Analog Electronics II
Laboratory
Exercise 1
BJT Amplifier

Aim of the exercise

The aim of this laboratory exercise is to become familiar with the operation of the simple amplifiers with single bipolar junction transistor. Students learn about the transistor polarization, frequency characteristics and nonlinear distortions.

Equipment

- Oscilloscope;
- Measurement set: function generator, digital multimeter, frequency meter, power supply;
- Soldering toolbox;
- Measurement toolbox;
- Soldering station;
- Prototype board.

Before the exercise please check the contents of the toolbox with the checklist on the box. If anything is missing report it to your teacher.

Warning! Soldering iron is heated to the temperature above 300ºC. Please use it carefully in order to prevent getting burn.

Control questions

1. How do the voltage and current amplifications change while increasing the amplifier's load?
2. How do the changes of the point of work of the transistor influence the input characteristics?
3. How do you choose the appropriate point of work of the bipolar junction transistor?
4. What is the linear stabilization of the point of work in discrete circuit?
5. What is the nonlinear compensation of BJT in the integrated circuits?

Amplifier circuit

Common-emitter amplifier circuit with single bipolar junction transistor is presented in fig. 2. Resistors R_{d1} and R_{d2} work as an input voltage divider and they are not a part of the amplifier. Resistors R_C, R_1 and R_2 are used for the polarization of the transistor and for setting the point of work.

