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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS - EMERALD

Intellectual Output_O1:
EMERALD e-book for developing of biomimetic mechatronic systems

MODULE 5
Sensors and Electronics

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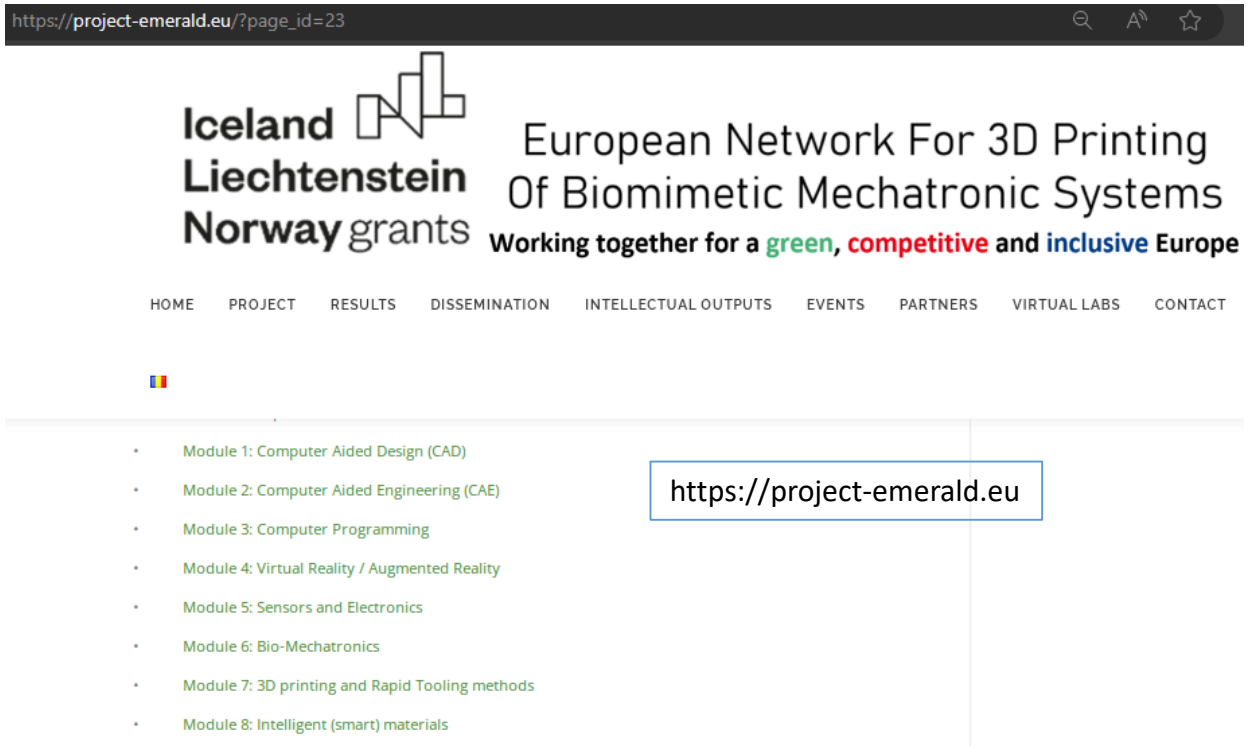

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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS

MODULE 5

Sensors and Electronics

Project Title	**European network for 3D printing of biomimetic mechatronic systems 21-COP-0019**
Output	**IO1 - EMERALD e-book for developing of biomimetic mechatronic systems**
Module	**Module 5 Sensors and Electronics**
Date of Delivery	**July 2022**
Authors	**Tom SAVU**
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Sensors and Electronics - Table of contents

