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 the transmitted signal is the pilot symbol, transmitted in place of an information symbol at intervals of R symbol periods. The pilot symbol is embodied as a pulse in the $M/2$th time slot of each affected Rth symbol period. In order to acquire the symbol and slot timing of the pilot signal, the receiver can correlate the received signal with variously delayed replicas of the pilot signal and choose the delay offset that yields the maximum correlation. The number of different correlations at increments of T_s is limited to MR; a coarse offset can thus be identified as whichever of these offsets yields the greatest correlation. Once the coarse offset has been determined, a finer estimate can be made by use of an early-late method with the adjacent correlation statistics.

In the method now proposed, there would be no pilot symbol. Instead, successive symbol periods would be separated by the aforementioned inter-symbol guard time, equal to one time slot T_s, during which no pulse would be transmitted. In effect, each symbol period would be divided into $M + 1$ time slots, of which the first M would be reserved for data pulses and the $M + 1$st, containing no pulse, would be used for synchronization. In this method, to acquire the symbol and slot timing of the received signal, one could seek either (1) the maximum correlation between the received signal and a synthetic signal consisting of pulses in all the data time slots or (2) the minimum correlation between the received signal and a synthetic signal consisting only of the inter-symbol guard time. In either case, the number of different correlations at increments of T_s would be limited to $M + 1$. As in the prior method, once the coarse offset had been determined, a finer estimate could be made by use of an early-late method with the adjacent correlation statistics.

Because fewer correlations would be needed to determine the coarse timing in the proposed method than are needed in the prior method, the proposed method could be implemented in a receiver by means of simpler, lower-power, less-massive computational circuitry, which is considered an acceptable trade-off to the slightly increased estimation error. Another advantage would be that unlike in the prior method, no energy would be expended in transmitting pilot symbols.

This work was done by William Far, Jonathan Gin, and Meera Srinivasan of Caltech and Kevin Quirk of Northrop Grumman Information Technology for NASA's Jet Propulsion Laboratory. For further information, cintact iaoffice@jpl.nasa.gov.
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