Project Ingenieurswetenschappen: Elektronisch ontwerp van de e-VUBOX speaker Oplossingen

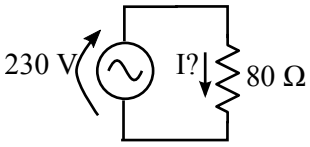
Vrije Universiteit Brussel

Versie 08.2015

Inhoudsopgave

1 Basis Elektronica

1.1 De weerstand



Figuur 1: Voorbeeldnetwerkje.

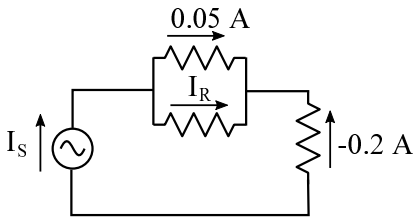
Doe-het-zelf 1

Wet van Ohm: $V = R \cdot I$
Vermogen: $P = V \cdot I$

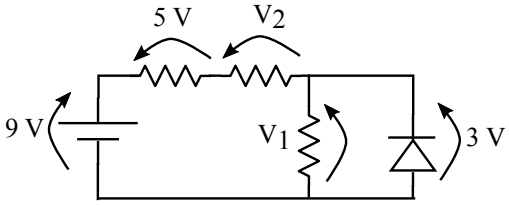
$$
\begin{aligned}
I &= V/R \\
&= 230\ V/80\ \Omega = 2.875A \\
P &= V \cdot I = V^2/R \\
&= (230\ V)^2/80\ \Omega = 661.25\ W
\end{aligned}
$$

$I = 2.875\ A$ $\qquad$ $P = 661.25\ W$

1.2 Netwerken



(a) Vind I_R en I_s.



(b) Vind V_R en U_C.

Figuur 2: De wetten van Kirchhoff

Doe-het-zelf 2

Stroomwetten:

$$
\begin{aligned}
I_S &= 0.05A + I_R \\
I_R &+ 0.05A - 0.2A = 0
\end{aligned}
$$

Oplossing:

$$I_R = 0.2A - 0.05A = 0.15A$$
$$I_S = 0.05A + 0.15A = 0.2A$$

Spannigswetten:

$$V_1 - 3V = 0$$
$$9V - 5V - V_2 - V_1 = 0$$

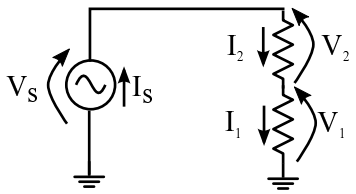
Oplossing:

$$V_1 = 3V$$
$$V_2 = 9V - 5V - 3V = 1V$$

$$I_S = 0.15\ A \qquad V_1 = 3\ V$$
$$I_R = 0.05\ A \qquad V_2 = 1\ V$$

2 Bouwstenen

2.1 Volumeknop



Figuur 3: Volumeregeling: de spanningsdeler

Doe-het-zelf 3

Shortcut met serieweerstand:

$$V_1 = R_1 \cdot I_1 = R_1 \cdot \frac{V_S}{R_1 + R_2}$$

Lange weg:

$$
\begin{aligned}
V_1 &= R_1 \cdot I_1 \\
V_1 &= R_1 \cdot I_2 \\
V_1 &= R_1 \cdot \frac{V_2}{R_2} \\
V_1 &= R_1 \cdot \frac{V_S - V_1}{R_2} \\
(1 + \frac{1}{R_2})V_1 &= R_1 \cdot \frac{V_S}{R_2} \\
V_1 &= \frac{R_1}{R_2} \cdot (\frac{R_2}{R_1 + R_2})V_S \\
V_1 &= \frac{R_1}{R_1 + R_2} \cdot V_S
\end{aligned}
$$

Doe-het-zelf 4

$$\frac{R_1}{R_1 + R_2} = \frac{1.5V}{9V} \tag{1}$$

$$\frac{1k\Omega}{1k\Omega + R_2} = \frac{1}{6} \tag{2}$$

$$\frac{1k\Omega + R_2}{1k\Omega} = 6 \tag{3}$$

$$R_2 = 6 \cdot 1k\Omega - 1k\Omega = 5k\Omega \tag{4}$$

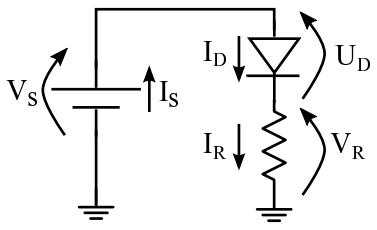
maar deze waarde is geen E12-waarde, we kiezen dus:

$$R_2 = 4.7k\Omega \tag{5}$$

Doe-het-zelf 5

$$
\begin{aligned}
P = V \cdot I &= V^2 / R_{pot} \\
R_{pot} &= (200mW)/4\mu W \\
R_{pot} &= 10k\Omega
\end{aligned}
$$

2.2 Statusledje



Figuur 4: Diode netwerk.

