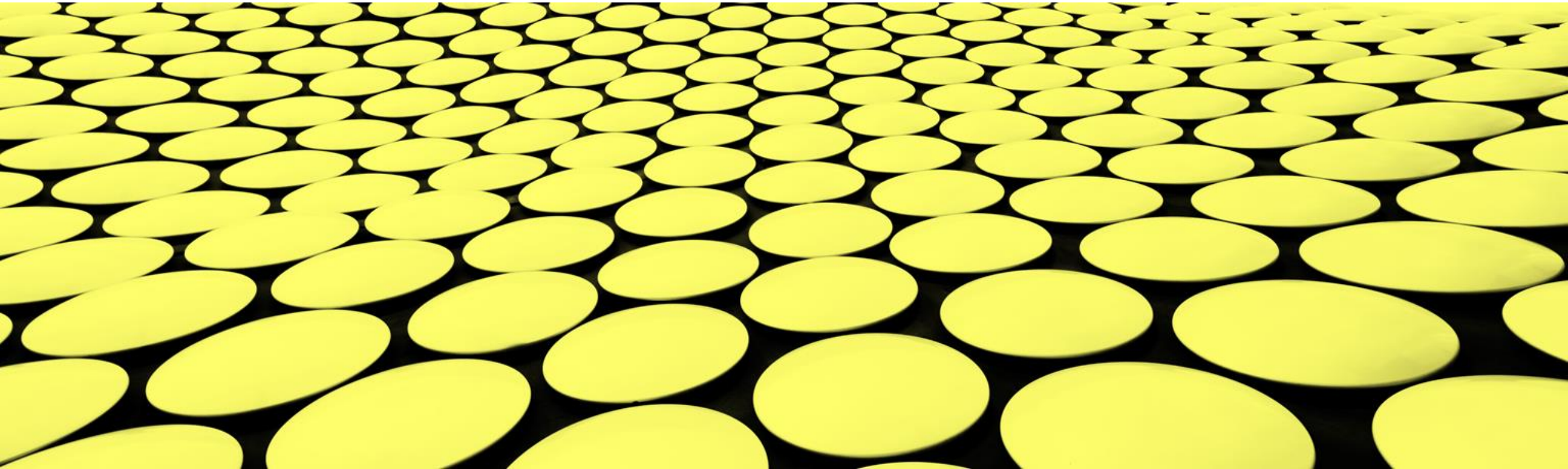# DATA ACQUISITION SYSTEMS

DR. A.M GAUR

# OBJECTIVES OF DATA ACQUISITION SYSTEMS

- Must acquire the necessary data at correct data rate and at specified time

- Utilisation of procured data to the operator to take corrective action

- To maintain optimum and safe operations

- Diagnosis of the fault

- Must be reliable, flexible and future expansion is possible

- Down time should be less than 0.1%.
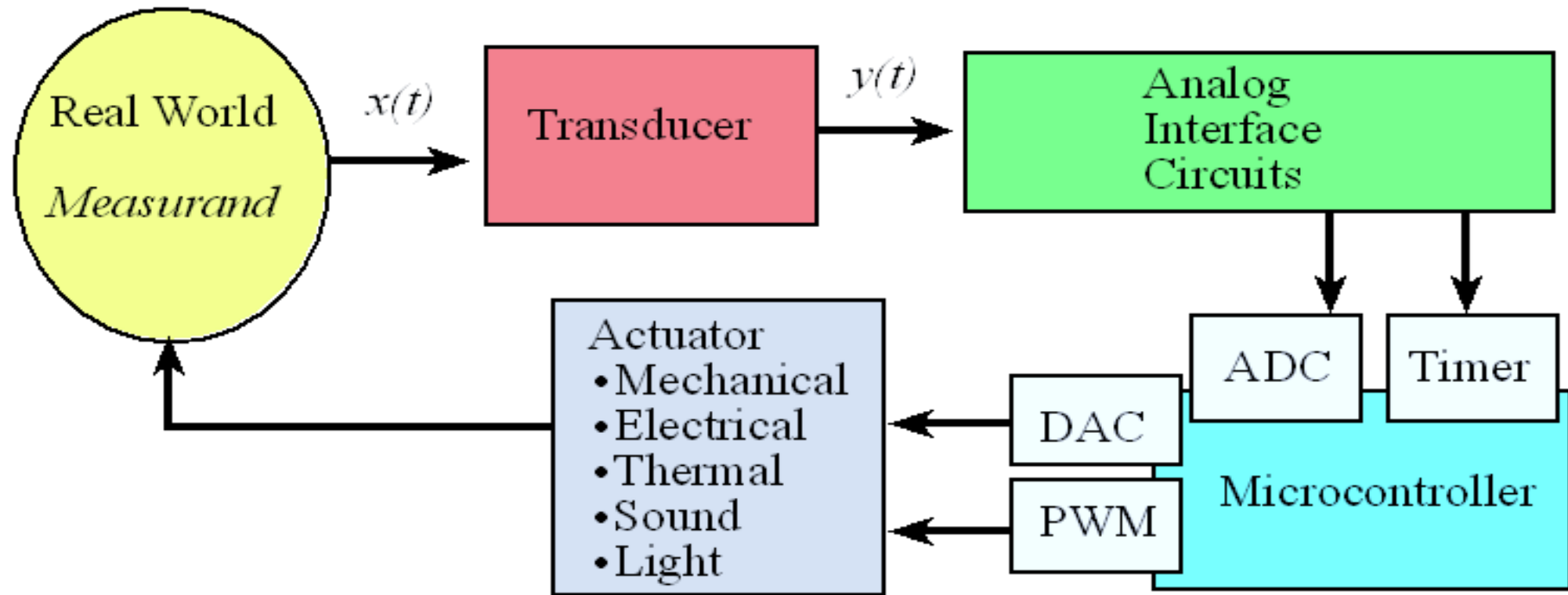
- Fast computing speed

