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Narrowband, Crystal-Controlled Biomedical Telemetry System

A miniature, single-channel, crystal-controlled transmitter has been developed for biomedical applications. Maximum operating range is achieved at minimum transmitter power by narrowband (±7 kHz) frequency modulation of the RF; since the radiated power is limited to meet FCC regulations in the 88- to 108-MHz band (50 μV/m at 15 m), only manufacturer's type approval is required for the device and the user does not need a license. Additionally, maximum operating range is achieved within the FCC power limitations by use of a narrow band that is consistent with the required medical information bandwidth. Since the transmission bands of commercial FM stations are relatively widely separated and carefully regulated, the biomedical transmitter frequency can be located in a guard band between stations in order to minimize interference.

For EKG and EEG applications, where an information bandwidth of 0.1 to 150 Hz is adequate, a subcarrier with a fixed frequency (approximately 1 kHz) is used with differential pulse-width modulation (DPWM). This type of subcarrier can be obtained with simple circuitry in both the transmitter and demodulator. Moreover, since DPWM is self-aligning, it can be handled effectively by magnetic tape recorders having relatively high tape speed errors. For EMG and other high frequency data signals, the RF can be frequency modulated directly without the use of a subcarrier.

The receiver used in conjunction with the biomedical transmitter is a narrowband superheterodyne FM receiver with crystal control in both conversion stages. Double conversion and a ceramic filter in the second IF stage provide a selectivity of 6 dB at ± 7 kHz and 50 dB at ± 15 kHz. The receiver is readily constructed by modifying a low-cost mobile monitor radio from the 148–174 MHz band to the 88–108 MHz band. Modification consists of tuning the RF amplifier to the lower frequency band and changing the first local oscillator from a frequency tripler to a doubler. A variable capacitor is added to the crystal circuit to allow alignment of the receiver (±10 kHz). The coupling between the RF amplifier, local oscillator, and mixer are also adjusted to the new carrier frequency.

The output from the receiver's FM discriminator is the DPWM subcarrier which is applied to the audio amplifier and subcarrier demodulator. The demodulator is a limiter which reshapes the direct-coupled rectangular waveform from the receiver; the limiting action maintains the subcarrier pulse train at uniform amplitude, and low-pass filtering of the rectangular waveform reproduces the original EEG input. For a subcarrier frequency of 1 kHz, a simple low-pass filter with 18 dB/octave rolloff at 100 Hz eliminates the sampling frequency, but the DC level information within the 0- to 100-Hz data bandwidth is retained.

Note:

Requests for further information may be directed to:

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(continued overleaf)

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Patent status:

NASA has decided not to apply for a patent.

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