“Amplifiers” application help.

“Amplifiers” is an electronics calculation and exercise generator application, dealing with transistor amplifiers:

- Biasing of a simple amplifier: Find the resistances to bias the circuit to the wanted DC output and AC voltage gain.
- Biasing of an emitter follower: Find the resistances to bias the circuit to the wanted DC output.
- Analysis of an amplifier circuit: Find the DC output, AC voltage gain and the lowest frequency at which the amplifier must operate (in the case, where there is an emitter bypass capacitor).

For help with amplifiers biasing and circuit analysis, please, have a look at an electronics book or website. Some details, concerning the calculations, are given further down in the text.

Menu “Circuit”.

Menu item “New exercise”.

Start a new amplifier exercise. The type(s) of exercise (types of circuit) will depend on your actual settings: Simple amplifier biasing, emitter follower biasing or circuit analysis. Note, that results have to be entered with 3 digits decimal precision (except, when other settings have been chosen), but that in intermediate calculations the ‘full values’ have to be used. Concerning the values, that have to be entered as biasing resistances (in order that they will correctly be evaluated by the application), please, cf. below.

Menu item “New circuit biasing”.

Do a new amplifier biasing calculation. A second window opens, where you can enter the circuit values. The first decision to make, is to choose, if you want to bias a simple amplifier or an emitter follower. If “Use standard resistor values” is checked, you must enter standard values for the R_C/R_E resistance.

Sample values: V_S = 10V; R_C/R_E = 1kΩ; β = 100; DC voltage = 5V and (for the simple amplifier) AC voltage gain = 10.

Menu item “New circuit analysis”.

Do a new amplifier circuit analysis calculation. Here too, a second window, where you can enter the circuit values, opens. Resistance values must be standard, if this option is checked, except for the transistor internal resistance. If your circuit includes a capacitor, indicate the capacitance value, otherwise let this field blank.

Sample values: V_S = 10V; R_C = 10kΩ; R_E = 1kΩ; β = 100; R_{in} = 2kΩ; R_1 = 160kΩ; R_2 = 22kΩ and C_E= 50 µF (if there is an emitter bypass capacitor).

Menu item “Exit”.

Exit application.

Menu “Settings”.

Menu items “Circuits for exercises > ...”.

Choose the circuit types, that should be used in the exercise: “Simple amplifier”, “Emitter follower” or “Circuit analysis”.

Menu item “Use standard resistor values”.

If this option is checked, the resistances to be entered for calculations, as well as the calculation results, are standard resistor values. In this case, you’ll also have to enter standard resistances, when doing the exercises (cf. below for details).

Menu item “Results with 2 decimal digits”.

If this option is checked, calculation results are displayed and the exercise results, you enter, are checked with a precision of 2 decimal digits; if unchecked, 3 decimal digits will be used (rounded values, of course).

Menu item “Base current in µA”.

Check this option to avoid the small values, as they occur with the base current. If the option is unchecked, base current is expressed in mA (as is the case for the other current values).

Menu item “Base current as integer”.

With “Base current in µA” checked, this option allows to display the base current as an integer value (instead of with 2 resp. 3 decimal digits).

Menu item “Frequency as integer”.

Similar as the base current, the lowest frequency value may be displayed as an integer value; check this option for doing so.

Menu “Help”.

Menu item “Standard resistor values”.

Opens a PDF document, showing the standard resistor values.

Menu item “Application help”.

Opens a PDF document, showing usage help for the “Amplifiers” application (this text).

Menu item “About”.

Displays version, author and date-written of the “Amplifiers” application.

Some calculation details.

Most calculations, necessary to solve the exercises, are a simple application of Ohm’s Law. Transistors are supposed to be silicon based, thus the difference between base and emitter voltage is 0.7V. A convenient rule of thumb to provide stability to the DC bias point, is setting $I_2 = 10 \cdot I_B$. A rule of thumb in the calculation of the lowest frequency, at which the amplifier must operate, is setting $X_C = R_E/10$.

Standard resistor values.

