

Intelligent Sensors

* Smart Sensor:- Smart Sensors are sensors with integrated electronics that can perform one or more of the following functions:

$$\text{Sensors} + \text{Interfacing hardware} = \text{Smart Sensor / Intelligent sensors}$$

- * Logic functions
- * Two way Communication
- * Make decisions

* Smart Sensor is defined as a transducer with an integrated circuit. Basically such a transducer and integrated circuit is considered as a single device.

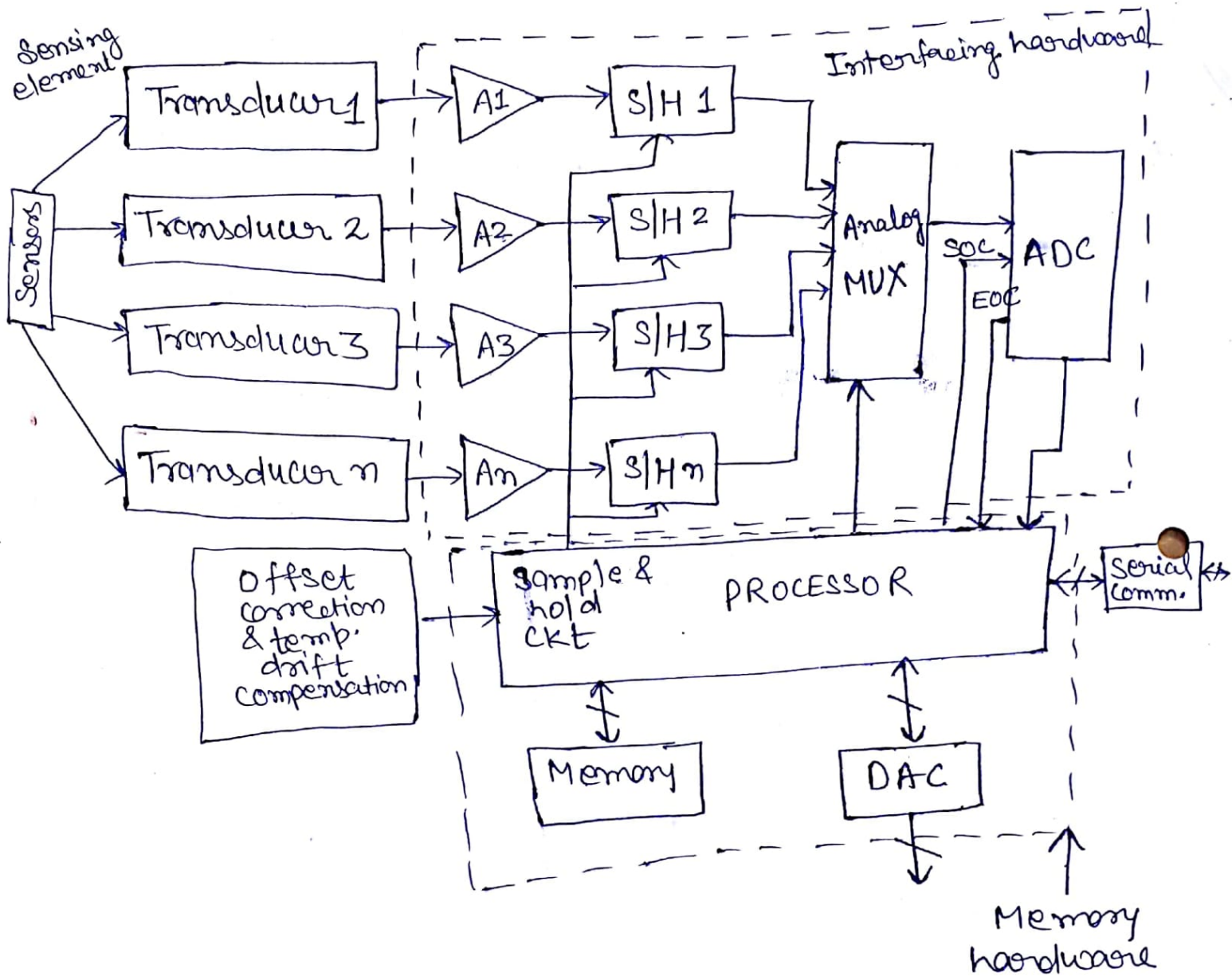
* Specifically Smart Sensor can be defined as a sensor with signal conditioning circuitry in house giving standard output signal in a digital form which can be communicated through a communication bus to the central control room in a process plant.

