LOW POWER MULTICHANNEL ELECTROMYOGRAPHIC DATA ACQUISITION SYSTEM

We describe the development of a stand-alone low power electromyograph (EMG) data acquisition system; it requires only 350 mW and provides four channels for signal measurement, with a maximum sampling rate of 10 kHz. The digitized results are available in 12 bit form. The system was designed for use with a microcomputer based myoelectric limb controller.

The EMG is produced by action potentials as they pass along muscle fibres. As additional action potentials are evoked in the muscle, the voltage of the EMG increases. Its frequency range is about 5–2000 Hz, with the main power band of the signal being in the range 20–200 Hz[1].

There are two ways of measuring the EMG signal. One involves the insertion of intramuscular needle electrodes, the other uses electrodes on the skin. For our purpose, surface electrodes only will be considered. Signals from surface electrodes have peak amplitudes of 0.1 – 1.0 mV but extraneous signals are often superimposed on the EMG (e.g. ECG, EEG, power line noise, and movement artefacts). A device which detects the EMG must have a large gain, a high common mode rejection ratio, and low noise at the input stage over the bandwidth of the EMG signal. In addition, the interface at the skin surface must conduct as little current as possible from the skin, i.e. it should not load the EMG signal source.

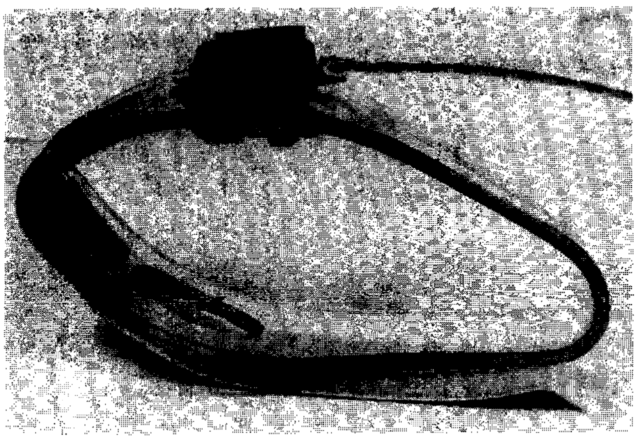

Figure 1 EMG amplifier and electrode clip used for placement of elecrode at test site

The electrode used at the skin interface is a standard commercial dry differential unit (Otto Bock) of proven durability and low d.c. offset. Dry electrodes are noisy because of poor electrical contact between electrode and skin but the noise may be minimized by pressing the electrode firmly to the skin. Other noise problems can also be reduced to acceptable levels by amplification at the electrode site, thereby reducing the effects of power frequency interference and movement artefacts.

Techniques such as implanting electrodes in the muscle site and transmitting the EMG signal to a receiver[2] by a telemetry link have been tried. They have been demonstrated only in a laboratory and are not yet clinically useful. In the interests of obtaining a flexible system for use with a microcomputer based myoelectric limb controller[3], filtering is not done at the electrode site, but in software. Shown in *Figure 1* is the custom dry electrode amplifier and a special electrode clip to aid the placement of electrodes on the skin. From the electrode site the amplified EMG signals are connected to a microcomputer by cables. Antialiasing filters are introduced on the acquisition system board.

The extensive use of CMOS units has resulted in a system which has a total power consumption of 350 mW: +15 V, 12 mA; −15V, 8 mA; and +5 V, 10 mA. Circuit diagrams are available from the authors.

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