figure 2. The width of the beam between 3-db points is as follows:

FREQ, MHz	POLARIZATION	AZIMUTH HALF-POWER BEAM-WIDTH (DEGREES)
3740	Vertical	2.5
	Horizontal	1.6
6325	Vertical	1.5
	Horizontal	1.25
10,960	Vertical	1.0
	Horizontal	0.8

C. Vertical Directivity

4.03 The shape of the main lobe in the vertical plane, with vertical and horizontal polarization, is shown in Figure 3. The width of the beam between 3-db points is as follows:

FREQ, MHz	POLARIZATION	ELEVATION HALF-POWER BEAM-WIDTH (DEGREES)
3740	Vertical	2.0
	Horizontal	2.13
6325	Vertical	1.25
	Horizontal	1.38
10,960	Vertical	0.75
	Horizontal	0.88

D. Relative Response Patterns

4.04 Figure 4 shows the complete patterns of the antenna in the horizontal plane with both vertical and horizontal polarizations. These graphs show the relative response for either transmitting or receiving at any angle around the antenna. The front-to-back ratio is 71 db or greater in the 4000 MHz, the 6000 MHz, and the 11,000 MHz bands. Also included are sample data for the antenna in the vertical plane for both vertical and horizontal polarizations at 4000 MHz and vertical directivity for vertical polarization at both 6000 MHz and 11,000 MHz.

E. Cross Polarization Discrimination

4.05 Cross polarization discrimination (XPD) of an antenna is a measure of the ability of that antenna to discriminate between two received signals polarized 90 degrees with respect to each other. The cross polarization discrimination of the horn-reflector antenna is maximum when signals arrive on the axis of the main lobe. This maximum XPD is as follows:

FREQ, MHz	XPD, DB
3740	46
6325	51
10,960	53

Figure 5 shows the cross polarization discrimination of the main lobe. Over the rest of the pattern the responses to orthogonally polarized signals are quite variable and dependent on the particular angle, frequency, choice of polarizations, and presence of nearby objects. The feasibility of utilizing cross polarization discrimination at angles other than on the main lobe is, therefore, dependent upon particular local conditions.

F. Crosstalk

4.06 Crosstalk (coupling) between similar antennas in operating position at the same level on a tower is approximately as given in the following list: (under field conditions, actual coupling may be appreciably increased by the presence of nearby objects which may tend to reduce these figures.)

FREQ, MHz	POLARIZATION	BACK-TO-BACK, DB	SIDE-BY-SIDE, DB
3740	Vertical	140	81
	Horizontal	122	89
6325	Vertical	140	120
	Horizontal	127	122
10,960	Vertical	139	94
	Horizontal	140	112

Figure 6 shows crosstalk between antennas for various relative positions in azimuth.

G. Return Loss

4.07 Typical values of return loss that exist in the antenna and feed horn combination are as follows:

FREQ, MHz	RETURN LOSS, DB
3700 to 4200	43
5925 to 6425	40
10,700 to 11,700	47

H. Representative Transmission Characteristics

4.08 Typical transmission characteristics for the KS-15676 horn-reflector antenna are shown in Table A.

5. CIRCULAR WAVEGUIDE

5.01 Flexible circular waveguide, KS-15690 or KS-20104, is used between the KS-15676 L3 feed horn and the rigid circular waveguide run. The L1 (8 foot length) is used to permit the full range of antenna elevation adjustment (±3°). The L2 (4 foot length) is used where there is insufficient space for the L1 and where nominal (approximately ±1½°) elevation adjustment will suffice. Flexible circular waveguide has an attenuation of 0.03 to 0.045 db per foot at 3.95 GHz provided that the bending radius is not less than 20 feet. Loss at 6 and 11 GHz will never exceed 0.1 db per foot provided that the bending radius is not less than 20 feet.

5.02 The ED-59409-70 circular waveguide (rigid) is available in lengths ranging from 1 foot to 12 feet 6¼ inches. The most commonly used length, 12 feet 6¼ inches, has been provided for installations on battered self-supporting towers. The 12 foot 6 inch lengths are also used on towers of constant cross section, both guyed and self-supporting. Shorter lengths are used to connect to system combining networks as required. In some cases, lengths shorter than 12½ feet may be required between the flexible waveguide coming from the antenna and the first 12½ foot length of rigid waveguide. This waveguide has a minimum bending radius of 500 feet and an attenuation of 0.36 db per 100 feet at 4.2 GHz, 0.28 db per 100 feet at 6.4 GHz, and 0.3 db per 100 feet at 11.7 GHz.

6. FIGURES AND REFERENCES

ILLUSTRATIONS

REFERENCES

Section 402-421-201 Fig. 12	KS-15676 TD-2/TH Horn-Reflector Antenna — Dimensions and Mounting Data
Section 402-421-201 Fig. 13	Horn-Reflector Mounting Assembly

TABLE A — REPRESENTATIVE TRANSMISSION CHARACTERISTICS

	GAIN, DB		FRONT-TO-BACK RATIO, DB		HALF-POWER BEAM-WIDTH, DEGREES				MAJOR SIDE LOBES DB DOWN		MINOR SIDE LOBES DB DOWN		CROSS POLARIZATION DISCRIMINATION ON BEAM, DB		CROSSTALK, DB			
					VERTICAL PLANE		HORIZONTAL PLANE								SIDE-BY-SIDE		BACK-TO-BACK	
POLARIZATION	VERT	HOR	VERT	HOR	VERT	HOR	VERT	HOR	VERT	HOR	VERT	HOR	VERT	HOR	VERT	HOR	VERT	HOR
3730 MHz	39.2	39.0																
3740 MHz			71	77	2.0	2.13	2.5	1.6	24	14	49	54	50	46	81	89	140	122
3950 MHz	39.6	39.4																
4170 MHz	40.1	39.9																
5925 MHz	42.5	42.8																
6175 MHz	43.2	43.0																
6325 MHz			71	71	1.25	1.38	1.5	1.25	19	14	49	57	51	51	120	122	140	127
6425 MHz	43.3	43.1																
10,700 MHz	47.7	46.6																
10,960 MHz			78	71	0.75	0.88	1.0	0.8	21	14	54	61	57	53	94	112	139	140
11,200 MHz	48.0	47.4																
11,700 MHz	48.3	47.2																

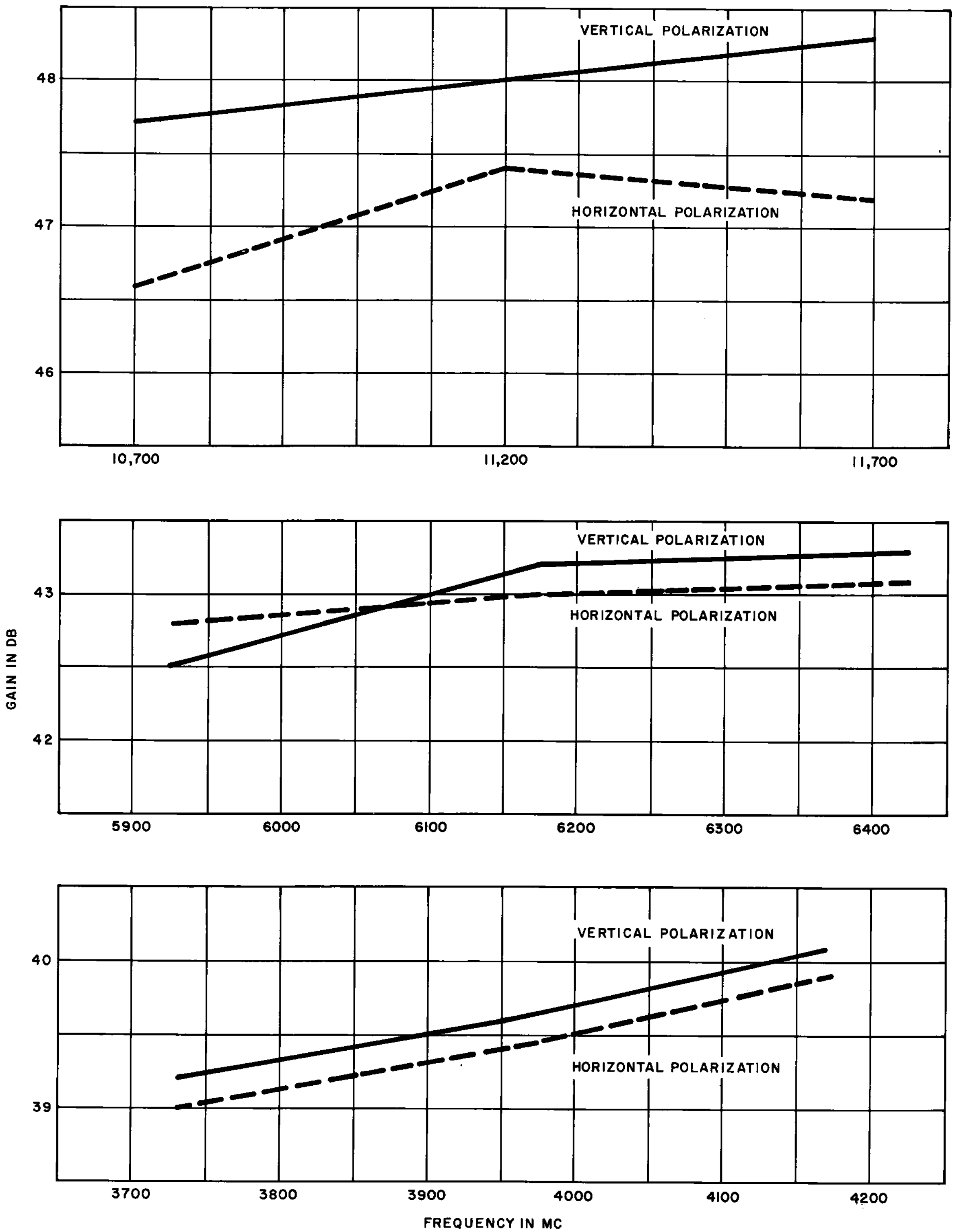


Fig. 1 — Gain Versus Frequency

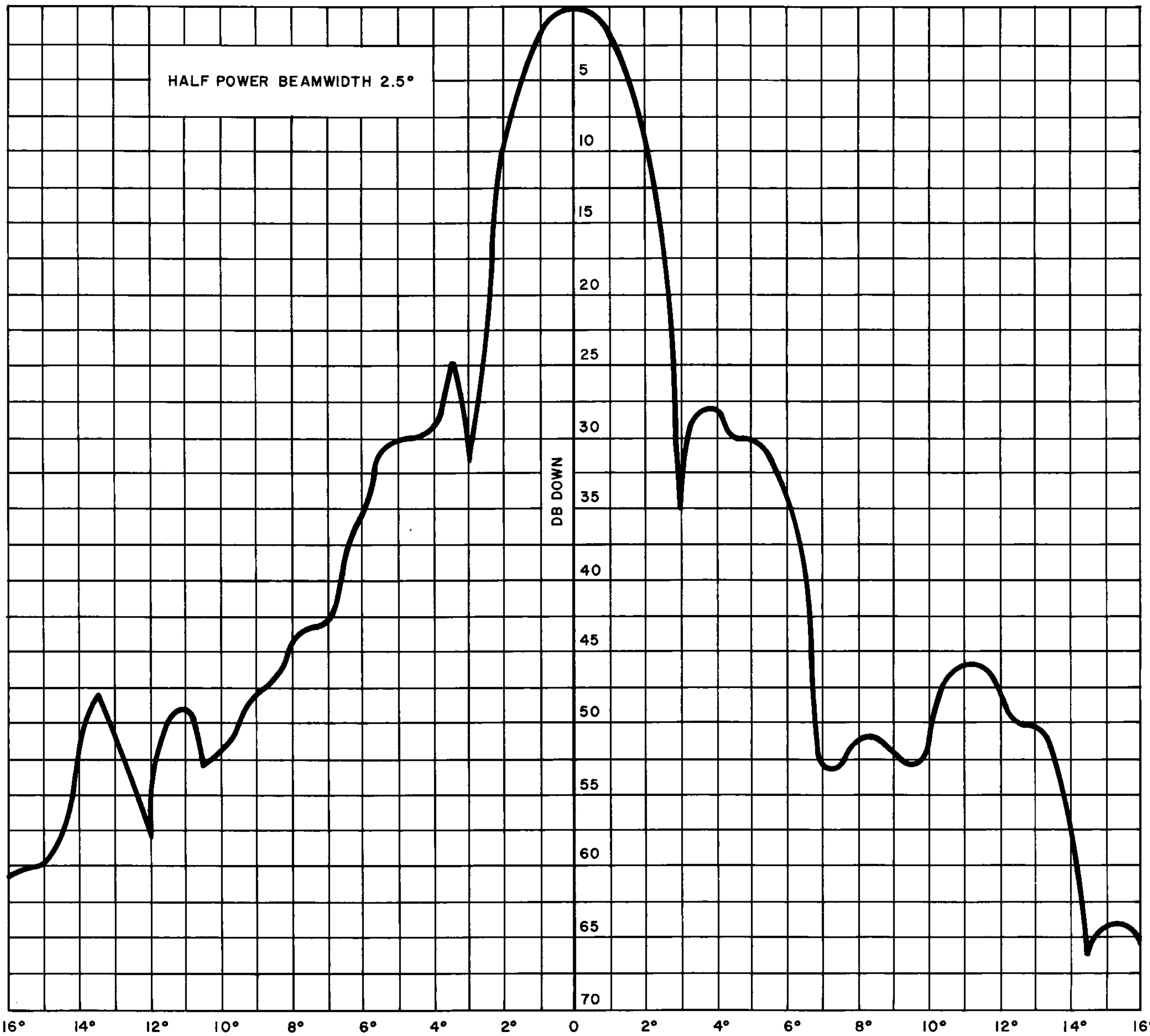


Fig. 2A — Horizontal Directivity (±16 Degrees) — Vertical Polarization — 3740 MHz

