PROTOCOL

Current sources

group / class	protocol-leader	signature
3/4 / 4AHELS	Krapfenbauer Michael	
exercise-/ deadline 19.05.2015 02.06.2015	colleague Höllmüller Manuel	signature
teacher Prof. Tillich	colleague Dier Christoph	signature
grade	colleague	signature

Device under test

Current sources

Used devices

device	manufacturer	type	place number

Content

1. Task

2. Task 1: Simple Current Source

2.1 Circuit and calculation

The following current source was build up and calculated.

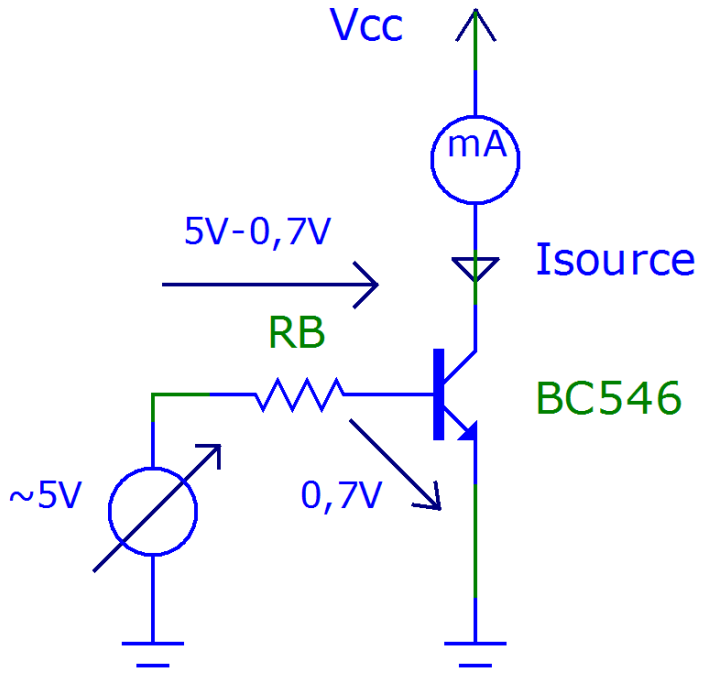


Figure 1: circuit from task 1

At first I_B was calculated, after this R_B was calculated.
I was about 3 mA and B was about 300.

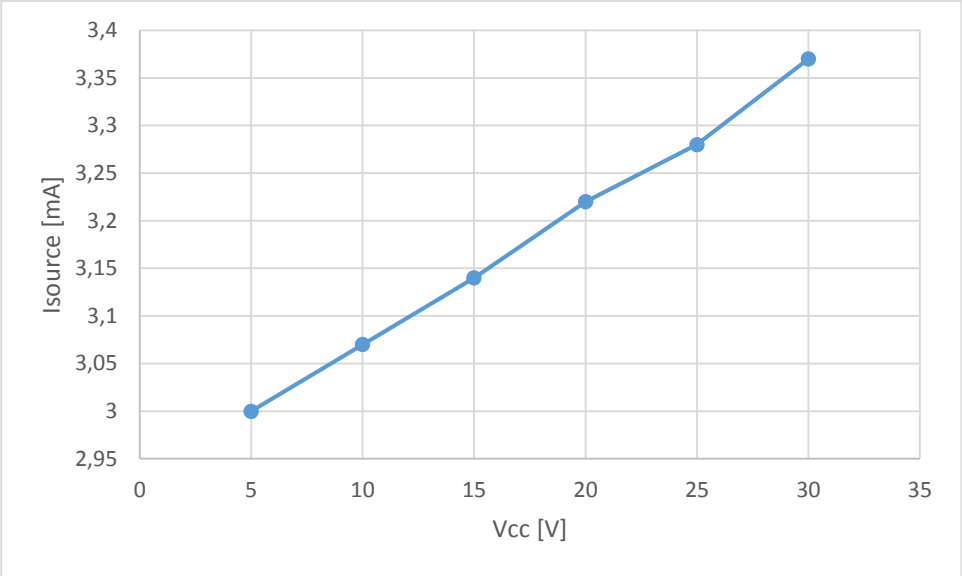
$$I_B = \frac{I}{B} = \frac{3\ mA}{300} = 10\ \mu A$$

$$R_B = \frac{U_B}{I_B} = \frac{5V - 0{,}7V}{10\ \mu A} = 430\ k\Omega => 470\ k\Omega$$

