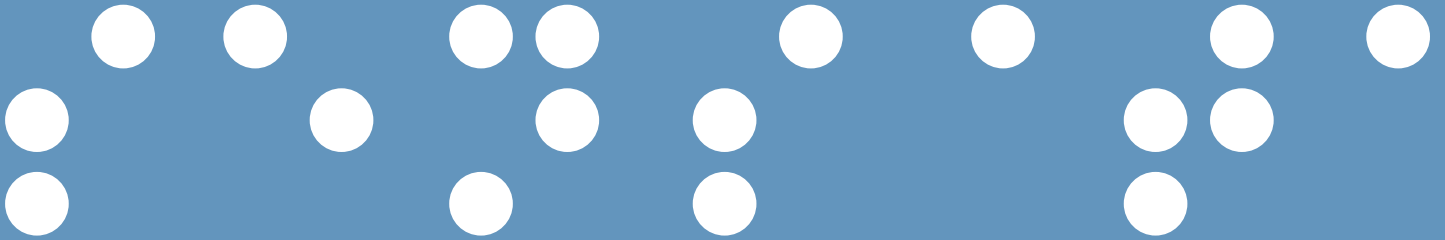


INDUSTRIAL SENSING TECHNOLOGIES




Sensata
Technologies

The World Depends on Sensors and Controls



Sensata Technologies: About us.

Sensata Technologies provides leaders in the global automotive, appliance, aircraft, industrial, and HVAC markets with sensing and protection solutions. Our mission is to improve safety, efficiency, and environmental protection for millions of people. Although Sensata Technologies is headquartered in Attleboro, Massachusetts, our European customers are supported by the best application and quality engineering, sales and customer support team out of Sensata's European business and technology development center located in the Netherlands. Supply flexibility within Europe is ensured by delivering all products from a central warehouse: our logistics center in the Netherlands. Sensata Technologies has nine technology and manufacturing centers in eight countries, and sales offices throughout the world.

The supplier you want. The partner you need.

At Sensata Technologies we do all we can to ensure your satisfaction. We implement our unsurpassed experience and expertise to focus on your needs. We adhere to the highest technical, manufacturing and testing standards. Our experts work with you to ensure the quality and precision it takes to meet the most demanding application requirements. No wonder, a world of businesses relies on the more than 600 million sensor and control devices we manufacture each year to optimize our customers' own leading-edge technologies.

WE DO IT ALL FOR YOU

The world depends on sensors and controls.

With more than 30 Sensata sensor and control devices in a typical home, Sensata Technologies is the world's leading supplier of sensors and controls. By listening to our customers, we understand their business. A few of the features that make us our customers' first choice – worldwide:

- Our rugged designs and in-house testing facilities ensure consistent quality.
- We are customer focused and globally deployed to satisfy your specific needs.
- Our Business Centers are close to your markets.
- We insist on the highest manufacturing standards – while offering scale benefits.
- We comply with European and other international regulations and standards.
- Our strong involvement and standards in automotive and industrial markets drives us to increase system performance and safety standards while lowering costs and emissions.


Where are Sensata products found?

Where increased safety and performance are required and where improved machine productivity and efficiency are desired. You will find our products in an endless number of applications including HVAC and refrigeration, transportation, construction, agricultural, and material handling equipment. Our products also support compressors, pumps, hydraulics, pneumatics, process control and factory automation equipment, alternative fuel systems, and much more.



SENSATA'S TECHNOLOGY AND MANUFACTURING CENTERS ARE ISO / TS16949 AND ISO 14001 CERTIFIED THROUGHOUT THE WORLD AND OUR PRODUCTS COMPLY WITH WORLDWIDE REGULATIONS AND STANDARDS.



 Sensata Technologies has already produced over 500 million pressure sensors.

PRESSURE

Sensors and switches that are as rugged as they are sensitive.

Sensata Technologies offers a wide choice of switching and sensing solutions for pressure applications of every kind. Whether you need only one or two switching points for a safety application or whether you prefer to have control over a complete pressure range with more functions, Sensata Technologies carries the right product in its portfolio.

