Electronics/Computers

Online Cable Tester and Rerouter

This technology enables proactive detection of impending cable failures, allowing for function rerouting.

John F. Kennedy Space Center, Florida

Hardware and algorithms have been developed to transfer electrical power and data connectivity safely, efficiently, and automatically from an identified damaged/defective wire in a cable to an alternate wire path. The combination of online cable testing capabilities, along with intelligent signal rerouting algorithms, allows the user to overcome the inherent difficulty of maintaining system integrity and configuration control, while autonomously rerouting signals and functions without introducing new failure modes. The incorporation of this capability will increase the reliability of systems by ensuring system availability during operations.

The operation of the innovation is based on the injection of a low-level and short-duration signal into a wire under test. The cable router master unit consists of a pulse generator, a multiplexer, a switch matrix, and a detector circuit. The pulse generator provides a step pulse that is applied to the multiplexer. The multiplexer, in turn, routes the test pulse to one of many wires. The signal then propagates through the selected wire until it reaches the cable route slave circuit. The slave circuit monitors the wire, and once it receives the signal, it routes it back to the master unit through a communication wire. The detector circuit in the master unit then determines the presence of the signal to indicate that a good connection is in place. The absence of the test pulse becomes an indication of a faulty connection. A plurality of communication wires is used, so that the individual state of health is not a determining factor for the analysis of the health of the wire(s) under test.

The master unit sequentially scans all the wires selected as "active" or "spares." The current implementation of the online rerouter system can monitor up to eight wires. However, the circuit can be expanded to monitor a larger number of wires. The wires can be independently assigned to be "active" or to be "spares." Once an active wire has been labeled as failed, the master and the slave units communicate with each other, and immediately route the signals that were flowing through the failed wire to one of the spare wires. This allows for the system to maintain integrity with a disruption shorter than one second in the current implementation.

The small amplitude of the test pulse injected into the wires requires multiple successive measurements to assess the integrity of the wire. The test pulse level has to be maintained at a low level in order not to interfere with signals being carried in the wire under test. This allows for discrimination between a large, non-correlated signal and a small, synchronous test pulse without interfering with the operation of the wire.

This work was done by Mark Lewis of Kennedy Space Center and Pedro Medelius of ASRC Aerospace Corporation. For more information, contact the Kennedy Space Center Innovative Partnerships Office at 321-867-5033. KSC-13440

A Three-Frequency Feed for Millimeter-Wave Radiometry

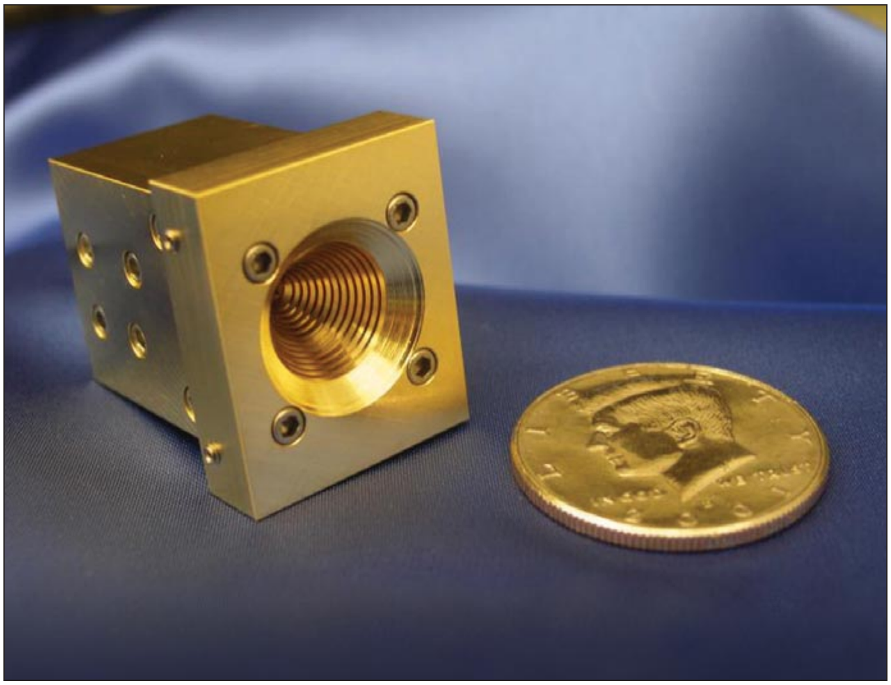
This wave feed operates at frequencies approximately five times higher than current feeds and provides greater bandwidth.

