interference suppressor," Inst. Med. Phys., Utrecht, The Netherlands, Prog. Rep. 5, pp. 194–199, 1976.
[8] J. C. Huhta and J. G. Webster, "60-Hz interference in electrocardiography," *IEEE Trans. Biomed. Eng.*, vol. BME-20, pp. 90–101, 1973.
[9] "Safe use of electricity in patient care areas of hospitals," Nat. Fire Protection Ass., Quincy, MA, NFPA 76B, 1980.
[10] F. J. Weibell, "Susceptibility of the heart to short-duration microshock," in *Proc. Annu. Conf. Eng. Med. Biol.*, vol. 20, 1978, p. 111.
[11] "Model 248J specification sheet," Analog Devices, Norwood, MA, 1980.
[12] W. N. Reining, "Bandwidth consideration for the elimination of '60 Hz' interference," in *Proc. AAMI Annu. Meet.*, 1977, p. 203.

Bruce B. Winter (S'80), for a photograph and biography, see this issue, p. 62.

John G. Webster (M'59–SM'69), for a photograph and biography, see this issue, p. 62.

Communications

An EMG Integrator for Muscle Activity Studies in Ambulatory Subjects

CHARLES G. BURGAR AND JOHN D. RUGH

Abstract—**A portable digital integrator is described for the measurement of electromyographic activity in the natural environment. Integrated muscle activity exceeding an adjustable threshold is accumulated and displayed on a seven digit LED readout in $\mu V \cdot s$. Technical specifications, schematic diagram, and application examples are provided.**

INTRODUCTION

Several musculoskeletal pain syndromes are believed to be a result of prolonged or excessive muscle activity [1]–[4]. Muscle hyperactivity is attributed to stressful life situations, habits, or one of several other factors such as bad posture, occupational demands, drug side effects, or cognitively mediated bracing. Experimental studies in the laboratory support the relationships between muscle hyperactivity and pain [5]–[8]; however, measurements in a patient's natural environment are necessary to verify these results.

Physiological data may be recorded in the patient's natural environment through several techniques. Telemetry systems have been described [9]–[11] which provide continuous analog data suitable for display on a chart recorder or storage on magnetic tape at the receiving station. Another technique involves the use of small FM tape recorders carried by the patient in his natural environment [12]–[15]. While these two recording techniques provide detailed data, they are not always convenient. The investigator is commonly faced with large amounts of data to analyze and the cost of most telemetry or FM recorder techniques often limits the investigator to studies of one or two subjects at a time. Finally, many musculoskeletal pain syndromes are cyclic in nature and therefore, may be several weeks or even months between exacerbations of the symptoms. It is difficult to justify devoting an elaborate recording system to one patient for such long periods.

Long-term investigations of muscle activity and myofascial pain carried out in our laboratory required an unobtrusive, portable, yet inexpensive EMG recorder which could be used by subjects in their natural environment over several weeks or months. Large numbers of subjects were to be recorded over extended periods and thus, simplicity of data reduction and analysis were essential. Preliminary studies indicated that cost effective data reduction could be achieved by integrating the raw EMG over specific time intervals before recording and by having patients record their own data. Rugh and Solberg [16] and Rugh [17], [18] described a portable EMG recording system employing an electrochemical integrator (E cell) for recording nocturnal muscle activity. While this instrument was found adequate for recording nocturnal EMG, the time required for the E-cell integrator to be "read out" made it impractical for daytime use where repeated readings were to be made. This paper describes a pocket-sized EMG integrator with a digital display for rapid readout.

Manuscript received September 10, 1981.
The authors are with the Health Sciences Center, University of Texas, San Antonio, TX 78284.

0018-9294/83/0100-0066$01.00 © 1983 IEEE

INSTRUMENT DESCRIPTION

The portable EMG integrator provides a seven-digit LED display of integrated muscle electrical activity. The instrument is calibrated to read in $\mu V \cdot s$ of muscle activity over time intervals ranging from a few seconds to 12 h. For simplicity of operation, only two front panel controls were made accessible to the subject: a power switch, which also serves to reset the digital integrator, and a push-button switch to read the display. A commercial portable timer [19] is used to signal the subject to record the reading at selected intervals. A threshold circuit is included which may be preset to eliminate postural muscle activity from the recordings when desired. The threshold is adjustable from 1 to 60 μV (average). The integrator accumulates total EMG activity whenever it exceeds the threshold and is linear (±5 percent) from 10 to 200 μV (180 Hz sinewave input).

Instrument-technical specifications and transfer functions were assessed using the test procedures described previously by us [20].

The input impedance is greater than 2 MΩ at 180 Hz. The frequency response is 100–310 Hz at the −3 dB points. Filter rolloff exceeds 12 dB per octave (36 dB per decade). Overall amplitude gain is 2000 (66 dB, ±1 dB). Input equivalent noise is less than 2 μV (rms). Sixty Hz suppression exceeds 90 dB. The common-mode rejection ratio at 60 Hz exceeds 80 dB, and at the geometric mean of the passband, exceeds 70 dB. Battery current consumption is less than 7 mA at 9 V. The overall physical dimensions are 3.0 X 5.9 X 1.1 in (7.5 X 15 X 2.8 cm), and the unit weighs 5.8 oz (164 g).

General Circuit Description

The block diagram shown in Fig. 1 gives a simplified view of instrument design. A differential amplifier is used to amplify

Dec 23, 2019; 3 min read; Solution Manual John G Webster Medical Instrumentation And Design Pdf Downloads 18. Solution Manual John G Webster Medical .... Solution Manual John G Webster Medical Instrumentation And Design Pdf Downloads 18 DOWNLOAD (Mirror #1). a363e5b4ee 0471676004 - Medical ...

Solution Manual Bioinstrumentation John Webster. and Design 4th medical ... Subject Download John Webster Medical Instrumentation Solution Manual - Read Free ... Solution Manual for Medical Instrumentation 4th Edition Author(s) John G.

BibMe Free Bibliography & Citation Maker - MLA, APA, Chicago, Harvard.

Design of instrument must match. Solution Manual John G Webster Medical Instrumentation And Design Pdf Downloads 18 DOWNLOAD (Mirror 1). Ae5b4ee .... Jul 31, 2020 — Solution Manual John G Webster Medical Instrumentation And Design Pdf Downloads 18 —— https://tinur.

gmail.com, 1/13/18 10:14 AM ... Solution manual Chemical Process Equipment Design (Richard Turton & Joseph A. Shaeiwitz) ... Solution manual Bioinstrumentation (John G. Webster) ... please send me the medical instrumentation application and design(webstar) solution manual free download..thanks in advance.. Solution Manual John G Webster Medical Instrumentation And Design Pdf Downloads 18 DOWNLOAD (Mirror #1). a363e5b4ee 0471676004 - Medical.. SOLUTIONS MANUAL MEDICAL INSTRUMENTATION ... edition by john g webster pdf ebook download as pdf file pdf text file txt or read download medical ... May 18th, 2020 - basic concepts of medical instrumentation medical instrumentation .... Manual. Right here, we have countless book medical instrumentation webster. Page 1/30 ... design john g webster houghton mifflin. Page 10/30 ... Solution Manual pdf Medical device. Wikipedia Tue ... Downloads 18 DOWNLOAD (Mirror #1).. Solutions to Medical Instrumentation Application and Design. Solution Manual John G Webster Medical Instrumentation And Design Pdf Downloads 18 ... 167bd3b6fa