tal filters with varying low- and high-frequency cutoffs. These filters, applied to the averaged signal, effect a band-pass operation in the frequency range from 150 to 250 Hz. The output of the band-pass filter is the desired high-frequency QRS signal. Further processing is then performed to obtain the power spectrum of the filtered signal, the beat-to-beat root mean square (rms) voltage amplitude of the filtered signal, certain variations of the rms voltage, and such standard measures as the heart rate and R-R interval at any given time.

*This work was done by Todd T. Schlegel of* **Johnson Space Center**, *Jude L. DePalma of Texas A & M University, and Saeed Moradi of Eix, Inc. Further information is contained in a TSP (see page 1).*

*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-23154.*

# Software for Improved Extraction of Data From Tape Storage

*Stennis Space Center, Mississippi*

A computer program has been written to replace the original software of Racal Storeplex Delta tape recorders, which are used at Stennis Space Center. The original software could be activated by a command-line interface only; the present software offers the option of a command-line or graphical user interface. The present software also offers the option of batch-file operation (activation by a file that contains command lines for operations performed consecutively). The present software is also more reliable than was the original software: The original software was plagued by several deficiencies that made it difficult to execute, modify, and test. In addition, when using the original software to extract data that had been recorded within specified intervals of time, the resolution with which one could control starting and stopping times was no finer than about a second (or, in some cases, several seconds). In contrast, the present software is capable of controlling playback times to within 1/100 second of times specified by the user, assuming that the tape-recorder clock is accurate to within 1/100 second.

*This program was written by Chiu-Fu Cheng of Lockheed Martin Corp. for* **Stennis Space Center**. *For further information, contact the Stennis Commercial Technology Office at (228) 688-1929. SSC-00156*

# Radio System for Locating Emergency Workers

**Locations and identities of workers are tracked in real time.**

*John F. Kennedy Space Center, Florida*

A system based on low-power radio transponders and associated analog and digital electronic circuitry has been developed for locating firefighters and other emergency workers deployed in a building or other structure. The system has obvious potential for saving lives and reducing the risk of injuries.

The system includes (1) a central station equipped with a computer and a transceiver; (2) active radio-frequency (RF) identification tags, each placed in a different room or region of the structure; and (3) transponder units worn by the emergency workers. The RF identification tags can be installed in a new building as built-in components of standard fire-detection devices or ground-fault electrical outlets or can be attached to such devices in a previously constructed building, without need for rewiring the building. Each RF identification tag contains information that uniquely identifies it. When each tag is installed, information on its location and identity are reported to, and stored at, the central station. In an emergency, if a building has not been prewired with RF identification tags, leading emergency workers could drop sequentially numbered portable tags in the rooms of the building, reporting the tag numbers and locations by radio to the central station as they proceed.

Each RF identification tag periodically transmits a short-burst, low-power signal containing its unique identifier code. The intervals between these transmissions are made pseudorandom to minimize interference among transmissions from different RF identification tags. Each emergency worker wears a transponder unit, which receives the codes transmitted by one or more RF identification tag(s) and measures their relative signal strengths. Each transponder also transmits a unique identifier code, which makes it possible to distinguish its wearer from other emergency workers.

The central station periodically transmits a polling command, in response to which each transponder transmits its identification code plus all of the RF-identification-tag information it has received during the preceding 5 seconds. For each such polling cycle, the central station issues only one polling command, and each transponder responds during a unique assigned time slot after that command, as determined by its code: this arrangement minimizes the "handshaking" needed to establish communication with transponders and reduces the cycle time for the location updates. On the basis of the relative strengths of RF-identification-tag signals reported by each transponder and the locations of the tags that transmitted those signals, the central-station computer calculates the location of the transponder and, hence, of the emergency worker who carries it. Thus, the locations of all emergency workers are repeatedly updated and displayed in real time at the central station.

The power for prewired RF identification tags is derived from the main AC power of the building by means of a rectifier/voltage-divider circuit, which also maintains a charge in a miniature, large-capacitance capacitor. The power demand of the RF identification tags is so low that in the likely event of loss of AC power during an emergency, the tags can continue to operate for at least 72 hours from the charge stored in the capacitor.

The design of the RF identification tags is based on a microcontroller chip. This design is amenable to easy and inexpensive integration of sensors. For instance, digital temperature sensors could be included within the RF identification tags. In that case, the information provided to the central station could also include the temperature of the wall, roof, or other portion of the structure where the tag is located. The temperature would be an additional indication of the integrity of the structure and progress of a fire through the building. The RF identification tags can be encapsulated for protection against water, smoke, and shock, and can be made from components that withstand extremes of temperature.

Most of the hardware and software of the system have been tested in a laboratory, and limited field tests have been performed. At the time of reporting the information for this article, several fire departments had expressed interest in this system.

*This work was done by William Larson of* **Kennedy Space Center** *and Pedro Medelius, Stan Starr, Guy Bedette, John Taylor, and Steve Moerk, of Dynacs Engineering Co. Further information is contained in a TSP (see page 1). KSC-12079*

# Software for Displaying High-Frequency Test Data

*Marshall Space Flight Center, Alabama*

An easy-to-use, intuitive computer program was written to satisfy a need of test operators and data requestors to quickly view and manipulate high-frequency test data recorded at the East and West Test Areas at Marshall Space Flight Center. By enabling rapid analysis, this program makes it possible to reduce times between test runs, thereby potentially reducing the overall cost of test operations. The program can be used to perform quick frequency analysis, using multiple fast-Fourier-transform windowing and amplitude options. The program can generate amplitude-versus-time plots with full zoom capabilities, frequency-component plots at specified time intervals, and waterfall plots (plots of spectral intensity versus frequency at successive small time intervals, showing the changing frequency components over time). There are options for printing of the plots and saving plot data as text files that can be imported into other application programs. The program can perform all of the aforementioned plotting and plot-data-handling functions on a relatively inexpensive computer; other software that performs the same functions requires computers with large amounts of power and memory.

*This program was written by Jason L. Elmore of* **Marshall Space Flight Center**. *For further information, contact the Marshall Commercial Technology Office at (256) 544-2615.*
*MFS-31700*