Transistor Circuits V

Rapid Design of Common–emitter Voltage-Divider Biased circuit
Basic Circuits

![Basic Circuits Diagram](image-url)
Steps for determining values

I. Pick a collector current within the transistors capability (i.e. 1mA)

II. Choose $R_E$ such that it drops 10% (1/10) of $V_{CC}$ at that current

III. Choose $R_2$ to be 10x bigger than $R_E$

IV. Choose $R_1$ to be 9x bigger than $R_2$

V. Choose $R_C$ to drop $\frac{1}{2}(V_{CC} - V_{RE})$
First example circuit

• Sketch a voltage-divider biased CE amplifier that must work with an 18V dc supply and have an $I_C = 2mA$. Specify available resistors that have a 10% tolerance.

<table>
<thead>
<tr>
<th>10% Standard Values</th>
<th>Decade multiples are available from 10 Ω through 1 MΩ</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

http://www.rfcafe.com/references/electrical/resistor-values.htm
Solution

I. \( I_C = 2 \text{mA} \)

II. \( R_E = \frac{\frac{1}{10}V_{CC}}{I_C} = \frac{\frac{1}{10}(18\text{V})}{2\text{mA}} = \frac{1.8\text{V}}{2\text{mA}} = 900\Omega \) (10\% value = 1k\Omega)

III. \( R_2 = 10R_E = 10(900\Omega) = 9k\Omega \) (10\% value = 10k\Omega)

IV. \( R_1 = 9R_2 = 9(9k\Omega) = 81k\Omega \) (10\% value = 82k\Omega)

V. \( R_C = \frac{\frac{1}{2}(V_{CC} - V_{RE})}{I_C} = \frac{\frac{1}{2}(18 - 1.8)}{2\text{mA}} = \frac{\frac{1}{2}(16.2\text{V})}{2\text{mA}} = \frac{8.1\text{V}}{2\text{mA}} = 4.05k\Omega \) (10\% value = 3.9k\Omega)
Second example circuit

• Sketch a voltage-divider biased CE amplifier that must work with a -15V dc supply and have an $I_C = 1mA$. Specify available resistors that have a 5% tolerance.

<table>
<thead>
<tr>
<th>5% Standard Values</th>
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</thead>
<tbody>
<tr>
<td>Decade multiples are available from 10 Ω through 22 MΩ</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>33</td>
</tr>
</tbody>
</table>

http://www.rfcafe.com/references/electrical/resistor-values.htm
Solution

I. \( I_C = 1 \text{mA} \)

II. \( R_E = \frac{\frac{1}{10}V_{CC}}{I_C} = \frac{\frac{1}{10}(15\text{V})}{1\text{mA}} = \frac{1.5\text{V}}{1\text{mA}} = 1.5\text{k}\Omega \) (5% value = 1.5k\Omega)

III. \( R_2 = 10R_E = 10(1.5\text{k}\Omega) = 15\text{k}\Omega \) (5% value = 15k\Omega)

IV. \( R_1 = 9R_2 = 9(15\text{k}\Omega) = 135\text{k}\Omega \) (5% value = 130k\Omega)

V. \( R_C = \frac{\frac{1}{2}(V_{CC}-V_{RE})}{I_C} = \frac{\frac{1}{2}(15-1.5)}{1\text{mA}} = \frac{\frac{1}{2}(13.5\text{V})}{1\text{mA}} = \frac{6.75\text{V}}{1\text{mA}} = 6.75\text{k}\Omega \) (5% value = 6.8k\Omega)
Circuit with values

VCC 15 V
R1 130kΩ
R2 15kΩ
RC 6.8kΩ
RE 1.5kΩ
Q1
U1 0.731 V
+
-
U2 3.281 V
+
-
Does it work well?

- Values are close enough to allow for verification of operation
  - Once that is done, values can be adjusted for better duplication of desired results
Any questions?

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