PROTOCOL

for lab-exercise

LC-Oscillator

Group / Class	Script writer	Signature
5 / 4AHELS	Thomas ASCH	
Date of Exercise / Hand-in Date	**Team member**	**Signature**
1.4.2014 8.4.2014	Andreas BÖHM	
Teacher	**Team member**	**Signature**
TILL	Peter Neunteufel	
Grade	**Team member**	**Signature**

SUMMARY (or DEVICE UNDER TEST)

LC-Oscillator

USED DEVICES

Number	Device	Company	Type	Inventory Number
1	Laboratory Power Supply	Tecstar	PS 2403D	EL-TFTKL 0057/02
2	Oszilloskop	Tektronics	TDS1001B	540-04/2007/5/16
3				

Stored on el-lab file Server: ____________

LC-Oscillator

Task 1:

Design an LC oscillator using a collector-ground circuit. The oscillator should have a frequency of approximately 900 kHz and a coil with 22µH. Build this circuit on the breadboard. Measure the voltage course and the FFT of the output voltage Ua with the oscilloscope.

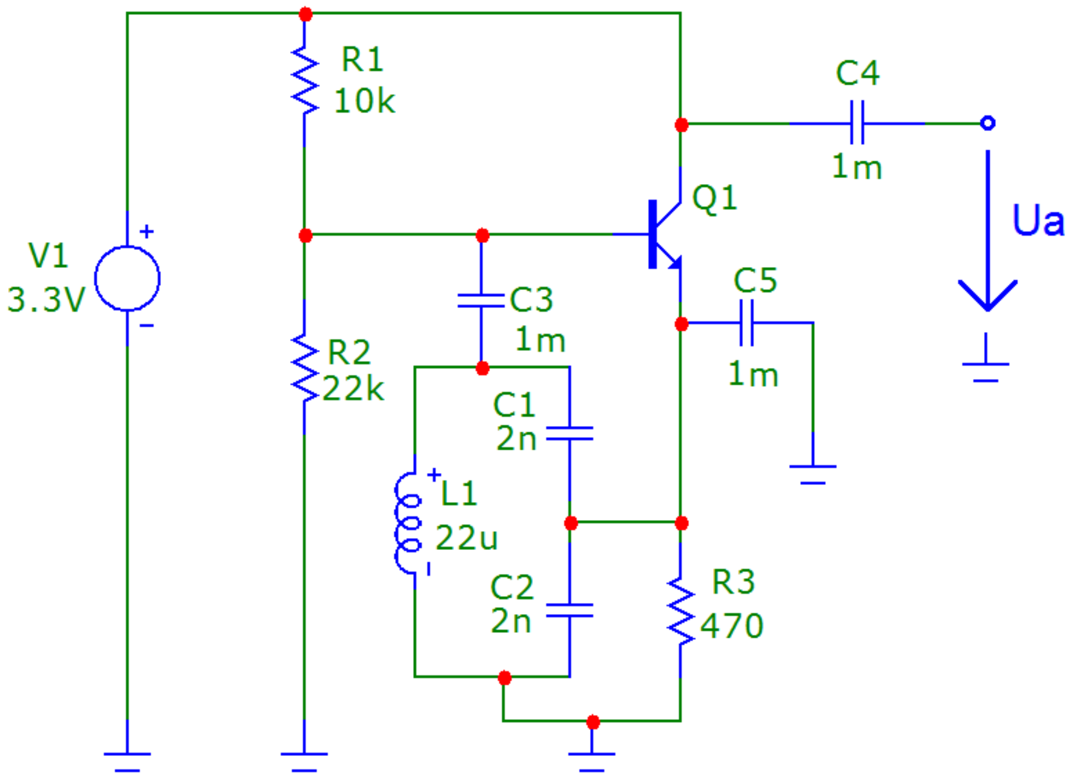

Fig. 1: Collector-ground circuit

Calculations:

$$fo = \frac{1}{2\pi * \sqrt{L * Cges}} \qquad /* \sqrt{L} \qquad /* 2\pi$$

$$fo * 2\pi * \sqrt{L} = \frac{1}{\sqrt{Cges}} \qquad /^2$$

$$\left(\frac{1}{2\pi * fo * \sqrt{L}}\right)^2 = Cges$$

$$Cges = \left(\frac{1}{2\pi * 900k * \sqrt{22\mu}}\right)^2 = 2nF$$

LC-Oscillator

$$Cges = \frac{C1 * C2}{C1 + C2} \qquad => \quad C1, C2 = 2nF$$

$$U_{R2} = Uo * \frac{R1}{R1 + R2}$$

$$U_{R2} = 3{,}3V * \frac{10k}{10k + 22k} = 2{,}27V$$

Measurements:

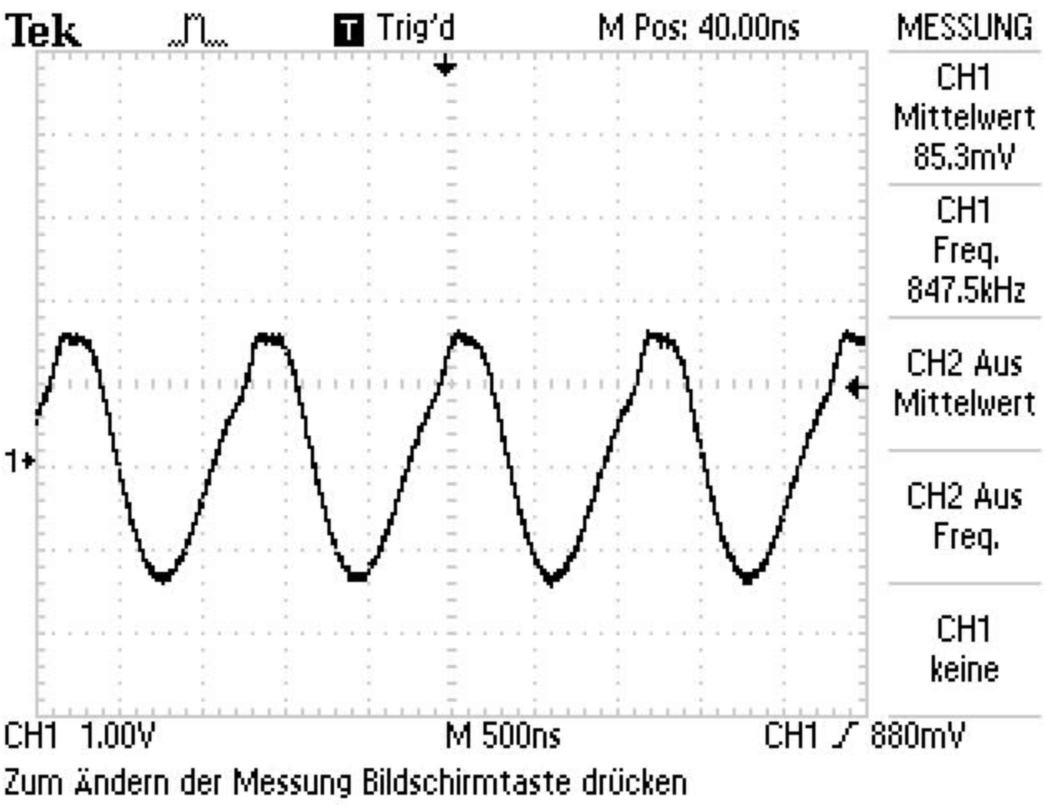

Fig. 2: Voltage course of the output voltage Ua

LC-Oscillator

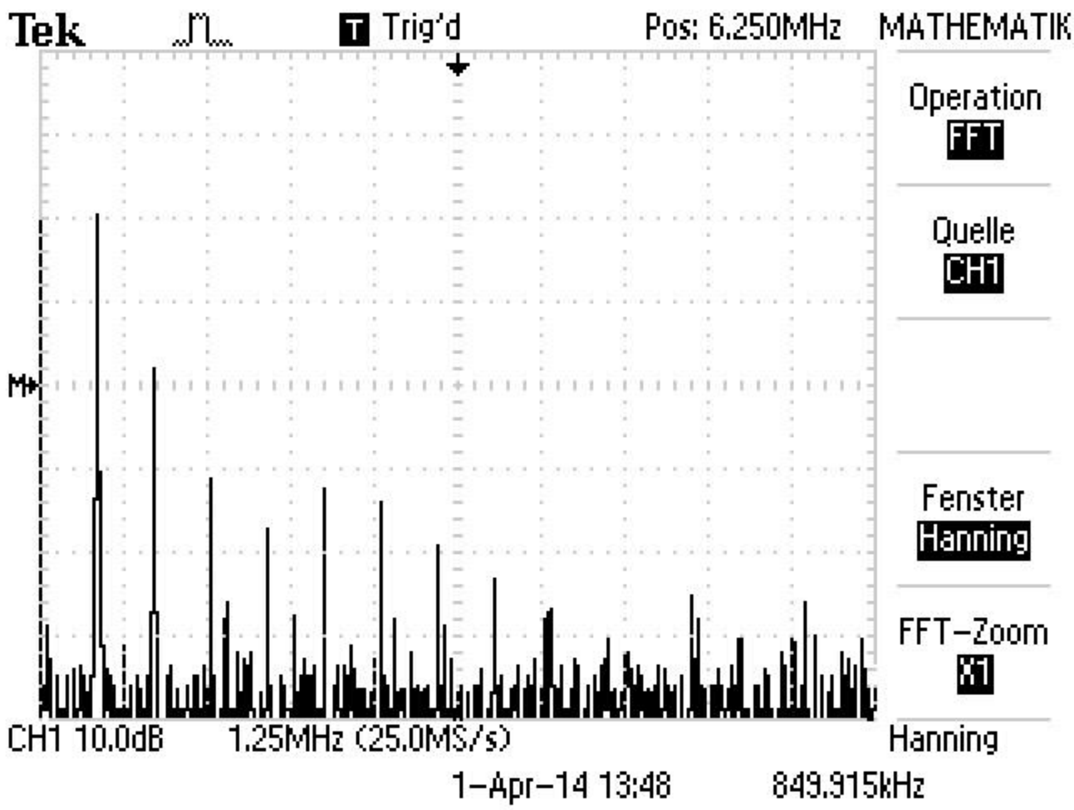

Fig. 3: FFT of the output voltage Ua

Calculation of the distortion factor:

U1/dBV	U1/V	U2/dBV	U2/V	U3/dBV	U3/V	U4/dBV	U4/V
20	10	2	1,26	-11	0,28	-17	0,14

$$K = \sqrt{\frac{1{,}26^2+0{,}28^2+0{,}14^2}{10^2+1{,}26^2+0{,}28^2+0{,}14^2}} = 0{,}129 \quad => 12{,}9\%$$

Comment:

After the 4th harmonic the FFT is uninteresting. In Figure 2 we see that the sine is not very nice. There were no problems in the construction and in the measurement.

LC-Oscillator

Task 2:

Design an LC oscillator using an emitter circuit. The oscillator should have a frequency of approximately 900 kHz and a coil with 22µH. Build this circuit on the breadboard. Measure the voltage course and the FFT of the output voltage Ua with the oscilloscope.

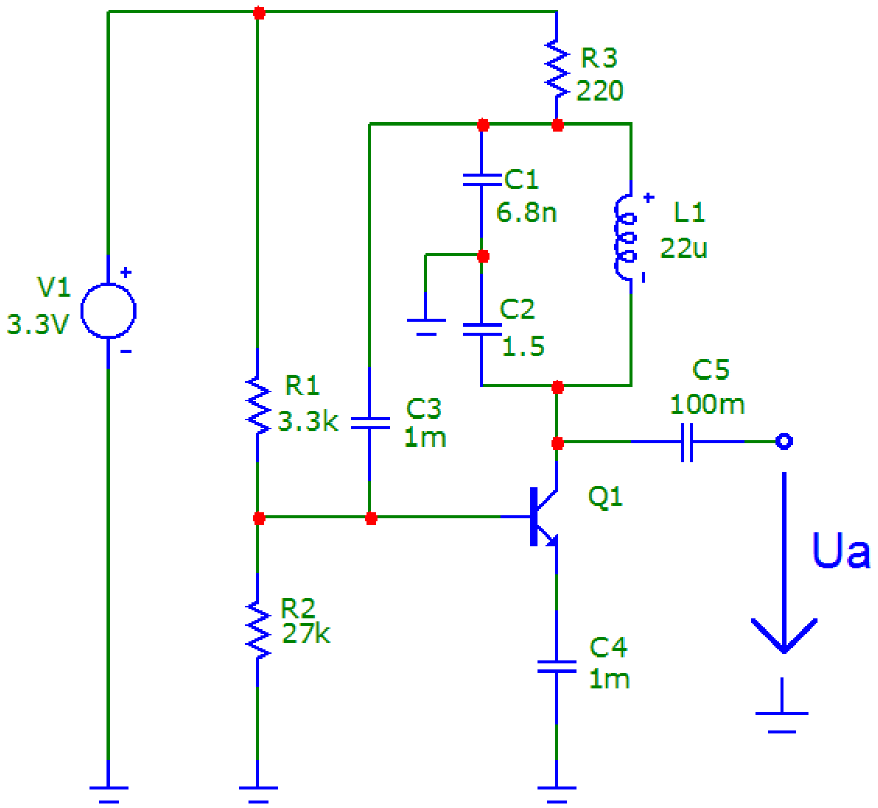

Fig. 4: Emitter circuit

Calculations:

C1 should 5- 10-times be as large as C2

=> C1 = 6,8n

=> C2 = 1,5n

R3 = 0,65V/ 3mA = 220Ω

R4 = 2V/ 3mA = 666,67Ω => R4 = 680Ω

LC-Oscillator

Measurements:

Our variant with the resistor R3:

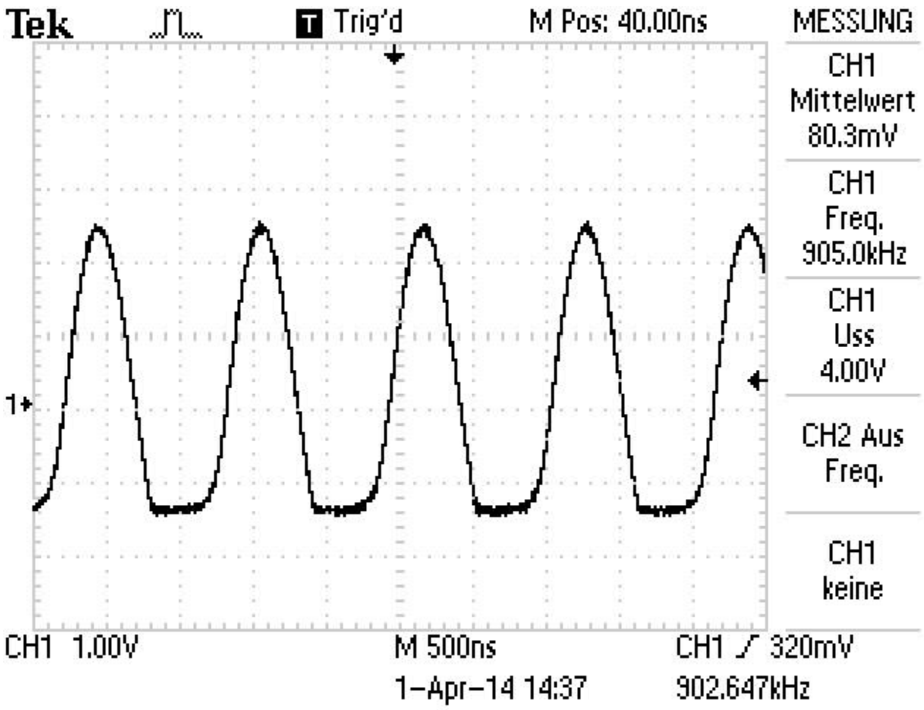

Fig. 5: Voltage course of the output voltage Ua

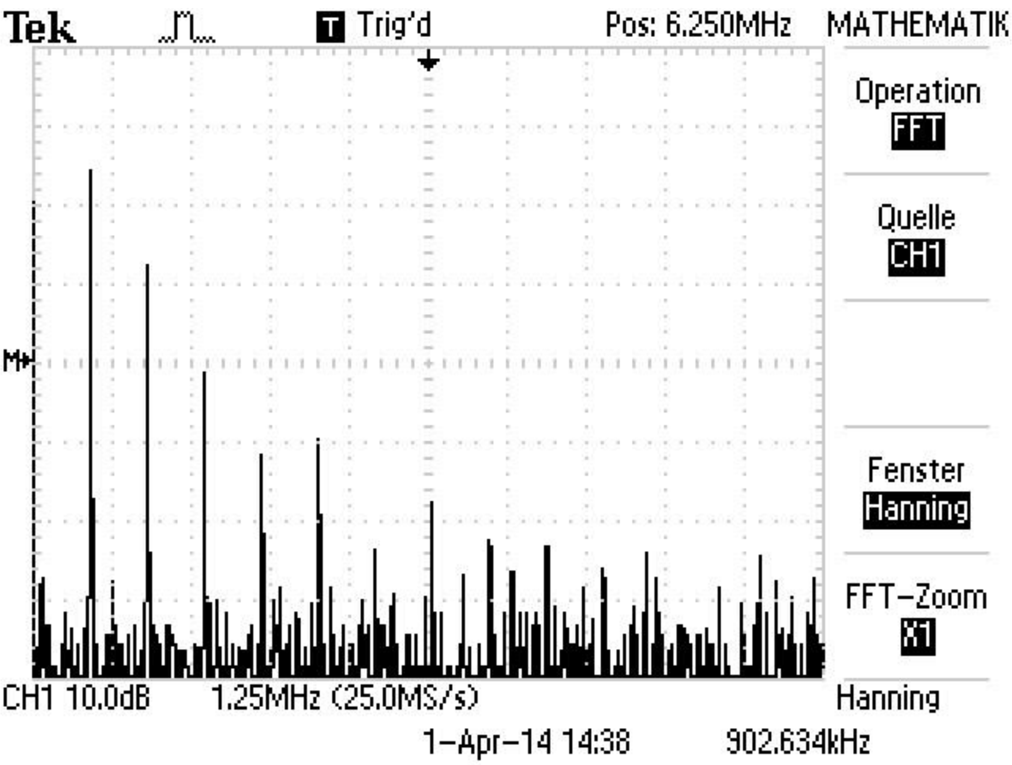

Fig. 6: FFT of the output voltage Ua

LC-Oscillator

Calculation of the distortion factor:

U1/dBV	U1/V	U2/dBV	U2/V	U3/dBV	U3/V	U4/dBV	U4/V
25	17,78	12	3,98	-1	0,89	-11	0,28

$$K = \sqrt{\frac{3{,}98^2+0{,}89^2+0{,}28^2}{17{,}78^2+3{,}98^2+0{,}89^2+0{,}28^2}} = 0{,}224 \quad => 22{,}4\%$$

Variant of Prof. Tillich without the resistor R3:

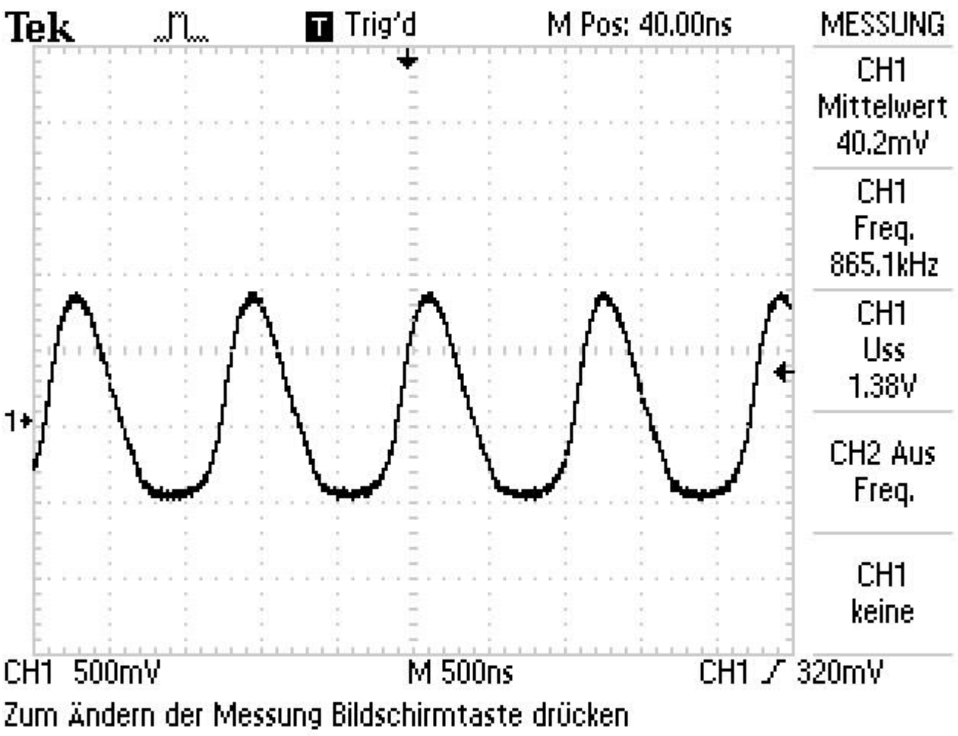

Fig. 7: Voltage course of the output voltage Ua

LC-Oscillator

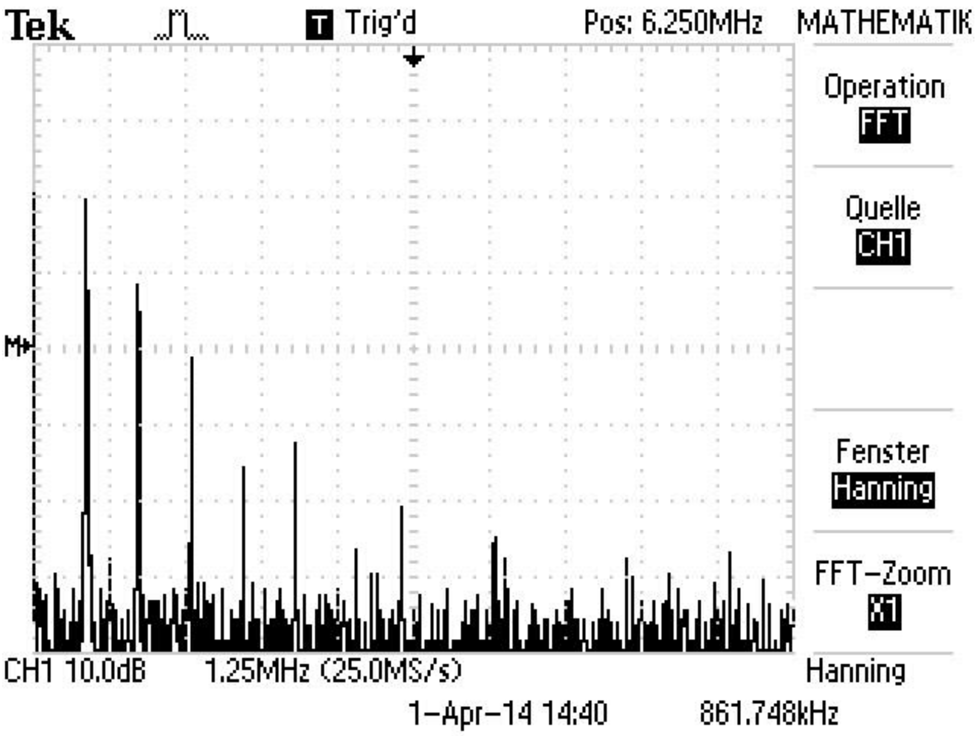

Fig. 8: FFT of the output voltage Ua

Calculation of the distortion factor:

U1/dBV	U1/V	U2/dBV	U2/V	U3/dBV	U3/V	U4/dBV	U4/V
20	10	9	2,82	-1	0,89	-15	0,18

$$K = \sqrt{\frac{2{,}82^2 + 0{,}89^2 + 0{,}18^2}{10^2 + 2{,}82^2 + 0{,}89^2 + 0{,}18^2}} = 0{,}284 \quad => 28{,}4\%$$

Comment:

In Figure 5 it can be seen that our variant is better with the resistor R3 because the sine look better. After the 4^{th} harmonic the FFT is uninteresting. There were no problems in the construction and in the measurement.

