T-shore Education

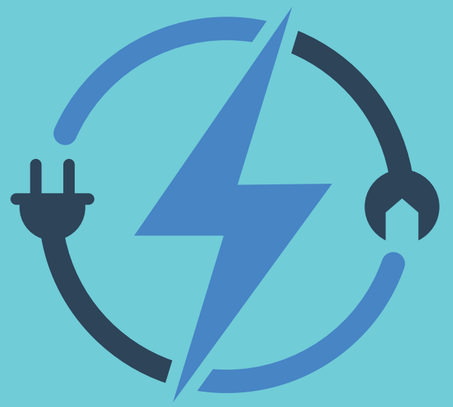
Basic Electrical Skills

Theory Presentation

Co-funded by the European Union

Funded by the European Union. Views and opinions expresse are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

This document has been created as part of the wider T-shore project, co-funded through the European Union's ERASMUS+ programme.



Erasmus+
Enriching lives, opening minds.

Vocational education and training

Document Information

Document Author Partners:

Skive College

Version no.	Date	Description of changes	Prepared by
01	11.12.2024	New presentation created	Jens Høffner, Heidi Katrine Rosenberg

Aims and Objectives of Intro to Basic Electrical skills

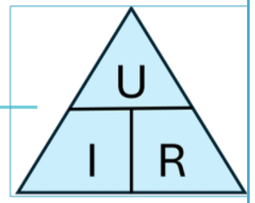
Main Aim

The purpose of this theory material is to provide an introduction to calculations on electrical DC circuits, as well as perform measurements of current, voltage and resistance with a multimeter. Build minor basic relay technical connections and knowledge of logic circuits in connection with relay and PLC controls, and use the mechanical limit switches and inductive sensors found on a control.

T-shore Education

Content

Ohms Law
Lesson 1



Capacitor and diodes
Lesson 2

Magnetism
Lesson 3

Relay technology
Lesson 4

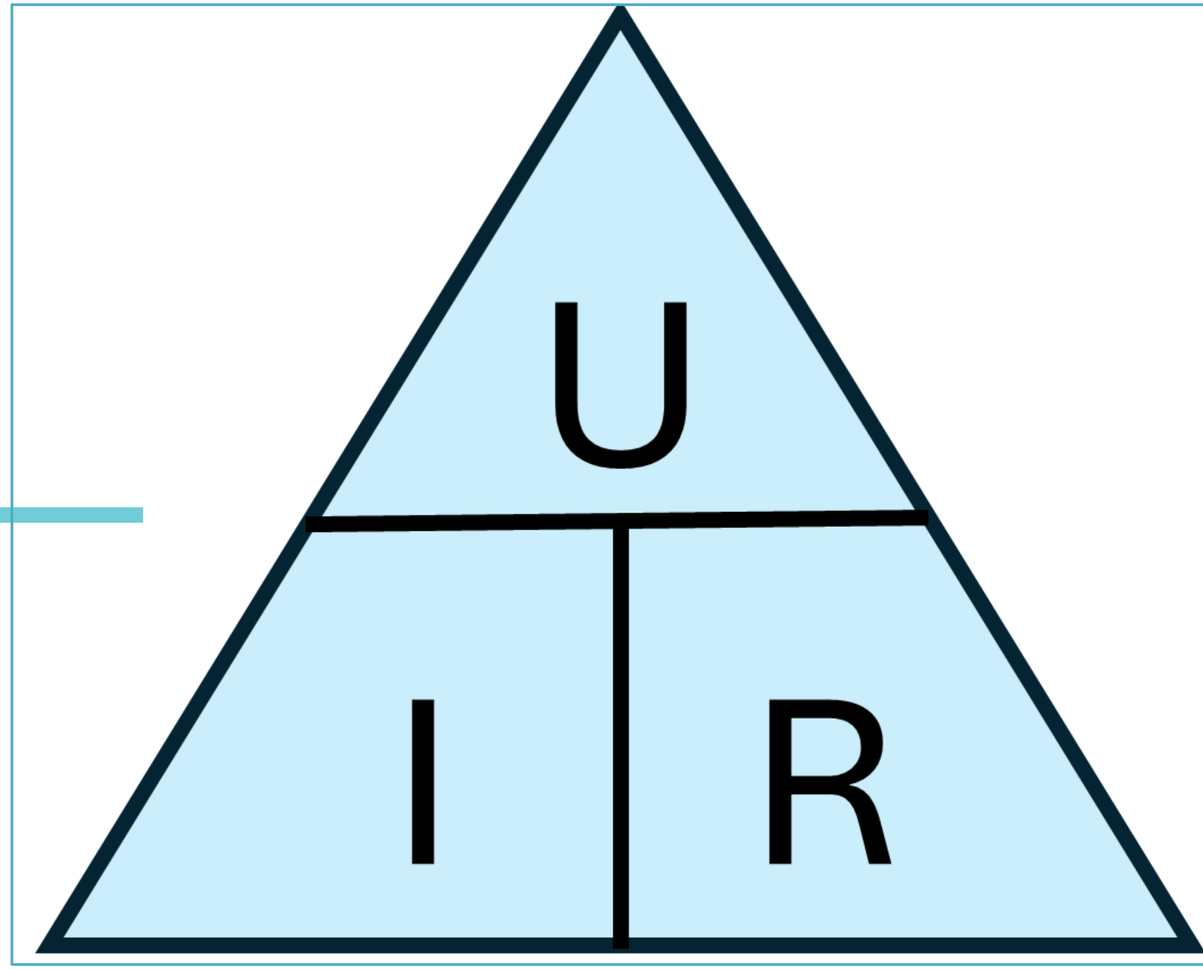
Sensors
Lesson 5

PLC
Lesson 6

T-shore Education

Ohms Law

Lesson 1



T-shore Education

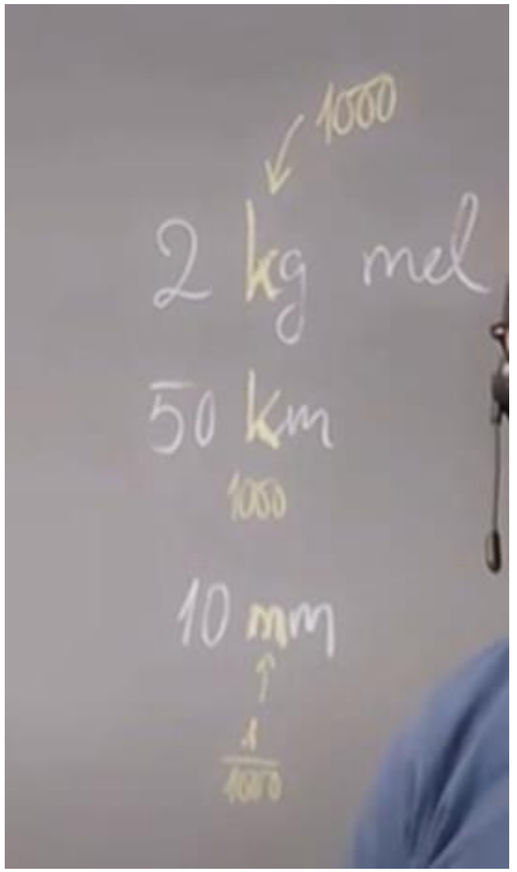
What is prefix?

Prefixes we use when we have a very large or small number. So when we need to convert units, we use prefix, to put in front of a unit.

We know it from, for example, 2 kg of flour or. 40 km, where the prefix here is "kilo" and means 1000 times more than our basic unit meter (m).

Or from, for example, 60 mm, where the prefix is "mili" and means 1/1000 less than our basic unit meter (m).

Wind turbines: E.g. one of 2 MW. Here the prefix is "Mega" and means 1000000 (million) times more than our base unit Watts (W).
- 2 MW is the same as 2000000 W.



T-shore Education

Prefix's table

Præfiks	Symbol	10 - potens	Talværdi
Terra	T	10^{12}	1 000 000 000 000
Giga	G	10^{9}	1 000 000 000
Mega	M	10^{6}	1 000 000
Kilo	k	10^{3}	1 000
Enheden	1	10^{0}	1
Milli	m	10^{-3}	0,001
Micro	μ	10^{-6}	0,000 001
Nano	n	10^{-9}	0,000 000 001
Pico	p	10^{-12}	0,000 000 000 001

Prefix

If we go up a notch, the next prefix is 1000 times larger. **1000 (thousand).** Here the prefix **kilo (k)** is which is **10^3** (10x10x10)

If we go up another thank, the next prefix is 1000 times bigger. **1000000 (million).** Here the prefix is **Mega (M)**, which is **10^6** (10x10x10x10x10xx10x10)

If we go up another thank, the next prefix is 1000 times bigger. **1000000000 (billion)** Here is the prefix **Giga (G)** which is **10^9** (10x10x10x10x10x10x10x10x10)

If we go up another thank, the next prefix is 1000 times bigger. **1000000000000 (billion)**. Here the prefix is **Tera (T)** which is **10^{12}** (10x10x10x10x10x10x10x10x10x10x10x10)

Prefix

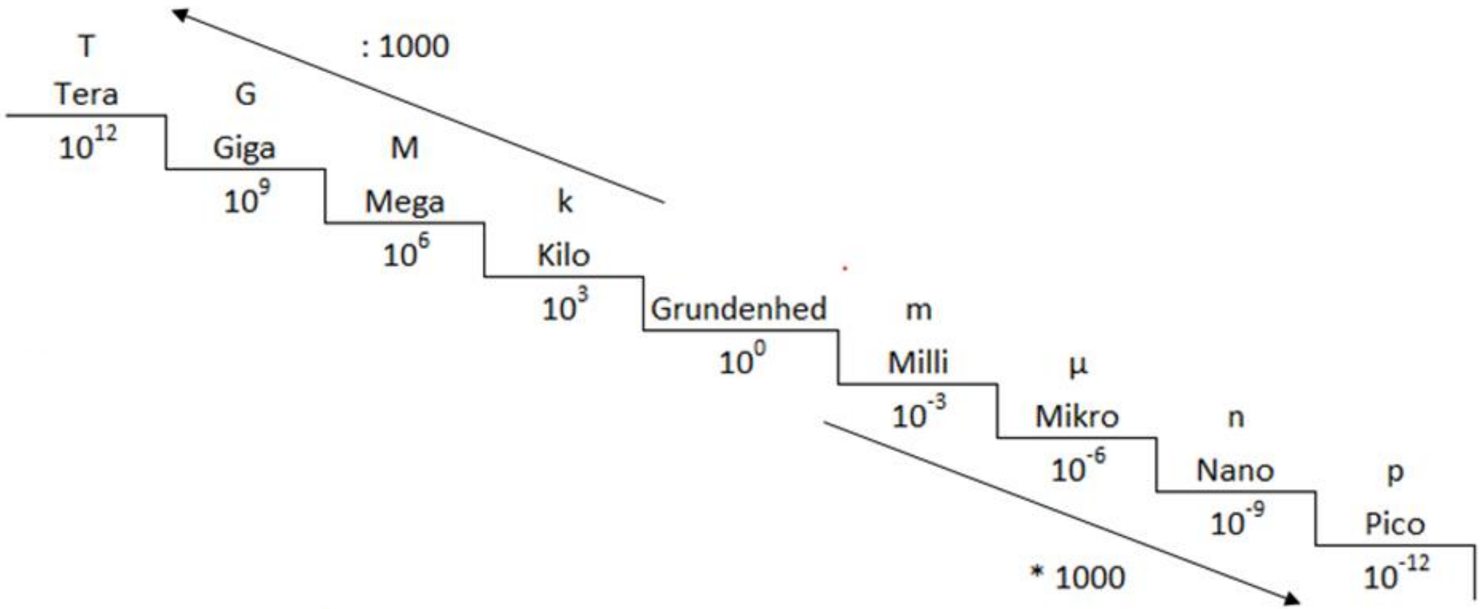
If we go down a notch, the next prefix is **1/1000** times smaller (thousand). Here is the prefix **mili (m)**, which is **10^{-3}** (10/10/10)

If we go down another thanks, the next prefix is **1/1000000** times smaller (million). Here is the prefix **micro (µ)** which is **10^{-6}** (10/10/10/10/10/10)

If we go down another thanks, the next prefix is **1/10000000000** times smaller (billion). Here the prefix is **nano(n)**, which is **10^{-9}** (10/10/10/10/10/10/10/10/10/10)

If we go down another thanks, the next prefix is **1/100000000000000** times smaller (trillion). Here is the prefix **pico(p)**, which is **10^{-12}** (10/10/10/10/10/10/10/10/10/10/10/10/10)

Prefix ladder



T-shore

What do we use Prefixes for?

We use this for when we calculate in electricity.

Numbers must always be inserted in the basic unit, in a formula.

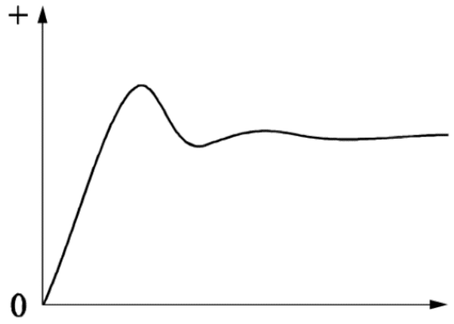
Then we have stated a unit called 2 kΩ, it must be converted to 2000 Ω before we start calculating.

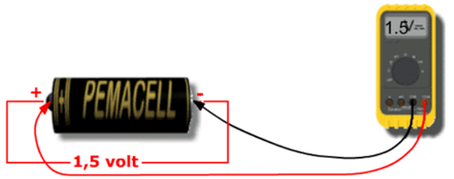
We will get to that when we are about to calculate in orbit!.
Example:

Stated that we have 5 kg (kilo) of sugar that must be added together with 500000 mg of sugar.
Then we must first convert it to pure units (grams).
5 kg is converted to (5 * 103) = 5000g and 500000 mg is converted to (500000 * 10-3) = 500g.
So, it will be a total of 5500 g (grams).

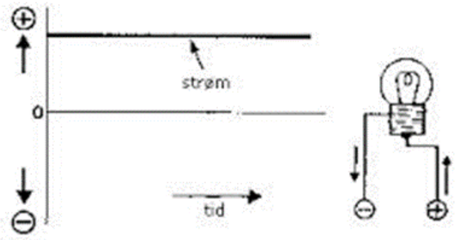
Direct current (DC)

Direct voltage is an electric current which runs continuously in the same direction through the wire, but it does not have to have constant strength.
One terminal is always + and the other always -





If a light bulb is connected to a battery, a current will run from one pole, through the bulb, to the other pole.



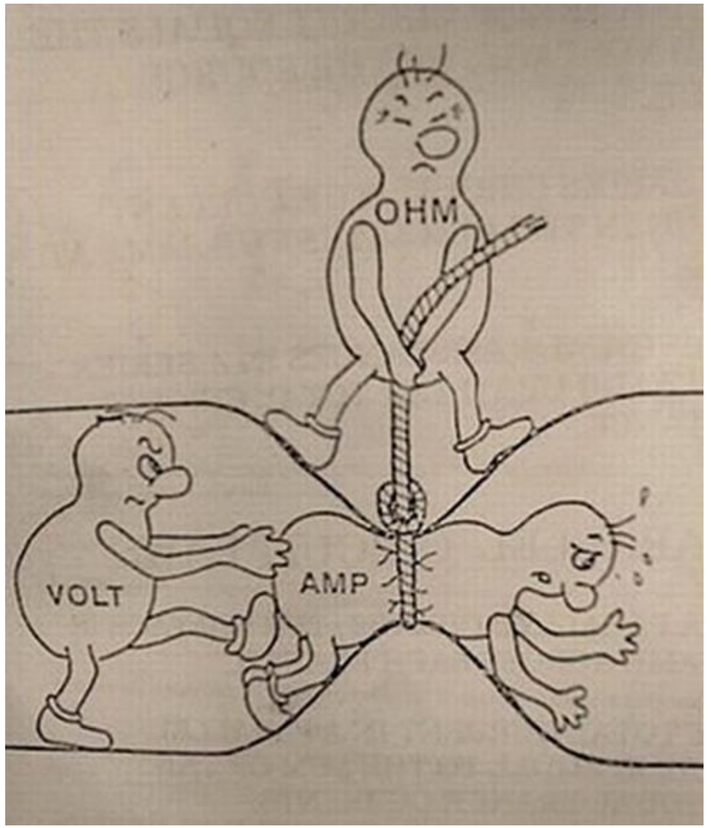
T-shore Education

Voltage (Voltage difference)

Between an electricity source and two connection terminals, there is a certain voltage difference. If an electrical utility is connected between such two terminals, a current will pass through the circuit lip.

The current strength is limited by the electrical resistance in the circuit.

The device 1 volt can be derived as the voltage needed to send a current of 1 ampere through a 1 ohm resistor.



Voltage (Voltage difference)

When talking about voltage, you have to remember that it is a difference, i.e. that it is the difference between two poles.

On a 1.5 V battery, 1.5 V is measured if I put a plug on both + pole and pole.

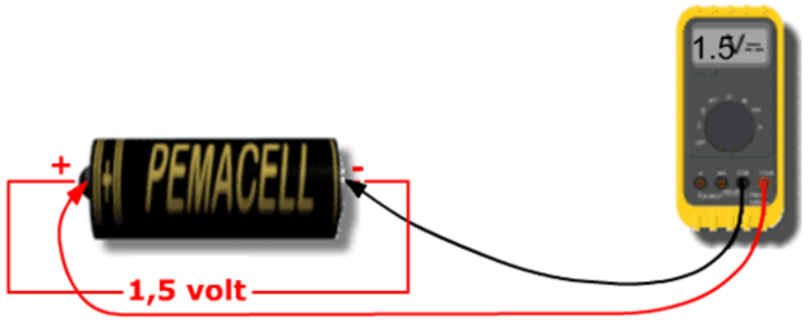
If I put both props on + or – the voltage will be 0 V, as there is now no voltage difference between the props.

Indications:

Denomination **Volt**

Abbreviation **V**

Formal Letter **U**



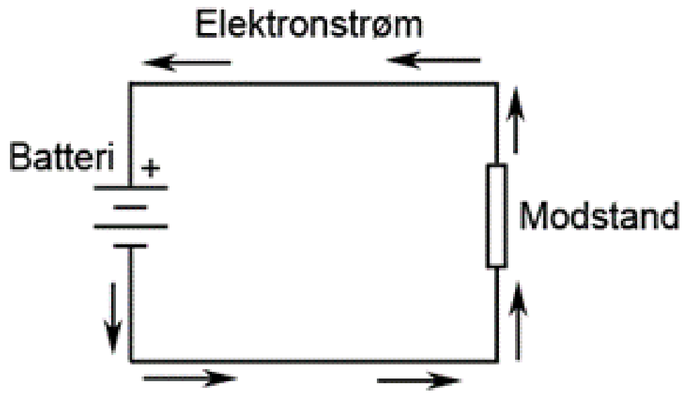
T-shore Education

Current

An electric current, or electron current, is a movement of electrons in a conductive material, e.g. copper or aluminium.

Conductive materials are when dug up from the ground filled with electrons, so these are not something that is replenished from the voltage source.

The voltage is the force that makes the electrons move, but the movement itself is called the current.



T-shore Education

Current

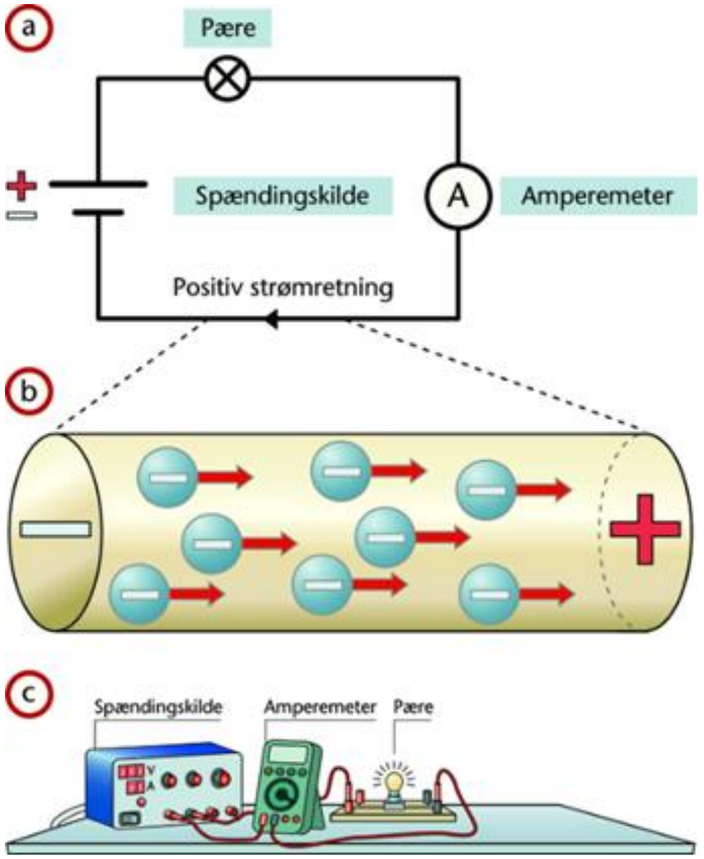
Since the electrons have negative charge, they will move in the direction of the positive clamp on the voltage source that is supplied at the same time, as many new electrons from the negative clamp of the voltage source.

Indications:

Denomination **Ampere**

Abbreviation **A**

Formal letter **I**



T-shore Education

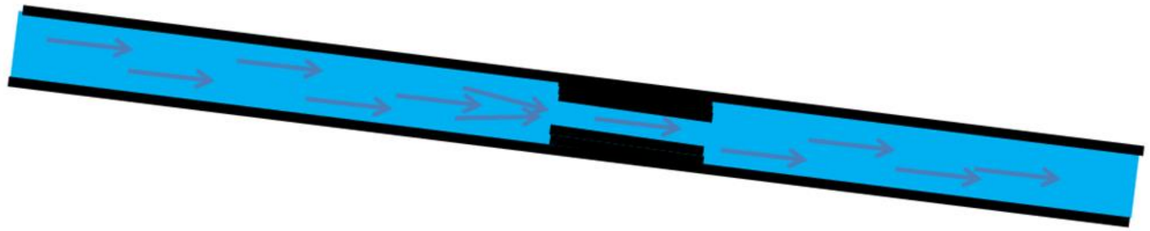
Resistance

Resistance, is the resistance a material provides against electrons running through it, resistance is measured in Ohms and the formula sign R.

The resistance tells us something about how difficult it is for the electrons to pass through the material.

A resistor has a resistance of 1 Ohm if a current of 1 Ampere runs through it when a voltage of 1 Volt is applied.

From this, Ohm's law is obtained: $U = I \cdot R$



T-shore Education

Resistance

Substances with a very small resistance are called conductors, e.g. Silver, aluminum and copper. Copper and aluminum are used for electrical wiring.

Silver is used for securing wire and coating on contact surfaces.

Substances with such great resistance that the current can hardly pass through are called insulators.

Examples of such are plastic, porcelain, rubber, paper and oil.

Indications:

Denomination **ohm**

Abbreviation **Ω**

Formal letter **R**

Ohm's Law

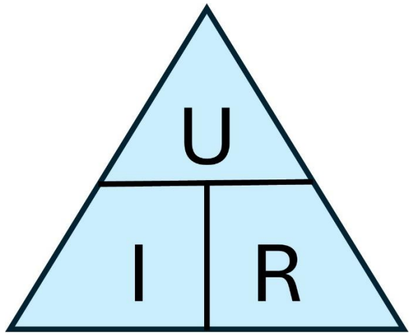
In Ohm's law, the following two equivalent statements apply: (equivalent = true statements)

1. The resistance is independent of the voltage.
2. The relationship between voltage and amperage is linear.

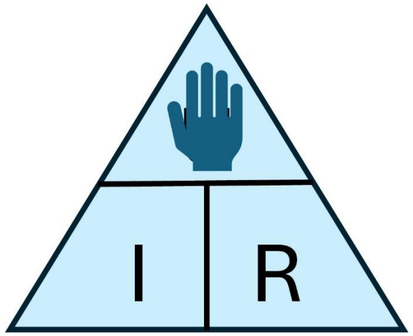
In symbols, this is written as follows:

U = I x R, i.e. voltage is equal to current times resistance.