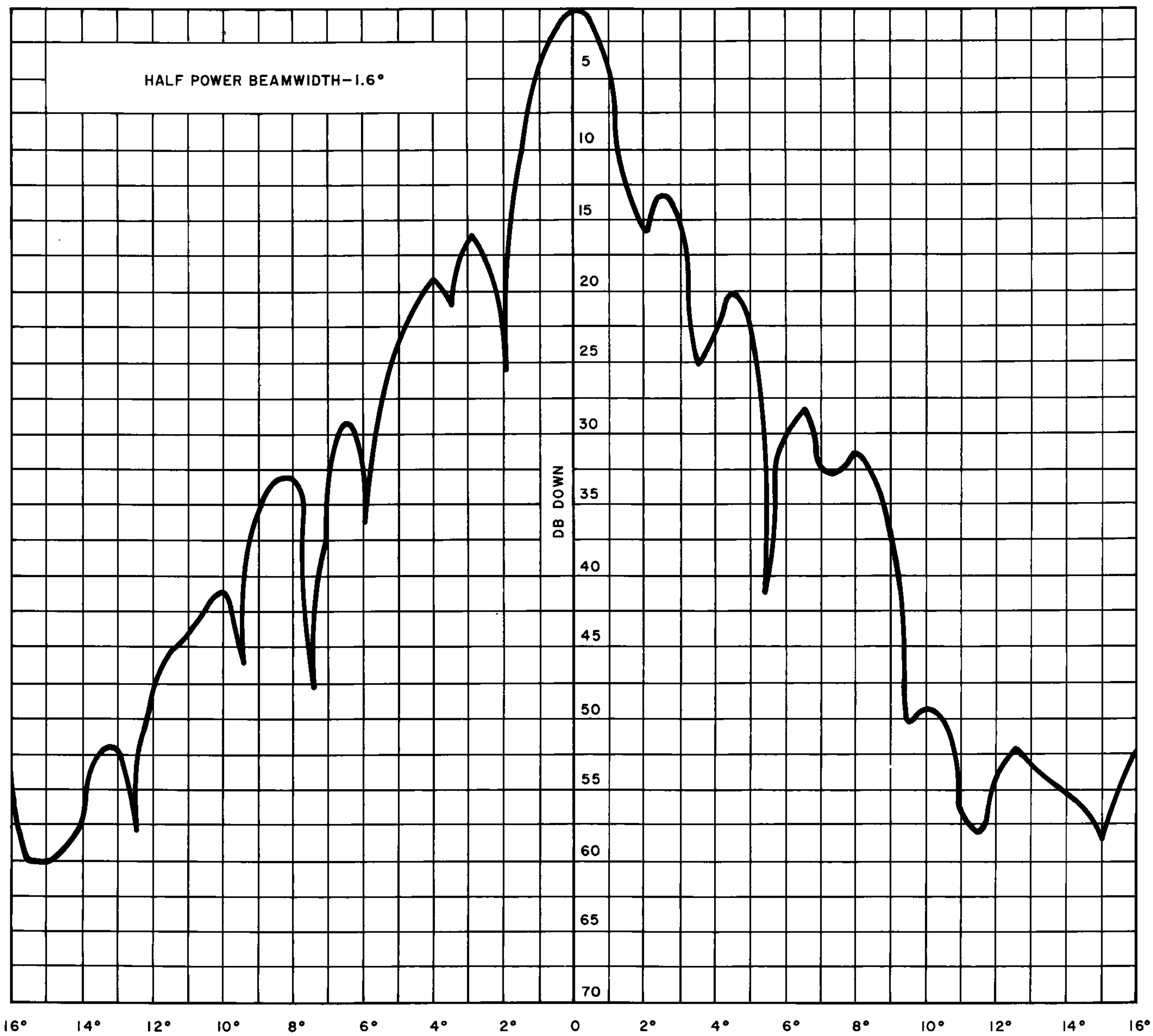


Fig. 2B — Horizontal Directivity (±16 Degrees) — Horizontal Polarization — 3740 MHz

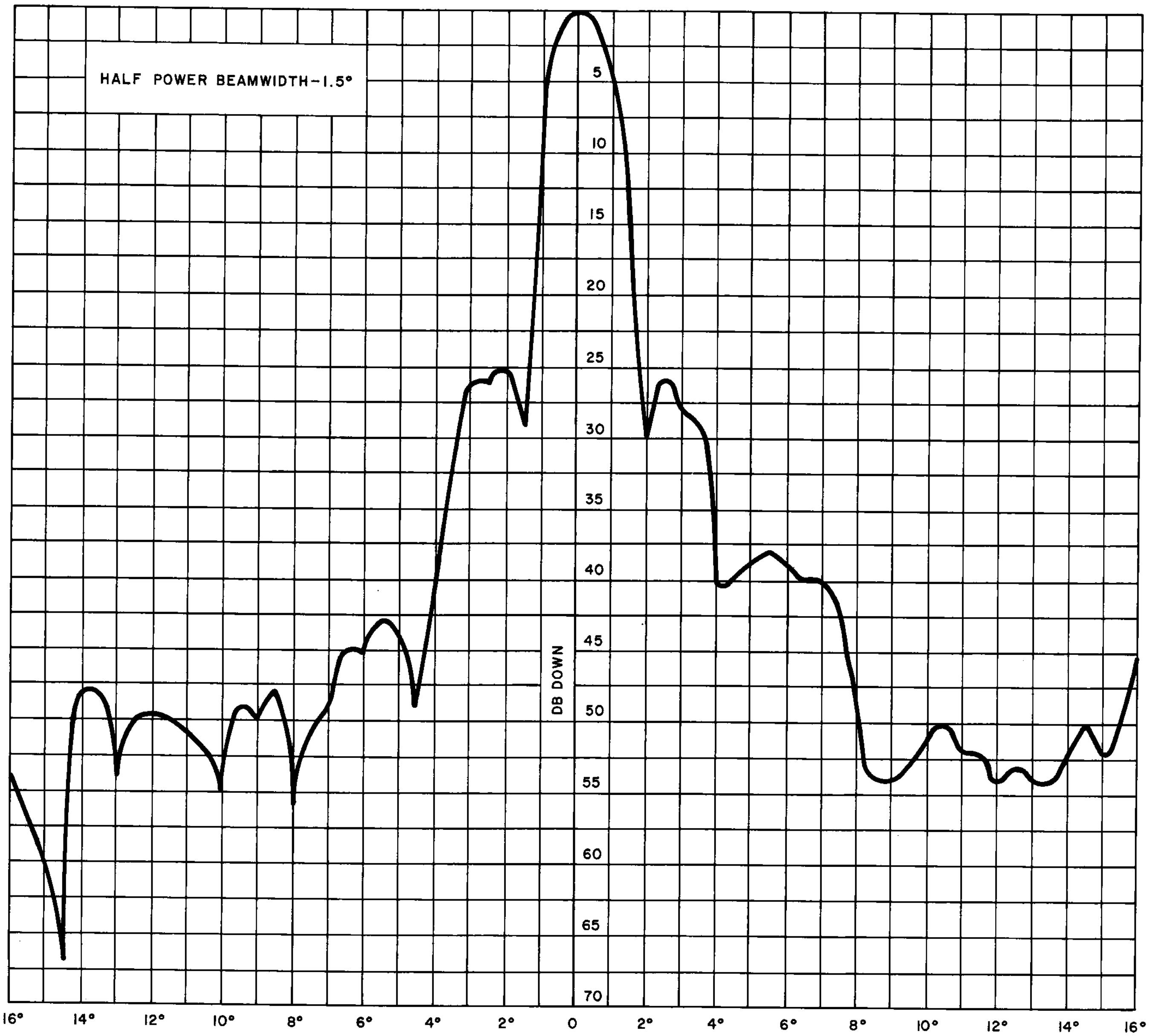


Fig. 2C — Horizontal Directivity (±16 Degrees) — Vertical Polarization — 6325 MHz

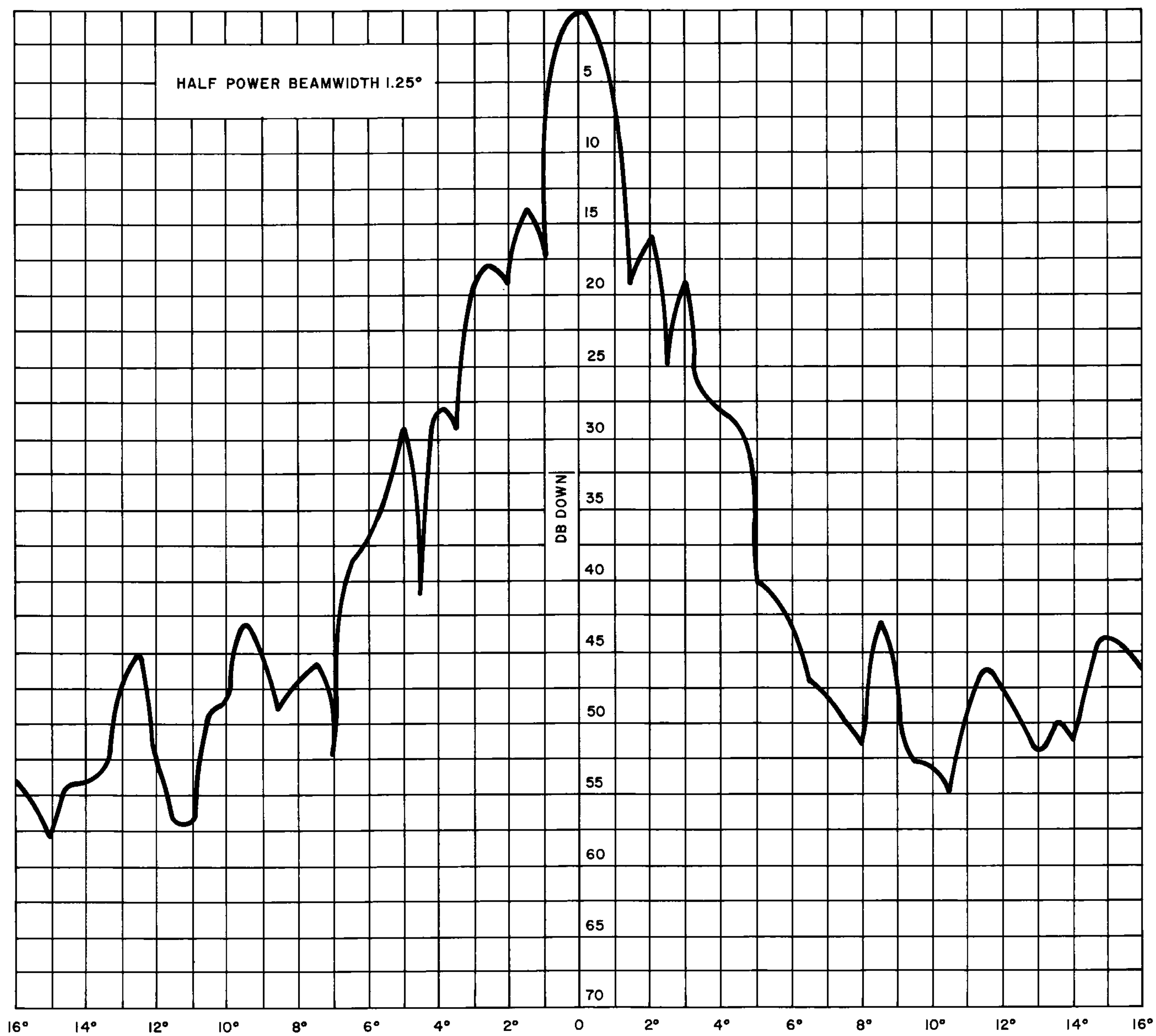


Fig. 2D — Horizontal Directivity (±16 Degrees) — Horizontal Polarization — 6325 MHz

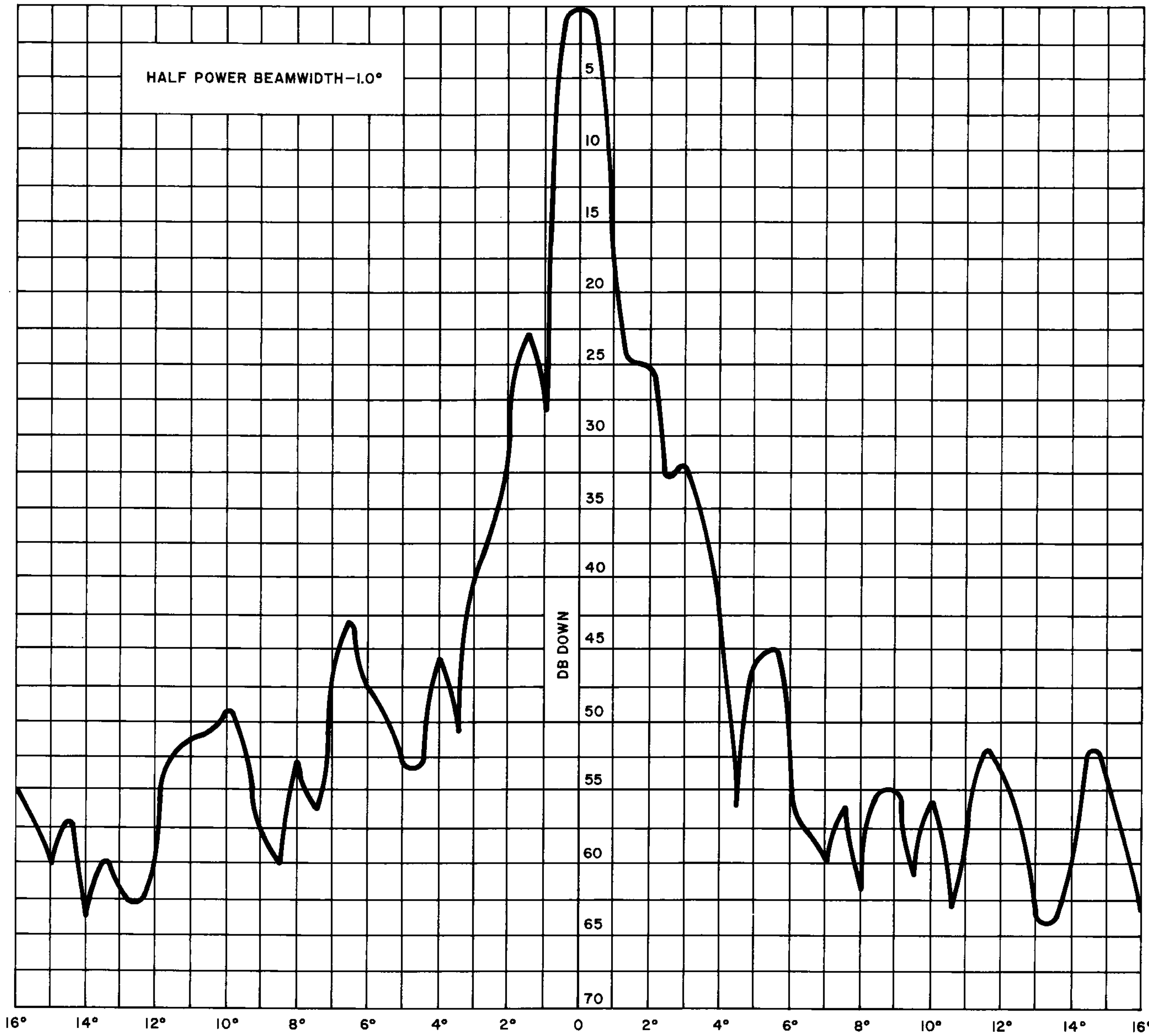


Fig. 2E — Horizontal Directivity (±16 Degrees) — Vertical Polarization — 10,960 MHz

