

Instrumentation II

CH – 05

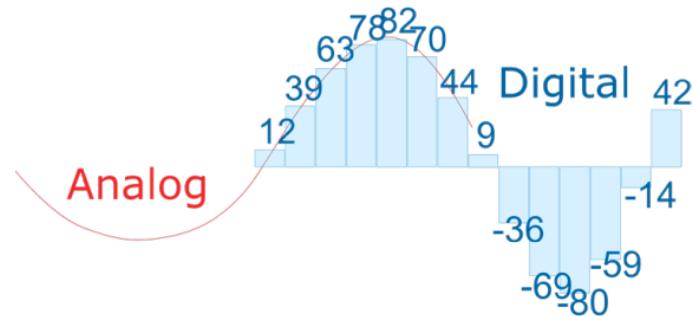
Data Acquisition System

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Analog & Digital Transmission

- ✓ An analog signal
 - amplitude varies continuously for all time.
- ✓ A Digital signals
 - obtained when discrete time signals are quantized and then coded.
- ✓ Advantages of digital transmission:
 - Increased immunity to channel noise and external interference.
 - Data, audio, video can be transmitted through same channel.
 - Security and privacy / Encryption and coding
- ✓ Disadvantages of digital transmission:
 - High bandwidth requirement
 - Complex circuitry than analog transmission



Analog & Digital Transmission (Cont..)

Analog Communication System

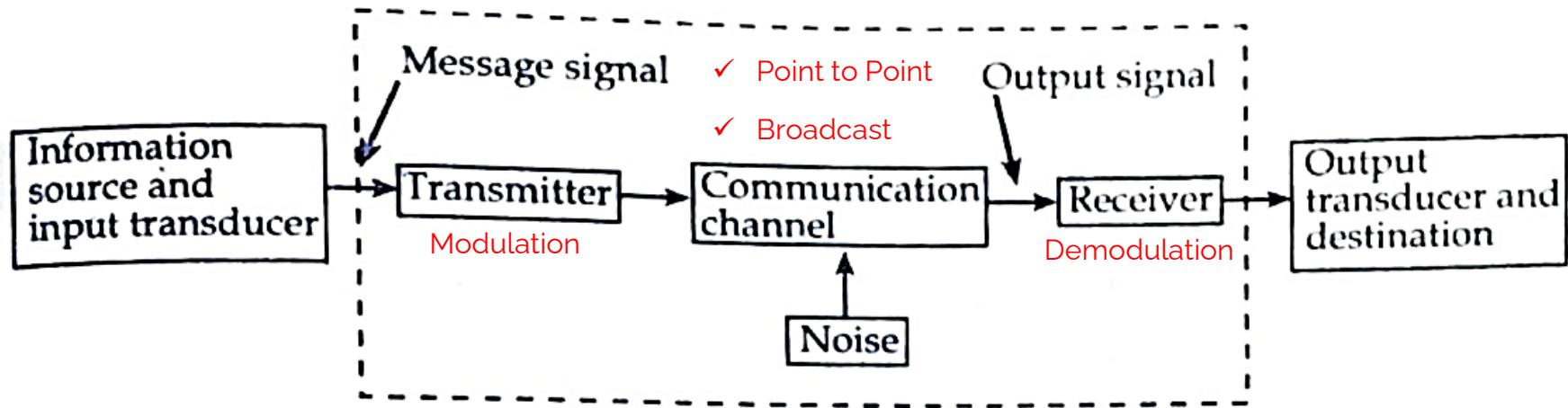
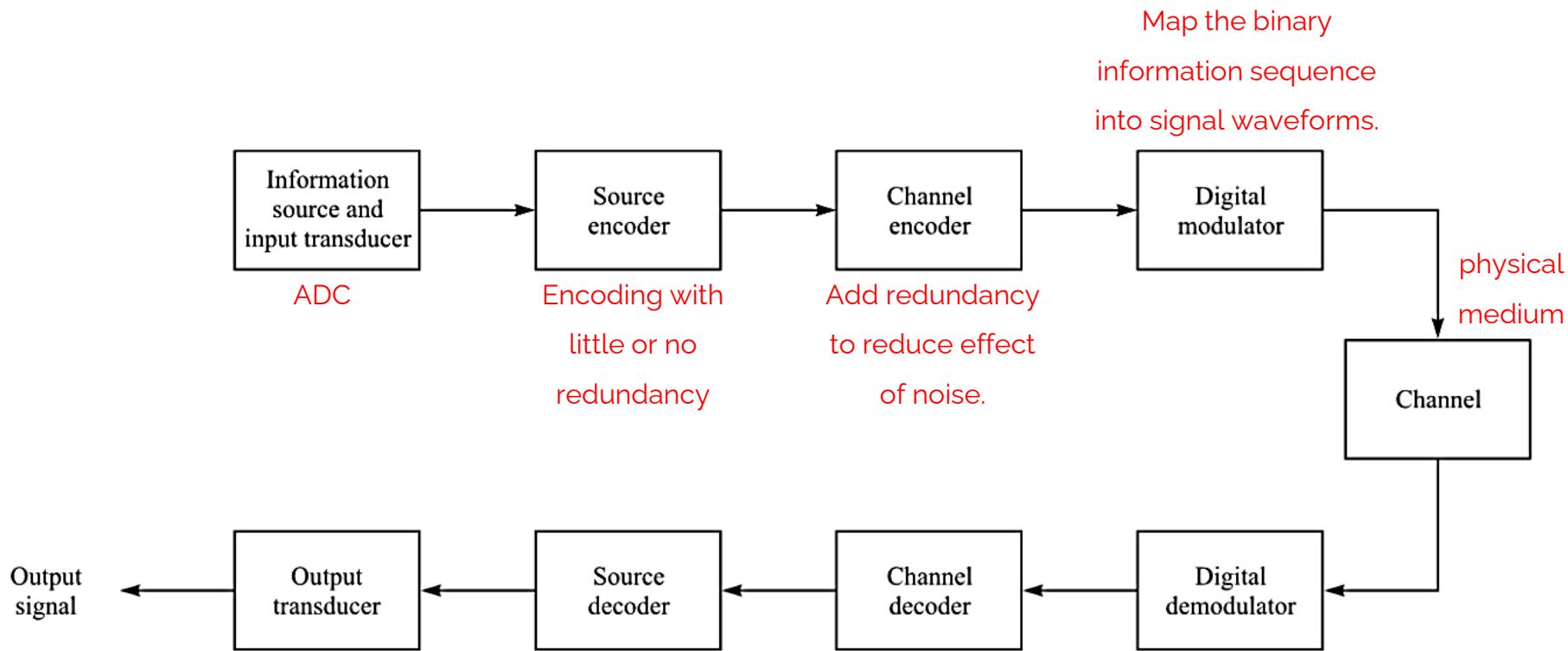