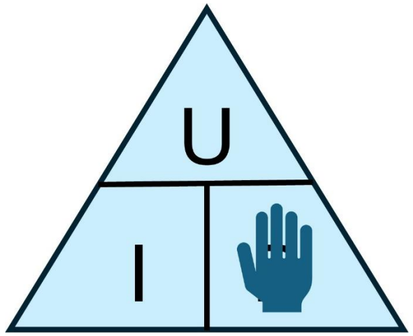
Ohm's Law



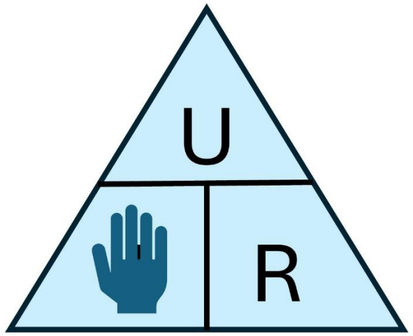
Ohm's law



Calculate voltage



Calculate resistance



Calculate current

T-shore Education

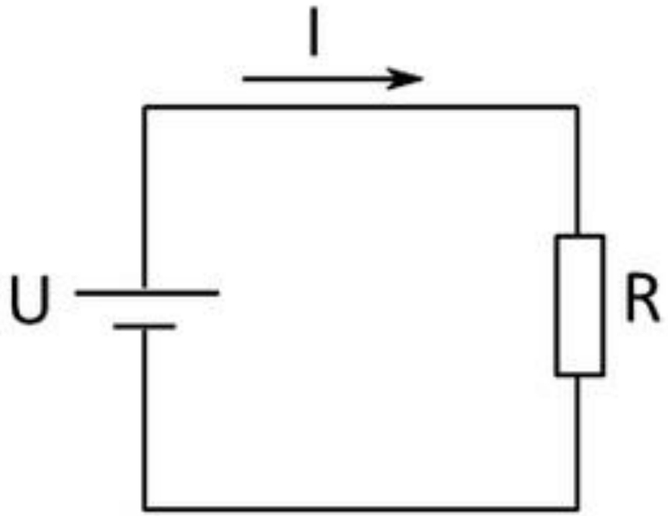
Ohm's Law

Ohm's law describes that between **voltage**, **current**, and **resistance** there is a **dependency** that means that you cannot change one of the parts without at least one of the other parts also being changed.

This cohesion between the quantities **U**, **I**, and **R** is expressed by the following formula, called **Ohm's law**:

Voltage = **current** * **resistance**:
U = **I** * **R** [**V**]

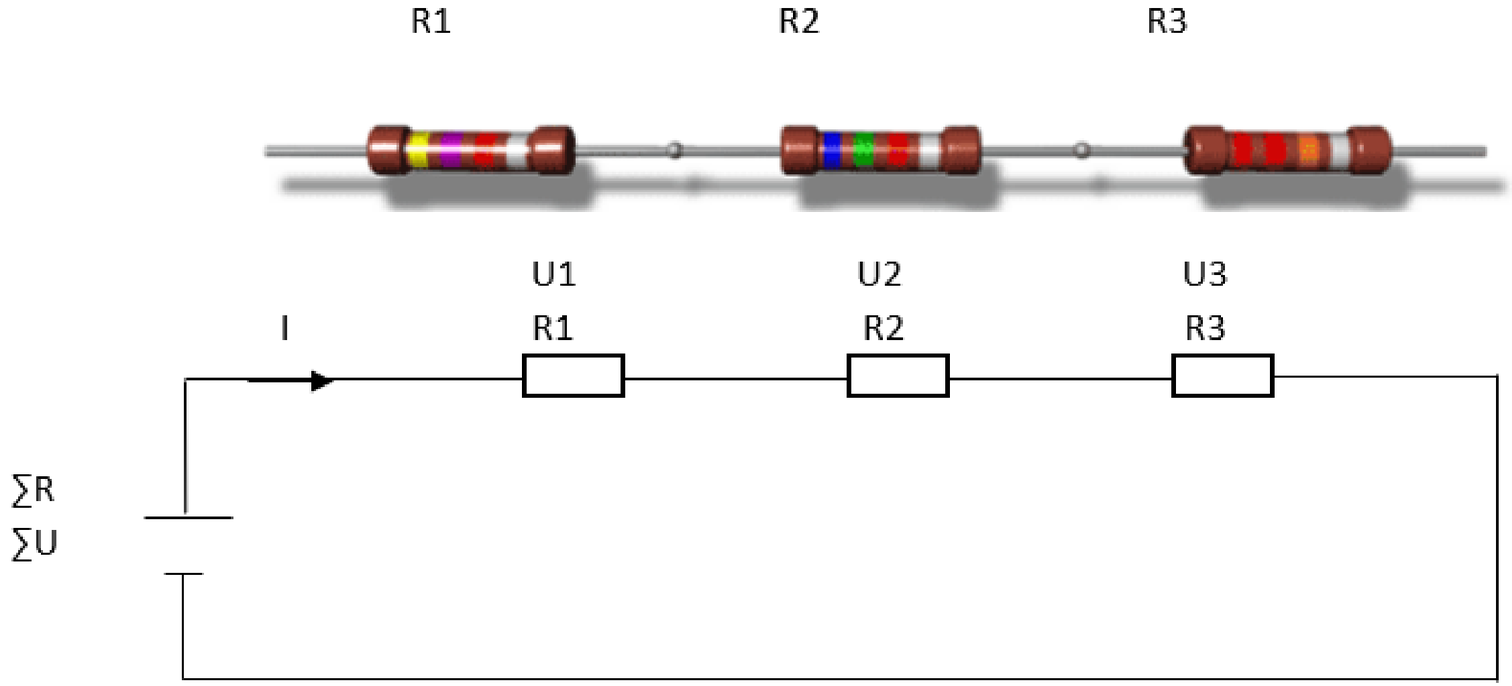
Ohm's Law can also be paraphrased to:
I = ***U*** / ***R*** [**A**]
R = ***U*** / ***I*** [**Ω**]



T-shore Education

Series connection

In series connections, the resistors are placed one after the other like beads on a string.



Series connection

Current and resistance

The same current must run through all the resistors to get back to the supply. It must therefore be possible to deduce that **the current is the same in a series connection**.

The total resistance in a series connection is found by adding all the resistors in the circuit together.

$\Sigma R = R1 + R2 + R3$ etc.

Series connection

Voltage

When a current passes through a resistor, a voltage drop will occur across the resistor.

Since U = I × R, the greatest voltage drop will be above the greatest resistance, and **the sum of the 3 voltage drops U1, U2 and U3 is equal to the supply voltage.**

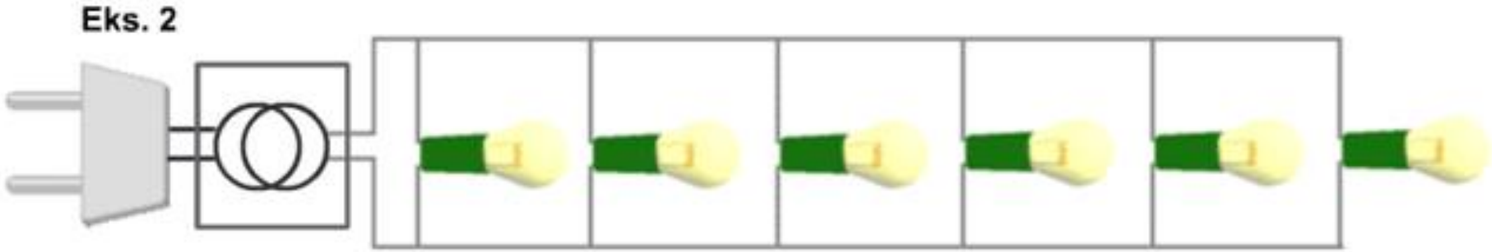
This can be deduced from Kirchhoff's 2 law.

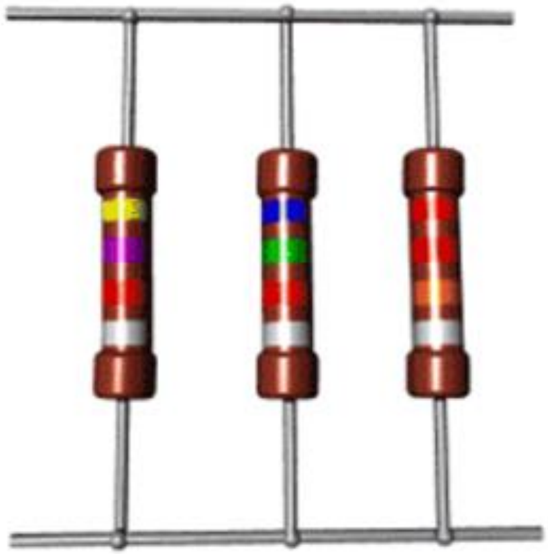
The sum of the partial voltage drops is equal to the applied voltage.

ΣU = U1 + U2 + U3

Parallel connection

In parallel connection, the resistors are placed as on a ladder.





Parallel connection

Voltage and current

The voltage drop/**voltage is the same** across all resistors in a parallel connection.
ΣU = U1 = U2 = U3

The current in a parallel connection will **divide over each resistor**, and run back to the starting point
ΣI = I1 + I2 + I3

Parallel connection

Resistance

The total resistance in a parallel connection is found by adding all resistors in the circuit together **reciprocatedly**.

$$\Sigma R = \frac{1}{\frac{1}{R1}+\frac{1}{R2}+\frac{1}{R3}} \quad \text{eller} \quad \Sigma R = (R1^{-1} + R2^{-1} + R3^{-1})^{-1}$$

<u>Rule of thumb</u>

The total resistance is ALWAYS less than the minimum resistance in the circuit.

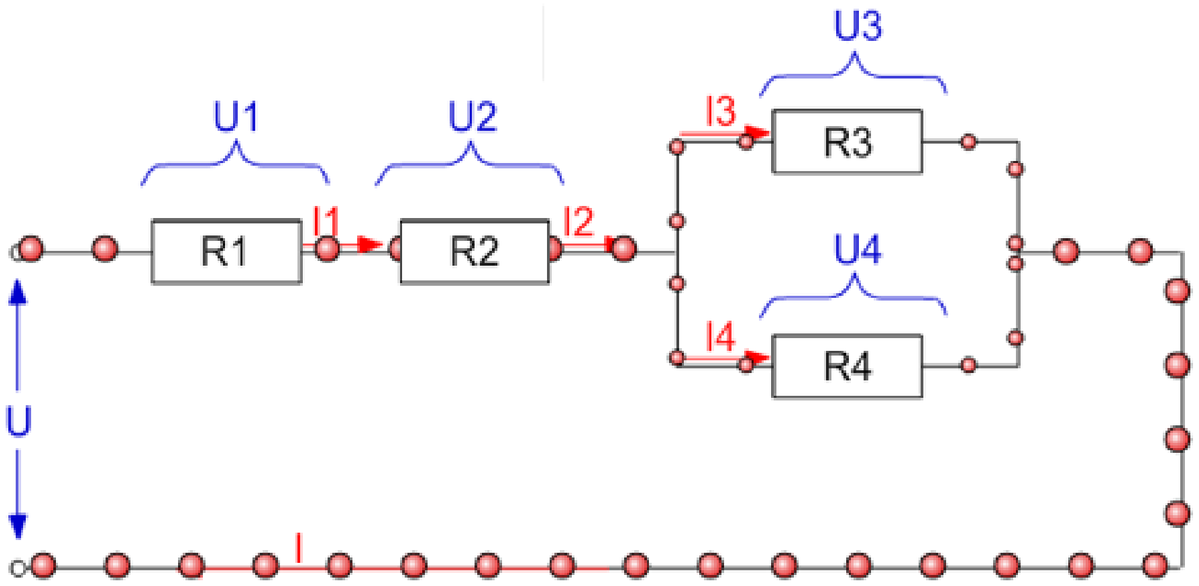
Mixed connection

Now it gets a little more complicated!

2 important rules to remember for mixed compounds:

1. EVERY TIME THERE IS A SERIES OF RESISTORS, THERE IS A VOLTAGE DROP

2. EVERY TIME THERE IS A PARALLEL CONNECTION, THERE IS A POWER SHARING.



Strøm: $I = I1 = I2 = (I3 + I4)$

Spænding: $U = U1 + U2 + (U3 \text{ eller } U4)$

Modstand: $R = R1 + R2 + \left(\frac{R3 \times R4}{R3 + R4}\right)$

T-shore Education

Parallel connection

Mixed connections are a circuit that includes **both series and parallel connections**.
In such cases, each small part must be calculated separately, drawing new and simpler diagrams all the time.
Thus, they try to make the circuit more and more simple, so that in the end you end up with a few series-connected resistors.
The new diagrams you sketch are called equivalent diagrams as they are equivalent (=meaning) to the previous ones.
On this one cannot establish simple and unambiguous rules, **only say that ohm's law applies and that the basic rules regarding series and parallel couplings apply**.

YOU SHOULD ALWAYS START BY MERGING RESISTORS WHERE THE VOLTAGE OR CURRENT IS THE SAME.

Measurements

Any measuring instrument must be designed so that it is "like a fly on a wall", i.e. it does not interfere with the circuit on which it is measured.

It is **important** that you know your measuring instrument and get it set correctly before measuring.

And then it is **also important** that you have an idea of what the measuring device should show when measuring.

T-shore Education

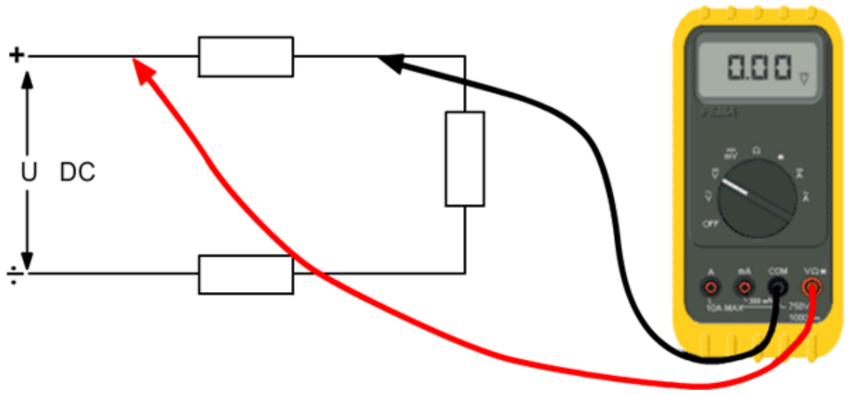
Measurements

Voltage

If the voltmeter is not to interfere in the way it is used, then it should preferably have a **LARGE internal resistance**, so that it does not "use current" from the circuit being measured.

Due to its large internal resistance, a voltmeter must ALWAYS be mounted parallel to what is being measured.

If inserted in series, it will slow down the flow of the circuit. The voltmeter should be connected **IN PARALLEL**.



T-shore Education

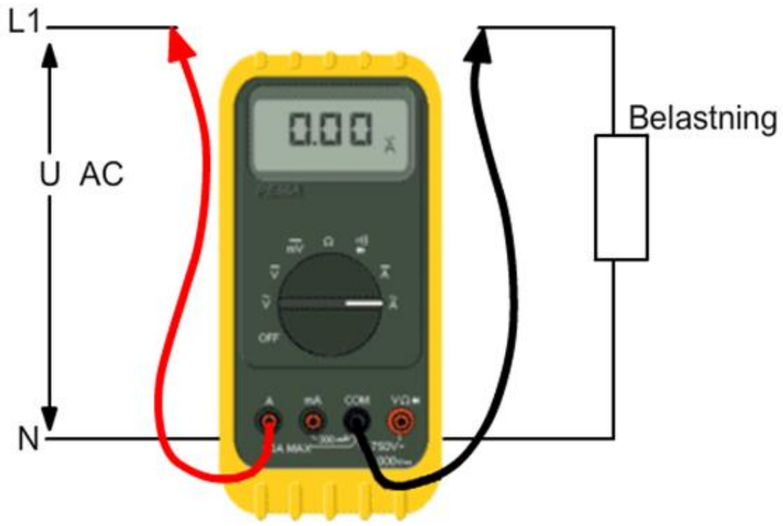
Measurements

Current

If the ammeter is not to interfere in the way it is used, then it must have a very **small internal resistance**, so that it does not slow down the current in the circuit in which it is measured. Due to its small internal resistance, an ammeter must always be mounted in series in the circuit in which it is measured.

If it is placed in parallel, it will change the resistance of the circuit and thereby also change the circuit.

The ammeter must always be connected in **SERIES** with the circuit.



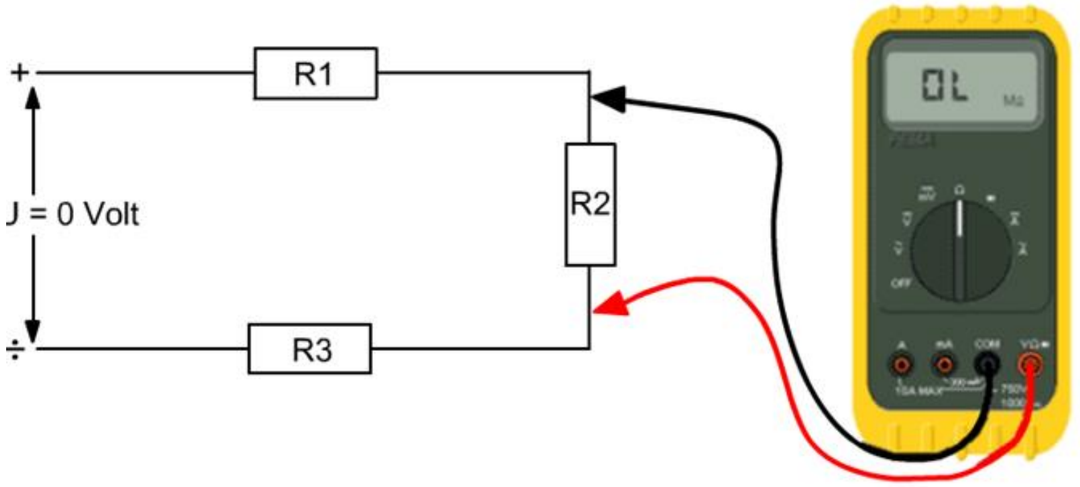
Measurements

Resistance

If the ohmmeter is not to interfere in the way it is used, then it must have a very **large internal resistance**, so that it does not change the total resistance that is measured.

The resistance is **ALWAYS measured** without voltage and one pin of the resistor must be detached from the PCB, so that only the individual resistor and not the entire circuit is measured.

The ohmmeter must be connected **IN PARALLEL** and measured **VOLTAGELESS**.



T-shore Education

Capacitor and diodes

Lesson 2

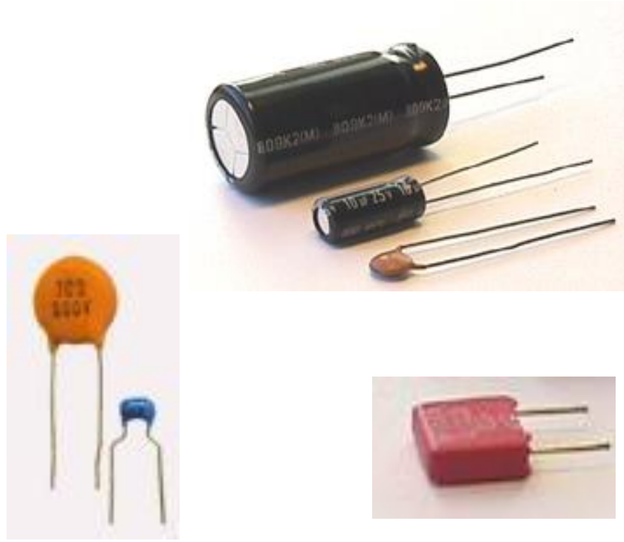
T-shore Education

What is a capacitor?

Two parallel conductive plates

The plates are separated from each other by an insulating material called dielectric

The capacitor has two to wires



How it works?

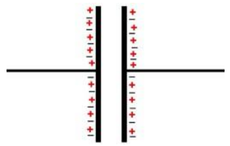
The capacitor can store an electrical charge – a portion of electrons

When the power is connected, the capacitor is filled with electrons

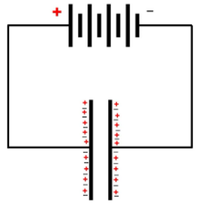
The size of the capacitor says something about how many electrons there is room for

The size of the capacitor is called capacity

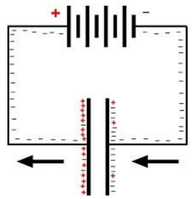
The capacitor
Voltage-free



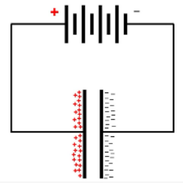
The capacitor
connected voltage



The capacitor
charges



The capacitor
fully charged



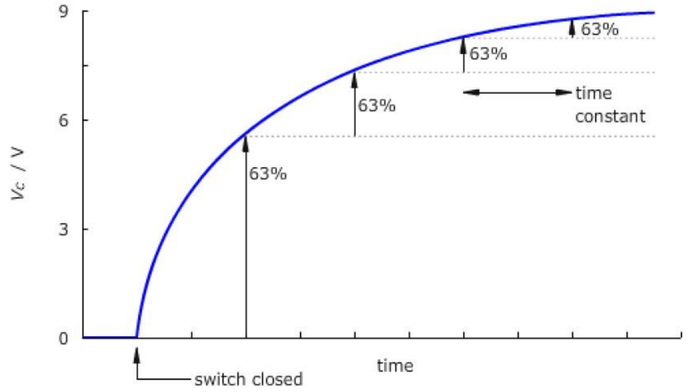
T-shore Education

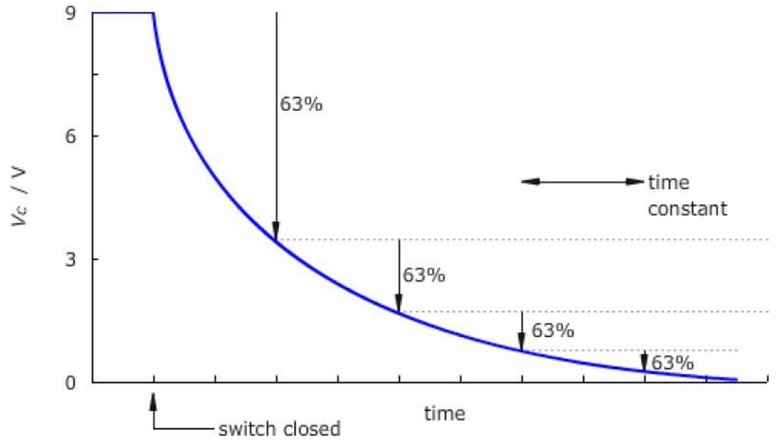
How it works?

Capacitor charging/discharging

A capacitor is in principle never charged, as can be seen from the curve, it is charged for every τ (tau) 63.2%, i.e.

After this, the capacitor is considered fully charged, even though in principle it continues to charge at 63.2% and never gets fully charged.





