Integrated Sensor System

- An integrated sensor is the core technology of a sensor without the package.

- It allows for multiple sensor technologies to be combined or "integrated" into a single plug-and-play assembly. Integrating as little as 3 sensors can reduce leak points by 75%, reduce footprint by up to 80%, while also reducing the complexity and optimizing the end-user's experience.

- The concept of sensor integration is close to the sensor fusion term, which is defined as “the art of processing data from multiple sensors with an aim to replicate a physical environment or induce intelligence to control a phenomenon with increased precision and reliability.”

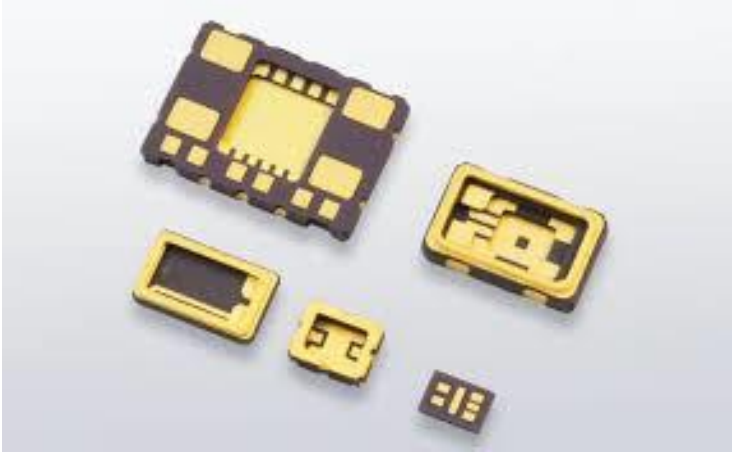
- Sensor fusion or integration is evolving rapidly as the basis of robust control systems that can make sense of imperfect input despite the environment in which it operates

- The integration of sensors in control and automation systems has received a great deal of attention from a considerable number of researchers and from the industrial community in the last years.
- Emphasis is placed on the importance of creating improvements in control and automation systems in order to meet the challenges of developing and refining new applications.
- These systems have to integrate a variety of sensory information and human knowledge for the sake of efficiently carrying out tasks with or without human intervention.

- The medical industry also makes frequent use of integrated sensors. Many sensors are able to identify minute amounts of a chemical.
- These can be used by pharmaceutical research groups and hospital physicians to closely monitor an experiment or medical test.
- The compact size of an integrated sensor makes it possible to gather data that would be inaccessible by other means.

Sensor Packaging

- Packaging methods for mechanical sensors and chemical sensors are described High reliability, small size and small packaging cost are required for many sensor applications. Electrical and mechanical instabilities which originate from surface ion and packaging stress respectively are reduced.



Types of Sensor Packaging

- In recent years, the trends in the assembly, packaging and interconnection technologies of sensors have been driven both by a technology push and by application demands. In the field of the manufacturing of sensors, especially new technologies for substrates and housings of sensors were developed.

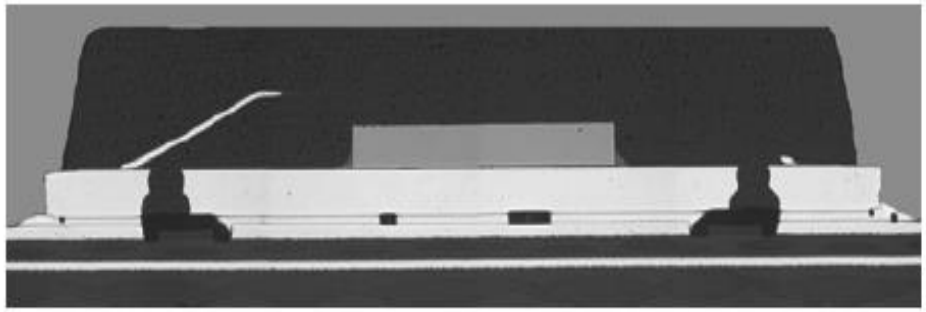
Sensor Packaging Types :

1. Standard Packages
2. Pre-Moulded Plastic Packaging
3. Hermetic Packaging
4. Water-Level Packaging and Testing

1.STANDARD PACKAGING

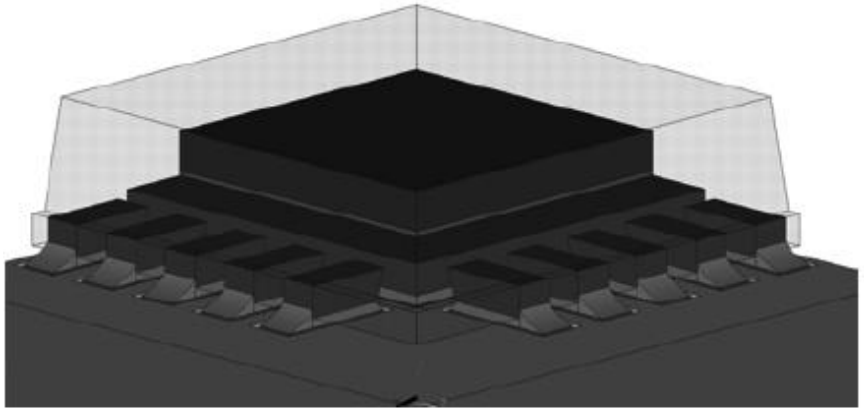
- Today, many sensor types are supplied from semiconductor Hall sensors, transfermoulding with reactive epoxy compounds is the dominating process. For these package types, costs of approximately 1 $ per pin have to be taken into account.
- Additionally in the field of ICs, so-called chip-scale-packages (CSP) have become quite relevant. These are surface-mounted devices with a package which is only 20 % larger than the size of the chip.