LC-Oscillator

Task 3:

Design a Low-Cost oscillator. The oscillator should have a frequency of approximately 900 kHz and a coil with 22µH. Build this circuit on the breadboard. Measure the voltage course and the FFT of the output voltage Ua with the oscilloscope.

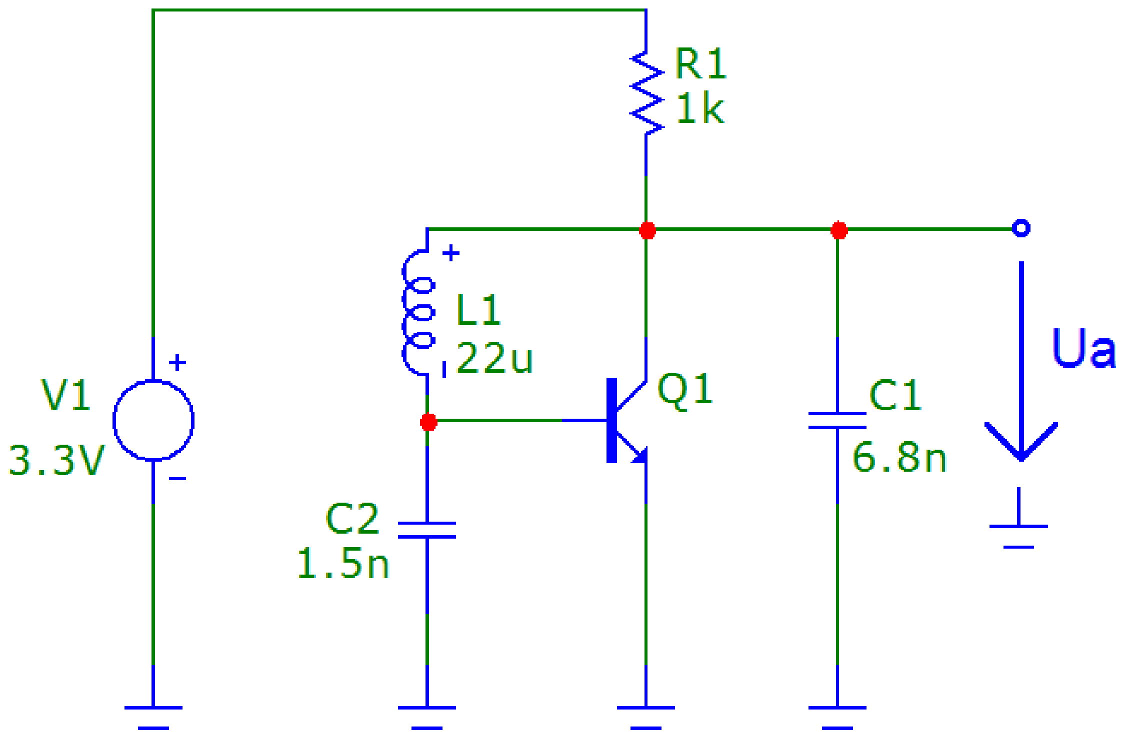

Fig. 9: Low-Cost-Oscillator

Calculations:

C1 should 5-10-times be as large as C2

=> C1 = 6,8n

=> C2 = 1,5n

LC-Oscillator

Measurements:

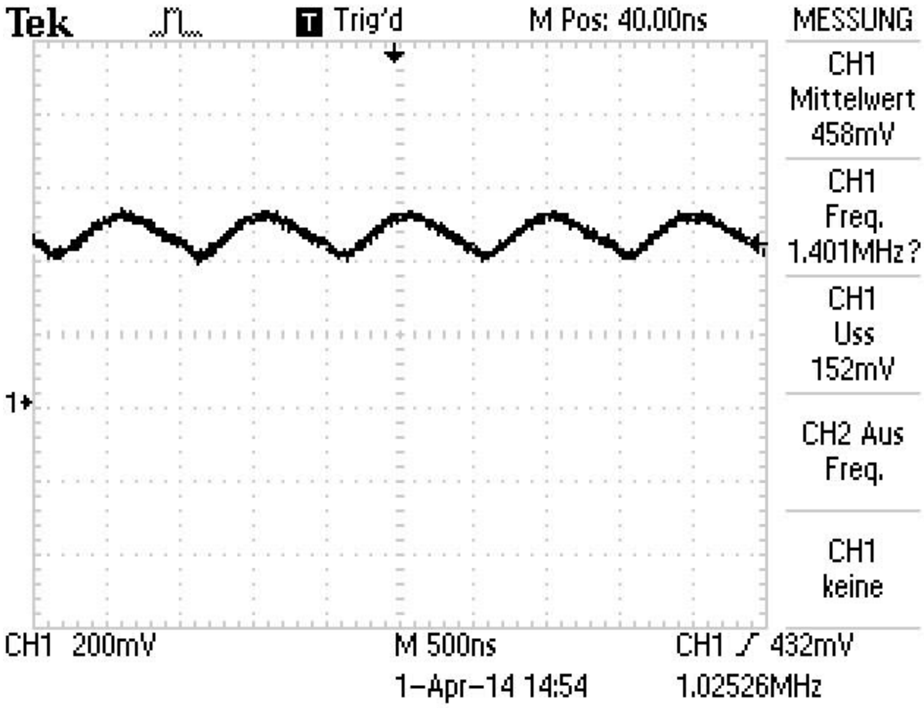

Fig. 10: Voltage course of the output voltage Ua
at a supply voltage of 0,7V

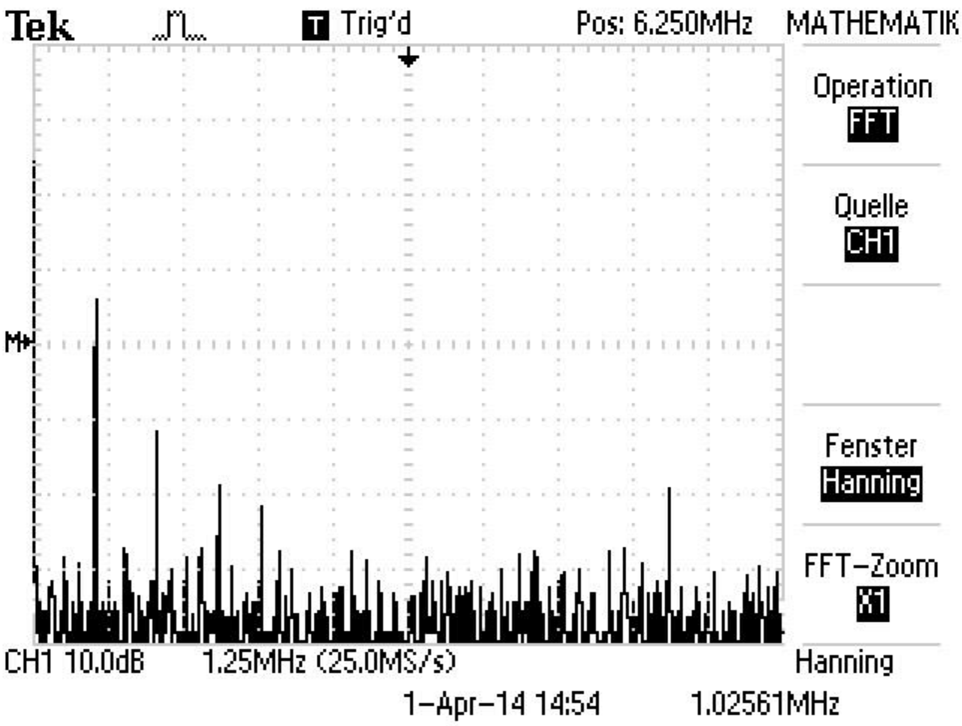

Fig. 11: FFT of the output voltage Ua
at a supply voltage of 0,7V

LC-Oscillator

Calculation of the distortion factor:

U1/dBV	U1/V	U2/dBV	U2/V	U3/dBV	U3/V	U4/dBV	U4/V
7	2,24	-10	0,316	-18	0,126	-21	0,089

$$K = \sqrt{\frac{0{,}316^2+0{,}126^2+0{,}089^2}{2{,}24^2+0{,}316^2+0{,}126^2+0{,}089^2}} = 0{,}157 \quad => 15{,}7\%$$

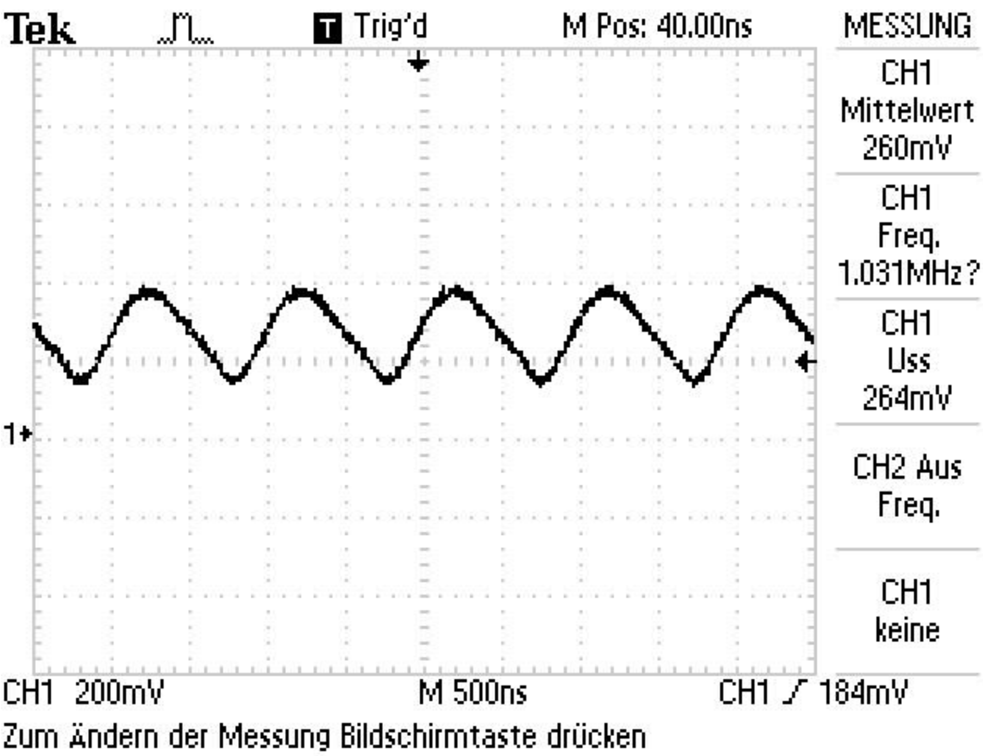

Fig. 12: Voltage course of the output voltage Ua
at a supply voltage of 1V

LC-Oscillator

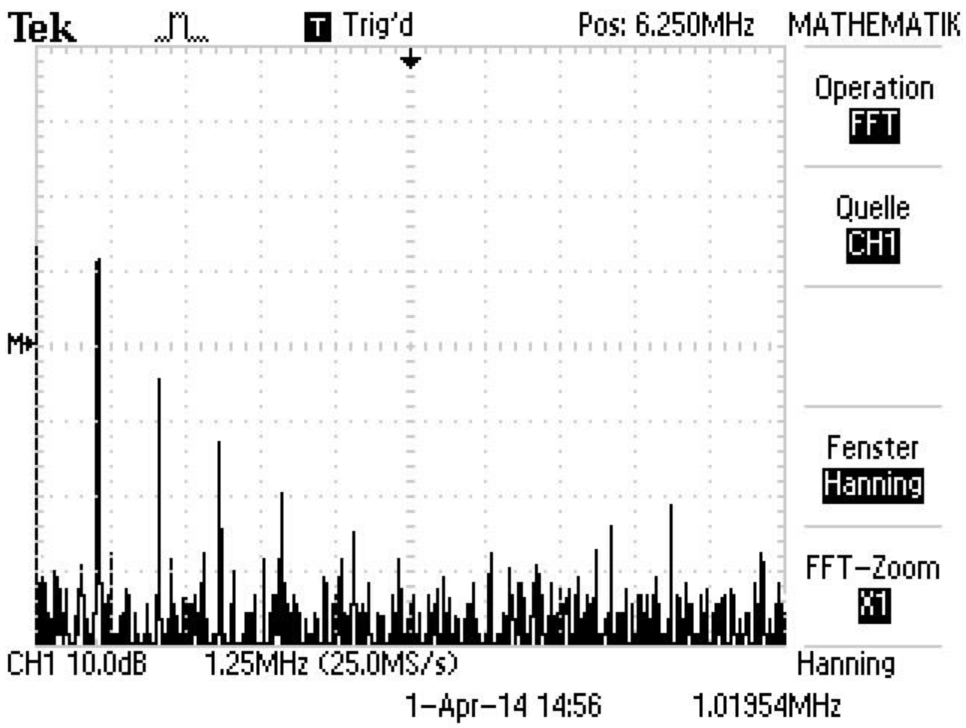

Fig. 13: FFT of the output voltage Ua
at a supply voltage of 1V

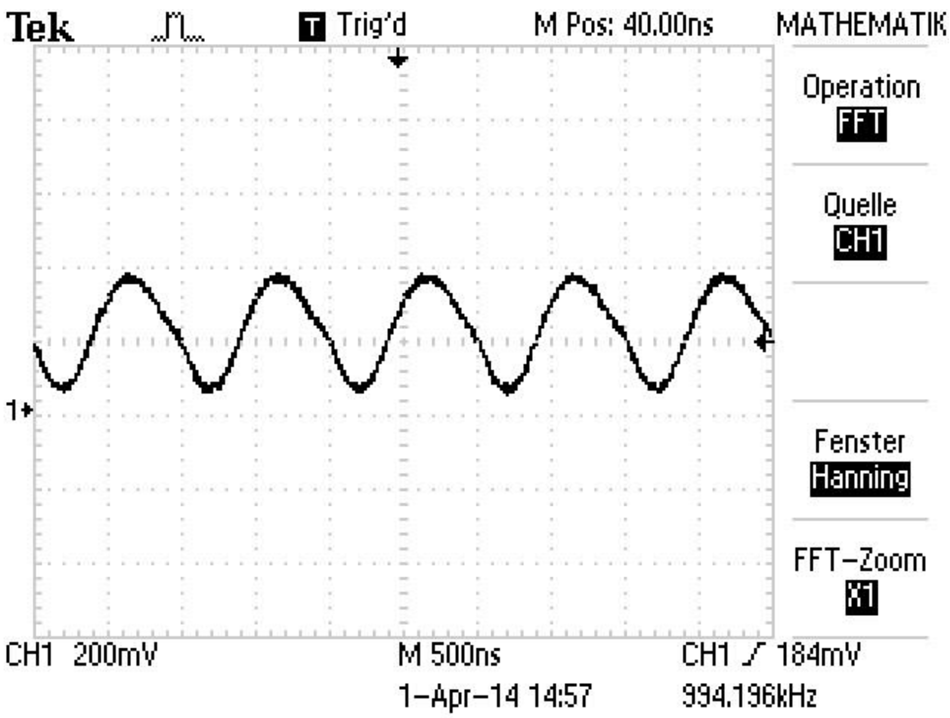

