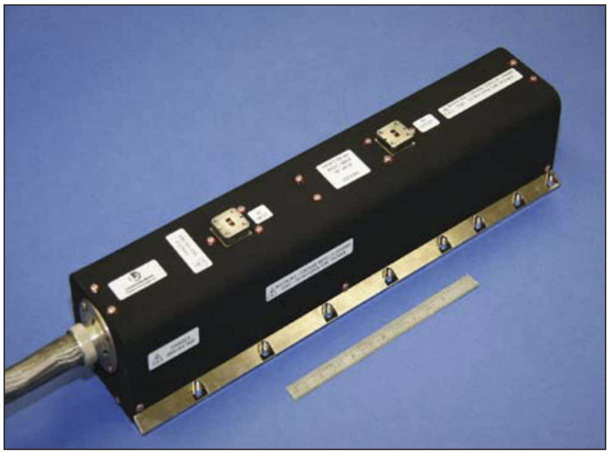
Electronics/Computers

Space-Qualified Traveling-Wave Tube

TWT was developed for use as a high-power microwave amplifier for high-rate transmission of data.

John H. Glenn Research Center, Cleveland, Ohio

The L-3 Communications Electron Technologies, Inc. Model 999HA traveling-wave tube (TWT), was developed for use as a high-power microwave amplifier for high-rate transmission of data and video signals from deep space to Earth (see figure). The 999HA is a successor to the 999H — a non-space-qualified TWT described in "High-Power, High-Efficiency Ka-Band Traveling-Wave Tube" (LEW-17900-1), *NASA Tech Briefs*, Vol. 31, No. 2 (February 2007), page 32. Operating in the 31.8-to-32.3 GHz frequency band, the 999HA has been shown to generate 252 W of continuous-wave output power at 62 percent overall power efficiency — a 75-percent increase in output power over the 999H.



A **Photo of the TWT** shows its approximate dimensions. [The ruler below is 6 in. (≈15 cm) long.]

The mass of the 999HA is 35 percent less than that of the 999H. Moreover, taking account of the elimination of a Faraday cage that is necessary for operation of the 999H but is obviated by a redesign of high-voltage feedthroughs for the 999HA, the overall reduction in mass becomes 57 percent with an 82 percent reduction in volume. Through a series of rigorous tests, the 999HA has been qualified for operation aboard spacecraft with a lifetime exceeding seven years. Offspring of the 999HA will fly on the Kepler and Lunar Reconnaissance Orbiter missions.

This work was done by Jeffrey D. Wilson, Richard Krawczyk, Rainee N. Simons, and Wallace D. Williams of Glenn Research Center and Neal R. Robbins, Daniel R. Dibb, William L. Menninger, Xiaoling Zhai, and Robert T. Benton of L-3 Communications Electron Technologies, Inc. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18220-1.

Smart Power Supply for Battery-Powered Systems

This power supply can be used in remote vehicles, or for any application requiring battery power or battery charging.

John H. Glenn Research Center, Cleveland, Ohio

A power supply for battery-powered systems has been designed with an embedded controller that is capable of monitoring and maintaining batteries, charging hardware, while maintaining output power. The power supply is primarily designed for rovers and other remote science and engineering vehicles, but it can be used in any battery alone, or battery and charging source applications. The supply can function autonomously, or can be connected to a host processor through a serial communications link. It can be programmed *a priori* or on the fly to return current and voltage readings to a host.

It has two output power busses: a constant 24-V direct current nominal bus, and a programmable bus for output from approximately 24 up to approximately 50 V. The programmable bus voltage level, and its output power limit, can be changed on the fly as well. The power supply also offers options to reduce the programmable bus to 24 V when the set power limit is reached, limiting output power in the case of a system fault detected in the system.

The smart power supply is based on an embedded 8051-type single-chip microcontroller. This choice was made in that a credible progression to flight (radiation hard, high reliability) can be assumed as many 8051 processors or gate arrays capable of accepting 8051-type core presently exist and will continue to do so for some time.

