Antenna and Quasioptical Product Capability

Millitech is a leading supplier of millimeter-wave antennas and associated products for frequencies ranging from 18 to above 600 GHz. The range of products offered cover virtually every application and functional requirement. Multiple options for specific needs are generally available to achieve an optimal solution. Please click on the Product Descriptions and Datasheets button in the Products tab for more information.

Most of the standard catalog products are available from 18 to 140 GHz, in single or dual polarization. The half-power beamwidth is determined by the diameter D and is typically 70λ/D over much of the band. **Figure 1** shows the relationship between gain, beamwidth and antenna size as a function of frequency. High efficiency and maximum achievable gain are key features of Millitech's antennas.

Special products are custom designed and include almost all Gaussian optics components, all products of nonstandard size or specification, special feedhorns and focused or compact optics antennas. Some of the antenna types offered by Millitech and the associated technology are described next.

Gaussian Optics Capability

Free space propagation is an established technique for achieving low loss at short wavelengths. We have used Gaussian optics in combination with other techniques to produce high performance antennas for many applications such as radar, surveillance, remote sensing, material studies, avionics, radioastronomy and plasma diagnostics.

The major advantage of quasioptical transmission over waveguide is its low loss, especially at near millimeter and submillimeter wavelengths. The actual loss in propagation between focusing elements can be made arbitrarily small by proper system design. The reflection loss from metal mirrors is virtually immeasurable throughout the millimeter region, while the loss from properly designed lenses is only a few percent. Other important advantages of free space transmission over waveguide include the ability to support all polarizations. Very high isolation (on the order of 30 dB) can be maintained between orthogonal polarizations. Gaussian optics can also support more than one spatial mode, which is useful for imaging and monopulse feed systems.

Applications of Gaussian Optics

Gaussian optics assemblies can be made impressively compact when compared to equivalent systems utilizing waveguide components. Devices such as frequency duplexers, polarization diplexers, circular-to-linear polarizers, ferrite rotators or phase shifters can be placed in the otherwise empty space between the lens and the feed instead of being added after the feedhorn. Adding waveguide components such as a circular-to-linear polarizer, a circular-to-rectangular transition or an orthomode transducer to a Gaussian optic lens antenna will increase the overall length by over 50%. A classical Gaussian optic lens antenna with these optical components can perform many tasks simultaneously, such as dual polarization conical scanning of either linear or circular (righthand or lefthand) polarization. A single Gaussian optic lens antenna can simultaneously span two widely separated bands such as 35 GHz and 94 GHz when a Gaussian optics frequency diplexer is used. These techniques can be used from microwave through submillimeter wavelengths.

Many quasioptical devices are clearly superior to their waveguide counterparts. A wire grid polarization diplexer can give up to 30 dB isolation and can operate over several waveguide bands. An optical linear-to-circular polarizer can have an axial ratio as low at 0.3 dB at center frequency.

At frequencies above WR-08 (140 GHz) waveguide components such as frequency filters, directional couplers and isolators are narrowband, lossy and difficult to produce. Quasioptical isolators have been developed for frequencies up to 300 GHz; directional couplers and frequency filters have been used at millimeter and submillimeter wavelengths. Series **GFS** free-standing wire grid polarizers can be designed for use at microwave frequencies, for infrared, or anything in between. Gaussian optics is gaining acceptance in high power applications where power density can cause arcing or overheating.

Gaussian optics components are readily integrated into waveguide systems via a

Antenna and Quasioptical Product Capability

scalar feedhorn which launches the beam. The beam propagates through the components(s) and is refocused into another scalar feedhorn, which couples the beam back into waveguide. **Table 1** shows various antenna polarization options using quasioptical waveguide components.

Reflector Antennas

Millitech offers series **CRA** symmetric Cassegrain antennas in diameters ranging from 6 to 48 inches. Offset Cassegrains are available by special order. These have no beam blockage, making the sidelobes significantly lower and the gain higher than that of symmetric Cassegrain antennas.

Cassegrain antennas are frequently used in monopulse systems, radars, communications and in special applications. For example, a 94 GHz offset Cassegrain antenna with quasioptical components scans ± 30 degrees in yaw and pitch while maintaining 30 dB polarization isolation in a beam having a 3:1 aspect ratio. Another special offset Cassegrain antenna has a completely quasioptical feed system which switches between three polarization senses. Nonstandard antennas with diameters as large as 90 inches may be tested at Millitech.

Our compact antenna range remains an ideal tool for evaluating antenna systems as large as eight feet in diameter and weighing up to one ton. This test range is housed in an anechoic chamber lined with absorber optimized for performance at higher microwave and millimeter-wave frequencies.

The advantage of using the compact antenna range test facility include elimination of the traditional far-field separation requirement, increased dynamic range and reduction of random scattering reflections.

Millitech also uses a far-field measurement system equipped for testing antennas with high angular precision. This set up can be used both indoors and outdoors.

