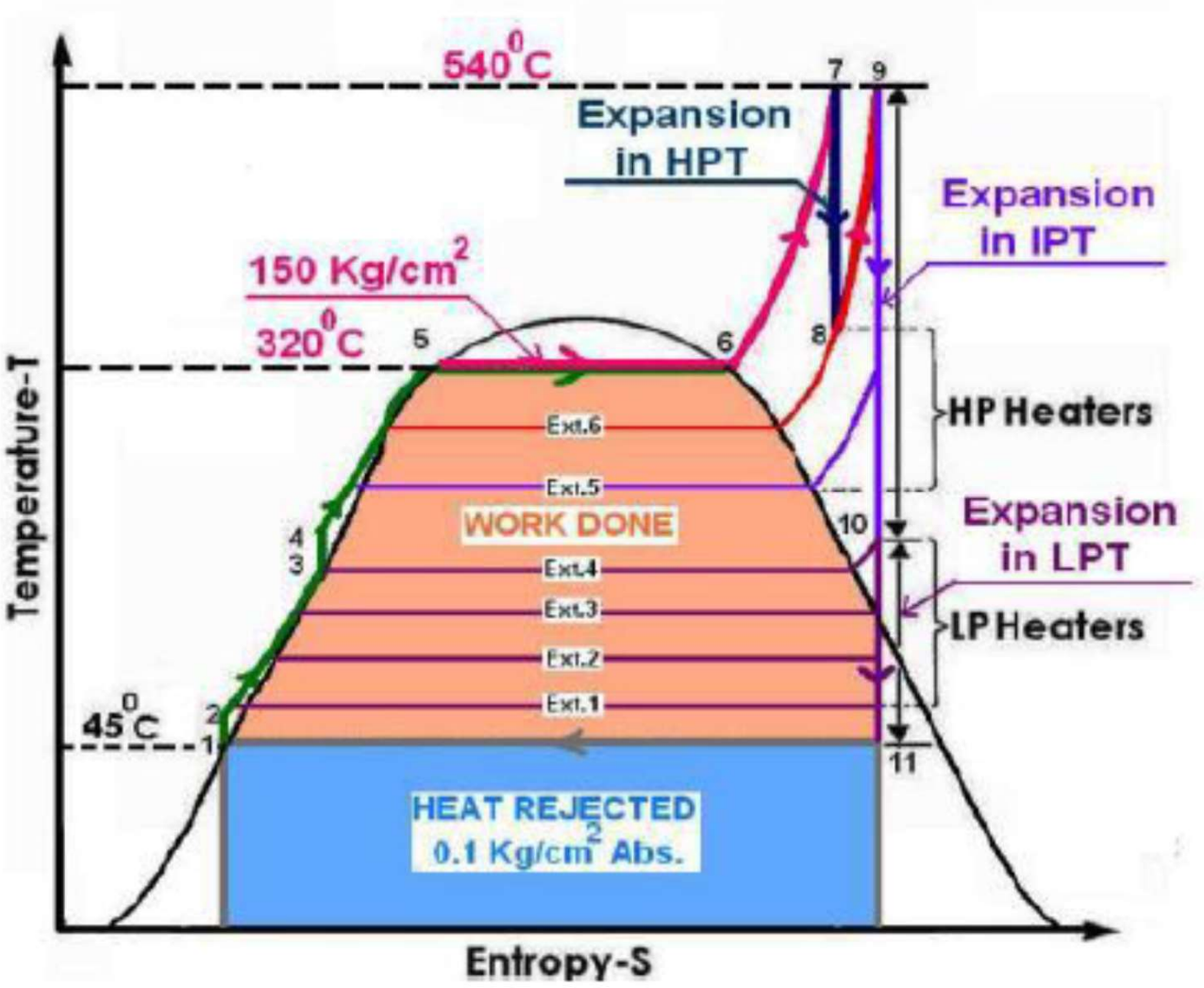
S/N	PLANT ITEM	PROCESS PARAMETER
1.	Combustion Air System	(a) Air heater temperature inlet (b) Air heater temperature outlet (c) Air heater differential pressure (d) Forced draft fan discharge pressure (e) Air flow rate
2	Fuel Control System (Natural Gas)	(a) Temperature (°C) – Burner inlet (b) Pressure (bar) – Burner inlet (c) Flow to Burner (x 1000 m^3/h)
3	Material Safety System	METAL TEMPERATURE (°C) (a) Drum – Water space - Steam space (b) Final super heater (c) Primary super heater (d) H. P. Casing (e) H. P. drain & stop valve
4	Main Steam System -	(a) Temperature (°C) - After primary superheater - After final superheater - H. P. stop valve - H. P. exhaust - L. P. inlet - L. P. exhaust - Condenser inlet (b) Main steam flow (x 1000 m^3 /h) (c) Main steam pressure (bar) - Drum - After final superheater H. P. Stop valve Wheel chamber H. P. turbine exhaust Bled steam to feed heaters L. P. inlet Deaerator Condenser vacuum (mmH_2O)