Chip-scale packages for sensor IC packaging :



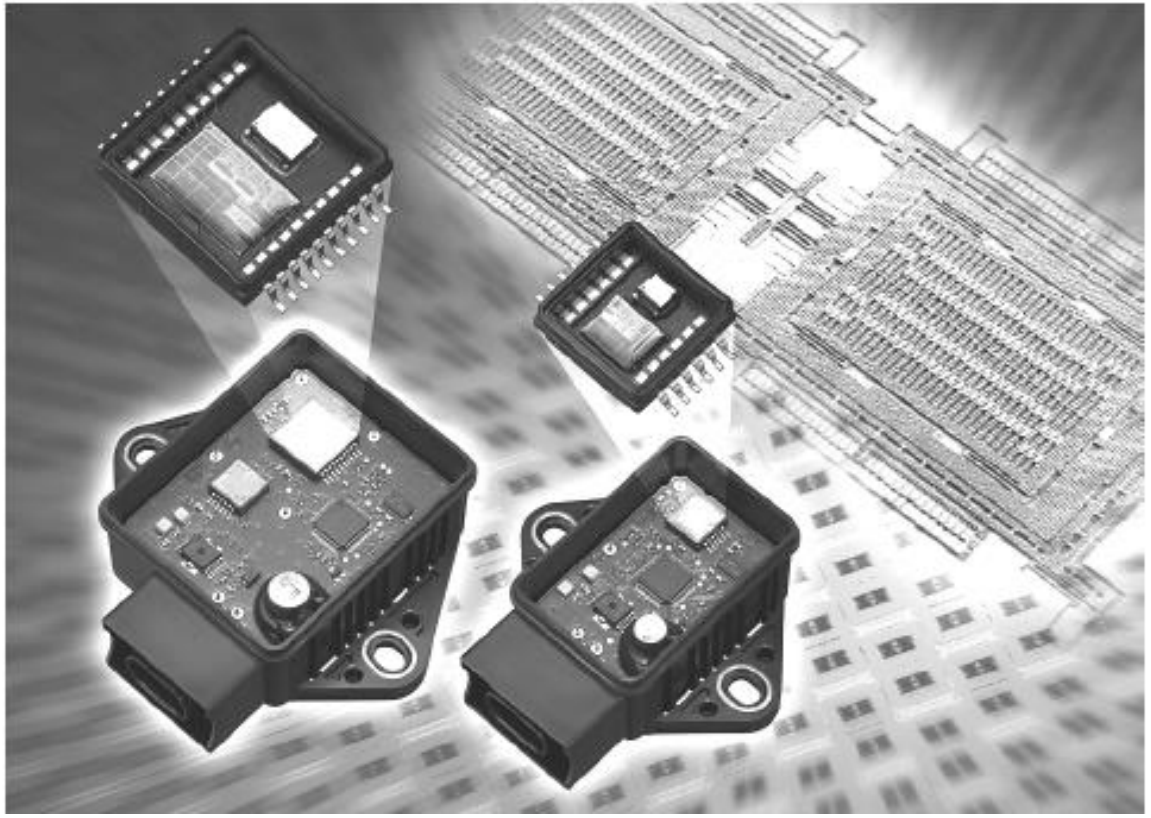
quad-flat-no-lead cross section

Finite Elements model of a QFN



2.PRE-MOULDED PLASTIC PACKAGING

- Many transducer principles need a cavity, in which a sensor is mounted and where the encapsulation material has no direct contact with the functional surface of the chip.
- This requirement is most relevant for pressure sensors, inertial sensors and optical or IR devices. To that purpose pre-moulded package types are suited well. Typically, these consist of a metal lead-frame which is embedded into a thermoplastic package body with an injection moulding machine.
- Subsequently the sensor devices are mounted, and in a last step a lid is used to cover the cavity. Two families of this package type can be distinguished, depending on the device to be packaged



Pre-moulded standard package for MEMS sensors

3.HERMETIC PACKAGING

Hermetic housings are a well-established technology, which allows to package sensors. The principal requirements are a size-dependent low helium leak rate < 10-9 Pa m!/s and restricted moisture contents <3000 ppm, as demanded for example by the MIL STD 883.

Metal and ceramic housings are utilised both as standard components as well as application-specific packages. Special hermetic variants are applicable up to temperatures of 200 °C, in some cases up to 250 °C.

The packaging costs are relatively high, roughly 10 ct per I/O-pin for higher pin-count standard packages. Especially metal and ceramic housings are advantageous for optical components as they combine both hermeticity and the ability to integrate of optical elements like windows for visible and IR light,

Hermetic package for IR sensors using the LTCC technology

Sealed with IR-transparent silicon lid

4.WAFER-LEVEL PACKAGING AND TESTING

- In applications which require hermetic encapsulation and especially for MEMS, presently a new protection strategy is developed. In many new sensor designs hermeticy is no longer achieved by a metal or ceramic package.
- The MEMS structure is protected on wafer-level using a capping wafer which forms a hermetic cavity with the substrate wafer(s).
- The interconnection between the silicon and also the glass substrates is accomplished by wafer bonding using thin glass or metal layers, electrostatic forces or attractive atomic forces.

- Contrary to this, wafers bonded with adhesives are under investigation, but they will not be hermetic. Novel wafer-level packaging also allows for the integration of optical as well as fluidic feed-through structures.

- Electrical interconnections into the cavity are formed by metal or implanted conductors.

- Sensor elements which are already sealed hermetically on-chip or on-wafer will become more significant in the future.


THANK
YOU!