

### 3.3 Kirchhoff's Current Law

Kirchhoff's Current Rule, also known as the first Kirchhoff law rule, states that the total current entering a junction in a circuit equals the total current leaving the junction. This law is based on the principle of conservation of charge and is expressed with eq. 1:

$$I_{x_1} + I_{x_2} + \dots = I_{y_1} + I_{y_2} + I_{y_3} + \dots \quad (1)$$

where:

- electrical currents with index  $I_x$  are entering currents and
- currents with index  $I_y$  are leaving junction currents.

We will explain the Kirchhoff's current rule on the same example shown in fig. 1

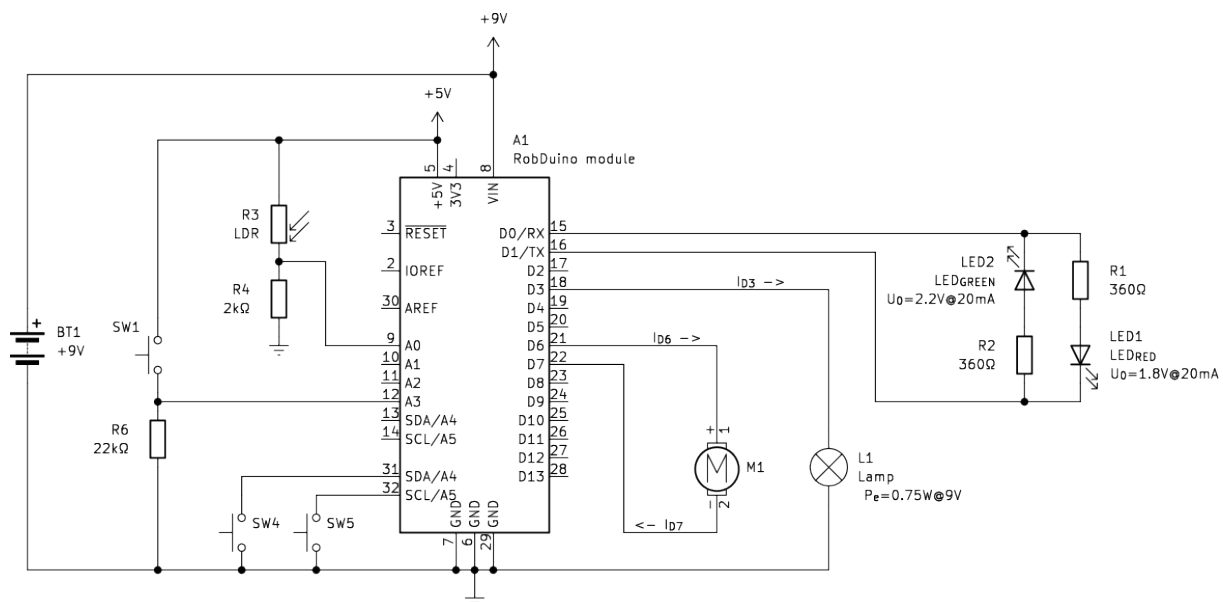


Figure 1: Electrical sheme of robotic device.

#### Practical Example in Robotics:

Imagine a robotic hand with multiple sensors (e.g., touch sensor and light sensor) connected to a single microcontroller. If the sensors draw 0.23 mA (when  $SW_1$  is closed) and 1.0 mA, and they are all connected to the same power supply junction, the total current entering the junction is:

$$I_{tot} = I_{tch} + I_{light} = 0.23mA + 1.0mA = 1.23mA \quad (2)$$

This information is critical for designing the power distribution network of the robot, ensuring that the power supply can handle the total current draw.

### 3.3.1 Questions

1. What is the total current of actuators (motor, light bulb, LEDs) when they are all on?
2. Current into input pin  $A_0$  is approximately  $I_{A_0} = 20nA$ . Compare this current to other two currents at the middle junction in the light sensor. Can it be ignored?