guide bridges at the junction; the inductive behavior of the bridges, in addition to CPW parasitic resonances, degrades the passband performance of the balun.

The new double-Y balun transitions from a microstrip line with truncated ground plane to a CPS line. The balun does not employ CPW lines; hence, CPW bridges are not required at the junction. In addition, the balun does not exhibit CPW parasitic resonances, thereby improving passband performance.

Figure 1 illustrates the new version of the double-Y balun designed to feed a complementary spiral antenna. Panels on the right illustrate an expanded view of the balun junction. Preliminary voltage standing-wave ratio (VSWR) and insertion loss data are illustrated in Figure 2. Measured data were compared with numerical results computed using Momentum. It is seen that the balun exhibits a VSWR of less than 1.5 from 400 MHz to 8 GHz and a VSWR of less than 1.8 up to 13 GHz. The

VSWR can be reduced further by reducing reflections from the balun junction and load resistor. Also, the balun is seen to exhibit an insertion loss of less than 1.5 dB up to 12 GHz. Further work involves characterizing the balun's performance when feeding a complementary spiral antenna.

A Topographical Lidar System for Terrain-Relative Navigation
Demand for memory is reduced by digitizing over a limited altitude range.

NASA's Jet Propulsion Laboratory, Pasadena, California

An imaging lidar system is being developed for use in navigation, relative to the local terrain. This technology will potentially be used for future spacecraft landing on the Moon. Systems like this one could also be used on Earth for diverse purposes, including mapping terrain, navigating aircraft with respect to terrain and military applications. The system has been field-tested aboard a helicopter in the Mojave Desert.

The use of imaging lidar systems to generate digital data sets equivalent to topographical maps is well established. Such systems are commercially available and often denoted simply as topographical or topographic lidar systems. As in other imaging lidar systems, a gimballed, actuated mirror is used to raster-scan a narrow laser beam across a field of view, the laser beam is emitted in short laser pulses, the pulses are reflected from the terrain, and the distance to the terrain in a given direction is determined from the total time of flight from the emission of the outgoing pulse to the receipt of the

reflected pulse. Then the combination of direction (azimuth and elevation angles associated with the mirror orientation) and the range (distance) for each such direction constitute raw data that can be used to generate a topographical map of the terrain.

When this system was designed, digitizers with sufficient sampling rate (2 GHz) were only available with very limited memory. Also, it was desirable to limit the amount of data to be transferred between the digitizer and the mass storage between individual frames. One of the novelty design features of this system was to design the system around the limited amount of memory of the digitizer. The system is required to operate over an altitude (distance) range from a few meters to ≈1 km, but for each scan across the full field of view, the digitizer memory is only able to hold data for an altitude range no more than 100 m. Therefore, the acquisition of data is limited to an altitude range 100 m wide in the following way: Initially a pulse is emitted and digitized over an altitude

range of 5 km. This process is repeated four more times, and the median time of the first return pulse of all five measurements is computed as the distance from which to expect future laser pulse to be reflected. A distance of 50 m is subtracted from the expected distance and the resulting distance is fed as a programming input to a programmable-delay pulse generator, which is triggered by the outgoing laser pulse and which, in turn, turns on the digitizer after the programmed delay. Thus, the digitizer is started at 50 m before the expected receipt of the return pulse. The digitizer then operates over an altitude interval of 100 m; it is stopped at 50 m after the expected return of the receipt of the return pulse.

Programmable Low-Voltage Circuit Breaker and Tester
This system could also detect some faults before turning on power.

John F. Kennedy Space Center, Florida

An instrumentation system that would comprise a remotely controllable and programmable low-voltage circuit breaker plus several electric-circuit-testing subsystems has been conceived, originally for use aboard a spacecraft during all phases of operation from pre-launch testing through launch, ascent, orbit, de-

scent, and landing. The system could also be adapted to similar use aboard aircraft. In comparison with remotely controllable circuit breakers heretofore commercially available, this system would be smaller, less massive, and capable of performing more functions, as needed for aerospace applications.

The circuit breaker in this system could be set open or closed and could be monitored, all remotely. Trip current could be set at a specified value or could be made to follow a trip curve (a specified trip current as a function of time). In a typical application, there might be a requirement to set a lower trip current