PHYWE	**How can a transistor amplifier stage be made insensitive to fluctuations in operating voltage?**	**EEP 13.7**	**S**

Problem

Investigate how a transistor amplifier stage reacts when an emitter resistor is added to the circuit.

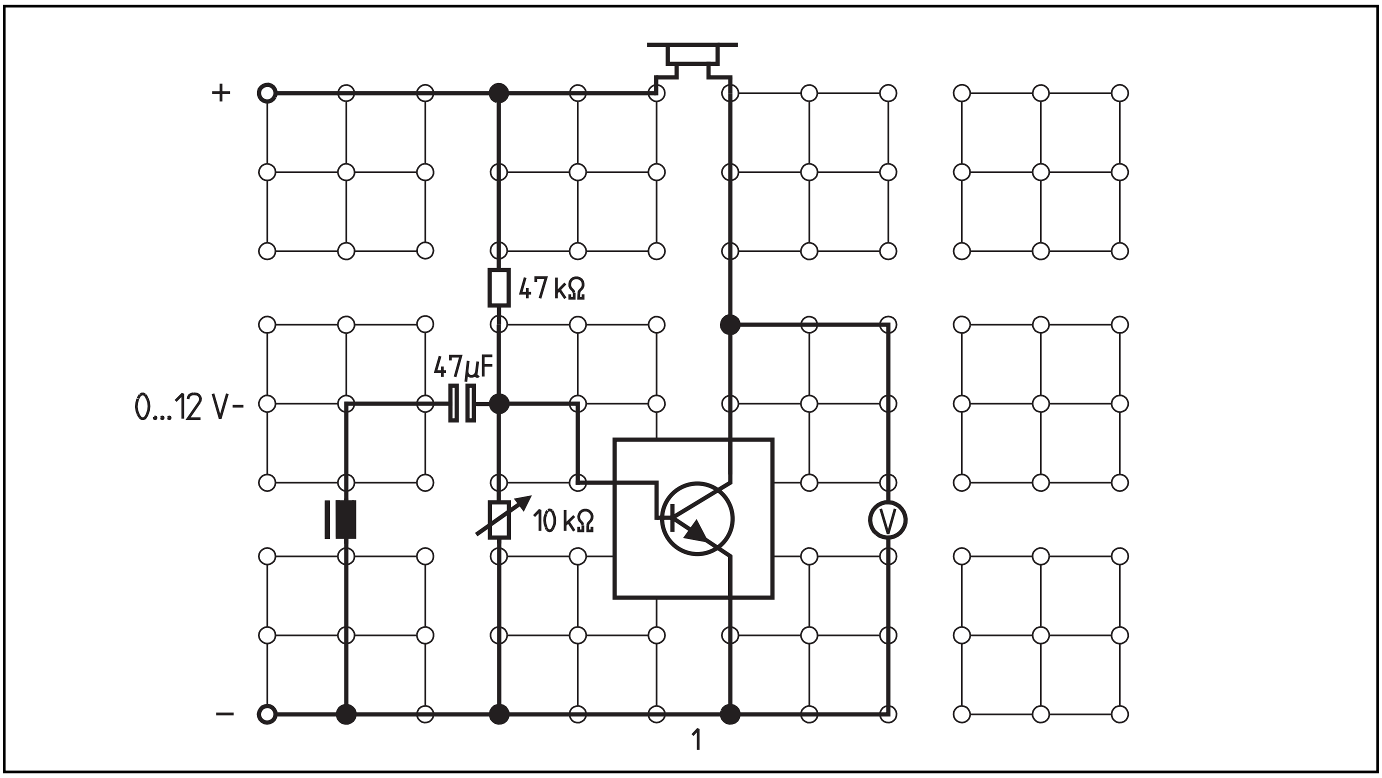
Equipment

Plug-in board	06033.00	1
Resistor, 47 Ω	39104.62	1
Resistor, 47 kΩ	39104.38	1
Adjustable resistor 10 kΩ	39108.03	1
Electrolytic capacitor, 470 µF, bipolar	39105.47	1
Electrolytic capacitor, 47 µF, bipolar	39105.45	1
Transistor BC337	39127.20	1
Headphones, 2 kΩ, 4-mm plug	06811.00	1
Coil, 1600 turns	07830.01	1
Yoke	07833.00	1
Wire building block	39120.00	4
Connecting cables, 25 cm, red	07360.01	1
Connecting cables, 25 cm, blue	07360.04	1
Connecting cables, 50 cm, red	07361.01	2
Connecting cables, 50 cm, blue	07361.04	2
Multi-range meter	07028.01	1
Power supply, 0...12 V-, 6 V~, 12 V~	13505.93	1