2.2 Measurement

At first the supply voltage was adjusted up to 6,44 V until I source was 3 mA. VCC was increased from 5V up to 30V and I source was measured in 5V steps.

Vcc [V]	Isource [mA]
5	3
10	3,07
15	3,14
20	3,22
25	3,28
30	3,37



After the measurement the VCC and Isource differences were calculated and the resistor ra was calculated.

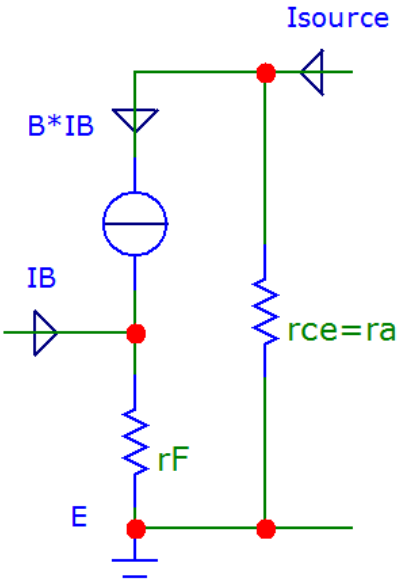


Figure 2: Simple Current Source equivalent circuit diagram

$$r_a = \frac{\Delta V_{CC}}{\Delta I_{source}} = \frac{30\ V - 5\ V}{3{,}37\ mA - 3\ mA} = 67{,}5\ k\Omega$$

3. Task 2: Improved current source

3.1 Circuit and calculation

The following circuit was build up and calculated.