Millitech has developed its own automated testing, control, display and analysis software that is used exclusively on the antenna range. By maintaining in-house control, Millitech is able to ensure quality, consistency and the ability to accommodate specialized testing and data processing requirements.

Performance Parameter		Compact Antenna Range	Far Field
Frequency Range, GHz		7 to 220	35 to 325
Maximum Antenna Size		8 feet	1 foot
Positioner Type		Scientific Atlanta 53150A	Klinger BG200 RT200
Positioner Precision	Azimuth	0.01°	0.001°
	Elevation	0.05°	0.001°
Bending Load, ft./lb.		2,500	20
Vertical Load, lbs.		2,500	20

Antenna and Quasioptical Product Capability

Special Antenna Applications

Millitech has combined the techniques discussed above to satisfy the specific requirements of an assembly or system. Quasioptical components with reflectors were combined to make a coboresighted frequency multiplexing system spanning two octaves and a 4' offset Cassegrain with a triple polarization feed system. This technique has also been used for an airborne scanning offset reflector antenna with multiple polarization and quasioptical feeds. Other newly developed components include septum polarizers and wideband orthomode transducers.

Monopulse Antennas

Millitech has developed monopulse antennas with waveguide feeds. Dual polarization monopulse antennas have also been develop for reflectors. Low loss and compact size are attributes of the monopulse antenna.

Compact Antenna Range Test Facilities

Millitech's commitment to provide the most advanced antenna test facilities and service is evident in our compact antenna range facility. The dedicated antennas test and assembly building is available for testing antennas and antenna systems at frequencies from 7 GHz to 110 GHz. Please visit our SATCOM Division facility section for more information on our compact antenna range.

ANTENNA AND QUASIOPTICAL PRODUCT CAPABILITY

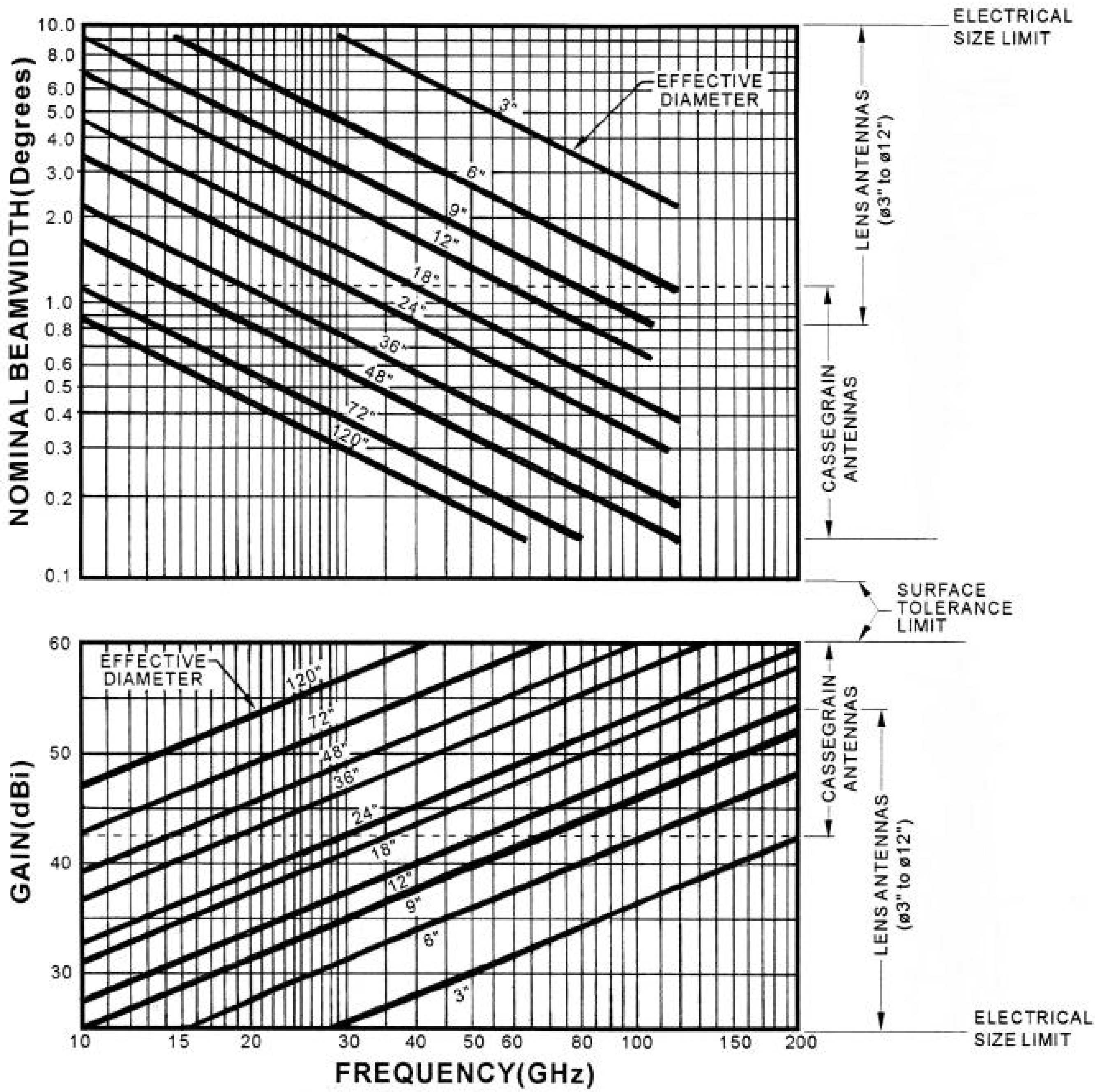
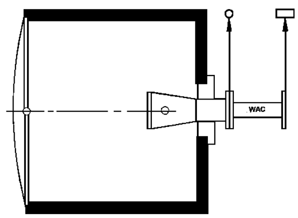
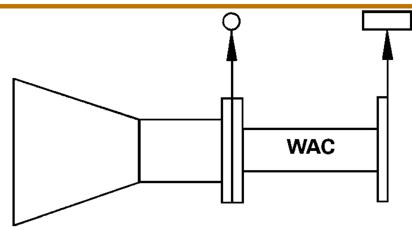


