Lab 138 - Transistors and Amplifiers

27 November 2014

Contents

Abstract

lab report for lab 138 - transistors and amplifiers - This lab is meant to teach and show the practical use of NPN bjt amplifiers. The lab includes constructing and measuring DC circuits, calculating biasing networks, amplification, bandwidth; and plotting characteristic curves of circuit parameters.

1 Ic-Uce-characteristics

1.1 Circuit

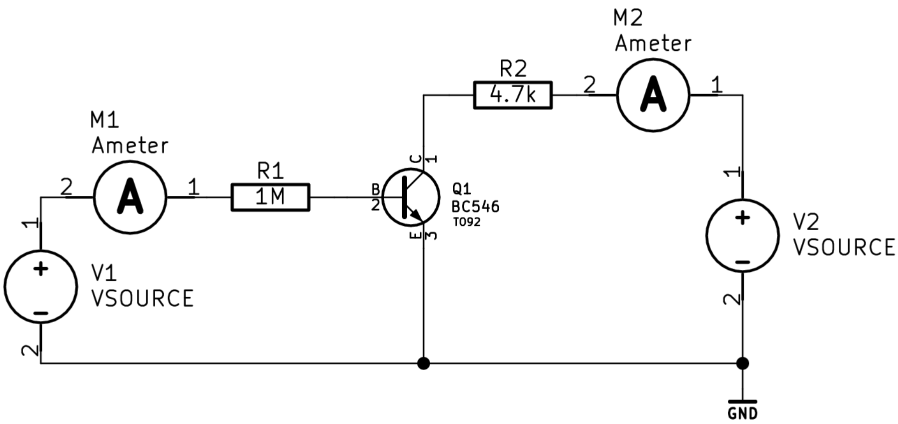

Figure 1: Measurement setup

1.1.1 Fixed collector voltage

With the collector resistor R2 left out or shorted, an adjustable power supply is connected directly across the collector-emitter junction, fixing the collector voltage. First we get the base currents for known collector currents. Adjusting voltage V1 translates to varying the base current Ib and in turn the collector current Ic. The transistor used is a BC547C.

1.1.2 Measurements

Ic (mA)	Ib (µA)
0.5	1.14

Ic (mA)	Ib (µA)
1.0	2.11
1.8	3.72

Table 1: Measurement of base current vs collector current

The base current is then held at a constant value and the collector-emitter voltage is swept over a range of 0-10V in 1V steps. The results is given in the plot.

1.1.3 Simulation

Spice circuit simulation confirms that measurements reflect typical bjt characteristics. The program used is Linear Technology ltspice, models extracted from transistor datasheet parameters.

2 Quiescent conditions

2.1 Circuit

E = 10V Rc = 4.7kΩ

2.1.1 Curve

TODO

3 Uce/Ib transfer function

Examine the output signal of the first circuit. Determine the linearity of the output, as in the relation of Uce to Ib. Uses the measurement setup and circuit shown in Figure 1.

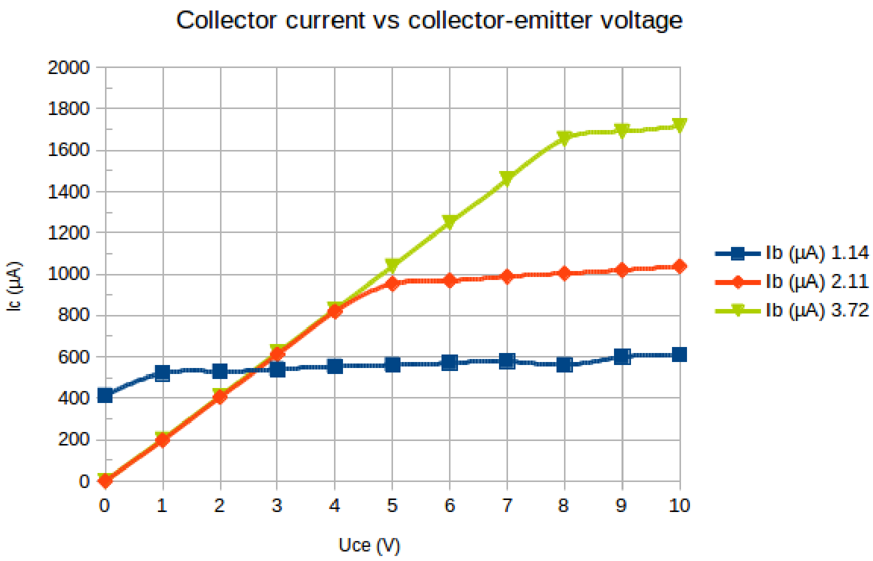

Figure 2: Ic-Uce results

4 Ic/Ib characteristics and current amplification

4.1 Measurements

4.2 Comments

TODO: Comment the curve, calculate current amplificationfactor deltaIc/deltaIb in regions of interest.

