

## Hybrid-Type Capacitive Pressure Sensor

Heedon Seo, Geunbae Lim<sup>1</sup> and Masayoshi Esashi<sup>2</sup>

Department of Electrical and Electronics Engineering,  
Toyohashi University of Technology, Tempaku-cho,  
Toyohashi 441, Japan

<sup>1</sup>Department of Electronics Engineering,  
Yeungnam University Kyong San 712-749, Korea

<sup>2</sup>Department of Mechatronics Engineering,  
Tohoku University Sendai 980, Japan

(Received June 26, 1992; accepted August 6, 1992)

**Key words:** capacitive pressure sensor, relative pressure, hybrid type, anodic bonding, monitor groove

This paper describes a capacitive pressure sensor of the hybrid type which contains CMOS integrated circuits to detect the capacitance. Relative pressure can be measured with this sensor. The sensor is  $4.5 \times 3.4$  mm square and  $400 \mu\text{m}$  thick. In order to simplify the fabrication process of the sensor, the diaphragm thickness was controlled by means of a monitor groove. The measured sensitivity of the sensor is about 70 ppm/mmHg. The thermal zero shift and the thermal sensitivity shift in the range 5 to  $45^\circ\text{C}$  are 0.1%F.S./ $^\circ\text{C}$  and less than 0.21%F.S./ $^\circ\text{C}$ , respectively. The interface circuit is fabricated with  $10 \mu\text{m}$  CMOS technology. The output frequency from the C-F converter can be detected with only two lead wires.

### 1. Introduction

A silicon diaphragm pressure sensor transforms applied pressure into an electrical signal, based on a piezoresistive effect<sup>(1,2)</sup> or a capacitive effect,<sup>(3,4)</sup> using a deformable silicon diaphragm. As a single-crystalline silicon has superior elastic characteristics, virtually no creep or hysteresis occurs, even if static pressure is applied to the diaphragm. Because of this reliability, silicon diaphragm pressure sensors have been widely used in such application fields as medical instrumentation and automobile engine control, as well as for industrial purposes. These sensors must have sufficient sensitivity, good stability, high signal-to-noise (S/N) ratio, and so