# CONTD..



Figure: Block diagram of DATA acquisition Systems
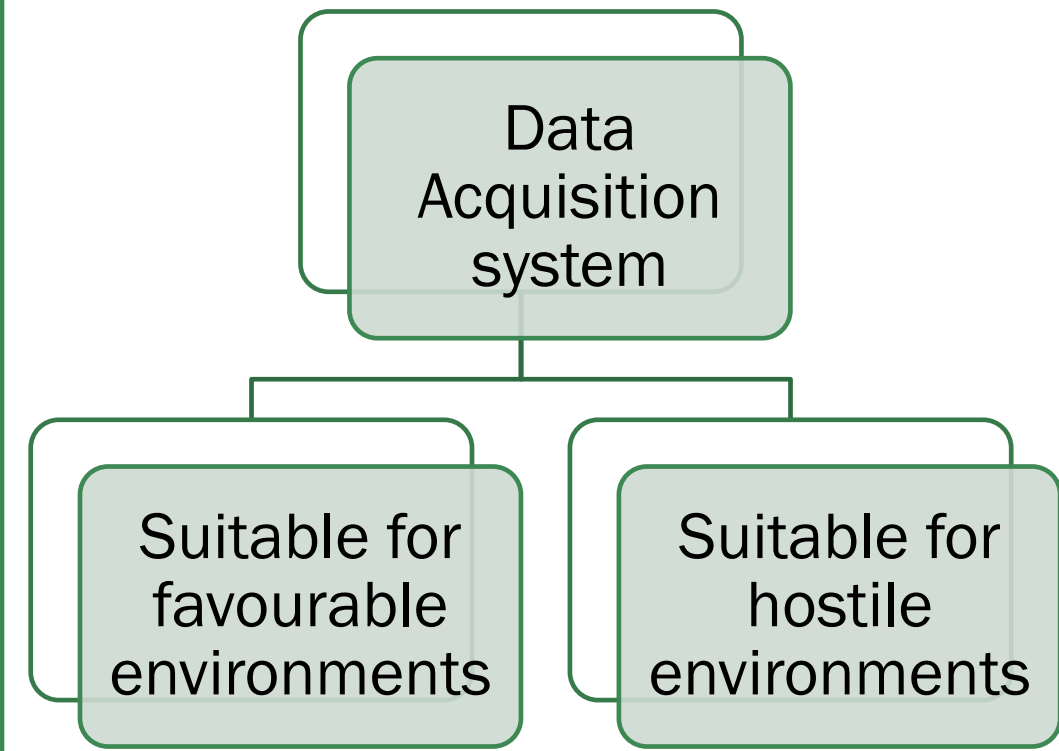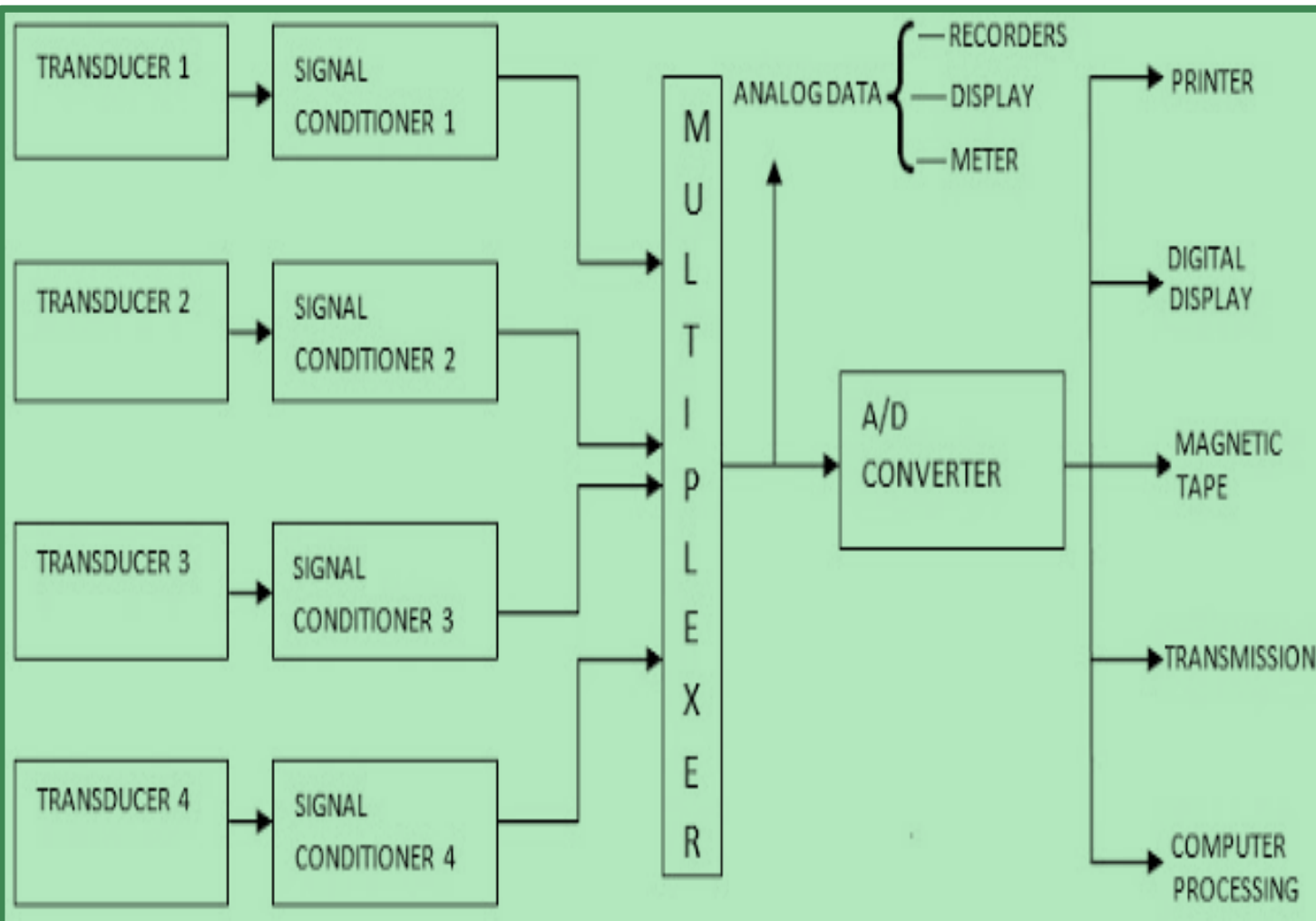
# FUNCTIONS OF DATA ACQUISITION SYSTEMS