By focusing our unparalleled engineering and manufacturing expertise on your needs, we will meet the highest expectations of all – your own. Products range from Klixon® pressure switches to ceramic capacitive, Microfused Strain Gauge and MEMS-based sensors. While all of these pressure sensing products are tailored to specific applications, they have the following benefits in common:

- Excellent quality at competitive prices
- Superb accuracy and stability over life
- Robust against environmental influences

SENSATA'S PRESSURE PRODUCTS: TOP CLASS

- Klixon® pressure switches: Reliable pressure control by means of on / off electrical switch
- Ceramic Capacitive Pressure Transducers (CPT): Best value solution for medium pressure applications
- Microfused Strain Gauge pressure sensors (MSG): The world's first choice for high pressure applications
- Micro-Electro-Mechanical-Systems pressure sensors (MEMS): True answer to differential and relative low pressure applications



Sensata Technologies' pressure product portfolio serves many industrial applications – covering all sensing principles from absolute to relative and differential, as well as pressures ranges even over 2500 bar.

Sensata Klixon® pressure switches are designed to meet the needs in a variety of industrial applications requiring precise repeatable pressure control over a wide range of ambient conditions. The reliable and durable construction uses the Klixon® snap-acting disc, which opens or closes a circuit by responding to a change in pressure.



Sensata's pressure products are essential elements in HVAC/Refrigeration designs – they have become an integral element of control systems designed to provide compressor protection against excessive stress caused by anomalies such as loss of charge.



Features & benefits:

- NO/NC contact logic
- Compact and direct mount
- Pressure capability up to 150 bar
- Long cycle life
- High volume, wide portfolio, competitive price

TYPICAL APPLICATIONS:

- High and low limit safety control in commercial and residential air conditioning systems
- Fan-cycling control in commercial refrigeration
- Engine, hydraulic and air conditioning pressure control for Off road – and Specialty vehicles
- Compressor and pump control
- Process control and Automation

A single hydraulic pump or air compressor can provide power and control for numerous machines or machine functions. Since compressed air systems consume considerable amounts of energy, improvements are being made to increase pressure, flow, reliability and efficiency. Sensata's pressure sensors support these market trends.



Sensata Technologies' Ceramic Capacitive Pressure Transducer (CPT) with its proven ceramic capacitive technology has been on the market for many years. Key application requirements like high accuracy over wide temperature range, good repeatability, multiple packaging, robustness and, last but not least, best value proposition have been addressed by Sensata's design and process experts. Our large portfolio with a variety of mechanical and electrical connections creates a broad range of innovative combination possibilities in order to comply with many application requirements. The CPT is ideally suited for environmentally demanding industrial applications where long-term reliability and accuracy is a must.



Features & benefits:

- Gasket-sealed and hermetic pressure sensors with multiple Input/Output options (incl. internal voltage regulation, 4...20mA, etc.)
- Superior performance and long term reliability
- Solid state operation coupled with ease of integration and installation
- Low hysteresis sensing element with excellent thermal stability
- Outstanding EMC performance and high dielectric strength associated with case isolation up to 1800 V

The most accurate technologies for a true **Differential Pressure Sensor (DPS)** are Micro-Electro-Mechanical-Systems (MEMS). Sensata Technologies' patented MEMS products offer the best-value solution for OEM differential pressure transducer applications.

TYPICAL APPLICATIONS:

- Off road – and Specialty vehicles (including engine and vehicle stability control, transmission and steering)
- Air conditioning and refrigeration
- Hydraulics and pneumatics
- Compressors and pumps
- Process controls and automation
- Medical controls

Sensata Technologies’ Microfused Strain Gauge pressure sensor (MSG) allows for the best control in an industrial system. A piezo-resistive technology has been selected, whereby the strain gauges are glass fused onto a metal membrane and hermetically sealed. The package is designed cost-effectively and allows easy adaptation of the hydraulic and electric interfaces such as small and large port fittings and a wide variety of connectors. The sensing element can easily be adapted for different pressures, and signal conditioning can be offered with various diagnostics.



Sensors for mobile hydraulics need to withstand extremely high environmental impacts. Sensata’s MSG sensors are based on rugged, fail-safe measuring technologies in order to withstand vibration, shock and aggressive media. Measuring hydraulic charge pressure and system pressure drives energy efficiency.