Figure 5.1: Block diagram of analog communication system.

Analog & Digital Transmission (Cont..)

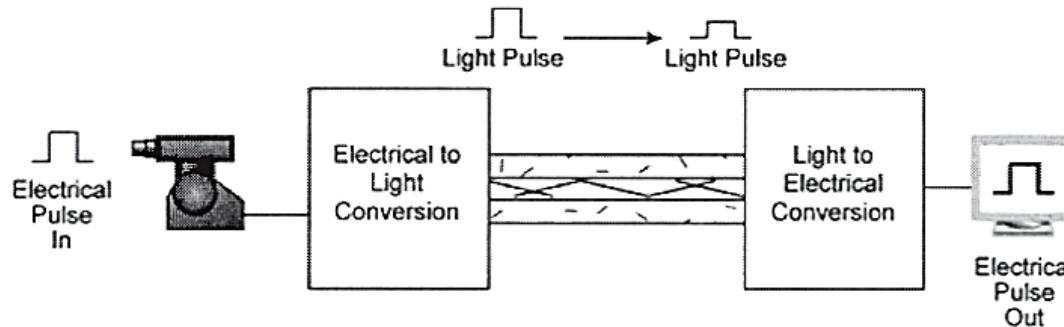
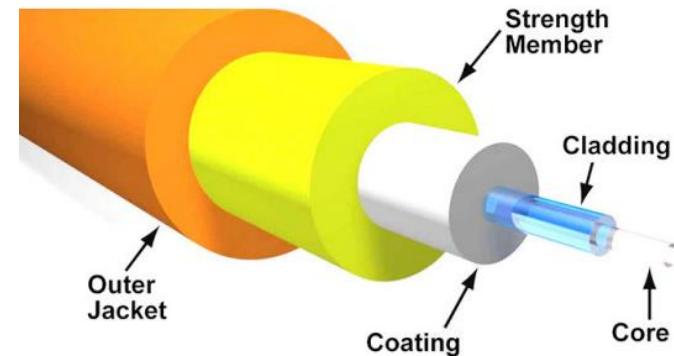
Digital Communication System