NASA's Jet Propulsion Laboratory, Pasadena, California

A three-frequency millimeter-wave feed horn was developed as part of an advanced component technology task that provides components necessary for higher-frequency radiometers to meet the needs of the Surface Water and Ocean Topography (SWOT) mission. The primary objectives of SWOT are to characterize ocean sub-mesoscale processes on 10-km and larger scales in the global oceans, and to measure the global water storage in inland surface water bodies, including rivers, lakes, reservoirs, and wetlands.

In this innovation, the feed provides three separate output ports in the 87-to-97-GHz, 125-to-135-GHz, and 161-to-183-GHz bands; WR10 for the 90-GHz channel, WR8 for the 130-GHz channel, and WR5 for the 170-GHz channel. These ports are in turn connected to individual radiometer channels that will also demonstrate component technology including new PIN-diode switches and noise diodes for internal calibration integrated into each radiometer front end. For this application, a prime focus feed is required with an edge taper of approximately 20 dB at an illumination angle of ±40°. A single polarization is provided in each band. Preliminary requirements called for a return loss of better than 15 dB, which is achieved across all three bands. Good pattern symmetry is also obtained throughout all three-frequency bands. This three-frequency broadband millimeter-wave feed also minimizes mass and provides a common focal point for all three millimeter-wave bands.

In order to achieve similar E and H plane beam widths over the combined 87-to-183-GHz band ring, loaded slots are employed in the corrugated portion of the feed. The feed operates in a flare-angle limited condition, which gives approximately constant beam width across the entire band, and provides a common phase center located near its apex.



The assembled prototype **Three-Frequency Feed** is shown, with the low-frequency combiner absent, along with a half-dollar coin for scale. The overall size of the feed, including the combiner block, is approximately 1×1.25×1.5 in. (≈2.5×3.2×3.8 cm).

The half-flare angle for the feed is approximately 30°. Analysis and optimization of the overall feed design employed a combination of finite element and mode-matching tools.

The illumination requirements and relative frequency spacing for this application are similar to those required for the Scanning Multichannel Microwave Radiometer (SMMR) on Seasat, the (TOPEX)/Poseidon, and the Jason missions. However, in this particular application the required fractional bandwidth is larger. Thus, while the three-frequency feed horn described here shares many features in common with the feed previously developed for the above missions, enhancements are necessary in order to achieve broad band performance and manufacturability in the millimeter-wave bands.

This work was done by Daniel J. Hoppe, Behrouz Khayatian, John B. Sosnowski, Alan K. Johnson, and Peter J. Bruneau of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-48528

Capacitance Probe Resonator for Multichannel Electrometer

NASA's Jet Propulsion Laboratory, Pasadena, California

A multichannel electrometer voltmeter has been developed that employs a mechanical resonator with voltage-sensing capacitance-probe electrodes that enable high-impedance, high-voltage, radiation-hardened measurement of an Internal Electrostatic Discharge Monitor (IESDM) sensor. The IESDM is new sensor technology targeted for integration into a Space Environmental Monitor (SEM) subsystem used for the characterization and monitoring of deep dielectric charging on spacecraft.

The resonator solution relies on a non-contact, voltage-sensing, sinusoidal-varying capacitor to achieve input impedances as high as 10 petaohms as determined by the resonator materials, geometries, cleanliness, and construction. The resonator is designed with one dominant mechanical degree of freedom, so it resonates as a simple harmonic oscillator and because of the linearity of the variable sense capacitor to displacement, generates a pure sinusoidal current signal for a fixed input voltage under measurement. This enables the use of an idealized phase-lock sensing scheme for optimal signal detection in the presence of noise.

This work was done by Brent R. Blaes, Rembrandt T. Schaefer, and Robert J. Glaser of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47335

Inverted Three-Junction Tandem Thermophotovoltaic Modules

John H. Glenn Research Center, Cleveland, Ohio

An InGaAs-based three-junction (3J) tandem thermophotovoltaic (TPV) cell has been investigated to utilize more of the blackbody spectrum (from a 1,100 °C general purpose heat source — GPHS) efficiently. The tandem consists of three vertically stacked subcells, a 0.74-eV InGaAs cell, a 0.6-eV InGaAs cell, and a 0.55-eV InGaAs cell, as well as two interconnecting tunnel junctions.

A >20% TPV system efficiency was achieved by another group with a 1,040 °C blackbody using a single-bandgap 0.6-eV InGaAs cell MIM (monolithic interconnected module) (30 lateral junctions) that delivered about 12 V/30 or 0.4 V/junction. It is expected that a three-bandgap tandem MIM will eventually have about 3× this voltage (1.15 V) and about half the current. A 4 A/cm^2 would be generated by a single-bandgap 0.6-V InGaAs MIM, as opposed to the 2 A/cm^2 available from the same spectrum when split among the three series-connected junctions in the tandem stack. This would then be about a 50%