The PTC resistor (Item No.: P1400700)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physics	Age 14-16	Electricity	Properties of electrical components	The PTC resistor

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

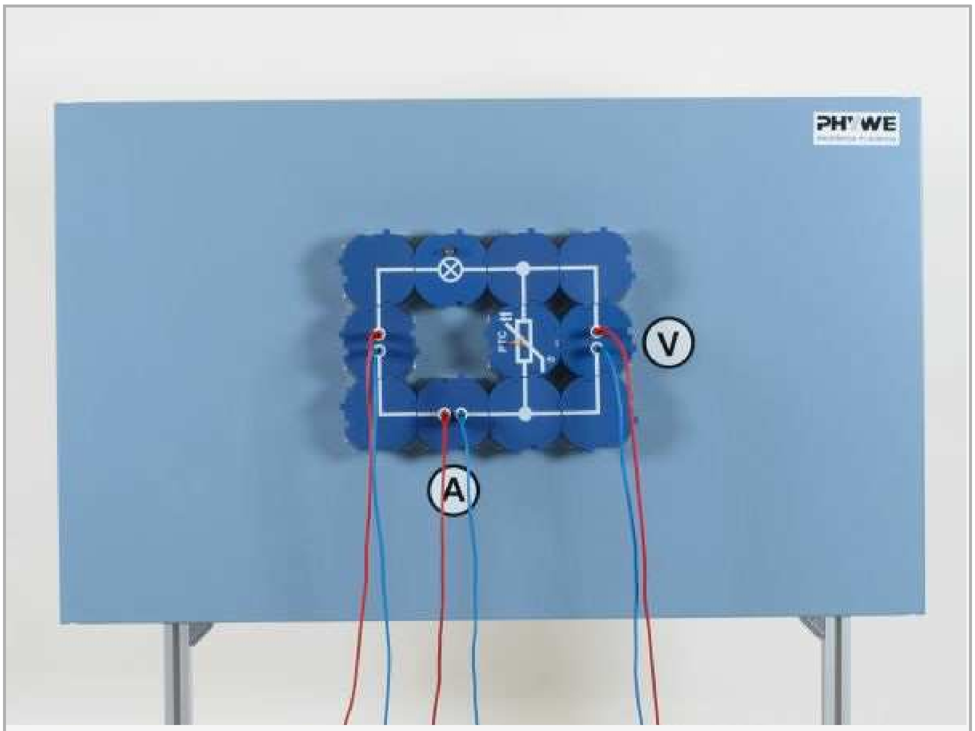
Experiment Variations:

Keywords:

Principle and equipment

Principle

An investigation is to be made into how the resistance of a PTC resistor is affected by temperature changes.



Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Multimeter ADM2, demo., analogue	13820-01	2
2	PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13500-93	1
3	Demo Physics board with stand	02150-00	1
4	Stop clock, demo.; diam. 13 cm	03075-00	1
5	Hot/cold air blower, 1800 W	04030-93	1
6	Socket for incandescent lamp E10 ,module DB	09404-00	1
7	Connector interrupted, module DB	09401-04	3
8	PTC-resistor, module DB	09431-00	1
9	Electr.symbols f.demo-board,12pcs	02154-03	1
10	Connector, straight, module DB	09401-01	1
11	Connector, angled, module DB	09401-02	4
12	Connector, T-shaped, module DB	09401-03	2
13	Filament lamps 4V/0.04A, E10, 10	06154-03	1
14	Connecting cord, 32 A, 1000 mm, red	07363-01	2
15	Connecting cord, 32 A, 1000 mm, blue	07363-04	2
16	Connecting cord, 32 A, 750 mm, red	07362-01	1
17	Connecting cord, 32 A, 750 mm, blue	07362-04	1
Additional material:			
	Fan (hot and cold air blower 04030.93)		
	Clock with seconds hand (0307 4.00)		

Set-up and procedure

1st. Experiment

- Set up the experiment as shown in Fig. 1; select the 10 V- and 100 mA- measurement ranges.
- Switch on the power supply and adjust the voltage to 12 V-
- Observe the filament lamp and measuring instrument for the current for about one minute.
- Touch the PTC resistor with your fingers; observe the filament lamp and ammeter; switch off the power supply and note your observations.

