

# Circular Polarization vs. Linear Polarization



## Executive Summary

The objective of this white paper is to provide a high level analysis of circular and linear polarization, and to alleviate the confusion and misconceptions surrounding these forms of technology.

Once the decision to purchase satellite capacity or services is made, a determining factor that customers must recognize and consider is that of frequency polarization. Preference for polarization is relatively low, ranking well behind bandwidth, power, and price in the decision process.

The most common forms of polarization utilized are linear polarization and circular polarization. The following report will assist in better understanding both of these forms of polarization, and discuss some of the advantages of circular polarization.

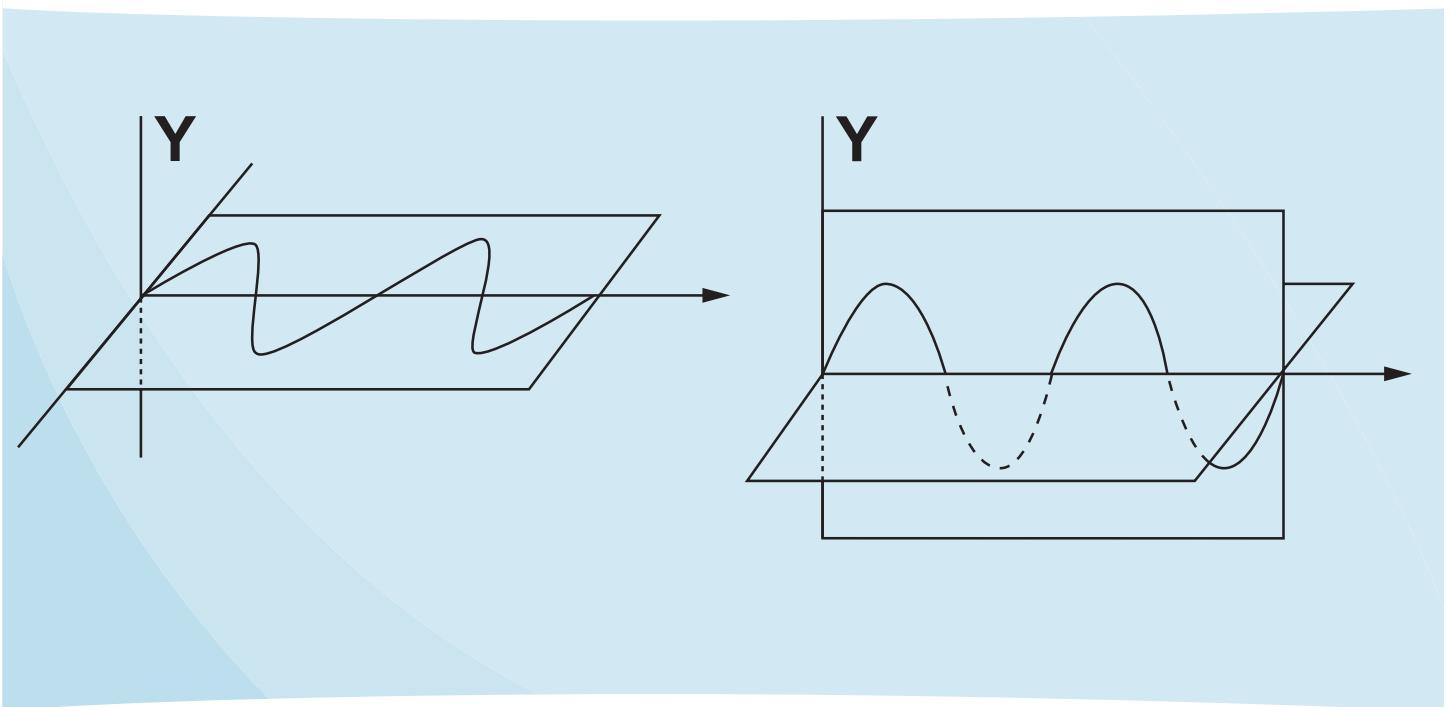
For more information, we invite you to talk to our experts and discuss your specific requirements. Contact us by visiting [www.intelsat.com/network](http://www.intelsat.com/network).