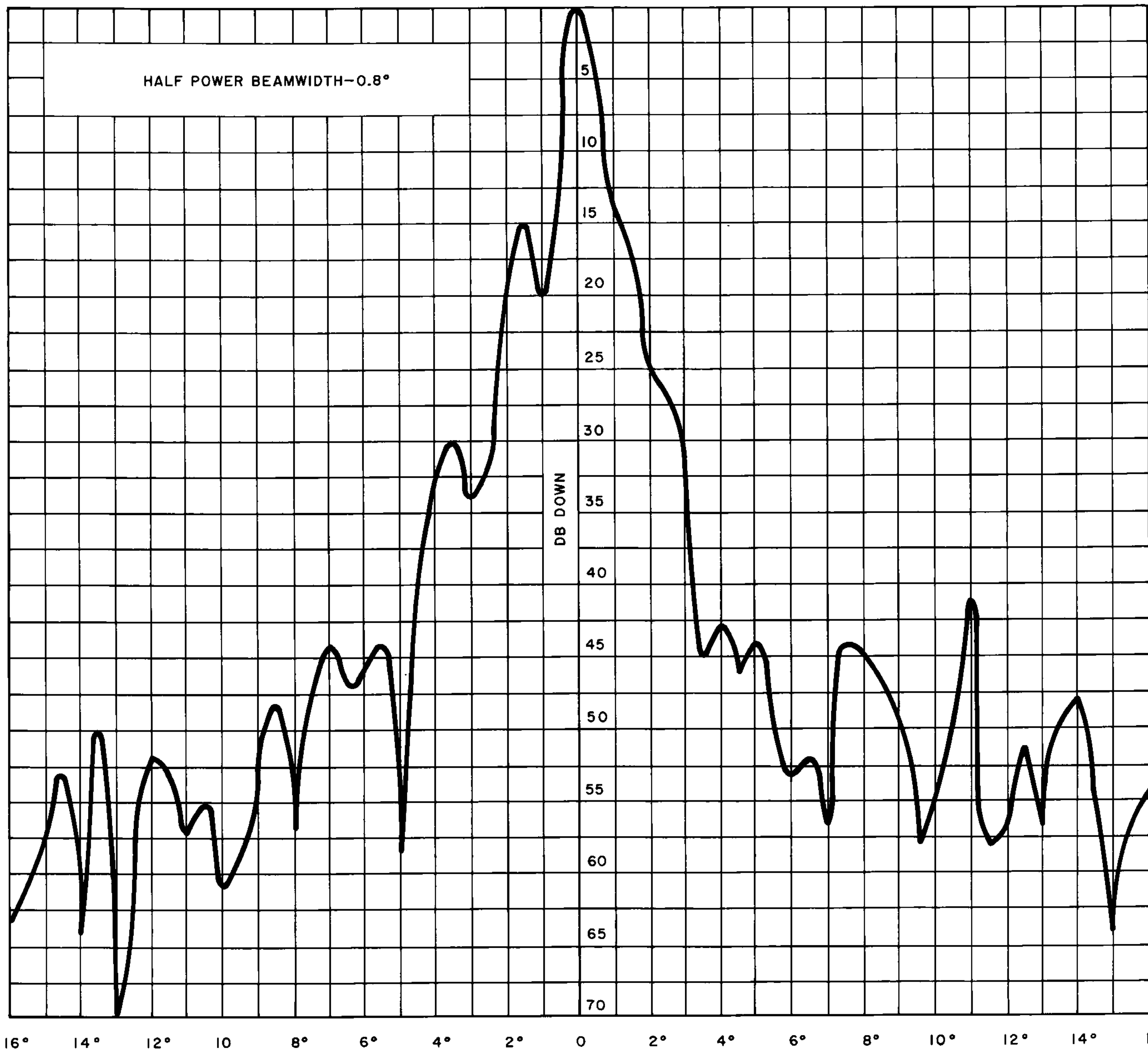


Fig. 2F — Horizontal Directivity (±16 Degrees) — Horizontal Polarization — 10,960 MHz

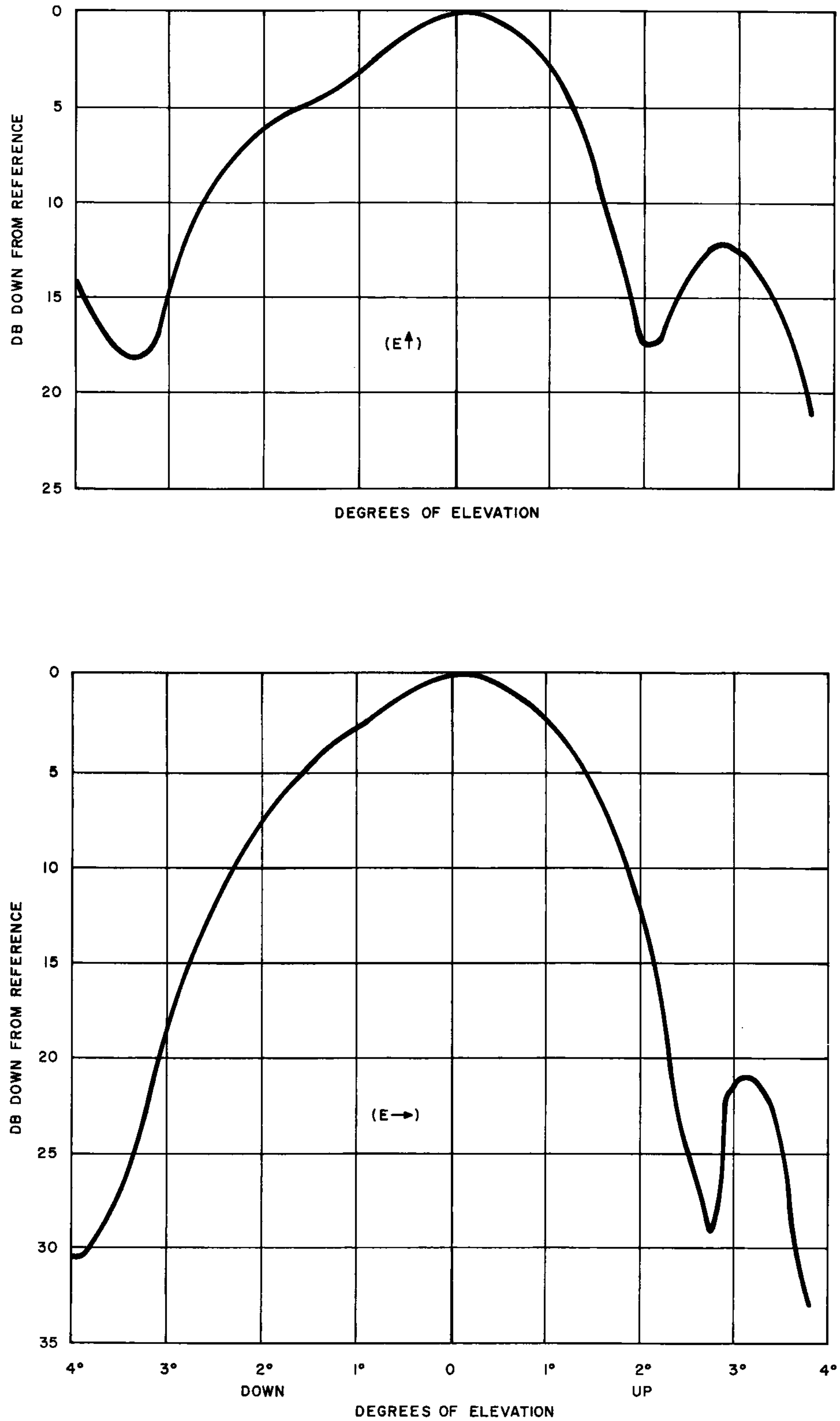


Fig. 3A — Vertical Directivity — 3740 MHz ($\pm$4 Degrees)

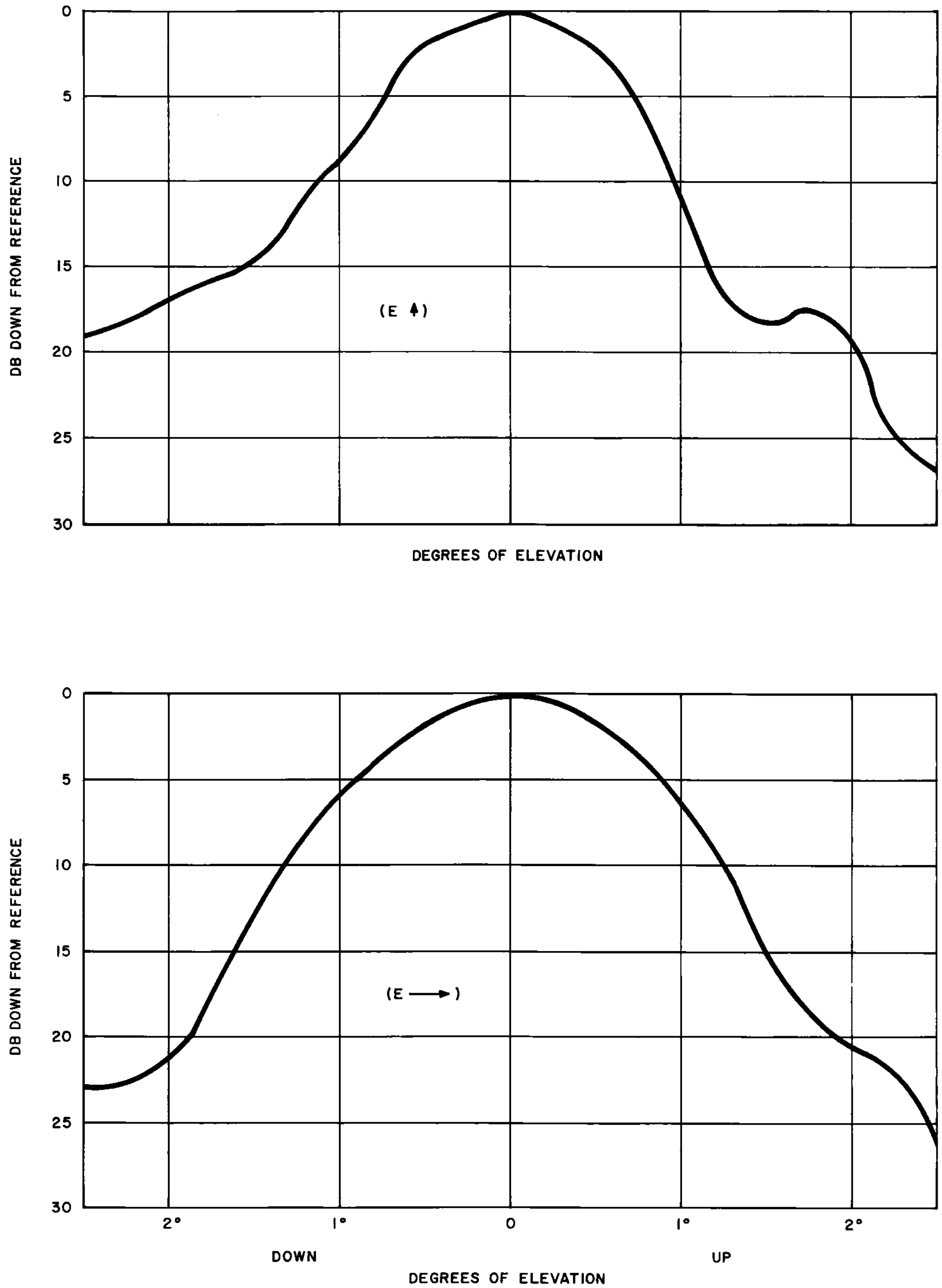
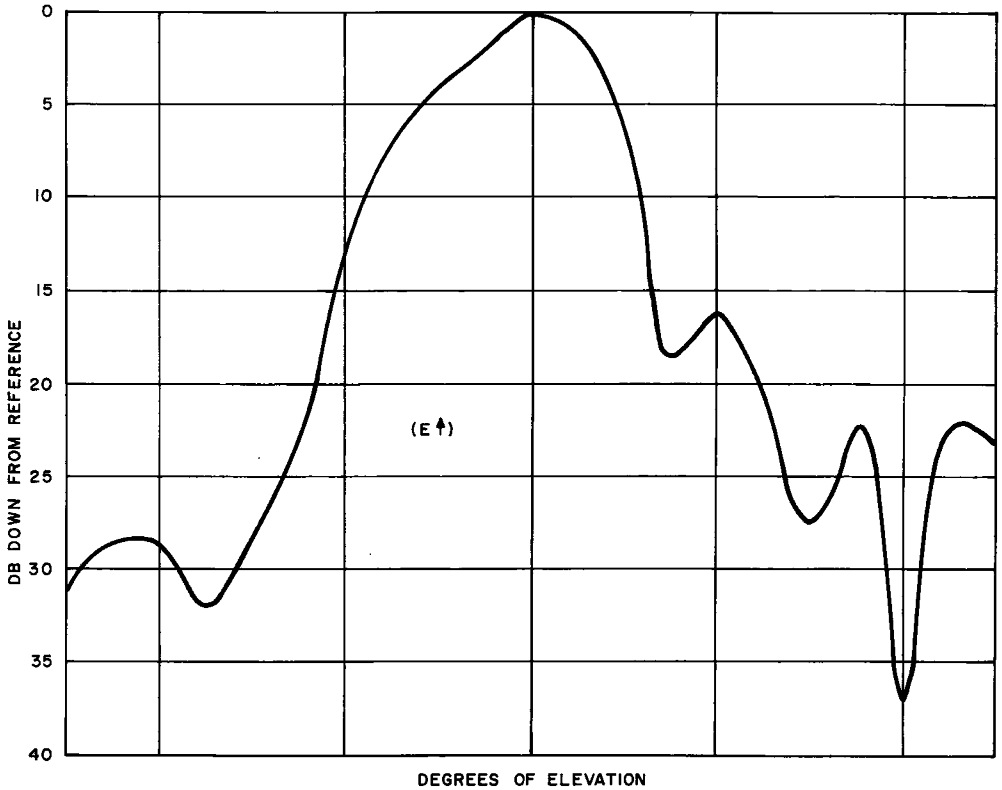