Features & benefits:

- Suitable for high-pressure applications even over 2500 bar
- Highly accurate operation over wide temperature range
- Unmatched resistance to vibration and electromagnetic interferences
- Inherent hermetic structure for unparalleled media resistance
- Stainless steel housing

TYPICAL APPLICATIONS:

- Brake pressure, vehicle stability control, diesel common rail, transmission and electro-hydraulics in Off road – and Specialty vehicles
- CO₂ pressure in HVAC/Refrigeration systems
- Alternative fuel system pressure

Initially Sensata Technologies
manufactured exclusively
Klixons®.

TEMPERATURE

Technology that heats it up and cools it down.

Sensata Technologies' combined pressure and temperature sensors deliver the benefit of both pressure and in-stream temperature measurement in a single robust package. This integrated solution provides not only high performance and easy single mounting to your system but is also more cost-effective than two discrete sensors. This product combines a ceramic capacitive sensing element with a fast and accurate NTC thermistor. A temperature output capability can be also added to our high pressure MSG technology as well as to our low pressure MEMS technology.

Sensata Klixon® temperature switches have met a broad range of specific application requirements for over 50 years. We offer a wide portfolio of fixed temperature thermostats for a variety of commercial applications. The tamper-proof Klixon® snap-acting disc provides reliable switch actuation and the outstanding thermal response provides excellent temperature control for a wide range of control systems.



TYPICAL APPLICATIONS:

- Air conditioning and refrigeration – including CO₂ system control
- Alternative energy management
- Engine controls and monitoring
- Compressors and pump control

ACCELERATION

Technology that helps products get ahead.

Sensata Technologies' Capacitive Acceleration Sensor (CAS) is a very reliable solid state device. It is backed by years of production experience and designed to measure acceleration or tilt angles. CAS shares its packaging design, its sensing technology and its signal conditioning electronics with the ceramic capacitive pressure transducer, whereas acceleration or tilt changes the capacitance of the capacitive sensing element. CAS is tailored for assembly concepts that employ low-cost, high-quality assembly approaches. The sensor qualifies for interior, under-hood or chassis mountings.

Features & benefits:

- Suitable for +/- 1 to 10 g range
- High sensitivity from 3 to 0.2 V/g
- No temperature compensation required
- Resistant to 200 V/m EMC excitation

Sensata's CAS products provide enhanced stability and control in cornering and severe handling manoeuvres of Off road vehicles. Thus, they improve riding comfort, safety and vehicle agility.

TYPICAL APPLICATIONS:

- Vehicle stability/Tilt angle control
- Smart suspension and braking systems
- Traction control systems
- Rough road detection
- Inclination sensing
- Shock (impact) detection and logging at rental/lease equipment



Sensata Technologies has more than 15 years of experience in automotive acceleration sensing.



! Since 1987 Sensata Technologies has manufactured sensors for multiple automotive applications.

MASS AIRFLOW

Technology that lets engines breathe easier.

Sensata Technologies' mass airflow sensors are designed for critical measurement applications that require high accuracy of the net mass airflow and a fast response. Thanks to the transducer element's robust design, contamination caused by dust particles and water droplets can be easily avoided. Superb signal conditioning, combined with cost-effective manufacturing and component sourcing, result in a sensor with an outstanding price/performance ratio. Sensata's OEM mass airflow sensor can optimize your design with exceptional performance and precise mechanical configuration.

Features & benefits:

- Measuring range: 3 kg/h up to 1000 kg/h
- Superior accuracy over a wide temperature range
- Excellent pulsation recognition
- Various output circuitries

TYPICAL APPLICATIONS:

- Off road – and Specialty vehicle engine air intake
- Alternative energy management control
- Environmental climate control
- Medical control