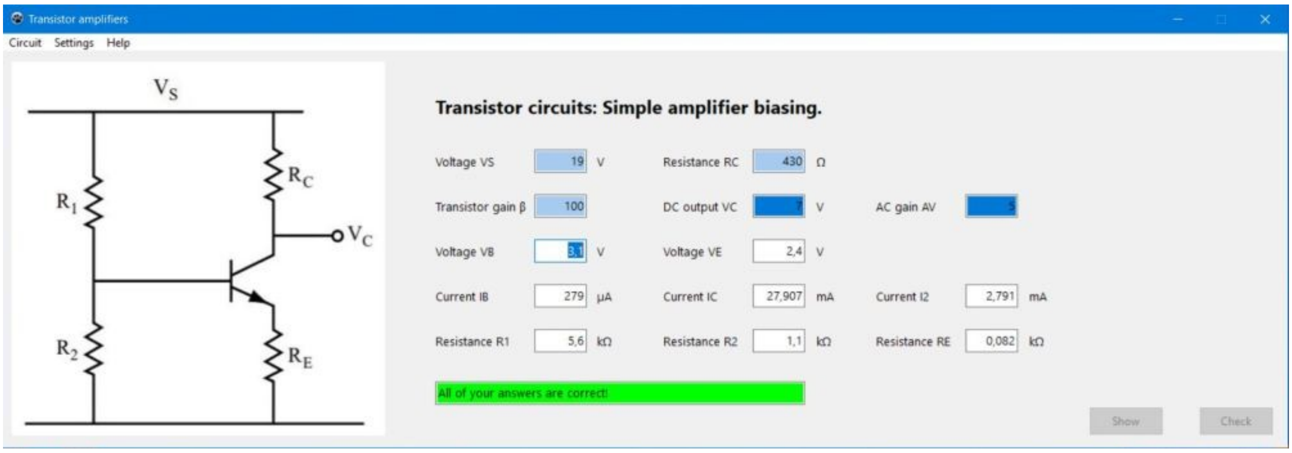
In calculations, the resistances to be entered by the user and those, displayed as calculation results, have to be/are standard values, only if this option is actually checked. In exercises, the resistance values given are always standard; those to be entered by the user as exercise result, must be standard, if this option is checked, and must be the calculated values, if not.

For R_E, the standard value to be entered is the standard value, that’s closest to the calculated value. For the biasing resistances R_1 and R_2, it’s more complicated. In fact, it has to be checked, if the base current, obtained with the standard resistors, used instead of those with the calculated values, are reasonably close to the V_B calculated from V_E. The V_B for the standard resistances is calculated, using the voltage divider formula: $V_B = V_S \cdot [R_2/(R_1+R_2)]$. The standard resistances chosen are considered to be acceptable, if the difference between the V_B calculated and this value is less than 10%.

In the calculations, the application determines the “optimal combination” of possible standard resistances and in the exercises, it awaits from the user to do so, too. Thus, to get your R_1 and R_2 evaluated as correct:

- Calculate R_1 and R_2 using Ohm’s Law.
- If “Use standard resistor values” is unchecked, use the calculated values, otherwise proceed as follows.
- If the resistance calculated is a standard resistor value, just keep this value.
- If it isn’t, determine the two closest standard resistor values.
- For all possible standard R_1 and R_2 combinations (there are 4 possibilities, if both resistances calculated aren’t standard), calculate V_B.
- As answer to the exercise, use the resistance pair, for which the difference between their V_B and the V_B calculated from V_E is the smallest one (in the exercises, there is always at least one R_1 and R_2 combination with a base voltage difference of less than 10%).

Example:



In the exercise, shown on the screenshot, calculated R_1 and R_2 values are 5.12 and 1.11 respectively. This gives standard resistor values of 1.1 and 1.2 for R_1 and 5.1 and 5.6 for R_2. Calculating V_B for all possible standard resistance combinations, gives a base current of 3.119 for R_1 = 5.6 and R_2 = 1.1 (the other V_B values being 3.371, 3.619 and 3.353). With the base current, calculated from V_E being 3.1, this is the value with the smallest difference and it's these two resistances, that the application awaits as answers to the exercise.