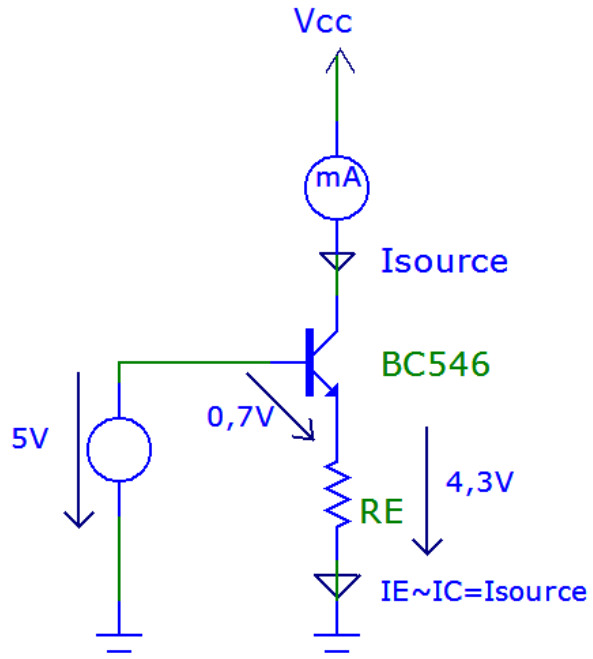


Figure 3: task 2 circuit

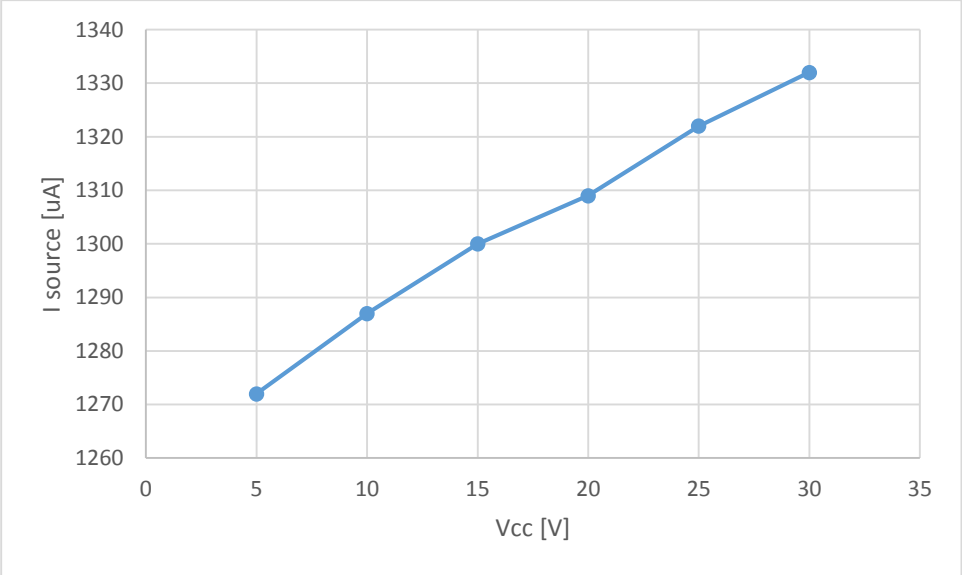
RE had to be calculated.

$$R_E = \frac{U_E}{I_E} = \frac{4{,}3\ V}{3\ mA} = 1{,}4\ k\Omega$$

3.2 Measurements

The supply voltage was set to 5V and VCC was increased from 5V to 30V and Isource was measured every 5V step.

Vcc [V]	Isource [uA]
5	1272
10	1287
15	1300
20	1309
25	1322
30	1332



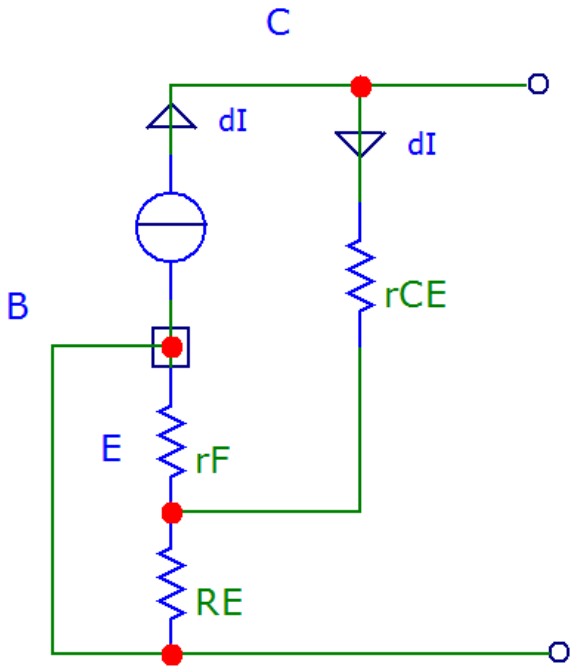


Figure 4: Improved current source equivalent circuit diagram

After the measurement the VCC and Isource differences were calculated and the resistor ra was calculated.

$$r_a = \frac{\Delta V_{CC}}{\Delta I_{source}} = \frac{30\ V - 5\ V}{1332\ uA - 1272\ uA} = 0{,}416\ M\Omega$$

$$r_a \approx r_{CE} * \left(1 + \frac{R_E}{r_F}\right) \qquad r_a \leq \beta * r_{CE} \qquad r_F = \frac{U_T}{I_C} =$$