What is measured?

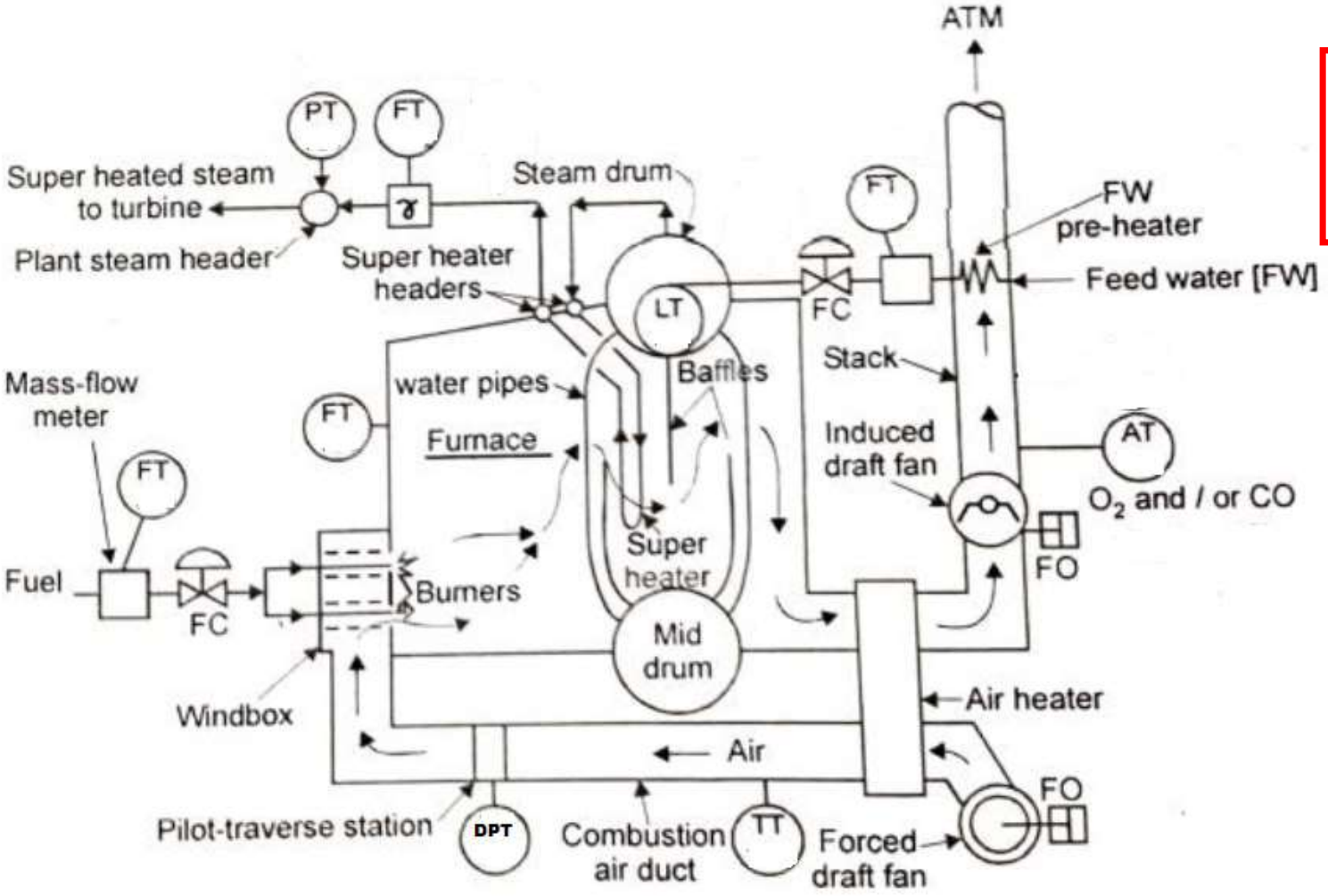
5	Feed Water System	(a) Temperature (°C) Economizer inlet Economizer outlet Condensate temperature before extraction pump Condensate temperature before and after feed heaters (b) Pressure (bar) – Economizer outlet (c) Flow rate (m^3 /h)
6	Flue Gas System	(a) Temperature (°C) - Main air heater inlet - Main air heater outlet (b) Analysis - Dust density - Smoke density - Combustibles - Oxygen
7	Condenser Cooling Water System	- Flow rate (m^3 /h) - Inlet temperature °C - Outlet temperature °C
8	Turbine Supervisory System	- Absolute expansion (µm) - Differential expansion (µm) - Bearing vibration (µm) - Eccentricity (%) - Speed (rpm) - Power generated (MW)