- Signal conditioning

- Multiplexing

- Data conversion
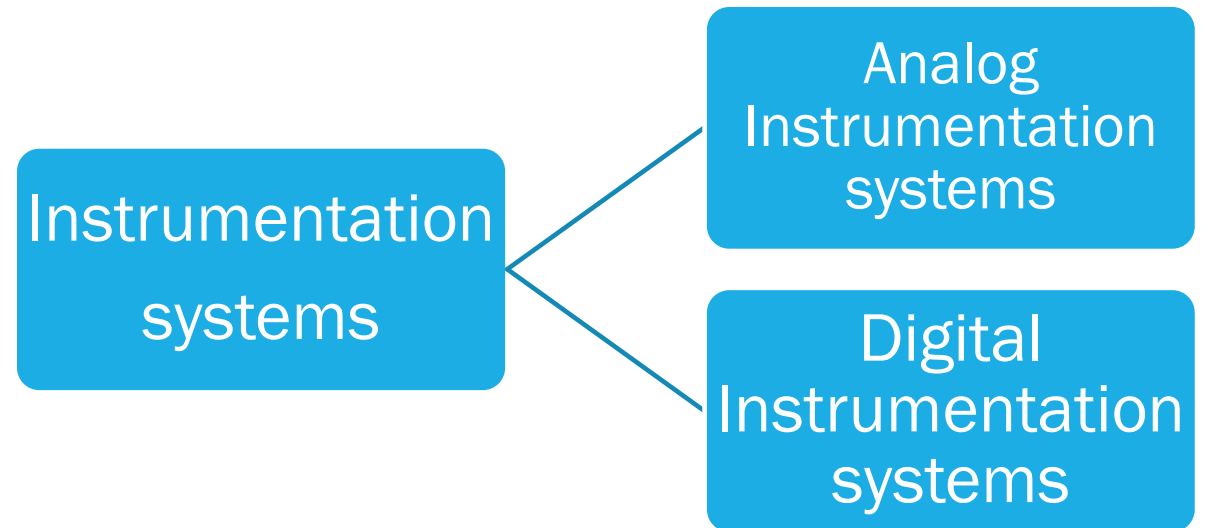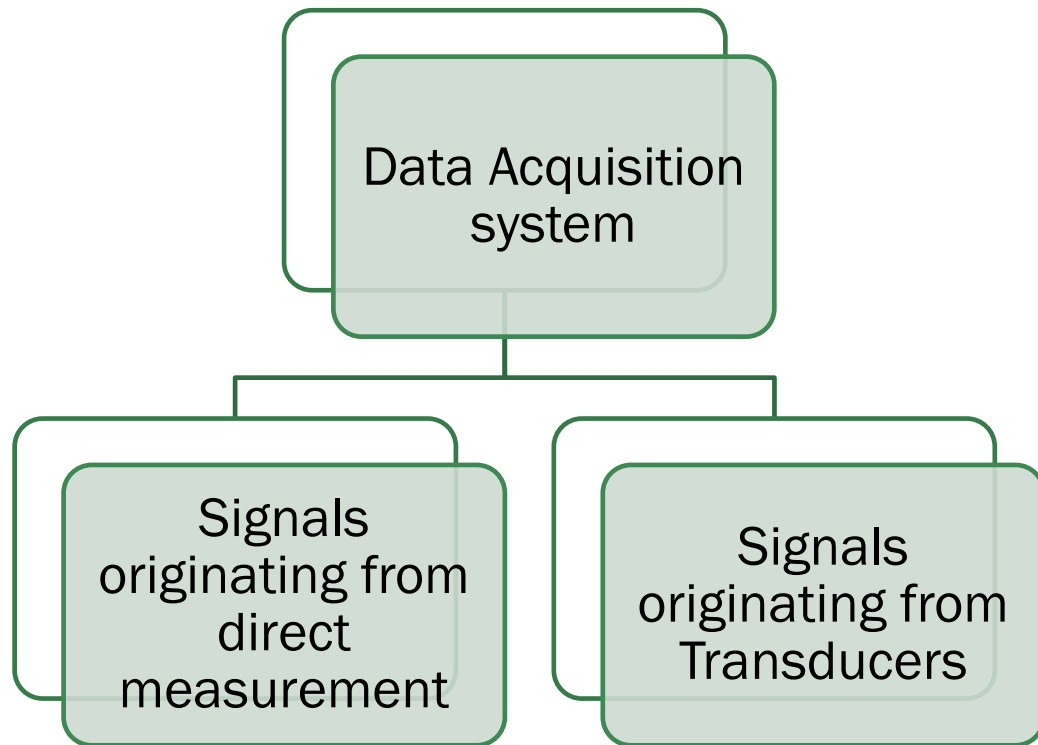
- Data Processing

- Data handling

# CONTD..

- A data acquisition system is a complex system that consists of all the required subsystems for collection, conditioning, conversion, processing, display, storage and transmission of data.

- Processing- It involves the simple comparison to complex mathematical manipulations.

- It may include information collection, data conversion, calculation of various parameters associated with performance analysis.

- Also the data for controlling particular process, separating the noise from the signal, and displaying the signal on multiple displays.

# GENERAL DATA ACQUISITION SYSTEMS

# INSTRUMENTATION SYSTEMS

Data Acquisition system

Signals originating from direct measurement

Signals originating from Transducers

Instrumentation systems
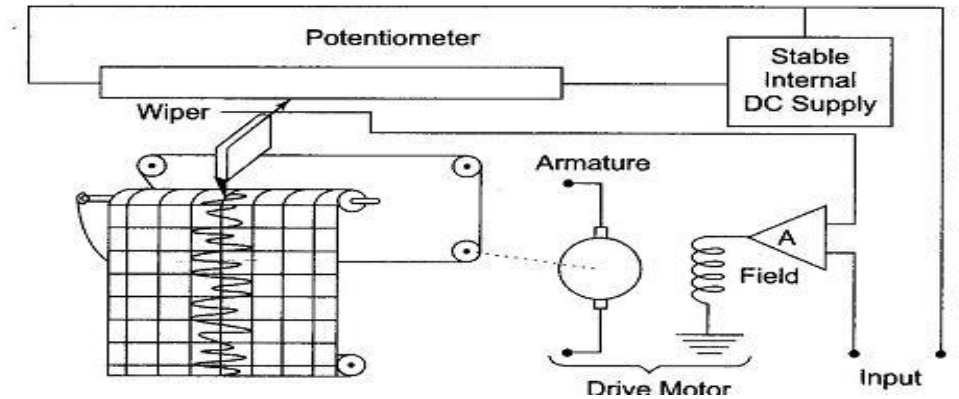
Analog Instrumentation systems

Digital Instrumentation systems

# COMPONENTS OF ANALOG INSTRUMENTATION SYSTEMS

- **Transducers**- the transducer translates physical parameters to electrical signals acceptable by the acquisition system. The physical parameters include temperature, pressure, acceleration, weight, displacement, velocity etc. Electrical quantities such as voltage, and frequency may be measured directly.

- **Signal Conditioners**- The signal conditioner includes the supporting circuitry for the transducer. This circuit may provide excitation power, balancing circuits and calibration elements and an example of this is a strain-gauge bridge lance and power supply unit. The scanner or multiplexer accepts multiple analog inputs and sequentially connects them to one measuring instrument.

- **Calibrating Equipment's**-This involves the millivolt calibration of the all input circuits and all bridge, transducer circuits.