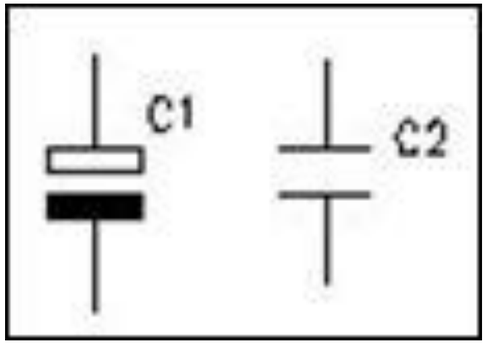
T-shore Education

The names of the capacitor.

Kondensatorens størrelse måles i **Farad F**

Eks. 10 mF, 5µF, 47nF eller 100pF

Diagramsymbolet er **C**



T-shore Education

Size - Capacitor

Physical size of the capacitor
- With a large plate area, the capacity increases. There may be more electrons on the plates.

The distance between the plates
- The thickness of the insulation material.
- Large distance means less capacity.

Material of insulation
- The insulating material's ability to conduct power lines in relation to air
- Called the dielectric of the capacitor

Formal calculation of capacitor

The alternating current resistance of the capacitor is called reactance

The designation is X_C and is measured in ohms

At higher frequency, X_C decreases

$$X_C = \frac{1}{2 \cdot \pi \cdot f \cdot C} \quad \text{or} \quad X_C = \frac{u_C}{i_C}$$

X_C = Reactance in ohms

u_C = voltage

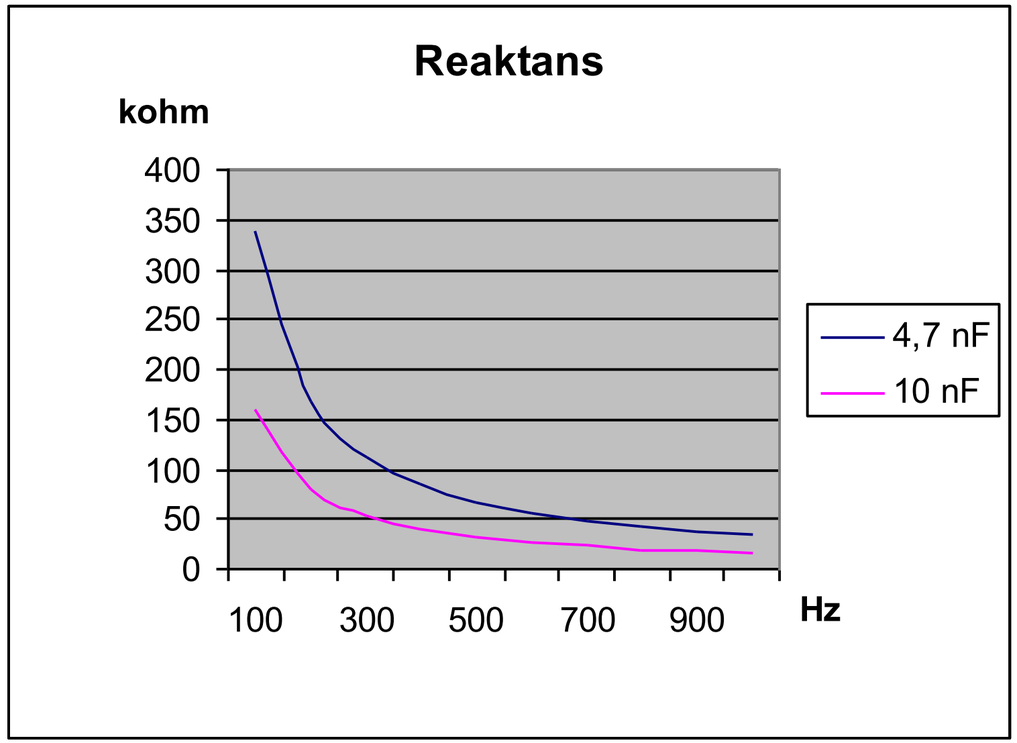
i_C = current

F = frequency in Hz

C = capacity in F

T-shore Education

X_C as a function of frequency



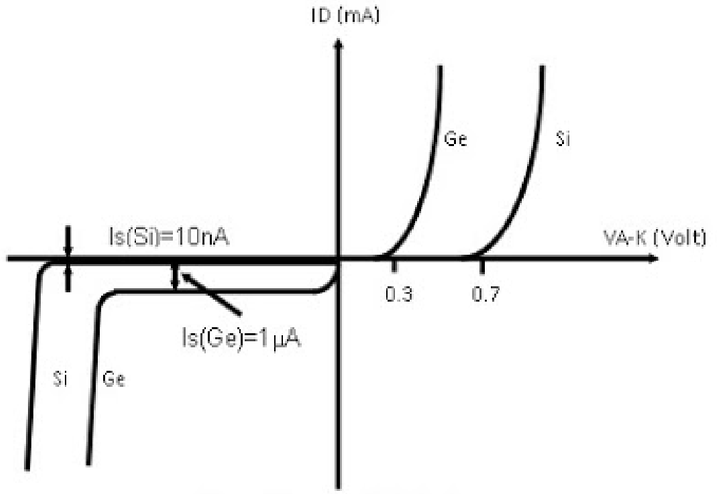
T-shore Education

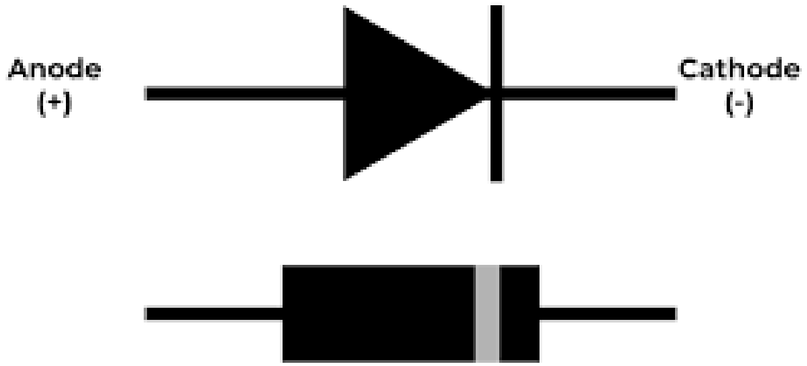
Diode

The diode is a simple, yet very important in any electrical circuit.

The diode is a component that only allows current to pass through one way (the direction of conduction) and provides great resistance in the other direction (the direction of blockage).

The diode is therefore also called a rectifier valve.





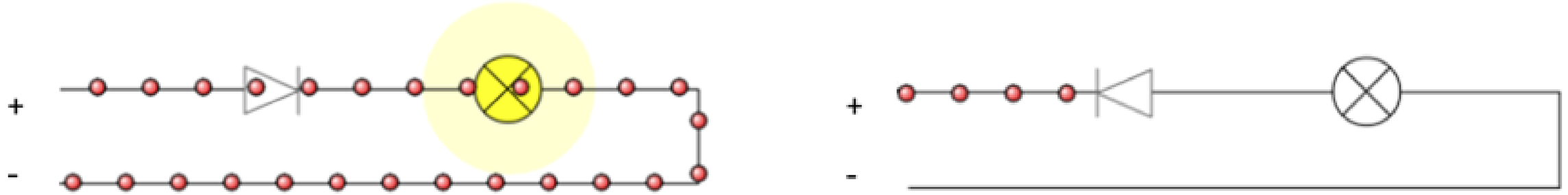
T-shore Education

Diode

The diode is a semiconductor that is made from the element silicon (Si) or germanium (Ge). The diode has two connections:

Anode and cathode.

The diode conducts current when the anode is positive and blocks when the anode is negative.



T-shore Education

Lock tension and barrier tensioning

The sluice voltage is the minimum value the diode must be pressurised before the current can begin, for germanium diodes the sluice voltage is about 0.3 volts and for silicon diodes about 0.7 volts.

Blocking voltage is the maximum voltage that the diode can block. If this voltage is exceeded, there will be a breakthrough, and the diode will be destroyed.

Silicon diode up to 1000V

Germanium diode up to 100V

Temperature

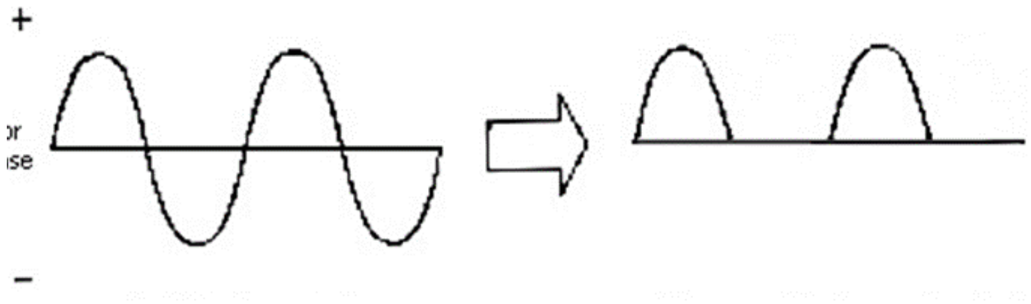
There is a difference in the temperatures under which the two diode types can work:

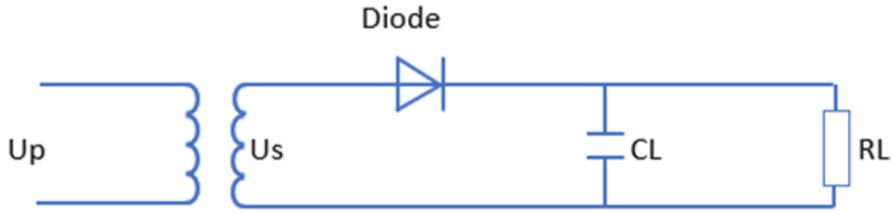
The germanium diodes can withstand temperatures up to approx. 80-90°C and the silicon diodes up to approx. 200°C.

Use of diode

The diode is used for many different purposes, but most often to convert alternating voltage into direct voltage (rectification).

Since current can only flow one way through the diode, current will only flow in one of the two half periods of the alternating voltage. It will not be a very "even" voltage that comes out of it, but it is by definition a direct voltage, and it is called a pulsating DC.





T-shore Education

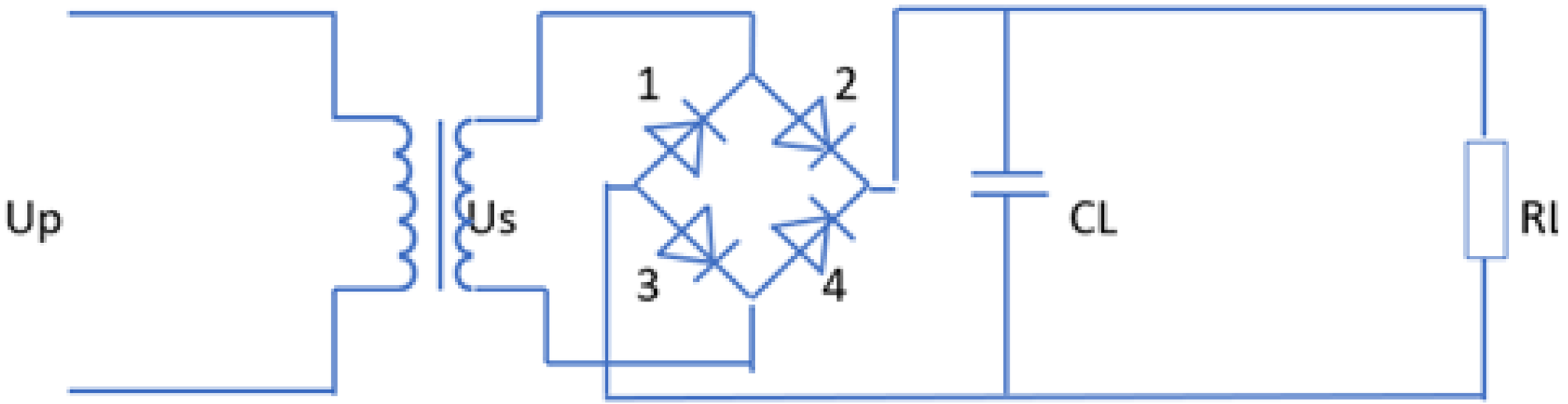
Double one-way

In double rectification, the diodes work together in pairs (2-3) and (1-4).

In the first period, there is a plus in on the diode between 1 and 2 - diode 1 blocks and diode 2 conducts the current through it. The current flows out through the RL and back between diode 1-3. Since the current always wants to return to minus, it must be diode 3 that conducts the current through it.

Then it is diode 1-4 that work together. Plus now comes in between diode 3-4, diode 3 blocks and diode 4 conducts the current through it. The current runs out through RL and back between diode 1-3.

Double one-way

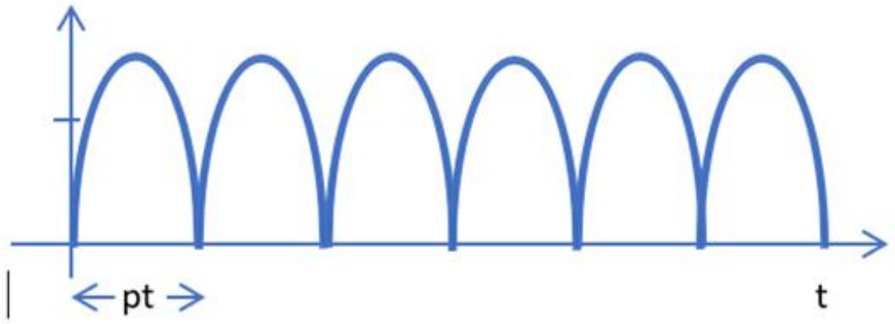


T-shore Education

Double one-way

Here is the curve after the diode, as you can see, we use both half periods for double rectification

pt= the period time is equal to 10ms



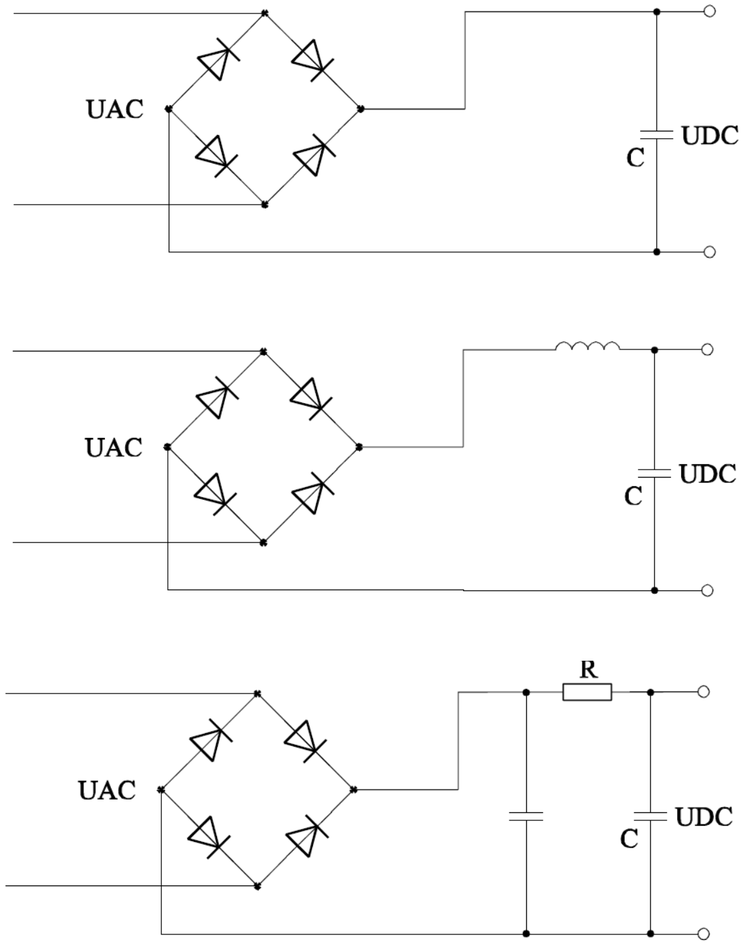
Double rectification is the most commonly used form of rectification

Smoothing

However, an electric control will not be able to use pulsed direct voltage, which is why it will be necessary to smooth it out.

This smoothing is done with a capacitor. In some cases, smoothing is done by a combination of a coil and a capacitor or by means of resistors and capacitors.

In all three cases, it will be a pure DC voltage that comes from the rectifier.



Magnetism

Lesson 3

T-shore Education

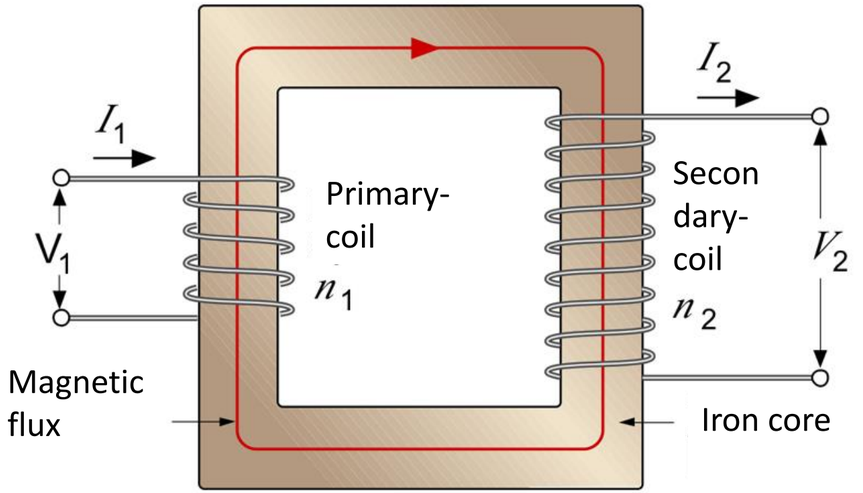
Transformation

Enables the transmission of large amounts of energies (currents) at high voltages.

The electrical losses are significantly reduced.

Translates the printed voltage into another.

Right or lower voltage

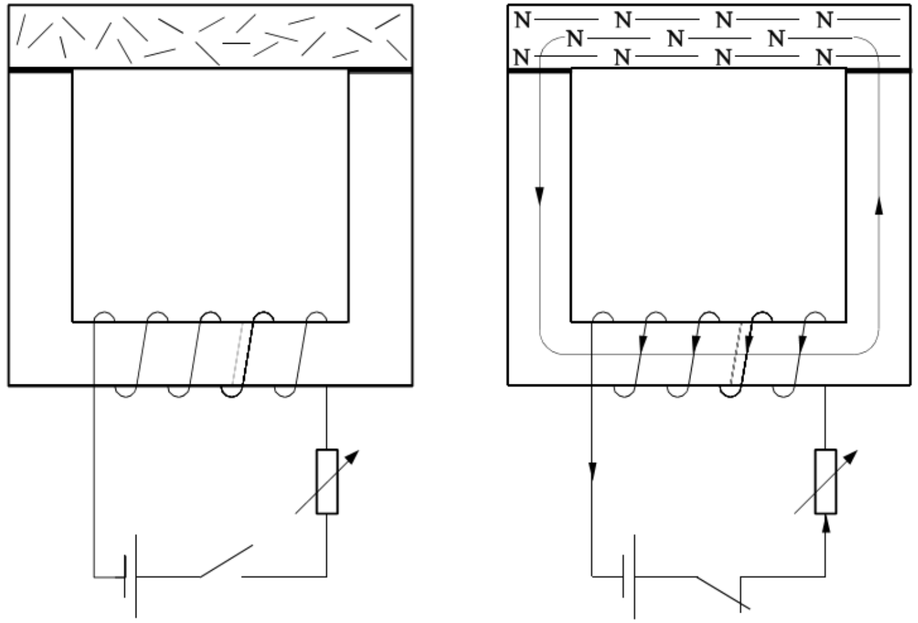


T-shore Education

Electromagnet

If the circuit is open, there is chaos in the magnetic circuit.

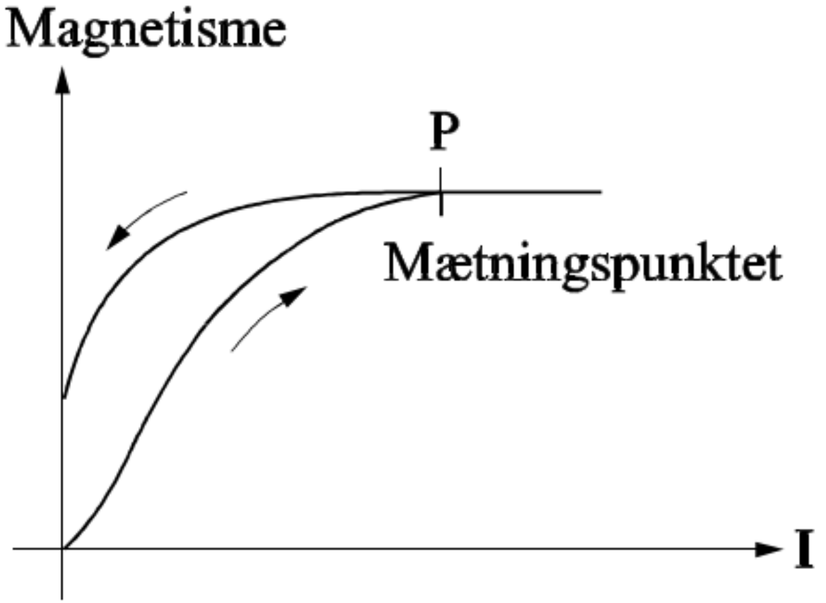
If the circuit is closed, the coil ensures that a field is created and the magnetic circuit is brought to order.



T-shore Education

Saturation of iron

When all the small magnets in the steel bar have been put in order, the saturation point has been reached, i.e. no increase in the magnetic strength of the steel bar is achieved by continuing to iron or increasing the current in the coil of the electromagnet.
force.



T-shore Education

An simple transformer

The primary side is connected to a voltage, thereby inducing a magnetic field in the iron core.

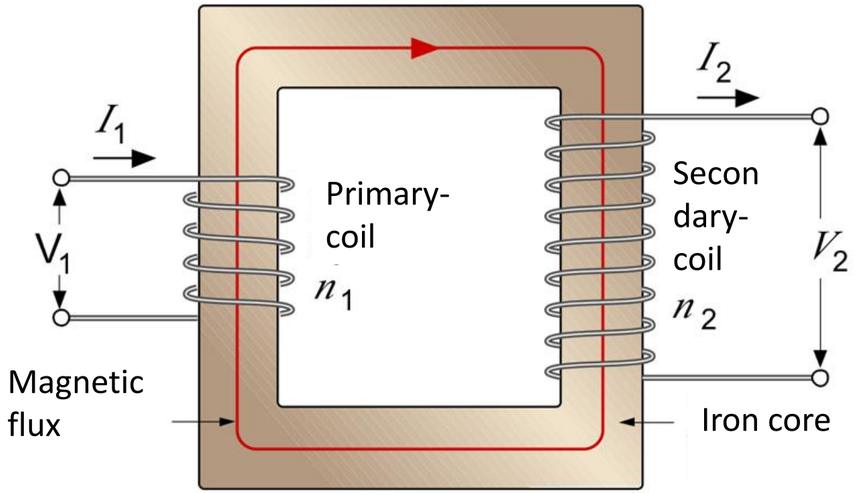
This magnetic field passes through the secondary winding, thereby inducing a voltage in it.

Each winding on the primary and secondary sides is traversed by the same magnetic field.

Therefore, the same tension will also be induced over each turn.

The voltage on the secondary side will therefore depend on how many turns it has in relation to the primary side.

Fewer turns, lower voltage, more turns, higher voltage.



