frequency but with a corrected wave shape. Since its configuration circuit can be easily changed, the new PLL can do the following: readily respond to variations in VCO ranges, duty cycle, SNR, amplitude, and jitter; continuously operate in the correct VCO range because of its consensus state machine; and use its range detector implements to overlap seven frequency ranges with hysteresis, thus giving the current design a flexibility that exceeds anything available at the time of this development. These features will benefit any industry in which safe and timely clock signals are vital to operation.

This work was done by Robert D. Koudelka of the **Johnson Space Center**.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-22875.

Portable Electromyograph

Signals from 16 differential EMG electrodes can be recorded for 8 hours.

Lyndon B. Johnson Space Center, Houston, Texas

A portable electronic apparatus records electromyographic (EMG) signals in as many as 16 channels at a sampling rate of 1,024 Hz in each channel. The apparatus (see figure) includes 16 differential EMG electrodes (each electrode corresponding to one channel) with cables and attachment hardware, reference electrodes, an input/output-and-power-adapter unit, a 16-bit analog-to-digital converter, and a hand-held computer that contains a removable 256-MB flash memory card. When all 16 EMG electrodes are in use, full-bandwidth data can be recorded in each channel for as long as 8 hours. The apparatus is powered by a battery and is small enough that it can be carried in a waist pouch.

The computer is equipped with a small screen that can be used to display the incoming signals on each channel. Amplitude and time adjustments of this display can be made easily by use of touch buttons on the screen. The user can also set up a data-acquisition schedule to conform to experimental protocols or to manage battery energy and memory efficiently.

This **Portable Electromyograph** can record signals from as many as 16 differential EMG electrodes. The overall mass of the equipment is 1.1 kg. A wireless version of this device is scheduled for release in the near future.

Once the EMG data have been recorded, the flash memory card is removed from the EMG apparatus and placed in a flash-memory-card-reading external drive unit connected to a personal computer (PC). The PC can then read the data recorded in the 16 channels. Preferably, before further analysis, the data should be stored in the hard drive of the PC. The data files are opened and viewed on the PC by use of special-purpose software.

The software for operation of the apparatus resides in a random-access memory (RAM), with backup power supplied by a small internal lithium cell. A backup copy of this software resides on the flash memory card. In the event of loss of both main and backup battery power and consequent loss of this software, the backup copy can be used to restore the RAM copy after power has been restored.

Accessories for this device are also available. These include goniometers, accelerometers, foot switches, and force gauges.

This work was done by Gianluca De Luca, Carlo J. De Luca, and Per Bergman of DelSys, Inc., for **Johnson Space Center**. *For further information, contact:*

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