

similar orthogonal-polarization characteristics, including high degrees of polarization purity. The diagonal orientation helps in realizing a symmetrical feed network for both polarizations with similar impedance characteristics and radiation patterns. RF MEMS switches would be included in a production model but are not included in the prototype: Instead, to simplify computational simulation and testing, switching of polarizations is represented by the presence of hard-wired open and short circuits at switch locations.

Figure 2 is a plan view of a switchable phase shifter — in this case, one that can be switched between two different phase shifts. The device includes electrostatically actuated RF MEMS switches that

are used to make and break connections to eight microstrip delay lines having different lengths (e.g., 1 wavelength versus  $3/4$  wavelength). Necessarily omitting details for the sake of brevity, each MEMS switch includes a microscopic flexible electrically conductive member that, through application of a suitably large DC bias voltage, can be pulled into proximity with microstrip conductors on opposite sides of the gap. The flexible member is covered to prevent direct electrical contact with the microstrip conductors, but the effect of the proximity is such as to enable substantial capacitive coupling of the microwave signal across the gap. The measured loss of the four-bit packaged phase shifter is only 0.24 dB per bit with a phase error less

than  $4^\circ$  at 14 GHz. At the time of this reporting, this is the first package flexible organic RF MEMS multibit phase shifter ever documented.

*This work was done by Dane Thompson, Ramanan Bairavasubramanian, Guoan Wang, Nickolas D. Kingsley, Ioannis Pappaloum, Emmanouil M. Tenteris, Gerald DeJean, and RongLin Li of Georgia Institute of Technology for 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-17980-1.*

## Applications for Subvocal Speech

*Ames Research Center, Moffett Field, California*

A research and development effort now underway is directed toward the use of subvocal speech for communication in settings in which (1) acoustic noise could interfere excessively with ordinary vocal communication and/or (2) acoustic silence or secrecy of communication is required. By “subvocal speech” is meant sub-audible electromyographic (EMG) signals, associated with speech, that are acquired from the surface of the larynx and lingual areas of the throat. Topics addressed in this effort include recogni-

tion of the sub-vocal EMG signals that represent specific original words or phrases; transformation (including encoding and/or enciphering) of the signals into forms that are less vulnerable to distortion, degradation, and/or interception; and reconstruction of the original words or phrases at the receiving end of a communication link. Potential applications include ordinary verbal communications among hazardous-material-cleanup workers in protective suits, workers in noisy environments, divers, and firefighters, and

secret communications among law-enforcement officers and military personnel in combat and other confrontational situations.

*This work was done by Charles Jorgensen of Ames Research Center and Bradley Betts of Computer Sciences Corporation.*

*This invention is owned by NASA and a patent application has been filed. Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-15519-1.*

## Multiloop Rapid-Rise/Rapid Fall High-Voltage Power Supply

*Marshall Space Flight Center, Alabama*

A proposed multiloop power supply would generate a potential as high as 1.25 kV with rise and fall times  $<100 \mu\text{s}$ . This power supply would, moreover, be programmable to generate output potentials from 20 to 1,250 V and would be capable of supplying a current of at least 300  $\mu\text{A}$  at 1,250 V. This power supply is intended to be a means of electronic shuttering of a microchannel plate that would be used to intensify the output of a charge-coupled-device imager to obtain exposure times as short as 1 ms. The basic design of this power supply could also be adapted to other applications in which high voltages and high slew rates are needed. At the time of reporting the information for this

article, there was no commercially available power supply capable of satisfying the stated combination of voltage, rise-time, and fall-time requirements.

The power supply would include a preregulator that would be used to program a voltage  $1/30$  of the desired output voltage. By means of a circuit that would include a pulse-width modulator (PWM), two voltage doublers, and a transformer having two primary and two secondary windings, the preregulator output voltage would be amplified by a factor of 30. A resistor would limit the current by controlling a drive voltage applied to field-effect transistors (FETs) during turn-on of the PWM. Two feed-

back loops would be used to regulate the high output voltage. A pulse transformer would be used to turn on four FETs to short-circuit output capacitors when the outputs of the PWM were disabled. Application of a 0-to-5-V square wave to a PWM shut-down pin would cause a 20-to-1,250-V square wave to appear at the output.

*This work was done by Douglas Bearden of Marshall Space Flight Center.*

*This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32137-1.*