T-shore Education

An simple transformer

N_p = Number of windings on the primary side (also calledN_1)

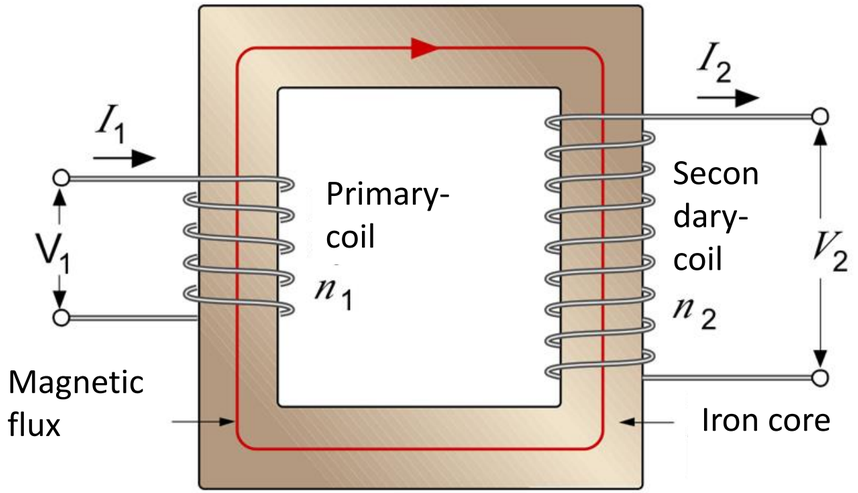
$$N_P = N_S \, x \, n$$

N_s = Number of windings on the secondary side (also calledN_2)

$$N_s = \frac{N_P}{n}$$

n = The turnover ratio

$$n = \frac{N_1}{N_2} = \frac{U_1}{U_2} = \frac{I_2}{I_1}$$



T-shore Education

An simple transformer

U_p = The excitement on the primary side (also calledU_1)

$$U_P = \frac{S}{I_P} \quad \text{eller} \quad U_P = U_S \, x \, n$$

U_s = The voltage on the secondary side (also calledU_2)

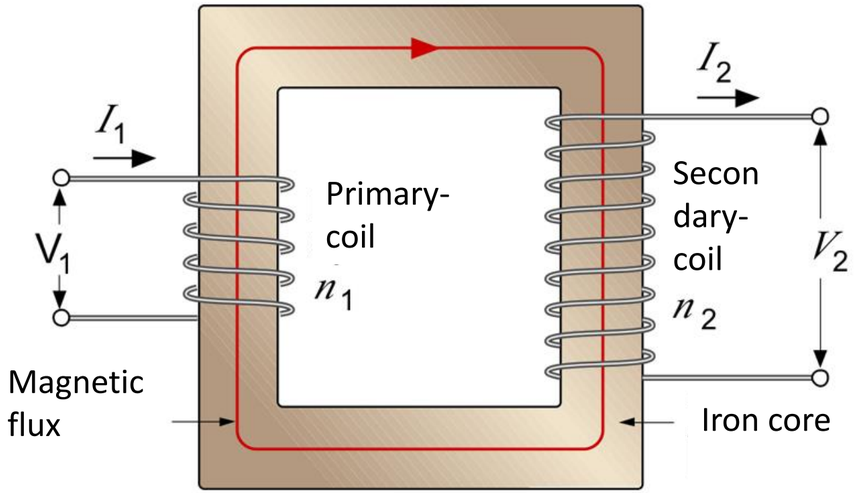
$$U_S = \frac{S}{I_S} \quad \text{eller} \quad U_S = \frac{U_P}{n}$$

I_p = Electricity on the primary side (also calledI_1)

$$I_P = \frac{S}{U_P} \quad \text{eller} \quad I_P = \frac{I_S}{n}$$

I_s = The power on the secondary side (also calledI_2)

$$I_S = \frac{S}{U_S} \quad \text{eller} \quad I_S = I_P \, x \, n$$



T-shore Education

An simple transformer

V/N = Former pr. vikling (is the same on both sides)

$$V/N = \frac{Up}{Np}$$

N/V = Viklinger pr. volt (is the same on both sides)

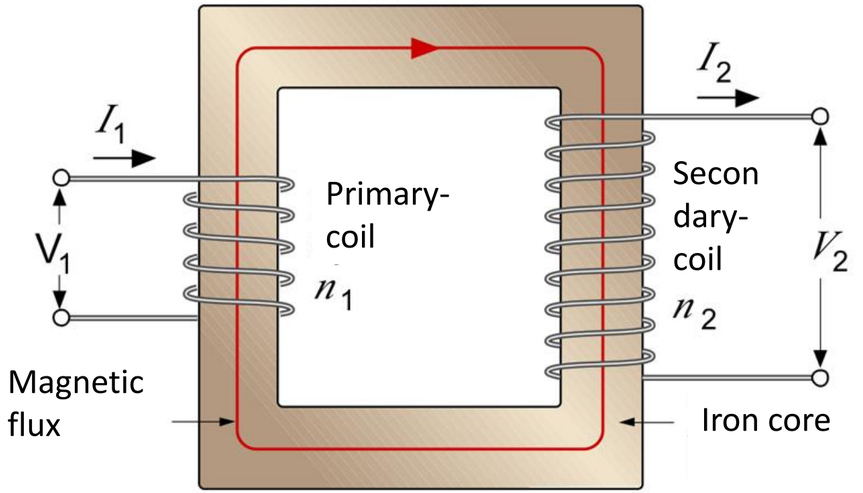
$$N/V = \frac{Np}{Up}$$

S = Transformer size in VA or kVA

$$S = U * I$$

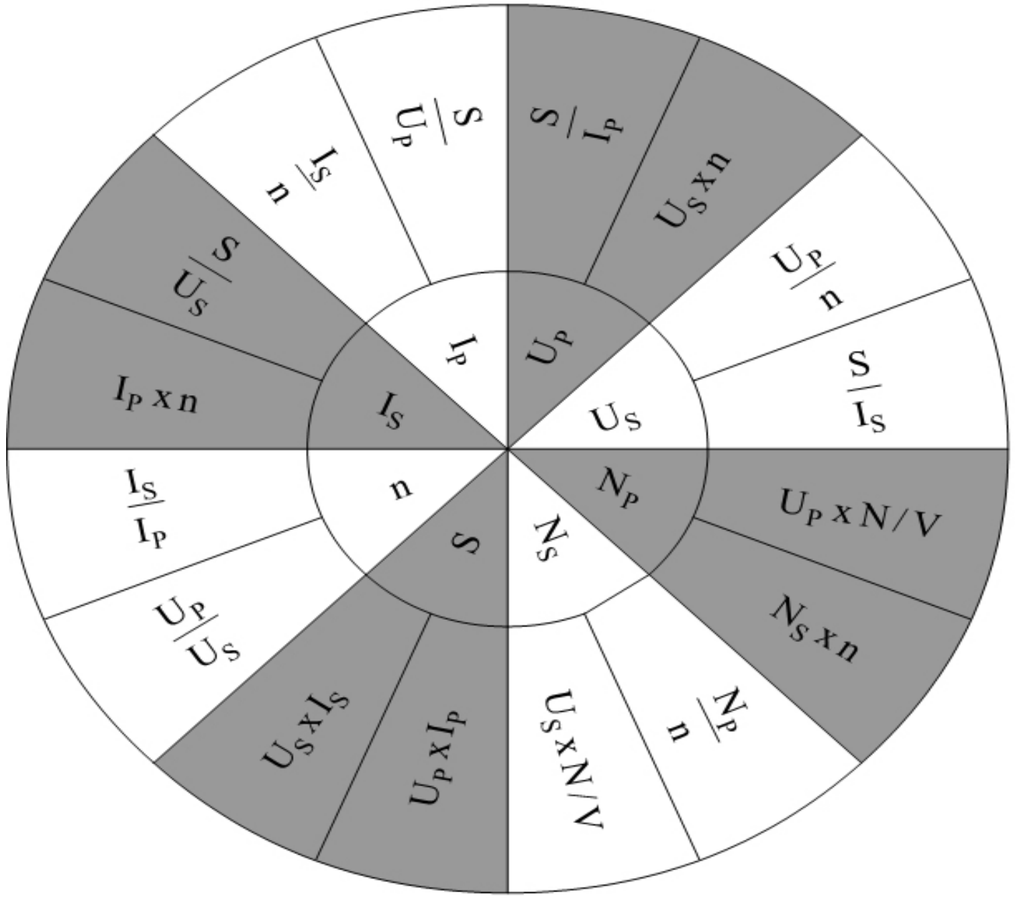
P = The power output in W

$$P = U * I * cos\varphi$$



T-shore Education

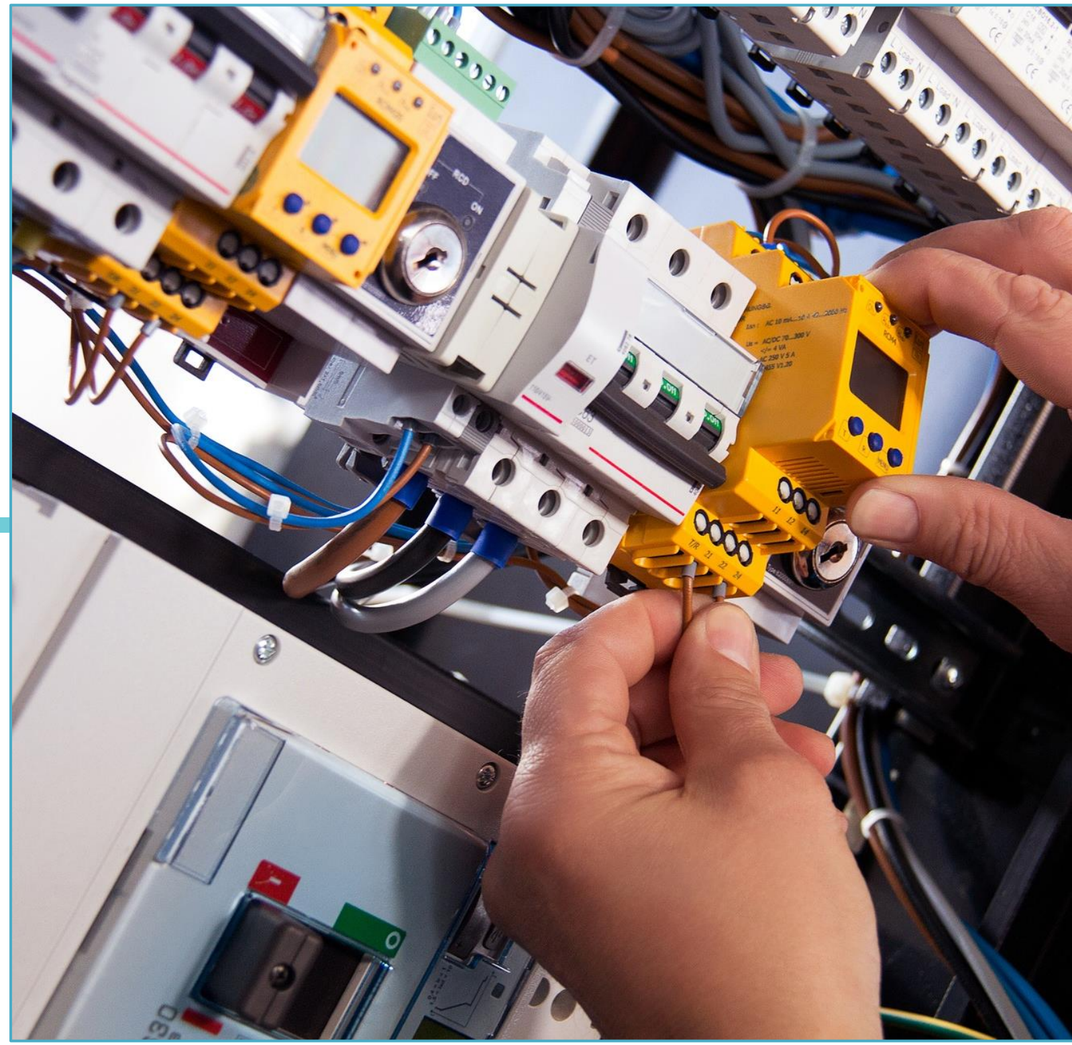
An simple transformer



T-shore Education

Relay technology

Lesson 4



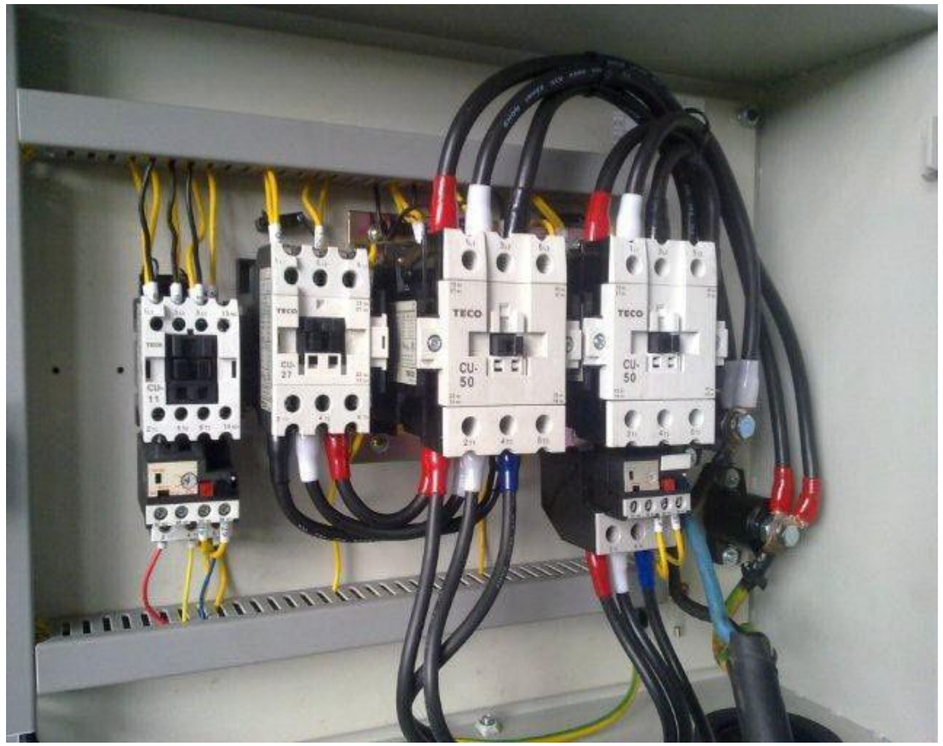
T-shore Education

What is relay technology?

There is a difference between main power and control

Relays are a low-practical solution for control, but work

PLCs are a more complex solution but have become a low-cost alternative.



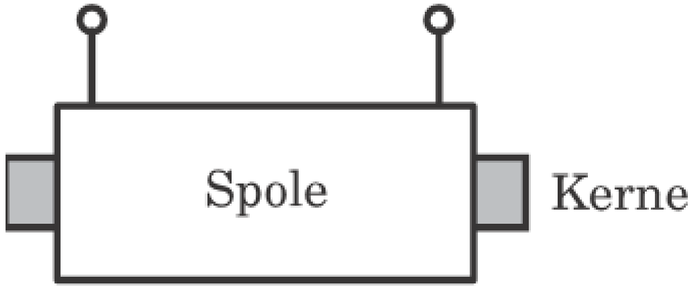
T-shore Education

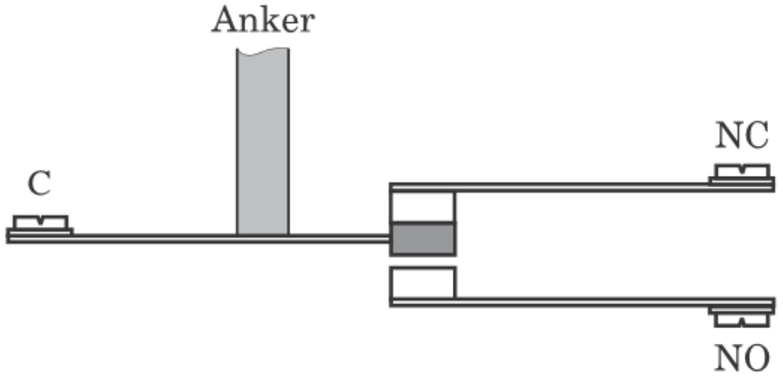
Relay

The relay consists of two main components.

The coil that activates the contact set.

The switch set that either opens or closes.



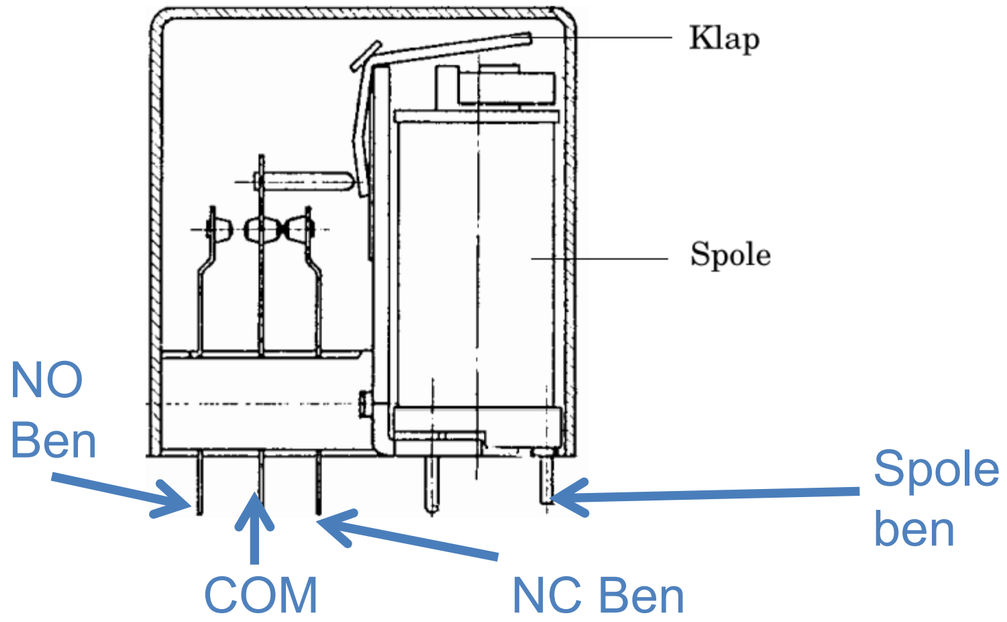


T-shore Education

Relay

It could look like this.

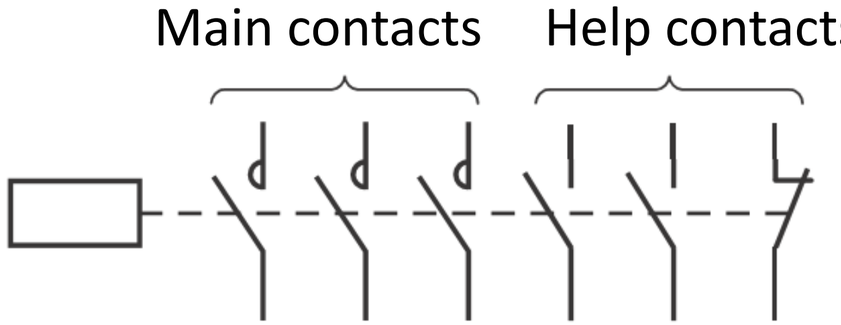
This is a plug pin relay.

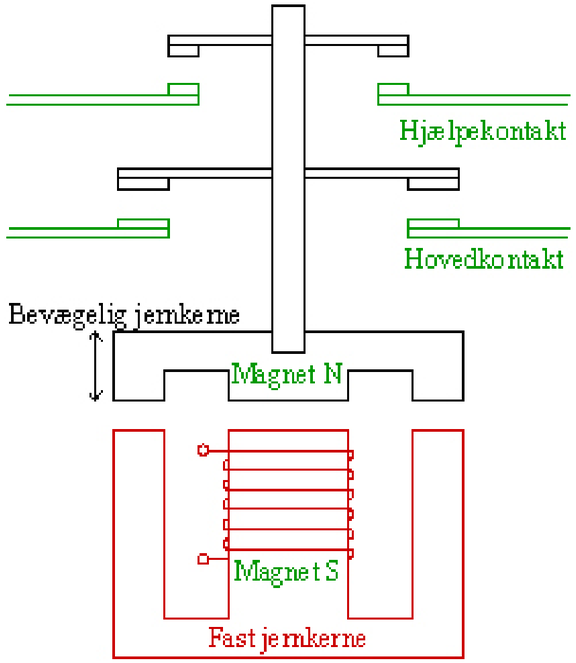


T-shore Education

Standard Relay

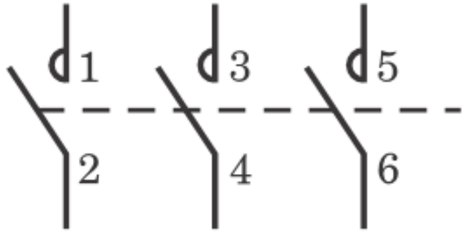
Killed by large currents



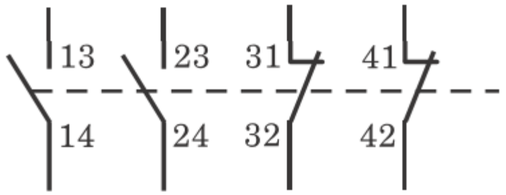


T-shore Education

Contacts plating and numbering



Head Contact Set

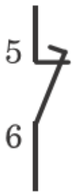


Help contact set

End contact set

Early quit

Breaking contact set



Sen bryde

T-shore Education

Drift former

Belastningsart			Slutte			Bryde		
			I	***U***	cos ***φ***	***I***	***U***	cos ***φ***
AC-1	ohmsk og svagt induktiv		I_e	U_e	0,95	I_e	U_e	0,95
AC-2	slæberingsmotorer med standsbremsning og reversering		$2{,}5 \times I_e$	U_e	0,65	$2{,}5 \times I_e$	U_e	0,65
~~AC-2~~ AC3	kortslutningsmotor under normal drift	$I_e \leq 17$ A	$6 \times I_e$	U_e	0,65	I_e	$0{,}17 \times U_e$	0,35
		$I_e > 17$ A			0,35			
AC-4	kortslutningsmotor, tipkoblinger og reversering	$I_e \leq 17$ A	$6 \times I_e$	U_e	0,65	$6 \times I_e$	U_e	0,35
		$I_e > 17$ A			0,35			
AC-11	ind- og udkobling af elektromagneter		$10 \times I_e$	U_e	0,7	I_e	U_e	0,4

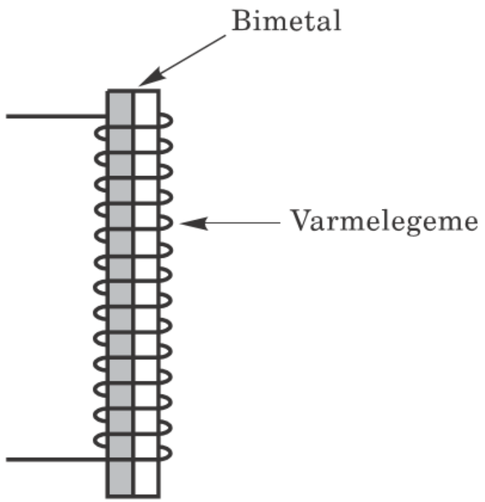
Errors in book

Contactor type 1 is defective after a large short circuit

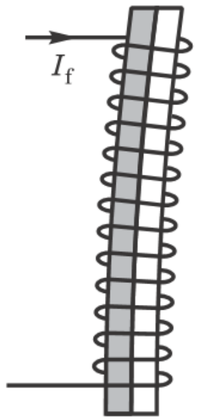
Type 2 contactor should still work after a large short circuit

