# Electronics/Computers

## Frequency to Voltage Converter Analog Front-End Prototype

### The device compares multiple filter circuits side-by-side.

*John F. Kennedy Space Center, Florida*

The frequency to voltage converter analog front end evaluation prototype (F2V AFE) is an evaluation board designed for comparison of different methods of accurately extracting the frequency of a sinusoidal input signal. A configurable input stage is routed to one or several of five separate, configurable filtering circuits, and then to a configurable output stage. Amplifier selection and gain, filter corner frequencies, and comparator hysteresis and voltage reference are all easily configurable through the use of jumpers and potentiometers.

Certain types of liquid and gas flow measurement devices utilize a turbine and magnetic sensor to output a sinusoidal signal with a frequency proportional to the rate of flow through the turbine. In order to interface with the Command and Control infrastructure at Kennedy Space Center (KSC), this sinusoidal frequency must be converted into an analog voltage level proportional to the frequency. Existing commercial off-the-shelf (COTS) signal conditioners designed for this task are either obsolete or unqualified for use at KSC. In order to design a replacement signal conditioner that will meet the environmental and operational requirements for use at KSC, an accurate and reliable analog circuit must be designed to convert the input sine wave into a square wave of the same frequency, while eliminating inaccuracies due to ambient temperature, electromagnetic interference (EMI), and varying signal amplitudes from the turbine sensor. The F2V AFE evaluation board allows side-by-side comparison of several circuit designs to help determine which is optimal.

The F2V AFE evaluation board consists of eight main sections: power, input stage, output stage and five separate, parallel filtering and amplification stages. The power stage accepts external 5 VDC power and generates a –5 VDC supply from this. Both supplies are routed to the other circuit stages. The input stage takes the input sinusoidal signal and passes it through an optional gain amplifier to a header where it can be routed to one or several of the five filter topologies. The output stage contains a header that can be used to select the output of one of the five filters for conversion to a square wave. The five filter topologies represent different methods for amplifying and filtering the input signal. This evaluation board provides a wide array of options for determining the optimal configuration for accurately extracting the frequency of a sine wave varying in amplitude from 10 mV to >1 V, and in frequency from 20 Hz to 2.5 kHz.

This device is intended to be an evaluation platform for determining an optimum frequency detection circuit design. An evaluation platform benefiting from the constrained routing and component size and placement of surface-mount design, and containing the actual components that will be used in the final design, has many benefits over older breadboard prototyping techniques, where parasitic inductances and capacitance may have a significant effect on test circuits. This device is useful for situations where multiple design options must be compared before a circuit is selected for a final production design. The evaluation board is designed to accurately detect signals from 10 mV peak up to 5 V peak, and frequencies from 20 Hz to 3 kHz, but component substitution will allow both the frequency and voltage range to be significantly expanded or contracted. Other input waveforms, including square waves, can also be processed.

*This work was done by Carlos Mata and Matthew Raines of ASRC Aerospace Corp. for Kennedy Space Center. Further information is contained in a TSP (see page 1).* KSC-13582

## Dust-Tolerant Intelligent Electrical Connection System

### This technology has application in aerospace, military, homeland security, mining, and oil and gas exploration operations that are conducted in uncontrolled environments.

*John F. Kennedy Space Center, Florida*

Faults in wiring systems are a serious concern for the aerospace and aeronautic (commercial, military, and civilian) industries. Circuit failures and vehicle accidents have occurred and have been attributed to faulty wiring created by open and/or short circuits. Often, such circuit failures occur due to vibration during vehicle launch or operation. Therefore, developing non-intrusive fault-tolerant techniques is necessary to detect circuit faults and automatically route signals through alternate recovery paths while the vehicle or lunar surface systems equipment is in operation. Electrical connector concepts combining dust mitigation strategies and cable diagnostic technologies have significant application for lunar and Martian surface systems, as well as for dusty terrestrial applications.

By creating intelligent electrical connectors that detect, identify, and locate circuit faults and that then bypass damaged conductors and route to available spares, the detection of connector failures is improved, and it becomes possible to recover from mission-threatening circuit faults and failures. Three styles of electrical connector concepts for use in zero-gravity and reduced-gravity dusty environments were developed: conventional connector systems with protective