Importance and adoption of Smart Sensor:-

(Why Smart sensors are preferred?)

The presence of controller/processor in smart sensor has lead to corrections for different undesirable sensor characteristics which include input offset and span variation, non linearity and cross sensitivity. As these are carried in software, no additional hardware is required and thus calibration becomes an electronic process.

* General Structure of Smart Sensor:-



Smart Sensor has following components:

1. Sensing element and Transducers
2. Interfacing hardware / Data Acquisition system (DAS)
3. Signal Conditioning Devices
4. Conversion Devices
5. Programming Devices (Processor)
6. Communication Interface.

Sensing elements: - A sensing element or a detector is that part of transducer which responds to a physical phenomenon or a change in a physical phenomenon. Chore

Transducers: → Transducers may be defined as a device that converts one form of energy into other form of energy. It converts a non electrical physical quantity (such as force, temp, displacement) to an electrical quantity (voltage or current).

Sample & Hold ckt: - The Sample & hold ckt is an electronic circuit which creates the samples of voltage given to it as input and after that, it holds these samples for the definite time. The time during which Sample & hold ckt generates the sample of the input signal is called sampling time. Similarly, the time duration of the ckt during which it holds the sampled value is called holding time.

Data Acquisition System: - Data Acquisition System is a collection of hardware and software components that enable a computer to receive physical signals. This system is used for data processing, data conversion, data transmission & data storage.

Signal conditioning devices: - Signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. Signal conditioning typically involves steps

that isolate, filter, amplifier or convert a sensor input signal to a proportional output signal that is transmitted to another control devices.

ADC starts conversion when receives a SOC (start of conversion) signal from processor. outputs of all the sample & hold ckt are multiplexed together so that we can use a single ADC which will reduce the cost of chip.

smart sensor also includes internal memory so that we can store data & program required.

functions of smart sensor: →

- Sensor Excitation
- Analogue Input
- Data Conversion
- Digital Data bus Interface

Controller embedded in smart sensor supports

communication by digital data bus

- Monitoring & Diagnostic function
- Control processor
- level of Integration.

Characteristics of Smart Sensor:-

1) Self calibration:- Self calibration means adjusting some parameters of sensor during fabrication. Self calibration is to adjust the deviation of the output of sensor from the desired value when the input is at minimum or it can be an initial adjustment of gain.

Recalibration problem can be solved with smart sensors as it has built in microprocessor that has the correction functions in its memory.

2) Self communicating:- This is often denoted as the process where certain information is conveyed or exchanged.

This is one of the basic applications of smart sensor as they give information about possible things that they are

sensing.

3) Self testing:- The ability of a sensor to test its functionality is highly desirable. Recent developments in the field of smart sensors are leading to sensors with some limited diagnostic capability. This is basically an ability of a sensor to determine whether it is functioning normally.

A complete failure would usually be detected by the user as the output, either current or voltage, falls below its operating specification. In many cases a sensor can fail to perform adequately but provide a reasonable output.

Applications of Smart Sensor: →

- Industrial → In industries machines and equipments are monitored and controlled for pressure, temp., humidity level and also for vibration.
- Automotives → Communications between engine, transmission, suspension, braking and ^{other} controls has long been anticipated.
- Finger Print Recognition → A fingerprint sensor is an electronic device used to capture a digital image of the fingerprint pattern. The captured image is called a live scan. This live scan is digitally processed to create a biometric template which is stored and used for matching.
- Telecommunication → A smart card known as a Wireless Identity Module, is similar to the Subscriber Identity Module (SIM) used on existing GSM cellular phones. The card guarantees 100% security for e-commerce transactions by providing authentication of the parties involved, by means of encryption and digital signature.

• Biomedical Applications:-

A number of smart sensors for biomedical applications have also been developed by using chip technology & biochips. Cyto-sensor micro-physio-meter: biological applications of Silicon technology.

• MEMS and Process Control:-

MEMS (Micro-Electro-Mechanical Systems) is a class of systems that are physically small. These systems have both electrical and mechanical components. MEMS originally used modified integrated circuit fabrication techniques and materials to create these very small mechanical devices.

• Defence Applications:-

Smart cameras that can operate sophisticated software analytics onboard the camera itself, and then report alarms remotely using IP networking facilities. It has ability to perform object detection, crowd pattern analysis, secure zone intrusion detection, and so on boost the efficiency and accuracy of a human operator who is likely monitoring multiple banks of displays.