T-shore Education

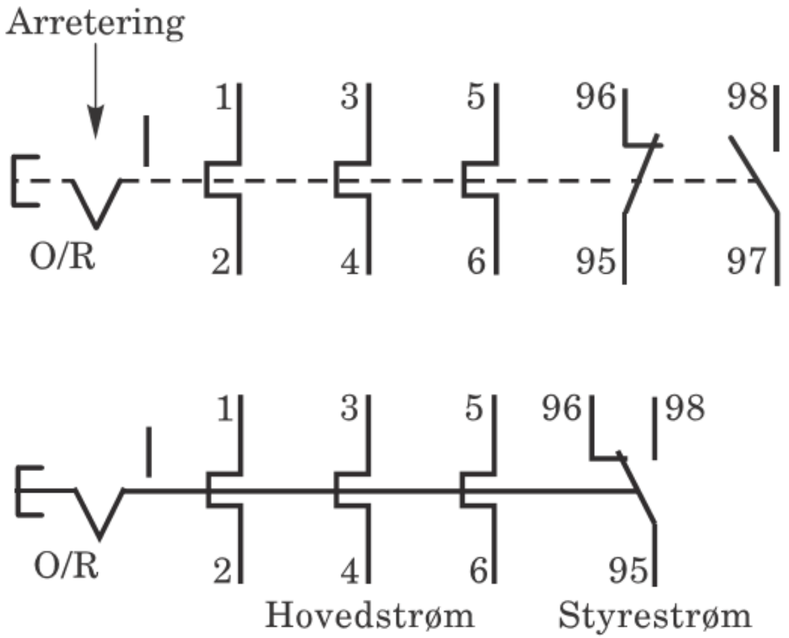
Thermo relay



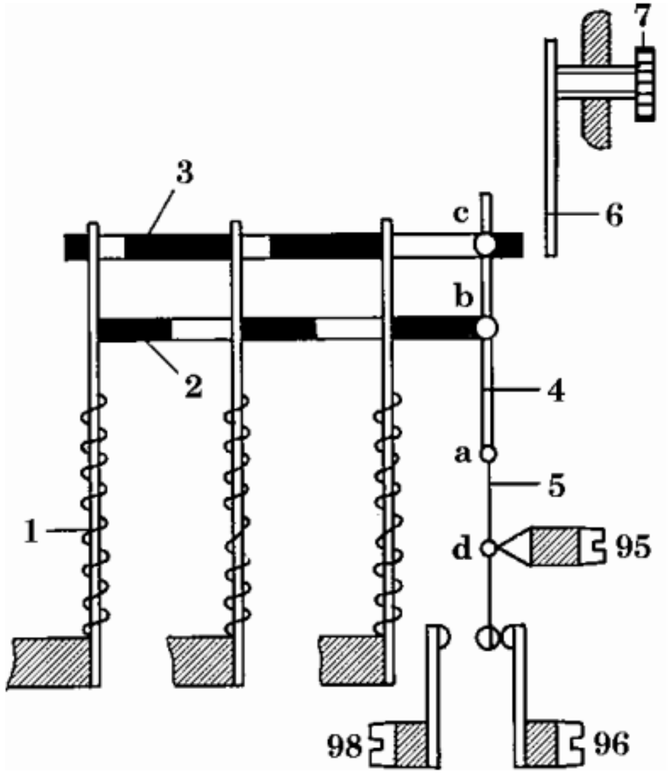
Kold tilstand



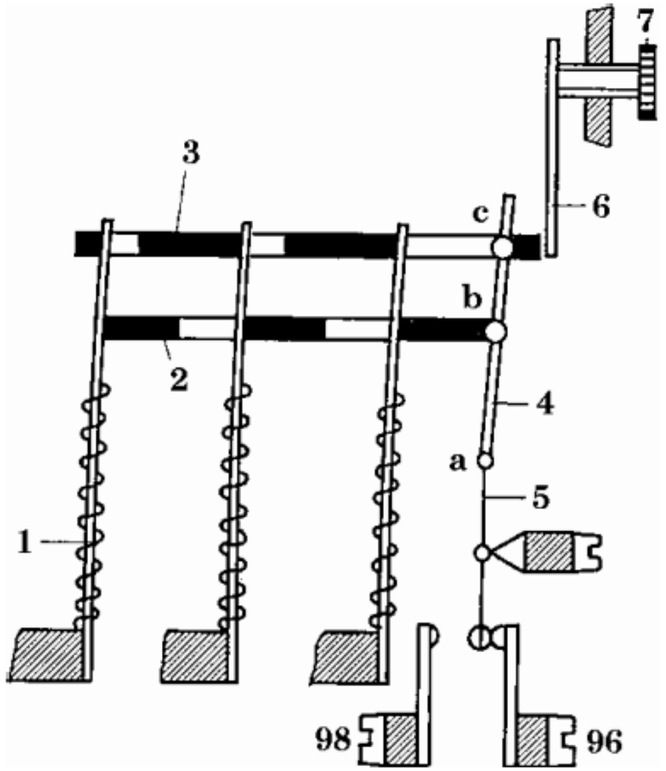
Opvarmet



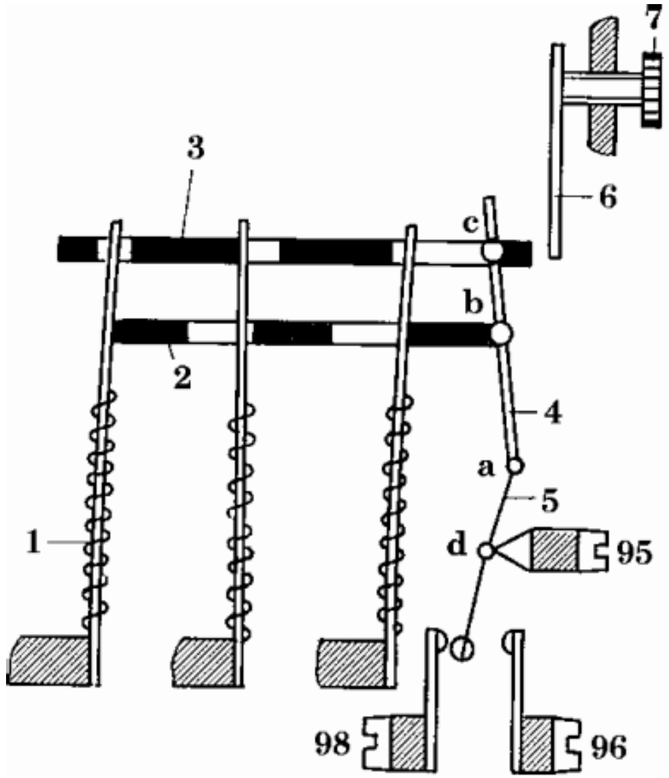
Thermo relay



Cold



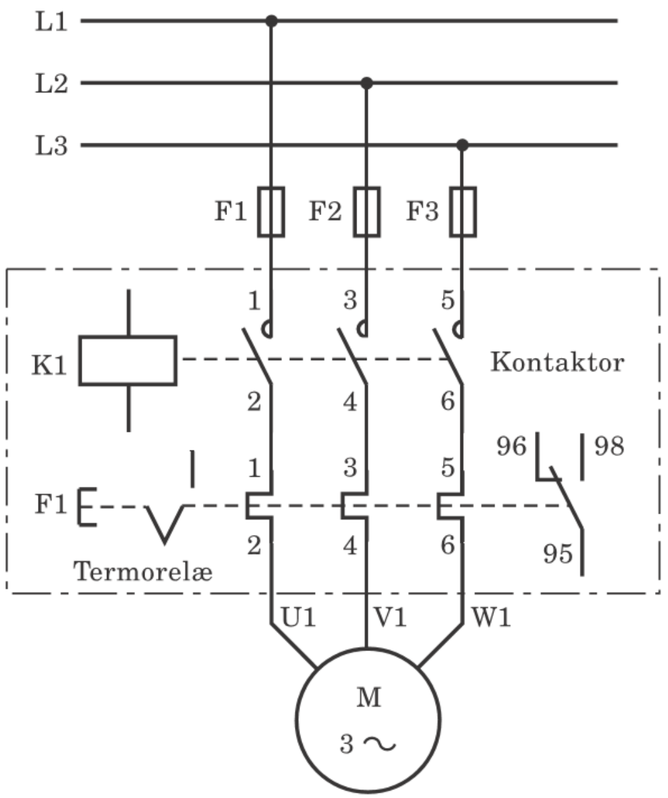
Operation hot

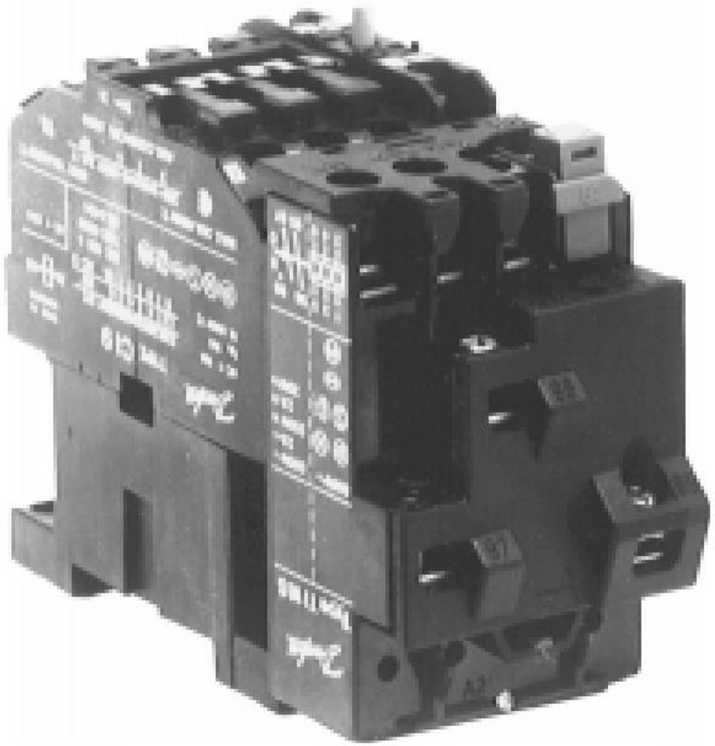


Disconnected

T-shore Education

Magnet operated motor protection - engine start





GL type that is still used

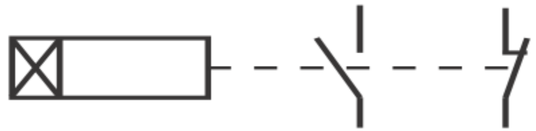
T-shore Education

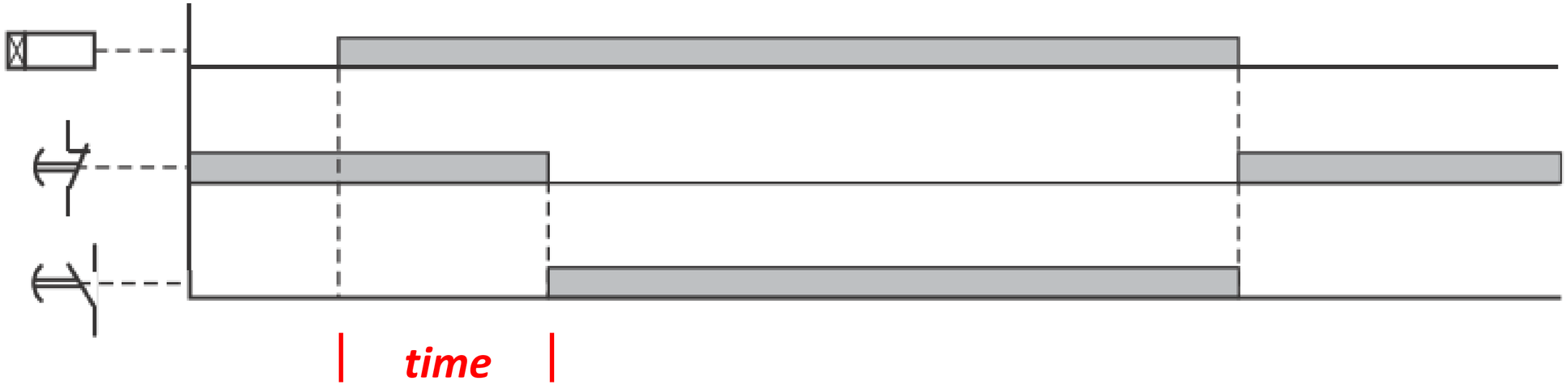
Time relay

Delayed attraction

Time starts when the time circuit gets tension

After the measured time, the contact set changes





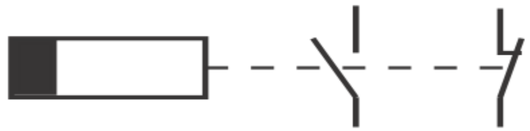
T-shore Education

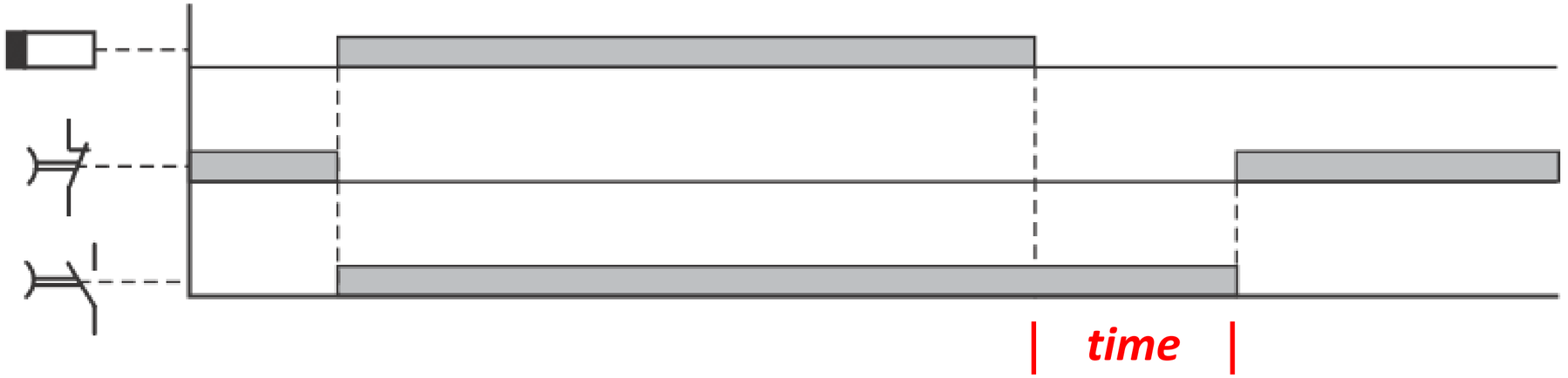
Time relay

Delayed drop-out rate

Time starts when the voltage to the time circuit is broken

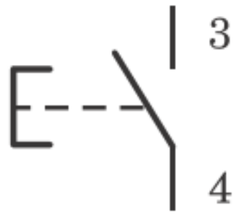
After the measured time, the contact set changes

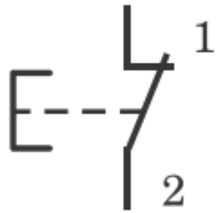


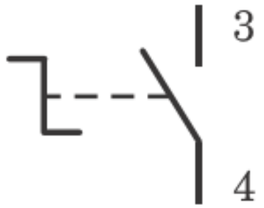


T-shore Education

Push buttons and switches

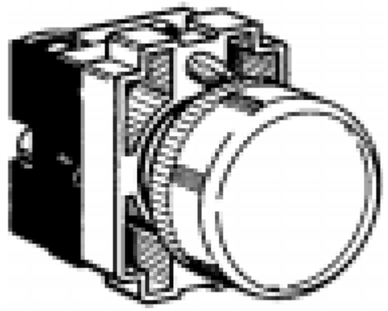


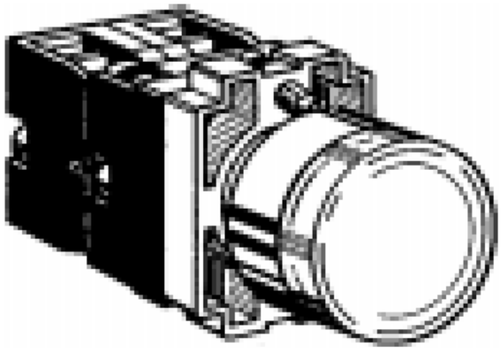


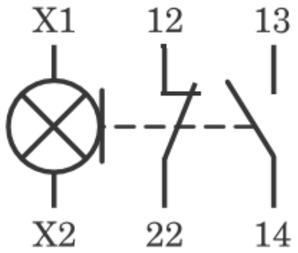


T-shore Education

Lamp and lamp pressure



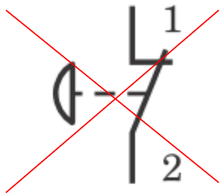


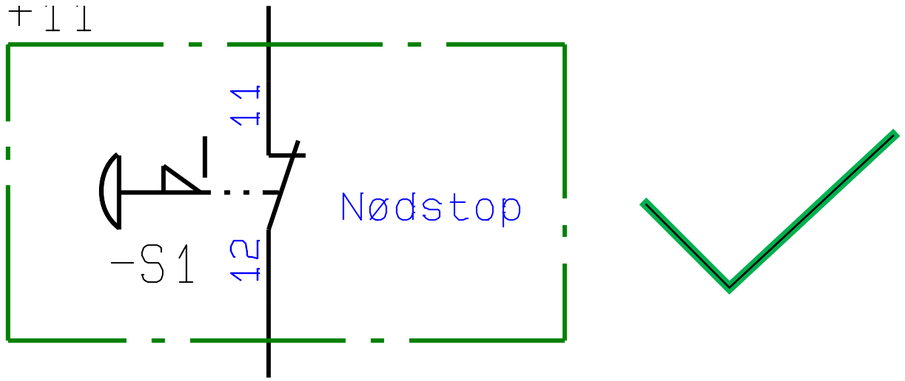


T-shore Education

Emergency stop

This is not an emergency stop, but a toad tap





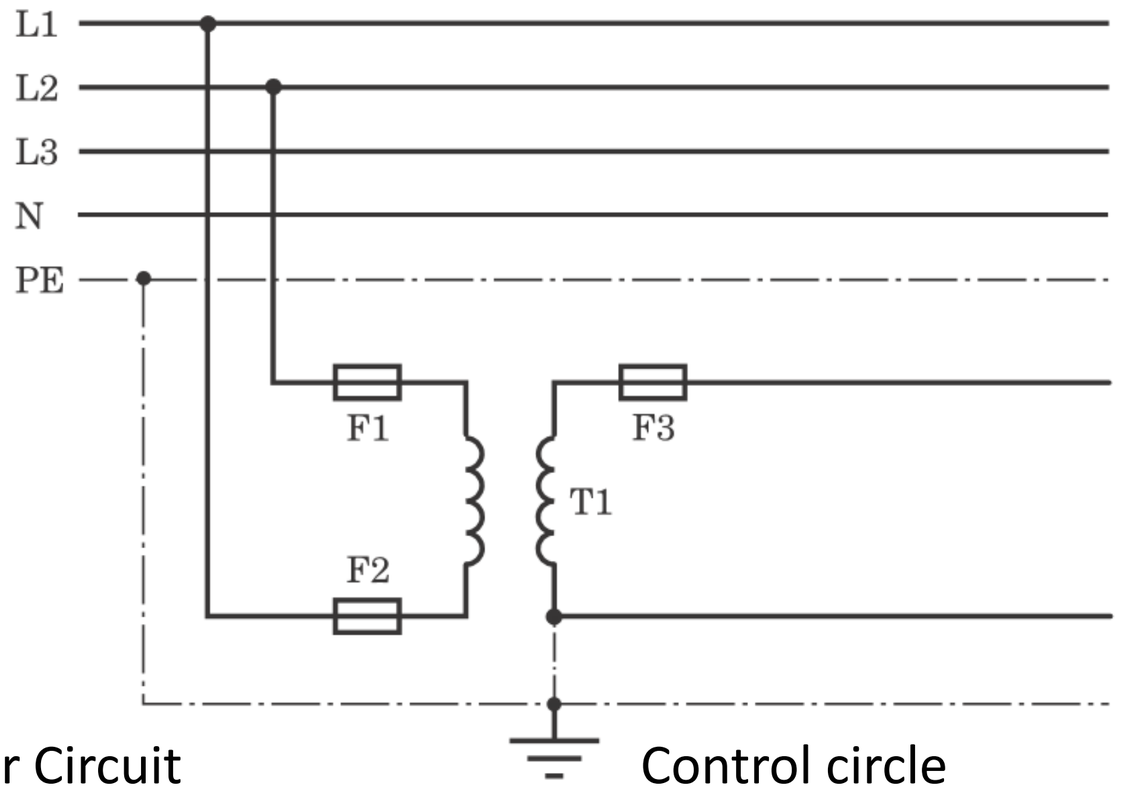
T-shore Education

Wire Colors

Black	:	AC and DC Power Circuits
Red	:	AC Control Circuits
Blue	:	DC Control Circuits
Orange	:	Control circuits with foreign control voltage
Yellow/Green	:	Protective conductor
Light blue	:	Zero conductor

T-shore Education

Control Transformer



Power Circuit
Transformer short-circuit protection

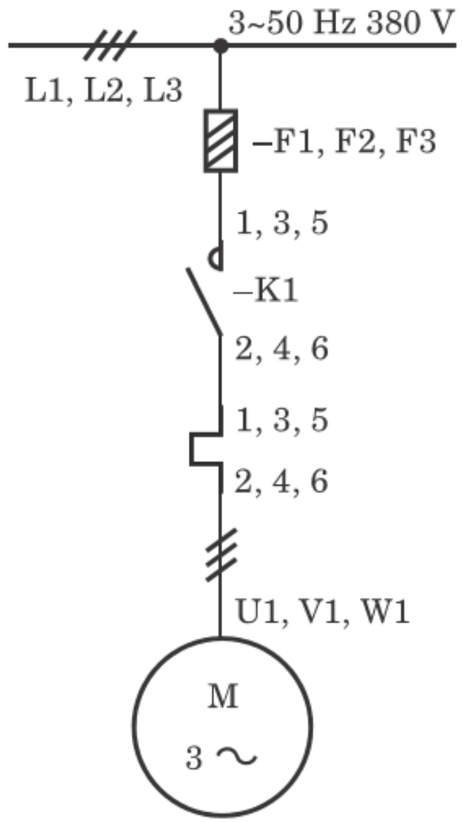
Control circle
transformer overload protection

T-shore Education

One-line chart

The one-line chart is not the most commonly used but is often found on smaller machines.

