Newsletter 4.5

October 2013

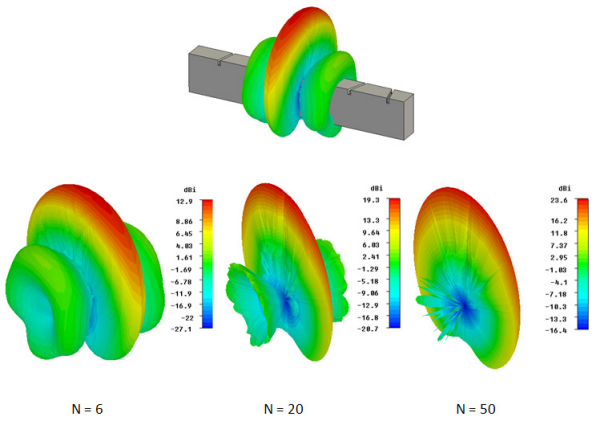
Antenna Magus version 4.5 released!

We are pleased to announce the release of Antenna Magus Version 4.5. This release sees the addition of 7 new antennas - increasing the total number of antenna templates shipped with Antenna Magus to 225. The new antennas are:

- Linear resonant narrow wall slotted guide array
- Linear array of rectangular patches (including a corporate feed network)
- Short dual-waveguide-fed pyramidal horn antenna
- Dual-ridged pyramidal horn antenna with sidewalls removed
- Dual-band self-phased quadrifilar helix antenna
- 4-arm Sinuous antenna with an absorber-loaded cavity-backing
- 2-arm log-periodic antenna with an absorber-loaded cavity-backing

New antennas in Version 4.5

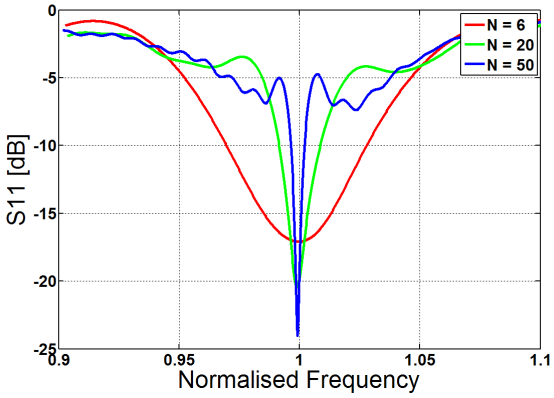
Linear resonant narrow wall slotted guide array



Fan-beam radiation patterns of linear resonant narrow wall slotted guide arrays with 6, 20 and 50 elements respectively.

The narrow-wall slot array is a popular microwave frequency antenna, which is especially useful for RADAR applications, where mechanical robustness, low-loss and the ability to withstand high power are advantageous. A single instance of the linear array produces a fan beam, while a pencil beam may be created by stacking a number of them to realise a planar array configuration.

The resonant slotted waveguide array is terminated by a short circuit, so as to produce a standing wave within the guide. The slots are placed so that (at the operating frequency) identical field maxima of the standing wave occur at the centres of each slot. The phase of the radiation of each slot is identical at the operating frequency, resulting in a broadside beam. In terms of both impedance and pattern quality, the performance is limited to a narrow band, as shown in the image below.

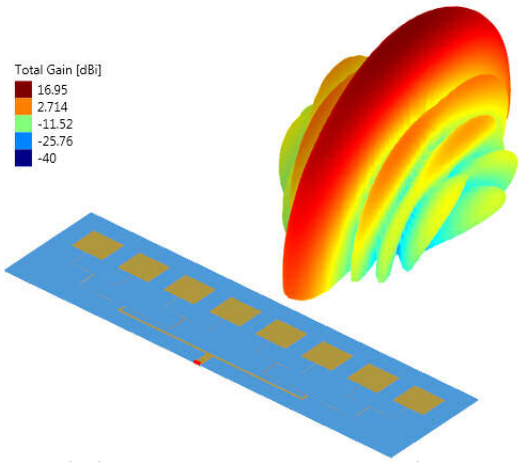


Reflection coefficient performance of narrow wall resonant slot array normalised to the operating frequency, for 6, 20 and 50 slots

Linear array of rectangular patches

The N-by-1 patch array combines the design of the individual patch elements in the array, with the design of a corporate feed network realised in microstrip. A unique feature of this antenna is that the number of patches can be chosen as 2, 4, 8, 16, 32 or 64, allowing the user to design for gains ranging from 8 to 20 dBi. The design includes a practical corporate feed network, implemented using realistic microstrip line dimensions.

