Millimeter-wave Antenna Solutions

By Eravant

Eravant offers various millimeter wave antennas in the frequency range of 8.2 to 325 GHz for millimeter-wave radar, communication, antenna ranges, and many system applications. The antenna families developed, designed, and manufactured by Eravant include both the planar and 3D horn antennas with various gains and beamwidth. The following types are available on the company's official website: rectangular horn, circular horn, scalar feed horn, choke flange feed horn, probe antenna, lens correct horn, Gaussian optics antenna, omni directional antenna, sector antenna, Cassegrain antenna, microstrip patch array antenna, slotted waveguide array antenna, and more. Millimeter-wave antennas with customized specifications are available upon request as well.

The antenna families include both the planar and 3D horn antennas with various gains and beamwidth.

Rectangular horns, also known as pyramidal horns, are equipped with a rectangular waveguide interface (Fig. 1. SAR-2507-03-S2). The rectangular horns cover a full waveguide bandwidth with return loss over 20 dB, within the frequency range of 8.2 to 325 GHz. They only support linear polarization. The commercial off-the-shelf (COTS) models provided by Eravant have nominal gains of 10, 15, 20, 23 and 25 dBi, which correspond to typical half power beamwidths of 55, 32, 13, 11, and 9 degrees at the center frequency of the band. The typical sidelobe levels at E-plane and H-plane are around -13 dB and -25 dB, respectively. Moreover, the company provides 24 dBi standard gain horn antennas with calibrated gain chart. These standard gain horns are mainly offered for antenna range calibration purposes (Fig. 2. SAZ-2410-05-S1).

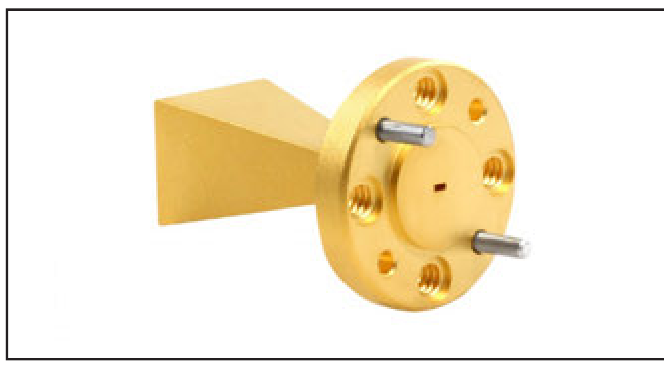

Figure 1 • SAR-2507-03-S2

Figure 2 • SAZ-2410-05-S1

Conical horns are offered with either a circular or rectangular waveguide interface (Fig. 3. SAC-2507-10-S2). While conical gain horns with a rectangular waveguide interface can only support linear polarization, models with a circular waveguide interface can support both linear and circular polarization. The conical horns exhibit a typical return loss of 20 dB for each waveguide band within the frequency range of 8.2 to 325

Figure 3 • SAC-2507-10-S2

Figure 4 • SAF-1141741535-082-S1

GHz. The COTS models of conical horns with nominal gains of 10, 15, 20, 23 and 25 dBi are offered, which correspond to typical half power beamwidths of 55, 32, 13, 11, and 9 degrees at the center frequency of the band. The typical sidelobe levels at E-plane and H-plane are around -13 dB and -25 dB, respectively. Both the rectangular horns and conical horns can be integrated with coax to waveguide adapters for a coaxial interface by integrating Eravant's waveguide to coax adapters (SWC series).

Scalar feed horns are offered with a waveguide interface. The scalar feed horns exhibit typical return loss of 20 dB for each waveguide band, within the frequency range of 8.2 to 220 GHz. There are two types of scalar feed horn designs, i.e., standard design and flat gain design. For the standard scalar feed horn, the gain increases linearly with the frequency. The COTS models of standard scalar feed horns with nominal gains of 15 and 17 dBi are offered, which correspond to typical half power beamwidths of 35 and 25 degrees at the center frequency of the operating band. Fig. 4. is a D Band standard scalar feed horn, model number SAF-1141741535-082-S1. For the flat gain scalar feed horn, the gain variation is within ± 2 dB for the full waveguide band operation. The COTS model of flat gain scalar feed horns is offered with a nominal gain of 13 dBi, which corresponds to a typical half power beamwidth of 40 degrees at the center frequency of the operating band. An example of this horn is shown in Fig. 5, model number SAF-6039031340-141-S1-2. Compared with standard gain horns, scalar feed horns have the advantage of low sidelobe levels of -25 dB and nearly equal beamwidth both E and H plane. Scalar feed horns are widely used to feed the Gaussian optical antennas and Cassegrain antennas.