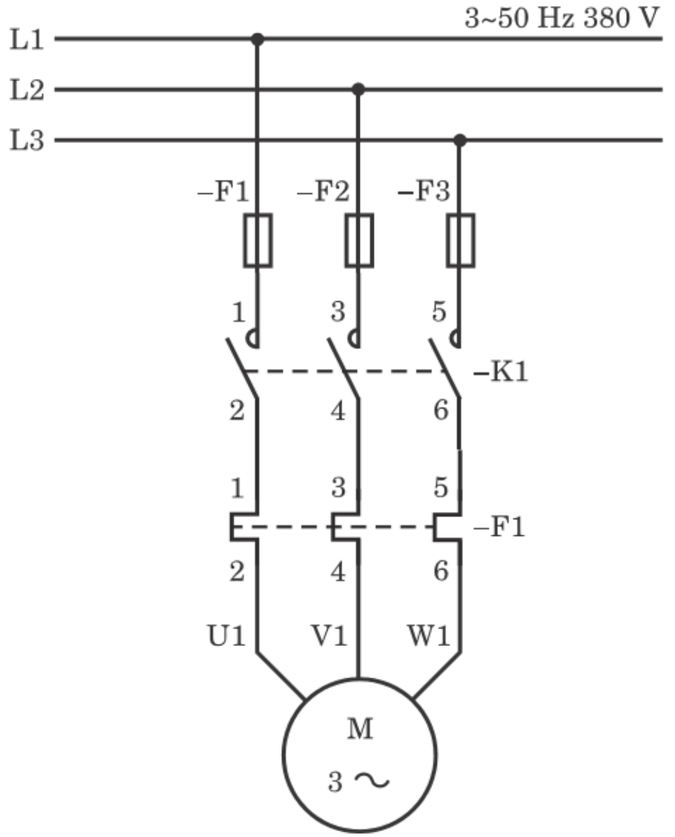
The inclined roasts indicate the leader number



T-shore Education

More lines chart

The most commonly used drawing style for the main power circuit

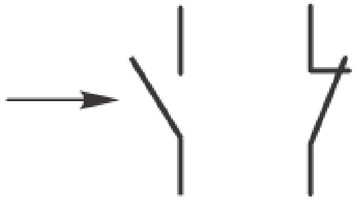


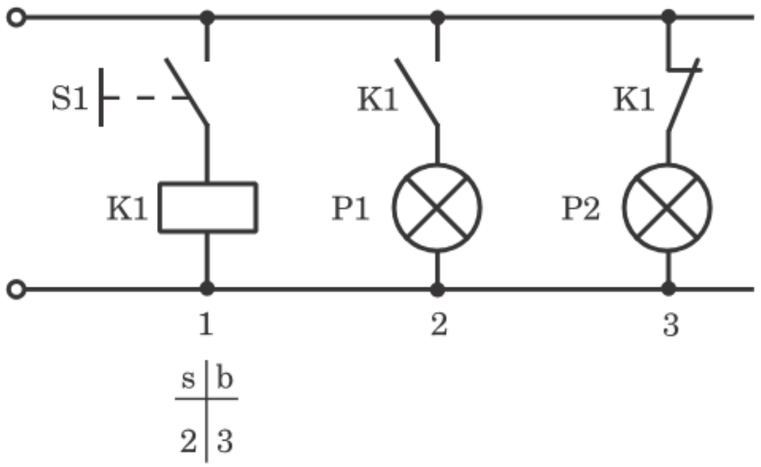
T-shore Education

Controlling the circuit chart

Contact position

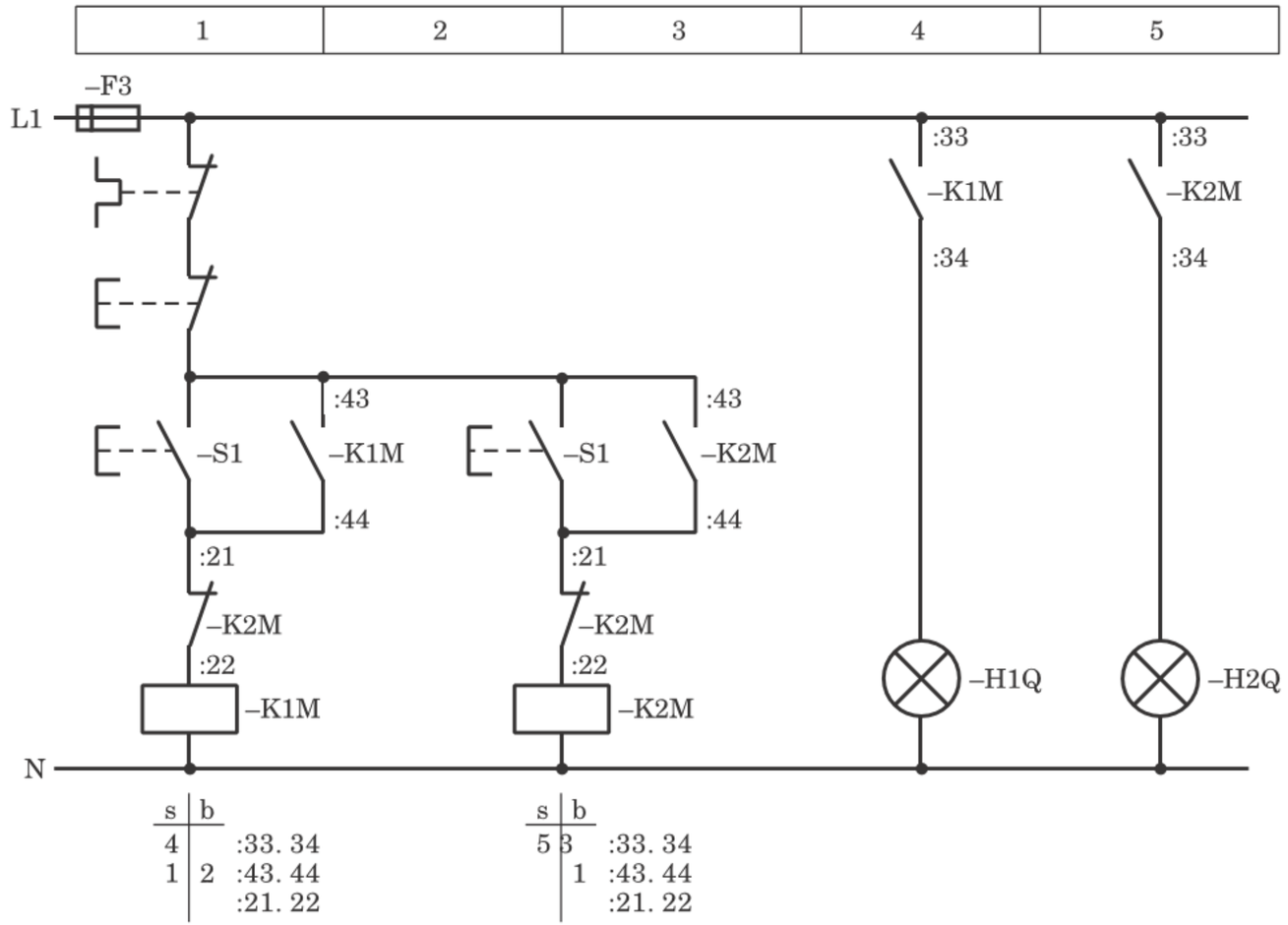
The individual contacts In a key schema, the individual contacts are always drawn un activated and for contact movement from left to right.





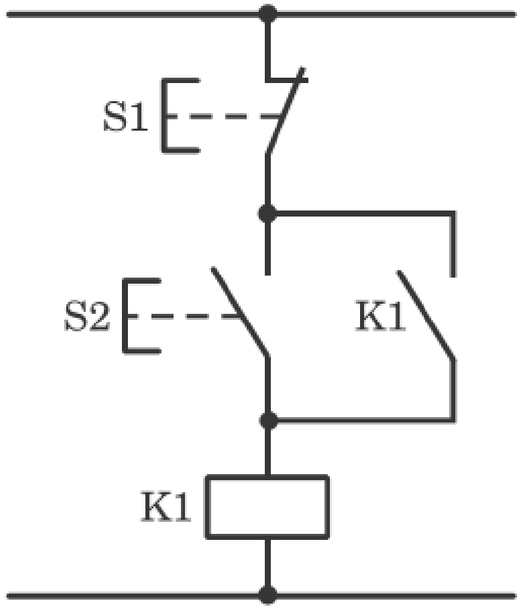
T-shore Education

Controlling the circuit chart

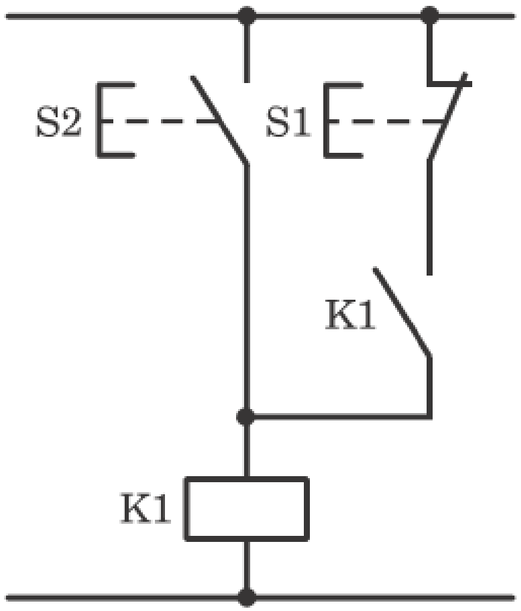


T-shore Education

Switching in with self-control



Stop dominance

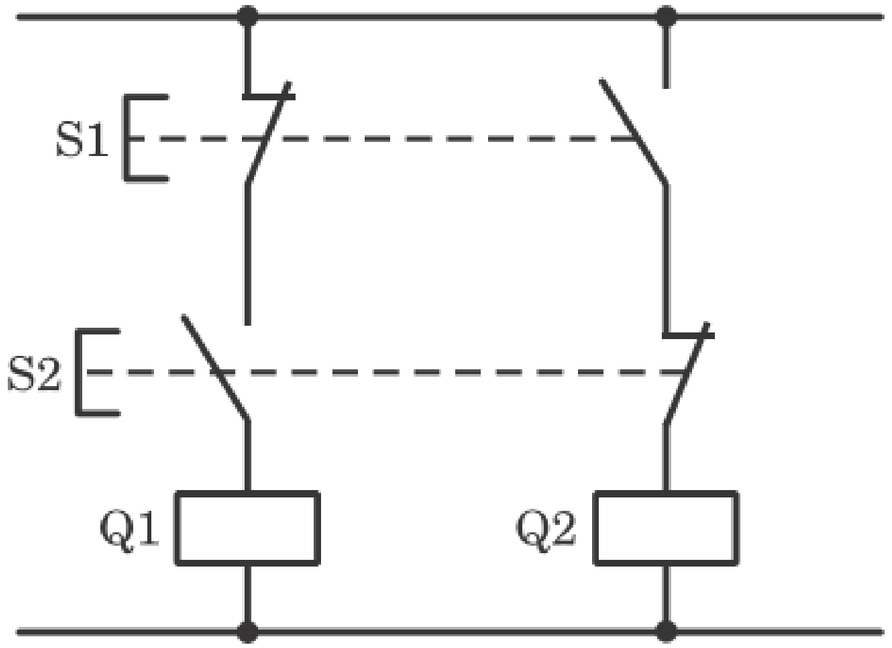


Start dominance

T-shore Education

Locking switching

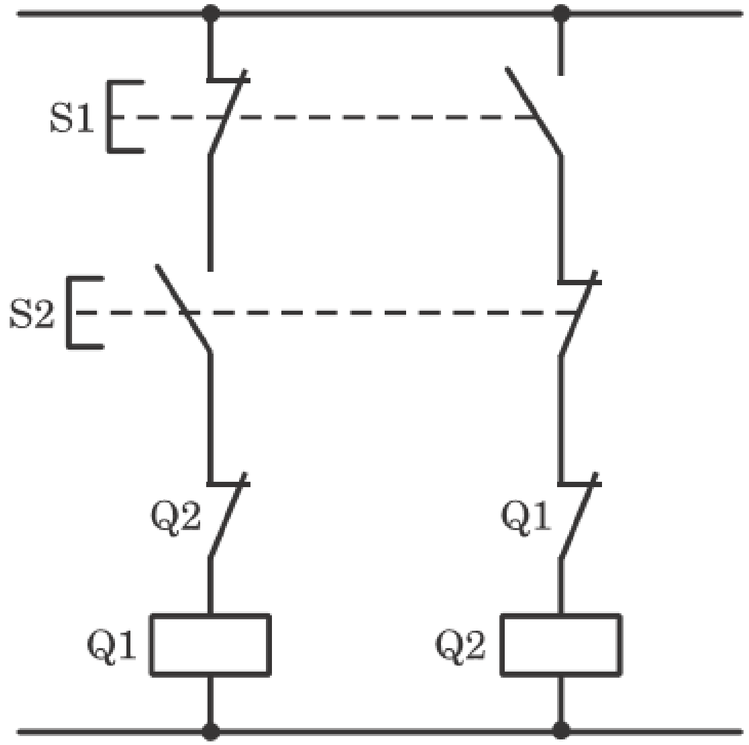
Problem when welding contactor



T-shore Education

Locking switching with relay monitoring

Problem reduced by having the second relay in the circuit as a barrier



T-shore Education

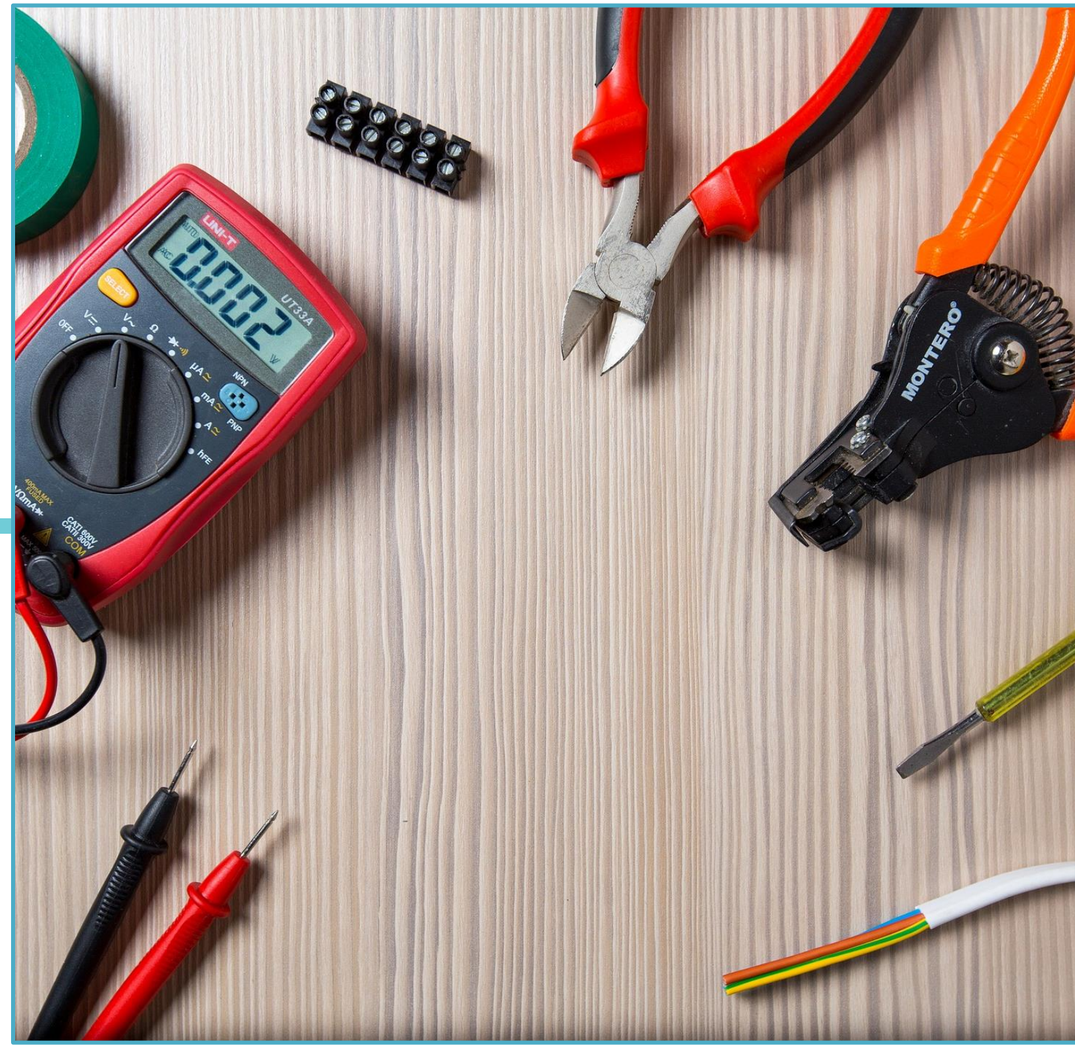
Symbol list

Component	Name	Clamps	Use	Term
	K-x according to which relay it sits on	3 & 4	Auxiliary contact	Make contact Normally open
	K-x according to which relay it sits on	1 & 2	Auxiliary contact	Break contact Nomally closed
	KxT by which timer it belongs to	15 & 18	Timers	Delayed contact Normally open
	KxT by which timer it belongs to	15 & 16	Timers	Delayed Contact Normally closed
	KxT by which timer it belongs to	15 & 18	Timers	Delayed drop-out rate Normally open
	KxT by which timer it belongs to	15 & 16	Timers	Delayed drop-out rate Normally closed
	Sx	3 & 4	Spring return starting pressure	Normally open
	Sx	1 & 2	Spring return stop pressure	Normally closed
	Sx	1 & 2	Switch	Normally closed
	For example, according to which thermo relay is referred to	95 & 96	Thermo relay	Normally closed
	EX refers to which end stop it belongs to	13 & 14	Touch-sensitive limit switch	Normally open
	K-x by contactor number	A1 & A2	Contactor	
	KxT by Timer Number	A1 & A2 and Y1	Hours	Delayed drop-out rate
	KxT by Timer Number	A1 & A2 and Y1	Hours	Delayed contact
	Make and brake			Sits under each switch
	Fx, refer to		Fuse	Protects control current from short circuits
	Px		Lamp	Lamp for indication
		X	Connection	Used to indicate what is internal and external in the control

T-shore Education

Sensors

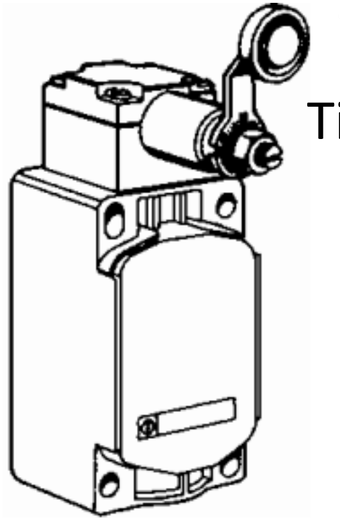
Lesson 5



T-shore Education

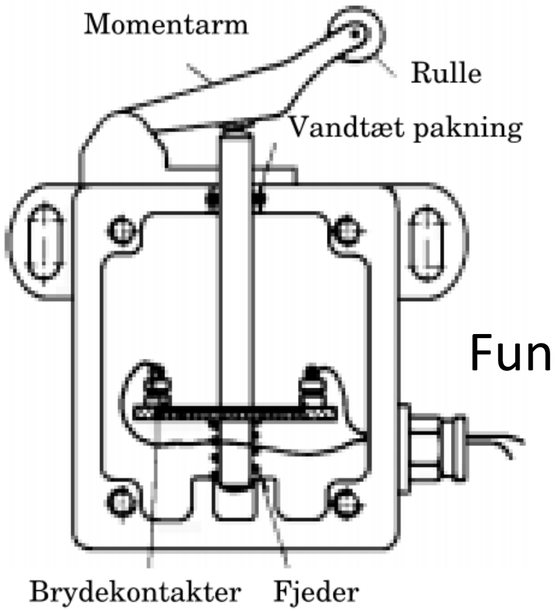
End Stop

End stops come in many varieties.



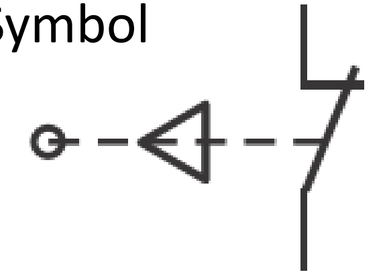
Scroll head switch

Tilt/spring arm switch



Function

Symbol



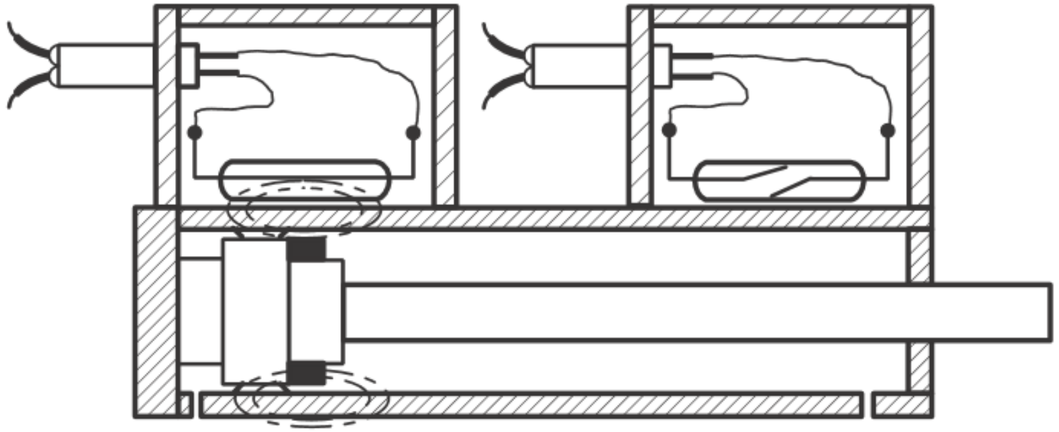
T-shore Education

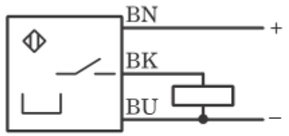
Sensor

Magnetic sensing at cylinders

Reed kontakt

Symbol for en reed-kontakt



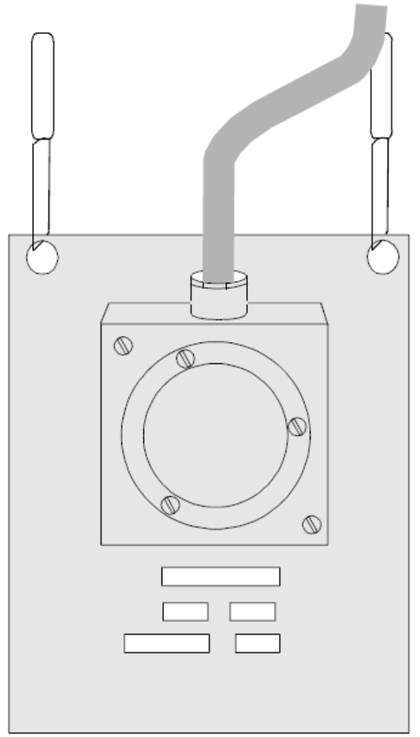


Hall element

Level guards

The level monitor is used for filling in silos for grain, plastic granules, coffee, stone and many other materials.