Fig. 3B — Vertical Directivity — 6325 MHz (±4 Degrees)



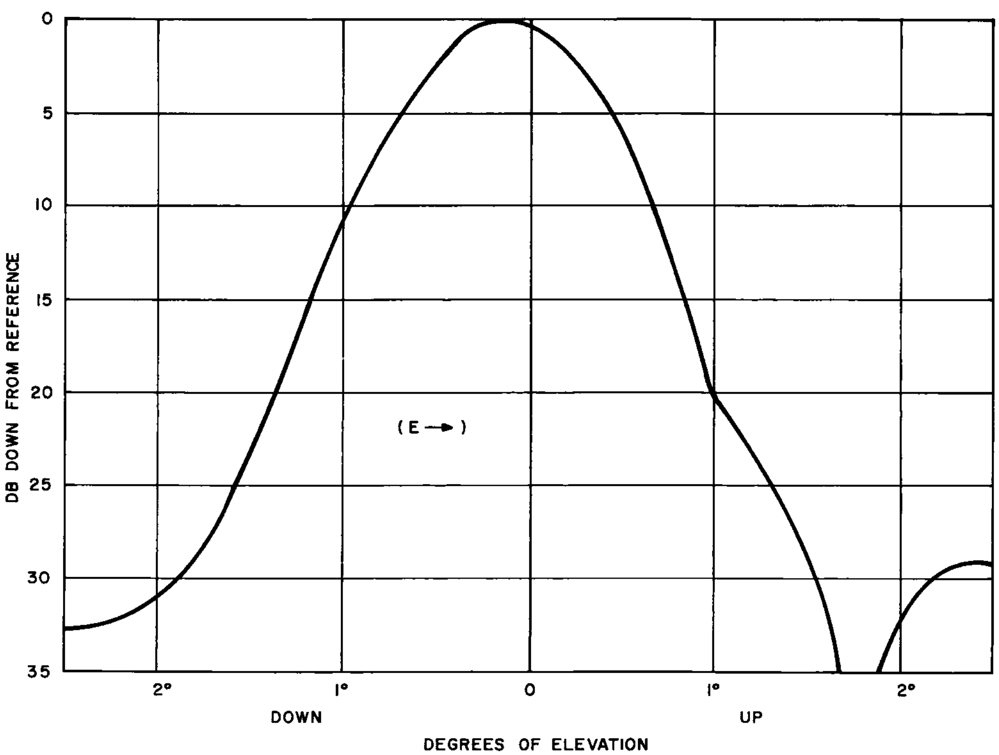


Fig. 3C — Vertical Directivity — 10,960 MHz (±4 Degrees)

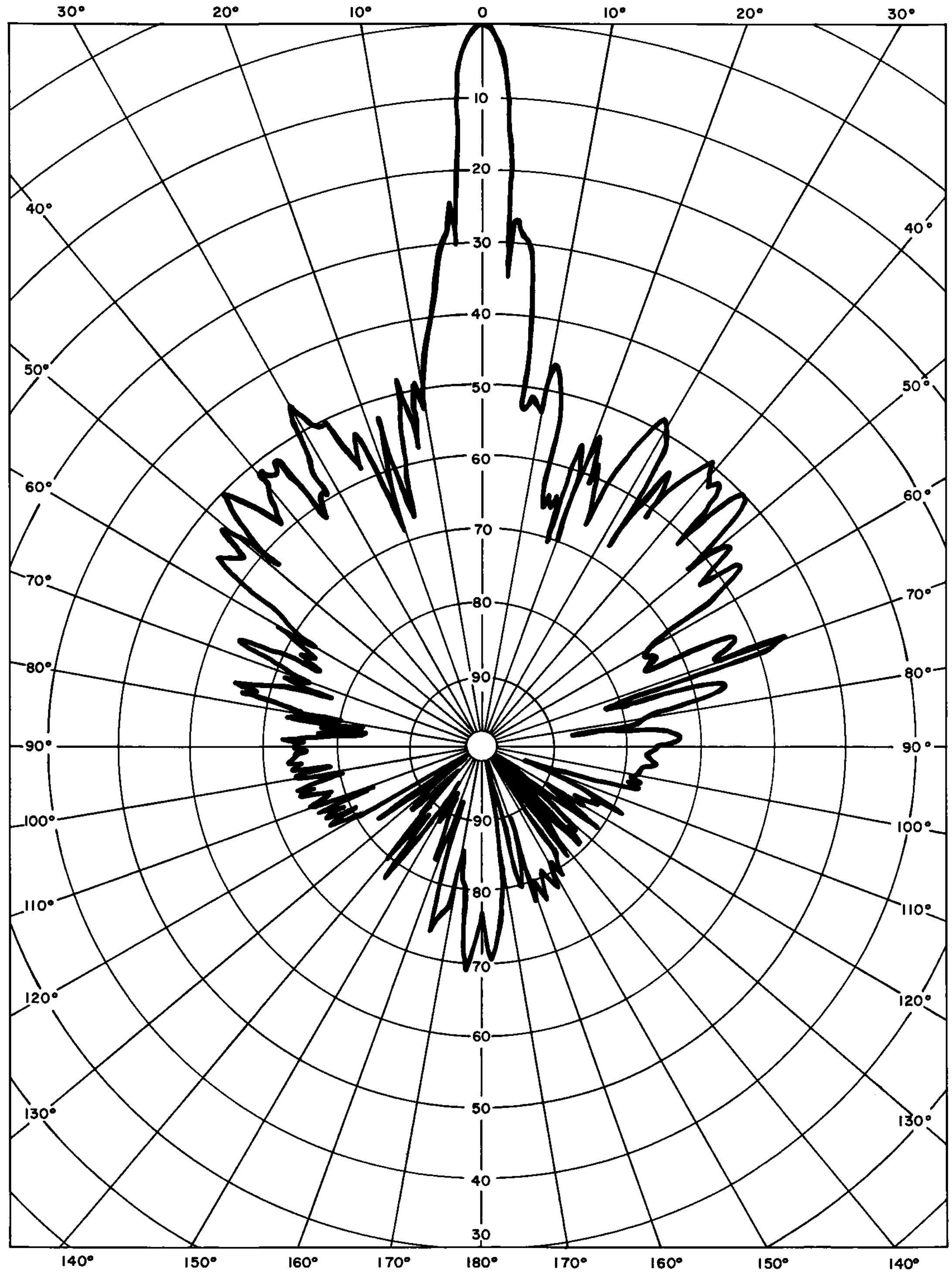


Fig. 4A — Horizontal Directivity — Vertical Polarization — 3740 MHz (360 Degrees)

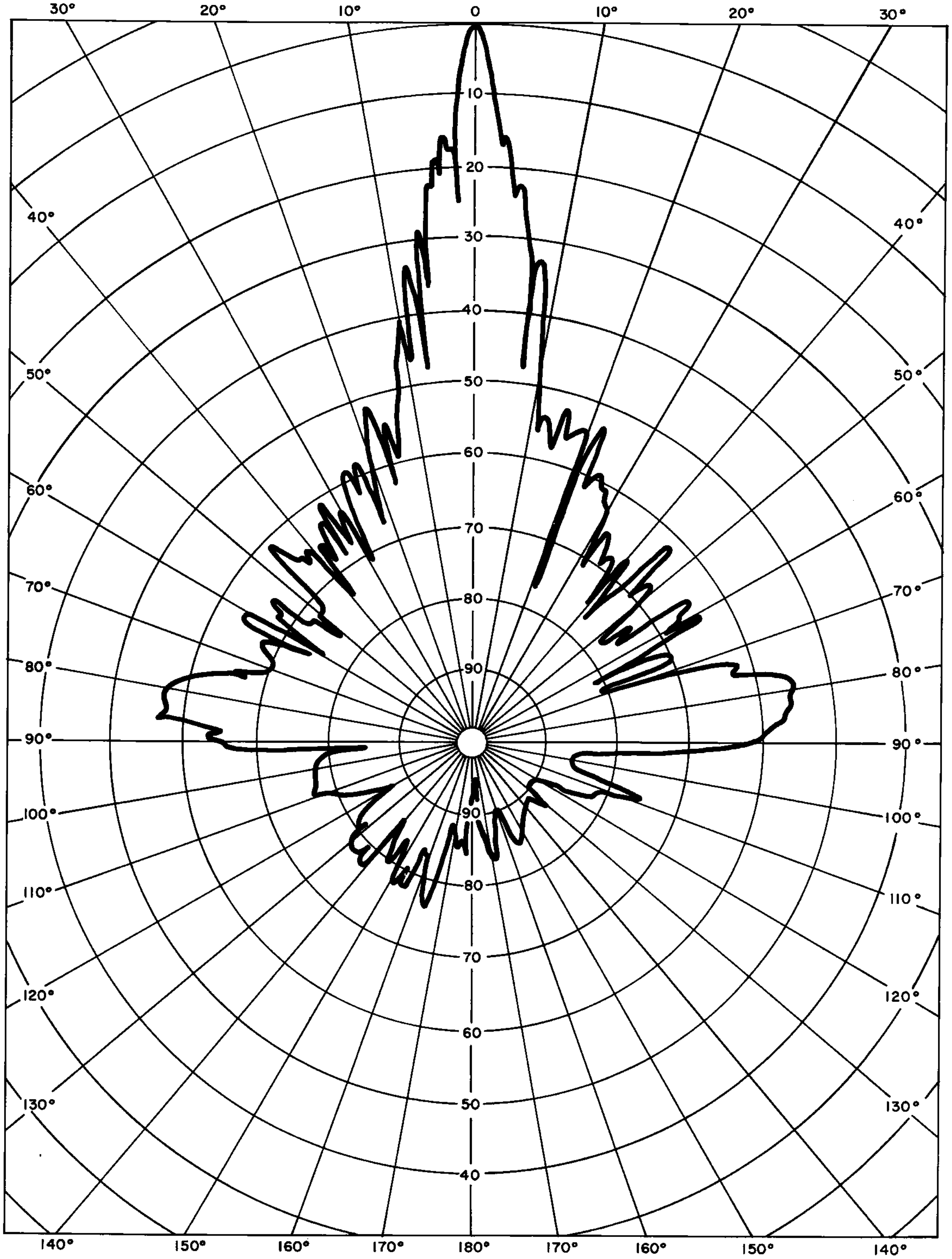


Fig. 4B — Horizontal Directivity — Horizontal Polarization — 3740 MHz (360 Degrees)

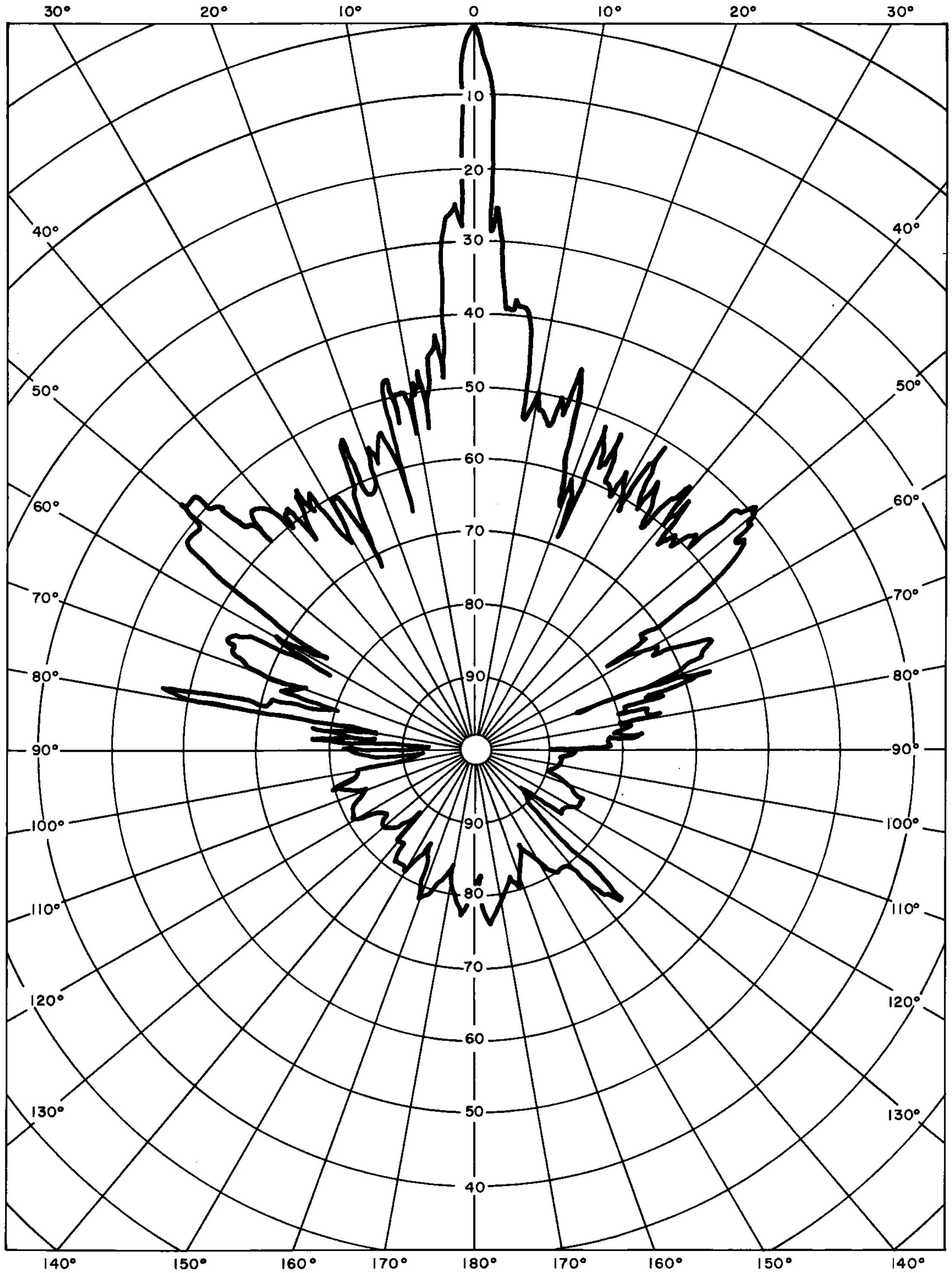


Fig. 4C — Horizontal Directivity — Vertical Polarization — 6325 MHz (360 Degrees)

