AMSYS
Analog - Digitale
Mikromechanische
Sensorsysteme

- MS8607-

The Worldwide Smallest Weather Station

AMSYS [1] presents a new multi-functional smart-sensor. The 24-bit triple sensor MS8607 (MEAS Inc.) measures tree environmental physical values: barometric pressure, ambient temperature and the relative humidity with high accuracy.

The MS8607 is an OEM sensor which is supplied in a reflow-capable LGA package.

This multifunctional sensor is the result of the high integration density of modern semiconductor processes coupled with perfected assembling and packaging technology.

On MS8607 three physical values (barometric pressure, ambient temperature and relative humidity) are measured using three different principles of measurement. The combined MS8607 module consists of just two MEMS (micro-electro-mechanical sensing elements) and a high integrated signal conditioning ASIC.

Figure 1: view of the MS8607 (MEAS)

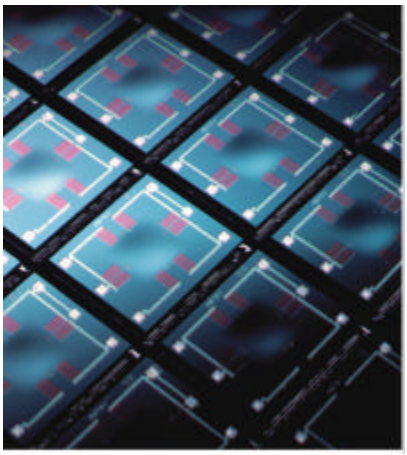
All three components are mounted on a small PCB and connected internally to one another and to the external connecting pads by bonding technology.

The first component is a piezoresistive pressure sensing element which is manufactured in wafer form with the help of semiconductor-specific processes, such as gas diffusion, plasma etching and anodic bonding. This silicon chip records the barometric pressure and the temperature with high precision.

The second component is a capacitive sensing element which can measure relative humidity. This comprises a capacitor with very thin layers in a sandwich structure (see *Figure 3*).

Finally there is a C-MOS ASIC inside for the signal conditioning and for the electrical calibration.

Multifunctional Sensor MS8607



The piezoresistive MEMS is a silicon absolute pressure sensor [3] which is shaped like a cube with an area of very few mm^3 (typically $4mm^3$). Inside it is a vacuum which is sealed by a thin membrane. This membrane deflects when pressure is applied. In *Figure 2* the deflection in the membrane caused by atmospheric pressure is discernible. The sensing element therefore measures atmospheric pressure in relation to the vacuum in the sensing element (< 10 mbar).
When pressure is applied a Wheatstone resistance bridge implanted in the surface of the sensing element generates an unamplified analog output signal (˜ 100mV) which is proportional to the change in pressure.

Figure 2: silicon absolute pressure sensing element in wafer form

The second measurable variable recorded by MS8607 (temperature) is logged by a temperature-dependent resistor in the pressure sensing bridge. This means that the value measured is directly equivalent to the temperature of the ambient air.

The capacitive sensing element works on the basis of a dielectric polymer film which is inserted between two electrodes and sensitive to humidity (*Figure 3*). This is thus an ultra-miniaturized, humidity-sensitive capacitor.

