A Multi-Function Millimeter-Wave Phased Array for Small Satellites

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There is a growing emphasis on the use of small satellites (for instance CubeSats) in Low Earth Orbit (LEO) to accomplish a wide variety of communication and sensing tasks. However unlike their larger counterparts, small-sat platforms do not have sufficient physical space to house a large number of antenna systems, dictating the need for a spectrally agile, multi-function aperture. This can be accomplished through the use of low-profile and electronically scanned, ultra-wideband arrays. One such class of arrays is the Tightly Coupled Dipole Array (TCDA), which has previously been demonstrated to achieve up to 8:1 bandwidth and >60° scanning, with a height above the groundplane of only $1/16\,\lambda_{low}$ (wavelength at the lowest frequency of operation). These arrays have historically been limited to operation below the Ku-band (18 GHz), due to fabrication limitations encountered in the feed network.

However, the recent resurgence in popularity for large LEO constellations in industry leans heavily on access to the millimeter-wave spectrum, to achieve high capacity backhaul and fine resolution sensing. To achieve access to these frequencies, we demonstrate a novel TCDA feed and element design, optimized for simple fabrication. With this development, we present an ultra-wideband, millimeter-wave phased array, well suited to the needs of small satellite platforms. Operating from 24 GHz–86 GHz, this array provides access to an unprecedented 62 GHz swath of spectrum. Frequencies of interest within this band include Ka-band communications with existing Near Earth Network infrastructure, Q-band Earth observations, the ISM 60 GHz band (V-band), as well as ITU satellite allocations at 76 GHz and 86 GHz (W-band). We will show the array can be easily extended to dual polarizations, and is capable of wide angle scanning in all planes. The full array can be fabricated in a single step, using very low cost techniques, on low loss laminates.