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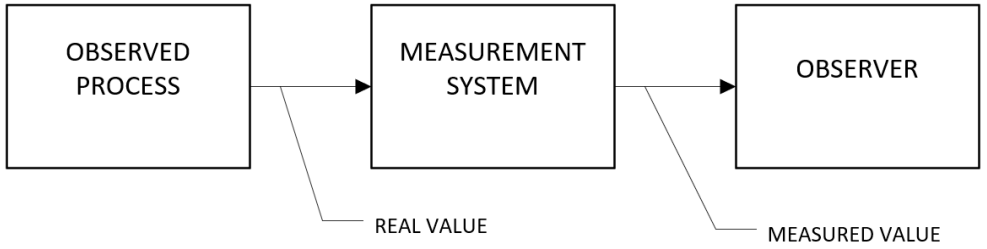
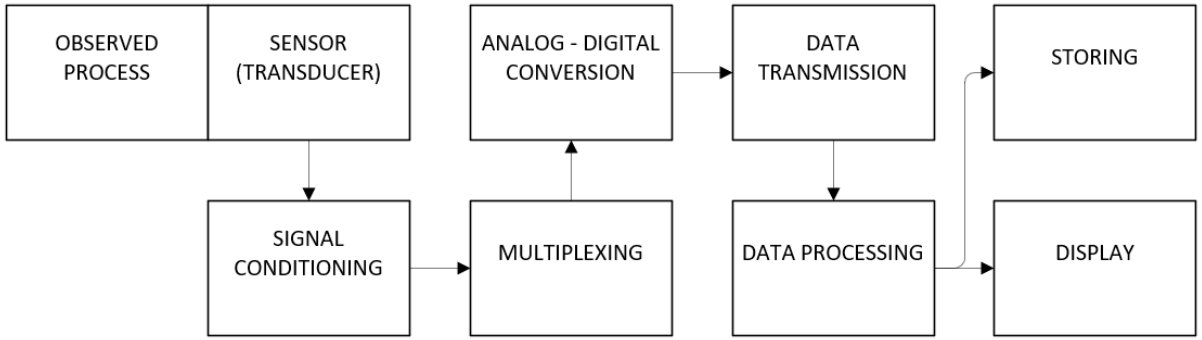
1. *Measurement systems*



Measurement system's place, between the observed process and the observer



General structure of a measurement system

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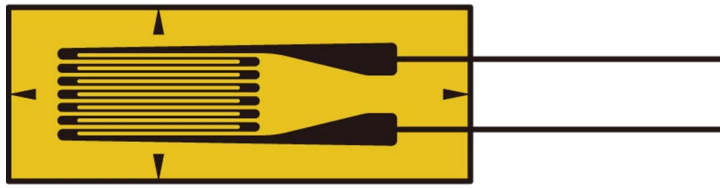
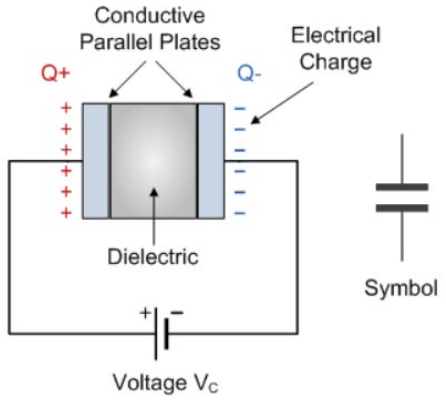
Types of sensors and transducers