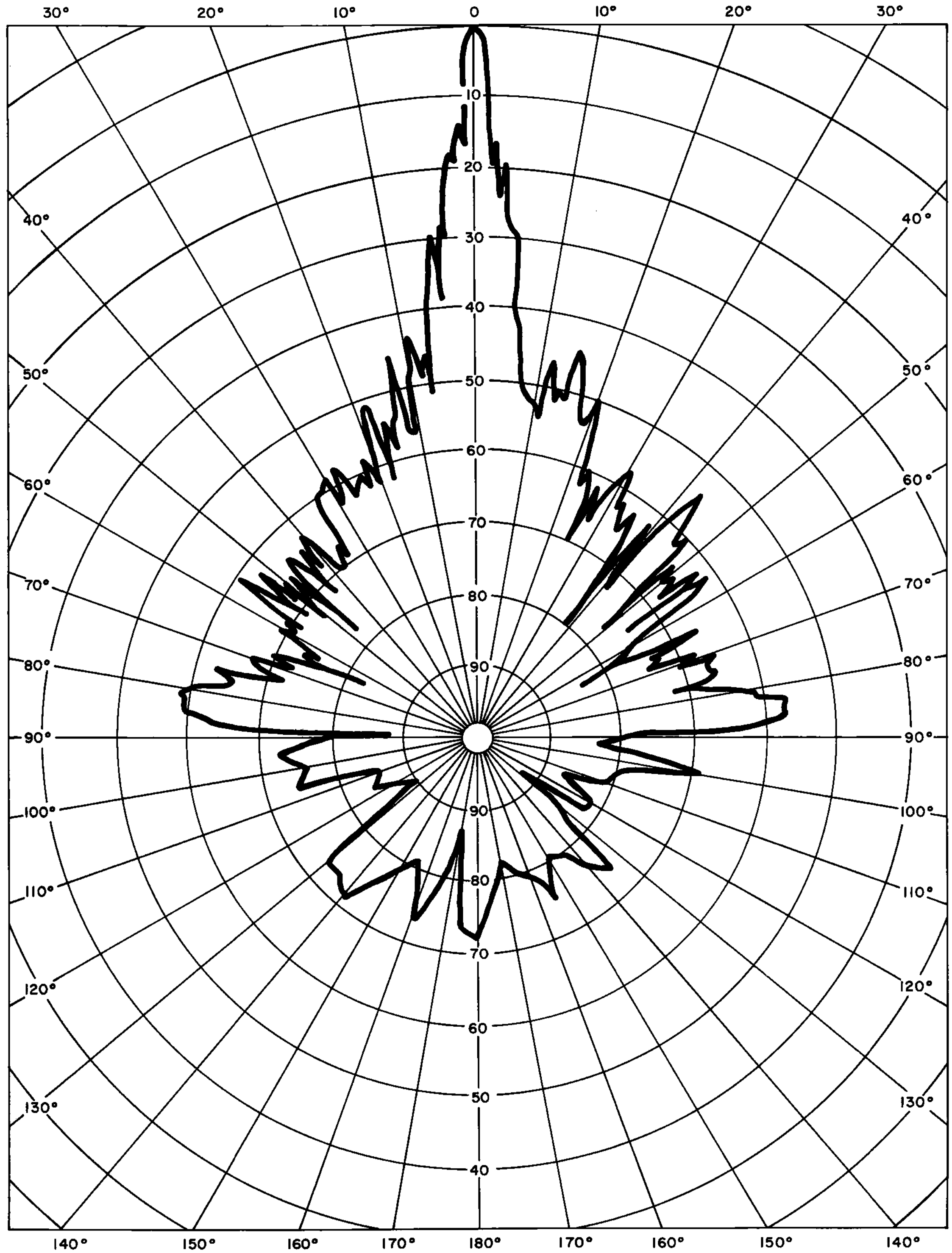


Fig. 4D — Horizontal Directivity — Horizontal Polarization — 6325 MHz (360 Degrees)

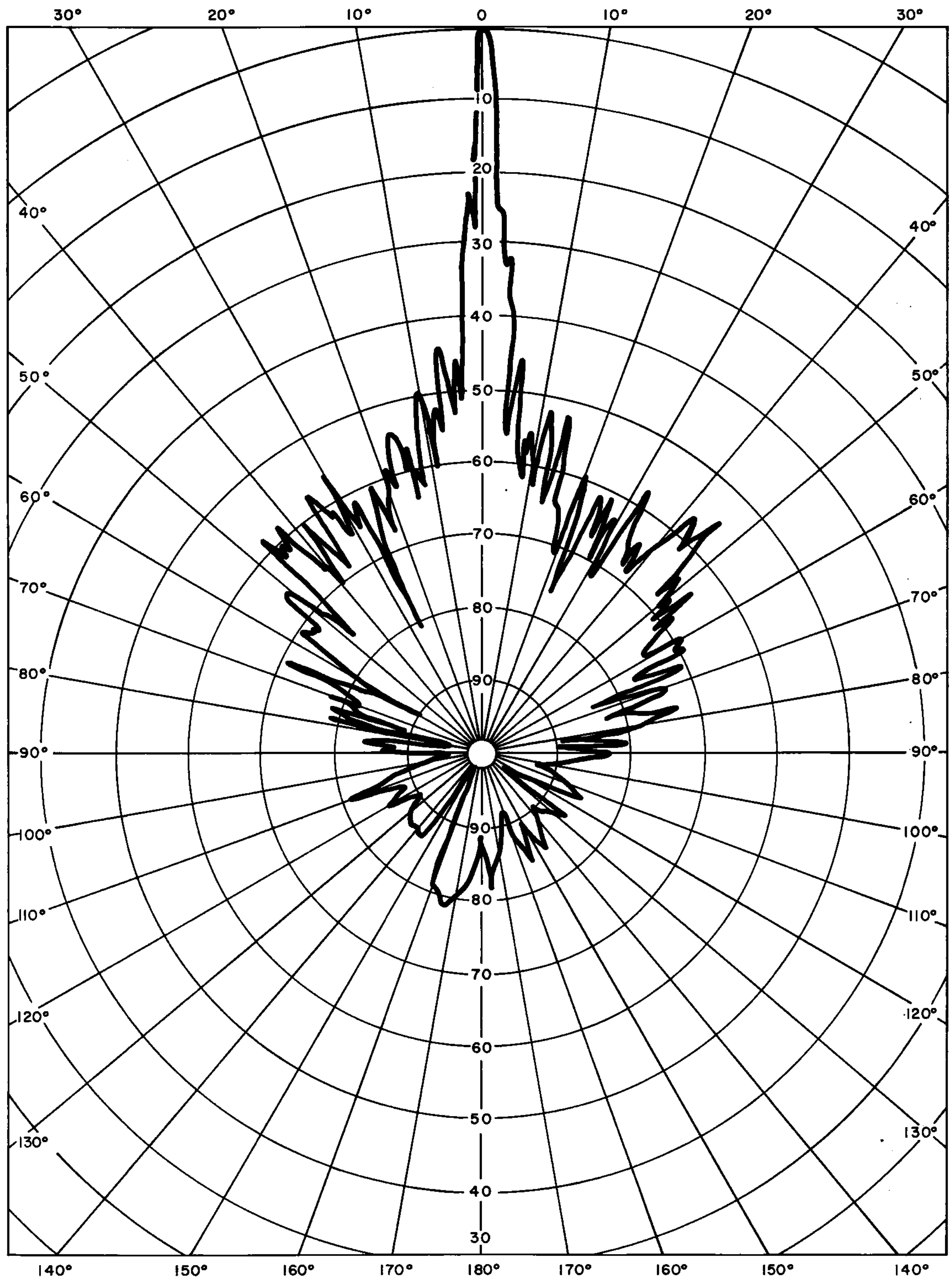


Fig. 4E — Horizontal Directivity — Vertical Polarization — 10,960 MHz (360 Degrees)

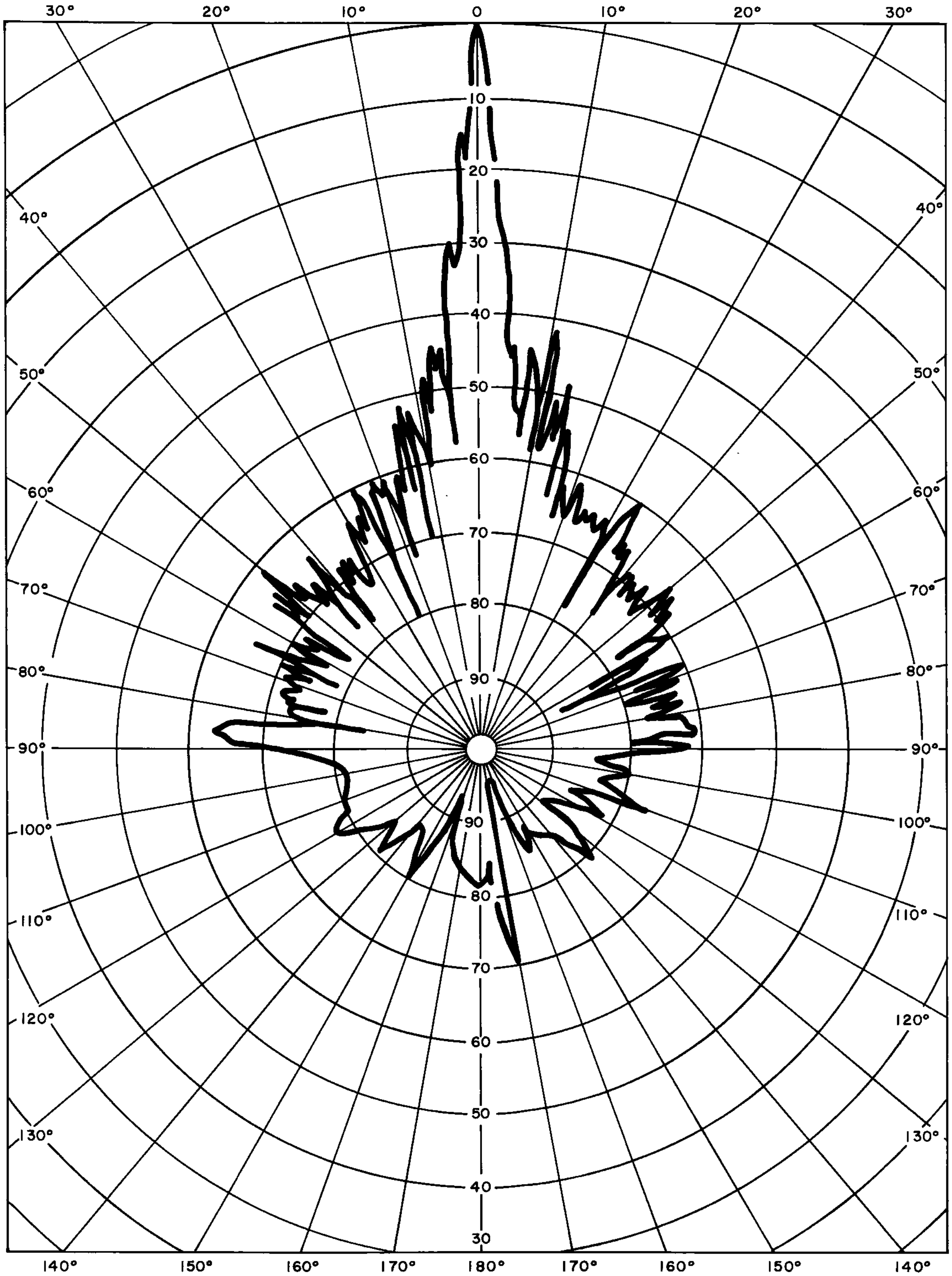


Fig. 4F — Horizontal Directivity — Horizontal Polarization — 10,960 MHz (360 Degrees)

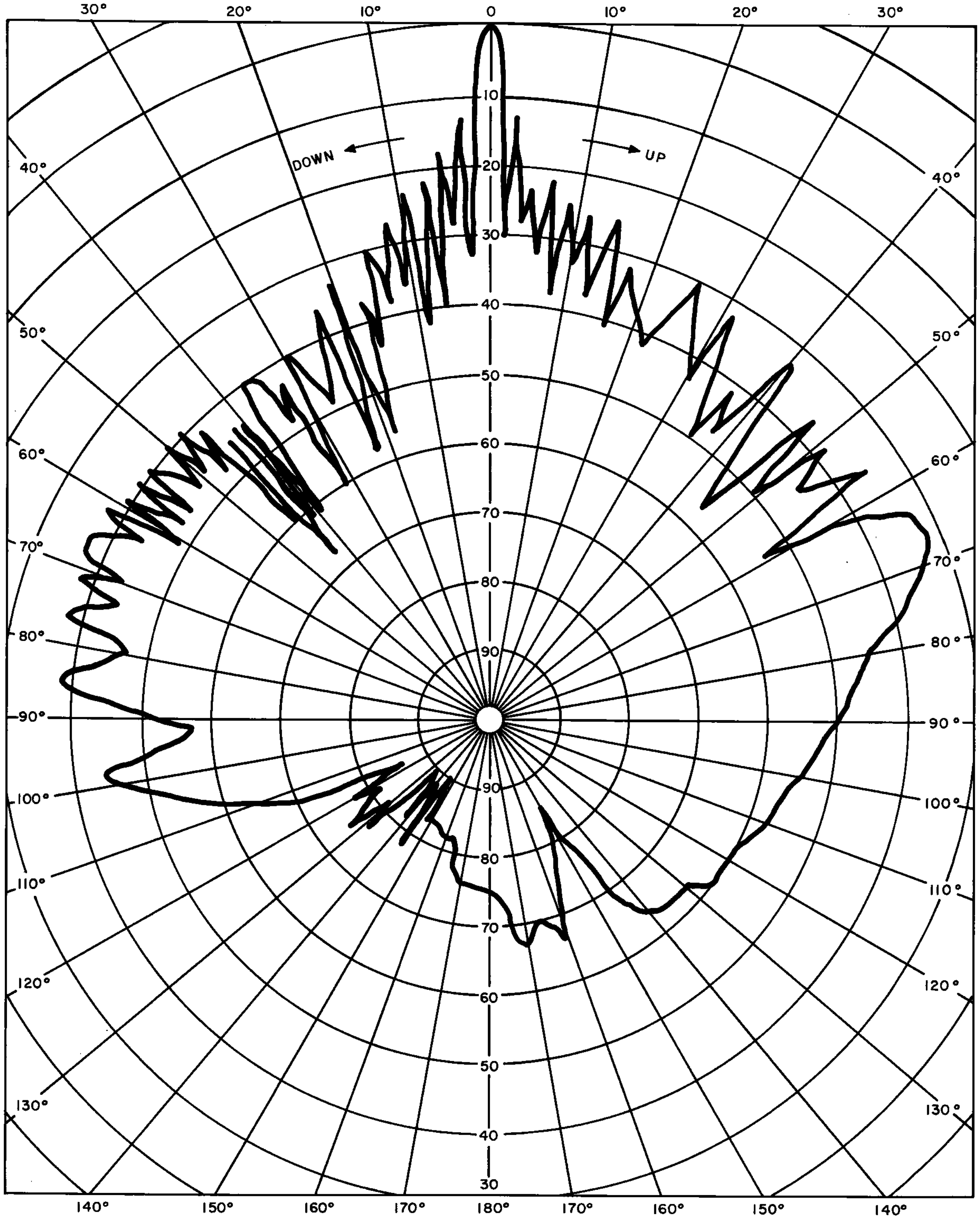


Fig. 4G — Vertical Directivity — Vertical Polarization — 3.740 GHz (360 Degrees)

