

toward a three-state Faraday rotator. The components of the Faraday rotator would be a ferrite disk, a solenoidal electromagnet coil for applying magnetic bias, and two impedance-matching plates — one on each side of the ferrite disk. The output port would be positioned on the side opposite the input side of the Faraday rotator and would be oriented to support polarization at an angle of 45° relative to both of the input polarizations.

The operating state would be selected by adjusting the magnetic bias to select one of three states of the Faraday rotator. In one state, the magnetic bias would be set to cause the polarization of a propagating signal to rotate through an angle of +45° so as to allow one of the

input signals to propagate to the output port. In another state, the direction of the magnetic bias would be set at the reverse of that of the first-mentioned state to obtain a polarization rotation of 45°, thereby allowing the other input signal to propagate to the output port.

The third state would be used for combining the powers of two mutually coherent input signals that, in an ideal case, would be of equal magnitude and would differ in phase by 90°. In this state, the magnetic bias (and thus, the Faraday rotation) would be set to zero and the superposition of the input signals would result in a 45°-polarized sum signal that would propagate to the output port. In practice, because of magnetic hysteresis, this state could not be obtained by simply abruptly

turning off the current in the electromagnet: It would be necessary to apply a damped sinusoidal excitation to the electromagnet coil to effect degaussing.

This work was done by Raul Perez of Caltech for NASA's Jet Propulsion Laboratory.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-44316, volume and number of this NASA Tech Briefs issue, and the page number.

Compact Low-Loss Planar Magic-T

These wireless communications components are useful for base-station receivers, consumer electronics, and industrial microwave instrumentation.

Goddard Space Flight Center, Greenbelt, Maryland

This design allows broadband power combining with high isolation between the H port and E port, and achieves a lower insertion loss than any other broadband planar magic-T. Passive microwave/millimeter-wave signal power is combined both in-phase and out-of-phase at the ports, with the phase error being less than $\pm 1^\circ$, which is limited by port impedance.

The in-phase signal combiner consists of two quarter-wavelength-long transmission lines combined at the microstrip line junction. The out-of-phase signal combiner consists of two half-wavelength-long transmission lines combined in series. Structural symmetry creates a virtual

ground plane at the combining junction, and the combined signal is converted from microstrip line to slotline. Optimum realizable characteristic impedances are used so that the magic-T provides broadband response with low return loss.

The magic-T is used in microwave and millimeter-wave frequencies, with the operating bandwidth being approximately 100 percent. The minimum isolation obtainable is 32 dB from port E to port H. The magic-T VSWR is less than 1.1 in the operating band. Operating temperature is mainly dependent on the variation in the dielectric constant of the substrate. Using crystallized substrate, the invention can operate in an ex-

tremely broad range of temperatures (from 0 to 400 K). It has a very high reliability because it has no moving parts and requires no maintenance, though it is desirable that the magic-T operate in a low-humidity environment. Fabrication of this design is very simple, using only two metallized layers. No bond wires, via holes, or air bridges are required. Additionally, this magic-T can operate as an individual component without auxiliary components.

This work was done by Kongpop U-yen, Edward J. Wollack, Terence Doiron, and Samuel H. Moseley of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15353-1

Using Pipelined XNOR Logic to Reduce SEU Risks in State Machines

Risk is reduced by use of fast state-machine and error-detection logic.

NASA's Jet Propulsion Laboratory, Pasadena, California

Single-event upsets (SEUs) pose great threats to avionic systems' state machine control logic, which are frequently used to control sequence of events and to qualify protocols. The risks of SEUs manifest in two ways: (a) the state machine's state information is changed, causing the state

machine to unexpectedly transition to another state; (b) due to the asynchronous nature of SEU, the state machine's state registers become metastable, consequently causing any combinational logic associated with the metastable registers to malfunction temporarily. Effect (a) can

be mitigated with methods such as triple-modular redundancy (TMR). However, effect (b) cannot be eliminated and can degrade the effectiveness of any mitigation method of effect (a).

Although there is no way to completely eliminate the risk of SEU-in-