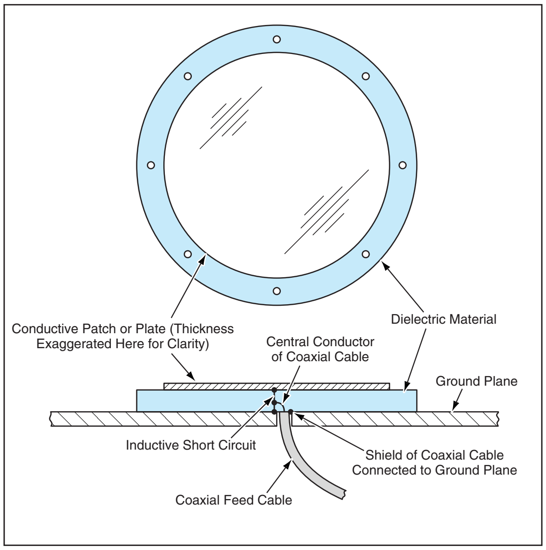

The **Inductive-Short-Circuit Feed Configuration** of this microstrip-style antenna makes it possible for the antenna to have a smaller diameter and still radiate efficiently.

a tenth and a third of that necessitated by the conventional feed configuration, the modified configuration makes it possible to install such antennas in places where they could not previously be installed and thereby helps to realize the potential advantages (concealment and/or reduction of aerodynamic drag) of microstrip versus whip antennas.

In both the conventional approach and the innovative approach, a microstrip-patch (or microstrip-patch-style) antenna for generating a monopole radiation pattern includes an electrically conductive patch or plate separated from an electrically conductive ground plane by a layer of electrically insulating material. In the conventional approach, the electrically insulating layer is typically a printed-circuit board about 1/16 in. (≈1.6 mm) thick. Ordinarily, a coaxial cable from a transmitter, receiver, or transceiver is attached at the center on the ground-plane side, the shield of the cable being electrically connected to the ground plane. In the conventional approach, the coaxial cable is mated with a connector mounted on the ground plane. The center pin of this connector connects to the center of the coaxial cable and passes through a hole in the ground plane and a small hole in the insulating layer and then connects with the patch above one-third of the radial distance from the center.

The modified feed configuration of the innovative approach is an inductive-short-circuit configuration that provides impedance matching and that has been used for many years on other antennas but not on microstrip-style monopole antennas. In this configuration, the pin is connected to both the conductive patch and the ground plane. As before, the shield of the coaxial cable is connected to the ground plane, but now the central conductor is connected to a point on the pin between the ground plane and the conductive plate (see figure). The location of the connection point on the pin is chosen so that together, the inductive short circuit and the conductive plate or patch act as components of a lumped-element resonant circuit that radiates efficiently at the resonance frequency and, at the resonance frequency, has an impedance that matches that of the coaxial cable.

It should be noted that the innovative design entails two significant disadvantages. One disadvantage is that the frequency bandwidth for efficient operation is only about 1/20 to 1/15 that of a whip antenna designed for the same nominal frequency. The other disadvantage is that the estimated gain is between 3-1/2 and 4-1/2 dB below that of the whip antenna. However, if an affected radio-communication system used only a few adjacent frequency channels and the design of the components of the system other than the antenna provided adequate power or gain margin, then these disadvantages could be overcome.

This work was done by W. Robert Young of **Langley Research Center**. *Further information is contained in a TSP (see page 1).*
LAR-16330

A 2-to-48-MHz Phase-Locked Loop

Noisy and degraded reference clock signals are taken as input and phase-locked clock signals of the same frequency are output with a corrected wave shape.

Lyndon B. Johnson Space Center, Houston, Texas

A 2-to-48-MHz phase-locked loop (PLL), developed for the U.S. space program, meets or exceeds all space shuttle clock electrical interface requirements by taking as its reference a 2-to-48-MHz clock signal and outputting a phase-locked clock signal set at the same frequency as the reference clock with transistor-transistor logic (TTL) voltage levels. Because it is more adaptable than other PLLs, the new PLL can be used in industries that employ signaling devices and as a tool in future space missions.

A conventional PLL consists of a phase/frequency detector, loop filter, and voltage-controlled oscillator in which each component exists individually and is integrated into a single device. PLL components phase-lock to a single frequency or to a narrow bandwidth of frequencies. It is this design, however, that prohibits them from maintaining phase lock to a dynamically changing reference clock when a large bandwidth is required — a deficiency the new PLL overcomes. Since most PLL components require their voltage-controlled oscillators to operate at greater than 2-MHz frequencies, conventional PLLs often cannot achieve the low-frequency phase lock allowed by the new PLL.

The 2-to-48-MHz PLL is built on a wire-wrap board with pins wired to three position jumpers; this makes changing configurations easy. It responds to variations in voltage-controlled oscillator (VCO) ranges, duty cycle, signal-to-noise ratio (SNR), amplitude, and jitter, exceeding design specifications. A consensus state machine, implemented in a VCO range detector which assures the PLL continues to operate in the correct range, is the primary control state machine for the 2-to-48-MHz PLL circuit. By using seven overlapping frequency ranges with hysteresis, the PLL output sets the resulting phase-locked clock signal at a frequency that agrees with the reference clock with TTL voltage levels.

As a space-shuttle tool, the new PLL circuit takes the noisy, degraded reference clock signals as input and outputs phase-locked clock signals of the same 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.

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.

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.

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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