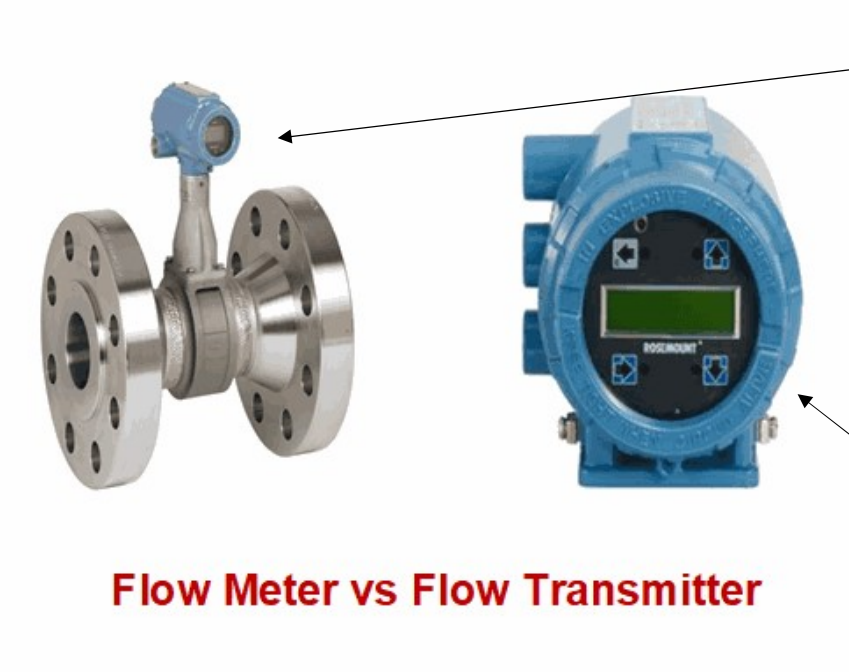
What is measured?



Typical Process Values

Measuring Instruments





Flow Meter vs Flow Transmitter

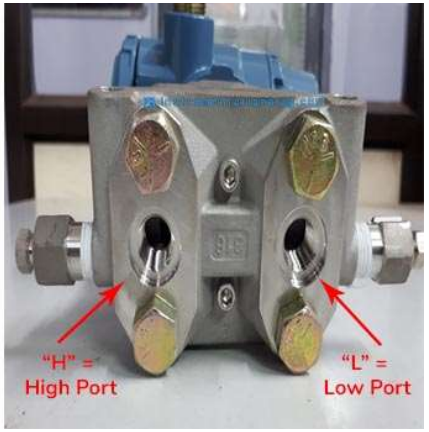
A flow meter is an instrument designed for measuring the rate of fluid flow via a fluid transmission system. It measures the flow rate of a fluid, liquid, or gas when it passes through a confined transmission system. There are different types of flow meters like orifice meters, venturimeters, rotameters, flow nozzles, etc.
(These have been covered in your Sensors and Transducers Class and/or Fluid Mechanics Course)