The level guard is a plate made of stainless steel that is suspended from two chains. A can is mounted on the plate in which a mercury contact is placed. The mercury contact is usually either a breaking or a terminal contact

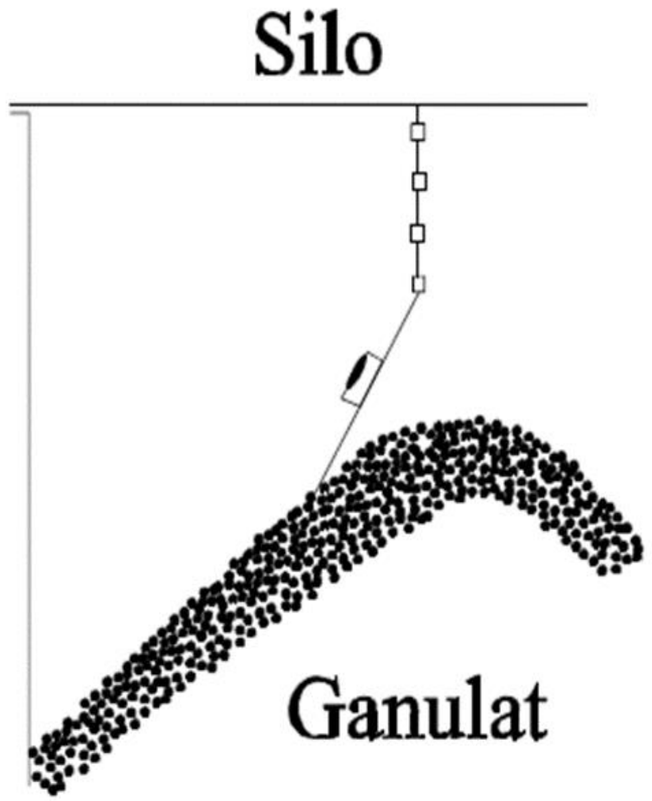


T-shore Education

Level guards

Characteristic data:

- Contacts: Closing or breaking switch
- 2 A, 250 V AC

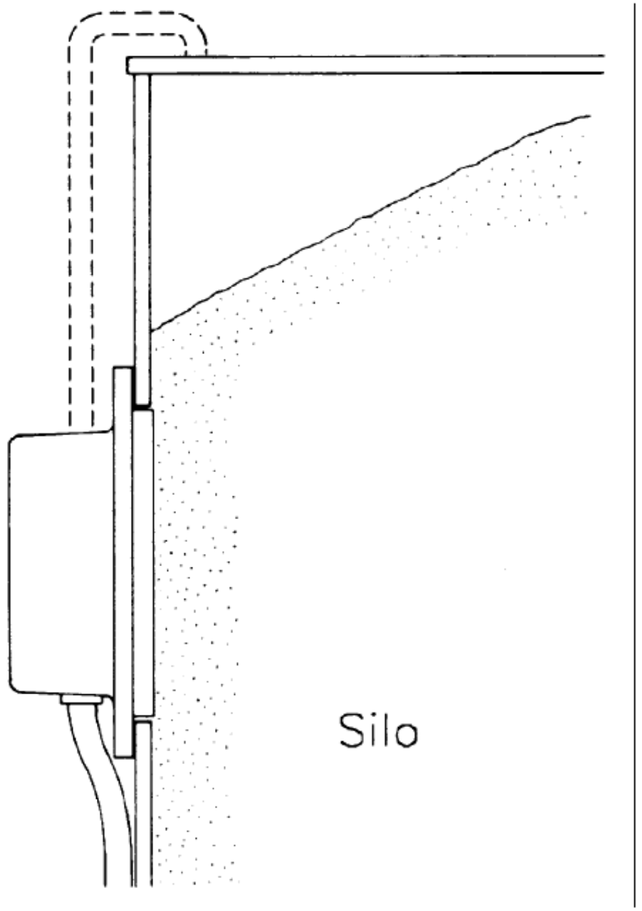


Diaphragm Contactors

The diaphragm switch is used for filling in silos.

The membrane switch has a built-in microswitch that is activated by the pressure of the stored component against the membrane.

The operating pressure depends on the type of diaphragm and spring.



Diaphragm Contactors

Characteristic data:

- Contacts: Switch Switch
- 6 A, 400 V AC

Diaphragm: Oil-resistant perbunan

Housing: Alloy

T-shore Education

Swim Switches

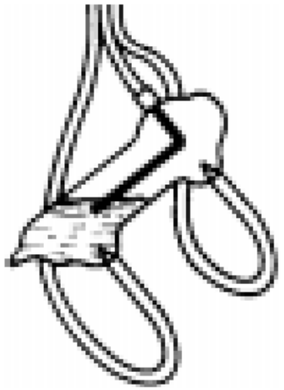
Inside the seesaw, a mercury switch and a ballast are mounted.

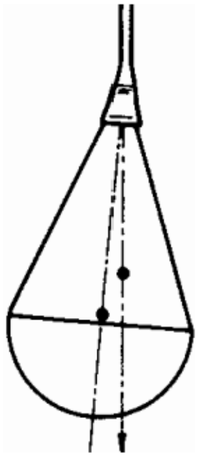
The ballast ensures that the centre of gravity and the PVC bell's buoyancy point are shifted to each other, so that the level rocker capsises in the same way every time the liquid rises around it.

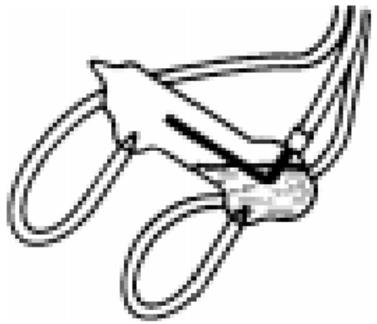
The level switch is available with a switch, switch or termination switch.

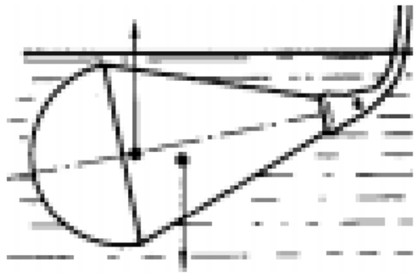
T-shore Education

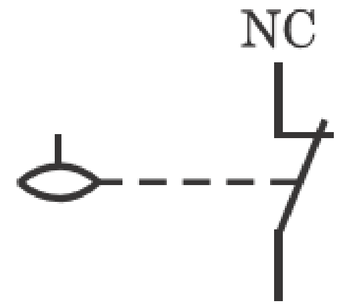
Swim Switches

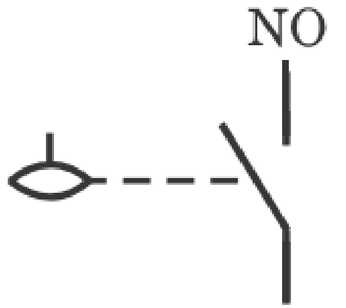










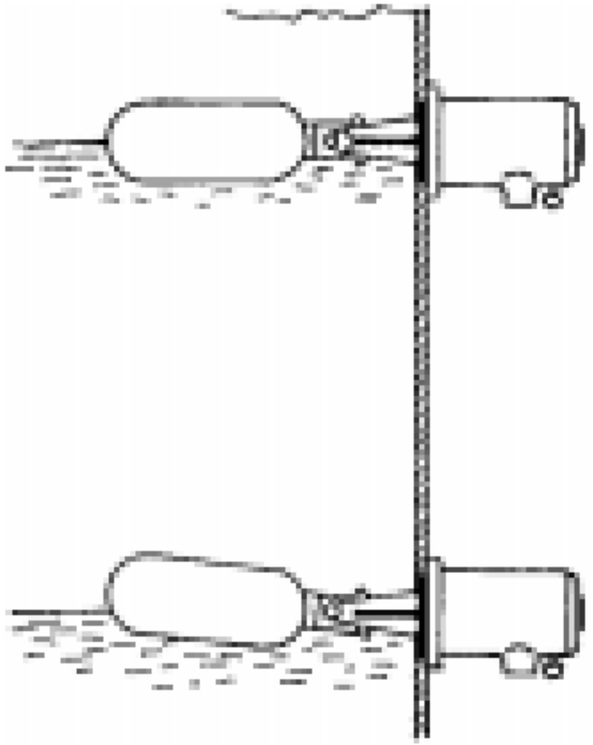


T-shore Education

Level rocker switch

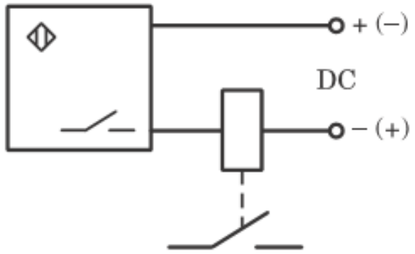
This is one of the most widely used level sensors.

It is usually made with magnetic transition so that no liquid can get to contact the elements

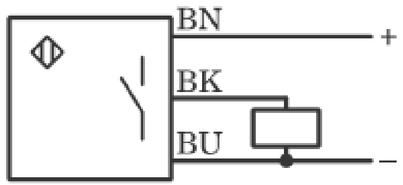


T-shore Education

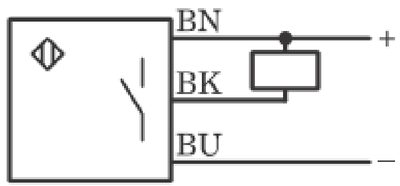
Sensor Wiring



Two-wire sensor



PNP



NPN

Ledning	Farve	Forkortelse
+	Brun/brown	BN
Signal	Sort/black	BK
Signal	Hvid/white	WH
–	Blå/blue	BU

T-shore Education

PLC

Lesson 6

T-shore Education

PLC´s history and use

Programmerbar **L**ogisk **C**ontroller <=> **P**rogrammable **L**ogic **C**ontroller

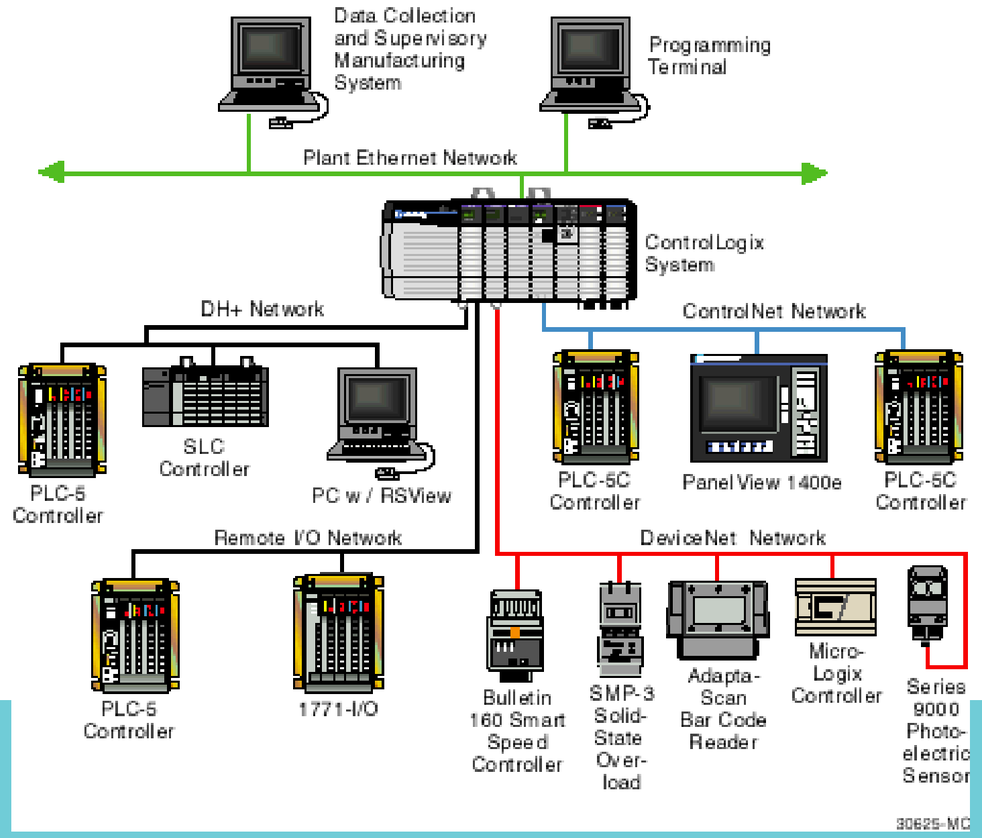
T-shore Education

PLC´s types

Construction of PLC:

- Compact
- Rack

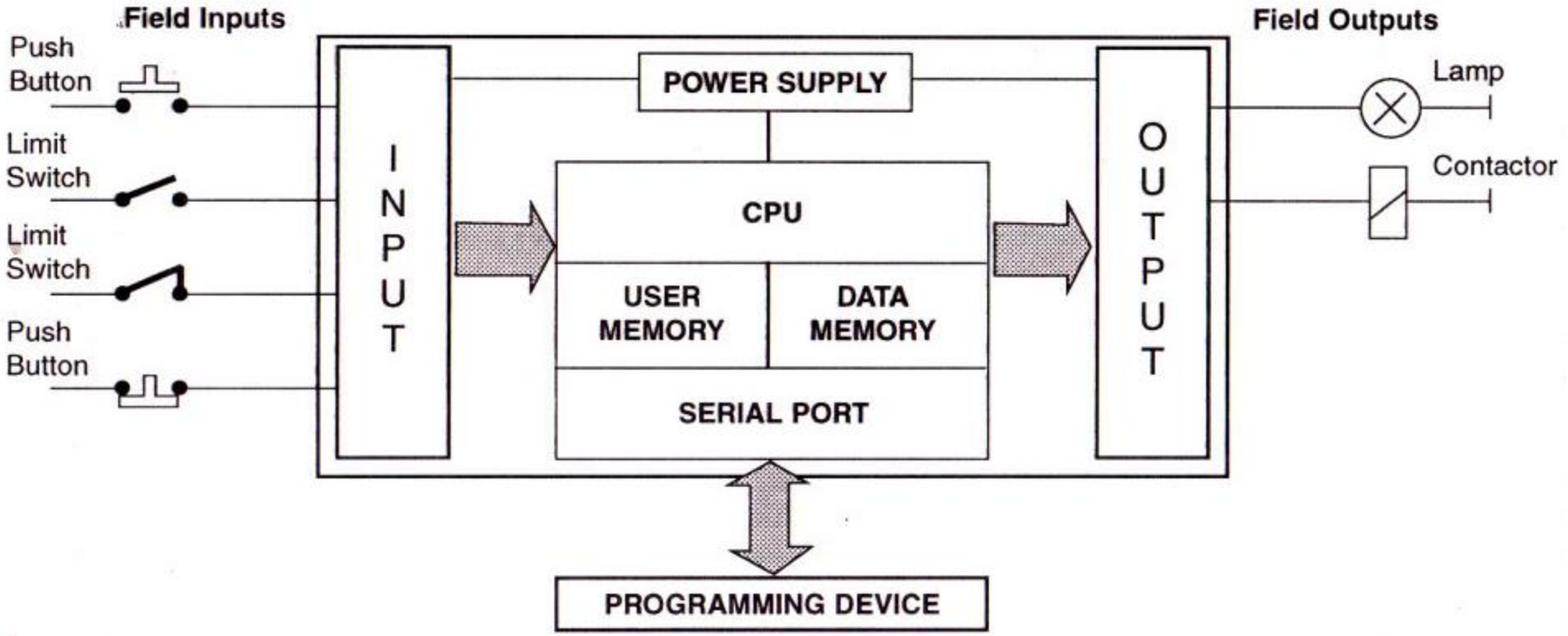
Network



T-shore Education

PLC´s construction

The construction of a plc.

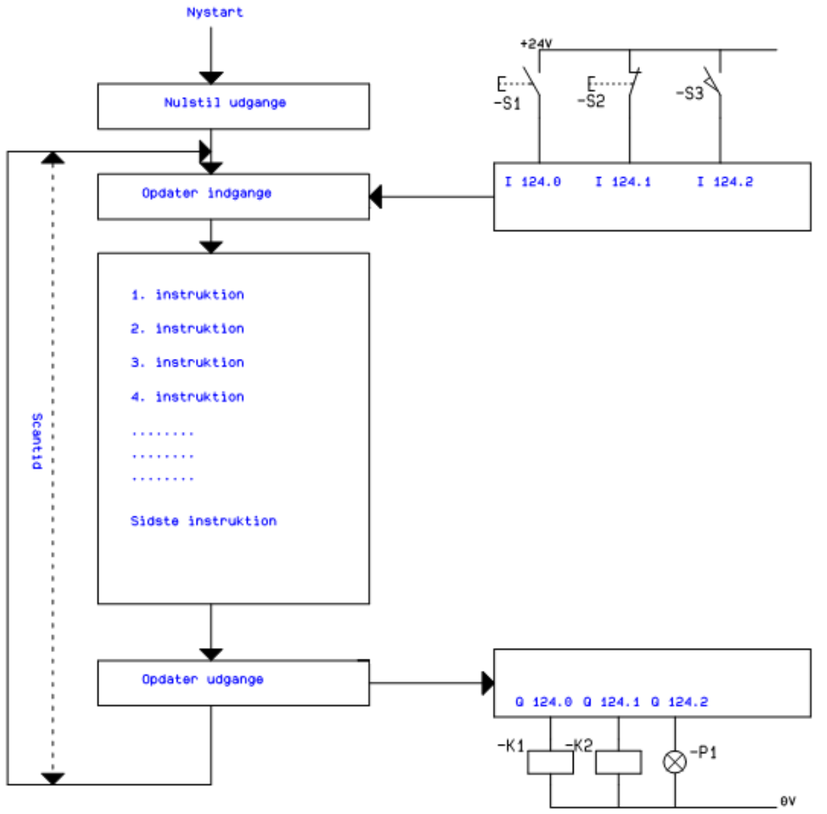


T-shore Education

PLC´s Scantid

In a PLC, the instructions are processed in a predetermined order. When all instructions have been processed, start over in the order.

The results of the various instructions are stored in a number of internal registers that are continuously changed during the programme execution.



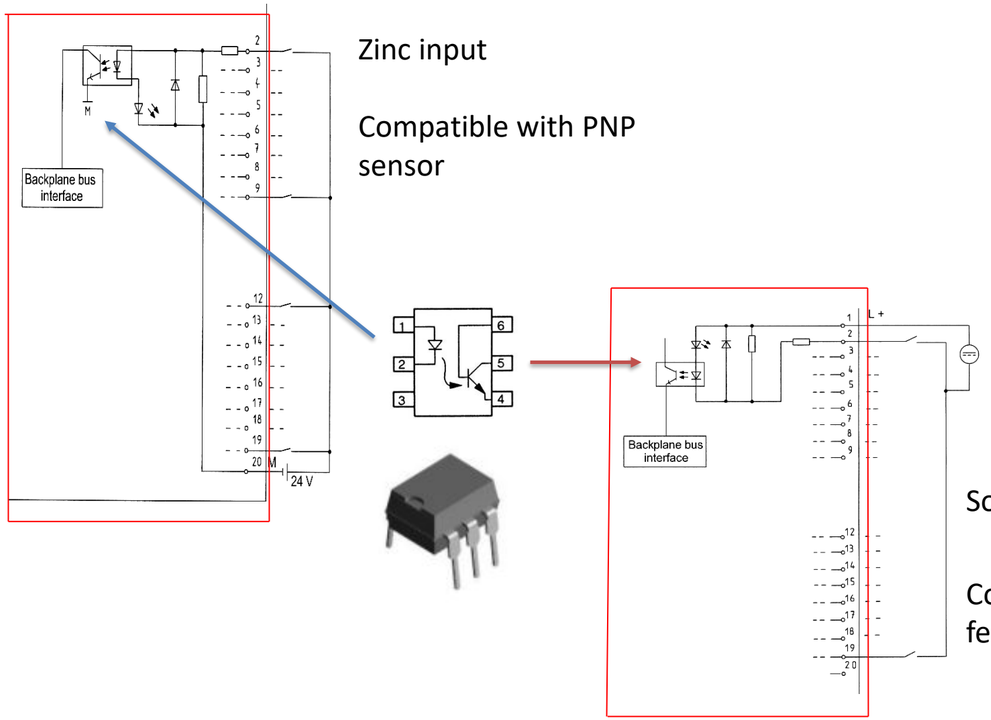
The overall programme consists of:

- Loading from inputs
- Program execution of user program
- Readout to outputs

The scan time depends on the number of instructions and the CPU used. Typically, the time is between 1 and 10 ms for 1000 binary instructions.

T-shore Education

PLC´s Indput



Zinc input

Compatible with PNP sensor

Source input

Compatible with NPN feel

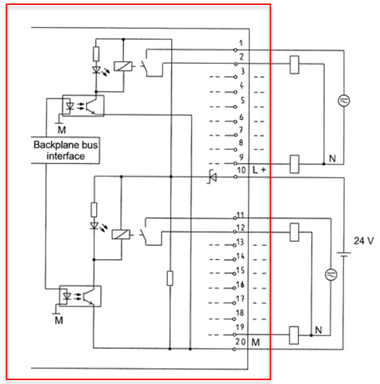
Inputs – the most commonly used:

SWITCH (On/Off switch) – as a 1 pole switch.
MAKE (End function) – as a 1 pin switch with spring return.
BRAKE (Invited End Function) – Invited MAKE signal.

The I/O board is galvanically separated from the plc bus by an optocoupler

T-shore Education

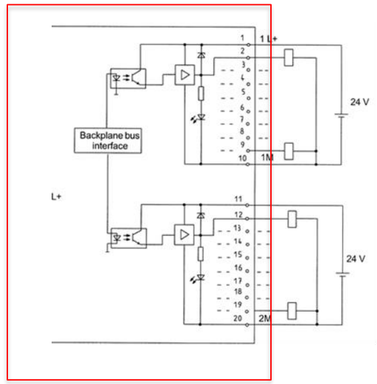
PLC´s Output



Relay output

Multi voltage

Slow



Transistor output "source"

Fast

DC only

T-shore Education

PLC´s Programming language

IEC 1131

5 Programming languages:

- LD Ladder
- IL Instructional List
- ST Structured text
- FDB Function Block
- SFC Graphic Sequence

PLC´s Brackets

Siemens

Allan Bradly

Omron

Modicon

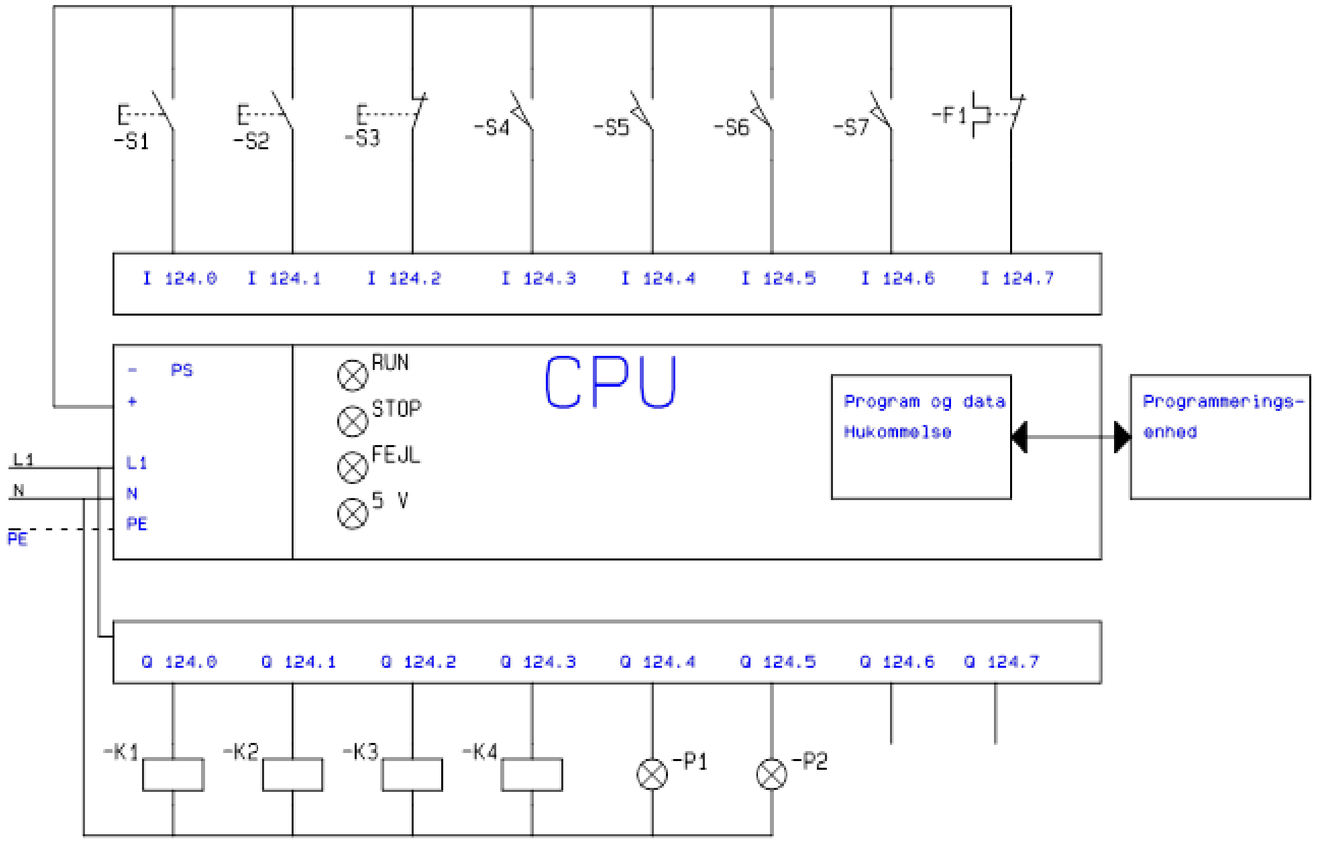
Izumi

Bechoff

Which is best??