To solve the problem of centralized control, this innovation moves an embedded microcontroller to the power supply and assigns it the task of overseeing the operation and charging of the power supply assets. This embedded processor is connected to the application central processor via a serial data link such that the central processor can request updates of various parameters within the supply, such as battery current, bus voltage, remaining power in battery estimations, etc. This supply has a direct connection to the battery bus for common (quiescent) power application. Because components from multiple vendors may have differing power needs, this supply also has a secondary power bus, which can be programmed *a priori* or on-the-fly to boost the primary battery voltage level from 24 to 50 V to accommodate various loads as they are brought on line. Through voltage and current monitoring, the device can also shield the charging source from overloads, keep it within safe operating modes, and can meter available power to the application and maintain safe operations.

This work was done by Michael J. Krasowski, Lawrence C. Greer, and Norman F. Prokop of Glenn Research Center and Joseph M. Flatico of Ohio Aerospace Institute. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18317-1.

Parallel Processing of Broad-Band PPM Signals

Timing-error correction is independent of timing-error estimation.

NASA's Jet Propulsion Laboratory, Pasadena, California

A parallel-processing algorithm and a hardware architecture to implement the algorithm have been devised for time-slot synchronization in the reception of pulse-position-modulated (PPM) optical or radio signals. As in the cases of some prior algorithms and architectures for parallel, discrete-time, digital processing of signals other than PPM, an incoming broadband signal is divided into multiple parallel narrower-band signals by means of sub-sampling and filtering. The number of parallel streams is chosen so that the frequency content of the narrower-band signals is low enough to enable processing by relatively-low-speed complementary metal oxide semiconductor (CMOS) electronic circuitry.

The algorithm and architecture are intended to satisfy requirements for time-varying time-slot synchronization and post-detection filtering, with correction of timing errors independent of estimation of timing errors. They are also intended to afford flexibility for dynamic reconfiguration and upgrading. The architecture is implemented in a reconfigurable CMOS processor in the form of a field-programmable gate array. The algorithm and its hardware implementation incorporate three separate time-varying filter banks for three distinct functions: correction of sub-sample timing errors, post-detection filtering, and post-detection estimation of timing errors. The design of the filter bank for correction of timing errors, the method of estimating timing errors, and the design of a feedback-loop filter are governed by a host of parameters, the most critical one, with regard to processing very broadband signals with CMOS hardware, being the number of parallel streams (equivalently, the rate-reduction parameter).

This work was done by Andrew Gray, Edward Kang, Norman Lay, Victor Vilnrotter, Meera Srinivasan, and Clement Lee 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-40711, volume and number of this NASA Tech Briefs *issue, and the page number.*

Inexpensive Implementation of Many Strain Gauges

Arrays of metal film resistors would sense strains at multiple locations.

NASA's Jet Propulsion Laboratory, Pasadena, California

It has been proposed to develop arrays of strain gauges as arrays of ordinary metal film resistors and associated electronic readout circuitry on printed-circuit boards or other suitable substrates. This proposal is a by-product of a development of instrumentation utilizing metal film resistors on printed-circuit boards to measure temperatures at multiple locations. In the course of that development, it was observed that in addition to being sensitive to temperature, the metal film resistors were also sensitive to strains in the printed-circuit boards to which they were attached. Because of the low cost of ordinary metal film resistors (typically <$0.01 apiece at 2007 prices), the proposal could enable inexpensive implementation of arrays of many (e.g., 100 or more) strain gauges, possibly concentrated in small areas. For example, such an array could be designed for use as a computer keyboard with no moving parts, as a device for sensing the shape of an object resting on a surface, or as a device for measuring strains at many points on a mirror, a fuel tank, an airplane wing, or other large object.

Ordinarily, the effect of strain on resistance would be regarded as a nuisance in a temperature-measuring application, and the effect of temperature on resistance would be regarded as a nuisance in a strain-measuring application. The strain-induced changes in resistance of the metal film resistors in question are less than those of films in traditional strain gauges. The main novel aspect of present proposal lies in the use of circuitry affording sufficient sensitivity to measure strain plus means for compensating for the effect of temperature.

For an array of metal film resistors used as proposed, the readout circuits would include a high-accuracy analog-to-digital converter fed by a low noise current source, amplifier chain, and an analog multiplexer chain. Corrections would be provided by use of