Transmission Schemes

Fiber Optics

- ✓ Optical fiber is a flexible optically transparent fiber:
 - Usually made of glass or plastic,
 - Principle - successive total internal reflections.
- ✓ Three parts:
 - Protective layer, Cladding, and Core.
- ✓ The refractive index of the core is greater than that of the cladding.



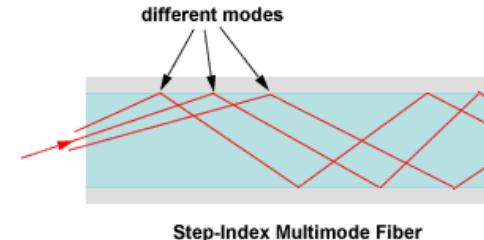
Transmission Schemes (Cont..)

Fiber Optics (Cont..)

Fiber Optics Classification

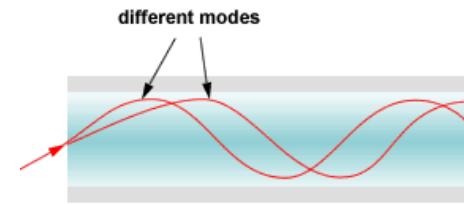
✓ Step Index Fibers:

- Core - Cladding → uniform index of refraction.
- Relatively easy to manufacture, cheaper than other types, larger layer NA.



✓ Graded Index Fibers:

- Core - Cladding → gradually
- Dispersion is low, Greater bandwidth.

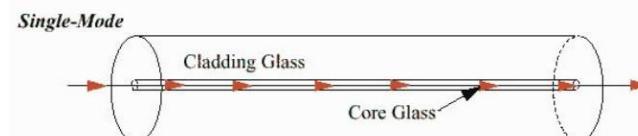
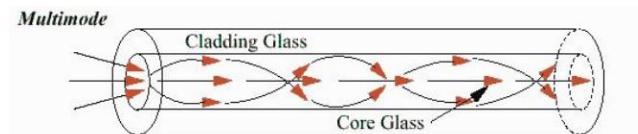


✓ Single-mode optical fibers

- Small diameter core, Single beam, Expensive

✓ Multi-mode optical fiber

- Larger core opening.



Fiber Optics (Cont..)

Advantages:

- Enormous potential bandwidth - 100GHz
- Small size and weight
- Electrical isolation - made up of glass or plastic polymer
- Immunity to interference
- Signal security
- Low transmission loss
- System reliability and ease of maintenance

Dis-advantages:

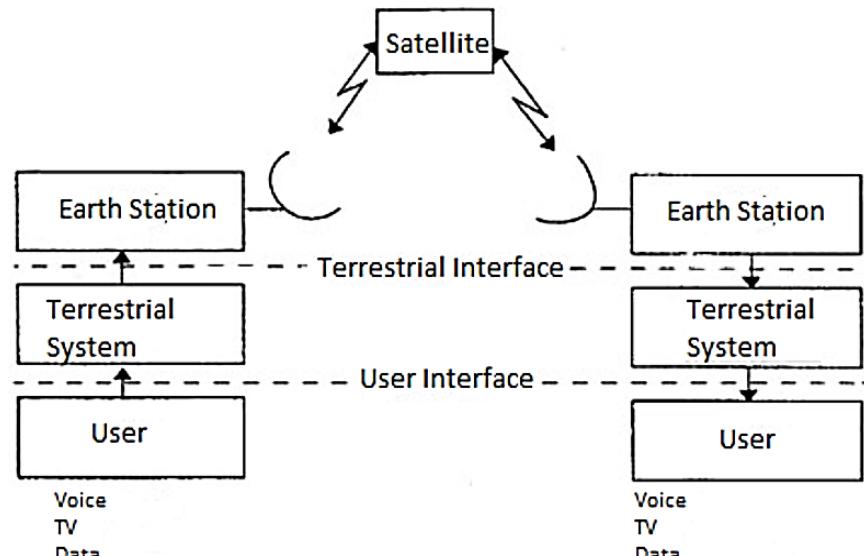
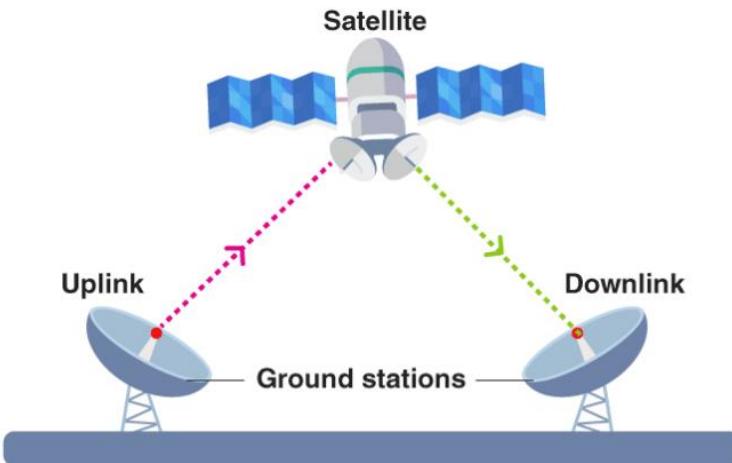
- Splicing (Joining two optical fibers) is difficult and expensive.

Transmission Schemes (Cont..)

Satellite Communication System

✓ A satellite is simply a repeater:

- which consists **transponders** each of which listens to some portion of the spectrum,
- amplifies the incoming signal,
- and then rebroadcasts it at another frequency.



Elements of Satellite Communication

Satellite (Cont..)

Two major elements of satellite communication systems are:

- ✓ 1. Space segment
 - Satellite
- ✓ 2. Ground segment
 - **Transmit** the signal to the satellite and **receive** the signal from the satellite
 - Establishes the communication links with the satellite and the user.
 - Consists of:
 - Earth stations
 - User terminal and interface network

Transmission Schemes (Cont..)

Types of Satellite

✓ Low Earth Orbit (LEO)

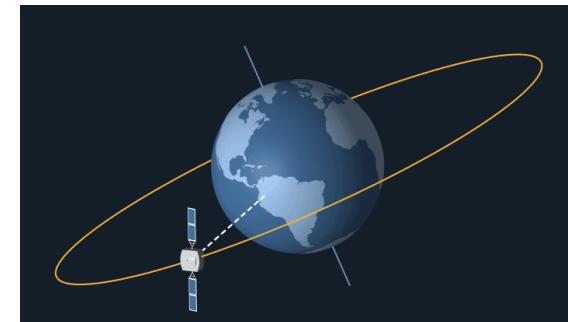
- Much closer to the Earth (500-1500 km)
- Don't stay in fixed position relative to the surface.
- Only visible for 15 to 20 minutes each pass.
- A network of LEO satellites is necessary for LEO satellites to be useful.

✓ Medium Earth Orbit (MEO)

- In orbit somewhere between 8,000 km and 18,000 km
- Visible for much longer periods of time than LEO (usually between 2 to 8 hours)
- Have a larger coverage area than LEO satellites.

✓ Geostationary Earth Orbit (GEO)

- In orbit 35,863 km above the earth's surface along the equator.
- Revolve around the earth at the same speed as the earth rotates.
- Remain in the same position relative to the surface of earth.



Bluetooth Devices

- ✓ Bluetooth is a short-range wireless communication technology
 - based on RF that allows devices to transmit data or voice wirelessly.
- ✓ Creates personal networks operating within the unlicensed 2.4 GHz band (ISM Band).
- ✓ Bluetooth device - which uses Bluetooth protocol for data transfer.

Transmission Schemes (Cont..)

Bluetooth Devices (Cont..)