Figure 1. Gain, Beamwidth and Antenna Size as a Function of Frequency.

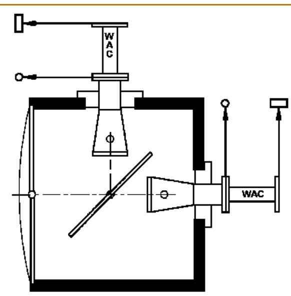
Antenna and Quasioptical Product Capability

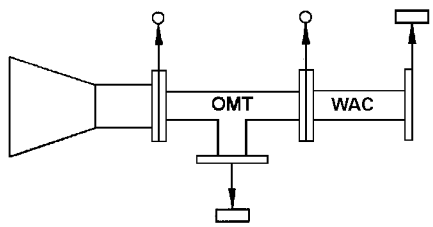
Quasioptical Version	Waveguide Version	Feed Type



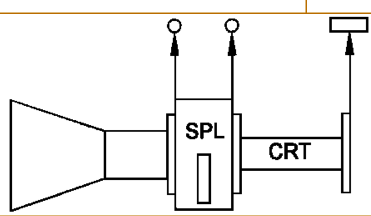


Series **GOA** and series **WAC** circular-to-rectangular waveguide transition will provide a linearly polarized feed.

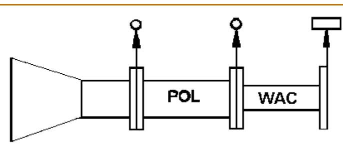




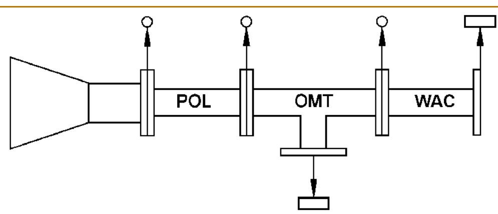
By inserting a series **OMT** orthomode transducer in the above configuration, a simultaneously dual-linear (horizontal and vertical) polarization is obtained.



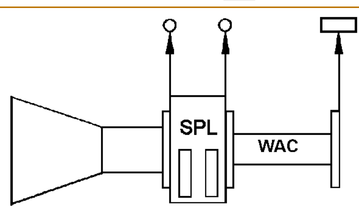
The antenna can be mechanically switched from horizontal to vertical polarization by using series **SPL** and series **WAC** with the antenna.



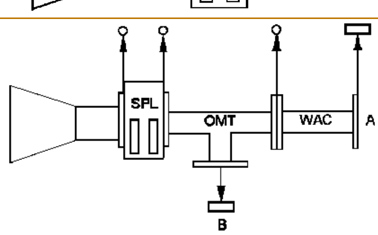
When the series **POL** circular polarizer is inserted in place of series **SPL** in the above configuration, a circularly polarized feed, which may be set up at assembly for either left- or righthand circularity, is provided.



Through the addition of the series **OMT** orthomode transducer, the feed assembly can operate with left- and righthand circular polarization simultaneously.



The insertion of the series **SPL** linear-circular switchable polarizer in the above configuration provides a feed that can be switched: 1) righthand circular, 2) left-hand circular, or 3) linear. By the addition of the series **OMT**, orthomode transducer, the following combinations can be provided:



OUTPUT	POLARIZER SETTING		
	RHC	LHC	LINEAR
A	RHC	LHC	VERTICAL
B	LHC	RHC	HORIZONTAL

Table 1 Antenna Polarization Options Using Quasioptical Waveguide Components.