

Events associated with the aforementioned data are recorded and are time-stamped with sufficient precision to enable synchronization within a time increment of 1 ms. The data are then organized into a text file and stored in a compact flash memory card, from whence the data can be uploaded.

The system (see figure) includes a base station and several self-contained, microprocessor-controlled sensor units that (1) can be mounted remotely from the base station and (2) transmit data to the base station via low-power, short-range [≤ 35 ft (up to about 10 m)] digital radio communication links in the frequency band from 902 to 928 MHz. Each sensor unit has overall dimensions of 3 by 2½ by 2 in. (about 7.6 by 6.4 by 5.1 cm) — small enough to be mounted in the confined spaces typically available for mounting on valves of the type used in the original rocket-engine-testing application. Each sensor unit is potted in a flame-retardant epoxy and designed to draw a current of no more than 0.25 A at a supply potential of 9 V, as required for safe operation in an atmosphere that may contain hydrogen. The base station is not potted; instead, it is mounted in an enclosure that is purged with nitrogen.

Each sensor unit contains two changeable battery packs and a voltage regulator that enables bumpless transfer of the load from one battery pack to the other. The temperatures of the battery packs and the microprocessor are monitored to safeguard against operation outside temperature limits. Each sensor unit includes a display-and-control panel through which a human technician can effect setup and can receive a low-battery indication. An interface port for on-board programming and serial communication is also provided. In the case of a strain-sensor unit, to minimize time-average power demand and thereby prolong battery life, the microprocessor is designed to spend most of the time in a low-power sleep mode, from which it is awakened when any valve movement is detected by a highly sensitive piezoelectric vibration-detection subunit.

The base station includes a receiver module, for each sensor unit, comprising a radio receiver and an associated microprocessor. The base station also includes another microprocessor that serves as the base-station controller, a compact flash module comprising the aforementioned flash memory card and its controller, a local-area-network (LAN)

communication module, a power supply with battery backup, and an interface to a source of time-stamp signals that conform to an Inter Range Instrumentation Group (IRIG) standard. The base-station controller correlates related data from the sensor units and generates data-event log entries, which are transferred to the compact flash module. In addition, if the system is connected into a network, these log entries can be transferred to the LAN communication module for broadcasting over the network. The compact flash module can be manually removed to obtain access to the data stored therein.

Each receiver module maintains communications and time synchronization. It relays, to the base-station controller, information on events correlated with sensory and diagnostic information from its sensor unit. Each receiver module includes an interface port for on-board programming and serial communication with a mobile computer.

This work was done by Scott L. Jensen of Stennis Space Center and George J. Drouant of Jacobs Technology.

Inquiries concerning this technology should be addressed to the Intellectual Property Manager at Stennis Space Center (228) 688-1929. SSC-00247-1

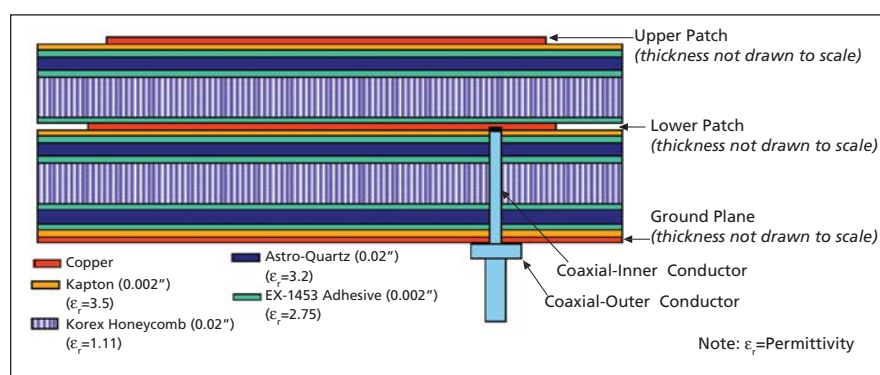
Microstrip Antenna for Remote Sensing of Soil Moisture and Sea Surface Salinity

The microstrip array design enables combined radar and radiometer instrumentation for satellite or airborne remote sensing.

NASA's Jet Propulsion Laboratory, Pasadena, California

This compact, lightweight, dual-frequency antenna feed developed for future soil moisture and sea surface salinity (SSS) missions can benefit future soil and ocean studies by lowering mass, volume, and cost of the antenna system. It also allows for airborne soil moisture and salinity remote sensors operating on small aircraft. While microstrip antenna technology has been developed for radio communications, it has yet to be applied to combined radar and radiometer for Earth remote sensing.