Characteristics

- ✓ Nominal link range → 10 cm to 10 m, extended → 100 m
- ✓ Creates personal area network (PAN) or piconet
- ✓ Low 1mW of power
- ✓ It can network between two and eight devices.
- ✓ Uses frequency-hopping spread spectrum (FHSS) modulation.
 - signal is transmitted over 79 narrow frequency channels in the 2.4 GHz frequency band changing channels up to 1600 times per second.
- ✓ Master/Slave mode of data communication
- ✓ Non line-of-sight (LOS) transmission

Transmission Schemes (Cont..)

Bluetooth Devices (Cont..)

Topology

- ✓ **Piconet:** A maximum of 8 devices (7 active slaves plus 1 master) form a Piconet.
 - Up to 7 active slaves; up to 255 parked slaves.
- ✓ **Scatternet:** Interconnected piconets, one master per piconet.
 - A few devices shared between piconets.

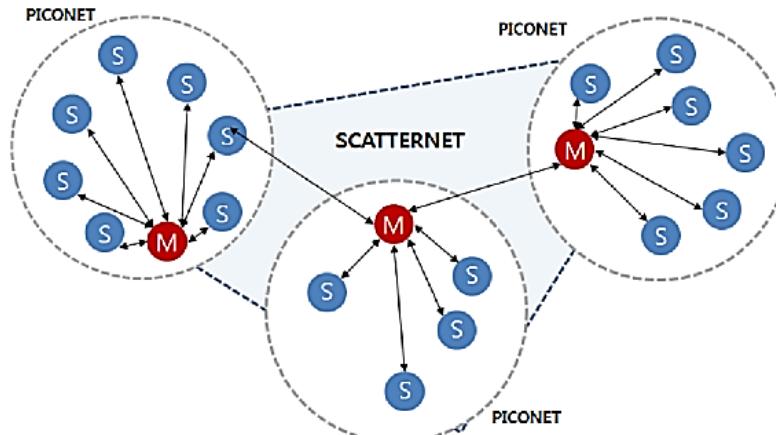


Figure 1. Bluetooth Piconet & Scatternet

Bluetooth Devices (Cont..)

Connection

Connections are made between a master and a slave.

Steps of creating a Bluetooth connection between two devices:

✓ Inquiry:

- Initially, one device sends out the inquiry request to discover another device.
- Another listened device will respond with address and other information

✓ Paging

- Process of forming connection between two Bluetooth devices.

✓ Connection

- After connection, it becomes either active or stays in low power mode.
- Active Mode, Sniff Mode, Hold Mode, Park Mode

Adv/Dis-Advantage of Satellite

✓ Advantages of satellite:

- Larger coverage area
- Lower transmission cost
- Satellite to Satellite communication is very precise.
- Higher Bandwidth

✓ Disadvantages of satellite:

- Bandwidth is decreased due to gradually becoming used up.
- Launching satellites into orbit is costly.
- There is a larger propagation delay in satellite communication than in terrestrial communication.