- **Integrating Equipment's**-Digital methods are used for this purpose.
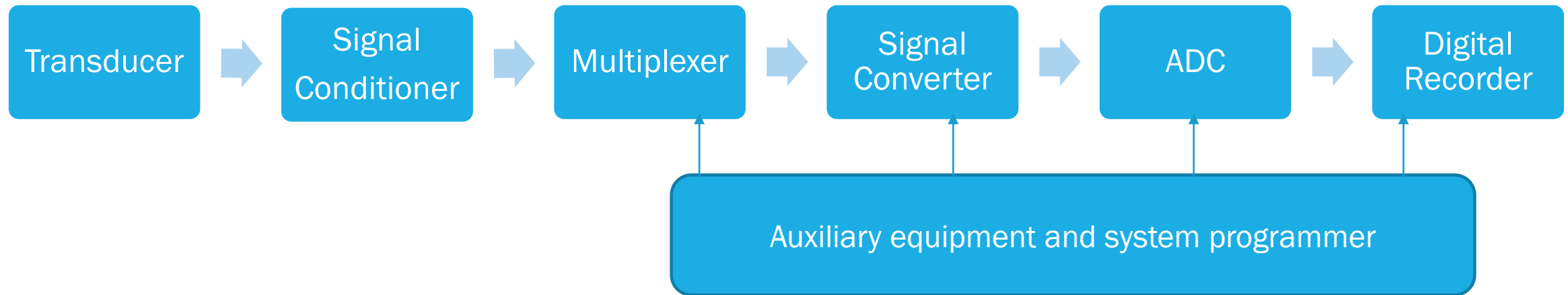
# CONTD..





- Visual Devices-Single or multi channel CRO, numerical displays, panel meters.

- Graphing Recording Instruments

- Magnetic Tape Instruments

- Computers

- High Speed Cameras and Display Devices

# COMPONENTS OF DIGITAL INSTRUMENTATION SYSTEMS

Transducer → Signal Conditioner → Multiplexer → Signal Converter → ADC → Digital Recorder

Auxiliary equipment and system programmer

# CONTD..

- **Digital Recorders**-These recorders record the process parameter on punched cards, perforated paper, hard disk, USB Drives.

- **Digital Printers**-After processing of all data, the data is to be configured into meaningful conclusions. As with digital Printers hard copy of data is available for analysis purpose.
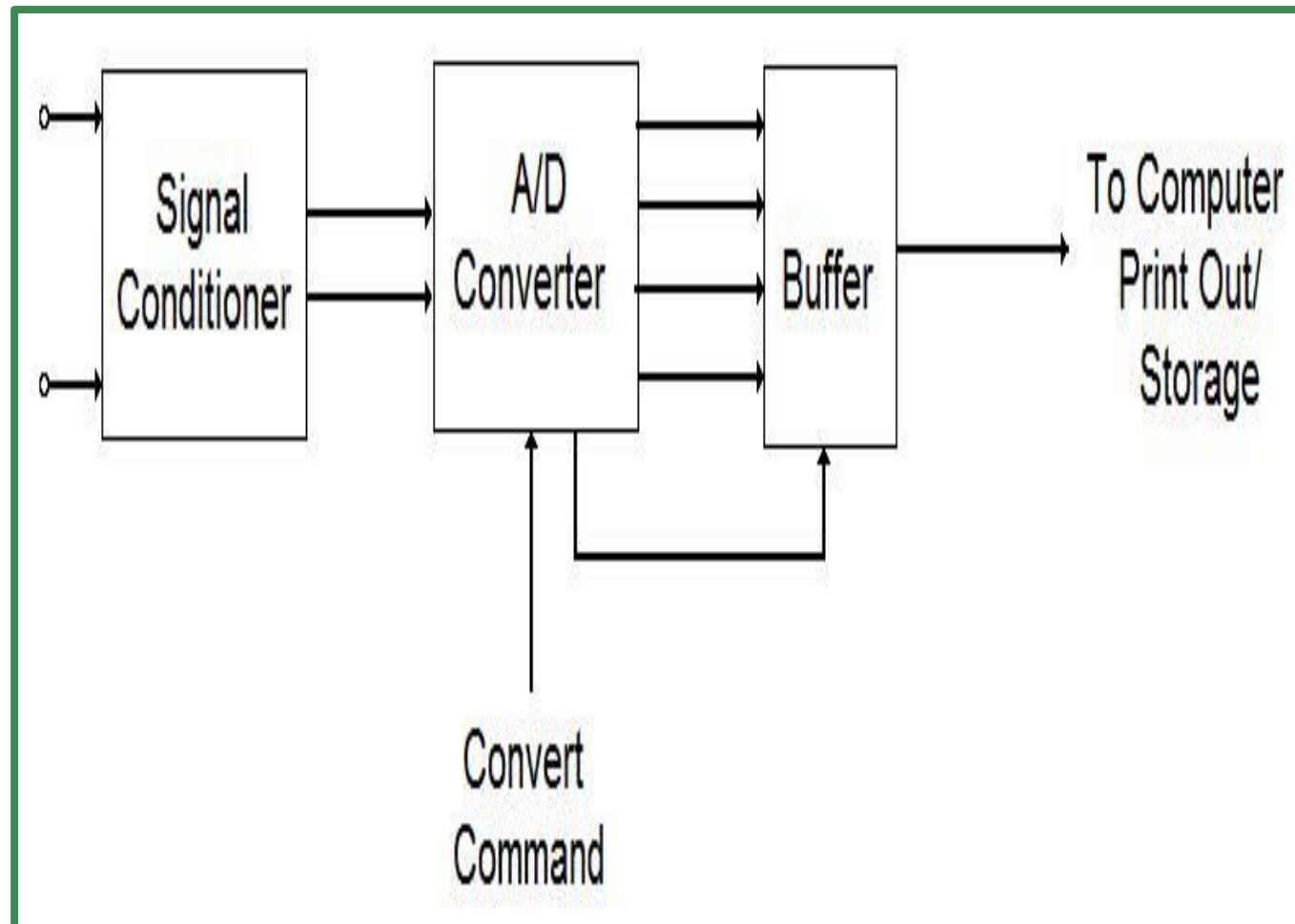
# CHARACTERISTICS OF DATA ACQUISITION SYSTEM

- Resolution and accuracy

- No of channels to be connected

- Sampling rate per channel

- Signal conditioning requirement of each channel

- Cost of system

## SINGLE CHANNEL DATA ACQUISITION SYSTEMS

- It is consist of signal conditioner followed with ADC performing the repetitive conversion of the measurand at pre determined rate.