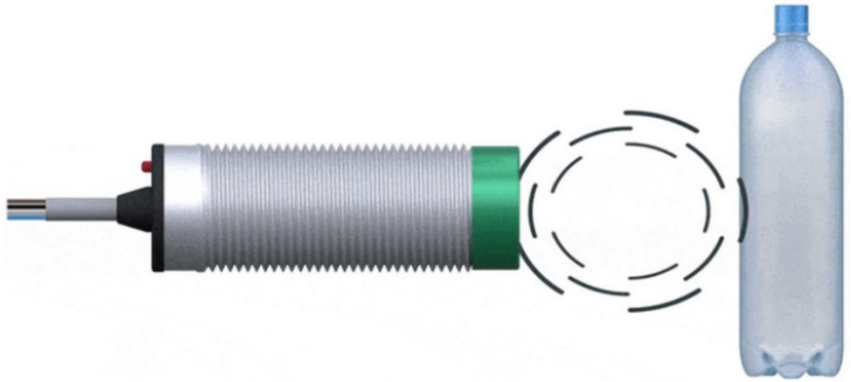


Strain gage example

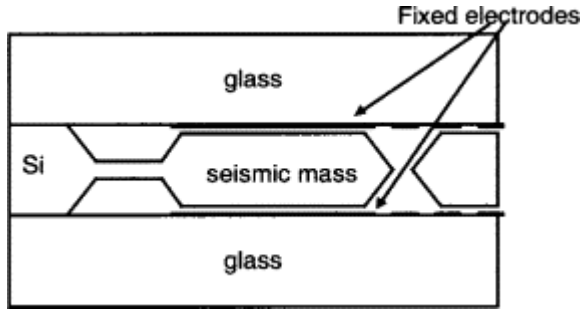
Miniature thin film RTD



Capacitor's structure



Proximity capacitive sensor



The structure of a MEMS accelerometer

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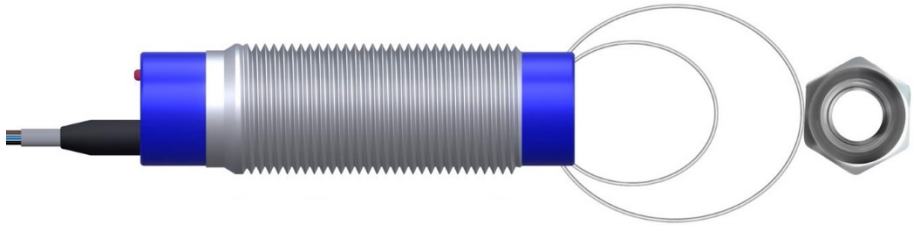
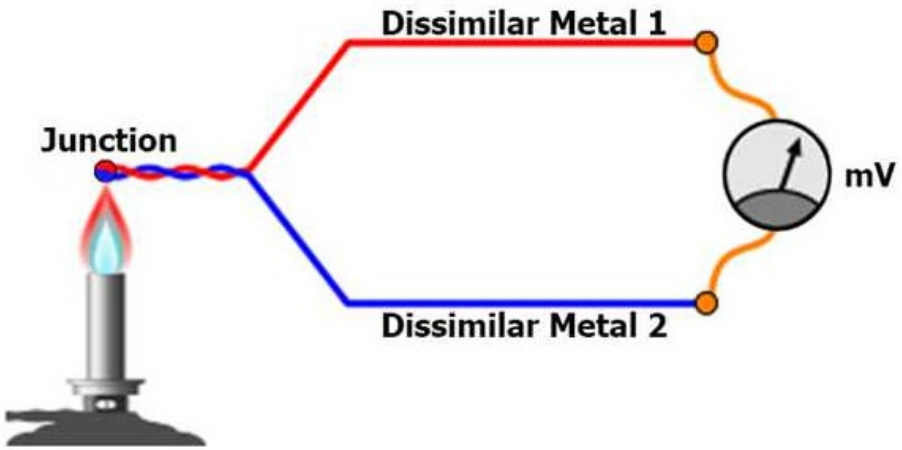
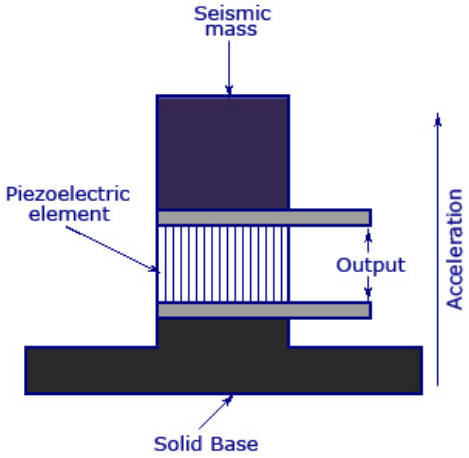


Inductive proximity sensor detecting a metallic object

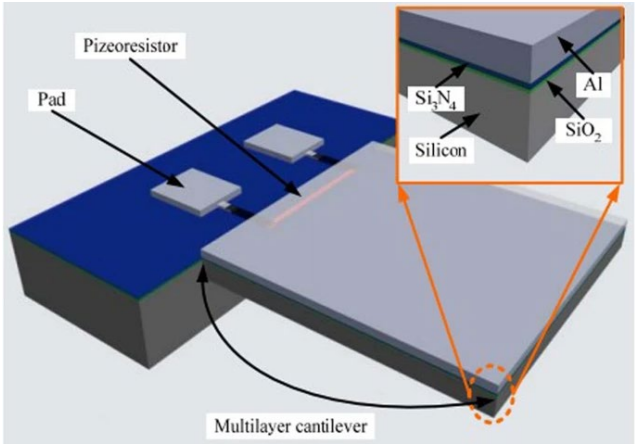
LVDT Inductive displacement sensor.



A thermocouple's structure



An accelereometer's structure



The structure of a piezorezistive temperature sensor.