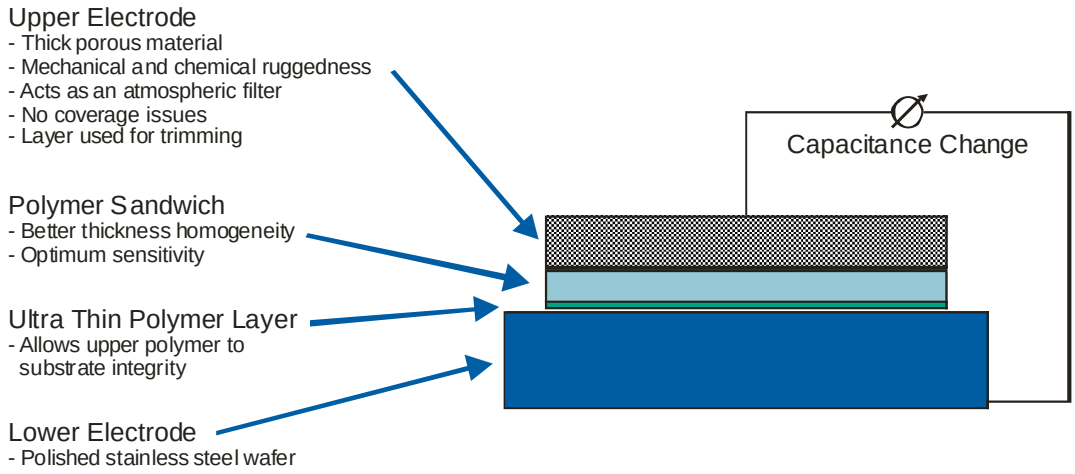


Figure 3: diagram of a microelectromechanical humidity sensing element

With a change in humidity, relative permittivity e_r changes. (The permittivity of a material between the capacitor plates indicates by which magnitude the capacitance of a capacitor increases with an insulator as opposed to a capacitor in a vacuum or air). According to the following equation:

$C = e_O e_r A/d$, (where e_O is the electric constant, e_r the relative permittivity, A the capacitor area and d the distance between the plates)

a change in relative permittivity yields an analog voltage signal which is dependent on the humidity and processed parallel to the pressure/temperature signal by the signal conditioning electronics.

Multifunctional Sensor MS8607

Description of MS8607 *[2]*

In the case of MS8607 this is an integrated S? ADC which amplifies and digitizes the non-compensated analog voltages of the sensing elements (see *Figure 4*).

The pressure and temperature are converted into 24-bit data words and the relative humidity into a 16-bit word.

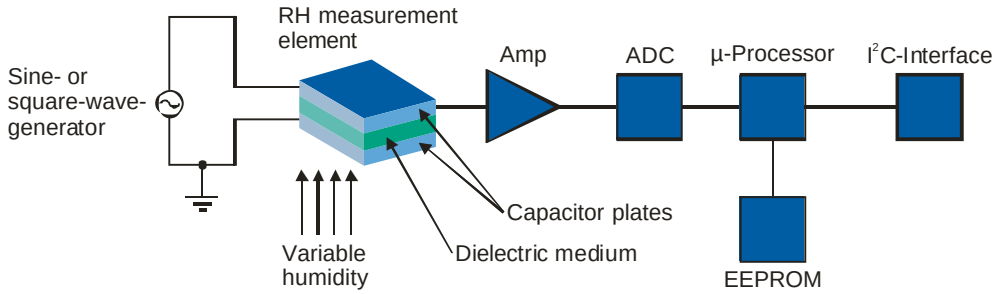


Figure 4: integrated humidity signal conditioning on triple-sensor

After signal conditioning the data words for the barometric pressure, temperature and relative atmospheric humidity are available as independent output signals in I²C format. For the pressure and the temperature individual coefficients stored on the integrated EEPROM during manufacture permit highly precise correction of the analog measurements by an external microprocessor using a simple algorithm. With this operation the measured pressure and temperature values are individually linearized, temperature compensated and calibrated. With the relative humidity digital value (see *Figure 4*) the relative humidity is obtained by a simple formula with help of the external microprocessor.

For the pressure- and temperature measurement the possibility exists to adjust the OSR (over sampling ration) and to set the conversion time and the power consumption in multi-steps.

This does apply also for the humidity measurement. Furthermore an integrated heater in the humidity measurement element serves for a functionally analysis, because relative humidity drops upon a rising temperature.

Using the MS8607 for mobile applications with a long life time the battery status can be monitored.

To ensure the data integrity the transfer of the pressure, temperature- and the humidity values are controlled by an implanted CRC (cyclic redundancy check).

In principle the pressure range of the MS8607 lies between 10 and 2,000 mbar. Within the barometric range of 300 to 1,200 mbar (calibration range) the overall accuracy at 25 °C is ±2.0 mbar. The pressure resolution is given as 0.016 mbar.