## Linear Polarization

From a technical perspective, linear polarization is defined as polarization of an electromagnetic wave in which the electric vector at a fixed point in space remains pointing in a fixed direction, although varying in magnitude. There are two forms of linear polarization: vertical, where the electric field is perpendicular to the Earth's surface, and horizontal, where the electric field is parallel to the Earth's surface. Both directions can

be used simultaneously on the same frequency. Some customers consider linear polarization to be superior, if only because the specific equipment costs are marginally less. Linear polarization can be found in both C-Band and Ku-Band (see Table 1).

**Figure 1: Linear Polarization**

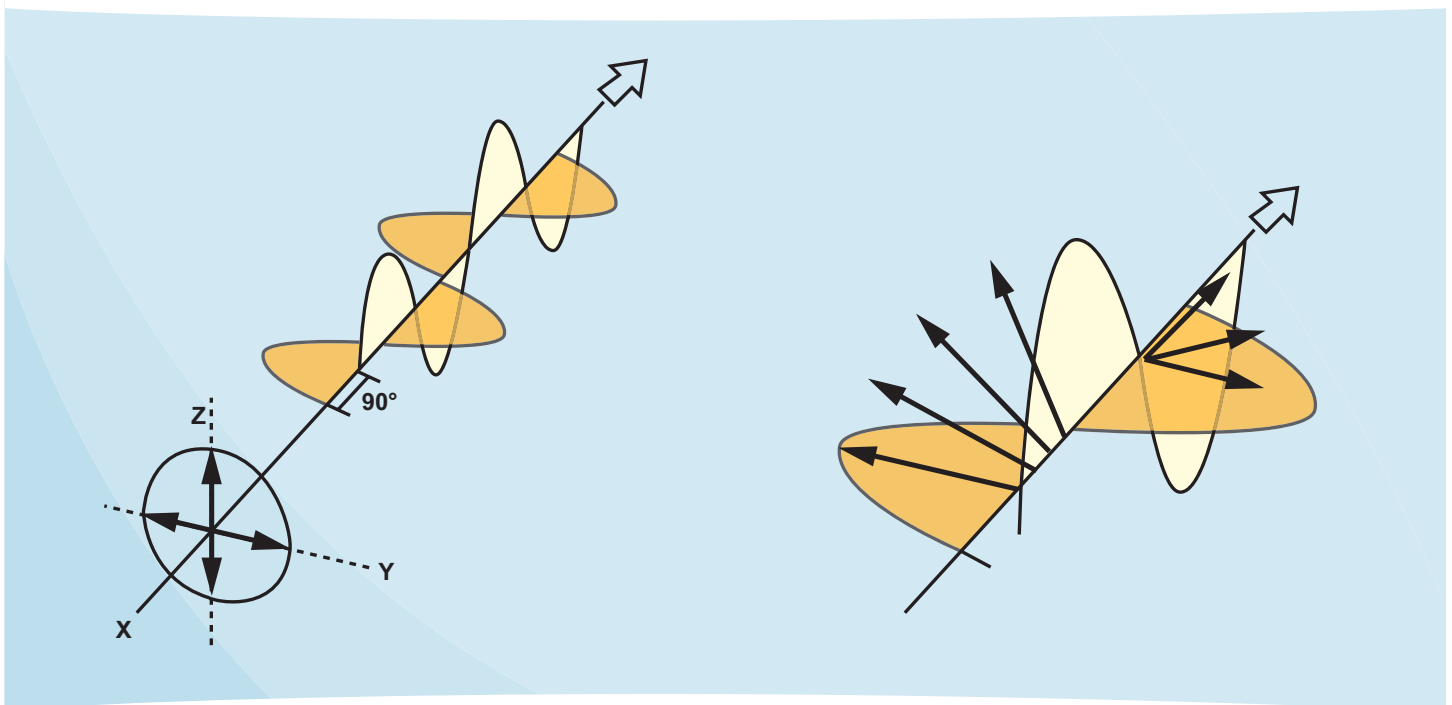


## Circular Polarization

Some customers feel that circular polarization is not as desirable as linear polarization. The reasons for this view are not clear; one possible reason is due to the customer not being fully educated on the benefits or the price sensitivity towards equipment. Some customers may also feel that since Intelsat is the only satellite provider offering C-Band, the availability of antennas could become an issue. However, it is important to realize that the increased reliability in signal strength, resistance to weather conditions, and ease of installation outweigh the expense of the feed horn. Technically speaking, circular polarization involves the plane of polarization rotating in a corkscrew pattern, making one complete revolution during each wavelength. The