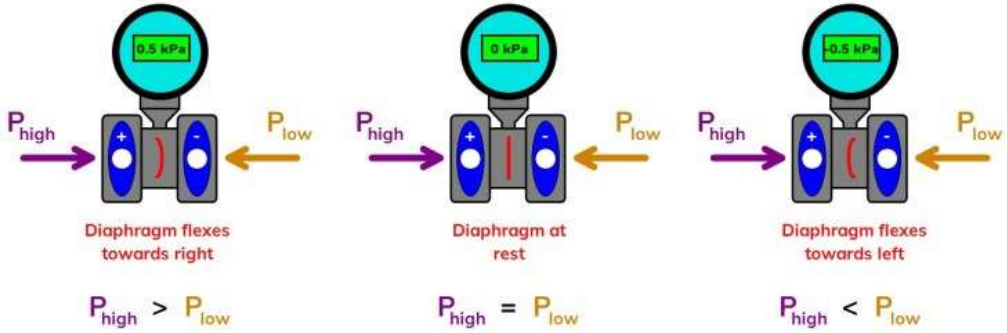
A flow transmitter is an upgraded version of the flow meter. It is a flow meter with an integrated electronic circuit as an operational system. In the flow transmitter, the activity of flow rate measurement is performed by the electronic circuit on receiving the commands from the operator. Since the flow transmitters feature an electronic circuit, it is possible to control and monitor the fluid flow using these devices.

Rosemount 3051 shown here

https://www.transmittershop.com/blog/difference-between-flow-meter-and-flow-transmitter/

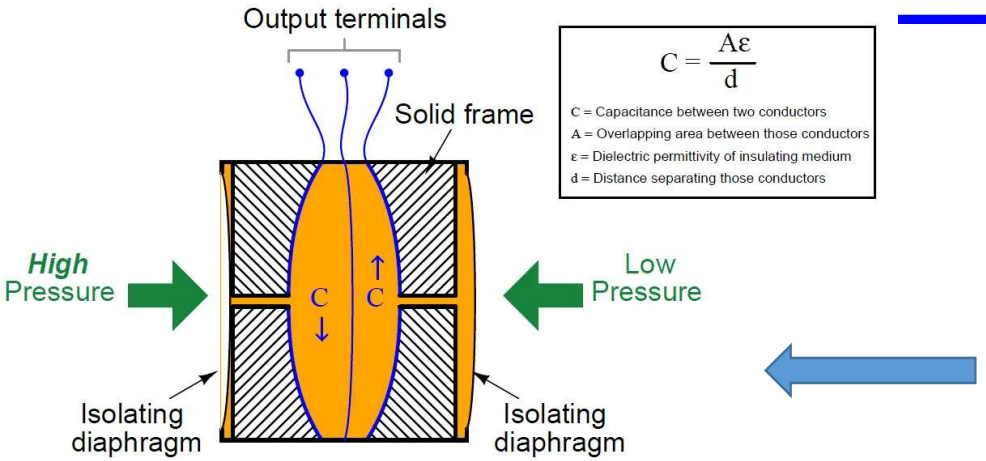
Differential Pressure Transmitter





The most common type of pressure sensing element used in the DP transmitter is a diaphragm. One side of the diaphragm receives pressure from the "high" port and the other side o the diaphragm receives pressure from the "Low" port.