Besides flat gain scalar feed horns, choke flange horns are another type of antenna that features low sidelobe levels and flat gain across the full waveguide band. A widely used 5G mmW choke flange horn antenna is shown in Fig. 6., model number SAH-2434231060-328-S1. The choke flange horns exhibit a typical return loss of 20 dB for each waveguide band within the frequency range of 24 to 110 GHz. The COTS models of standard choke flange horns with nominal gains of 10 dBi are offered, which correspond to typical half power beamwidths of 60 degrees at the center frequency of the

Figure 5 • SAF-6039031340-141-S1-2

Figure 6 • SAH-2434231060-328-S1

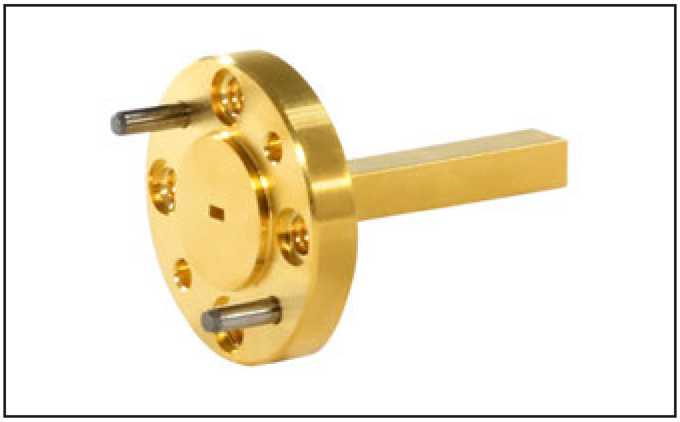

Figure 7 • SAP-04-R2

Figure 8 • SAL-7531143004-094-S1

operating band. Similar to scalar feed horns, the choke flange horns have the advantage of low sidelobe levels of -25 dB and nearly equal beamwidth in both E and H plane. The gain variation is within ±1 dB for the full waveguide band. Choke flange horns are widely used to feed the Gaussian optical antennas and Cassegrain antennas.

Probe antennas are offered with a rectangular waveguide interface (Fig. 7. SAP-04-R2). Probe antennas can only support linear polarization. The standard models operate across the full waveguide band from 8.2 to 325 GHz. The COTS models offer 6.5 dBi nominal gain and a half power beamwidth of 115 and 55 degrees at E-plane and H-plane, respectively. These antennas are often used for antenna gain measurements in many antenna ranges as reference horns.

Besides horn antennas with open apertures, horn antennas with lenses are developed in Eravant for various applications. Lens corrected antennas are offered with a waveguide interface (Fig. 8. SAL-7531143004-094-S1). Both circular and rectangular waveguide interfaces are offered. The lens corrected antennas exhibit typical return loss of 20 dB for each waveguide band, within the frequency range of 8.2 to 325 GHz. The typical sidelobe levels at E-plane and H-plane are around -17 dB and -25 dB, respectively. The dielectric lens not only provides phase error corrections but serves as a radome to protect from environmental conditions as well. Lens corrected antennas can achieve gain levels up to 36 dBi with moderate side lobe rejections. When a higher gain level is required, Gaussian optics antennas are a better choice.

Gaussian optics antennas are offered with a waveguide interface (Fig. 9. SAG-1441544002-059-S1). Both circular and rectangular waveguide interfaces are offered to support circular and linear polarization waveforms. The Gaussian optics antenna assembly is mainly composed of three parts, i.e., one scalar feed horn, one lens, and one mechanical supporting enclosure. The Gaussian optics antennas exhibit a typical return loss of 15 dB for each waveguide band, within the frequency range of 18 to 170 GHz. There are three standard lens diameters available, i.e., 3”, 6” and 12”. With proper selection of feed horn and lens diameters, the Gaussian optics antennas can realize gain as high as 48 dBi. The typical sidelobe levels at both E-plane and H-plane are

Figure 9 • SAG-1441544002-059-S1

Figure 10 • SAO-2734030810-KF-S1

Figure 11 • SAO-2734031845-KF-C1-BL

Figure 12 • SAE-2832930645180-28-S1

around -20 dB. The dielectric lens plays the role as in the lens corrected antenna design. Custom models with various lens diameters are available.