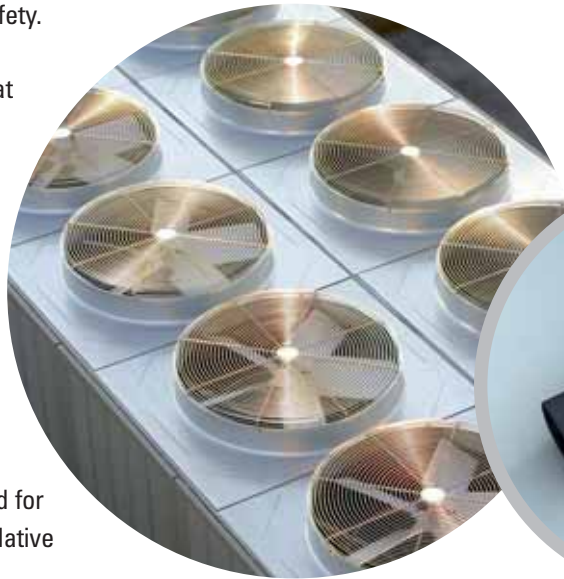
Mass Airflow sensors measure the air mass in the intake manifold of a diesel engine. The sensor uses the mass airflow engine mapping and fresh air measurements to determine the exact amount of re-circulated exhaust gas. This is then adjusted to maintain stable combustion without high nitrogen-oxide emissions.

HUMIDITY AND GAS

Technology with a “nose” for success.

Sensata Technologies’ air quality and humidity sensors provide advanced sensing solutions for tomorrow’s building automation market. The climate control industry is driven by the need for fast, reliable and affordable sensors for monitoring thermal, gas and humidity levels. These sensors can control the entire atmosphere of a building while creating the highest degree of environmental comfort and safety.

Accurate gas detection is what Sensata’s air quality sensor is all about. It contains electro-chemical sensing cells that detect unhealthy gases like nitrogen oxides as well as a large variety of Volatile Organic Compounds, which build up smells. In addition, Sensata also offers sensors, which use innovative thin-film technology, to set the standard for automatic temperature and relative humidity control.



The optimization of air conditioning refrigerant loops requires not only pressure sensors but also calls for competitively-priced and maintenance-free gas analyzers and humidity sensors. Where contemporary HVAC systems provide accurate, but basic, temperature control, the near future will see increasingly sophisticated systems in building automation with the help of humidity and air quality sensors.

TYPICAL APPLICATIONS:

- Comfort control in commercial and residential air conditioning units
- System optimization of commercial refrigeration and air compressors applications
- Safety of process equipment e.g. food transportation, processing and storage
- Indoor air quality control

Sensata Technologies’ sensors are contributing more to the safety and efficiency of an industrial system than any other technology.



SENSING TECHNOLOGIES

Technologies that make ideas work.

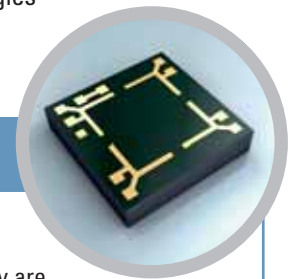
Of all the pressure sensing technologies some of the most sophisticated ones have been developed for automotive applications. Why? They must be highly accurate and stable. They must be robust against environmental influences and available at an affordable price in high volumes. For this reason, the most widely used pressure sensing technologies utilize transducer materials made of silicon, ceramic or stainless steel.

MEMS-based pressure sensors.

Silicon is an ideal material for integrating piezo-resistive resistors, which are often integrated with signal conditioning. These solutions can be provided at low cost – especially for low pressure applications. Silicon or MEMS (Micro-Electro-Mechanical-Systems) are highly sensitive and very small.

PIEZO-RESISTIVE SENSING ELEMENTS

Piezo-resistive structures are formed in monolithic silicon by using standard semi-conductor manufacturing processes. They are also used for mass production of solid state integrated circuits. After processing of the resistive structures and metallization for interconnection, wet etching techniques are used to create a thin pressure diaphragm at the location of the stress-sensitive piezo-resistive structures.



CERAMIC SENSING ELEMENTS

A ceramic substrate and diaphragm are plated with a metal that serves as electrodes. While the ceramic parts are united by a glass seal, and maintain a well-controlled gap, the metal electrodes form an electrical capacitance. Applying pressure causes a change in the gap between substrate and diaphragm, which in turn changes the capacitance of the sensing element.

In terms of cost-effective packaging techniques, the silicon element is either bonded to glass, silicon or ceramic (by means of a flexible epoxy). The maximum pressure allowed is limited by the adhesion of the silicon element. Because higher pressures necessitate design changes and additional costs, other technologies like the following are preferred.

