PSITRON

SHORT CIRCUIT AND ELECTRONIC FUSE
VOLTAGE, CURRENT, RESISTANCE AND OHM'S LAW

LAB A1

1. TASK

How does a battery behave when shorted ? How can you prevent a short circuit?

2. BACKGROUND INFORMATION

Lab A1.1: If the positive and negative poles of a battery are directly connected to each other then a short-circuit current flows whose height is limited by the internal resistance of the battery. This results from the chemical components of a battery. Since the short-circuit current of a brand-new 9V battery can amount to a few amperes, an electronic current limitation of approximately 100mA was built into the circuit of the included PSITRON battery module. A kind of fuse to avoid major damage and to protect the electronic components in a circuit in case of failure.

Lab A1.2: In the circuit a load resistor RL is placed between the plus and minus pole so that the PSITRON battery module does not run into the electronic current limit. When selecting the resistor the max. allowed power loss must be taken into account. If this value is exceeded during operation then the resistance can be destroyed because of heat development.

3. EXPERIMENT DESCRIPTION

Lab A1.1: Connect the plus and minus poles of the PSITRON battery module to create a short circuit. Measure the voltage between the plus and minus poles.

Lab A1.2: Insert a resistance of 1kΩ between the plus and minus poles of the PSITRON battery module.

LEARNING SUCCESS

The short-circuit current is limited by the internal resistance and the chemical properties of a battery. An external load resistor can be used to reduce the current in the circuit. Since heat is generated by moving charge carriers, the max. „withstanding" power loss has to be considered.

4. OBSERVATION

Lab A1.1: The electronic current limitation of the PSITRON battery module is activated immediately after short-circuiting the two poles and the red LED lights up. The battery voltage breaks down and drops to 0V.
Lab A1.2: The red LED of the PSITRON battery module does not light up because the current limitation has not been activated. A current of less than 100mA flows in the circuit.

5. EXPLANATION AND MATHEMATICAL VIEW

Lab A1.1: In the event of a short circuit, the entire battery voltage drops on the internal resistance of the battery.

! Please do not do this experiment by yourself with a single 9V battery, because a short-circuited battery without current limitation gets very hot !
With a new 9V block battery we measured a voltage of approx. 9.5 V without external circuit (load). When connecting the + and - poles, the battery voltage drops down to 0V. The short-circuit current was approx. 5.5A. Formula F1 (please see Intro document) is used to calculate the internal resistance Ri of the 9V battery as follows:

Ri = Ui / IK = **9.5 V / 5.5 A = 1.73 Ω**

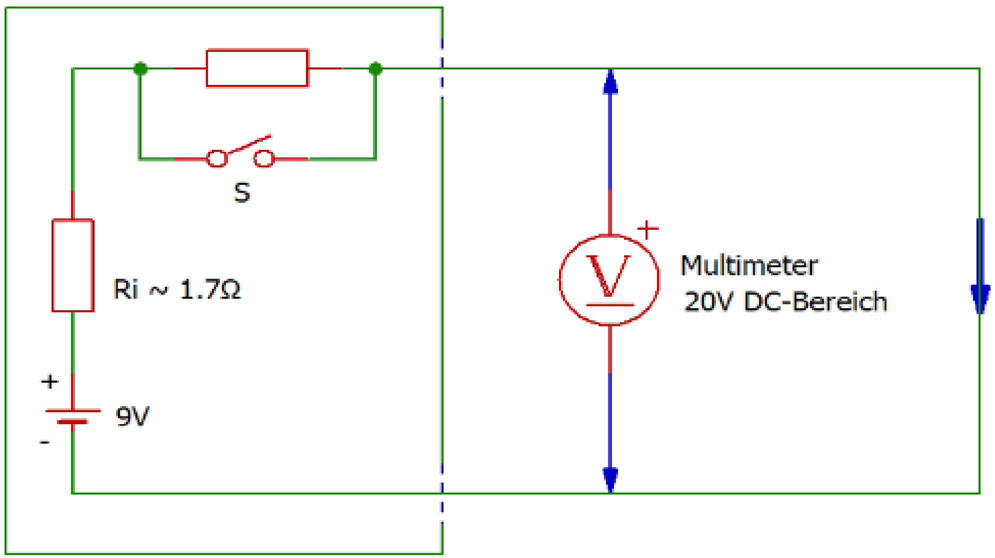
Lab A1.2: The current through the external load resistance is calculated according to formula F3 (please see Intro document) as follows (neglecting the internal resistance of 1.73Ω):

IL=U/RL = IL=9.5V/1000Ω=9.5mA.

The current limitation is not activated because this current is smaller than the threshold-value of the current limitation (about 100mA). The power converted into heat at the resistor is calculated by formulas F6 and F7:
P = U * I = U 2 / R = ((9.5V) 2 / 1000Ω) W = approx. 90mW.
When selecting load resistor RL we therefore provide a resistor with a max. possible sustainable power loss of e.g. 250mW .

AUTHOR: PSITRON UG

PSITRON-Batteriemodul

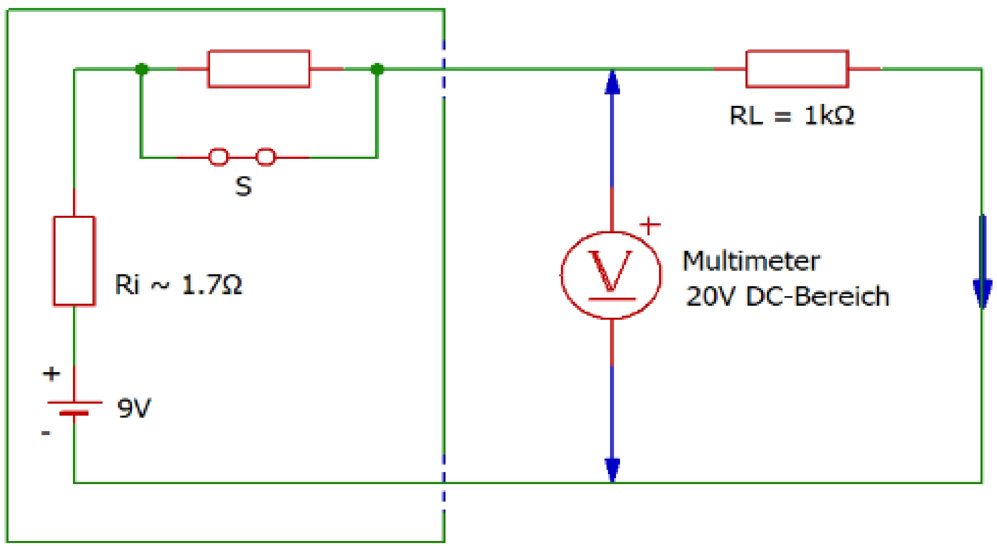


IL ~ 100mA

Strombegrenzung aktiv
-> Schalter S offen

Lab A1.1 PSITRON battery with short circuit

PSITRON-Batteriemodul



IL ~ 9mA

Strombegrenzung nicht aktiv
-> Schalter S geschlossen

Lab A1.2 PSITRON battery with load resistance

AUTHOR: PSITRON UG