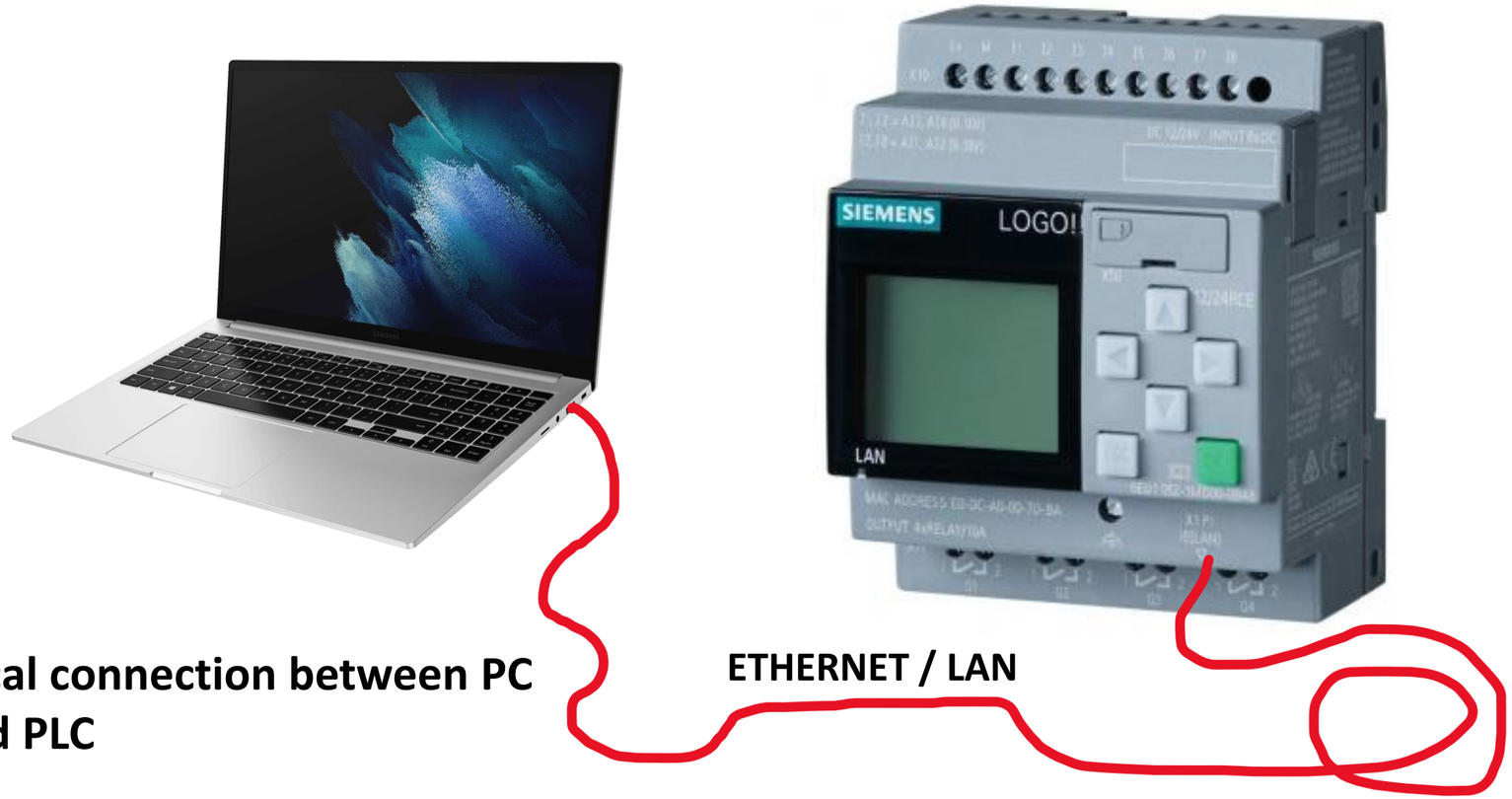
T-shore Education

In practice, everyone is the same ☺



T-shore Education

PLC connection

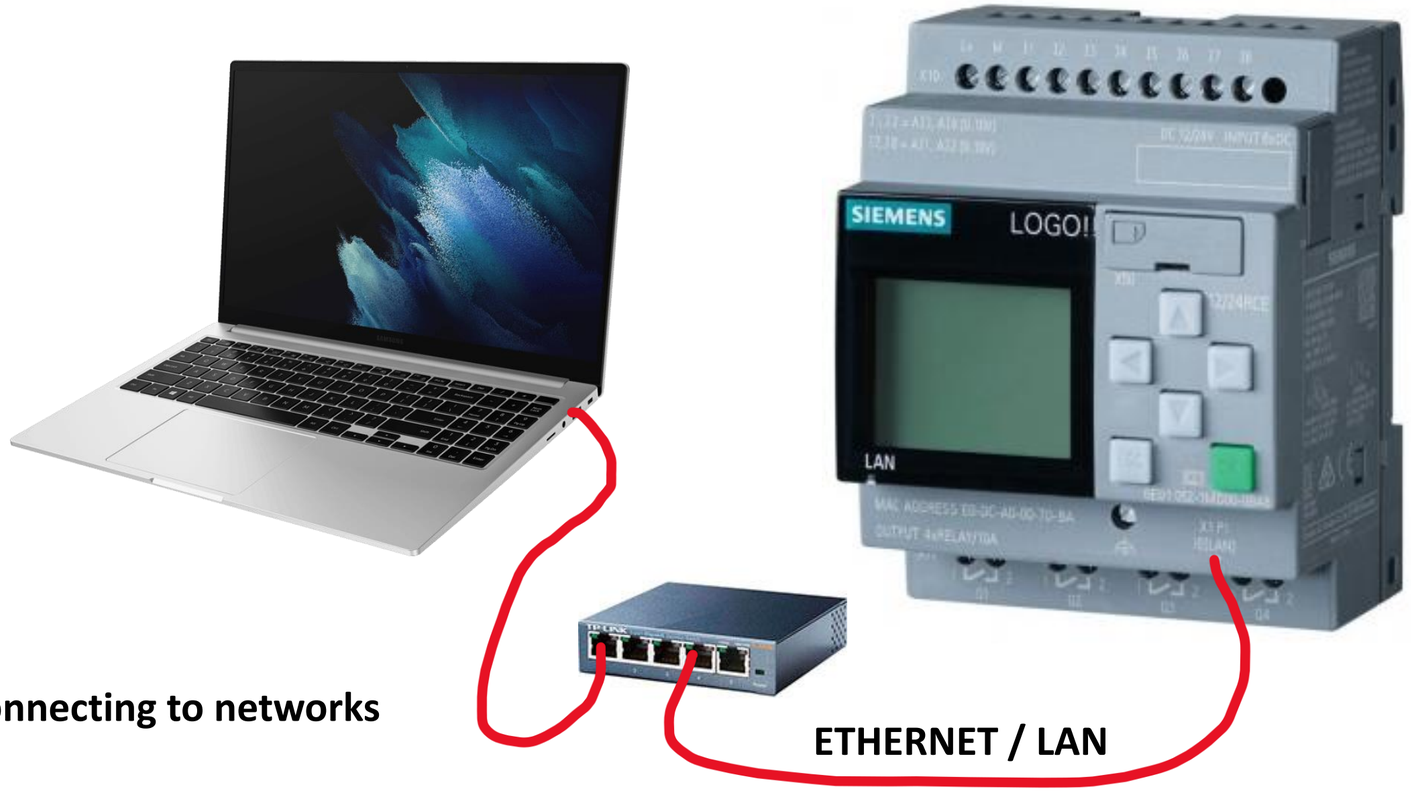


Local connection between PC and PLC

ETHERNET / LAN

T-shore Education

PLC connection



Connecting to networks

T-shore Education

Programming

Parameter List:

START press = S1 = input 1 = I1 = NO switch

STOP pressure = S2 = input 2 = I2 = NC contact

Relay/contactor = Q1 = output 1

Signalgiver	Benævnelse	Klem nr.	Parameter
START trykknap	S1	I1	I1
STOP trykkanp	S2	I2	I2
Relæ / kontaktor	K1	Q1.1	Q1

Programming

The binary concept shows how physical sets (binary variables) that can exist in one of two states, can be represented as 1 or 0 (HIGH or LOW - ON or OFF).

Statements that combine two or more of these binary variables can result in either a TRUE or FALSE state, represented by 1 and 0, respectively.

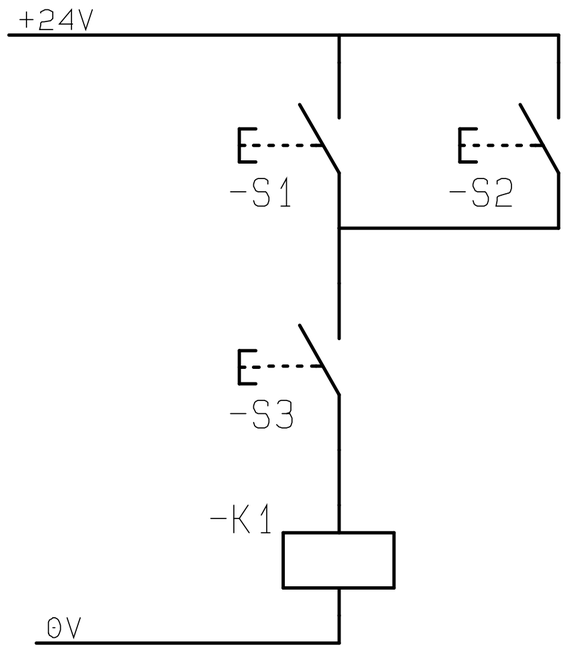
Programmable Logic Controllers (PLCs) make decisions based on the results of these types of logic statements.

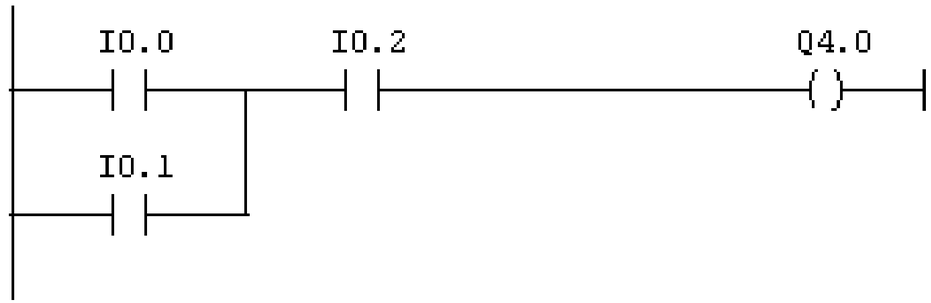
Operations performed by digital equipment, such as programmable controllers, are based on three basic ladder logic functions – AND, OR, AND NOT.

These functions combine binary variables to form statements. Each function has a rule that determines the sentence result (TRUE or FALSE) and a symbol that represents it.

Ladder diagram

A ladder chart is like a key chart on the page.

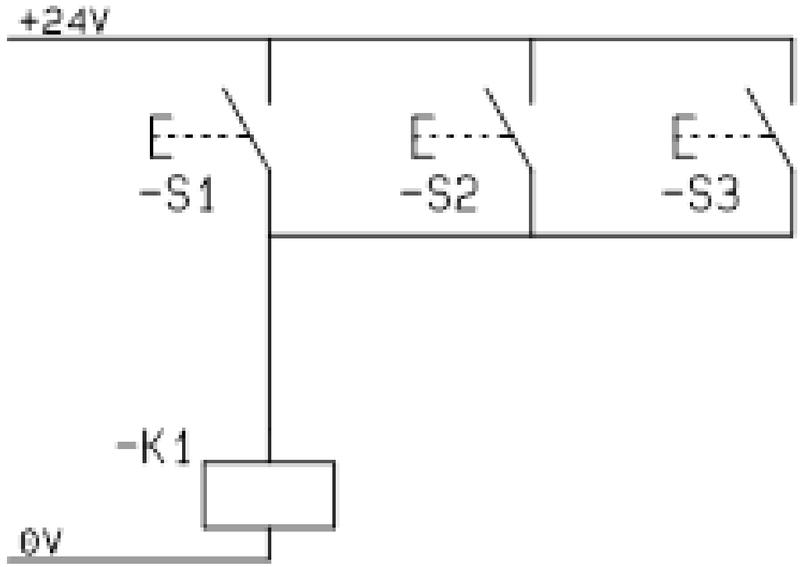




T-shore Education

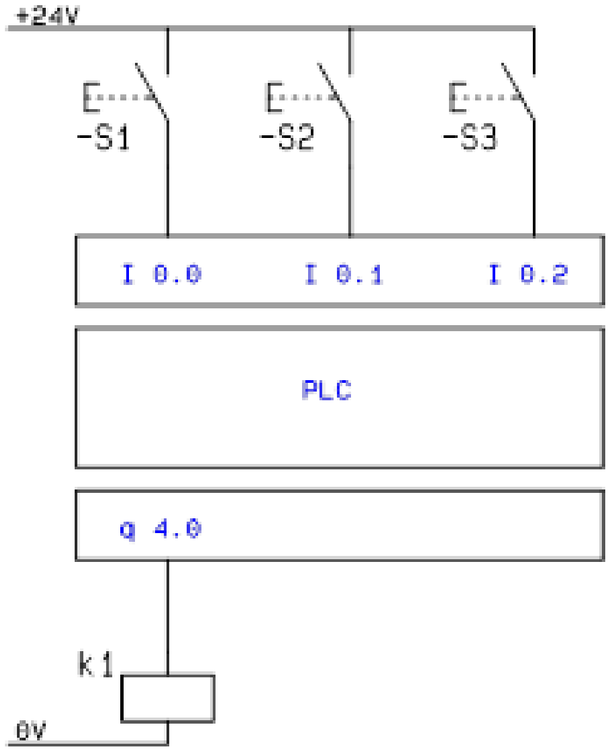
Parrallel circuit / Or

Boolean expression: K1 = S1 + S2 + S3

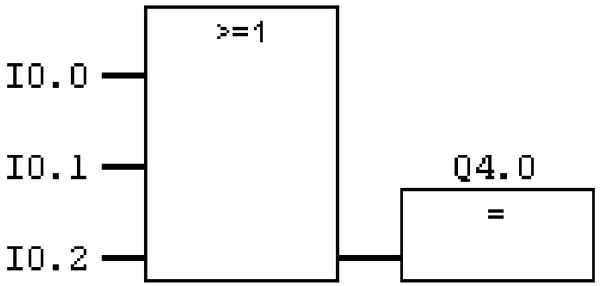


Parrallel circuit / Or

Cabling of the PLC



Programming

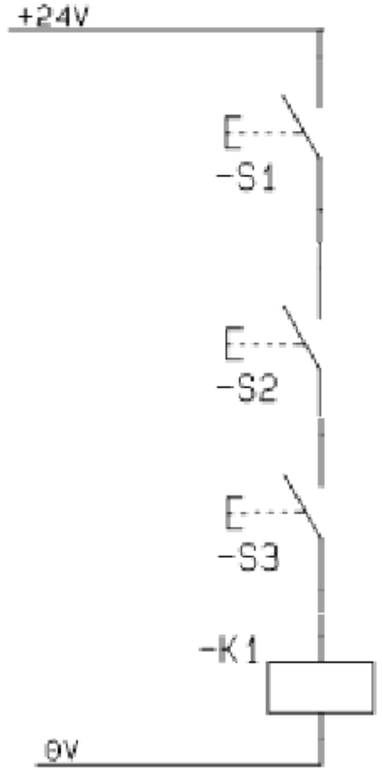



```
0       I       0.0
0       I       0.1
0       I       0.2
=       Q       4.0
```

T-shore Education

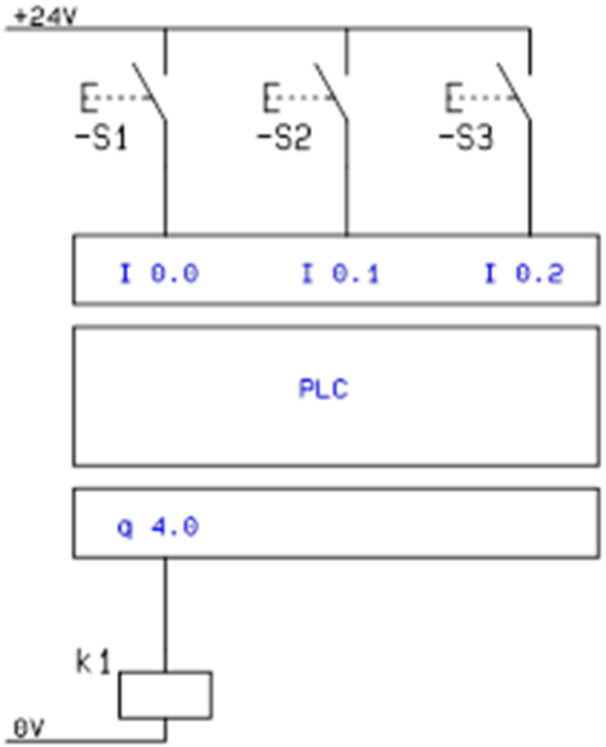
Series circuit / And

Boolean expression: K1 = S1 x S2 x S3

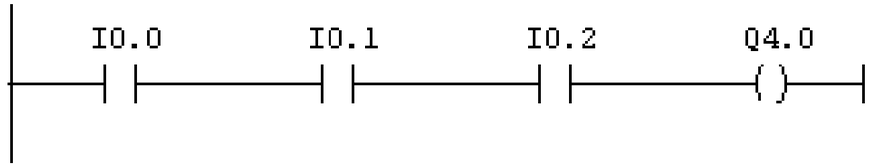


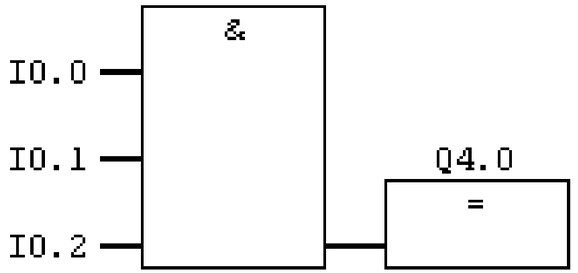
Series circuit / And

Cabling of the PLC



Programming



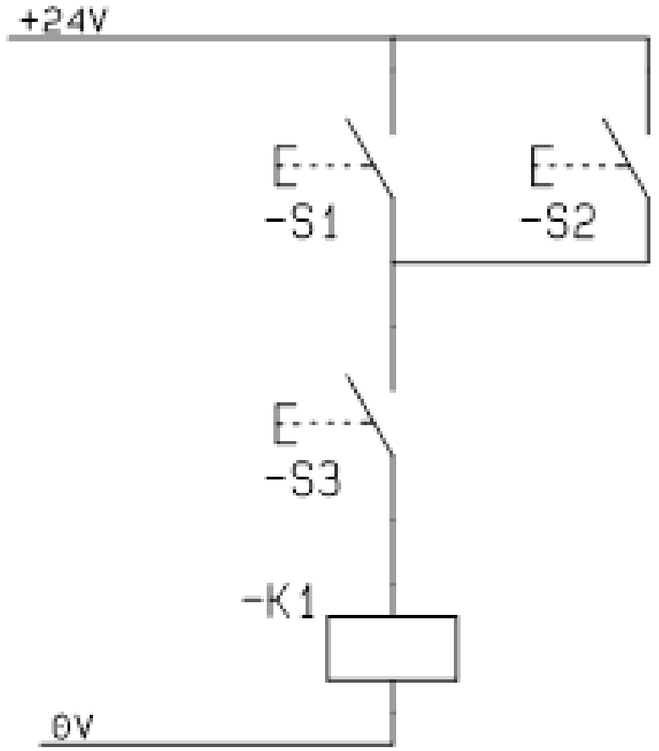



```
A     I     0.0
A     I     0.1
A     I     0.2
=     Q     4.0
```

T-shore Education

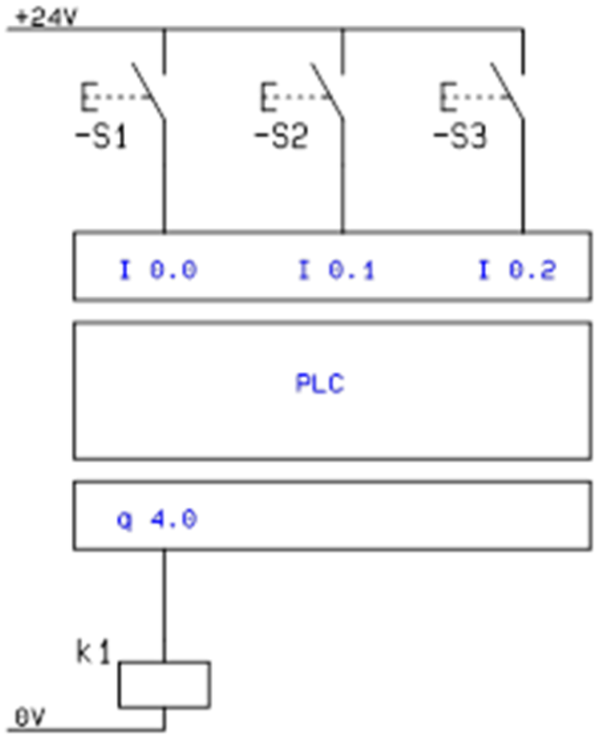
Combinatorial

Boolean expression: K1 = (S1 + S2) x S3

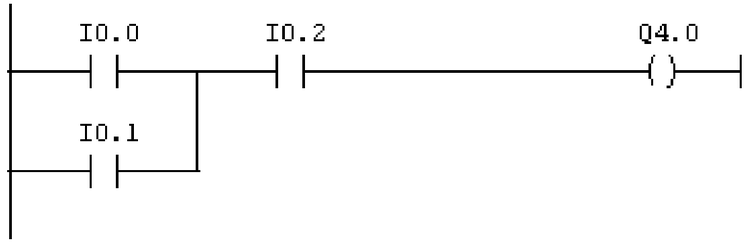


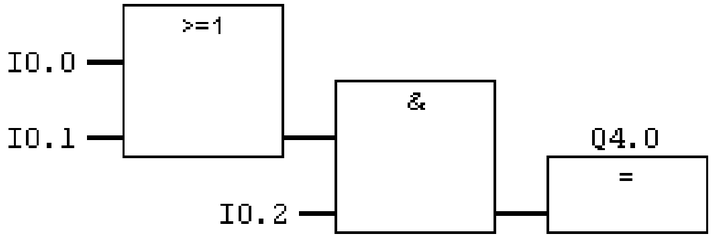
Combinatorial

Cabling of the PLC



Programming






```
A(
O       I       0.0
O       I       0.1
)
A       I       0.2
=       Q       4.0
```

T-shore Education

Thank you!

Skive College

Erasmus+
Enriching lives, opening minds.

Vocational education and training

T-shore

tshore.eu@gmail.com
t-shore.eu

Co-funded by the European Union