4. Task 3: Two transistor current source

4.1 Circuit and calculation

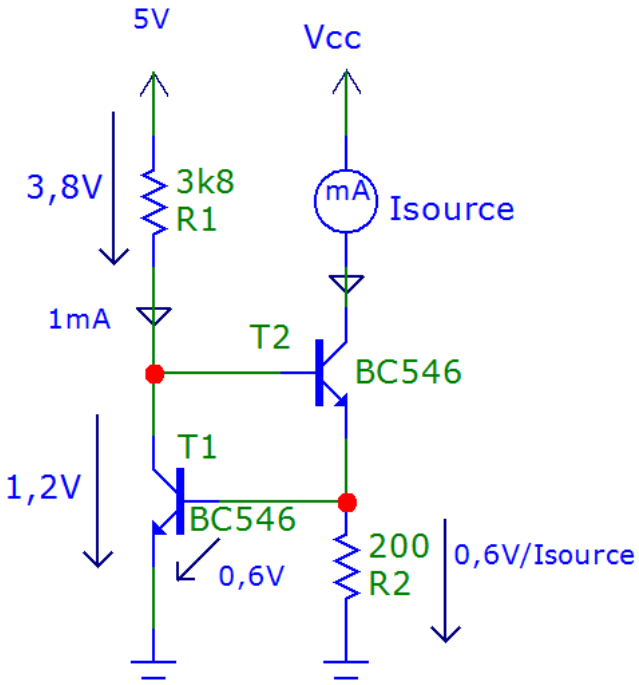


Figure 5: two trans. current source

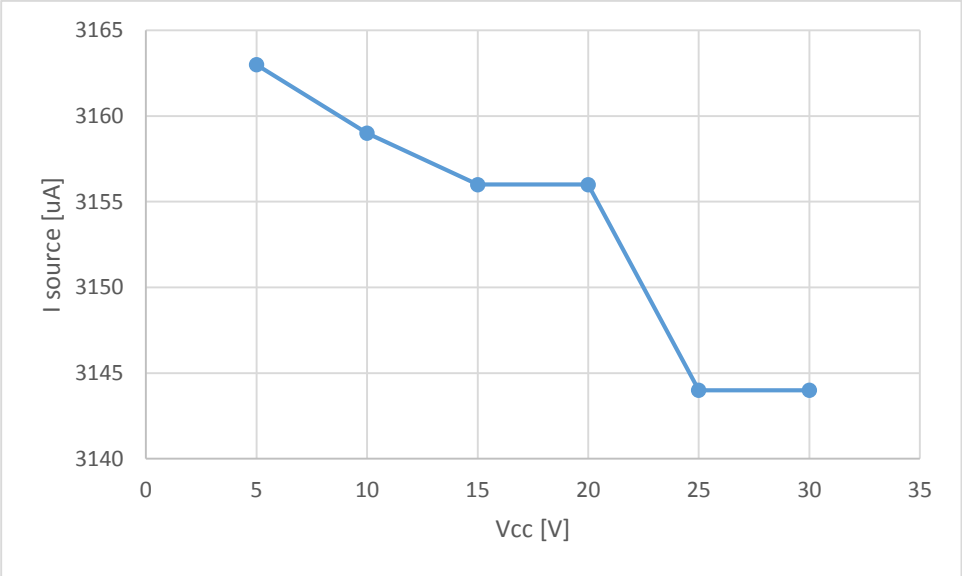
$$R_1 = \frac{3{,}8\ V}{1\ mA} = 3{,}8\ k\Omega$$

$$R_2 = \frac{0{,}6\ V}{3\ mA} = 200\ \Omega$$

4.2 Measurement

The supply voltage was set to 5V and VCC was increased from 5V to 30V and Isource was measured every 5V step.

Vcc [V]	Isource [uA]
5	3163
10	3159
15	3156
20	3156
25	3144
30	3144



Isource decreased because the transistor was thermal not commute in.
Because of this problem the values were negative in the calculation.

$$r_a = \frac{\Delta V_{CC}}{\Delta I_{source}} = \frac{30\ V - 5\ V}{3144\ uA - 3163\ uA} = -1{,}315\ M\Omega$$

5. Task 4: Current mirror

5.1 Circuit and calculation

The following circuit was build up and calculated.

