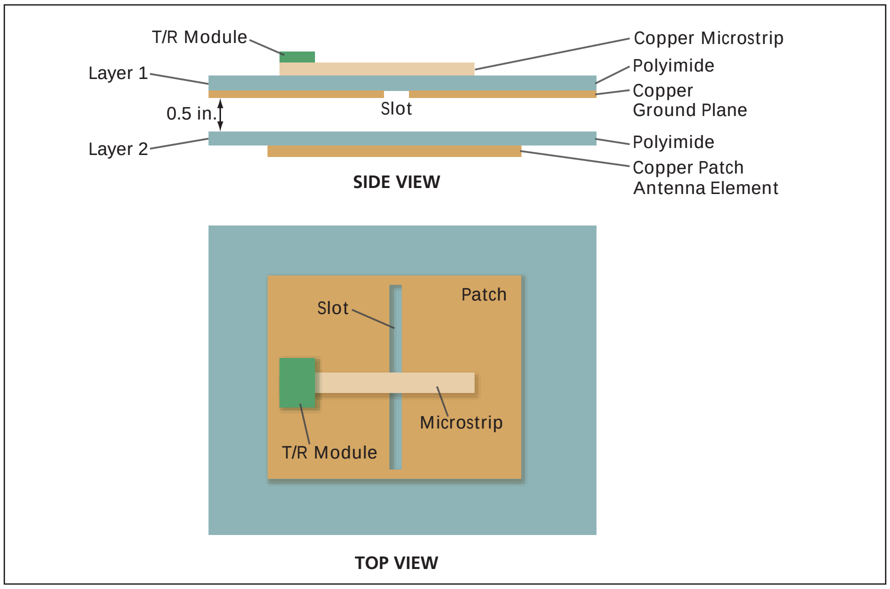

Figure 1. A **Unit Cell** of a phased-array antenna contains active and passive circuitry supported on two polyimide membrane layers.

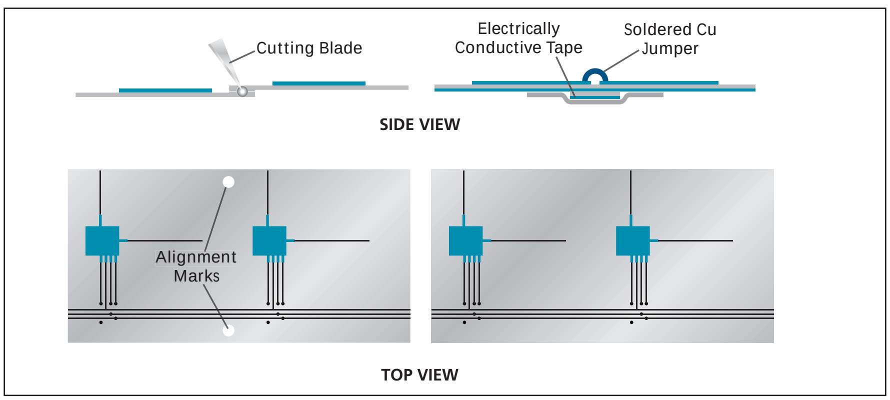

Figure 2. **Aligned Adjacent Panels** containing small (in this case, 1×2) membrane phased arrays are cut, then seamed together at the common cut line.

and is RF-coupled to the patch element via a slot. The T/R module is a hybrid multilayer module assembled and packaged independently and attached to the membrane array. At the time of reporting the information for this article, an 8×16 passive array (not including T/R modules) and a 2×4 active array (including T/R modules) had been demonstrated, and it was planned to fabricate and test larger arrays.

Because of limitations of available materials and equipment, the largest array that can be constructed as a single unit of the prototype design is a 2×8 array, which has dimensions of 0.28 m by 1.14 m. To construct a larger array, it is necessary to seam together 2×8 or smaller arrays. Figure 2 depicts selected aspects of the seaming process. Adjacent panels containing arrays to be seamed together are aligned using alignment marks on the panels and temporary tape. After the entire array has been aligned with temporary tape, the seams are match cut using an electric cutter. Finally, the cut panels are aligned, mechanically joined using a permanent adhesive and electrically joined using a combination of electrically conductive tape and soldered copper foil jumpers for the aforementioned conductive traces.

This work was done by Alina Moussessian, Mark Zawadzki, Ubaldo Quijano, Linda Del Castillo, and Etai Weininger of Caltech for NASA's Jet Propulsion Laboratory.

For more information, contact iaoffice@jpl.nasa.gov. NPO-45152

Optical Injection Locking of a VCSEL in an OEO

Compact, low-power atomic clocks could be developed.

NASA's Jet Propulsion Laboratory, Pasadena, California

Optical injection locking has been demonstrated to be effective as a means of stabilizing the wavelength of light emitted by a vertical-cavity surface-emitting laser (VCSEL) that is an active element in the frequency-control loop of an opto-electronic oscillator (OEO) designed to implement an atomic clock based on an electromagnetically-induced-transparency resonance. This particular optical-injection-locking scheme is expected to enable the development of small, low-power, high-stability atomic clocks that would be suitable for use in applications involving precise navigation and/or communication.