5 BJT biasing

Rb	Ve	Ve	Rc
390kΩ	00	00	00
470kΩ	00	00	00
560kΩ	00	00	00
680kΩ	00	00	00
820kΩ	00	00	00

Rb	Ve	Ve	Rc
1MΩ	00	00	00

Table 2: Bias resistor with bias voltages

6 BJT amplifier

6.0.1 Amplification

	Without AC bypass	AC bypassed
Input voltage (mVtt)	111	111
Output voltage (Vtt)	111	111
Voltage gain (multiple)	111	111
Voltage gain (dB)	111	111
Phase shift (degrees)	111	111

Table 3: Amplifier gain measurements

6.0.2 Frequency response

6.0.3 Improved biasing

The one resistor base bias is in practice not very reliable as it is dependant on transistor beta. A more practical design that scales better for production adds a second resistor, forming a voltage divider that fixes the base at a suitable level. For maximum dynamic range half of Vsupply, plus a diode drop to compensate for the base-emitter voltage.

6.0.4 “Noiseless” biasing

For small signals and high input impedance, the biasing can be improved further in terms of bias voltage “stiffness” and power supply noise rejection. The bias voltage is derived from a separate low impedance voltage divider, heavily filtered and almost a short circuit as far as AC signals are concerned. The bias voltage is tapped with a higher value resistor which effectively sets the input impedance of the stage.