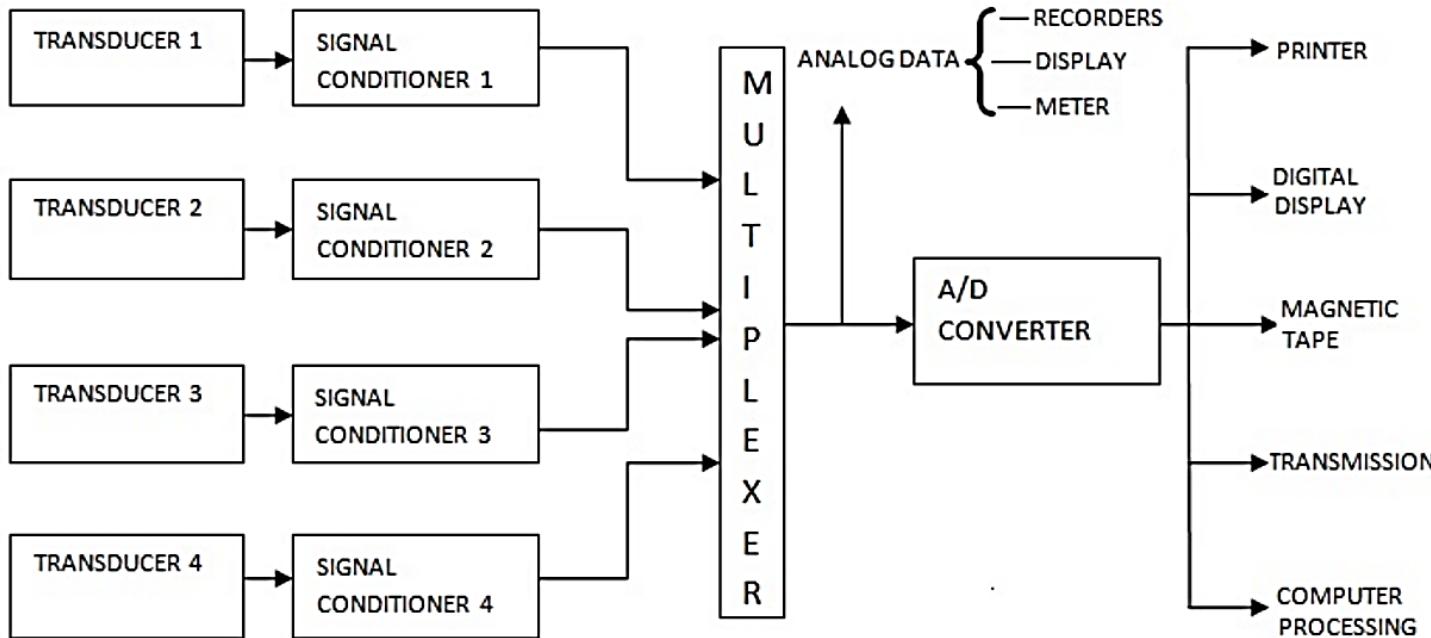
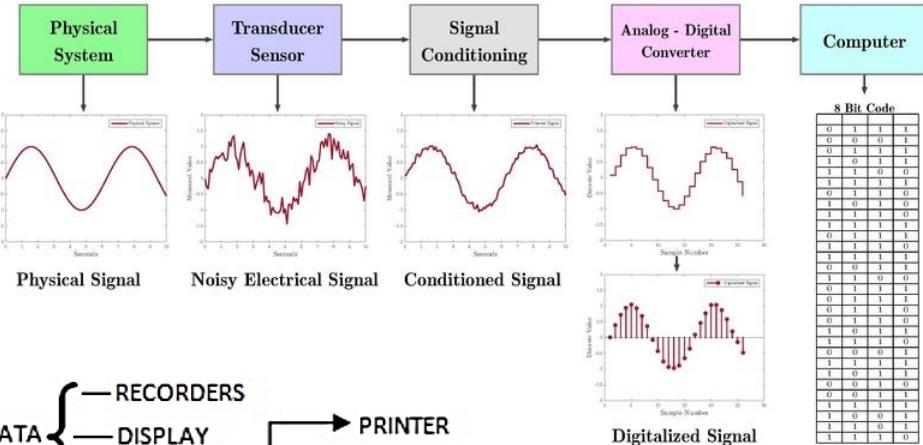
Data Acquisition System

- ✓ An information system that
 - **collects, stores and distributes** information.
- ✓ The components of data acquisition systems include
 - Sensors/Transducer
 - Signal conditioning circuitry
 - Data acquisition hardware
 - Computer interface and software
- ✓ The process of data acquisition involves:
 - Sensor → Signal conditioning circuitry → ADC converters → Process → Analyze
→ Store → Transmission/Display

Data Acquisition System (Cont..)

Block Diagram of DAS

Digital Data Acquisition System



Data Acquisition System (Cont..)

Examples and Application of DAS

✓ Applications of DAS

- Collecting various information.
- Data measurement, monitoring, recording and controlling in industries.
- Predictive maintenance
- Remote monitoring and control

✓ Examples

- Environmental monitoring systems
- Industrial process control systems
- Medical monitoring systems
- Structural health monitoring systems

Data Acquisition System (Cont..)