- Oil and Gas flow through the pipe
- A water treatment plan, monitor the water flow
- Sprinkle system
- Pressure drops across valves can be monitored.
- Pump control monitoring.



$$C = \frac{A\varepsilon}{d}$$

C = Capacitance between two conductors
A = Overlapping area between those conductors
ε = Dielectric permittivity of insulating medium
d = Distance separating those conductors

A common electrical pressure sensor design works on the principle of differential capacitance. In this design, the sensing element is a taut metal diaphragm located equidistant between two stationary metal surfaces, comprising three plates for a complementary pair of capacitors. An electrically insulating fill fluid (usually a liquid silicone compound) transfers motion from the isolating diaphragms to the sensing diaphragm, and also doubles as an effective dielectric for the two capacitors:

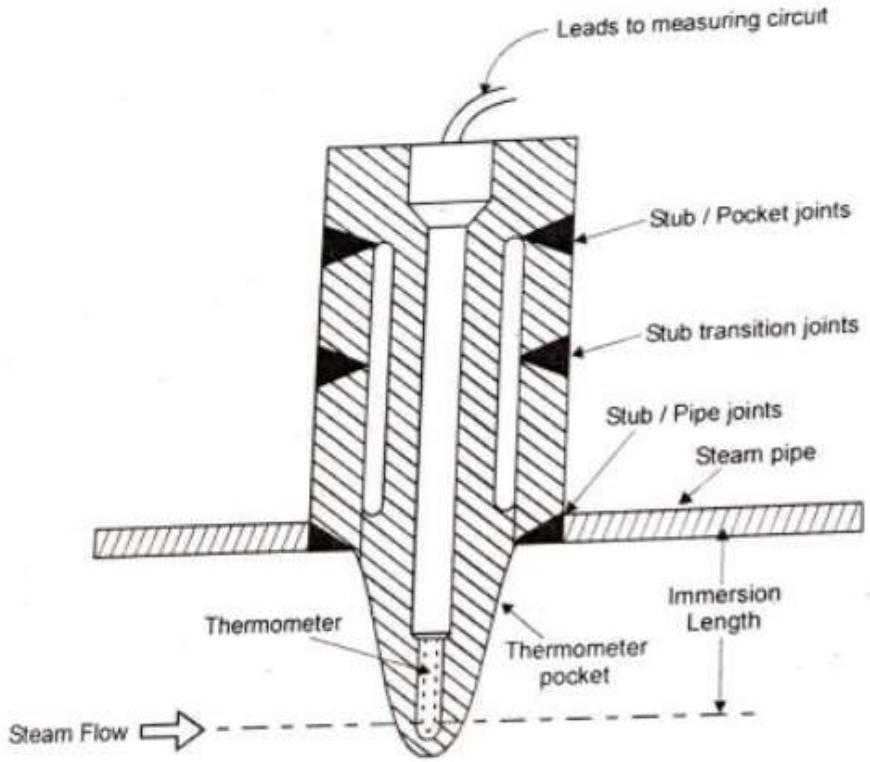
Any difference of pressure across the cell causes the diaphragm to flex in the direction of least pressure. The sensing diaphragm is a precision-manufactured spring element, meaning that its displacement is a predictable function of applied force. The applied force in this case can only be a function of differential pressure acting against the surface area of the diaphragm in accordance with the standard force-pressure-area equation $F = PA=(P_1-P_2)A$.

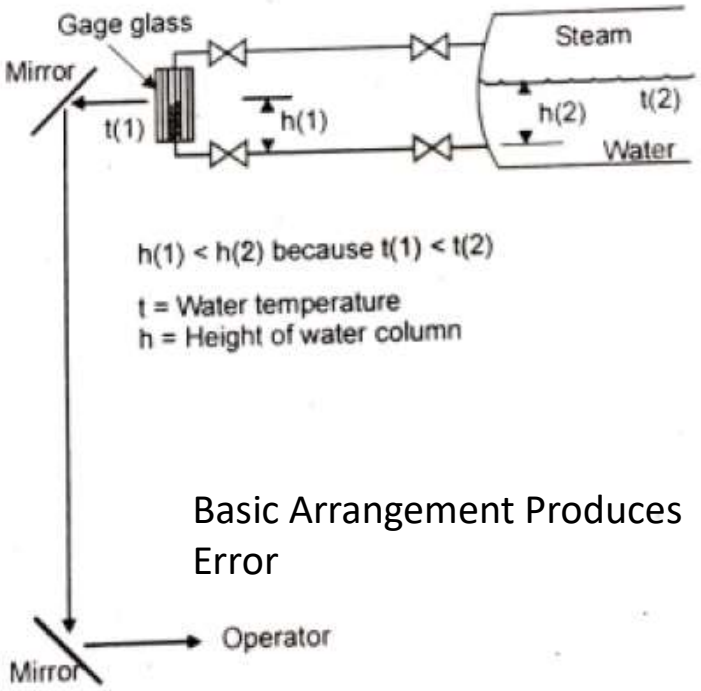
Please refer to notes on Capacitive Displacement Measurement in Sensors and Transducers Class