The humidity ranges from 0 to 100 % RH and has an overall accuracy of ±3.0 % RH (at 25 °C within a range of 20–80 % RH). The resolution is 0.04 % RH.

The temperature sensor measures between -20 °C to +85 °C with an overall accuracy of ±2.0 °C and a temperature resolution of 0.002 °C.

MS8607 does not require any additional components and is designed for a wide supply voltage range of 1.5 to 3.6 V. The module features a standby current consumption of typically 0.03 µA and is thus particularly suitable for mobile devices. The optimum compromise between the converter rate and average current consumption can be individually set using the application software and thus adjusted to suit the specific application.

Multifunctional Sensor MS8607

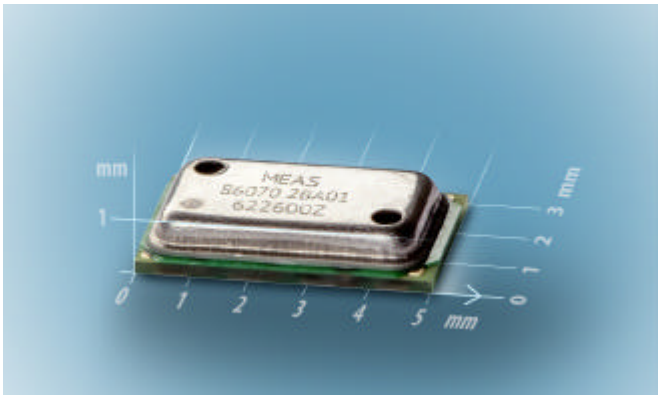


Figure 5: triple sensor module MS8607

MS8607 (*Figure 5*) consists of an FR4 substrate onto which the electronic components and a metal cap have been mounted. This allows an LGA (land grid array-) package measuring 5.0 x 3.0 x 1.0 mm³ to be realized (with contacts on the reverse only) which is suitable for reflow soldering.

Thanks to its optimized manufacturing process MS8607 is also of interest to large-scale projects, where cost is an important issue.

Applications

The new triple MS8607 sensor module for barometric pressure, ambient temperature and relative humidity satisfies the demands made of intelligent mobile sensors thanks to its slight dimensions, wide supply voltage range and low current consumption.

Possible applications include indoor navigation and fitness devices which in the future will define how multifunctional sensors are used.

Sensors such as MS8607 are especially suitable for use in consumer electronics, such as smart phones, tablet PCs and mobile weather stations.

Typical industrial applications continue to be in the field of home automation (the smart home), such as in heating/ventilation and air conditioning systems, and in room surveillance equipment (as used in museums, for instance). Household appliances, humidifiers, industrial dryers and inhalation devices are further areas of application.

MS8607 is of particular interest when monitoring the operating conditions of sensitive electronic devices, such as in electrical cabinets and computer systems, for example, and for the intelligent transportation control of critical goods, such as those shipped in containers.

Almost all of these areas of application fall under the bracket of Industry 4.0 for which these multipurpose sensors have been designed.

In boosting the efficiency of and consistently miniaturizing these devices the price/performance ratio has been improved to such an extent that triple sensor MS8607 is perfectly suitable for use in cost-sensitive applications.

Conclusion

Pressure, temperature and humidity module MS8607 belongs to the new generation of electronically calibrated sensors whose properties make them ideal for use in mobile applications. They have attained a maximum degree of miniaturization and with their high resolution and minimum error quota open up new avenues in measurement technology. They are core components in modern, mobile measurement reading devices.

With regard to IoT (Internet of Things) requirements this new generation of highly integrated pressure, temperature and humidity sensors creates the pertinent contact points of this network with physical reality, thus promoting the diversity of our new 'smart' world.

Literature

[1] The AMSYS website: www.amsys.info

[2] MS8607 datasheet: www.amsys.info/sheets/amsys.en.ms8607.pdf

[3] White paper: www.amsys.de/sheets/amsys.en/wp02.pdf[1]