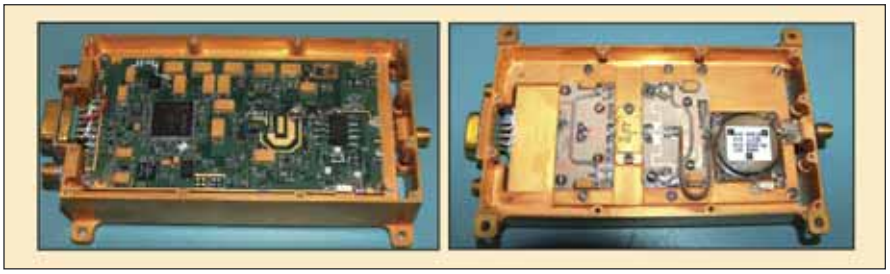
L-Band Transmit/Receive Module for Phase-Stable Array Antennas

A self-calibrating interferometric synthetic aperture radar instrument uses an electronically steerable radar antenna to achieve greater accuracy.

NASA's Jet Propulsion Laboratory, Pasadena, California

Interferometric synthetic aperture radar (InSAR) has been shown to provide very sensitive measurements of surface deformation and displacement on the order of 1 cm. Future systematic measurements of surface deformation will require this capability over very large areas (300 km) from space. To achieve these required accuracies, these spaceborne sensors must exhibit low temporal decorrelation and be temporally stable systems. An L-band (24-cm-wavelength) InSAR instrument using an electronically steerable radar antenna is suited to meet these needs. In order to achieve the 1-cm displacement accuracy, the phased array antenna requires phase-stable transmit/receive (T/R) modules. The T/R module operates at L-band (1.24 GHz) and has less than 1-deg absolute phase stability and less than 0.1-dB absolute amplitude stability over temperature. The T/R module is also high power (30 W) and power efficient (60-percent overall efficiency). The design is currently implemented using discrete components and surface mount technology.



The photo shows the **T/R Module** on the front side and the **30-W Power Amp** on the reverse side.

The basic T/R module architecture is augmented with a calibration loop to compensate for temperature variations, component variations, and path loss variations as a function of beam settings. The calibration circuit consists of an amplitude and phase detector, and other control circuitry, to compare the measured gain and phase to a reference signal and uses this signal to control a precision analog phase shifter and analog attenuator. An architecture was developed to allow for the module to be bidirectional, to operate in both transmit and receive mode. The architecture also includes a power detector used to maintain a transmitter power output constant within 0.1 dB.

The use of a simple, stable, low-cost, and high-accuracy gain and phase detector made by Analog Devices (AD8302), combined with a very-high-efficiency T/R module, is novel. While a self-calibrating T/R module capability has been sought for years, a practical and cost-effective solution has never been demonstrated. By adding the calibration loop to an existing high-efficiency T/R module, there is a demonstrated order-of-magnitude improvement in the amplitude and phase stability.

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Microwave Power Combiner/Switch Utilizing a Faraday Rotator

Either or both of two input ports could be coupled to one output port.

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A proposed device for combining or switching electromagnetic beams would have three ports, would not contain any moving parts, and would be switchable among three operating states:

- Two of the ports would be for input; the remaining port would be for output.
- In one operating state, the signals at both input ports would be coupled through to the output port.
- In each of the other two operating states, the signal at only one input port would be coupled to the output port. The input port would be selected through choice of the operating state.

In one potential application, the device would be used to switch or combine microwave signals in a quasi-optical transmission-line assembly that would be part of a millimeter-wave radar or telecommunication system. In another potential application, a modified version of the device would be used to switch or combine light signals in a fiber-optic telecommunication link.

The two input ports would be configured to accommodate signals having mutually orthogonal linear polarizations. A polarizer would be positioned to bisect the right angle formed by the longitudinal axes of the input ports, and its polarization would be oriented to so that it would allow one input signal to pass through and would reflect the other input signal. The orientations of the aforementioned components would be such that after impinging on the polarizer, both input signals would propagate