- The digital outputs are sent to the buffer for storage purpose and further conveyed for printing purpose.
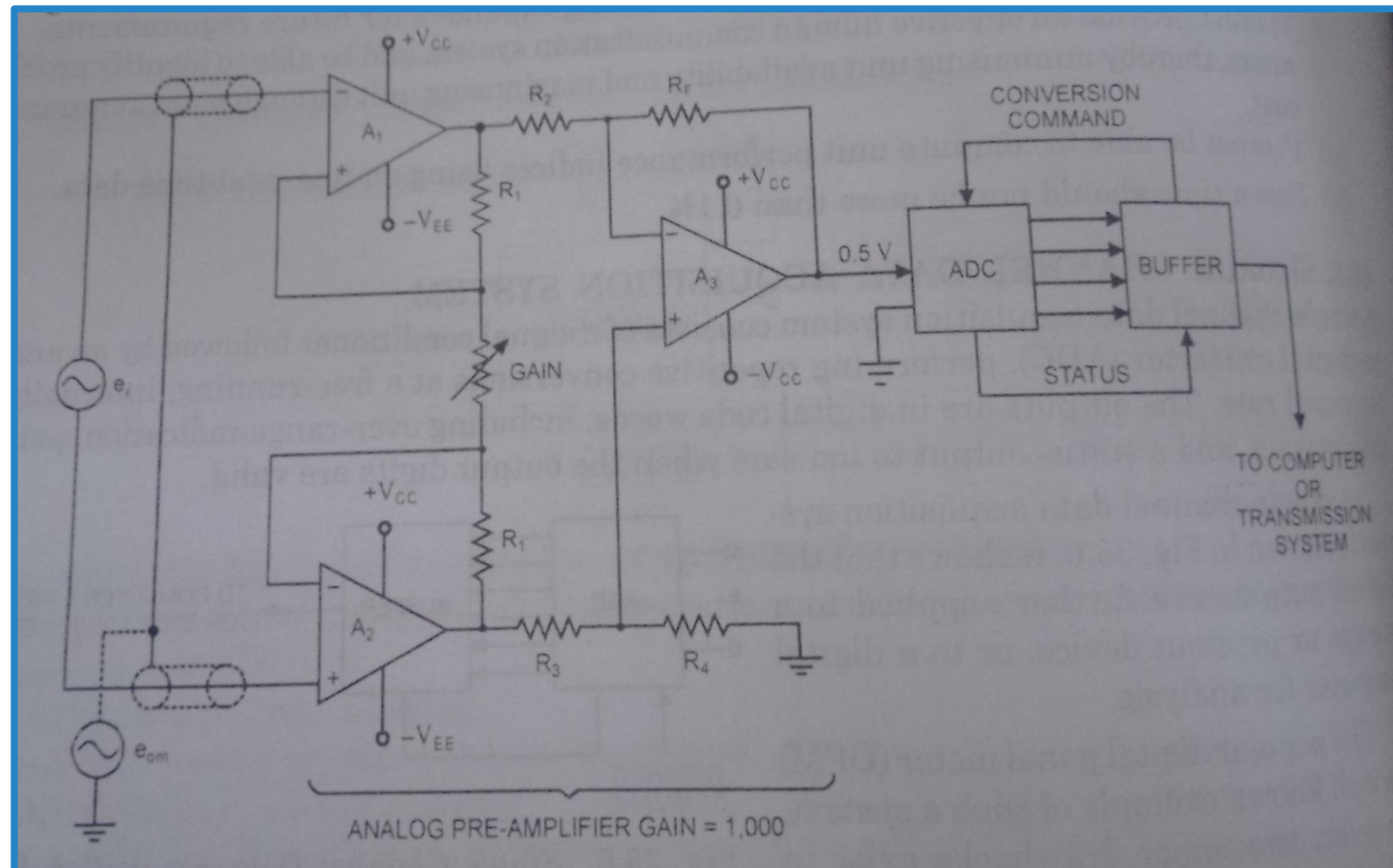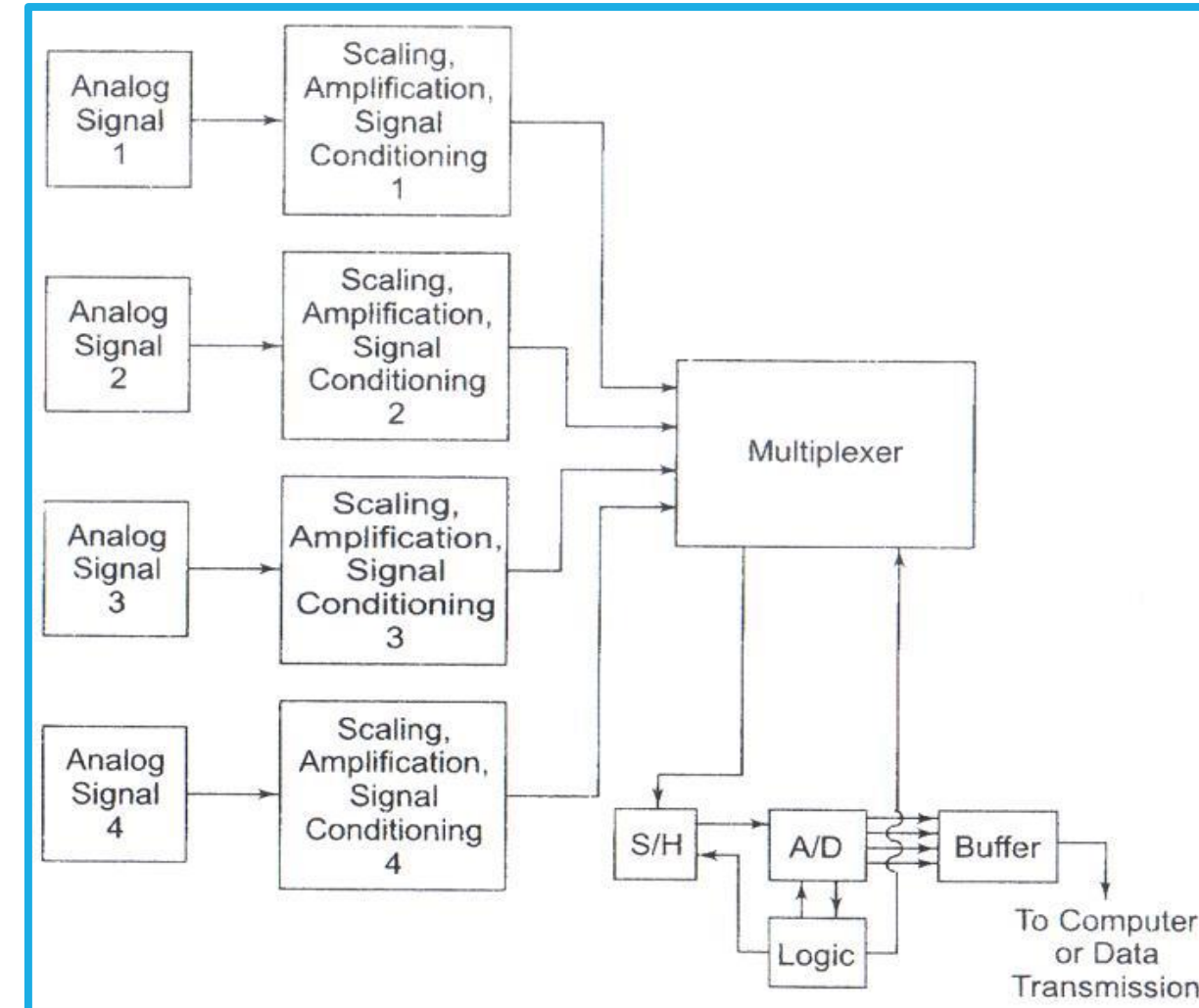
## CONTD..