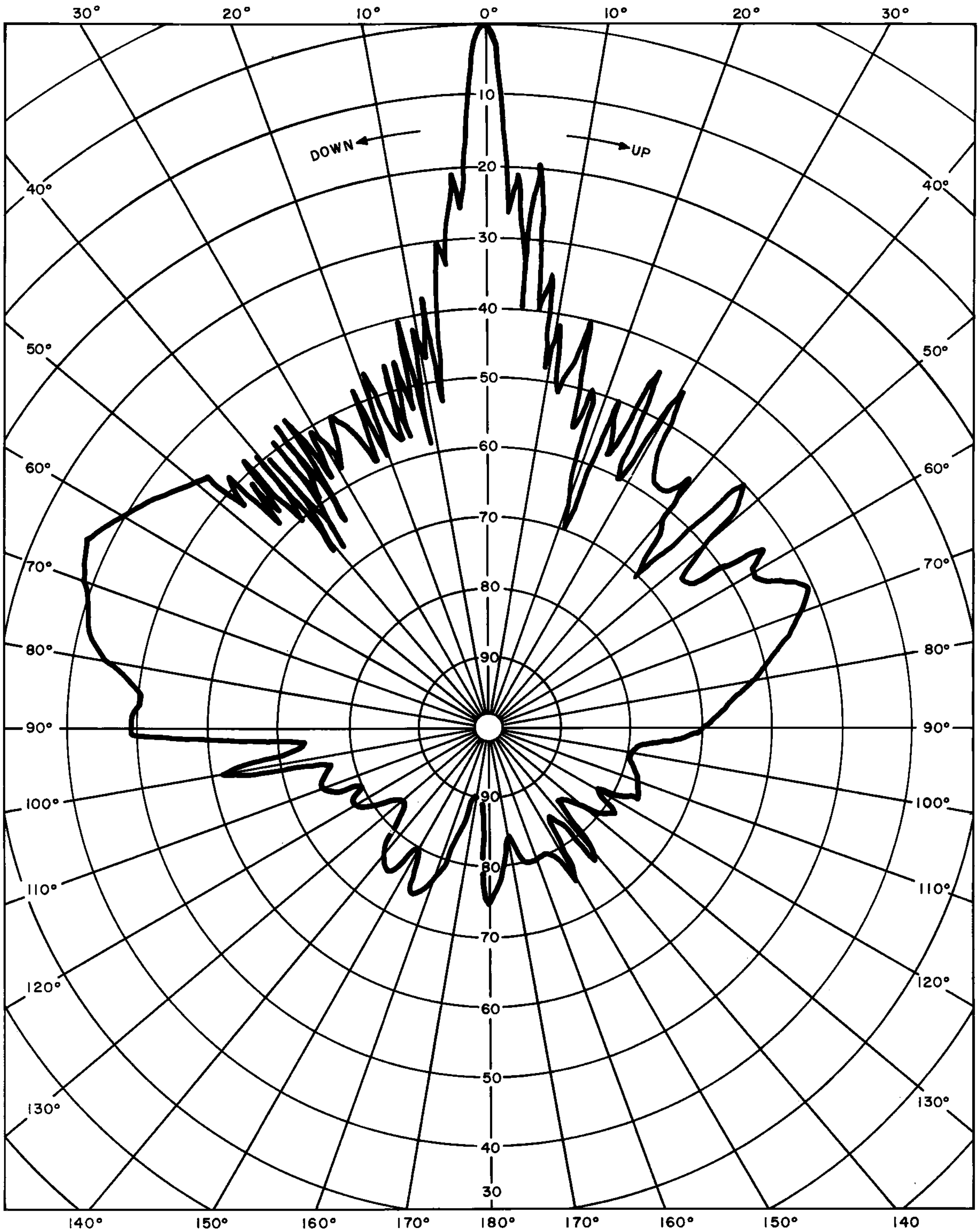


Fig. 4H — Vertical Directivity — Horizontal Polarization — 3.740 GHz (360 Degrees)

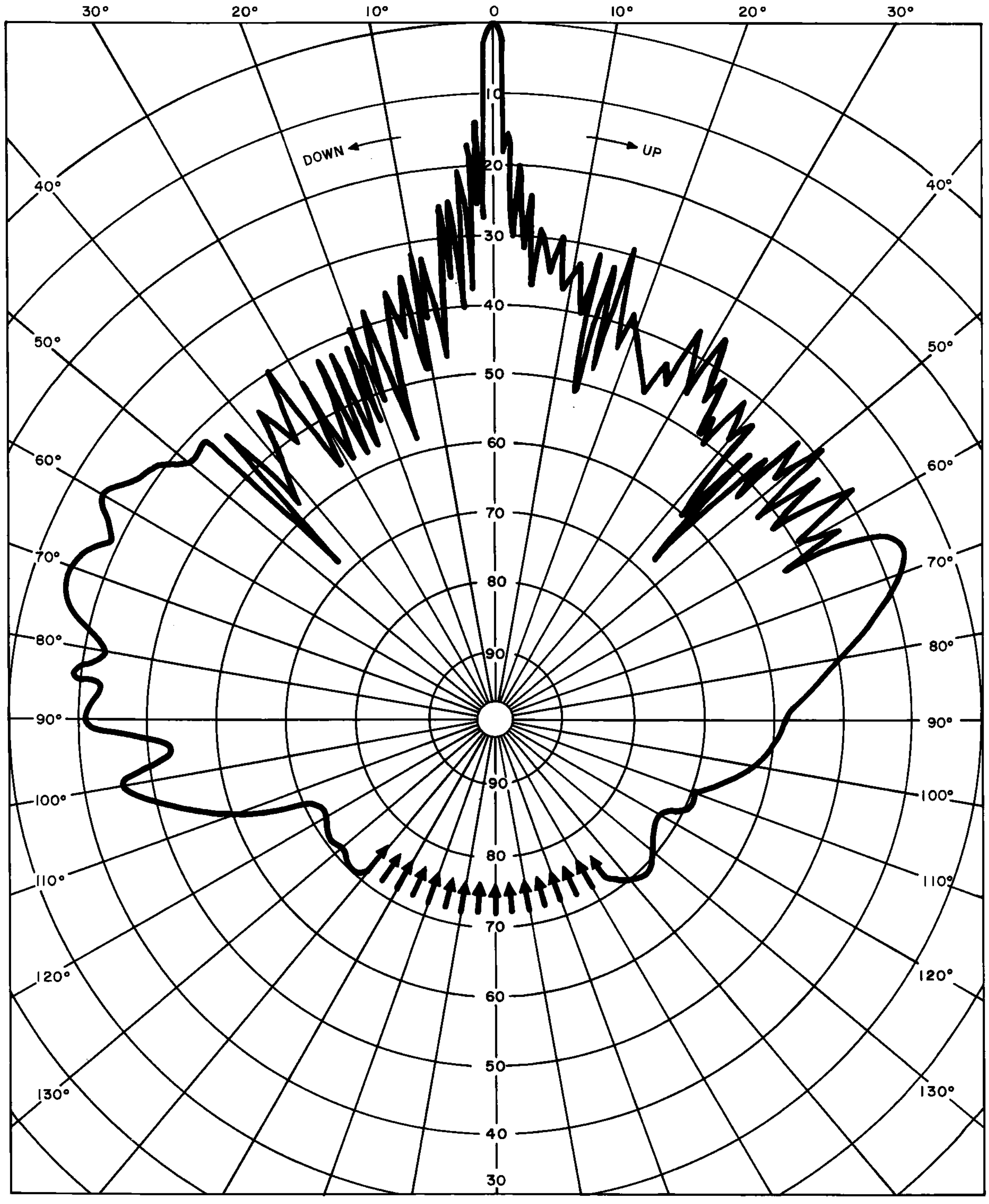


Fig. 41 — Vertical Directivity — Vertical Polarization — 6.325 GHz (360 Degrees)

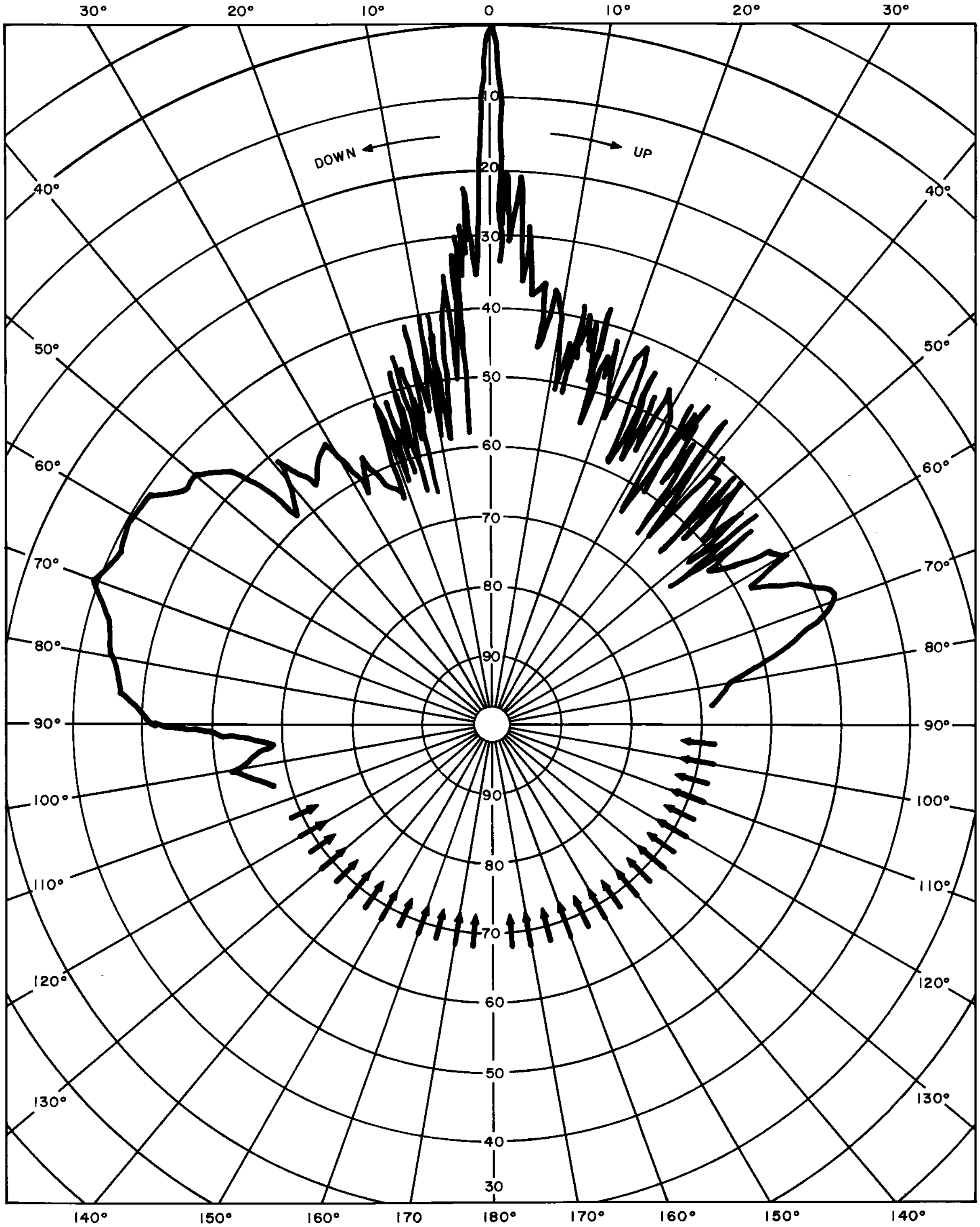


Fig. 4J — Vertical Directivity — Vertical Polarization — 10.960 GHz (360 Degrees)