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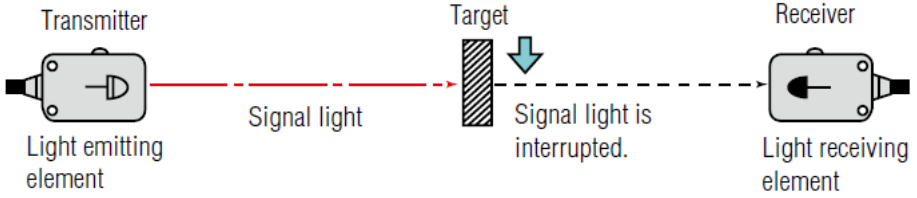
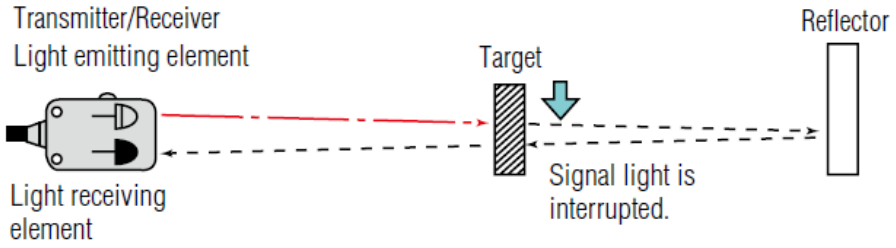
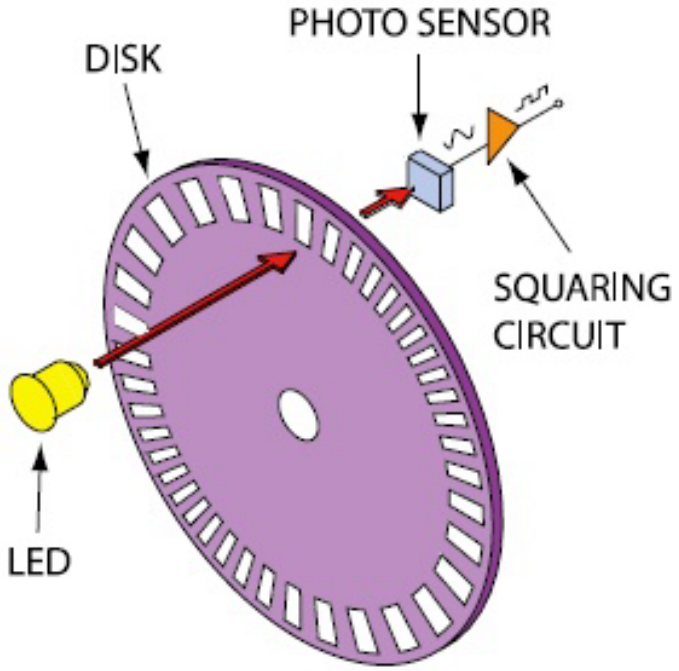


Thrubeam photodetector model.



Retroreflective photodetector model.



A rotary encoder.