- Digital panel meter is one example of single channel data acquisition systems

- The major drawback associated with this system is BCD is to be modified into binary coding if the output is to be used by digital equipment.

- The other disadvantage is that the data transfer rate is determined by digital panel meter.

# DATA ACQUISITION SYSTEM WITH PREAMPLIFICATION

# MULTI CHANNEL DATA ACQUISITION SYSTEMS

- The analog signals are applied directly to the signal amplification before the multiplexing.

- Signal conditioning can be carried out if amplification is required.

- The multiplexer is used for connecting the multiple channels.

- The sample and hold circuit converted the previous data into digital form.

- When the data acquisition is completed the Sample and hold is switched to hold mode and conversion begins and multiplexer selects the channel again.
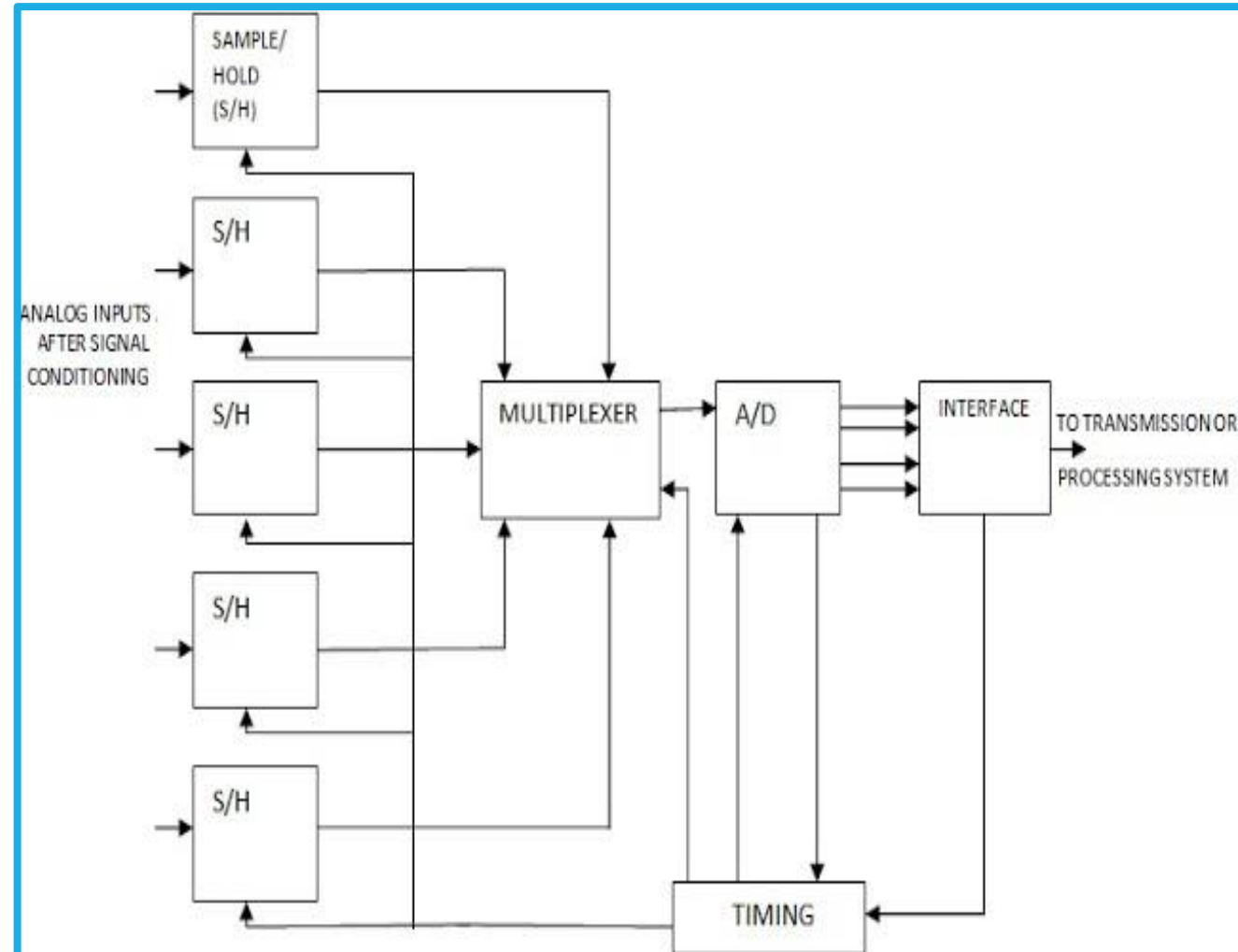
# COMPONENTS

