Deployable Fresnel Rings

This antenna technology can be used by first-responders and soldiers requiring cellular range extension or satellite links to handheld devices.

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Deployable Fresnel rings (DFRs) significantly enhance the realizable gain of an antenna. This innovation is intended to be used in combination with another antenna element, as the DFR itself acts as a focusing or microwave lens element for a primary antenna. This method is completely passive, and is also completely wireless in that it requires neither a cable, nor a connector from the antenna port of the primary antenna to the DFR.

The technology improves upon the previous NASA technology called a Tri-Sector Deployable Array Antenna in at least three critical aspects. In contrast to the previous technology, this innovation requires no connector, cable, or other physical interface to the primary communication radio or sensor device. The achievable improvement in terms of antenna gain is significantly higher than has been achieved with the previous technology. Also, where previous embodiments of the Tri-Sector antenna have been constructed with combinations of conventional (e.g., printed circuit board) and conductive fabric materials, this innovation is realized using only conductive and non-conductive fabric (i.e., "e-textile") materials, with the possible exception of a spring-like deployment ring.

Conceptually, a DFR operates by canceling the out-of-phase radiation at a plane by insertion of a conducting ring or rings of a specific size and distance from the source antenna, defined by Fresnel zones. Design of DFRs follow similar procedures to those outlined for conventional Fresnel zone rings.

Gain enhancement using a single ring is verified experimentally and through computational simulation. The experimental test setup involves a microstrip patch antenna that is directly behind a single-ring DFR and is radiating towards a second microstrip patch antenna. The first patch antenna and DFR are shown in Figure 1. At 2.42 GHz, the DFR improves the transmit antenna gain by 8.6 dB, as shown in Figure 2, relative to the wireless link without the DFR. Figure 2 illustrates the relative strength of power

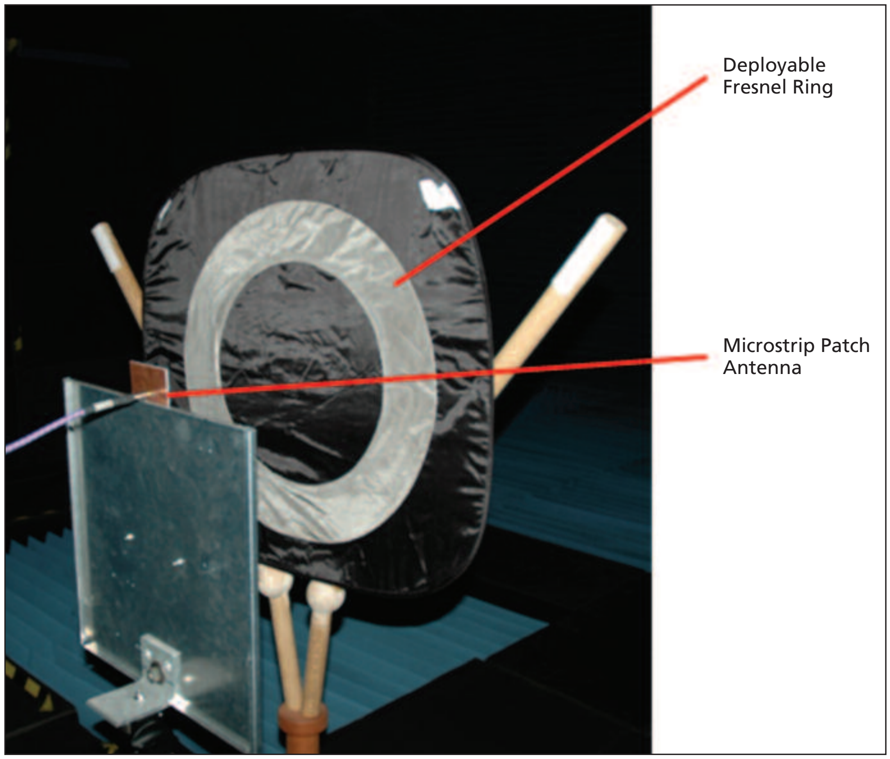

Figure 1. **Microstrip Patch Antenna + DFR** used in the experimental setup for testing transmitted power enhancement using the DFR.

