Manufacturing & Prototyping

Single-Layer, All-Metal Patch Antenna Element With Wide Bandwidth

This design is suitable for military and commercial environments with high ESD susceptibility.

NASA's Jet Propulsion Laboratory, Pasadena, California

It is known that the impedance at the center of a patch antenna element is a short circuit, implying that a wire or post can be connected from the patch to the groundplane at this point without impacting radiation performance. In principle, this central post can be used to support the patch element, thus eliminating the need for dielectric. In spaceborne applications, this approach is problematic because a patch element supported by a single, thin post is highly susceptible to acoustic loads during launch.

The technology reported here uses a large-diameter center post as its supporting structure. The supporting structure allows for the fabrication of a sufficiently rigid antenna element that can survive launch loads. The post may be either hollow or solid, depending on fabrication approach and/or mass constraints. The patch antenna element and support post are envisioned as being fabricated (milled) from a single piece of aluminum or other metal. Alternately, the patch plate and support column can be fabricated separately and then joined using fasteners, adhesive, or welding. Casting and electroforming are also viable techniques for manufacturing the metal patch part(s). The patch structure is then either bonded or fastened to the supporting groundplane. Arrays of patch elements can be fabricated by attaching several structures to a common groundplane/support structure.

Patch antennas can be fed in a number of different ways; the current design is envisioned as being fed from a coaxial probe, the connector of which is attached to the backside of a supporting groundplane. The probe can be either soldered to the patch or attached by means of a slip-fit connector assembly in the patch. The latter approach provides stress relief for the probe attachment during launch. The thickness of the patch material, interconnect technique, and attachment technique will depend on individual mass and launch load requirements. Alternatively, techniques such as aperture coupling or proximity coupling could be used to feed the patch.

The all-metal design eliminates the use of dielectric in patch substrate, making it suitable to environments with high electrostatic discharge (ESD) susceptibility. Elimination of dielectric also makes the tuning of the element largely independent of material properties (principally permittivity) and eliminates dielectric losses, which become appreciable at high frequencies. This simplifies the design and modeling of the antenna element. Concurrence between measurements and modeling is thus driven by the fidelity of the modeling software and fabrication tolerances (as opposed to material properties). Additionally, the large central support column has been shown to increase the bandwidth of the element to 20% without significantly affecting the radiation pattern performance. Typically, a stacked patch design is used to obtain an impedance bandwidth of 20% or more. While the new technology was conceived for the purpose of eliminating dielectric from the patch-radiating element, a large-diameter ground post could be added to dielectric-based patch designs to increase bandwidth without having to add extra radiating layers. The new design has good cross-polarization suppression (better than 50 dB) because of the symmetry of the design.

This work was done by Neil F. Chamberlain, Richard E. Hodges, and Mark S. Zawadzki of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office–JPL. Refer to NPO-46843.

Scanning Laser Infrared Molecular Spectrometer (SLIMS)

This instrument can be used in any application requiring chemical sensing.

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This prototype innovation is a novel design that achieves very long, effective laser path lengths that are able to yield ppb (parts per billion) and sub-ppb measurements of trace gases. SLIMS can also accommodate multiple laser channels covering a wide range of wavelengths, resulting in detection of more chemicals of interest. The mechanical design of the mirror cell allows for the large effective path length within a small footprint. The same design provides a robust structure that lends itself to being immune to some of the alignment challenges that similar cells face.

By taking a hollow cylinder and by cutting an elliptically or spherically curved surface into its inner wall, the basic geometry of a reflecting ring is created. If the curved, inner surface is diamond-turned and highly polished, a surface that is very highly reflective can be formed. The surface finish can be further improved by adding a thin chrome or gold film over the surface. This creates a high-quality, curved, mirrored sur-