circularly polarized wave will radiate energy in the horizontal and vertical plane, as well as every plane in between. There are two directions of propagation that come with circular polarization: Right-Hand-Circular (RHC) which follows a clockwise pattern, and Left-Hand-Circular (LHC) which follows a counterclockwise pattern. As with linear polarization, both directions can be used simultaneously on the same frequency, allowing higher revenue generation through the doubling of capacity on the satellites. Circular polarization can be found on both C-Band and Ku-Band. It is important to note that Intelsat does not have any Ku-Band fleet with circular polarization (see Table 1).

**Figure 2: Circular Polarization**



## Feed horns

Switching from linear polarization to circular polarization is easier than many think; it simply requires changing the feed horn that is mounted at the antenna's focal point. The price difference can be almost negligible. For example, a low cost VSAT antenna with two port feeds is a mere \$200 more than a linear feed horn. However, in some cases the feed horn can be significantly more expensive for circular polarization, an investment which will be at least partially offset by its advantages.

Operationally, the feed horn conveys radio waves between the transceiver and the reflector. The feed horn also separates the two polarities (vertical from horizontal or left from right hand) of the signal being received. This removes unwanted signals, (for example, left hand circular), from the desired signal, (for example, right hand circular) of a given frequency. For a linear feed horn to properly separate the polarizations, it must be precisely rotated to the exact alignment with the satellite's signals. A circular feed horn does not have this requirement.