https://instrumentationtools.com/

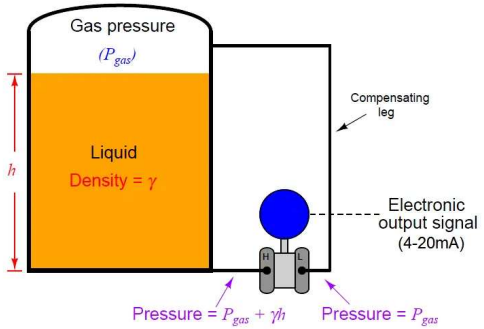
The higher-pressure isolating diaphragm gets pushed toward the metal frame, transferring its motion to the sensing diaphragm via the fill fluid. If too much pressure is applied to that side, the isolating diaphragm will merely “flatten” against the solid frame of the capsule and stop moving. This positively limits the isolating diaphragm’s motion so that it cannot possibly exert any more force on the sensing diaphragm, even if additional process fluid pressure is applied. This use of isolating diaphragms and fill fluid to transfer motion to the sensing diaphragm, employed in other styles of differential pressure sensor as well, gives modern differential pressure instruments excellent resistance to over-pressure damage.

Arrangement for Steam Temperature Measurement using Thermocouples and RTDs





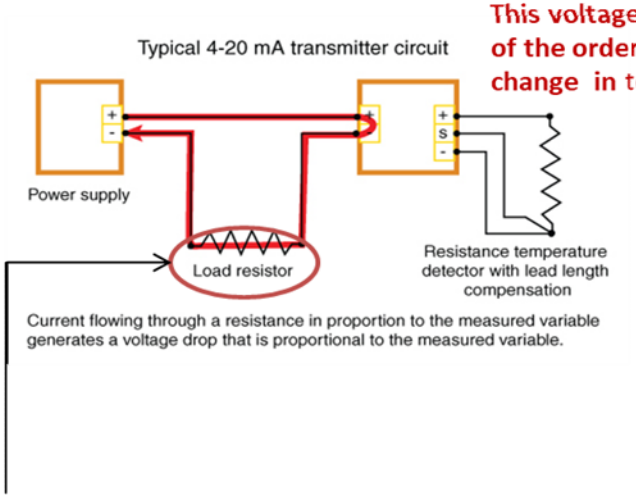
Basic Arrangement Produces Error



$$(P_{gas} + \gamma h) - P_{gas} = \gamma h$$

Eliminating Effect of Gas Pressure

Connecting a sensor



This voltage is very small of the order of mv /deg C change in temperature

This voltage indicates the temperature

A control cable running parallel to a power cable ,for example, would pick up 10-15AC! A current loop is immune to voltage interferences. Unshielded cables can be used.

Q. Why is this voltage not used?

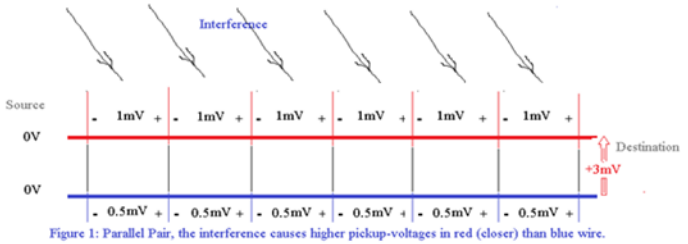


Figure 1: Parallel Pair, the interference causes higher pickup-voltages in red (closer) than blue wire.

