# The transistor time-delay switch (Item No.: P1374600)

## Curricular Relevance

**Area of Expertise:** Physik
**Education Level:** Klasse 10-13
**Topic:** Elektrizitätslehre
**Subtopic:** Elektronik
**Experiment:** Der Transistor-Zeitschalter

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

**Additional Requirements:**

**Experiment Variations:**

**Keywords:**

## Task and equipment

## Information for teachers

## Additional information

Delay circuits are presently in wide usage for delaying the switching on of alarm systems. Their working principle is based on the time involved in the charging and discharging of capacitors, which the students have already dealt with. An increasing or decreasing capacitor voltage brings the transistor to a conductive or to a blocked state, as soon as the base-emitter voltage reaches the appropriate threshold value or goes below it.

## Notes on setup and procedure

As the input resistance of a transistor in an emitter circuit is very low, it would noticeably accelerate the charging process, because it is connecting in parallel to the capacitor. An emitter resistance of $R_E = 100\ \Omega$ is therefore included in the circuit here. This effects a counter coupling, and so leads to a considerable increase in the input resistance, and consequently also in the delay time.

## Remarks

This experiment represents a highly simplified principle of a delay circuit, as the transistor continually goes from one to the other condition. It only allows semi-quantitative statements on the dependence of the delay time on the capacity and the resistance, as, because of the exponential course of the voltage-time function, the exact end point of the delay can only be approximately determined.
Due to the highly damped measuring system used – it has an adjusting time of about 3 seconds – the smaller delay times which are measured are subject to error and deviate clearly from the expected values. Flip-flops with a positive feedback are used in delay circuits with real switching characteristics. They contain at least two active components.

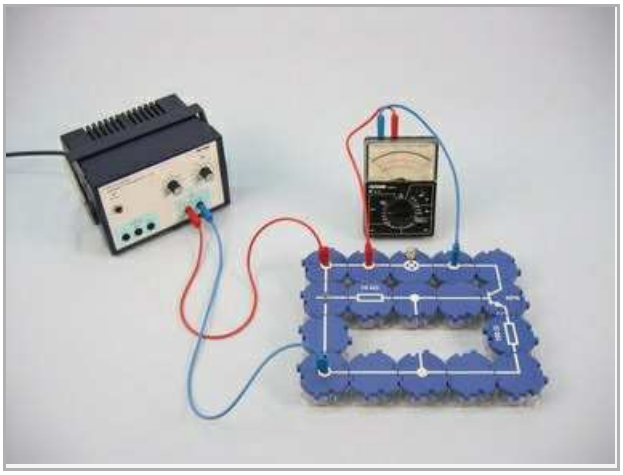
# The transistor time-delay switch (Item No.: P1374600)

## Task and equipment

## Task

## How can the switching of a transistor be delayed?

Determine the factors on which a delay in the switching of a transistor is dependent.



## Equipment


| Position No. | Material | Order No. | Quantity |
|---|---|---|---|
| 1 | Straight connector module, SB | 05601-01 | 4 |
| 2 | Angled connector module, SB | 05601-02 | 2 |
| 3 | T-shaped connector module, SB | 05601-03 | 2 |
| 4 | Straight connector module with socket, SB | 05601-11 | 2 |
| 5 | Angled connector module with socket, SB | 05601-12 | 2 |
| 6 | Change-over switch module, SB | 05602-02 | 1 |
| 7 | Socket module for incandescent lamp E10, SB | 05604-00 | 1 |
| 8 | Resistor module 100 Ohm, SB | 05613-10 | 1 |
| 9 | Resistor module 10 kOhm, SB | 05615-10 | 1 |
| 10 | Resistor module 47 kOhm, SB | 05615-47 | 1 |
| 11 | Capacitor module 47 µF non-polar electrolytic, SB | 05645-47 | 1 |
| 12 | Capacitor module 470 µF non-polar electrolytic, SB | 05646-47 | 1 |
| 13 | NPN transistor module BC337, SB | 05656-00 | 1 |
| 14 | Connecting cord, 32 A, 500 mm, red | 07361-01 | 2 |
| 15 | Connecting cord, 32 A, 500 mm, blue | 07361-04 | 2 |
| 16 | Filament lamps 12V/0.1A, E10, 10 | 07505-03 | 1 piece |
| 17 | PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A | 13506-93 | 1 |
| 18 | Multi-range meter, analogue | 07028-01 | 2 |

# Set-up and procedure

## Set-up

Set up the circuit as shown in Fig. 1 and Fig. 2, with $R_E$ = 100 Ω and R = 10 kΩ ; without capacitor to start with.