Omnidirectional antennas are offered with either a coaxial or a waveguide interface (Fig. 10. SAO-2734030810-KF-S1). Omnidirectional antennas support vertical polarization and provide a complete azimuth coverage of 360˚ with ±1 dB angular gain flatness. The COTS models with nominal gains from 0 to 10 dBi are available, which correspond to a vertical beamwidth from 45 to 10 degrees. The typical return loss is around 10 dB. Omnidirectional amplified antennas with integrated low-noise amplifiers provide boosted gain of 18 or 30 dBi, while keeping the vertical beamwidth unchanged (Fig. 11. SAO-2734031845-KF-C1-BL). These omnidirectional antennas cover full waveguide bands from 26.5 to 110 GHz. They are also constructed with precisely machined top and bottom housings and a protective radome to ensure a rugged mechanical configuration. Weather resistant models which can be used outdoors are available as well.

Sector antennas cover a part of azimuth angles, e.g., 180 or 120 degrees (Fig. 12. SAE-2832930645180-28-S1). Antenna port configurations with coaxial or waveguide interfaces are both available. It shares the same feature as omnidirectional antennas: wider vertical angles corresponding to higher gain. The typical return loss of a sector antennas is 15 dB. There are two Ka-band COTS models available. Other sector angles are available upon request.

Cassegrain antennas are offered with a waveguide interface (Fig. 13. SAY-3334035006-250-S1). The Cassegrain antenna assembly is mainly composed of three parts, i.e., one feed horn, one main reflector dish, and one sub-reflector. The Cassegrain antennas exhibit a typical return loss of 15 dB, within the frequency range of 33 to 100 GHz. The operating bandwidth of these antennas is mainly limited by the circular waveguide's dominant mode operation. Cassegrain antennas are offered with a 6”, 12”, 18”, 24”, 36” and 48” diameter main reflector dish. The supporting structures are designed to keep side lobe levels under 18 dB for narrow band operations and under 16 dB for broadband operation. Cassegrain antennas can realize gain as high as 51 dBi.

Figure 13 • SAY-3334035006-250-S1

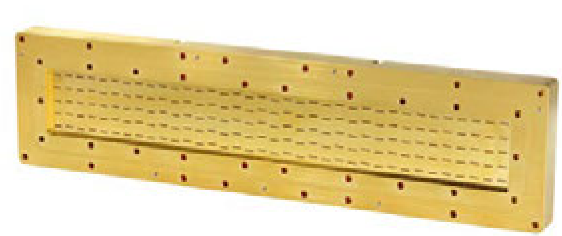

Figure 14 • SAW-3533532716-28-L2-WR

Figure 15 • SAV-4525031429-2F-U5

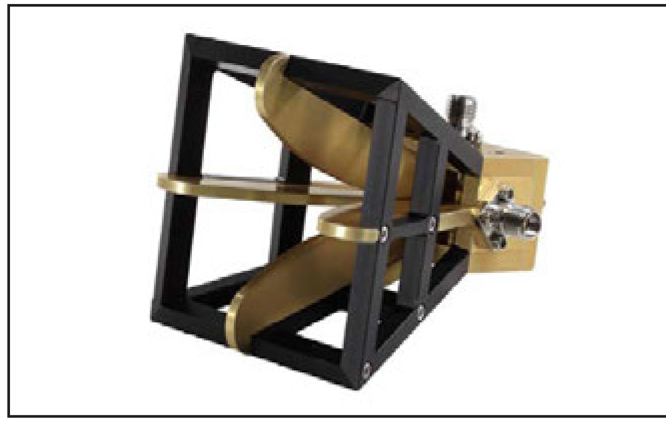

Figure 16 • SAV-0434031428-KF-U5-QR

Slotted waveguide array antennas have the advantage of high efficiency, high power handling, high gain, low mechanical profile, good mechanical strength and so on (Fig. 14. SAW-3533532716-28-L2-WR). Antenna port configurations with coaxial or waveguide interfaces are both available. There are two COTS models available, one is in X-band and the other is in Ka-band. Both slotted waveguide arrays show a return loss of 13 dB, gain of 27 dBi, and sidelobe levels of -15 dB. With carefully designed and manufactured radomes, both slotted waveguide arrays are weather resistant and can be used outdoors.

