

All Sensors **Pressure Points** are application tips to simplify designing with microelectromechanical (MEMS) pressure sensors and avoiding common pitfalls.

## **Pressure Point 4: Dual Die Compensation for MEMS Pressure Sensors**

Several pressure sensor manufactures promote product incorporating “dual die compensation.” This compensation technique is employed for very low pressure sensors where common mode errors cannot be compensated by any other means for either gage or differential pressure measurements. There are two forms of dual die compensation. One form of dual die compensation incorporates two pressure sensors but only one of the two sensors provides a pressure sensitive output. The second sensor is passive and is used solely to correct for common mode errors. The second form of dual die compensation incorporates two pressure sensors and both sensors provide a pressure sensitive signal. Both these compensation techniques are embodied in patent 6,023,978. This compensation technique applies to all common mode errors and is the only technique available to compensate for long term drift of output offset voltage. Figures 1 and 2 illustrate dual die compensation methods where common mode errors are reduced in comparison to traditional methods. Figure 3 illustrates a reference to traditional sensor construction where common mode errors are not reduced.

### **Reference Dual Die Compensation using electrical cross coupling:**

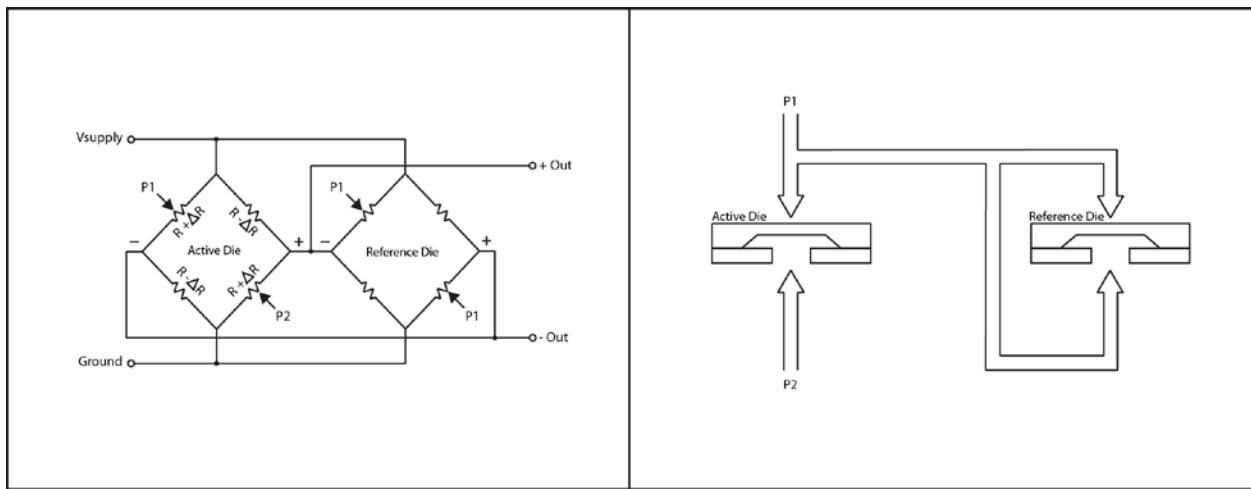
Figure 1 shows the schematic for passive dual die compensation. The active die provides an output signal proportional to pressure while the reference die is used to virtually eliminate all common mode errors of the active die. This compensation is done by electrically cross coupling the outputs of the two sensors. To provide the highest degree of compensation accuracy the two die are selected as adjacent die on the same wafer. This form of compensation will correct for output signal offset errors associated with long term drift, warm-up drift, and offset drift over temperature. This compensation is used in lieu of active dual die compensation when there are package size limitations and the output signal is acceptable at one-half the single die level. For the lowest pressures, one inch of water or less full scale, generally active dual die compensation is the preferred approach.

### **Active Dual Die Compensation using pneumatic, fluidic cross coupling and electrical cross coupling:**

Active dual die compensation has both electrical cross coupling of the sensors outputs and pneumatic cross coupling of the pressure. In doing both electrical and pneumatic cross coupling the signal strength is not reduced and the common mode error compensation is optimized. This is a result of a double negative multiplier effect. Figure 2 shows how the pneumatic cross coupling is done. For gage pressure measurement ambient pressure is applied to one side of one pressure sensor diaphragm and is also applied to the opposite side of the second pressure sensor diaphragm. The pressure being measured is also pneumatically coupled to the opposite sides of the two pressures sensors from the ambient pressure.