Doe-het-zelf 6

Kirchhoff:

$$V_S - U_D - V_R = 0$$
$$I_S = I_D = I_R$$

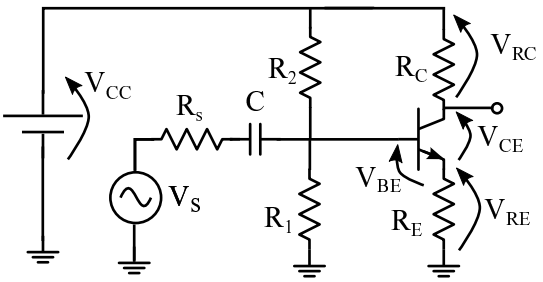
De weerstand die nodig is:

$$\begin{aligned} R_{led} &= \frac{V_R}{I_R} \\ &= \frac{V_S - U_D}{I_D} \\ &= \frac{9V - 1.8V}{10mA} \\ &= \frac{7.2V}{10mA} = 720\Omega \end{aligned}$$

We kiezen een weerstand in de E12 reeks:

$$R_{led} = 680\Omega$$

2.3 Versterker



Figuur 5: Versterkerschakeling met de transistor.

Doe-het-zelf 7

$$I_C + I_B + I_E = 0$$
$$I_C + \frac{I_C}{\beta} + I_E = 0$$
$$(1 + \frac{1}{\beta})I_C + I_E = 0$$

stel dat β 1000 is en rond af:

$$I_C \approx -I_E$$

Doe-het-zelf 8

$$
\begin{aligned}
V_C &= V_{CC} - V_{R_C} \\
V_C &= V_{CC} - R_C \cdot I_C \\
V_C &= V_{CC} + R_C \cdot I_E \\
V_C &= V_{CC} - R_C \cdot \frac{V_E}{R_E} \\
V_C &= V_{CC} - \frac{R_C}{R_E} \cdot V_E \\
V_C &= V_{CC} - \frac{R_C}{R_E} \cdot (V_B - 0.7V)
\end{aligned}
$$

Doe-het-zelf 9

$$R_C = \frac{V_{R_C}}{I_{R_C}} = \frac{V_{CC} - V_C}{I_C} = \frac{9V - 3.5V}{10mA} = 550\Omega \tag{6}$$

$$R_E = \frac{R_C}{5} = 110\Omega \tag{7}$$

Weerstanden in E12 series:

$$R_C = 560\Omega \tag{8}$$

$$R_E = 100\Omega \tag{9}$$

Doe-het-zelf 10

Biasvoltage:

$$V_B = V_E + 0.7V = R_E \cdot (-I_E) = 100\Omega \cdot 10mA + 0.7V = 1.7V$$

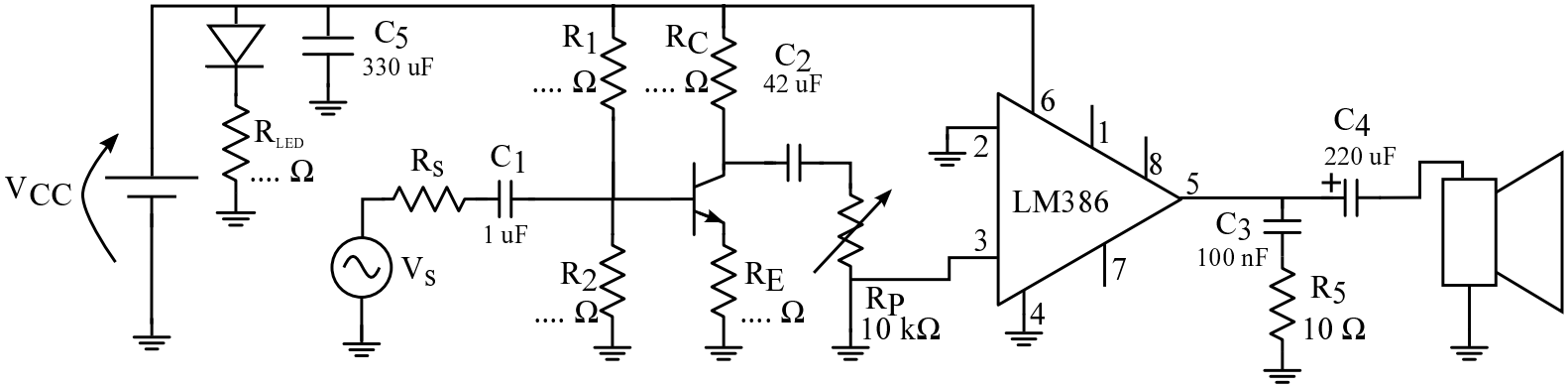
Weerstandsdeler:

$$
\begin{aligned}
V_B &= \frac{R_1}{R_1 + R_2} V_{CC} \\
\frac{V_B}{V_{CC}} &= \frac{R_1}{R_1 + R_2} \\
\frac{V_{CC}}{V_B} &= \frac{R_1 + R_2}{R_1} \\
\frac{V_{CC}}{V_B} \cdot R_1 - R_1 &= R_2 \\
\frac{9V}{1.7V} \cdot 1k\Omega - 1k\Omega &= R_2 \\
R_2 &= 5.29 \cdot 1k\Omega - 1k\Omega \\
R_2 &= 4.29k\Omega
\end{aligned}
$$

weerstand in de E12-serie, een beetje groter genomen om stroom te beperken

$$R_2 = 4.8k\Omega$$

3 Overzicht



Figuur 6: Volledig Schema