



## Movement of Wave Antennas through Analytical Modelling

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### DESCRIPTION

Semantically, “travelling wave antennas” denote a class of antennas where the current distribution on the antenna length/surface/volume is of travelling wave type. Unlike conventional resonant antennas where a spatial variation of field magnitude is created at the frequency of resonance, the travelling wave antennas exhibit a spatial distribution of phase of the internal fields instead of the magnitude. Field magnitude remains essentially constant along such antenna leading to an inherent wideband nature while the phase variation gives rise to beam steering with frequency. The internal electric and magnetic fields are in these cases mostly of a slow wave nature bound in the structure to a Quasi TEM mode of propagation. All slow wave structures being essentially non-radiating in nature, they require open or semi open structures with considerable introduction of discontinuities for substantial radiation to occur. Higher order modes generated near such discontinuities tend to become “fast” locally and eventually contribute to the total radiation from such structures. Typical examples of these kind of slow wave based travelling wave antennas are long wire antenna, rhombic antenna, bend based microstrip line antennas.

As is evident from the radiation mechanism itself, these travelling wave antennas tend to exhibit very interesting properties. In most cases, the antenna is excited from one end and the other end is terminated in matched impedance. This gives rise to wide impedance bandwidth as well as minimized load reflections resulting in reduced side lobe levels. This is a very interesting feature in designing receiving systems with lower interference. The most remarkable feature of a travelling wave antenna is its beam scanning with frequency. This feature along with controllable scan rate and narrow beam width (using a longer antenna length) is very suitable for use in radar and microwave imaging applications. Some of these travelling wave arrays can very easily be designed to obtain circular polarization

without incorporation of complicated feed networks or tedious geometry modifications. Leaky wave antennas are a special group of antennas inside the travelling wave antenna family that have some distinctive features forcing them to be recognized independently.

Based mostly on microstrip, semi-open waveguide and hybrid-waveguide technologies, these antennas are of the fast wave nature. The internal electric and magnetic fields are loosely bound to the structure through a higher order mode with a leaky region just above the cut off frequency of the concerned mode. The fast wave nature of the structure allows power to radiate all along the length of the structure without necessitating the introduction of discontinuities. In microstrip configuration, there are two different sub classes of the leaky wave antenna, namely the uniform leaky wave antenna and the periodic leaky wave antenna. In case of the periodic leaky wave antenna on the other hand, a propagating mode bound to the structure is perturbed using periodic loads. Dictated by the Floquet theorem, a bunch of spatial harmonics are generated some of which enter the leaky fast wave region and tend to radiate substantially.

### CONCLUSION

Among all the configurations of both travelling wave and leaky wave antennas the ones based on microstrip technology have become the most popular one owing to their ease of fabrication, conformal nature and simplicity in design and analysis. Analysis techniques based on transmission line model and circuit based techniques have been popular for Quasi TEM mode based travelling wave antennas. On the other hand leaky fast wave antennas were initially analyzed using a hybrid transmission line-cavity model by Menzel but later on steepest descent techniques and rigorous full wave techniques were preferred for complete description of the complex nature of the leaky wave fields.

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