Lunar Dust-Tolerant Electrical Connector

John H. Glenn Research Center, Cleveland, Ohio

An electrical connector was developed that is tolerant of the presence of lunar dust. Novel features of the connector include the use of a permeable membrane to act both as a dust barrier and as a wiper to limit the amount of dust that makes its way into the internal chamber of the connector. The development focused on the Constellation lunar extra-vehicular activity (EVA) spacesuit’s portable life support system (PLSS) battery recharge connector; however, continued research is applying this technology to other lunar surface systems such as lunar rover subsystems and cryogenic fluid transfer connections for in-situ resource utilization (ISRU) applications.

Lunar dust has been identified as a significant and present challenge in future exploration missions. In addition to posing contamination and health risks for human explorers, the interlocking, angular nature of lunar dust and its broad grain size distribution make it particularly harmful to mechanisms with which it may come into contact. All Apollo lunar missions experienced some degree of equipment failure because of dust, and it appears that dust accumulation on exposed material is unavoidable and difficult to reverse. Both human EVA and ISRU activities are on the mission horizon and are paramount to the establishment of a permanent human base on the Moon. Reusable and dust-tolerant connection mechanisms are a critical component for mission success.

The need for dust-tolerant solutions is also seen in utility work and repair, mass transit applications, construction, mining, arctic and marine environments, diving (search and rescue), and various operations in deserts, where dust or sand clogging and coating different mechanisms and connections may render them difficult to operate or entirely inoperable.

This work was done by James Nessel and Richard Lee of Glenn Research Center. 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-18313-1.

Compact, Reliable EEPROM Controller

This controller prevents inadvertent writes in an EEPROM.

Goddard Space Flight Center, Greenbelt, Maryland

A compact, reliable controller for an electrically erasable, programmable read-only memory (EEPROM) has been developed specifically for a space-flight application. The design may be adaptable to other applications in which there are requirements for reliability in general and, in particular, for prevention of inadvertent writing of data in EEPROM cells. Inadvertent writes pose risks of loss of reliability in the original space-flight application and could pose such risks in other applications. Prior EEPROM controllers are large and complex and do not provide all reasonable protections (in many cases, few or no protections) against inadvertent writes. In contrast, the present controller provides several layers of protection against inadvertent writes. The controller also incorporates a write-time monitor, enabling determination of trends in the performance of an EEPROM.

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Quad-Chip Double-Balanced Frequency Tripler
This technology has uses such as high-resolution radar and spectroscopic screening.

**NASA's Jet Propulsion Laboratory, Pasadena, California**

Solid-state frequency multipliers are used to produce tunable broadband sources at millimeter and submillimeter wavelengths. The maximum power produced by a single chip is limited by the electrical breakdown of the semiconductor and by the thermal management properties of the chip. The solution is to split the drive power to a frequency tripler using waveguides to divide the power among four chips, then recombine the output power from the four chips back into a single waveguide.

To achieve this, a waveguide branch-line quadrature hybrid coupler splits a 100-GHz input signal into two paths with a 90° relative phase shift. These two paths are split again by a pair of waveguide Y-junctions. The signals from the four outputs of the Y-junctions are tripled in frequency using balanced Schottky diode frequency triplers before being recombined with another pair of Y-junctions. A final waveguide branch-line quadrature hybrid coupler completes the combination.

Using four chips instead of one enables using four-times higher power input, and produces a nearly four-fold power output as compared to using a single chip. The phase shifts introduced by the quadrature hybrid couplers provide isolation for the input and output waveguides, effectively eliminating standing waves between it and surrounding components. This is accomplished without introducing the high losses and expense of ferrite isolators.

A practical use of this technology is to drive local oscillators as was demonstrated around 300 GHz for a heterodyne spectrometer operating in the 2–3-THz band. Heterodyne spectroscopy in this frequency band is especially valuable for astrophysics due to the presence of a very large number of molecular spectral lines. Besides high-resolution radar and spectrographic screening applications, this technology could also be useful for laboratory spectroscopy.

**Ka-Band Waveguide Two-Way Hybrid Combiner for MMIC Amplifiers**
This technology is applicable as a power combiner for solid-state power amplifiers (SSPAs) with unequal and arbitrary power output ratios.

**John H. Glenn Research Center, Cleveland, Ohio**

The design, simulation, and characterization of a novel Ka-band (32.05±0.25 GHz) rectangular waveguide two-way branch-line hybrid unequal power combiner (with port impedances matched to that of a standard WR-28 waveguide) has been created to combine input signals, which are in phase and with an amplitude ratio of two. The measured return loss and isolation of the branch-line hybrid are better than 22 and 27 dB, respectively. The measured combining efficiency is 92.9 percent at the center frequency of 32.05 GHz. This circuit is efficacious in combining the unequal output power from two Ka-band GaAs pseudomorphic high electron mobility transistor (pHEMT) monolithic microwave integrated circuit (MMIC) power amplifiers (PAs) with high efficiency.

The component parts include the branch-line hybrid-based power combiner and the MMIC-based PAs. A two-way branch-line hybrid is a four-port device with all ports matched; power entering port 1 is divided in phase, and into the ratio 2:1 between ports 3 and 4. No power is coupled to port 2.

MMICs are a type of integrated circuit fabricated on GaAs that operates at microwave frequencies, and performs the function of signal amplification. The power combiner is designed to operate over the frequency band of 31.8 to 32.3 GHz.