A High-Accuracy Electronic Pressure Transducer with a Wide Temperature Range and Single Iteration Temperature Calibration

M. J. Burke
Dept. of Electronic and Electrical Engineering,
Trinity College Dublin,
College Green,
Dublin 2.
IRELAND.
mburke@tcd.ie http://www.mee.tcd.ie/~mburke

Abstract: - This article reports the development of a solid state pressure transducer for use in the measurement of blood pressure. It is intended to act as a replacement gauge for the mercury and aneroid manometers used in conventional sphygmomanometers. It measures pressure in the range 0-300mmHg (0-40kPa) with a resolution of 1mmHg (0.13kPa) and an accuracy of $\pm$1mmHg ($\pm$0.13kPa) which is displayed on a liquid crystal display. It operates from a 9V PP3 battery over a temperature range of -20 to +60^{o}C. It is fully temperature compensated and can be calibrated in a single temperature cycle.

Key-Words:- Pressure Transducer, Electronic Manometer, Blood Pressure Measurement, Sphygmomanometers, Temperature Compensation.

1 Introduction

Human blood pressure is measured using a sphygmomanometer. This instrument consists of a compression cuff wrapped around the subject's arm, a stethoscope to listen to arterial sounds and a manometer used to indicate the pressure in the cuff. The manometer may be of the mechanical aneroid type with a dial, or of the mercury-filled type having a columnar display.

A survey carried out some years ago by one of the authors showed that a large percentage of the aneroid and mercury sphygmomanometers in use in hospitals and general practice in the Rep. of Ireland were inaccurate [1]. In the case of aneroid devices, the inaccuracies were large and were caused by the inherent mechanical limitations of these types of manometers, combined with lack of regular maintenance and, in some cases, rough treatment. In the case of mercury devices, the inaccuracies were much lower and were due almost entirely to the lack of maintenance commensurate with their high frequency of usage. While intrinsically accurate when properly maintained, mercury devices suffer from all of the risks associated with toxic chemicals and maintenance must usually be carried out by professionals.

The use of mercury in instruments in which it can be replaced with a suitable alternative has already been discontinued in Sweden, Canada and many parts of the USA [2-4]. The use of mercury sphygmomanometers is currently being phased out in many European countries on a voluntary basis but this process is likely to become mandatory in the near future. This has led to the introduction of a wide and varied range of fully and semi-automatic electronic sphygmomanometers to the market.

Many of these devices do not meet high clinical standards and are consequently viewed with suspicion by much of the medical profession [5,6], whose preference is still for a manually carried out measurement in clinical situations. Meanwhile, aneroid sphygmomanometers continue to be used as portable instruments in the doctor’s case, despite their limitations. In fact, in many hospitals, aneroid manometers are being used in larger wall-mounted form to replace mercury manometers, even though not as accurate in the long term [7-9].

This article reports the development of an electronic pressure gauge that can be incorporated into existing sphygmomanometers to act as a suitable replacement for the traditional aneroid or mercury gauges, providing an accurate indication of the cuff pressure during the measurement of blood pressure. It will not alter the clinical auscultatory procedure used by the physician. This allows the superior accuracy of electronic technology to be exploited, while at the same time addressing the reservations expressed by physicians. The design presented improves on a previous version in providing operation over a wider temperature range