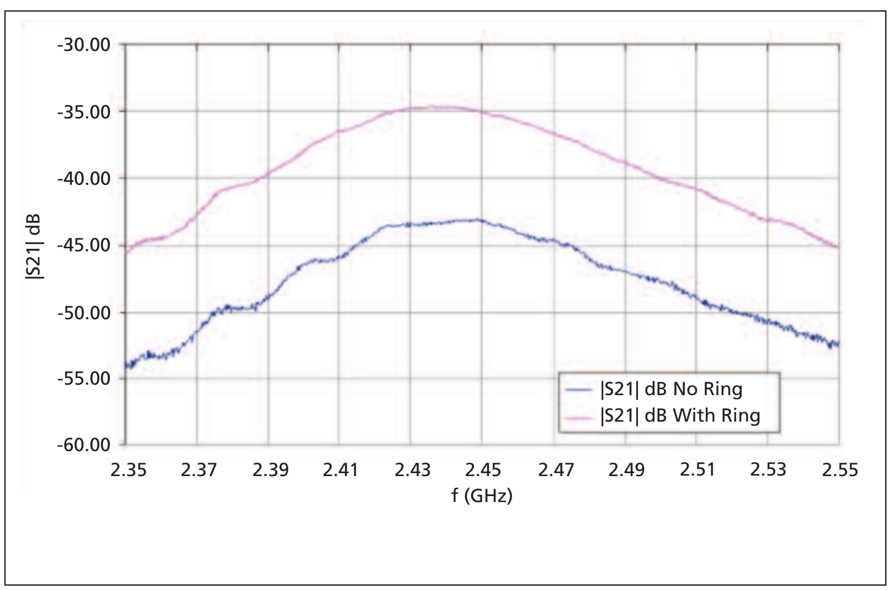

Figure 2. **Relative Power** received using the DFR and without the DFR.

coupling between the first and second microstrip antennas with and without the DFR. Typically, a DFR is designed for use at a particular frequency; however, testing of a DFR indicated a relatively wide operational bandwidth of approximately 8.2%. Wider bandwidth operation and multi-band operation are anticipated by extending the known art of conventional Fresnel rings to the DFRs.

Increasing the number of rings used to construct a DFR antenna increases the gain, with the upper bound limited often by the largest practical dimensions that can be tolerated for a given application. The maximum theoretical improvement in gain for a single ring is 9.5 dB. Experimental results are within 0.9 dB of this theoretical value. Adding rings increases gain, and theoretically, improvements of 10 to 13 dB above that of the primary antenna gain can be achieved with two- and three-ring versions.

This work was done by Timothy F. Kennedy, Patrick W. Fink, Andrew W. Chu, and Gregory Y. Lin of Johnson Space Center. Further information is contained in a TSP (see page 1).

This invention has been patented by NASA U.S. Patent No. 8,384,614. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-1003. Refer to MSC-24525-1.

Transition-Edge Hot-Electron Microbolometers for Millimeter and Submillimeter Astrophysics

New instruments promise to expand the investigation of cosmic microwave background radiation and its polarization to get better insight into the evolution of the universe.

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The millimeter and the submillimeter wavelengths of the electromagnetic spectrum hold a wealth of information about the evolution of the universe. In particular, cosmic microwave background (CMB) radiation and its polarization carry the oldest information in the universe, and provide the best test of the inflationary paradigm available to astronomy today. Detecting gravity waves through their imprint on the CMB polarization would have extraordinary repercussions for cosmology and physics.

A transition-edge hot-electron microbolometer (THM) consists of a superconducting bilayer transition-edge sensor (TES) with a thin-film absorber. Unlike traditional monolithic bolometers that make use of micromachined structures, the THM employs the decoupling between electrons and phonons at millikelvin temperatures to provide thermal isolation. The devices are fabricated photolithographically and are easily integrated with antennas via microstrip transmission lines, and with SQUID (superconducting quantum interference device) readouts. The small volume of the absorber and TES produces a short thermal time constant that facilitates rapid sky scanning.

The THM consists of a thin-film metal absorber overlapping a superconducting TES. The absorber forms the termination of a superconducting microstripline that carries RF power from an antenna. The purpose of forming a separate absorber and TES is to allow flexibility in the optimization of the two components. In particular, the absorbing film's impedance can be chosen to match the antenna, while the TES impedance can be chosen to match to the readout SQUID amplifier. This scheme combines the advantages of the TES with the advantages of planar millimeter-wave transmission line circuits.

Antenna-coupling to the detectors via planar transmission lines allows the detector dimensions to be much smaller than a wavelength, so the technique can be extended across the entire microwave, millimeter, and submillimeter wavelength ranges. The circuits are fabricated using standard microlithographic techniques and are compatible with uniform, large array formats. Unlike traditional monolithic bolometers that make use of micromachined structures, the THM employs the decoupling between electrons and phonons at millikelvin temperatures to provide thermal isolation. There is no fragile membrane in the structure for thermal isolation, which improves the fabrication yield.

This work was done by Wen-Ting Hsieh, Thomas Stevenson, Kongpop U-yen, and Edward Wollack of Goddard Space Flight Center; and Emily Barrentine of the University of Wisconsin at Madison. Further information is contained in a TSP (see page 1). GSC-16656-1