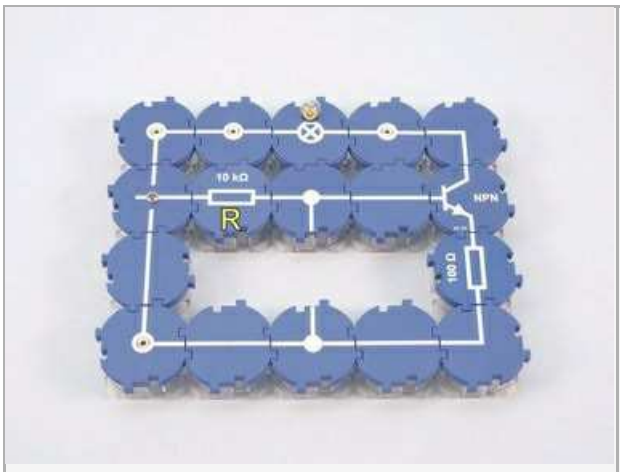


Fig. 1

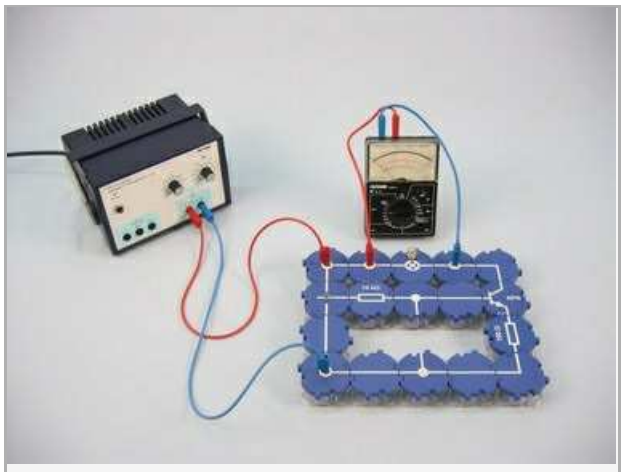


Fig. 2

## Procedure

- Switch on the power supply; set it to 12 V direct voltage.
- Switch the changeover switch back and forth several times; observe when the lamp lights up or goes out and note this under Result - Observations 1 in the report.

---

- Connect in the 470 µF capacitor as shown in Fig. 3 and Fig. 4; again repeatedly operate the changeover switch, observe when the lamp lights up or goes out and note this under Result - Observations 2.

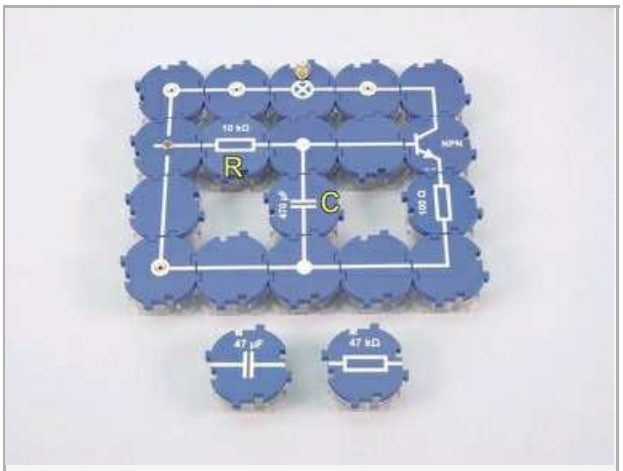


Fig. 3

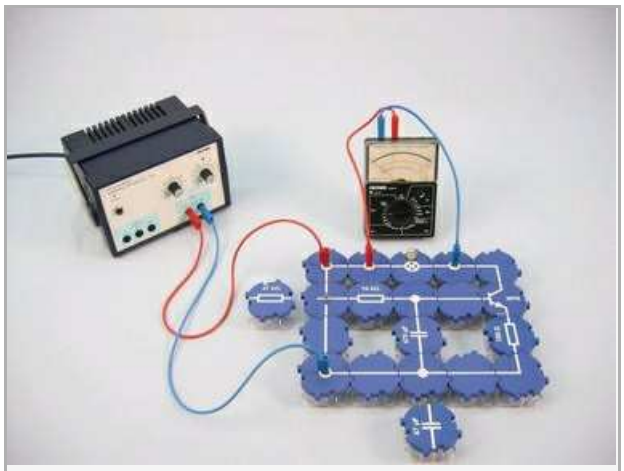


Fig. 4

- Again repeatedly operate the changeover switch, and determine the times $t_{on}$ and $t_{off}$ from the moment the switch is operated to the time the full voltage or 0 V voltage is applied to the lamp; enter the measured values in Table 1 in the report.
- Successively exchange the resistors and the capacitors as indicated in Table 1 and carry out the time measurement for each combination; note the measured values.
- Switch off the power supply.

# Report: The transistor time-delay switch

## Result - Observations 1

Note your observations.

.....

.....

.....

.....

## Result - Observations 2

Note your observations.

.....

.....

.....

.....

## Result - Table 1

Record your measured values in the table.

| Capacitor $C$ in µF | Resistor $R$ in kΩ | Switch on delay $t_{on}$ in s | Switch off delay $t_{off}$ in s |
|---|---|---|---|
| | | 1 ±0 | 1 ±0 |
| | | 1 ±0 | 1 ±0 |
| | | 1 ±0 | 1 ±0 |
| | | 1 ±0 | 1 ±0 |

## Evaluation - Question 1

Use the circuit diagram (Fig. 1) to explain the processes occurring at the two switch positions.

.....

.....

.....

.....

## Evaluation - Question 2

Why does the filament lamp not light up immediately, when the switch makes contact with the positive terminal of the current source?

.....

.....

.....

.....

## Evaluation - Question 3

Why does the filament lamp not immediately go out, when the switch makes contact with the negative terminal of the current source?

.....

.....

.....

.....

## Evaluation - Question 4

What are the time delays dependent on?

.....

.....

.....

.....

## Evaluation - Question 5

Name possible applications for delay circuits.

.....

.....

.....

.....

## Evaluation - Question 6

Which disadvantage of this simple circuit is shown by the behaviour of the filament lamp?

.....

.....

.....

.....