MICROWAVE
APPLICATIONS
GROUP

Electronic Scanning Antennas

Product Information

Microwave Applications Group (MAG) has a proven record of creativity and innovation in microwave component and subsystem design for government, military, and commercial applications. MAG has been at the forefront of electronically-steered radar technology, especially in the area of ferrite-based devices. Programs utilizing MAG designed and produced products over the last 30 years are well-known and continue to operate successfully. In more recent years, MAG has designed and built Electronically Scanning Antennas, utilizing years of component-level experience combined with engineering expertise. The following pages provide data on these antennas produced by MAG:

Phased Array Antenna System (PAAS), C-Band, X-Band, Ku-Band

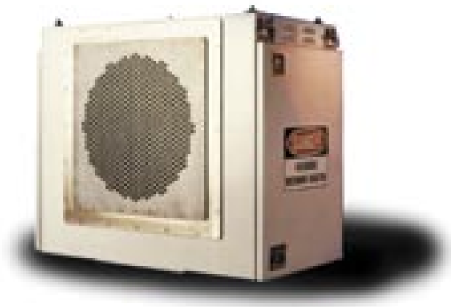
I-30 Expedient Antenna System, X-Band

Terminal Guidance Antenna, Ku-Band

Planar Phased Array Antenna, Ku-Band

Millimeter-Wave Antenna, Ka-Band

Phased Array Antenna System (PAAS), C-Band, X-Band, Ku-Band



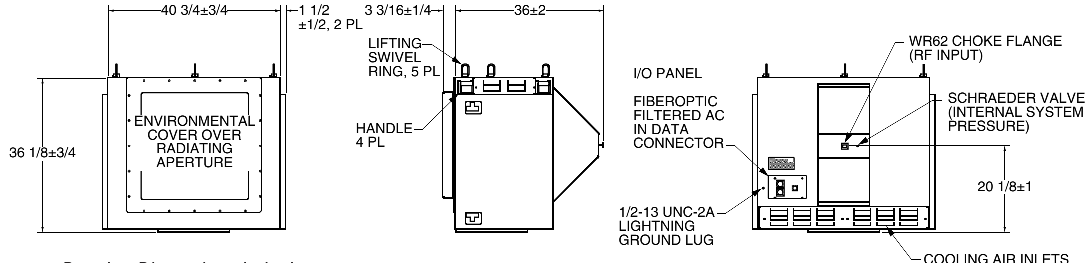
Designed for test range instrumentation applications, the Phased Array Antenna System (PAAS) is a family of ruggedized, low-cost electronically scanning antennas.

The antenna portion of the system is made up of a phased array transmission lens (bootlace lens) with a space feed. The lens consists of aperture and feed plates with ferrite phase shifters contained between the two plates. Radiating elements integrated into the aperture and feed plates are distributed on an equilateral triangular grid. The element spacing is selected to ensure that grating lobes do not occur in visible space when the beam is scanned to its limits, and the triangular grid geometry is used to minimize the number of elements.

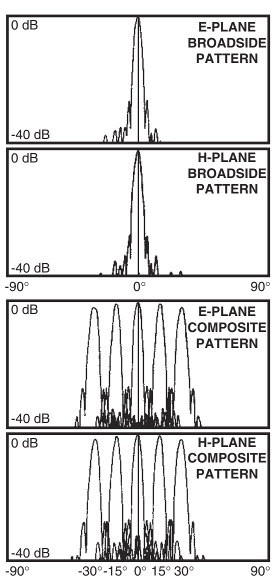
In addition to the antenna portion, the system also consists of a beam steering controller (BSC). The BSC accepts signals from the system controller and points the antenna main beam in a specified direction within a 60 degree cone about the antenna normal. Digital communication between the BSC and the antenna is accomplished via a fiberoptic network.

The mechanical and electrical characteristics, physical dimensions and interface data, as well as measured patterns are presented for the Ku-, X-, and C-Band PAAS antennas.