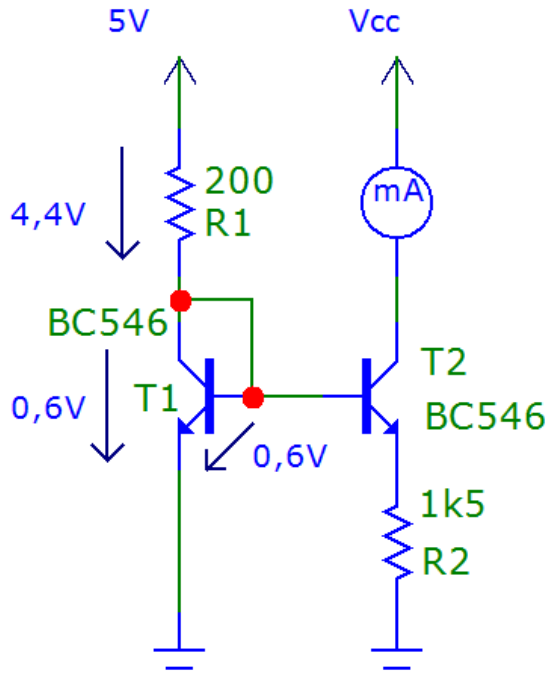


Figure 6: current mirror circuit

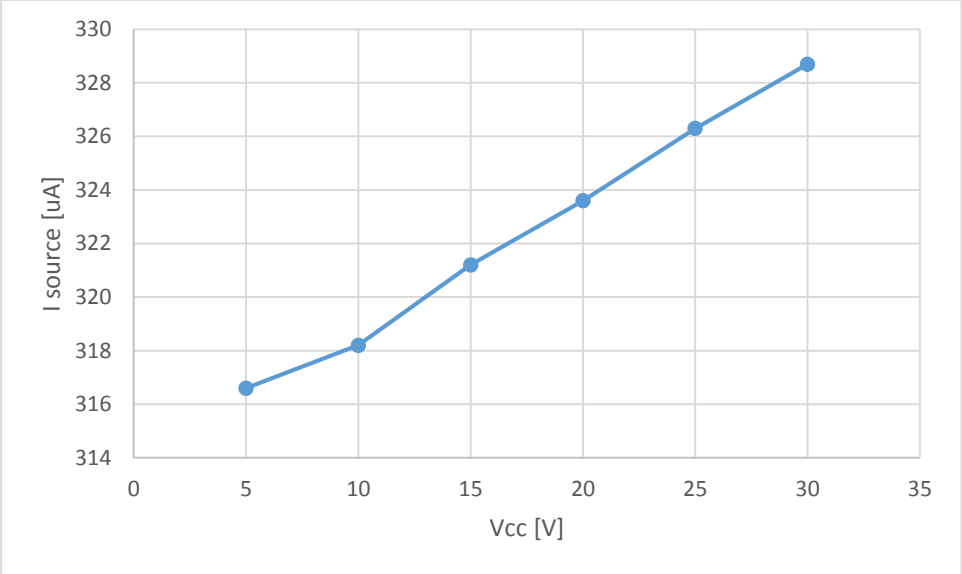
$$R_1 = \frac{60\ mV}{3\frac{mA}{10}} = 200\ \Omega$$

$$R_2 = \frac{4{,}4\ V}{3\ mA} = 1{,}5\ k\Omega$$

5.2 Measurement

The supply voltage was set to 5V and VCC was increased from 5V to 30V and Isource was measured every 5V step.

Vcc [V]	Isource [uA]
5	316,6
10	318,2
15	321,2
20	323,6
25	326,3
30	328,7



$$r_a = \frac{\Delta V_{CC}}{\Delta I_{source}} = \frac{30\ V - 5\ V}{328{,}7\ uA - 316{,}6\ uA} = 2{,}066\ M\Omega$$

6. Task 5: Improved current mirror

6.1 Circuit and calculation

The following circuit was build up and calculated.