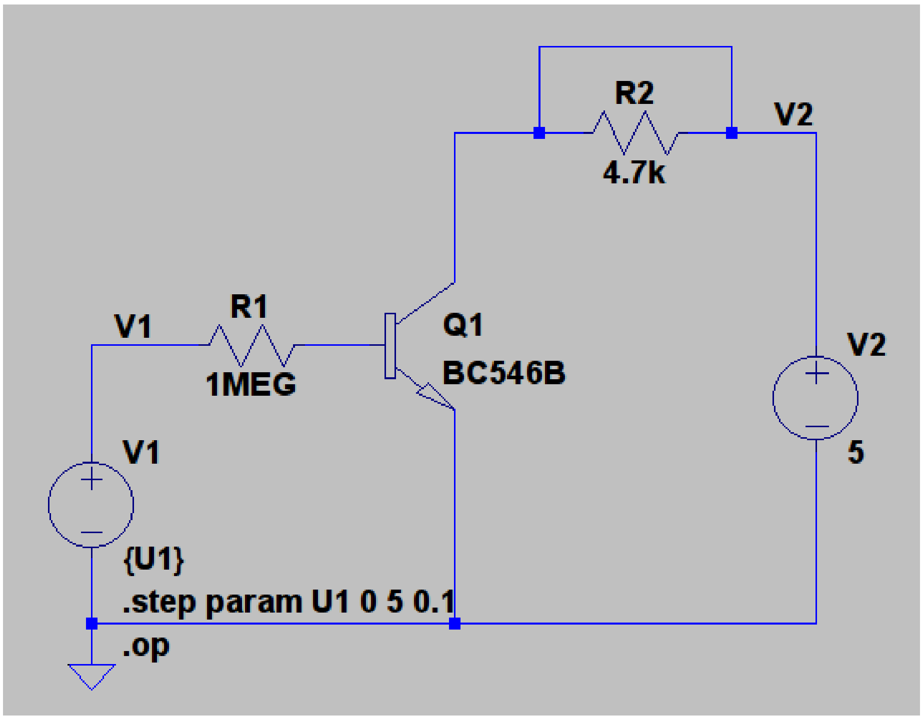

Figure 3: Ltspice schematic

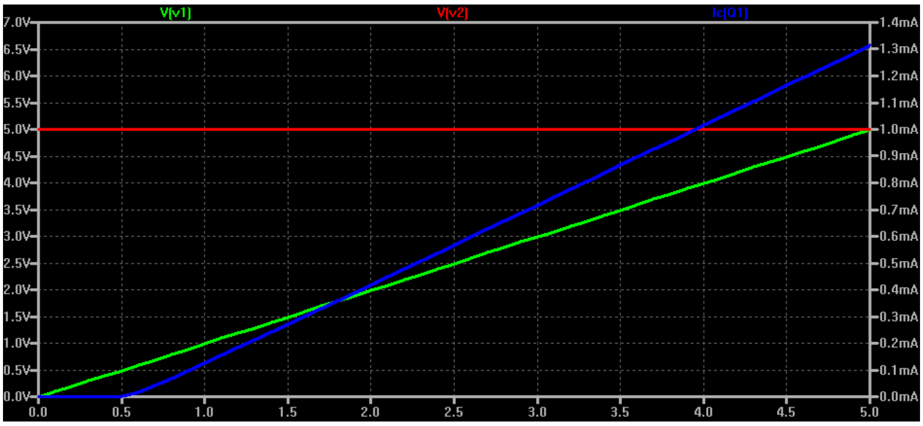

Figure 4: Ltspice simulation of Ic-Uce-characteristics

Figure 5: TODO

Figure 6: TODO

Figure 7: Ic as a function of Ib

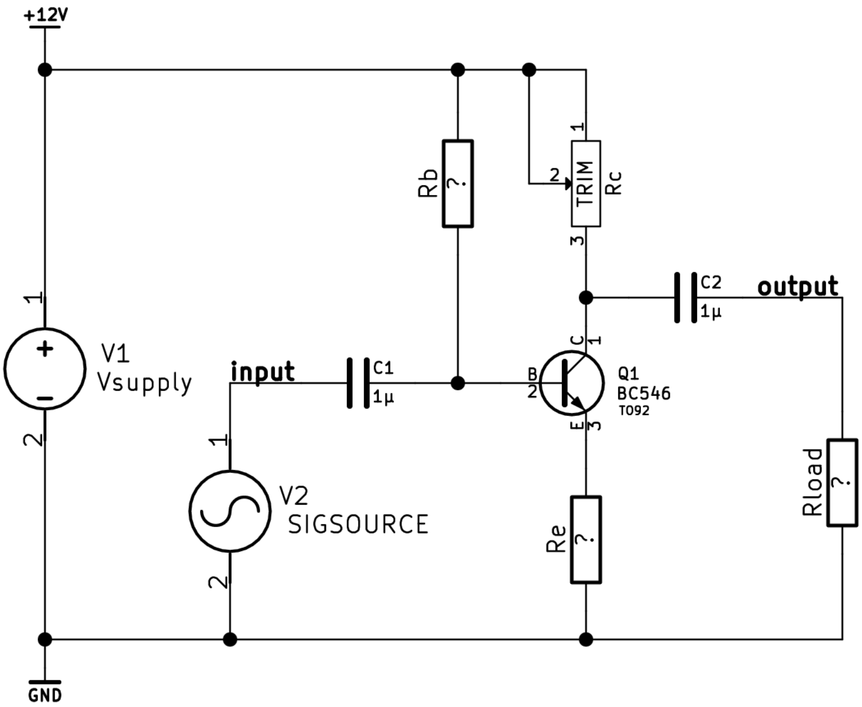