- Signal Conditioner
- Multiplexer
- Sample-Hold Circuit
- Analog to Digital Converter
- Logic Circuit
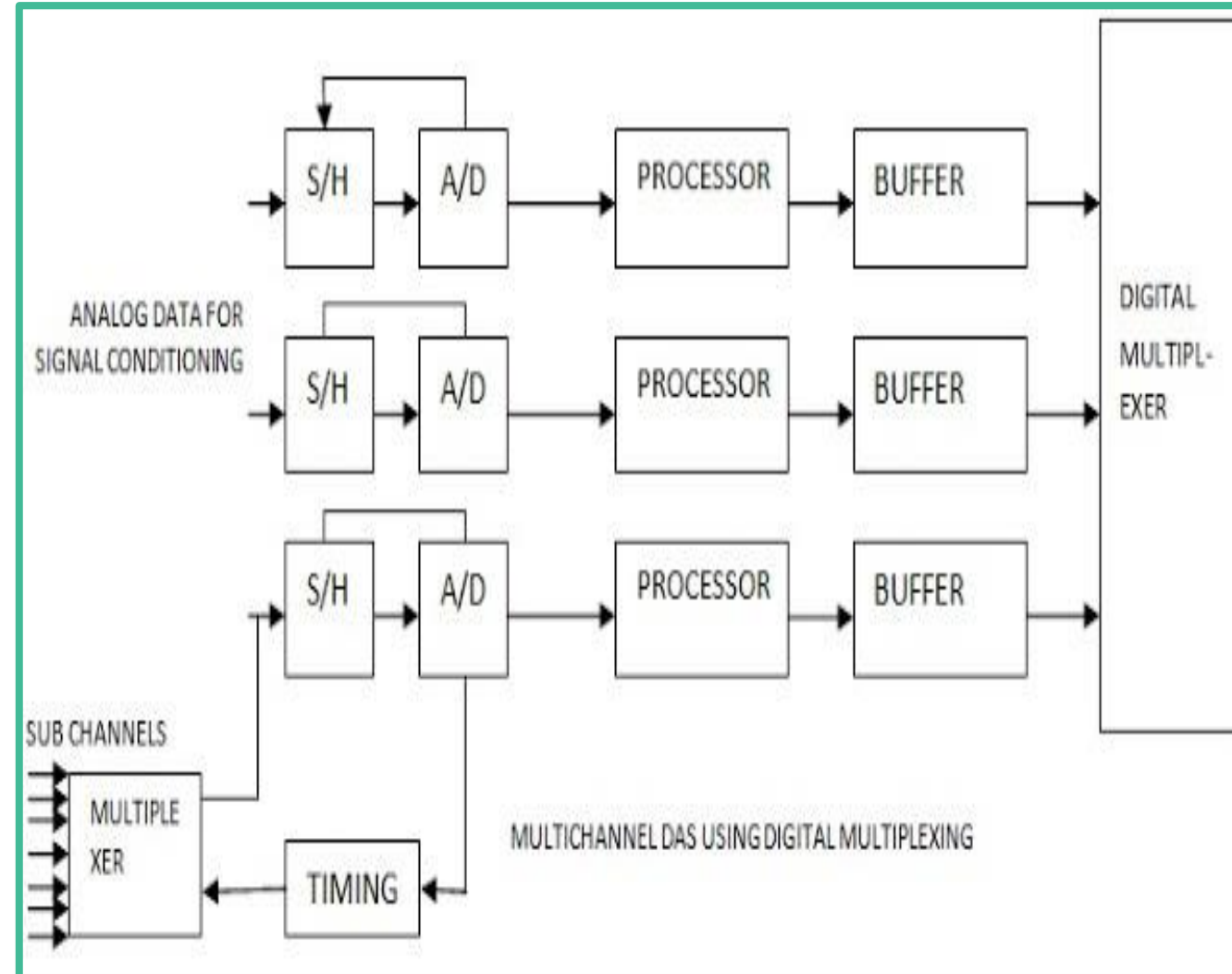- Buffer
- Processor/Controller

# MULTIPLEXING THE OUTPUT OF SAMPLE HOLDS

- This arrangement is called simultaneous sampled system multiplexer

- When large number of channels is to be monitored synchronously at moderate speeds this method is used.

- The analog signals after signal conditioning are supplied to individual sample hold circuits.

- The sample hold circuits an updated synchronously by the timing circuit.

- The multiplexer receives the outputs of all the sample hold circuits.

- The multiplexer is connected to the A/D converter.

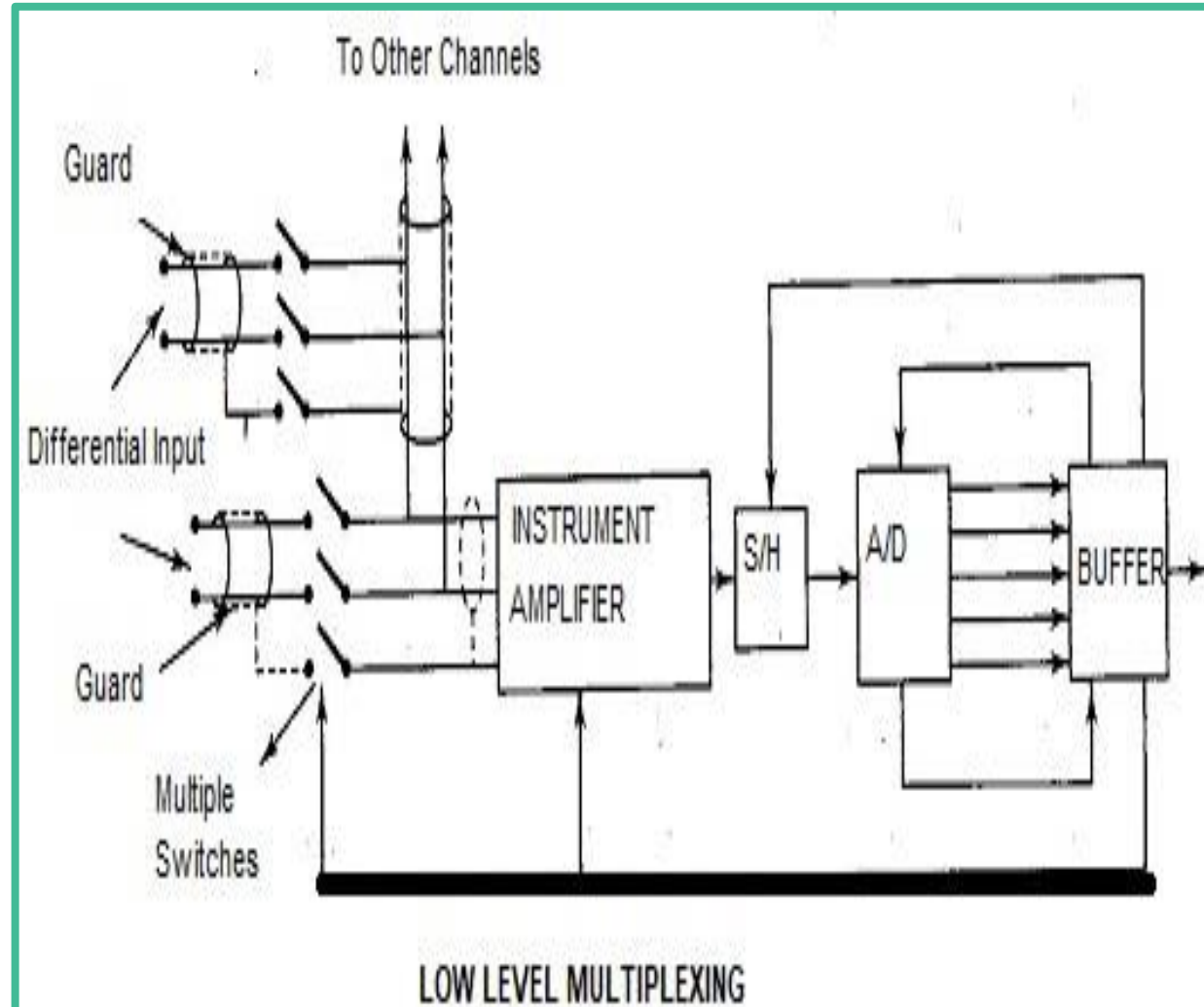- This results in a sequential readout of the outputs.