Data Loggers

- ✓ Recording of collected data over a period of time.
 - any device that can be used to **store data**.
- ✓ They generally are compact, battery-powered device equipped with an internal microprocessor, data storage, and one or more sensors, or sensor ports.
 - Some data loggers interface with a PC, while others have a local interface device (keypad, LCD) and can be used as a **stand-alone device**.
- ✓ Sensor → Store → Process → Analysis.
- ✓ Loggers can log parameters including temperature, humidity, power usage, CO₂, mV, mA, voltage, pulses or counts etc.

Data Acquisition System (Cont..)

Block Diagram of Data Loggers

The analog signals supplied by the three transducers are dual polarity (- 50 mV to 50 mV) having frequencies of 5, 10 and 15 KHz.

- Appropriate sampling rate from input scanner?
- Signal conditioner stage for the 8-bit ADC (0 Volts to 5 Volts)

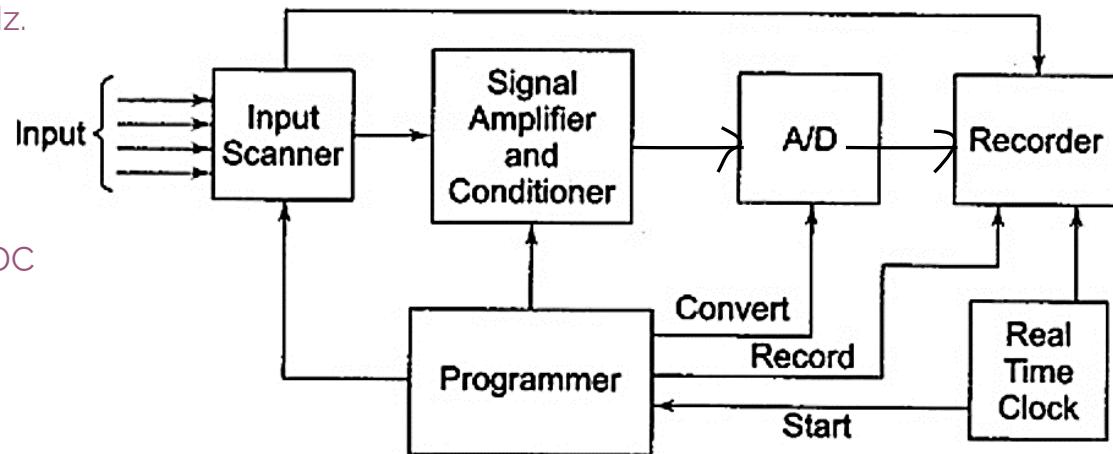


Fig. 17.24 Block Diagram of a Data Logger

✓ Applications

- Weather station recording
- Hydrographic recording
- Soil moisture level recording, Gas pressure, Environmental Monitoring
- Agricultural monitoring

Data Acquisition System (Cont..)

Data Archiving and Storage

- ✓ Data storage
 - is the recording (storing) of information (data) in a storage medium.

- ✓ An archive
 - is a collection of historical records that are kept for long-term retention and used for future reference.

Data Acquisition System (Cont..)

Data Archiving

- ✓ Process of moving data/information that is **no longer actively used** for long term **retention**.
- ✓ Nowadays data mainly achieved in semiconductor devices in remote cloud storage.
- ✓ Data archives are indexed and have search capabilities.
- ✓ Data backups and data archiving is not the same thing!
- ✓ Example:
 - Sensor data of 10 years from a weather station archived in database for further analysis.

Data Acquisition System (Cont..)

Data Storage

- ✓ The collected data from data acquisition system becomes crucial
 - to be stored for **future reference** and to be analyzed for **finding valuable information**, such as fault diagnosis information.

- ✓ Data storage factors:

- Access time
- Cost per unit of data
- Reliability



| | Magnetic tape | Hard disk | USB disk | CD ROM | Floppy disk |
|----------|---------------|-----------|----------|-----------|-------------|
| Cost | Medium | High | Medium | Low | Low |
| Speed | Slow | Fast | Medium | Med/ Slow | V. Slow |
| Capacity | High | High | Medium | Medium | Low |

- ✓ Can differentiate storage into:

- Volatile storage

Non-volatile storage

- ✓ Physical and Cloud Storage Types

- Local Storage

Networked Storage

Cloud Storage