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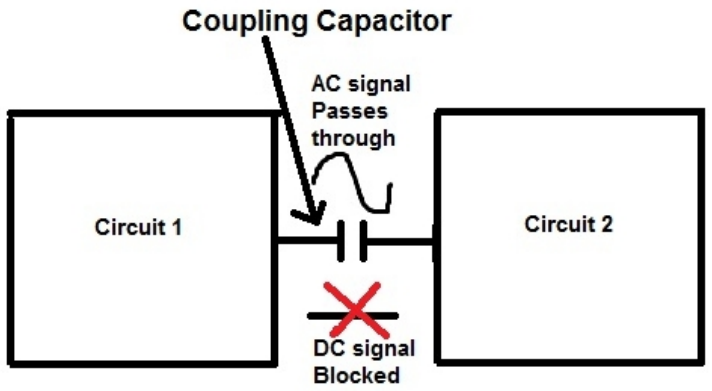
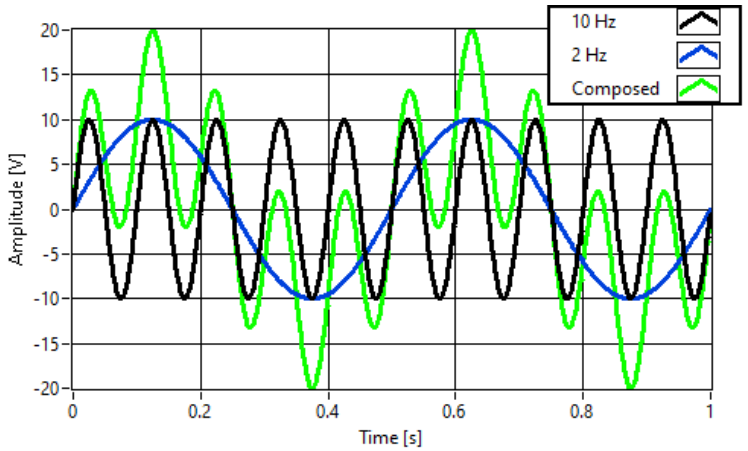
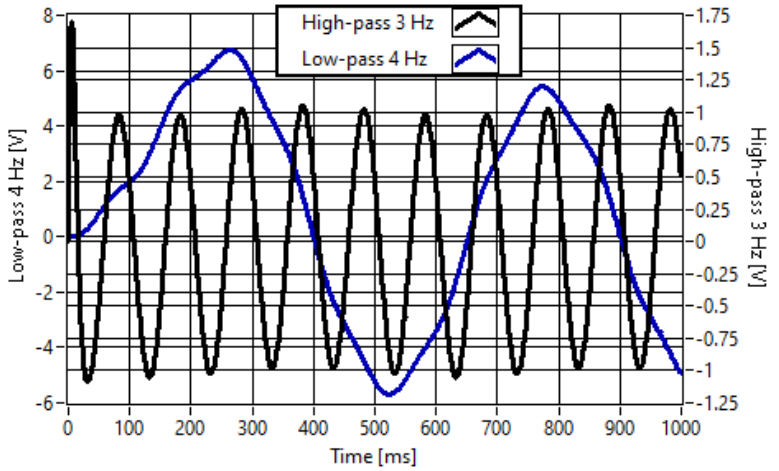
Signal conditioning



Input coupling circuit



Signals composition



Signal filtering results

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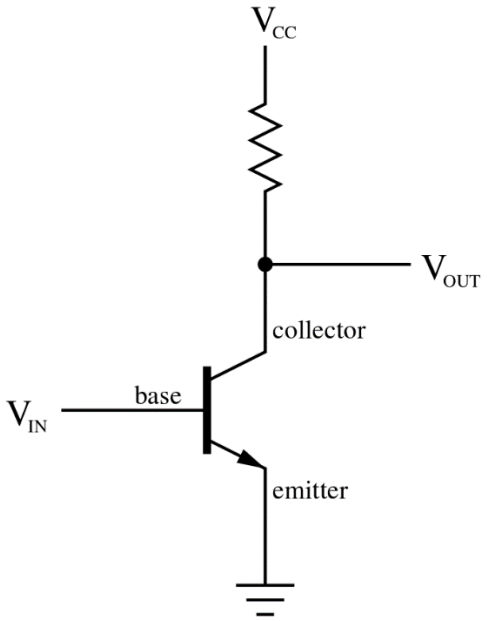
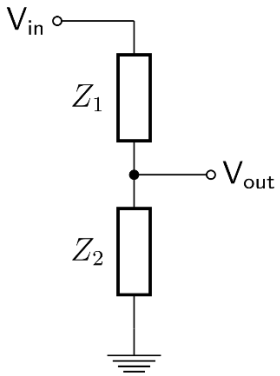
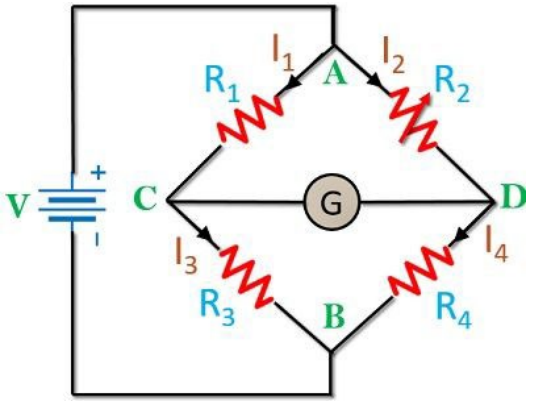
Amplification