The antenna feed provides a key instrument element enabling high-resolution radiometric observations with large, deployable antennas. The design is based on the microstrip stacked-patch array (MSPA) used to feed a large, lightweight, deployable, rotating mesh antenna for spaceborne L-band (≈ 1 GHz) passive and active



The **Microstrip Stacked-Patch Array** incorporates three layers that function as the upper patch, lower patch, and ground plane. The lower radar patches sit on a honeycomb structure above the ground plane. The lower radar patches are fed through the ground plane, while the upper patch acts as a parasitic patch.

sensing systems. The array consists of stacked patches to provide dual-frequency capability and suitable radiation patterns. The stacked-patch microstrip element was

designed to cover the required L-band center frequencies at 1.26 GHz (lower patch) and 1.413 GHz (upper patch), with dual-linear polarization capabilities. The

dimension of patches produces the required frequencies.

To achieve excellent polarization isolation and control of antenna sidelobes for the MSPA, the orientation of each stacked-patch element within the array is optimized to reduce the cross-polarization. A specialized feed-distribution network was designed to achieve the required excitation amplitude and phase for each stacked-patch element.

The patches are thin copper/Kapton layers bonded to Astro-Quartz layers. As illustrated in the figure, three copper/Kapton/Astro-Quartz layers are

built to function as the upper patch, lower patch, and ground plane. The lower radar patches sit on a honeycomb dielectric structure above the conducting ground plane. The honeycomb is filled mostly with air and, therefore, introduces only a small loss at L-band frequencies. On the top of the radar patches sits another honeycomb dielectric structure to support the radiometer patches. All of the layers and the honeycombs are drilled to allow attachment to the feed wires to the lower patch (radar). The lower patch is fed through the ground plane, while the upper patch acts as a par-

asitic patch to introduce the 1.413 GHz.

A seven-element stacked patch array with elements forming a hexagonal pattern is the most suitable for space applications; however, a 16-element array with a 4x4 rectangular configuration is better for airborne and ground applications.

This work was done by Yahya Ramhat-Samii, Keerti Kona, and Majid Manteghi of the University of California at Los Angeles (UCLA); and Steven Dinardo, Don Hunter, Eni Njoku, William Wilson, and Simon Yueh of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-44470

Biomedical Wireless Ambulatory Crew Monitor

John H. Glenn Research Center, Cleveland, Ohio

A compact, ambulatory biometric data acquisition system has been developed for space and commercial terrestrial use. BioWATCH (Biomedical Wireless and Ambulatory Telemetry for Crew Health) acquires signals from biomedical sensors using acquisition modules attached to a common data and power bus. Several slots allow the user to configure the unit by inserting sensor-specific modules. The data are then sent real-time from the unit over any com-

mercially implemented wireless network including 802.11b/g, WCDMA, 3G.

This system has a distributed computing hierarchy and has a common data controller on each sensor module. This allows for the modularity of the device along with the tailored ability to control the cards using a relatively small master processor. The distributed nature of this system affords the modularity, size, and power consumption that better the current state of the art in medical ambulatory data acquisition.

A new company was created to market this technology.

This work was done by Alan Chmiel and Brad Humphreys of ZIN Technologies 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-18357-1.

Wireless Avionics Packet To Support Fault Tolerance for Flight Applications

A simple network interface supports fault detection and autonomous fault recovery.

NASA's Jet Propulsion Laboratory, Pasadena, California

In this protocol and packet format, data traffic is monitored by all network interfaces to determine the health of transmitter and subsystems. When failures are detected, the network interface applies its recovery policies to provide continued service despite the presence of faults. The protocol, packet format, and interface are independent of the data link technology used. The current demonstration system supports both commercial off-the-shelf wireless connections and wired Ethernet connections. Other technologies such as 1553 or serial data links can be used for the network backbone.

The Wireless Avionics packet is divided into three parts: a header, a data payload, and a checksum. The header

has the following components: magic number, version, quality of service, time to live, sending transceiver, function code, payload length, source Application Data Interface (ADI) address, destination ADI address, sending node address, target node address, and a sequence number.

The magic number is used to identify WAV packets, and allows the packet format to be updated in the future. The quality of service field allows routing decisions to be made based on this value and can be used to route critical management data over a dedicated channel. The time to live value is used to discard misrouted packets while the source transceiver is updated at each hop. This information is used to moni-

tor the health of each transceiver in the network.

To identify the packet type, the function code is used. Besides having a regular data packet, the system supports diagnostic packets for fault detection and isolation. The payload length specifies the number of data bytes in the payload, and this supports variable-length packets in the network. The source ADI is the address of the originating interface. This can be used by the destination application to identify the originating source of the packet where the address consists of a subnet, subsystem class within the subnet, a subsystem unit, and the local ADI number. The destination ADI is used to route the packet to its ultimate destination. At each hop, the sending interface uses the