The two dimensional nature of planar arrays results in versatile structures, which are able to provide specified radiation patterns with low side lobes. Applications include, amongst others, tracking and search radars, altimeters, remote sensing, terrestrial and aerospace communication systems.



The radiation pattern of an 8 element linear patch array with a corporate feed network

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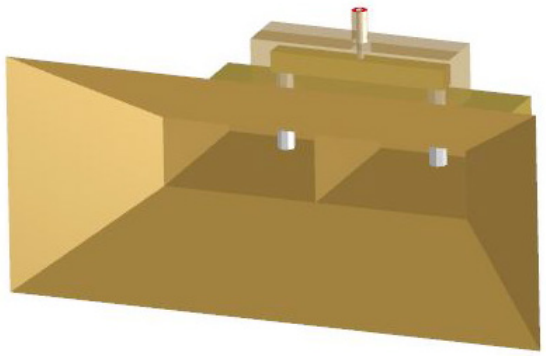
Short dual-waveguide-fed pyramidal horn antenna

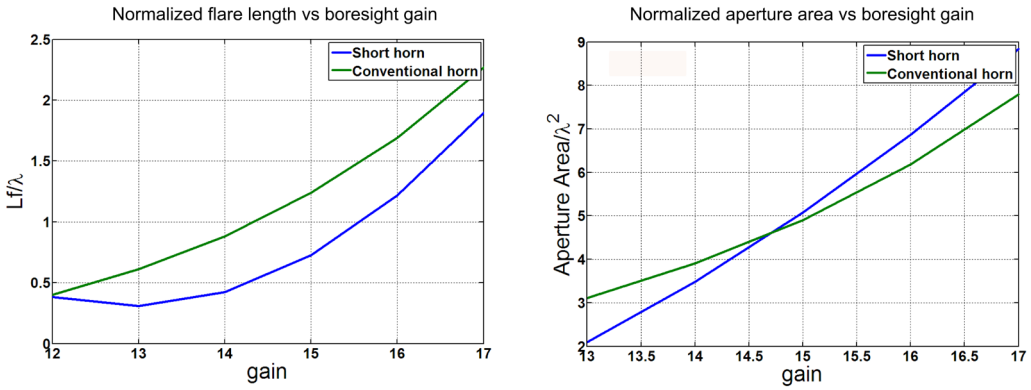
The Short dual-waveguide-fed pyramidal horn antenna is a modification of the conventional pyramidal horn. The modification includes a dual waveguide feed, which in turn is fed with a single coaxial feed and divider.

The dual waveguide feed improves the aperture efficiency of the pyramidal horn, resulting in a shorter flare length, when compared to a conventional pyramidal horn with the same boresight gain.

The input impedance of the dual-waveguide horn is designed for a 50 Ohm system, but may be optimized for other impedance systems by varying the divider dimensions and position, as well as the length of the feed pins in the waveguides. The gain can vary from 12dBi to 17dBi, but the aperture efficiency drops quickly as the gain increases. This antenna is typically used as an array element or as a reflector feed.