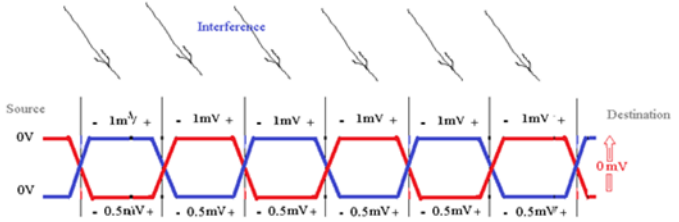
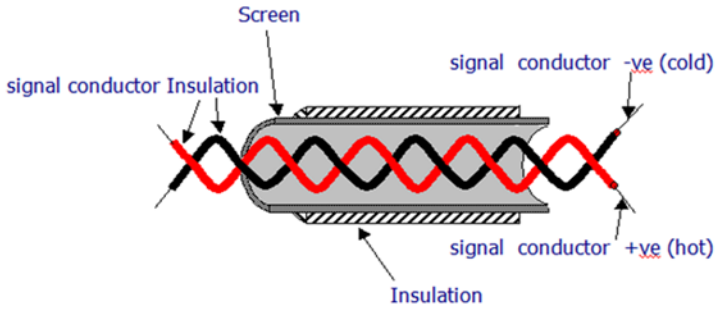
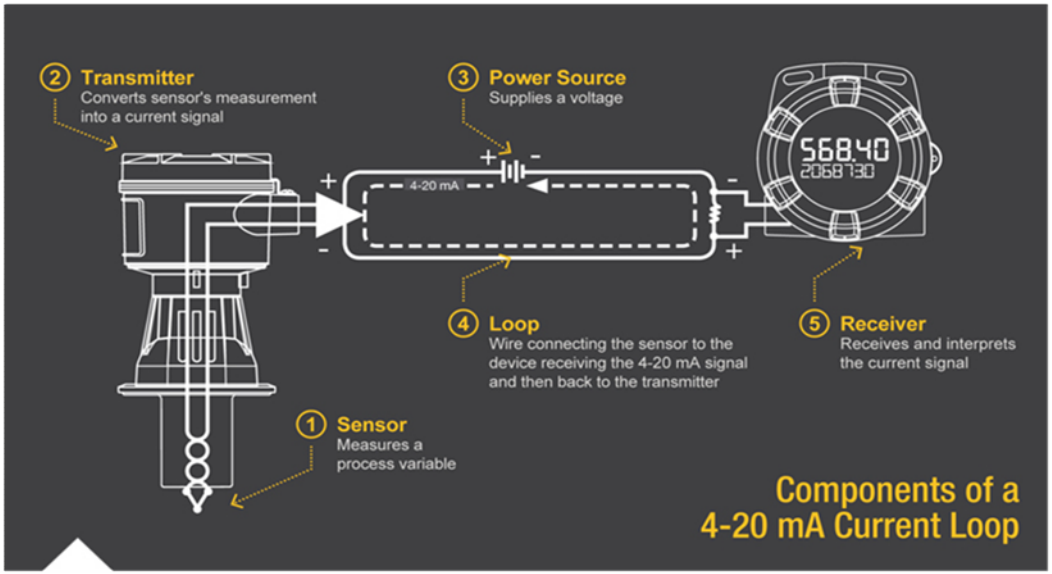


Figure 2: Twisted Pair, the interference alternatively produces high and low pickup-voltages in both wires.



The 4-20mA Loop



Transmitter: Converts the sensor measurement to the current signal (4 corresponds to 0 and 20mA to 100% percent)

Power Source: In order that the signal is produced, power is required and hence a power source is required.

https://www.predig.com/indicatorpage/back-basics-fundamentals-4-20-ma-current-loops

- The 4-20 mA current loop is the dominant standard in many industries.
- It uses less wiring and connections than other signals, greatly reducing initial setup costs.
- Better for traveling long distances, as current does not degrade over long connections like voltage.
- It is less sensitive to background electrical noise(current source has a high internal impedance)
- Since 4 mA is equal to 0% output, it is incredibly simple to detect a fault in the system.(live 0)