# MULTIPLEXING AFTER ANALOG-DIGITAL CONVERSION

- This type of scheme is advantageous in a data acquisition system that has several inputs distributed over vast plant area.

- The analog signals are converted into the required digital format at the source.

- Therefore transmission of data to the data centre can be made without line frequency and ground loop interferences.

- The data in the digital form will be used to perform logic operations and decisions.

- Depending on the relative speed at which data changes take place scanning rate can be increased or decreased.



MULTICHANNEL DAS USING DIGITAL MULTIPLEXING

# MULTIPLEXING LOW LEVEL DATA

- Each low level signal is provided with individual amplifier. Individual amplifier's output goes to sample hold circuit from which it is converted to the digital format.

- The input of the individual amplifiers can be either of the common mode type or differential type.

- This type of multiplexing is useful when large numbers of channels with low level outputs are available.

- As high quality amplifiers are available with affordable cost providing individual amplifiers is possible.



LOW LEVEL MULTIPLEXING

## CONTD..

The following factors are to be considered to implement low level multiplexing satisfactorily.

- Guarding is to be provided for each channel.

- Proper switching of guard is necessary.

- Signal to signal and common mode to differential cross-talk is to be avoided.

- Capacitive balance is necessary.

# MULTI CHANNEL DAS: CHARACTERISTICS

- Input from Multiple Data Source

- Work based on Input Sampling

- Multiple Input Multiplexed (TDM) before processed

- Can be divided into two different system type based on location of A/D-Multiplexer:

  - Multiple Input – A/D(s) – Multiplexer – Processor

  - Multiple Input – Multiplexer – A/D - Processor
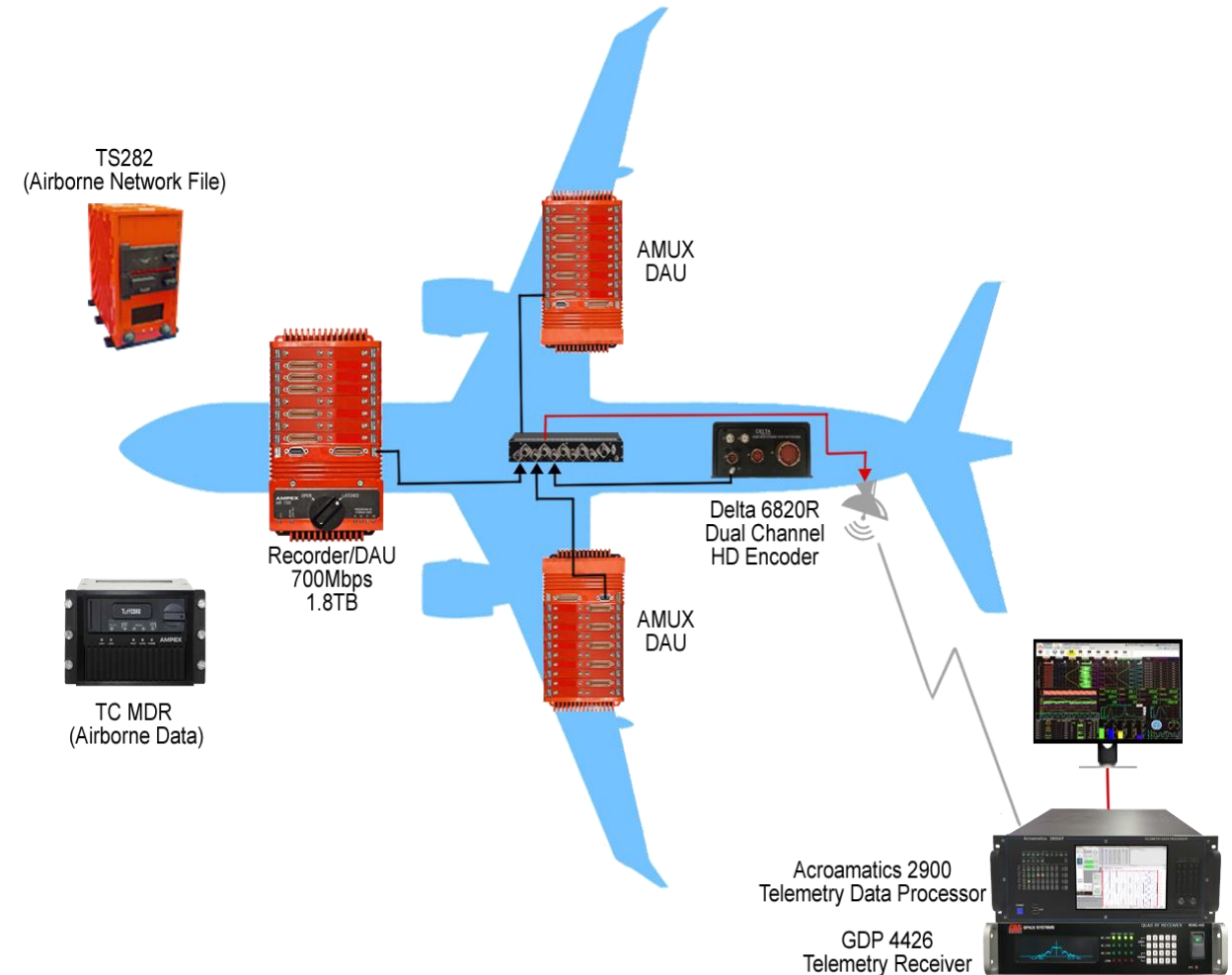
# COMPARISON

### Single Channel

- Simple

- Low parts count

- Slower since coding need to be change (BCD to Digital)

- Data availability time cannot be controlled

- Accurate

### Multiple channel

- Complex and need to be designed wisely to avoid high cost.

- Faster since data to be read already in digital form.

- Data always available.

- Less accurate but acceptable if sampling condition acceptable.

## APPLICATIONS

- For performing repeated calculations

- Generate information for display.

- Aircraft and missile control system.

- Electrical power generation.

- Industrial process control.



TS282
(Airborne Network File)

AMUX DAU

Recorder/DAU
700Mbps
1.8TB

Delta 6820R
Dual Channel
HD Encoder

TC MDR
(Airborne Data)

AMUX DAU

Acroamatics 2900
Telemetry Data Processor

GDP 4426
Telemetry Receiver

# REFERENCES

- Ernest Doebelin, Doebelin's Measurement System, Mcgraw Hill, 2017.

- A.K. Sawhney, A Course in Electronic Measurements and Instrumentation, Dhanpat Rai Publication, 2015.

- Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, CRC Press, 2003.