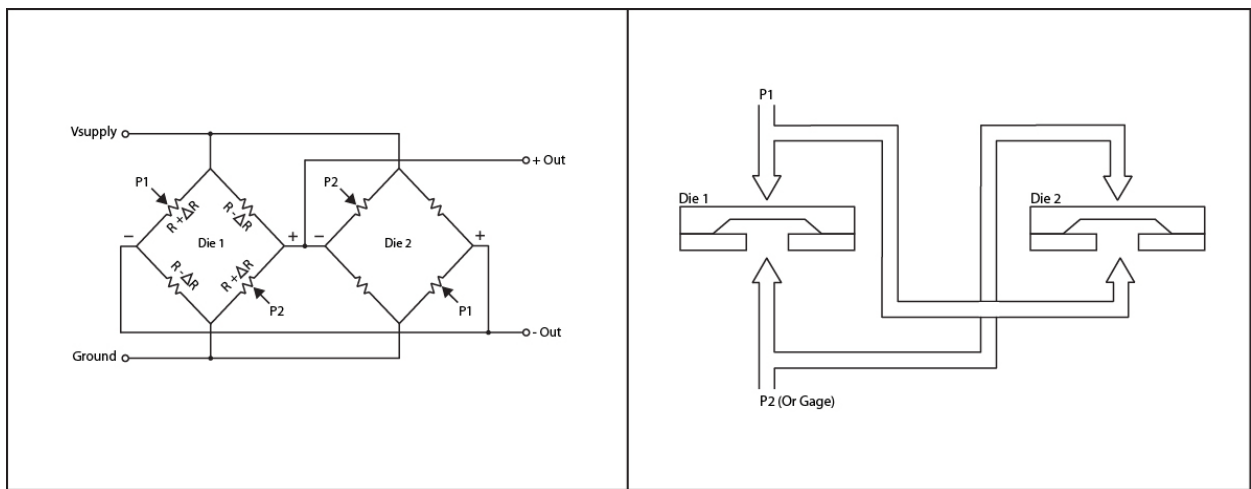
For differential pressure measurements the ambient pressure is replaced by the reference pressure (P2) and result in a differential pressure reading. The pneumatic cross coupling for both gage and differential pressure measurements is done using fluidic channels in the package housing of the pressure sensors.

The active dual die compensation is not only effective in reducing the common mode errors as in the reference dual die configuration but the front to back linearity is also dramatically improved. This is because for any given pressure measurement, the output is the average of one front side measurement and one backside measurement resulting in equal positive pressure and negative pressure sensitivities. This front to back linearity improvement together with the common mode error reduction and full output signal makes this configuration the preferred approach for very low pressure sensing and compensation.



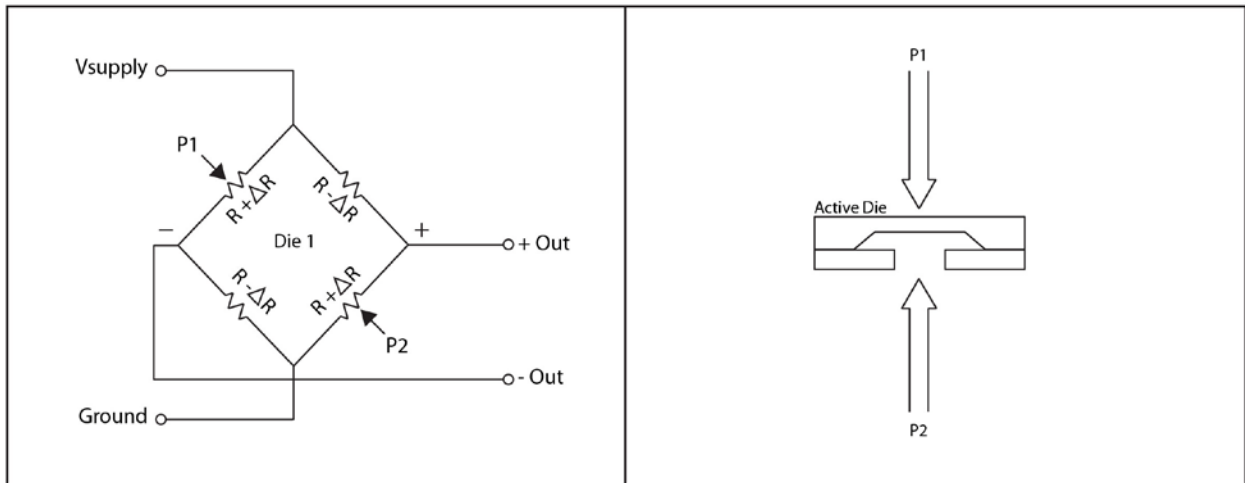
**Figure 1**

Electrical cross coupling compensation of active die using reference die



**Figure 2**

Pneumatic cross coupling compensation using fluidic channels in the pressure sensor package



**Figure 3**  
Single Die Configuration