Ku-Band

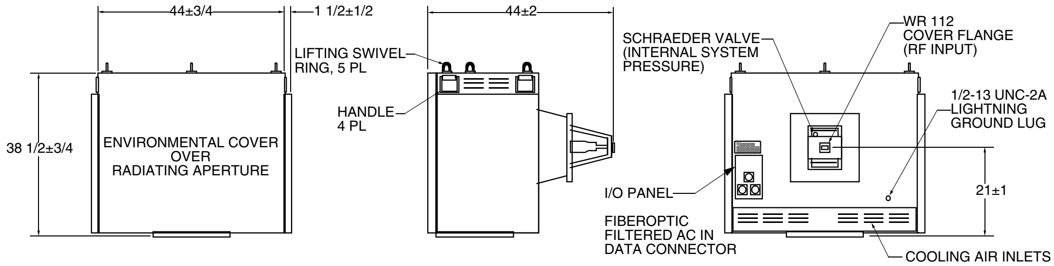


Drawing Dimensions in Inches



CHARACTERISTIC	DESCRIPTION
Frequency	Ku-Band, 7%
Instantaneous Bandwidth	100 MHz
Polarization	Circular, RHCP or LHCP Selectable
VSWR	1.40 : 1 max
Gain (Broadside)	30 dB min
Peak Power	30 KW
Average Power	1500 W
Beamwidth (Nominal)	Pencil Beam, 3.7 Degrees
Beam Pointing Accuracy	±0.3 Degrees max
Beam Resolution	0.6 Degrees max
Beam Broadening	0.9 Degrees max
Peak Sidelobe Level	-25 dB max
Beam Switching Time	120 Microseconds
Load Time	3.24 Milliseconds max
Operating Temperature	-20 to +50 Degrees C

X-Band



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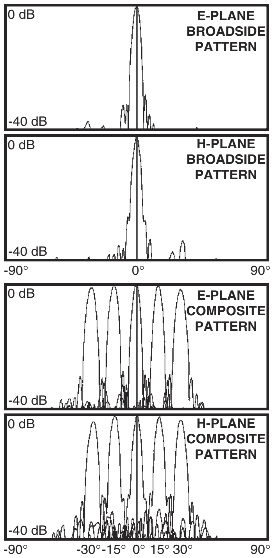
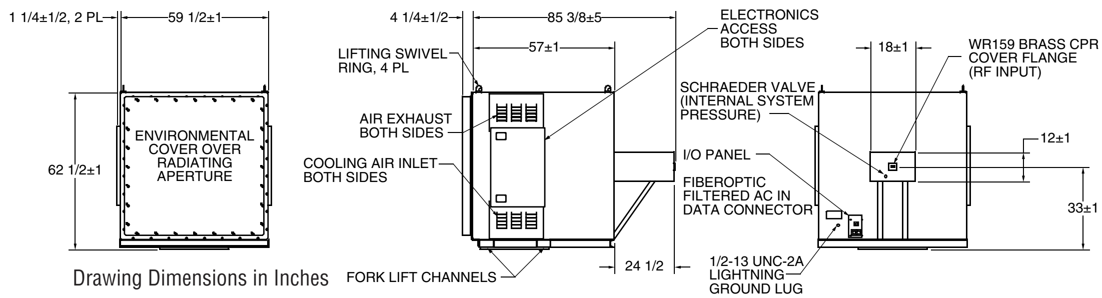
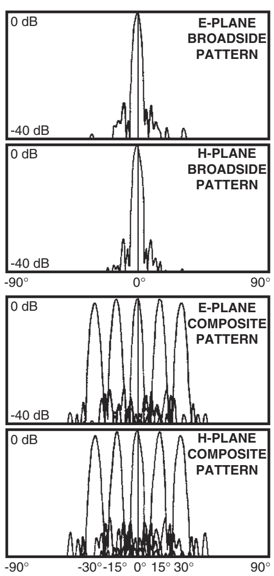


CHARACTERISTIC	DESCRIPTION
Frequency	X-Band, 7%
Instantaneous Bandwidth	50 MHz
Polarization	Linear and Circular Models
VSWR	1.50 : 1 max
Gain (Broadside)	30 dB min
Peak Power	50 KW
Average Power	3 KW
Beamwidth (Nominal)	Pencil Beam, 1.9 Degrees
Beam Pointing Accuracy	±0.3 Degrees max
Beam Resolution	0.6 Degrees max
Beam Broadening	0.9 Degrees max
Peak Sidelobe Level	-25 dB max
Beam Switching Time	120 Microseconds
Load Time	3.24 Milliseconds max
Operating Temperature	-20 to +50 Degrees C