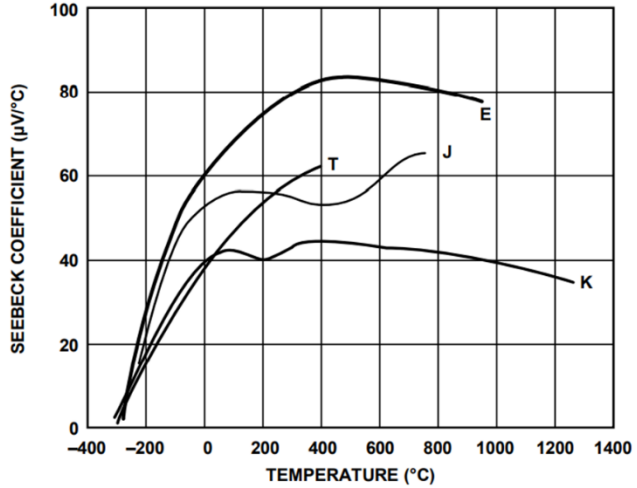
A transistor's circuit



Voltage divider circuit



The Wheatstone bridge



Seebeck coefficient

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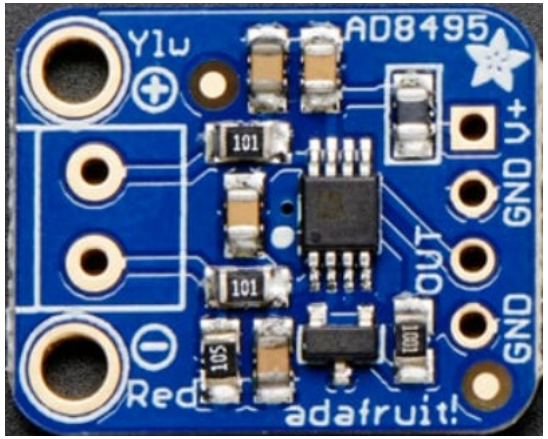
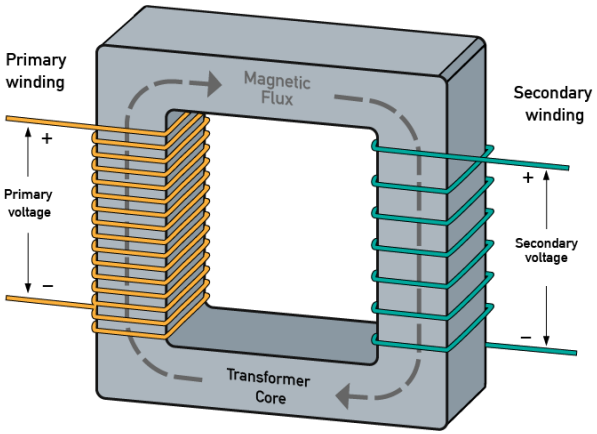
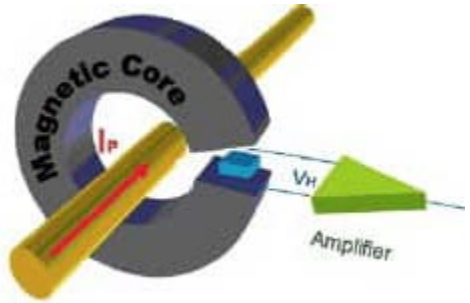
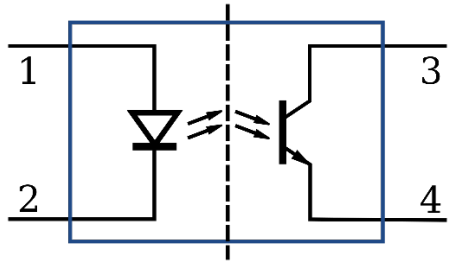