In one essential aspect of operation of an OEO of the type described above, a microwave modulation signal is coupled into the VCSEL. Heretofore, it has been well known that the wavelength of light emitted by a VCSEL depends on its temperature and drive current, necessitating thorough stabilization of these operational parameters. Recently, it was discovered that the wavelength also depends on the microwave power coupled into the VCSEL. Inasmuch as the microwave power circulating in the frequency-control loop is a dynamic frequency-control variable (and, hence, cannot be stabilized), there arises a need for another means of stabilizing the wavelength.

The present optical-injection-locking scheme satisfies the need for a means to stabilize the wavelength against microwave-power fluctuations. It is also expected to afford stabilization against temperature and current fluctuations. In an experiment performed to demonstrate this scheme, wavelength locking was observed when about 200 μW of the output power of a commercial tunable diode laser was injected into a commercial

VCSEL, designed to operate in the wavelength range of 795±3 nm, that was generating about 200 μW of optical power. (The use of relatively high injection power levels is a usual practice in injection locking of VCSELs.)

This work was done by Dmitry Strekalov, Andrey Matsko, Anatoliy Savchenkov, Nan Yu, and Lute Maleki of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

NPO-43454

Measuring Multiple Resistances Using Single-Point Excitation

Lyndon B. Johnson Space Center, Houston, Texas

In a proposed method of determining the resistances of individual DC electrical devices (e.g., batteries or fuel-cell stacks containing multiple electrochemical cells) connected in a series or parallel string, no attempt would be made to perform direct measurements on individual devices. Instead, (1) the devices would be instrumented by connecting reactive circuit components in parallel and/or in series with the devices, as appropriate; (2) a pulse or AC voltage excitation would be applied at a single point on the string; and (3) the transient or AC steady-state current response of the string would be measured at that point only. Each reactive component(s) associated with each device would be distinct in order to associate a unique time-dependent response with that device.

Using the known time-varying voltage excitation, the known values of inductance and/or capacitance, and the standard equation predicting the response for the known circuit configuration, the time-varying current response would be subjected to nonlinear regression analysis. In essence, this analysis would yield individual device resistances that result in a best fit between the predicted and actual time-varying current responses.

This work was done by Dan Hall of Lockheed Martin Corp. and Frank Davies of Hernandez Engineering, Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1).

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, Johnson Space Center, (281) 483-1003. Refer to MSC-23623-1.

Improved-Bandwidth Transimpedance Amplifier

NASA's Jet Propulsion Laboratory, Pasadena, California

The widest available operational amplifier, with the best voltage and current noise characteristics, is considered for transimpedance amplifier (TIA) applications where wide bandwidth is required to handle fast rising input signals (as for time-of-flight measurement cases). The added amplifier inside the TIA feedback loop can be configured to have slightly lower voltage gain than the bandwidth reduction factor (the ratio of the input capacitance plus the feedback capacitance to the feed capacitance). This innovation enables the optimization of design based on suitable space-approved operational amplifiers and provides better, stronger performance under radiation and wide temperature variations. In many cases, this approach can eliminate the need to qualify new amplifiers.

This work was done by Jacob Chapsky of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

NPO-45798

Inter-Symbol Guard Time for Synchronizing Optical PPM

This method would involve less computation than does the pilot-symbol method.

NASA's Jet Propulsion Laboratory, Pasadena, California

An inter-symbol guard time has been proposed as a means of synchronizing the symbol and slot clocks of an optical pulse-position modulation (PPM) receiver with the symbol and slot periods of an incoming optical PPM signal. (Such synchronization is necessary for correct identification of received symbols.) The proposal is applicable to the low-flux case in which the receiver photodetector operates in a photon-counting mode and the count can include contributions from incidental light sources and dark current. The use of the inter-symbol guard time would be an alternative to a prior synchronization method based on the periodic transmission of a fixed pilot symbol.

The proposal involves a modification of conventional M-ary optical PPM, in which each successive symbol period is divided into M time slots (0, 1, 2, ..., M-1), each slot being of duration T_S. Each time slot represents a different symbol in an alphabet of up to M symbols. At the transmitter, during each time slot, a laser either transmits a pulse or no pulse, depending on which symbol is to be sent. Synchronization of the receiver symbol and slot clocks is necessary because the task of the receiver is to determine which of the M possible symbols has been received by observing the photon counts accumulated during each of the M time slots of a symbol period.

In both the prior method and the method now proposed, the basic idea is to estimate the symbol and slot timing boundaries of the received signal by correlating the received-signal counts with a known component of the transmitted signal while taking account of the fact that the received-signal counts are related to the received-signal intensity through a Poisson distribution. In the prior method, the known component of