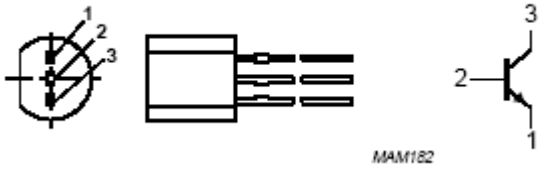

Fig. 1 Transistor pinning

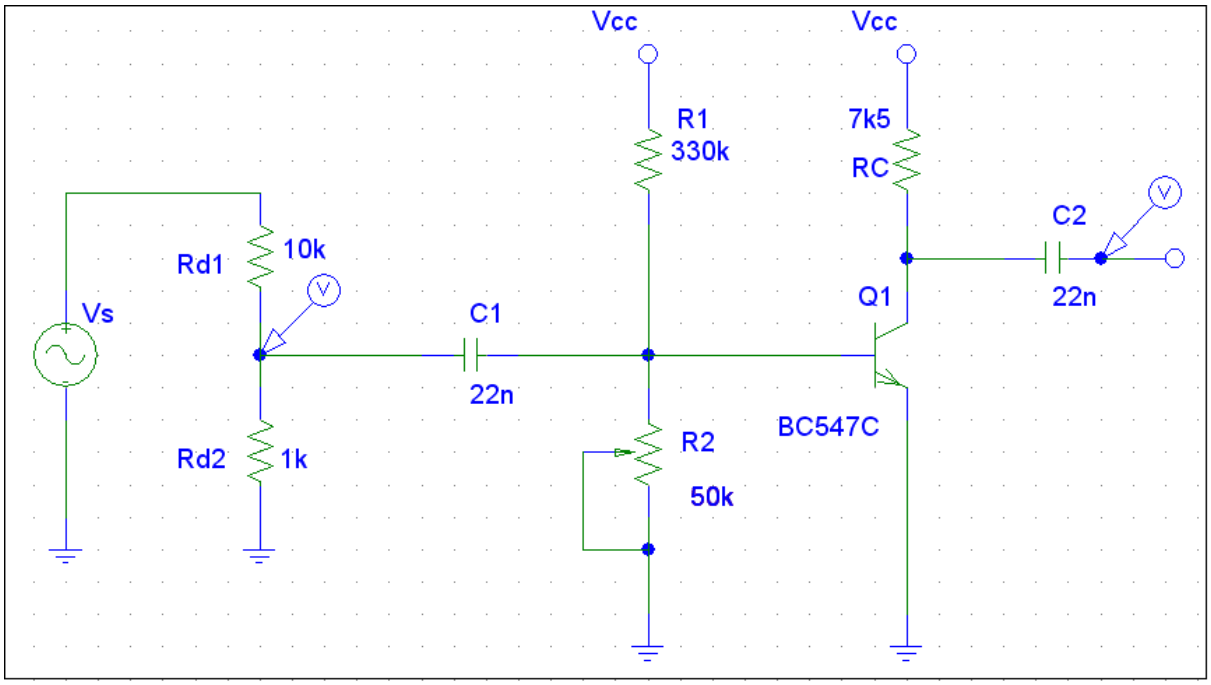

Fig. 2 Common-emitter amplifier with bipolar junction transistor

Tasks

1. Common-emitter amplifier with no feedback

1. Solder the circuit illustrated in fig. 2.
2. Supply the circuit with V_{CC} = 15V.
3. Set the point of work of the transistor using R2 potentiometer so that $V_{CE} = ½V_{CC}$
4. Connect the generator. Set the frequency of the generator to f =1kHz and the input voltage amplitude to V_{IN} = 10mV.
5. Connect the oscilloscope probes to the test points indicated by voltage markers.
6. Set the oscilloscope window to observe the input and output voltage V_{IN} and V_{OUT}. Set the cursors to calculate the amplification A_v of the circuit from fig. 2.
7. Find the maximum amplitude of the input signal V_{IN}, for which the output signal is not distorted.
8. Set the amplitude of the input voltage to V_{IN} = 10mV.
9. Observe the output signal V_{OUT} while changing the resistance of *R2* potentiometer.
10. Disconnect the generator. Set the point of work of the transistor using *R2* potentiometer so that $V_{CE} = ½V_{CC}$
11. Find the frequency characteristics of the amplifier (amplification vs. frequency). Remember to keep the constant input voltage.

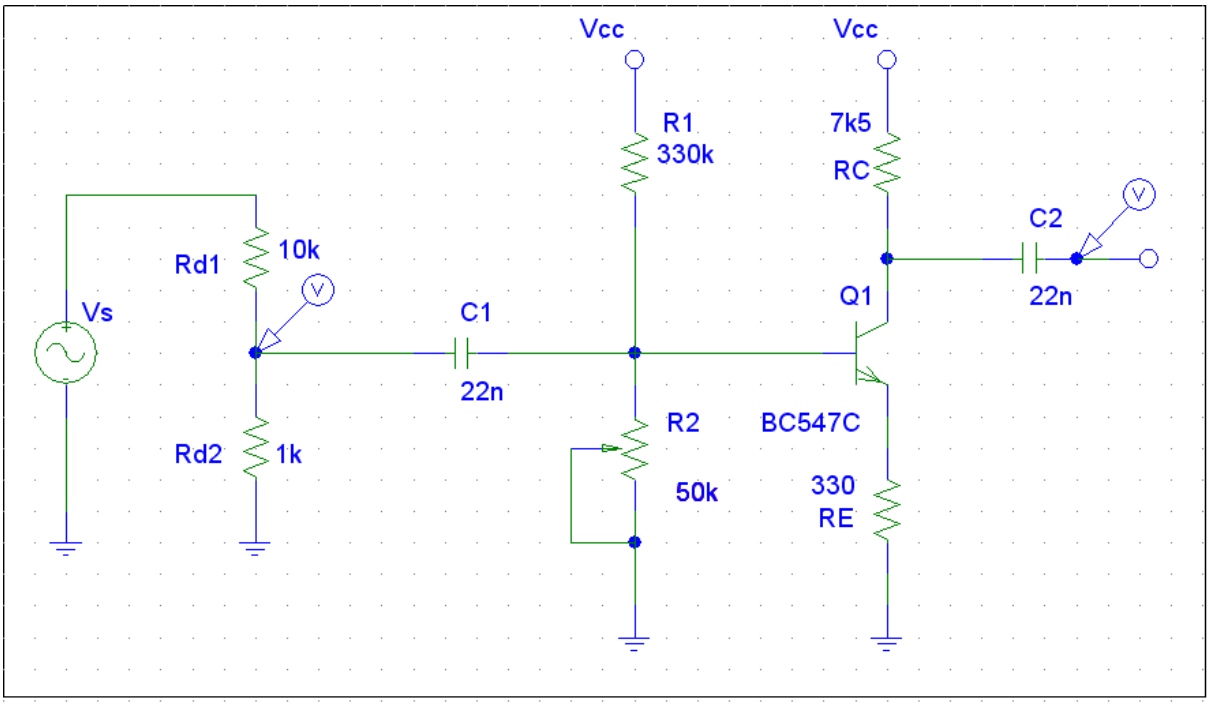

Fig. 3 BJT common-emitter amplifier with positive feedback.

2. Common-emitter amplifier with positive feedback

1. Solder circuit illustrated in fig. 3.
2. Supply the circuit with V_{CC} = 15V.
3. Set the point of work of the transistor using *R2* potentiometer so that $V_{CE} = ½V_{CC}$
4. Connect the generator. Set the frequency of the generator to f =1kHz and the input voltage amplitude to V_{IN} = 10mV.
5. Connect the oscilloscope probes to the test points indicated by voltage markers.
6. Set the oscilloscope window to observe the input and output voltage V_{IN} and V_{OUT}. Set the cursors to calculate the amplification A_v of the circuit from fig. 3.
7. Find the maximum amplitude of the input signal V_{IN}, for which the output signal is not distorted.
8. Set the amplitude of the input voltage to V_{IN} = 10mV.
9. Observe the output signal V_{OUT} while changing the resistance on *R2* potentiometer.
10. Disconnect the generator. Set the point of work of the transistor using *R2* potentiometer so that $V_{CE} = ½V_{CC}$
11. Find the frequency characteristics of the amplifier (amplification vs. frequency). Remember to keep the constant input voltage.