The structure of the short dual-waveguide fed horn antenna



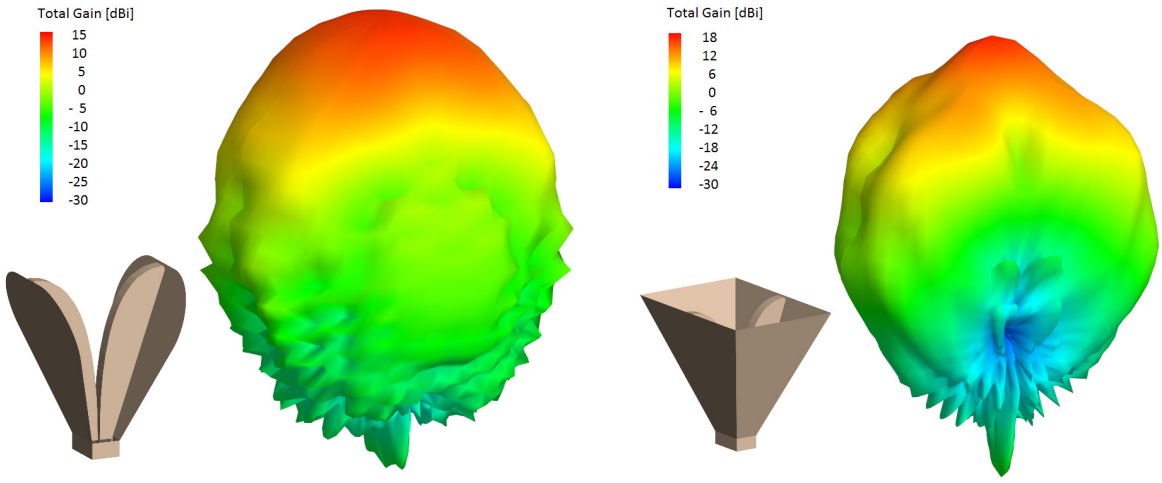
Comparison of the flare-length and aperture area of a conventional pyramidal horn and a dual-waveguide-fed horn, showing the shortened axial length required to achieve the same gain and aperture area for the dual-waveguide-fed horn.

Dual-ridged pyramidal horn antenna (no sidewalls)

Horn antennas cover a wide variety of applications, many of which require UWB operation. A common technique used to achieve UWB performance in horn antennas, involves the inclusion of a tapered ridge in the flare, which serves as an impedance transition between the waveguide feed and free space.

This antenna is a variation of the traditional Dual Ridged Pyramidal horn, which is currently available in Antenna Magus. The side walls of the horn have been removed, whilst the extreme tips of the antenna flare have been chamfered.

These modifications reduce the pattern degradation (beam splitting) seen at the higher frequencies with the traditional Dual Ridged Pyramidal horn. An increased pattern bandwidth of 11:1 is achieved before the beam splitting starts to occur. This is illustrated in the image below where the radiation patterns of both horns designed for an 11:1 bandwidth are shown at the highest frequency in the band. The degradation of the pattern of the horn with sidewalls is clear when compared to the horn without side walls.



A comparison of the radiation patterns of dual-ridged horn with and without side walls, showing the reduction in beam splitting at the higher frequencies for the design without side walls.

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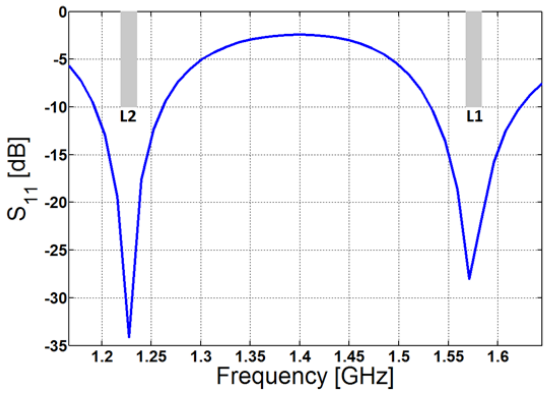
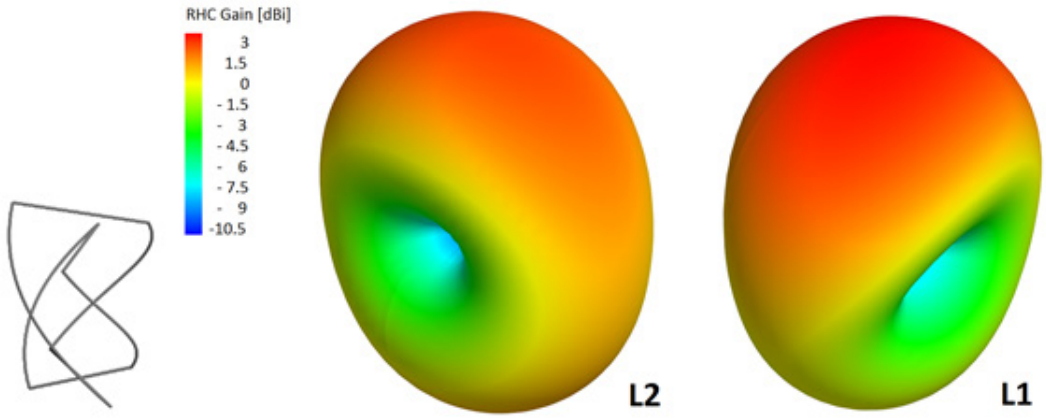
Dual-band self-phased quadrifilar helix antenna

By manipulating the dual resonant characteristics of the self-phased quadrifilar helix (S-P QHA) currently available in Antenna Magus, dual band, circularly polarized performance can be achieved. The Self-phased dual-band QHA, is designed for dual band applications by modifying the two bifilar loops of the antenna to obtain operating frequency ratios from 1.1 to 1.7. Dramatic pattern degradation is observed, when the ratio becomes greater than 1.7:1.