C-Band



Drawing Dimensions in Inches



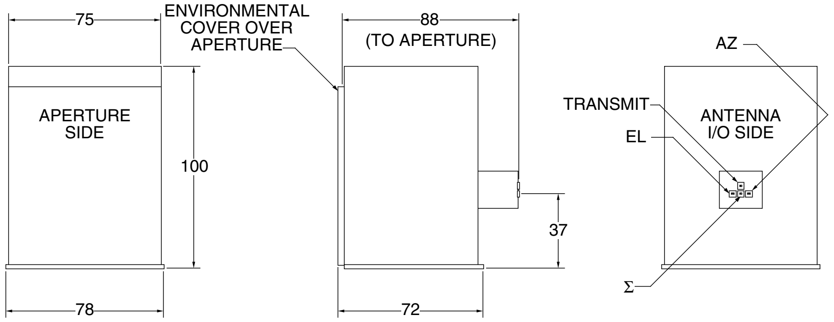
CHARACTERISTIC	DESCRIPTION
Frequency	C-Band, 17%
Instantaneous Bandwidth	100 MHz
Polarization	Circular, RHCP or LHCP Selectable
VSWR	1.40 : 1 max
Gain (Broadside)	30 dB min
Peak Power	25 KW
Average Power	10 KW
Beamwidth (Nominal)	Pencil Beam, 3.7 Degrees
Beam Pointing Accuracy	±0.3 Degrees max
Beam Resolution	0.6 Degrees max
Beam Broadening	0.9 Degrees max
Peak Sidelobe Level	-25 dB max
Beam Switching Time	200 Microseconds
Load Time	3.24 Milliseconds max
Operating Temperature	-20 to +50 Degrees C

I-30 Expedient Antenna System, X-Band

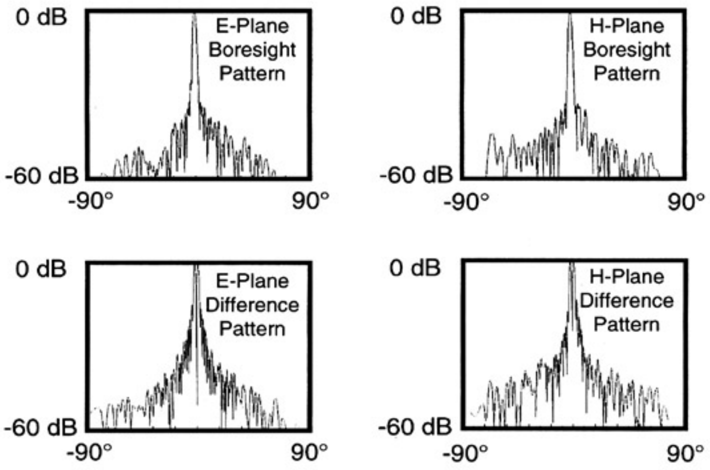
The I-30 Expedient Phased Array Antenna is an electronically steerable antenna designed for test range instrumentation applications.

The antenna consists of a phased array transmission lens (bootlace lens) with a space feed, a beam steering computer (BSC), and associated power supplies. Nonreciprocal ferrite phase shifters operating in a circularly polarized mode are contained between an aperture plate and a feed plate. Radiating elements are formed when dielectric transformers on each end of the ferrite phase shifters are inserted into circular cavities bored in the feed and aperture plates. Since the single-bounce target return is desired, the received circular polarization is opposite the transmitted circular polarization and commutation of the phase shifters is not required. Accordingly, the phase shifters are switched at the beam scan rate rather than at twice the radar pulse repetition frequency which minimizes power supply requirements.

The feed provides monopulse operation with either sense of circular polarization on receive as well as the duplexing function between the transmit and receive modes. Flare angle changes in a square multi-mode pyramidal horn generate higher order waveguide modes to obtain equal E and H plane primary patterns providing for efficient lens illumination and low spillover loss. The BSC accepts signals from the system controller and points the antenna beam in a specified direction. The BSC and power supply are housed separately in rugged, compact cases.