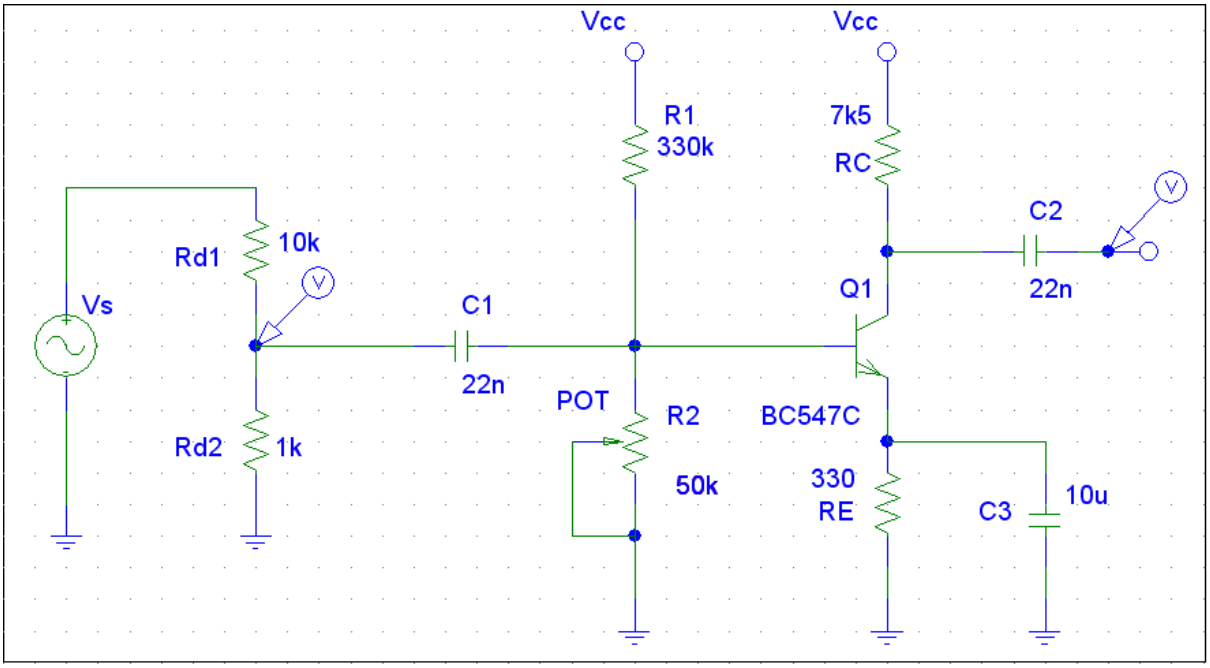

Fig. 4 BJT common-emitter amplifier with positive feedback for DC.

3. Common-emitter amplifier with positive feedback for DC

1. Solder circuit illustrated in fig. 4.
2. Supply the circuit with V_{CC} = 15V.
3. Set the point of work of the transistor using *R2* potentiometer so that $V_{CE} = ½V_{CC}$
4. Connect the generator. Set the frequency of the generator to f =1kHz and the input voltage amplitude to V_{IN} = 10mV.
5. Connect the oscilloscope probes to the test points indicated by voltage markers.
6. Set the oscilloscope window to observe the input and output voltage V_{IN} and V_{OUT}. Set the cursors to calculate the amplification A_v of the circuit from fig. 4.
7. Find the maximum amplitude of the input signal V_{IN} for which the output signal is not distorted.
8. Set the amplitude of the input voltage to V_{IN} = 10mV.
9. Observe the output signal V_{OUT} while changing the resistance with *R2* potentiometer.
10. Disconnect the generator. Set the point of work of the transistor using *R2* potentiometer so that $V_{CE} = ½V_{CC}$
11. Find the frequency characteristics of the amplifier (amplification vs. frequency). Remember to keep the constant input voltage.

Additional information

Parameters, documentation and SPICE models of BC547 transistor:
http://www.semiconductors.philips.com/pip/BC547.html

Report preparation

The report must be delivered in electronic form to your teacher. Each page in header should have named and id numbers of persons carried out the exercise. Oscilloscope plots should be drawn by hand on earlier prepared grid. Each report should include:

- schematics of the examined circuits (e.g. prepared in SPICE);
- measurements results;
- oscilloscope plots and marks of reference to appropriate plot in the report text;
- simulation results;
- comparison of the obtained measurement results and oscilloscope plots with SPICE simulation results;
- comments and conclusions;
- answers to control questions.