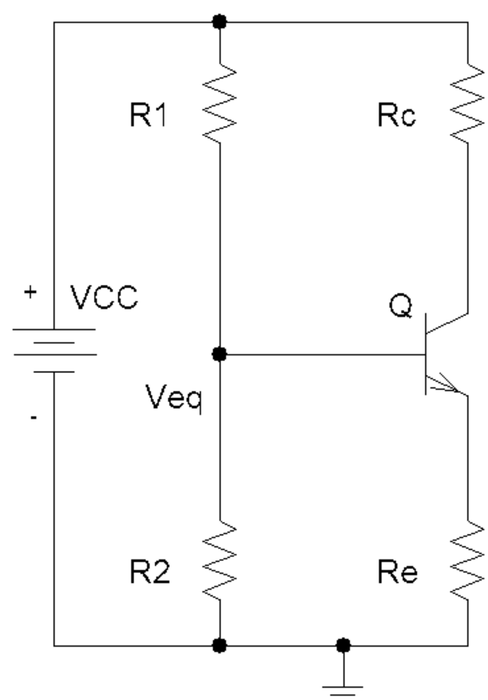
Universal Biasing BJT v 1.0

What is this?
It's a program that, given certain data, calculates the values of the resistors needed for the implementation of a bipolar NPN transistor bias circuit.

Setup?
Just transfer the attached file to your calculator, either by using the Connectivity Kit or the SD card. Execute the program with EVAL. It was tested on an HP50g calculator.

How does it work?
A bias circuit is such that it keeps the transistor on a fixed working point, generally stated by its collector current and collector-emitter voltage. It's shortly called as point Q: (I_{CQ}; V_{CEQ}).



One of the most commonly used circuits is the four-resistor network, also called the universal biasing circuit. Compared to other circuits, this one in particular keeps the state very stable since it hardly depends on the β factor or *hFE* (DC gain) of the transistor, thus making it insensitive to transistor swapping or temperature changes.
As a disadvantage, we could argue that its design is more complex, because we have four unknowns (the resistors) and not as many equations. This indicates that for a given Q state, there are many (infinity) possible combinations of resistors. Of course, practical considerations such the resistor's power dissipation, limit the number of solutions.
Many books introduce a receipt or algorithm for calculating the resistors that takes into account these practical limitations and it gives reasonable results for the majority of the cases.
This program uses this *magical receipt* for the purpose of finding the resistors. I've taken the receipt from the book **Design Of Microelectronics Circuits** by *Jaeger Richard and Blalock Travis* in its second edition.
The algorithm reads as follows:

1. Choose a base voltage V_{EQ} : $\frac{V_{CC}}{4} \leq V_{EQ} \leq \frac{V_{CC}}{2}$
2. Take $I_1 = 9I_B$ so that $R_1 = \frac{V_{EQ}}{9I_B}$
3. Take $I_2 = 10I_B$ so that $R_2 = \frac{V_{CC} - V_{EQ}}{10I_B}$
4. R_E is given by V_{EQ} and the desired collector current: $R_E \cong \frac{V_{EQ} - V_{BE}}{I_C}$
5. R_C is given by the desired collector-emitter voltage: $R_C \cong \frac{V_{CC} - V_{CE}}{I_C} - R_E$

The key of the procedure is to fix the currents flowing thru the base resistors so that a compromise can be reached between low resistor values (which translate into stable base voltage) and high resistor values which minimize power dissipation. It also adopts the equivalent voltage at the base pin. For satisfactory results, that voltage should be within the mentioned interval. The most usual value is one third of the power source voltage V_{CC}.

How to use it?

In fact, this program tries to be very user friendly so I think you should find its use quite straightforward. Simply enter the data it requests, which is:

- The bias collector current and current-emitter voltage. Q (I_{CQ}; V_{CEQ}). In [A] and [V]
- The β of the transistor. If you don't know it or it doesn't matter, just try with the standard value of 100.
- The power source voltage.V_{CC}. In Volts.
- V_{BE}. It's the base-emitter voltage. It's normally taken as a constant value of 0.7V for silicon transistors and 0.3V for germanium transistors. If you know the exact value of V_{BE} of your transistor, just type it here.
- Factor *a*. Equal to V_{CC}/V_{EQ}. It is generally defined as the inverse (V_{EQ}/V_{CC}) but I really found annoying to type fractions don't you agree? The standard value is 3 (that is to say, V_{EQ} is 1/3 of V_{CC}). If you don't get satisfactory values of resistors, you can try changing this factor for a number within 2 and 4.

For certain Q points, the magic receipt fails, and it's not possible to get any solutions at all. In this case, the program will notify you so that you can modify the parameters.

Finally, don't worry about your flags, this program won't mess them up ;)

Credits?

Created by Jorge Pires. Electronics Engineering. UNPSJB. Comodoro Rivadavia, Argentina.
2010. tehvolka@gmail.com
Hope you find it useful.