Drawing Dimensions in Inches



CHARACTERISTIC	DESCRIPTION
Frequency	X-Band, 7%
Instantaneous Bandwidth	50 MHz
Polarization	Circular
VSWR	1.50 : 1 max
Gain (Broadside)	36 dB min
Peak Power	100 KW
Average Power	8 KW
Beamwidth	Pencil Beam, 1.9 Degrees Nominal
Beam Pointing Accuracy	0.25 Milliradians
Beam Resolution	0.25 Milliradians
Beam Broadening	0.3 Degrees max
Peak Sidelobe Level	-25 dB max
Beam Switching Time	100 Microseconds
Load Time	500 Microseconds max
Operating Temperature	-15 to +46 Degrees C

Terminal Guidance Antenna, Ku-Band

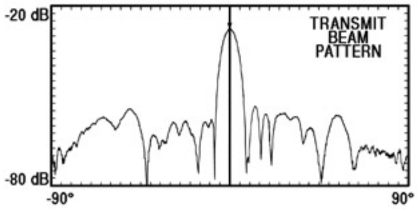
This small Ku-Band antenna is designed to provide electronic scanning capability for the terminal guidance system of a ground-to-air missile. Two-axis monopulse tracking is provided over an instantaneous frequency band of 500 MHz.

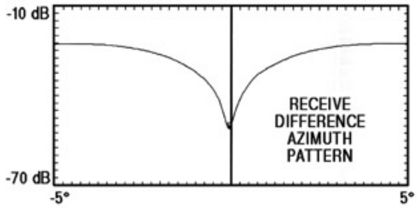
The RF portion of the antenna consists of the lens and feed assemblies and fits within a nine-inch diameter. The electronics portion consists of the phase shifter drivers, a phase shifter controller, and a PC-based beam controller.

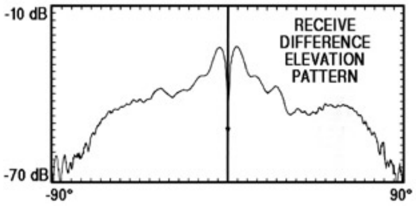
The lens assembly consists of 396 reciprocal dual-mode ferrite phase shifters arranged in an equilateral triangle pattern, contained between a feed network and a radiating ground plane. The phase shifters accept linearly polarized RF energy from the feed by means of a nonhomogeneous rectangular waveguide transition, provide variable phase shift, and radiate the same sense of linear polarization into space by use of a homogeneous circular waveguide radiating element integrated with the phase shifter. The radiating aperture consists of an aluminum ground plane with through holes which accept the radiating elements.

The feed assembly consists of the monopulse network, 5-way unequal power dividers, 6-way unequal power dividers and equal 4-way power dividers. The input power is divided into four equal parts by the monopulse network; this quadrant output is connected to the 5-way unequal power dividers used to feed the rows of the antenna. The outputs of the 5-way unequal power dividers are connected to the 6-way power dividers; each of these outputs is connected to a 4-way equal power divider; these outputs are connected to the phase shifters.

The phase shifter drivers use the MAG ASIC mounted to printed wiring boards; the phase shifter controller is a single board computer; the beam controller is either a desktop or laptop PC.







CHARACTERISTIC	DESCRIPTION
Frequency	Ku-Band, 6%
Instantaneous Bandwidth	500 MHz
Polarization	Linear
VSWR	1.50 : 1 max
Gain	29 dB
Peak Power	100 KW
Average Power	8 KW
Beamwidth	5.5 Degrees
Peak Sidelobe Level	-25 dB max
Beam Switching Time	35 Microseconds
Load Time	500 Microseconds max

Planar Phased Array Antenna, Ku-Band

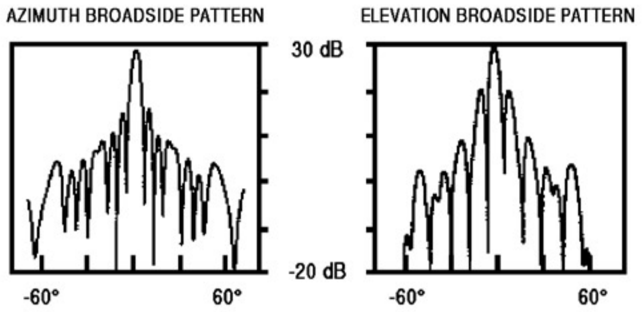
The MAG Planar Phased Array Antenna is a subsystem within a target auxiliary system which provides high power radar emitter simulation for training purposes.