Set-Up and Procedure

— Set up experiment as shown in Fig. 1. Place the wire building block 1 in the emitter line initially.
— Switch on power supply unit and set direct voltage to 8 V.
— Set the operating point of the transistor to a collector voltage of 4 V using the 10 kΩ adjustable resistor.
— Move coil with iron core close to the power supply unit until you hear a humming noise in the headphones. Keep the coil in this position. Note volume of noise in the headphones.
— Using the adjustment dial on the power supply unit, set the operating voltage higher and lower. Note the maximum and minimum value of the operating voltage at which the humming noise disappears. Enter values in Table 1.
— Replace wire building block 1 with the emitter resistor R_E = 47 Ω.
— Set operating voltage to 8 V and collector voltage to 4 V again. Note volume. Increase and decrease operating voltage as before until the noise disappears and note voltage values in Table 1.
— Connect the capacitor with a capacity of 470 µF in parallel to the emitter resistor. Set operating voltage to 8 V and collector voltage to 4 V and note volume.
— Compare the volume of the humming observed for each of the three situations. Note results in Table 1.
— Determine the range of operating voltage where there is a humming noise. Note results.

Fig. 1



Observations and Measurement Results

Table 1

Circuit	The humming noise disappears at		Volume
without R_E	U_{min} =	U_{max} =	
with R_E	U_{min} =	U_{max} =	
with R_E and C	U_{min} =	U_{max} =	

Evaluation

1. What affect does an emitter resistor have on the behavior of an amplifier stage?

2. What characteristics of the amplifier are different when a capacitor is connected in parallel to the emitter resistor?

(How can a transistor amplifier stage be made insensitive to fluctuations in operating voltage?)

Negative feedback is used to increase the stability of a transistor amplifier stage against fluctuations in temperature, operating voltage, and scattering of characteristic amplification quantities. This is achieved by feeding back a portion of the output voltage to the input of the amplifier with reverse phase position. For the negative current feedback used in this experiment, the amplified current in the emitter resistor produces the reverse-phase voltage (proportional to the current) used for the negative feedback.
In a negative voltage feedback, however, a portion of the amplified voltage from the collector is fed back to the base of the transistor.
Aside from the desired effects (increase stability of the amplifier, linearization of its characteristic curve, and modification of its characteristic quantities), negative feedback is always accompanied by a decrease in amplification. The greater the ratio of feedback voltage to output voltage, the greater the decrease in amplification.
The stabilizing effect of negative current feedback can be understood assuming there is a constant control voltage of, for example, 1 V at the output of the amplifier. This is divided between the base emitter line and the emitter resistor. Now, if the emitter current increases due to an increase in temperature or operating voltage, for example, then the voltage at the emitter resistor also increases. Consequently, only a small portion of the connected control voltage is effective for the scattering of the transistor for the base-emitter line. This counteracts the original increase in collector current. The same thing happens when an alternating voltage is used for controlling. Only a portion of the connected voltage is available for controlling the transistor when an emitter resistor is in the circuit.
If a capacitor with a large enough capacity is connected in parallel to the emitter resistor, then the negative feedback is canceled in the case of alternating voltage. This is not true of negative direct current feedback, though.

Notes on Set-Up and Procedure
The experiment set-up according to Fig. 1 should present no major problems. The voltage induced in the coil by the stray field of the transformer serves as the signal voltage to be amplified.
The values for operating voltage can be read from the adjustable resistor of the power supply unit or with a second multi-range meter.
In slightly altered form, the circuit can also be set up with negative voltage feedback. In this case, however, a capacitor can not cancel the negative alternating current feedback, and therefore can not prevent the decrease in amplification.

Observations and Measurement Results
Table 1

Circuit	The humming noise disappears at		Volume
without R_E	U_{min} = 6 V	U_{max} = 9 V	loud
with R_E	U_{min} = 4 V	U_{max} = 12 V	less loud
with R_E and C	U_{min} = 4 V	U_{max} = 12 V	loud

Evaluation
1. The emitter resistance prevents large fluctuations in operating voltage from influencing the function of the amplifier stage. This reduces amplification, though.
2. When a capacitor is connected in parallel to the emitter resistor, the insensitivity against fluctuations in operating voltage is unchanged, and amplification is just as large as without the emitter resistor.

Stabilization of the Operating Point

(How can a transistor amplifier stage be made insensitive to fluctuations in operating voltage?)

Room for notes