An Interface Circuitry for CMOS-Compatible, Micromachined-Chemical Sensor Arrays

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A low power interface circuitry for micromachined-chemical gas sensor with a 2x4 array configuration is designed full custom with AMS 0.35µm technology using Cadence™. The interface circuitry includes read-out circuitry, heater control circuitry, ADC and DAC (Fig. 1). A flexible configuration for a higher resolution output, parallel, fast, accurate and small area read-out and heater control is designed. In first diagram, sensor resistances that are measured by the read out circuitry are converted to digital output signals by a flash/parallel ADC. On the other hand, digital inputs from controller are converted to analog and sent to heater control circuit, in order to determine the temperature of the sensors.

In the read-out circuitry, we can measure the sensor resistances from very low resistances up to 14 Mohm (Fig. 3), compatible with typical resistance values of metal-oxides such as SnO_x, ZnO, TiO_2, etc. Sensor resistances, which are connected in the feedback loop, are converted to a voltage output by an Operational Transconductance Amplifier (OTA) (Fig. 4). Sensors are embedded in 2x4 array configuration in parallel and Fig. 2 shows one of the 8 cells. Sensor resistance is in the feedback part of the OTA, which is used to amplify the output value. The power consumption of read-out circuitry is 58,8 mW and the power consumption of ADC is 15,6 mW.

In the heater control part (Fig 5), the temperature of each sensor is adjusted by an input voltage. The digital input from microcontroller is converted to analog by a 9 bit ladder DAC and given as parallel to all heaters. The voltage on the heater resistor is compared with the input voltage and the sensor is either heated up or measured according to the result of comparison. When the temperature of the sensor approaches the desired temperature, first the heating up rate decreases by maintaining high current in every 2 successive clocks, then when it reaches the desired temperature, only a current of 1mA is sent in order to keep voltage constant to measure the sensor resistance.

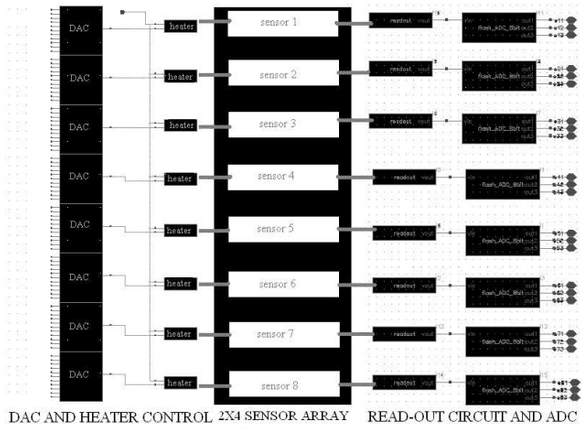

Fig.1: Overall Schematic

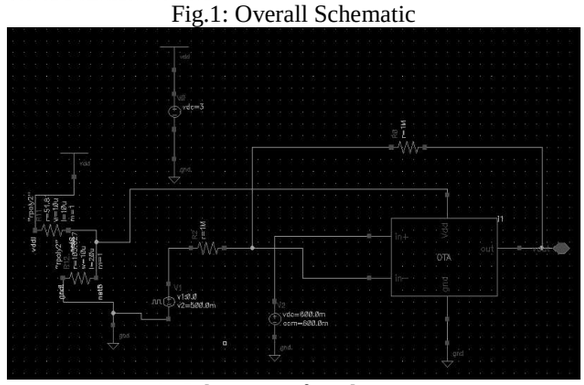

Fig. 2: Schematic of readout circuitry

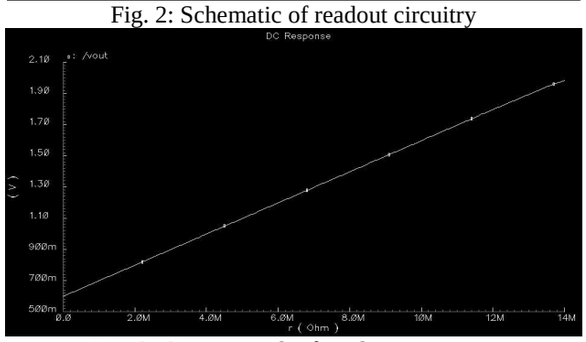

Fig. 3: Output graph of read-out circuitry

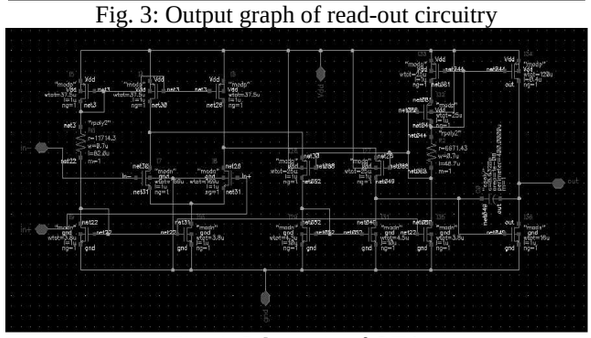
Fig. 4: Schematic of OTA

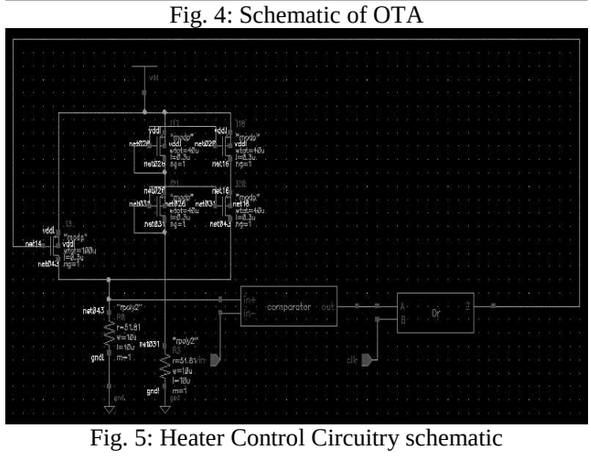

Fig. 5: Heater Control Circuitry schematic

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