First choice: Ceramic Capacitive Pressure Transducers (CPT).

Ceramic transducers using a capacitive measurement principle are the world's first choice for medium pressure ranges. These transducers are well known for their high sensitivity and low power consumption. The materials they use are impervious against harsh media and the transducers are very stable over a wide temperature range.



Packaging is very simple, by clamping the ceramic transducer in a metal can and using an elastomere seal for medium pressures. This principle is commonly accepted as the most cost effective pressure sensing technology for pressure ranges between 1 and 100 bar.

Best performance: Microfused Strain Gauge pressure sensors (MSG).

Finally, steel membranes with piezo-resistive resistors have been adopted as the common transducers for high pressures. Various concepts exist having in common the piezo-resistive resistors placed on a metal diaphragm, where stresses or strain from deflection under pressure induce the piezo-resistance effect. The difference is the realization of the resistors, where stable performance over temperature, minimum drift over life time, high sensitivity and lowest cost has been achieved. Also here, packaging is rather simple as the diaphragm is constructed in one part with the port interface.

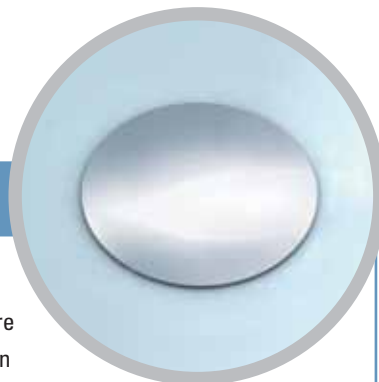


STRAIN GAUGES

Sensata Technologies use bulk micro-machined silicon strain gauges that are glass fused to a steel diaphragm. These strain gauges are realized in monolithic silicon in a batch process. One (6 or 8 inch diameter) silicon wafer will yield thousands of strain gauge elements.

KLIXON® PRESSURE SWITCH

The electro-mechanical switch utilizes a snap-acting stainless steel disc that reverses its curvature when pressurized to a customer specified actuation pressure. When the disc snaps, it opens or closes a set of electrical contacts by means of a transfer pin. Resetting the switch occurs automatically when pressure drops below the release value.



KLIXON





But it is not only offering a capable technology for a certain pressure range that led to the industry's choices. Just as important is the ability to manufacture in high volume at competitive costs. Sensata Technologies has built a portfolio that contains all of these leading pressure sensing technologies combined with manufacturing strategies to deliver the highest quality at an affordable cost. That's what makes Sensata's pressure products the preferred choice for the global industry.

Mass Airflow sensors.

Sensata Technologies uses hot-film technology for its mass airflow sensor products. The basis for this approach is a bulk micro-machined silicon transducer which, thanks to extremely responsive airflow dynamics, is able to measure forward and backflow movements.



Electro-chemical sensors.

Sensata Technologies offers a range of air quality sensors that measure the concentration of a number of gasses using MetalOxide Semiconductor (MOS) technology where oxide-based thick films are deposited onto silicon micro-machined substrates. These micro-sensors are equipped with electrodes that enable extremely accurate measurement of the resistance of the sensing layer. To ensure quick, sensitive, and selective detection, heaters are incorporated into the substrate. Changes in the composition of the ambient atmosphere create a corresponding change in the resistance of the sensing layer, allowing the sensor to detect a wide range of toxic and explosive gases even at very low concentrations.

Relative Humidity sensors.

Sensata Technologies' Relative Humidity (RH) and Dew Point sensors are based on a polymer capacitive type sensing technology, similar to the technology used in the pressure sensors that Sensata has been producing for a long period of time. The humidity in the probed air changes the dielectric capacity of the polymer layer in the sensing element. The change in capacity of the RH sensing element is subsequently converted into a calculated relative humidity and with the help of accurate NTC elements, a dew point is calculated.



LET'S MEET

Sensata Technologies just doesn't make sensors, we deliver solutions.



Our business is to help increase your business. That is why our manufacturing facilities are global while our salespeople, application engineers, consultants and distributors are local. Being where you want us when you need us, enables us to quickly respond to challenges pertaining to any aspect of our sensing or control technologies.

NOTES

*With compliments.
Your Sensata Technologies partner*



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