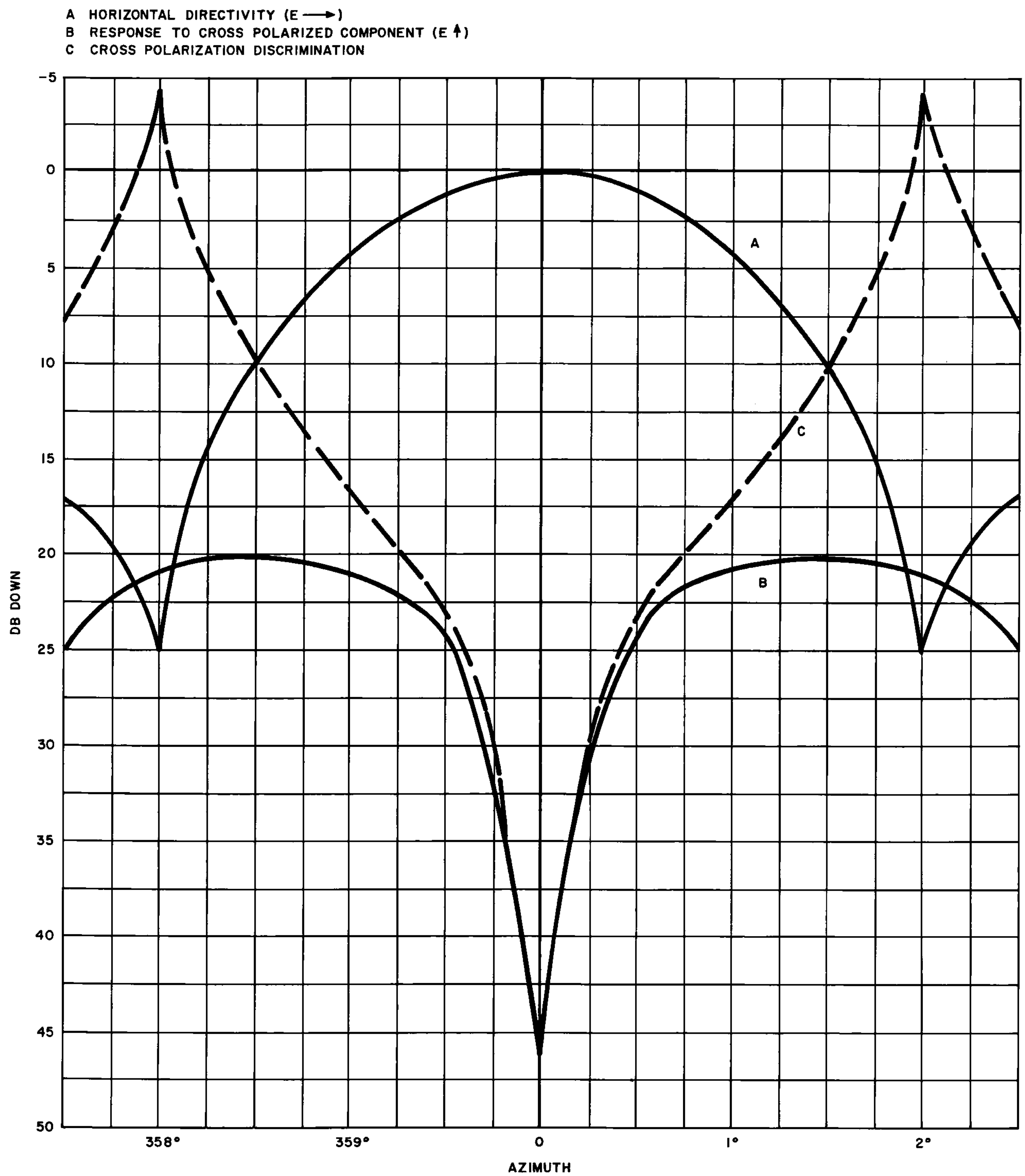


Fig. 5A — Cross Polarization Discrimination With Azimuth (±2.5 Degrees) — 3740 MHz

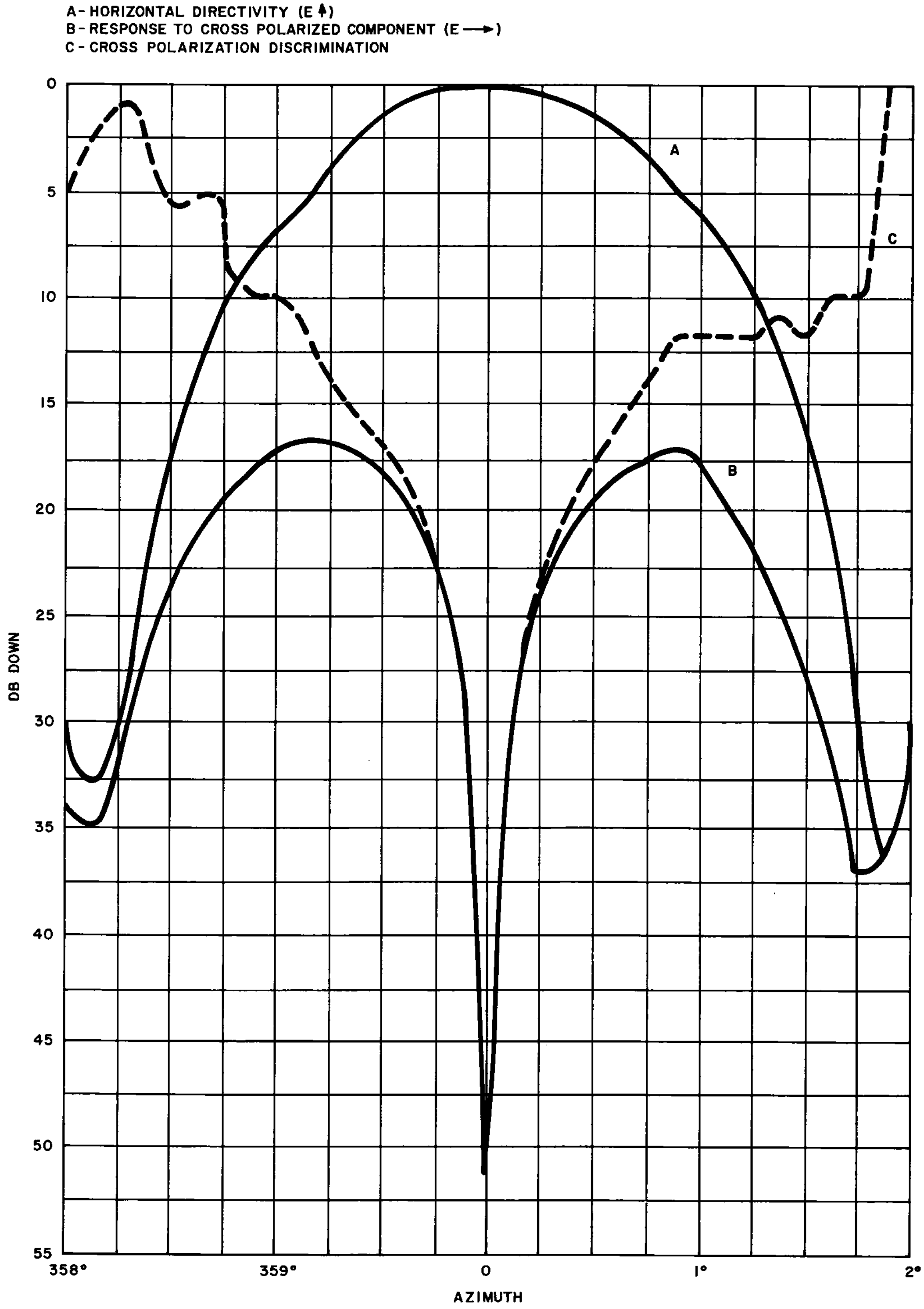


Fig. 5B — Cross Polarization Discrimination With Azimuth (±2.5 Degrees) — 6325 MHz

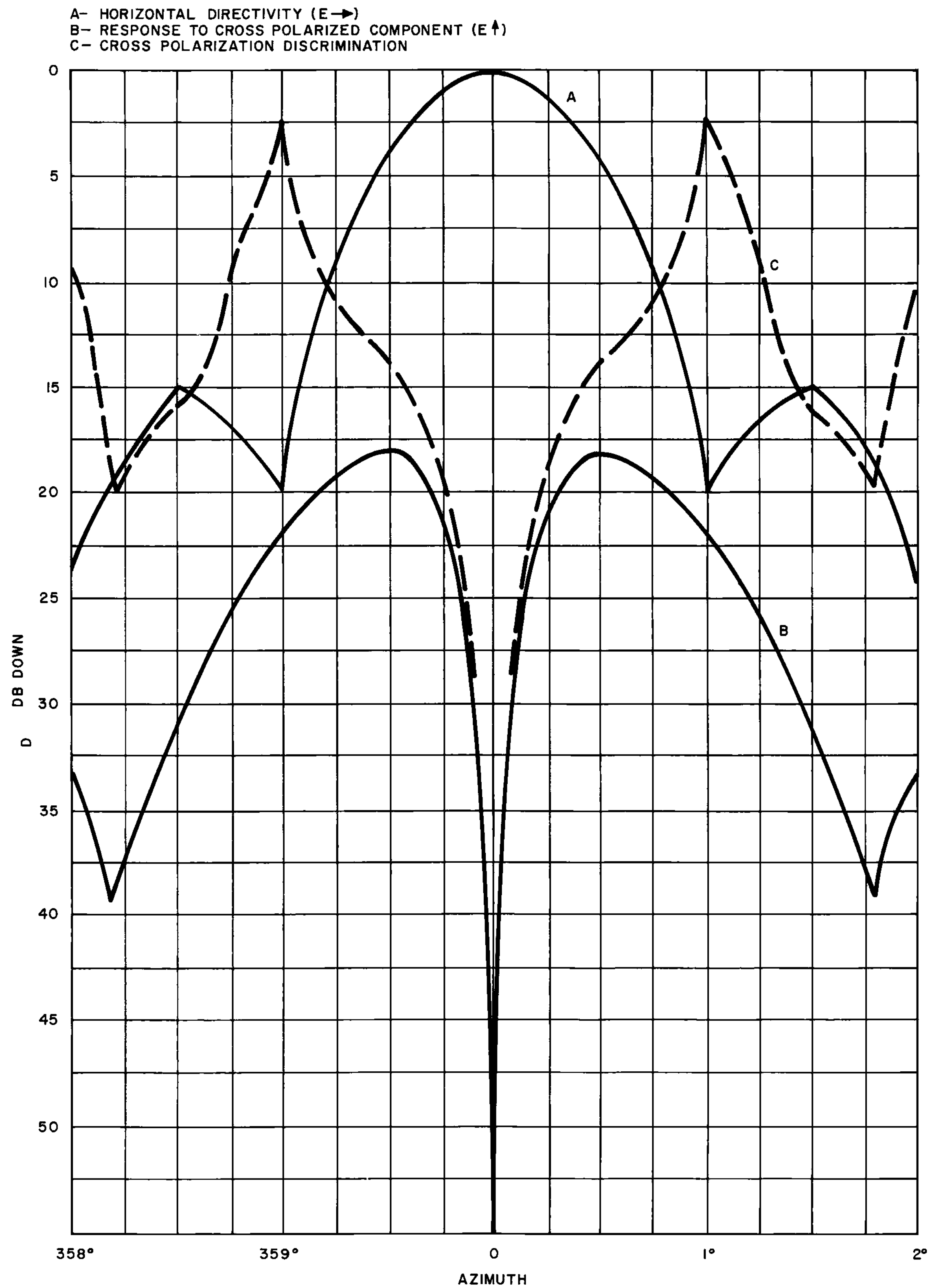


Fig. 5C — Cross Polarization Discrimination With Azimuth (±2 Degrees) — 10,960 MHz