The antenna portion of the subsystem consists of an array of eight radiating horn elements, each with a phase shifter providing a minimum of 360 degrees of phase shift, fed by an eight-way equal line-length corporate feed. This arrangement, along with the horn size, provides maximum utilization of the available aperture, and results in an element spacing which prevents grating lobes from entering the desired scan volume.

In addition to the antenna portion, the subsystem also includes a controller, which converts the analog input data into the required drive signals.

The unit's unique mechanical design allows for operation of the antenna in both a steerable mode utilizing the eight ferrite phase shifters, or in a stand-alone mode with the eight horns directly attached to the corporate feed.

CHARACTERISTIC	DESCRIPTION
Frequency	Ku-Band, 8%
Polarization	Linear Horizontal
VSWR	2.0 : 1
Gain	28.7 dB max
Peak Power	100 KW
Average Power	100 Watts
E-Plane Scan	±10 Degrees
H-Plane Scan	±5 Degrees
Beam Switching Time	100 Milliseconds
Operating Temperature	-54 to +71 Degrees C
Antenna Dimensions	12"w x 6"d x 12"h
Antenna Weight	10 lbs.



Millimeter-Wave Antenna, Ka-Band

The MAG Millimeter-Wave Antenna Subsystem is phase scanned in both azimuth and elevation planes. Monopulse capability is provided in the elevation plane, and the antenna is capable of switching from one beam position to any other within 30 microseconds. Instantaneous system bandwidth is 500 MHz.

The antenna consists of 216 MAG reciprocal ferrite phase shifters arranged on an isosceles triangular grid. The center-to-center element spacing is .258 inch within each row of 36 phase shifter elements, arranged into six rows with .180 inch spacing.

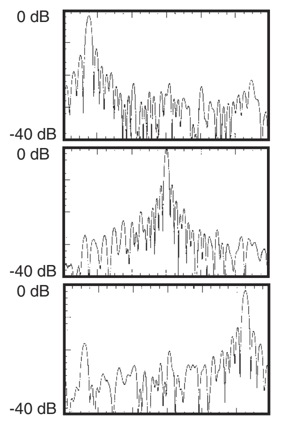
The radiating aperture is made up of circular dielectric-loaded waveguides in a metal ground plane. This type of element has broad patterns in both elevation and azimuth planes.

Electronic drivers use the MAG logic chip, and have built-in-test capability. Easy driver board replacement is made possible through access panels in the unit.

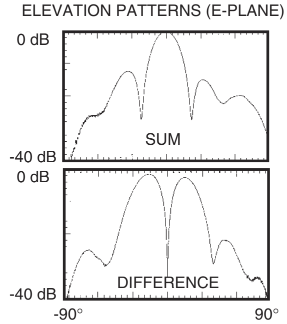
The array package is a self-contained, environmentally controlled unit. Blowers within the unit ensure a phase shifter temperature rise of less than 10 degrees C over ambient, alleviating the need for differential temperature compensation of phase shifter insertion phase.

CHARACTERISTIC	DESCRIPTION
Operating Frequency	Ka-Band
Instantaneous Bandwidth	500 MHz
Polarization	Vertical
Azimuth Scan Coverage	±45 Degrees
Elevation Scan Coverage	±35 Degrees
Azimuth Boresight Beamwidth	2±.2 Degrees
Elevation Boresight Beamwidth	18.5±1.0
Antenna Boresight Gain	25.0 dBi
Elevation Monopulse Null Depth	-30 dB
Elevation Monopulse Null Position Accuracy	1.0 Degree
Beam Steering Quantization Azimuth	.03 Degree
Beam Steering Quantization Elevation	.5 Degrees
Beam Pointing Accuracy Azimuth	±.1 Degrees
Beam Pointing Accuracy Elevation	±1.2 Degrees
Beam Switching Time	30 Microseconds
Operating Temperature	-32 to 71 Degrees C
Nonoperating Temperature	-54 to 71 Degrees C
Operating Altitude	0 to 15,000 Feet
Nonoperating Altitude	0 to 40,000 Feet
Average RF Power	100 Watts
Weight	35 lbs.
Size	5-3/4"h x 11-1/4"w x 13-1/8"d

AZIMUTH PATTERNS (H-PLANE)



ELEVATION PATTERNS (E-PLANE)



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