Adafruit breakout with AD8495 IC



Current transformer





An optoisolator diagram

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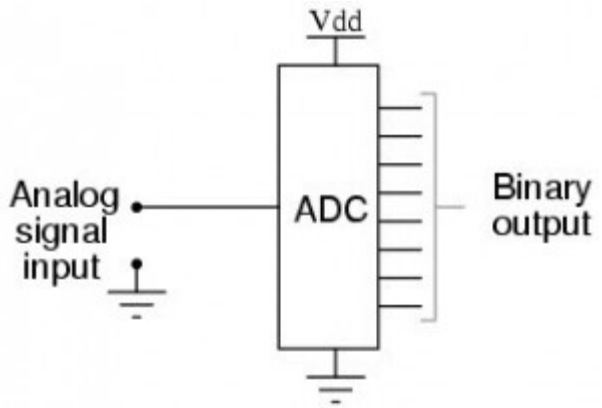
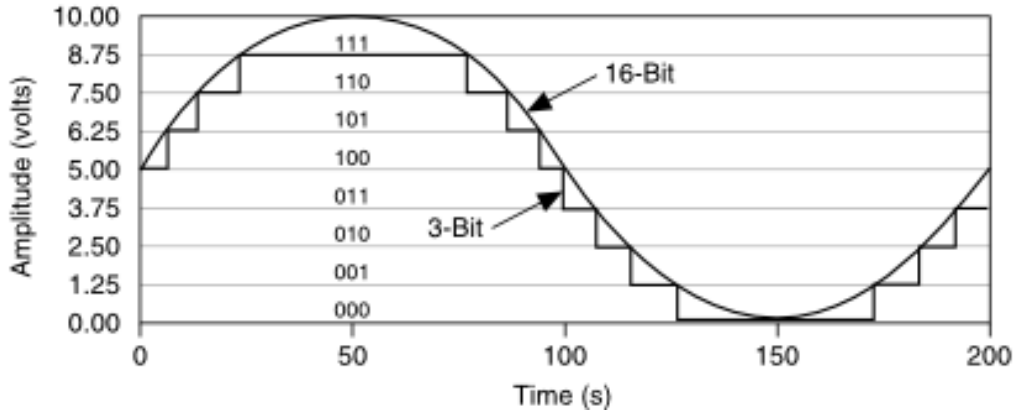
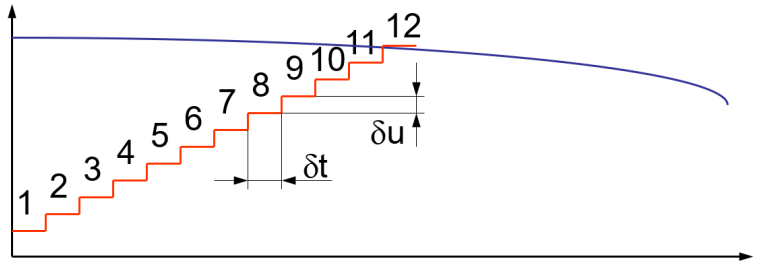
Analog-to-digital converters



An ADC's diagram



Dividing the measurement interval



Performing the comparison for conversion

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Summary

A **measurement system** is a set of devices, apparatus, equipments etc, used for extracting information from a process and to pass that information further. In most cases, information reffers to the values of one or more physical quantities: mechanical, thermical, electrical, chemical, optical etc. As information can not be transmitted without a transfer of matter and without an energy transfer, some material connection has to be established between the observed process and the measurement system. This material connection does not necessarily has to be thought as a mechanical one. Matter means also electrons or photons, so this connection could also be in the form of an electro-magnetical wave, either radio, infrared or visible light. For a connection to exist, some part of the measurement system has to be in contact with the observed process. In figure 2, this component is described as the **sensor**.

When interacting with the observed process, some sensors are changing some of their parameters without generating any amount of energy. These are called **parametric (passive) sensors**. Another category of sensors are those which are generating a certain amount of energy when interacting with the observed process. These are called **generative (active) sensors**.

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Summary

Discussing only about electrical parameters based sensors, parametric sensors can be further classified, according to the variable parameter, in **resistive** (strain gages, Resistance Temperature Detectors etc) **capacitive** (e.g. proximity sensors, MEMS accelerometers etc) and **inductive** sensors (proximity sensors, LVDT sensors etc). Generative (active) sensors are usually classified according to the physical quantity they are measuring: thermocouples, piezorezistive pressure sensors, accelerometers, piezoelectric temperature sensors, photodiodes, photodetectors, rotary encoders etc).

Signal conditioning represents the transformation of an analog signal in such a way that this becomes compatible with the next components of the measurement system. Extracting only the useful part of one signal also represents a category of signal conditioning. There are many types of signal conditioning operations, depending on the sensor's type, signal's type or on the requirements of the measurement system.

An **analog-to-digital converter (ADC)**, as its name suggests, is converting an analog signal into a digital one.

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