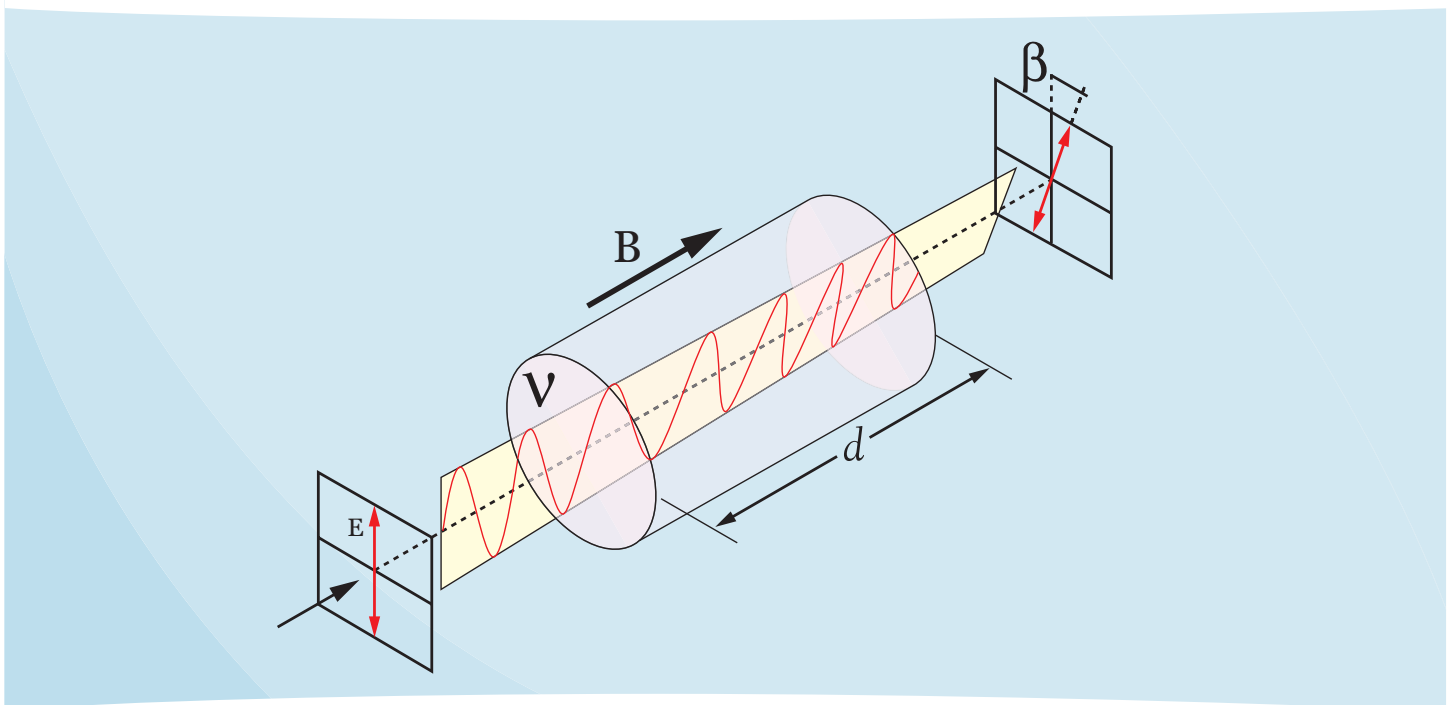
## Advantages of Circular Polarization

There are several key advantages for circular polarization over linear polarization, which make it more appealing:

### *The Faraday effect*

The Faraday effect deals with the interaction between light and magnetic fields. It affects linear, but not circular, polarized signals, and the effects are more severe at lower frequencies, such as C-Band, and not noticeable at higher ones, such as Ku-Band. As signals pass through the atmosphere they become de-polarized, causing undesirable reception of the opposing polarity. Linear polarized feeds are aligned in such a way to compensate for the Faraday effect, usually with the help of a tracking device; corrections can be made either by rotating the feed system or using adjustable polarizer's within the feed system. This can be very time consuming because the alignment must be exact. One result of incorrect alignment is increased interference. Fortunately, this is not a concern for circular polarization since there is no need for exact signal alignment. Ku-Band is at a high enough frequency that Faraday's effect is not a factor.

**Figure 3: Faraday's Effect: The Linear Polarized Signal Twists**



### Atmospheric Conditions

Circular polarization is more resistant to signal degradation due to atmospheric conditions. These conditions can cause changes in the rotation of the signal, and will more adversely affect linear polarization than circular polarization. The effect of a high frequency signal passing through rain can cause signal attenuation and accounts for the majority of the problems with rain fade. Moisture laden clouds are also a factor; by the time a signal passes through a cloud system it can be attenuated by as much as 1dB. Water droplets on the feed horn may also cause detrimental effects. However, the most important aspect to note is that higher frequencies (like Ku-Band) degrade faster, harder, and longer than their frequency counterparts (C-Band).

### Easier installation

The only requirement is ensuring that the antenna is aimed in the correct direction on the satellite; simply point and transmit. This allows for circular feeds to be set up quicker, and there is less of a risk of being misaligned.

### Higher link reliability

There is higher link reliability since there is a low risk of misalignment, and encountering interference. Faraday's effect will not affect transmission with circular C-band, so there will be no need to readjust the alignment. Finally, because transmission is sent and/or received at different frequencies, interference (cross polarization) is less of a concern.

### Availability on the Intelsat Fleet

Circular polarized C-band is available on key roles on the Intelsat fleet.

*Table 1: Breakdown of Polarization on Intelsat satellites*

Circular Polarization:	
C-Band	IS-601, IS-602, IS-603, IS-605, IS-701, IS-702, IS-704, IS-705, IS-706, IS-707, IS-709, IS-801, IS-802, IS-901, IS-902, IS-903, IS-904, IS-905, IS-906, IS-907, IS-10-02
Ku-Band	None
Linear Polarization:	
C-Band	G-3C, G-4R, G-9, G-10R, G-11, G-12, G-13, G-14, G-15, G-16, G-23, G-25, G-26, G-27, G-28, Horizons 1, APR-1, IS-1R, IS-2, IS-3R, IS-5, IS-6B, IS-7, IS-8, IS-805, IS-9, IS-10 and IS-12
Ku-Band	All Satellites

## Contact Us

For more information about Polarization and the Intelsat fleet, please contact your local regional representative at:

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