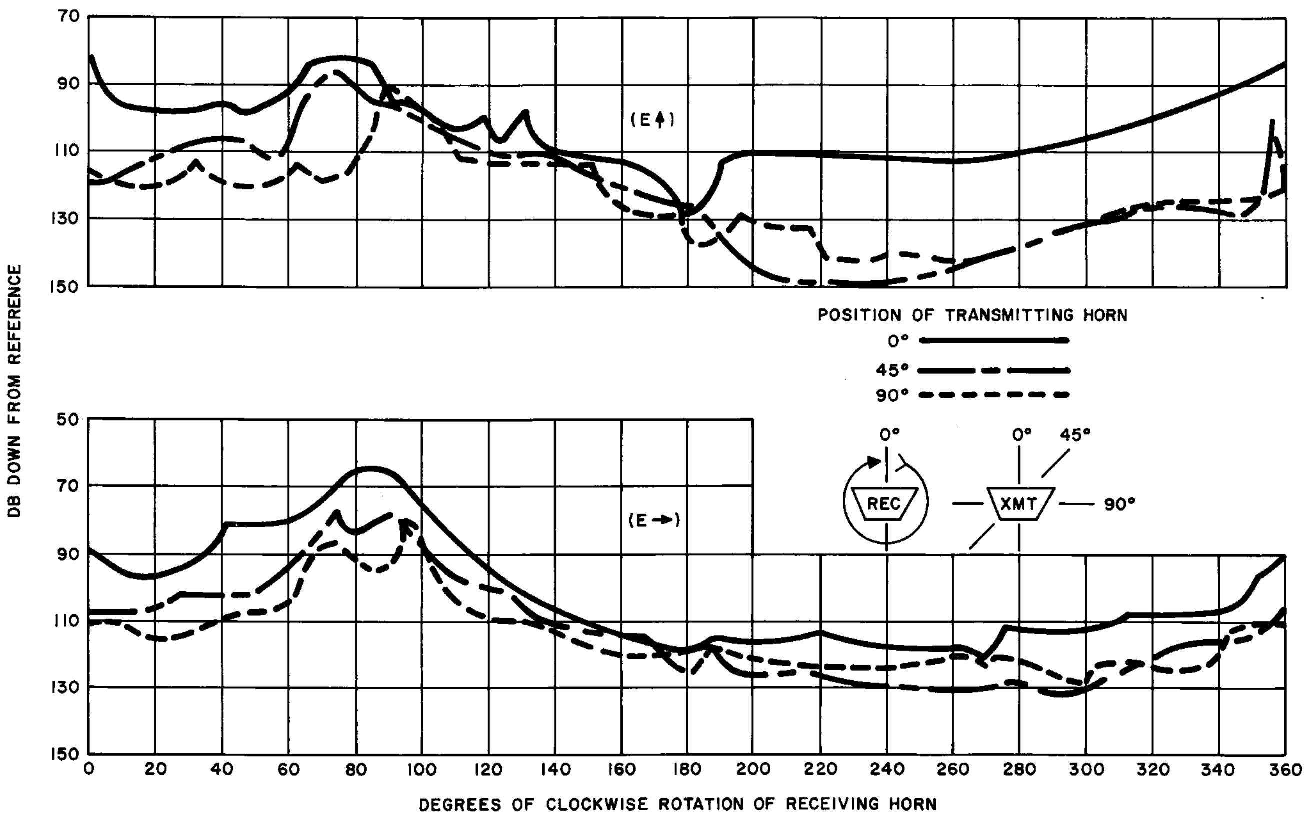


Fig. 6A — Crosstalk — 3740 MHz

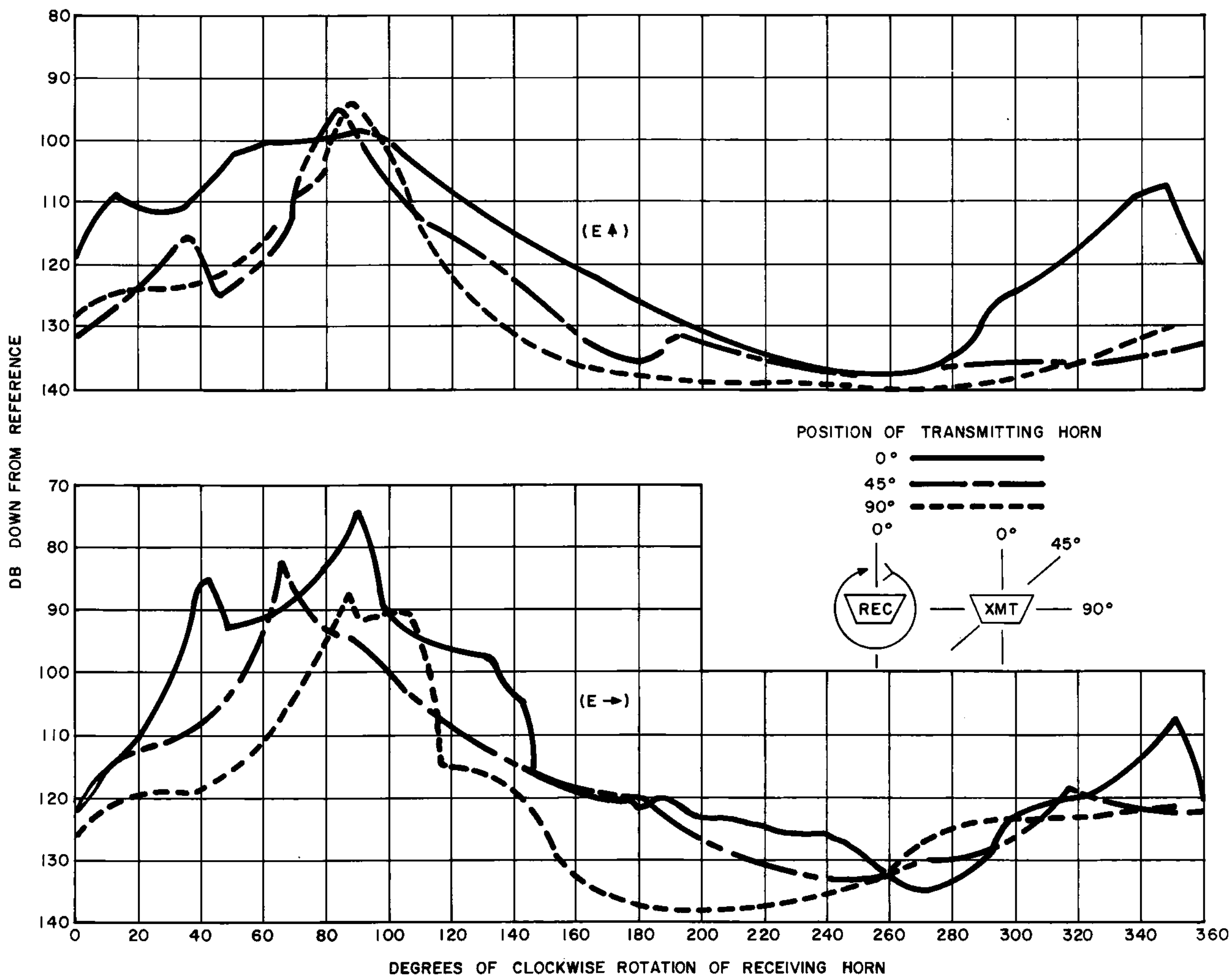


Fig. 6B — Crosstalk — 6325 MHz

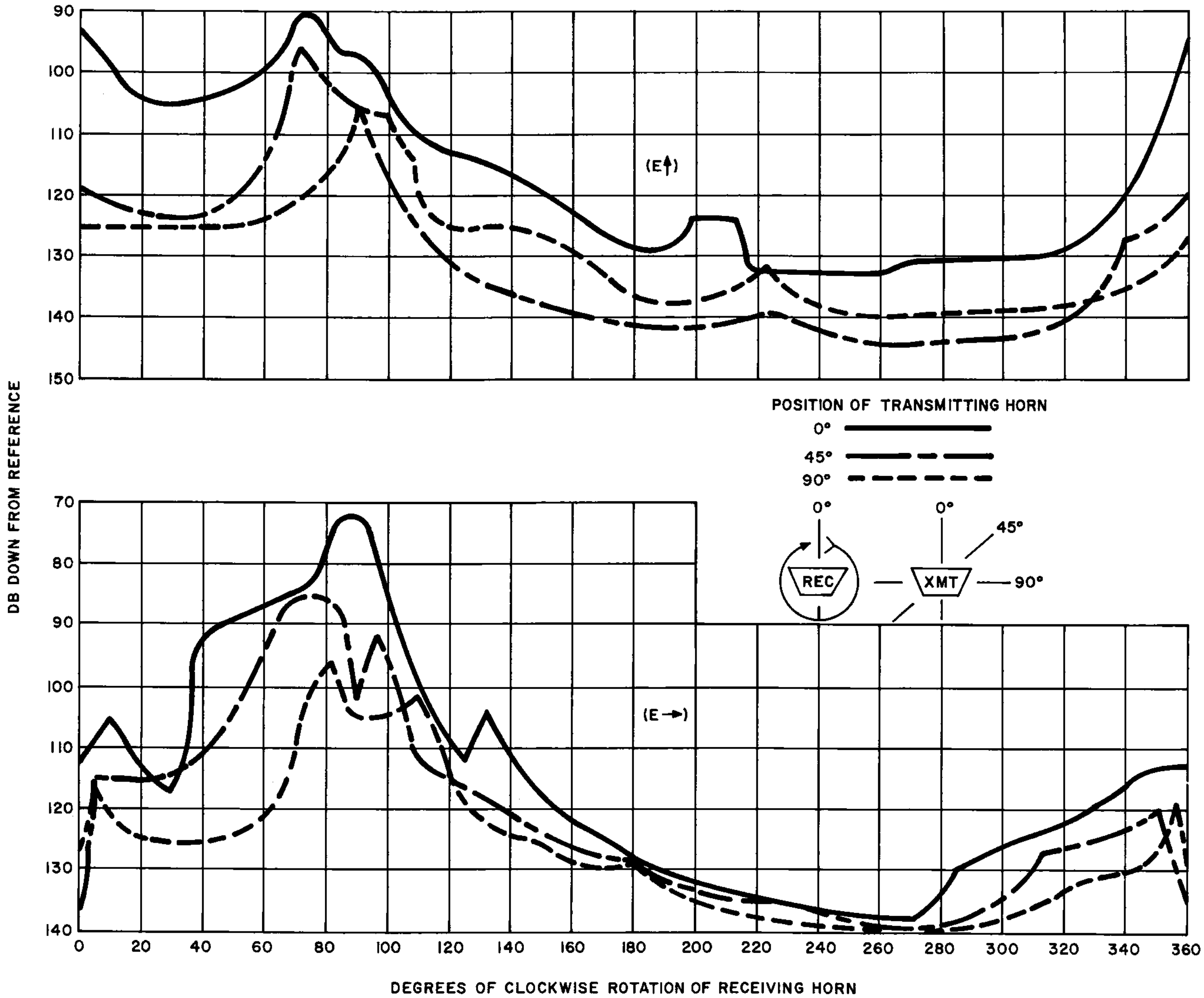


Fig. 6C — Crosstalk — 10,960 MHz

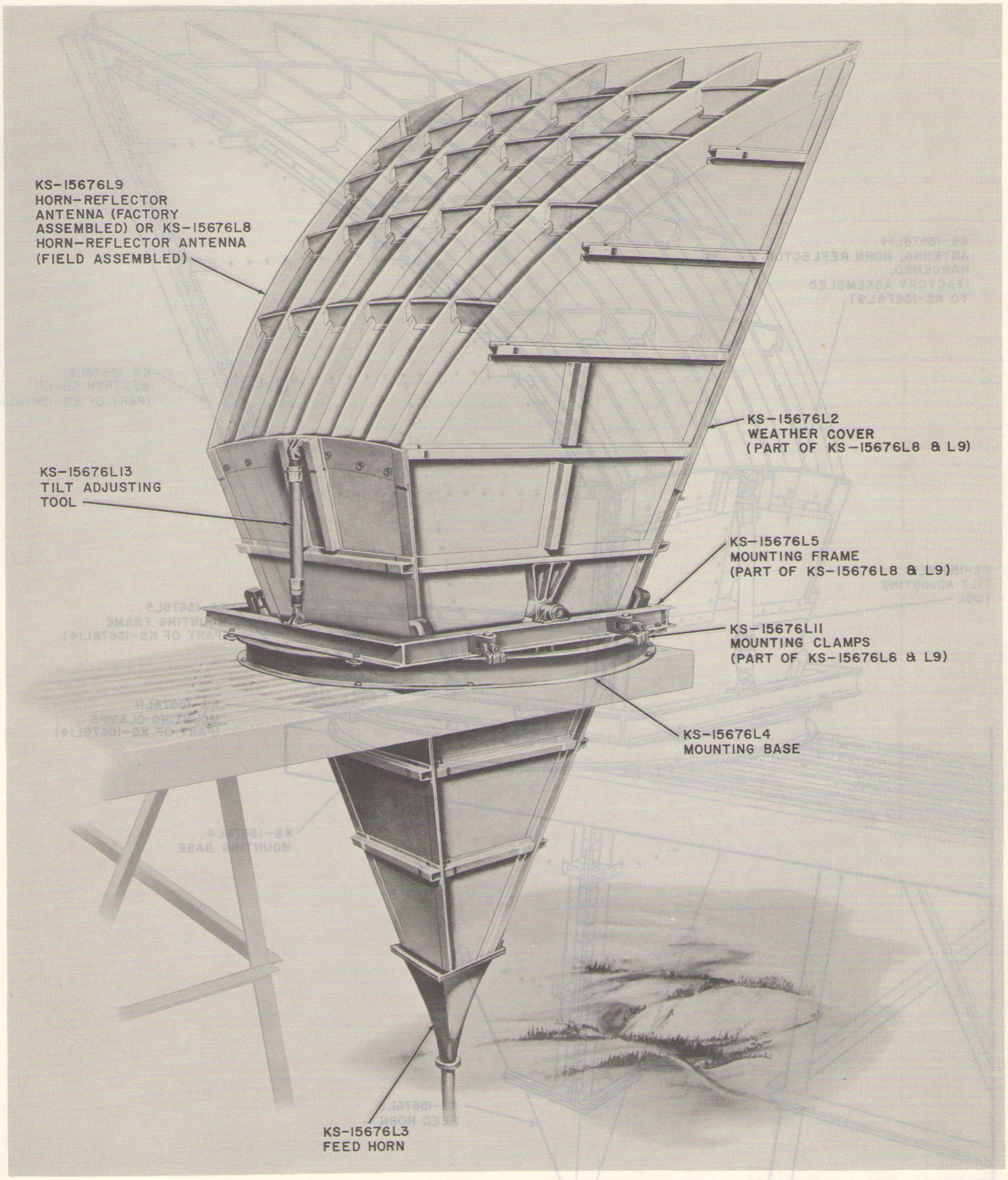


Fig. 7 — KS-15676 L8, L9 Horn Reflector Antenna

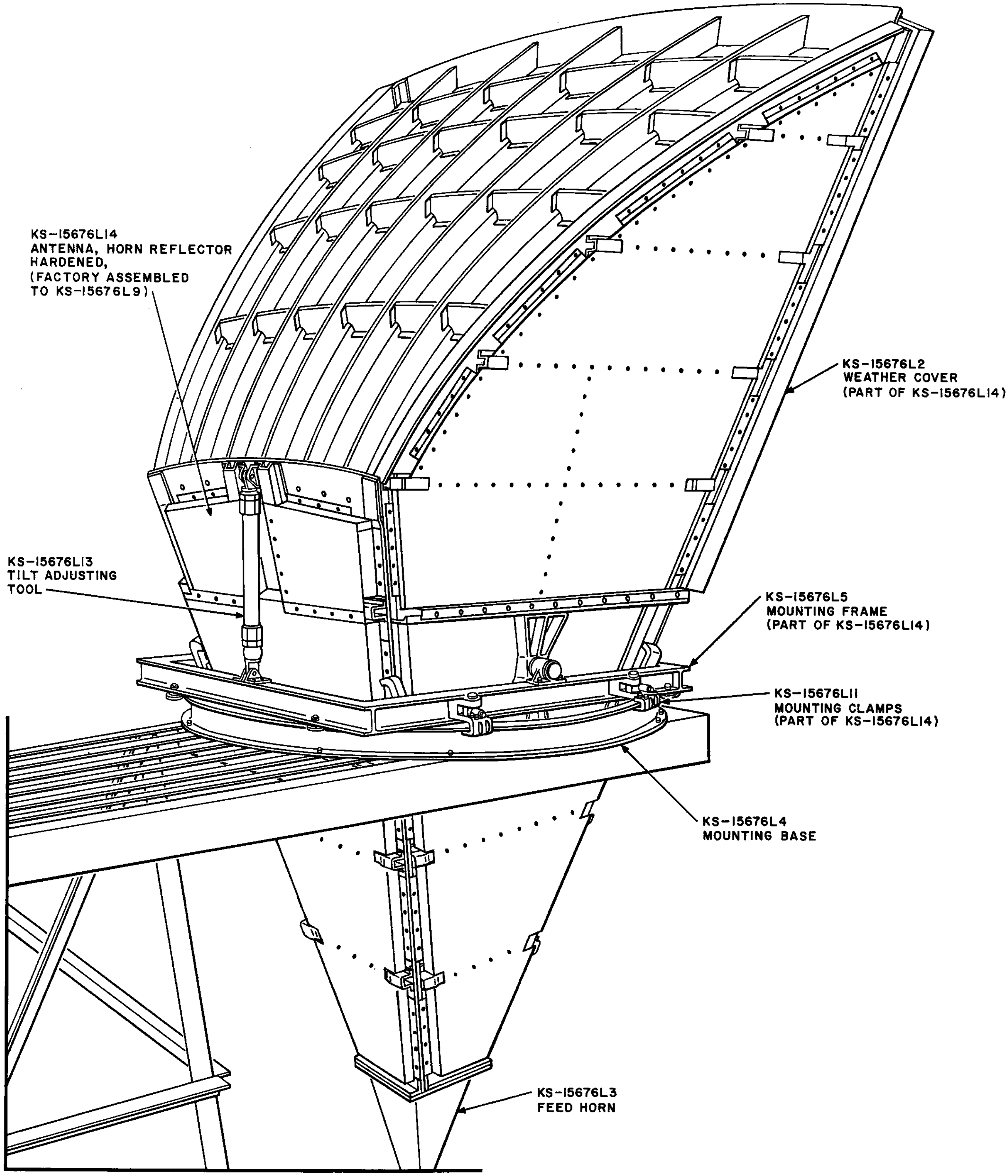


Fig. 8 — KS-15676 L14 Hardened Horn Reflector Antenna

Fig. 9 — Typical Installation, 100-Foot Type-A Tower