This antenna can be used for applications such as GPS (L1 at 1575.42 MHz and L2 at 1227.60 MHz), as shown on the right. The resonant frequencies are mainly controlled by the size of each of the bifilar loops. Interaction between the two bifilar loops must be taken into account for small frequency ratios where the loops become similarly sized.



Reflection coefficient of a dual-band QHA designed for GPS, showing the operation in the L1 and L2 bands.

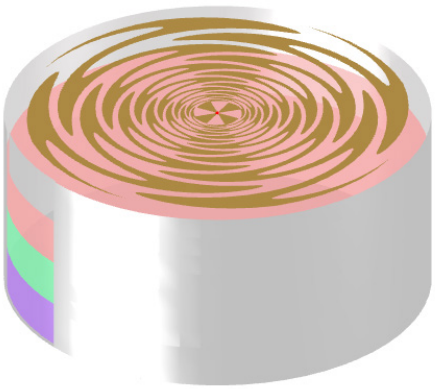


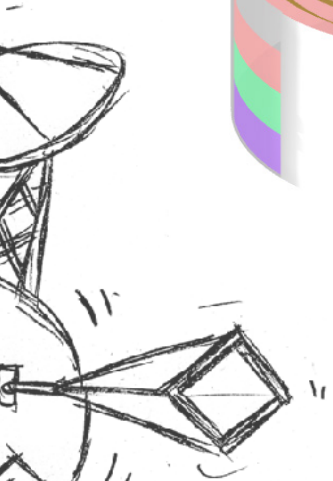
Radiation patterns of a dual-band self-phased quadrifilar helix antenna designed for GPS, at the L1 and L2 bands.

Cavity-backed Sinuous and Log-spiral antennas

Cavity backed spiral antennas can provide unidirectional, broadband, polarisation agile radiation patterns when the cavity backings are loaded with absorber layers.

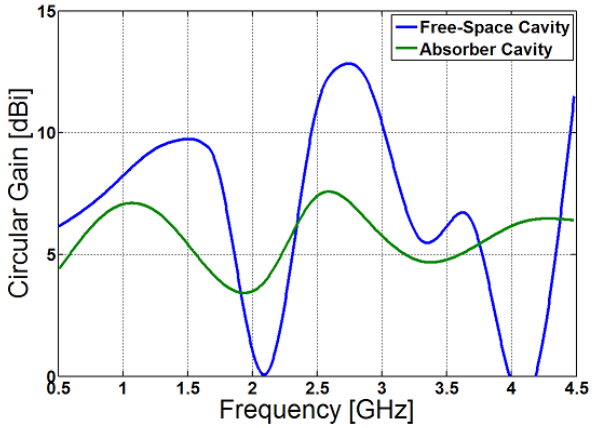
The basic radiating structures of the Log-Periodic and Sinuous antennas produce a bi-directional pattern along the axis of symmetry. Unidirectional radiation is obtained by positioning the antenna over a planar reflector placed one quarter-wavelength away at the centre frequency. Though this approach increases the broadside gain at the centre frequency by 3dBi, it is only feasible for narrow bandwidth applications as the gain varies very quickly away from the centre frequency.





By rather introducing a cavity backing that is filled with layered absorbers, multi-octave performance bandwidths, with relatively stable gain over the band can be achieved.

For both of these absorber-filled cavity-backed antennas, the physical structure usually consists of the radiating element etched on top of PCB, with the cylindrical cavity placed below the antenna. The absorbing material - usually a honey comb sub-structure, coated with lossy material - is placed inside the cavity. If required, an additional feed network is incorporated inside the cavity below the absorbing layers.



The boresight, circularly polarised gain vs frequency of a Sinuous antenna designed for 3:1 bandwidth from 1 - 3 GHz in free-space (a) placed above a free-space reflective cavity (b) above an absorbing cavity.

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