Figure 8: BJT biasing circuit

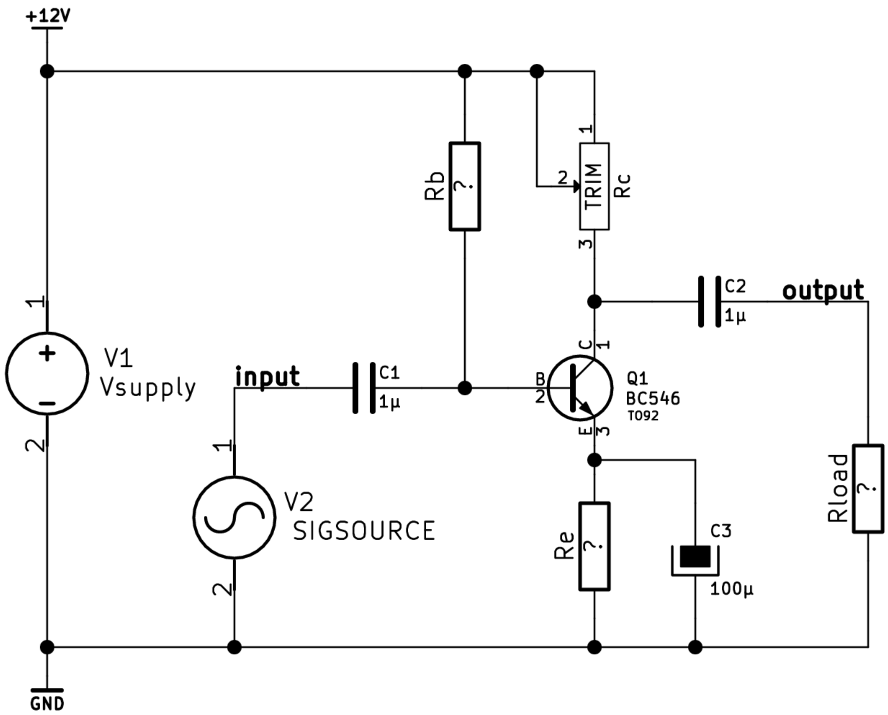

Figure 9: AC bypassed BJT amplifier

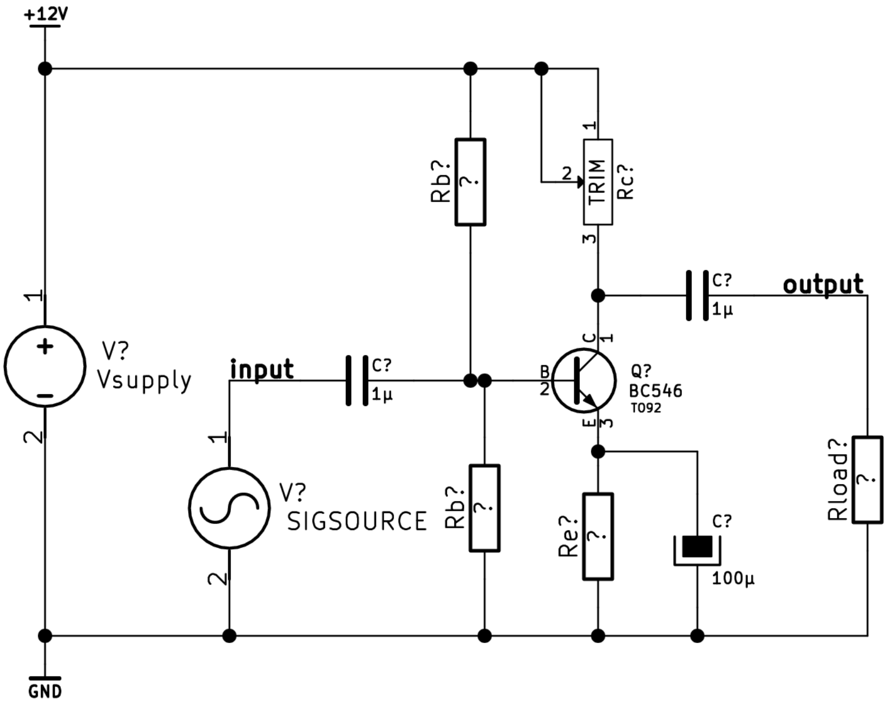

Figure 10: Voltage divider bias

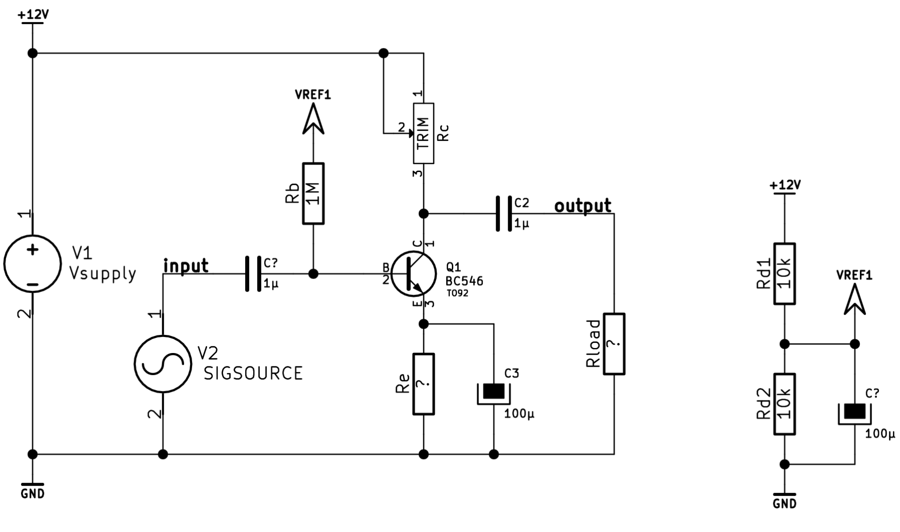

Figure 11: Voltage divider with filtered voltage reference