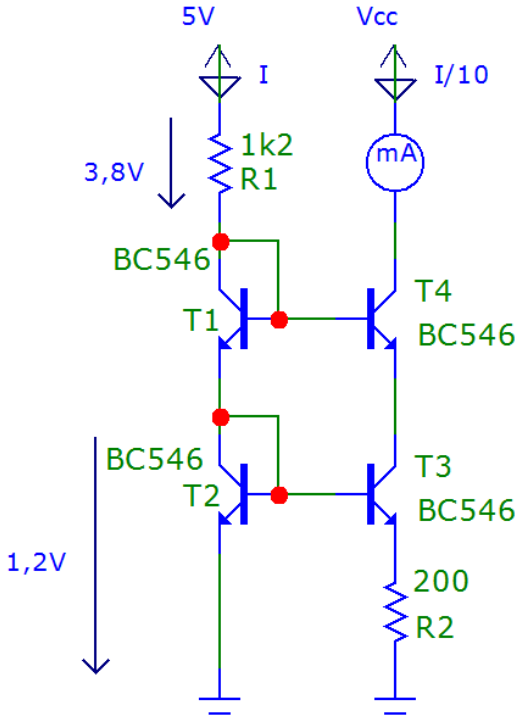


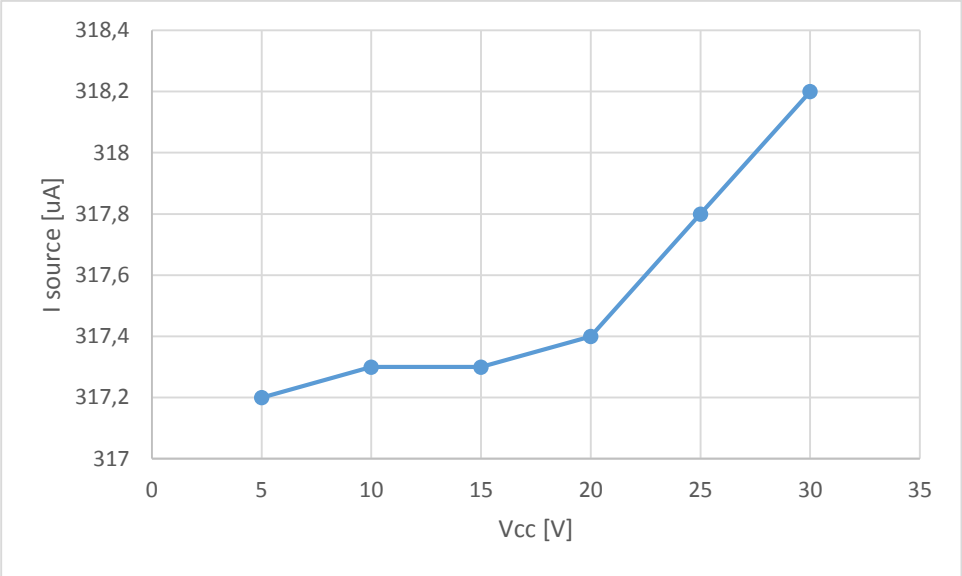
Figure 7: improved current mirror circuit

$$R_1 = \frac{3{,}8\ V}{3\ mA} = 1{,}2\ k\Omega$$

6.2 Measurement

The supply voltage was set to 5V and VCC was increased from 5V to 30V and Isource was measured every 5V step.

Vcc [V]	Isource [uA]
5	317,2
10	317,3
15	317,3
20	317,4
25	317,8
30	318,2



$$r_a = \frac{\Delta V_{CC}}{\Delta I_{source}} = \frac{30\ V - 5\ V}{318{,}2\ uA - 317{,}2\ uA} = 25\ M\Omega$$