Double ridged horn antennas are offered with coaxial interfaces (Fig. 15. SAV-4525031429-2F-U5). They provide multiple octave bandwidth, which is much wider than standard gain horn antennas. They provide a typical return loss of 10 dB across multi-octave bandwidth within the frequency range of 1 to 110 GHz. They only support linear polarization. The COTS models provided by Eravant have nominal gains of 14 dBi, and typical half power beamwidth of 29 degrees at the center frequency of the band. The typical sidelobe levels at E-plane and H-plane are around -10 dB and -15 dB, respectively. The double ridged horns are widely used in antenna ranges for gain measurement.

The dual polarized antenna is widely used in the industry due to its versatile characteristics. It is well known that the dual polarized antenna can support linear, elliptical, and circular polarized waveforms. Eravant offers two standard dual polarized antenna families, namely, quad-ridge based and orthomode transducer (OMT) based. The quad-ridge based antennas are offered with coaxial interfaces, which cover multi-octave operating bandwidth (Fig. 16. SAV-0434031428-KF-U5-QR). Due to stringent machining and assembly boundaries, the operating frequency of quad-ridge horns are within the frequency range of 1 to 50 GHz. They provide a typical return loss of 10 dB across multi-octave bandwidth. The COTS models with nominal gains from 8 to 17 dBi are available, which correspond to an E-plane beamwidth from 68 to 19°. The typical sidelobe levels of the quad-ridge horns are around -10 dB and -15 dB at E-plane and H-plane, respectively. The port-to-port isolation is around 30 dB. OMT-based dual polarized horns are composed of one OMT, one feed horn and one waveguide transition (Fig. 17. SAF-2434231535-328-S1-280-

Figure 17 • SAF-2434231535-328-S1-280-DP

Figure 18 • SAM-2432432212-KF-L1

Fig. 19-A, The Front View (Radiation Element Side) of SAM-2832830695-DM-L1-64C

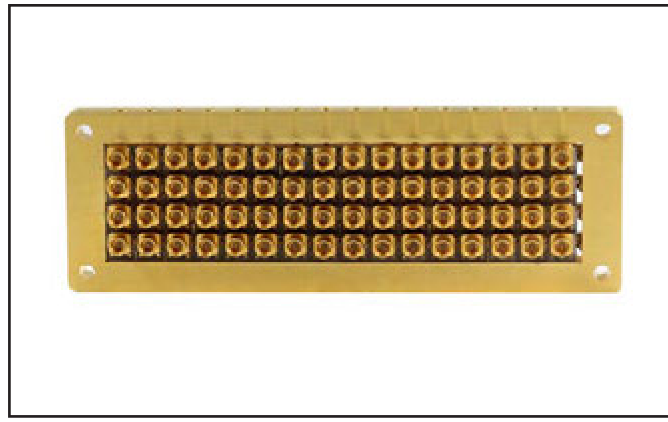

Fig. 19-B, The Back View (Connector Side) of SAM-2832830695-DM-L1-64C

DP). Scalar feed horns and choke flange horns are normally used in the assembly. Though limited to waveguide operating bandwidth, OMT-based dual polarized horns have lower sidelobe and cross-polarization levels, and higher port isolation, compared with quad-ridge horns. These assemblies inherit the antenna characteristics of the feed horns, while providing a port isolation of 35 dB and a sidelobe level of -25 dB.

Microstrip patch array antennas are offered with either a coaxial or a waveguide interface (Fig. 18. SAM-2432432212-KF-L1). These antennas are fabricated on millimeter wave substrates, which have advantages of light weight, planar configuration, ease of integration with millimeter wave systems, and so on. The COTS models with nominal gains from 15 to 25 dBi are available for X, Ku, K and Ka bands. They only support linear polarization. The patch array antennas show typical return loss of 10 dB. The typical sidelobe level rejection at both E-plane and H-plane are over 20 dB. Multiple-Input Multiple-Output (MIMO) antennas are another type of microstrip patch array antenna, with each element configured with one port individually (Fig. 19. SAM-2832830695-DM-L1-64C). The MIMO antennas have the capability of beamforming, which is widely used in 5G applications. The COTS models of MIMO antennas provided by Eravant have a theoretical beam-steering range of -90 degrees to 90 degrees. The antennas are within X, Ku, Ka and V bands. The typical return loss for each element port is around 8 dB. The scalable MIMO antennas with 32 and 64 elements have been developed by the company, as well.