

# Measuring instruments

Measuring can be described as a series of operations whose goal is to determine physical quantities of real-world objects. It serves as a source of information for scientific and technological progress, analysis and control of technological processes, control of product quality and manufacture, and protection of the citizens' health.

In 1863, Englishman Whetstone invented resistance bridge used to measure the electrical resistance and voltage. In 1846, German physicist Weber constructed electro-dynamometer which was capable of measuring alternating and direct current. In 1868, Werner Siemens perfected the electro-dynamometer and constructed universal galvanometer for measuring electrical voltage, currents and resistance. Today, there are universal instruments used to measure quantities. The uniformity of the measuring is responsibility of discipline called metrology. Metrology deals with measuring, units, measuring methods, and measuring instruments. For electro-technology there is the ELSECOM - The European Electro-technical Sectoral Committee for Testing and Certification.

A measuring instrument is designed to measure the values of a certain physical quantity. We use the voltmeter to measure voltage, the protractor to measure angles, and the scale to determine weight of objects. In electro-technology, we frequently use an instrument called the multi-meter to measure the electrical current, resistance and voltage.



## Classification of measuring instruments

Measuring instruments can be classified based on several criteria:

### Based on the purpose of use:

- **Common use** – used in our daily lives, at home, at work. They are less precise but also cheaper.
- **Metrological use** – used for comparing the common used measurement system with more precise ones. They are used mainly for calibration and thus are precise but also expensive.
- **Etalons** – a human-made object that is used as the standard of measurement of some physical quantity to base all measurement of that physical quantity against.

### Based on the output:

- **Direct output** – tape rule, micrometer, manometer
- **Paper feed** – barograph, seismograph
- **Incremental** – they record the value as a total sum, e.g. water meter, electricity meter

### Based on the type display type:

- **Analog** – show measured data on a scale with a moving pointer
- **Digital** – show measured data in numerical form



Analog measuring instrument



Digital measuring instrument

### Based on the type of contact with the measured medium

- **Contact** – the devices come into direct contact with the measured environment
- **Contactless** – the devices don't come into direct contact with the measured environment

## Measuring of electric quantities

### Measuring voltage

For direct measurements we use voltage meters (**V**). Voltage meters show data as needle deflection or numbers on screen. They are plugged into circuit in parallel.

#### *Instruments used to measure voltages*

- D'Arsonval meter – used as a general coverage meter
- Moving iron-vane meter – used as a general coverage meter
- electronic millivolt meter – used for measurement of small voltages
- electrostatic volt-meter – used for measurement of high voltage

### Measuring electric current

For direct methods we use ammeters (**A**). Ampere meters show data as needle deflection or numbers on screen. They are plugged into circuit in series.

To measure larger currents, a resistor called a shunt is placed in parallel with the meter. Most of the current flows through the shunt, and only a small fraction flows through the meter. This allows the meter to measure large currents.

### Measuring electric power

For direct measurement of electric power we use electro-dynamic or electromagnetic wattmeter (**W**).

Electric power can be measured indirectly by measuring voltage and current and calculating power from the following formula  $P = U \cdot I$ .



## Measuring electric resistance

For direct measurement of resistance we use ohmmeter. The measured resistor/load is connected directly to the measuring instrument.

When measuring resistance indirectly we measure the voltage on the resistor's terminals, the current that flows across the resistor and we use the ohm's law to calculate the resistance.

To measure large resistors (insulation resistance), extremely small resistors (contact resistance) and grounding resistance we use specialized measurement instruments.

## VOCABULARY

protractor – uhlomer

less precise – menej presný

more precise – presnejší, presnejšie

cheaper – lacnejší, lacnejšie

moving pointer – ručička meracieho  
prístroja

ammeter – ampérmeter

shunt – bočník

calibration – kontrola, porovnávanie ,  
nanesenie stupnice

human-made object – ludmi vyrobená vec

tape rule – meracie pasmo

insulation resistance – izolačný odpor

contact resistance – prechodový odpor

grounding resistance – odpor uzemnenia

moving iron-vane meter –

elektromagnetický systém

D'Arsonval meter is magneto-electric measuring instrument in Europe known as Depress system. This is system with a moving coil.

The electro-magnetic measuring system utilizes moving iron.