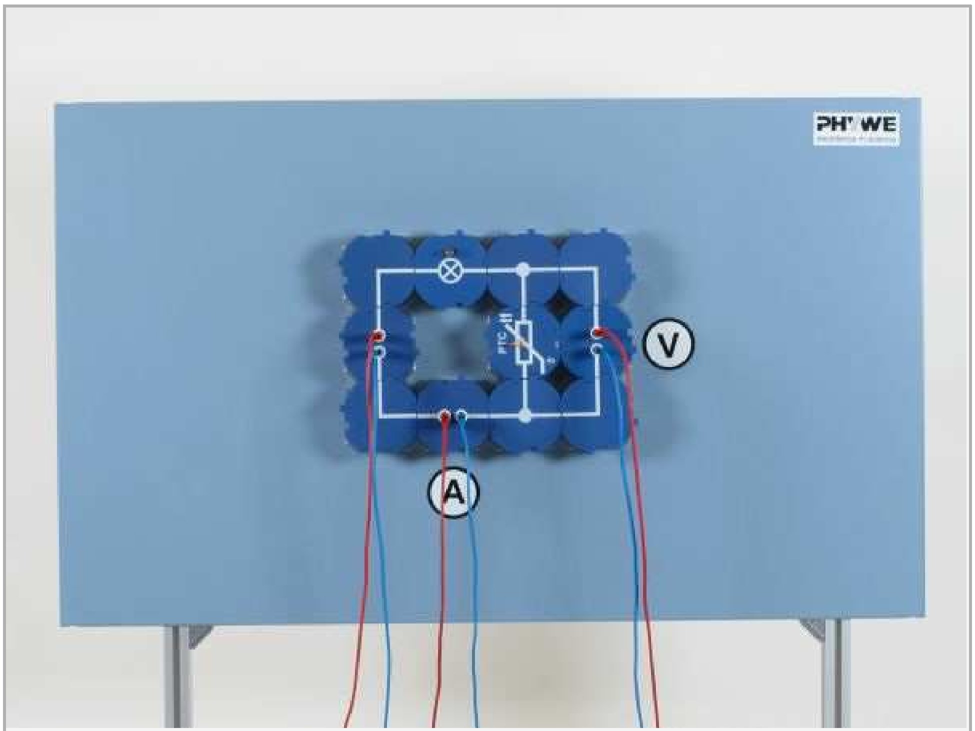


Fig. 1

2nd. Experiment

- Replace the filament lamp by the straight connector building block.
- Reduce the power supply voltage to 2 V, select the 30 mA- measurement range and switch on the power supply.
- Enter the measured values for voltage and current in Table 1.
- Heat the PTC resistor with the fan and read the value of the current every 5 seconds for about 1/2 a minute, entering the values in Table 1.
- Switch off the fan and carry on taking measurements of the current every 5 seconds for about 1/2 a minute, entering the values in Table 2.

Observation and evaluation

Observation

After switching on the power supply, the filament lamp first lights up very brightly and the ammeter shows a value of about $I = 60\mathrm{mA}$. Although the voltage does not change, the brightness of the lamp lessens and the current drops to about $I = 20\mathrm{mA}$. On touching the PTC resistor, the current increases and the lamp shines more brightly again.

Table 1: The measured current strengths I, and the resistances R calculated from them, at U = 2 V-, during heating the resistor up

$\frac{t}{s}$	0	5	10	15	20	25	30
$\frac{I}{mA}$	22.0	18.0	16.0	15.0	14.6	14.3	14.0
$\frac{R}{k\Omega}$	91	111	125	133	137	140	143

Table 2: The measured current strengths I, and the resistances R calculated from them, at U = 2 V-, during cooling

$\frac{t}{s}$	35	40	45	50	55	60
$\frac{I}{mA}$	14.5	15.7	16.0	17.0	17.5	18.0
$\frac{R}{k\Omega}$	138	127	125	118	114	111

Evaluation

The brightness of the lamp and the current strength decrease, because the PTC resistor heats up as a result of the flow of current and this causes its resistance to increase. When the hot resistor cools, then its resistance value decreases again.

The presentation of the dependence of the value of the resistance of the PTC resistor on time during heating up and cooling down (see Fig. 2), clearly shows that heating leads to an increase in resistance and cooling to a decrease in resistance.

The explanation of this behaviour is that the vibration of the lattice elements increases with increasing temperature, and this causes an increasing hindrance to the movement of the freely mobile charge carriers in the PTC resistor. PTC Resistors are therefore called cold conductors.

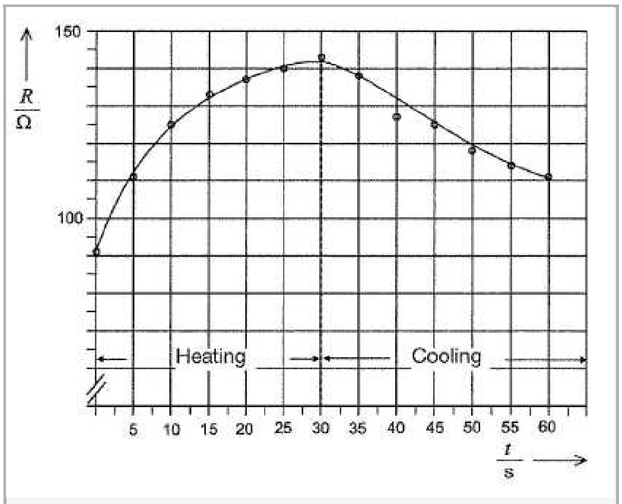


Abb. 2

Remarks

The distance of the fan from the PTC resistor should be so chosen, that the current strength decreases to about a third of its initial value within about half a minute. PTC Resistors (positive temperature coefficient) or cold conductors are made from doted polycrystalline titanateceramic material. They can be operated by their self-heating or by extraneous heating.

A relatively high voltage is applied for self-heating, whereupon the electric current causes the PTC resistor to heat up, its resistance is thereby increased and the current strength decreases. In the case of a temperature that is dependent on the drop in performance, this behaviour results in an equilibrium condition being reached that remains stable as long as the ambient temperature does not change.

With extraneous heating, only a small voltage is applied, which does not cause any perceptible self-heating. The value of the resistance is determined here by the ambient temperature.
PTC Resistors are used to display filling levels in containers of liquids and for temperature controlling of electrical installations.