Fig. 14: Voltage course of the output voltage Ua
at a supply voltage of 1,5V

LC-Oscillator

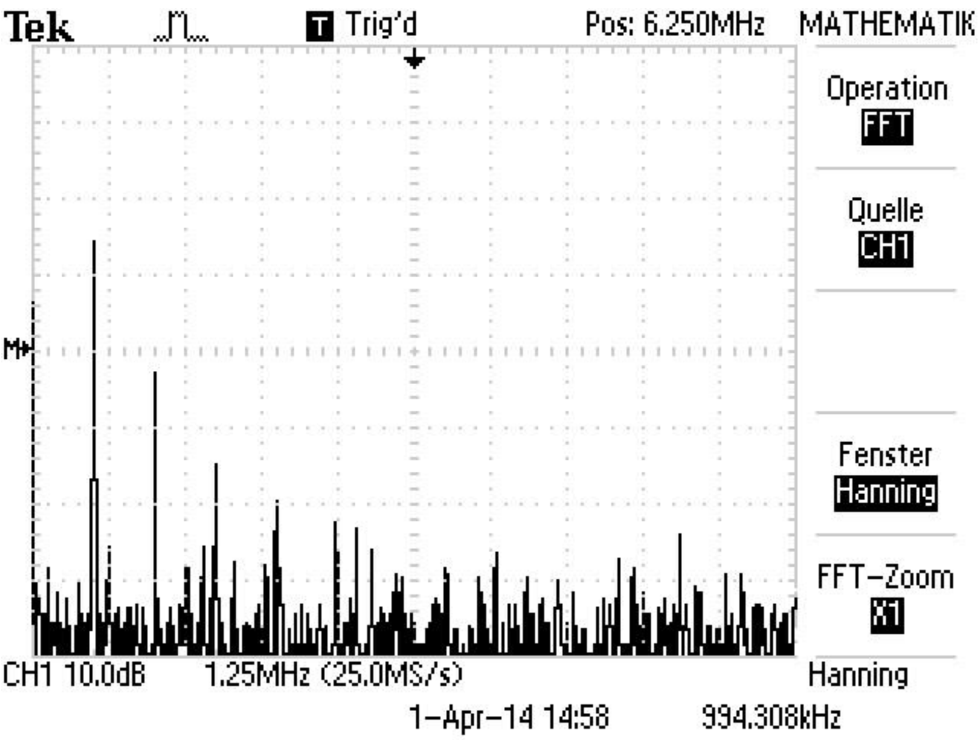

Fig. 15: FFT of the output voltage Ua
at a supply voltage of 1,5V

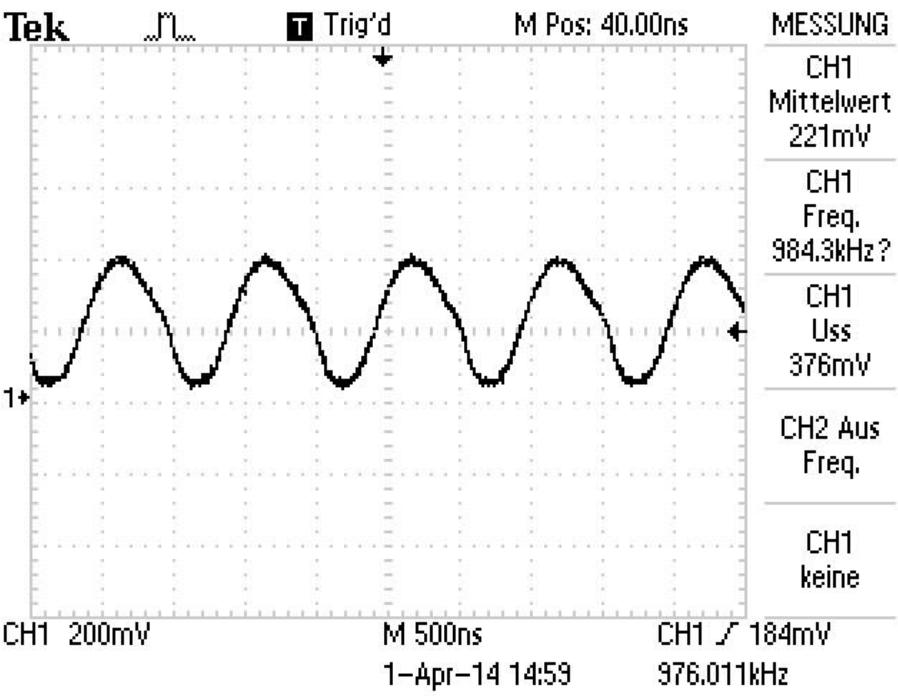

Fig. 16: Voltage course of the output voltage Ua
at a supply voltage of 2V

LC-Oscillator

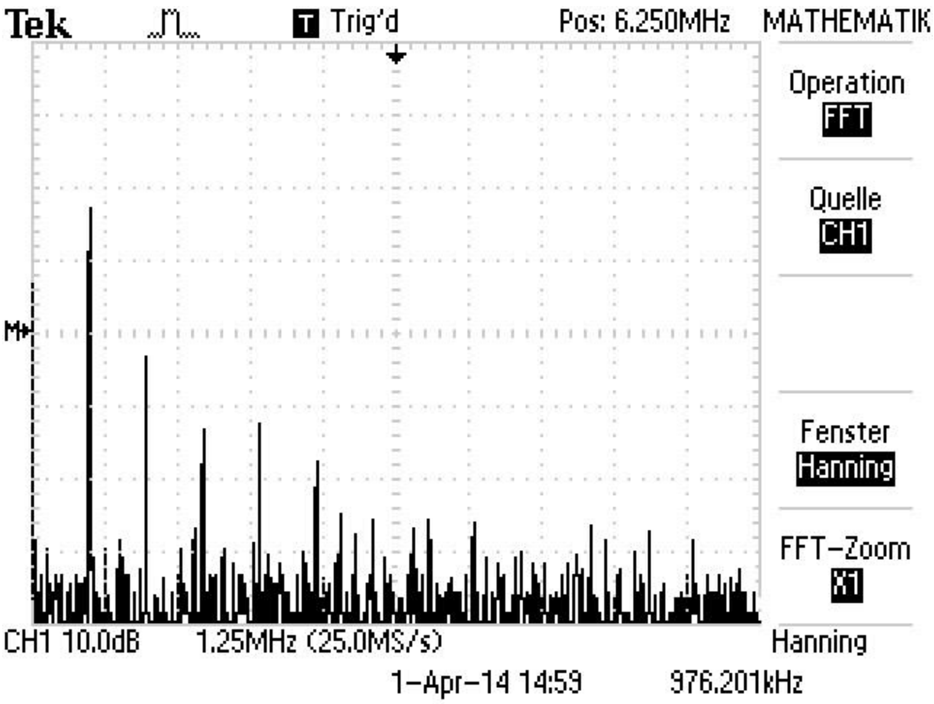

Fig. 17: FFT of the output voltage Ua
at a supply voltage of 2V

Calculation of the distortion factor:

U1/dBV	U1/V	U2/dBV	U2/V	U3/dBV	U3/V	U4/dBV	U4/V
18	7,94	-2	0,794	-13	0,224	-13	0,224

$$K = \sqrt{\frac{0{,}794^2 + 0{,}224^2 + 0{,}224^2}{7{,}94^2 + 0{,}794^2 + 0{,}224^2 + 0{,}224^2}} = 0{,}106 \quad => 10{,}6\%$$

LC-Oscillator

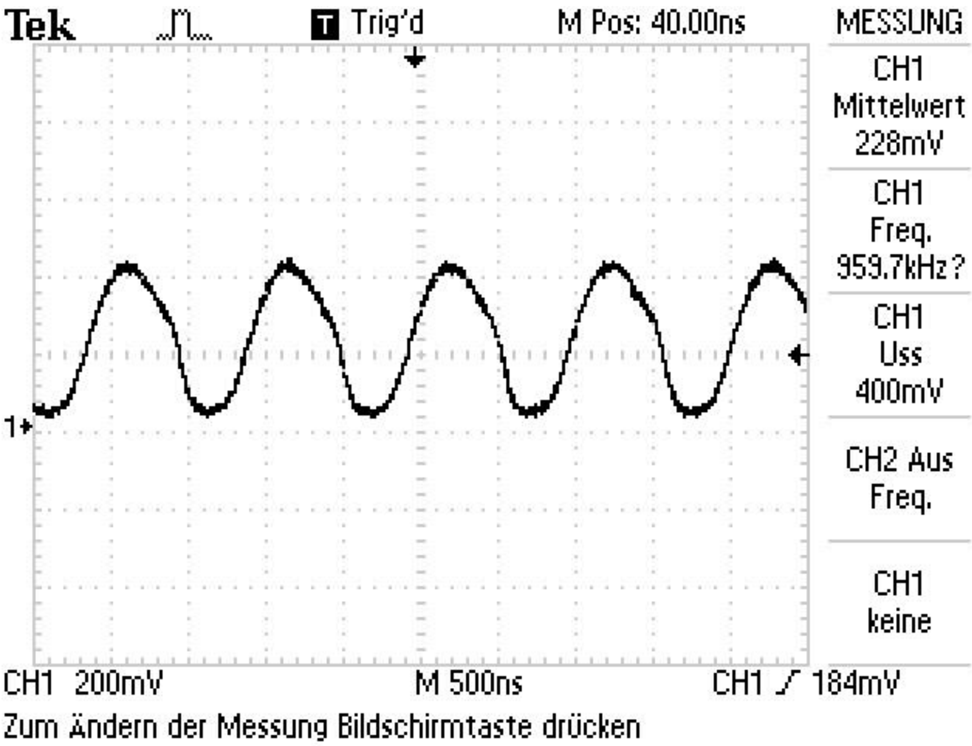

Fig. 18: Voltage course of the output voltage Ua
at a supply voltage of 2,5V

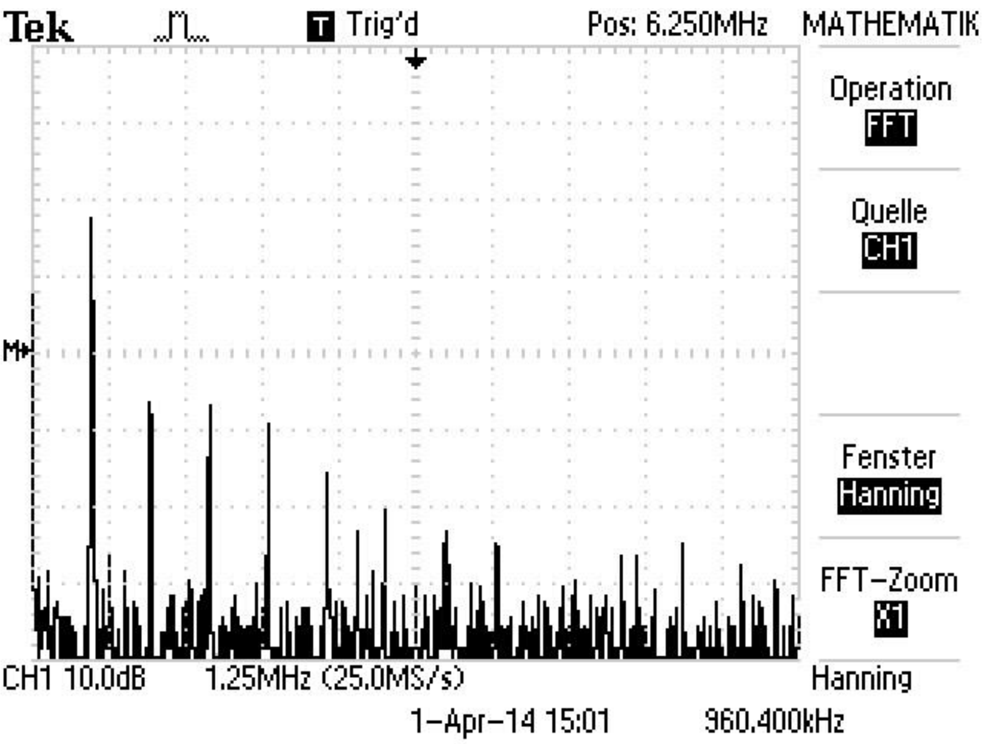

Fig. 19: FFT of the output voltage Ua
at a supply voltage of 2,5V

LC-Oscillator

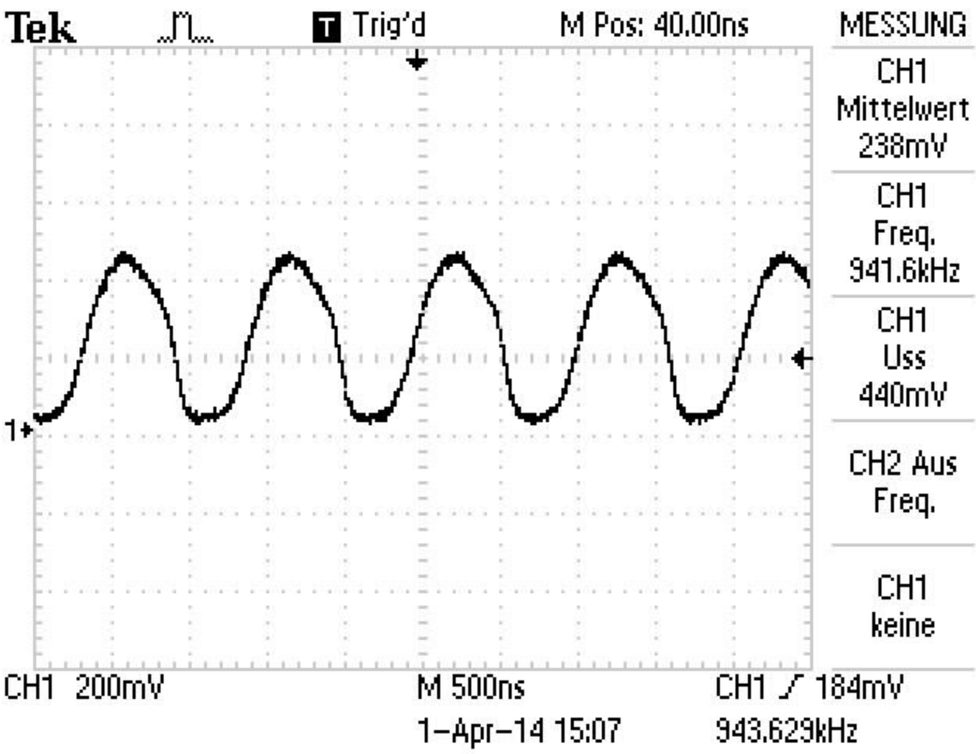

Fig. 20: Voltage course of the output voltage Ua
at a supply voltage of 3V

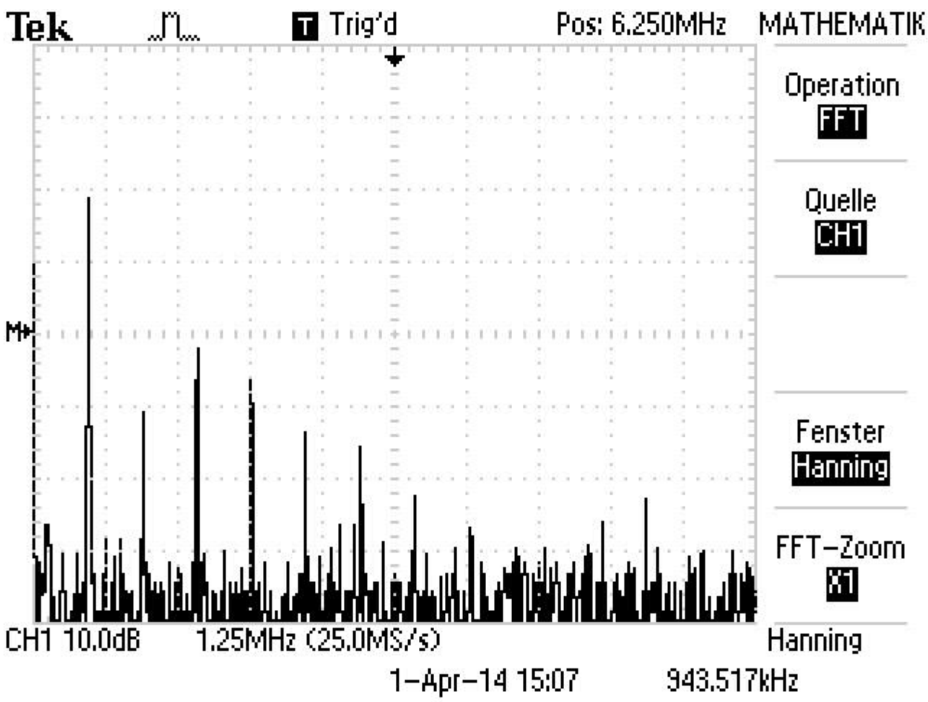

Fig. 21: FFT of the output voltage Ua
at a supply voltage of 3V

LC-Oscillator

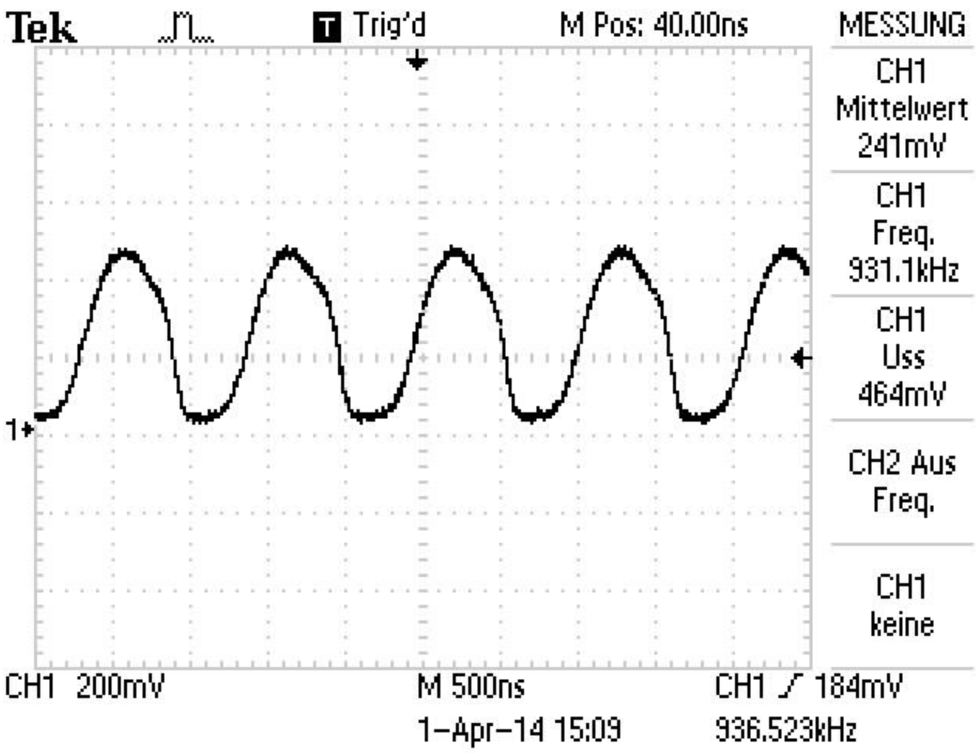

Fig. 22: Voltage course of the output voltage Ua
at a supply voltage of 3,3V

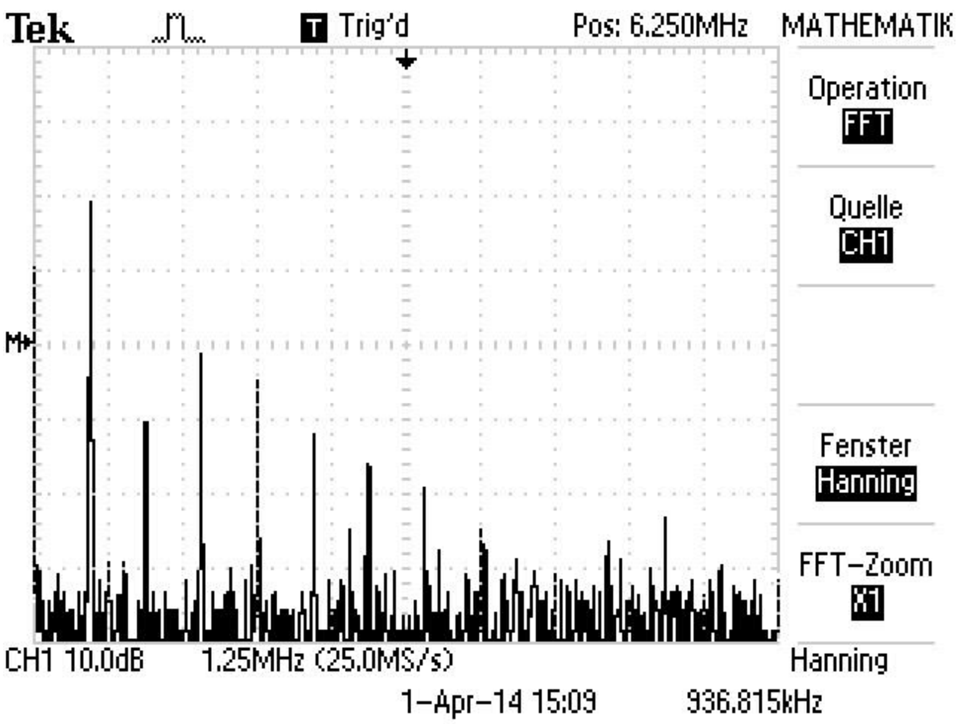

Fig. 23: FFT of the output voltage Ua
at a supply voltage of 3,3V

LC-Oscillator

Calculation of the distortion factor:

U1/dBV	U1/V	U2/dBV	U2/V	U3/dBV	U3/V	U4/dBV	U4/V
20	10	-10	0,316	-1	0,891	-25	0,056

$$K = \sqrt{\frac{0{,}316^2 + 0{,}891^2 + 0{,}056^2}{10^2 + 0{,}316^2 + 0{,}891^2 + 0{,}056^2}} = 0{,}094 \quad => 9{,}4\%$$

Comment:

It is apparent that the distortion factor and the offset voltage of Ua have become smaller, the closer to the supply voltage has risen to 3.3V. After the 4^{th} harmonic the FFT is uninteresting. There were no problems in the construction and in the measurement.

LC-Oscillator

Task 4:

Design an LC-oscillator with a basic circuit. The oscillator should have a frequency of approximately 900 kHz and a coil with 22µH. Build this circuit on the breadboard. Measure the voltage course and the FFT of the output voltage Ua with the oscilloscope.

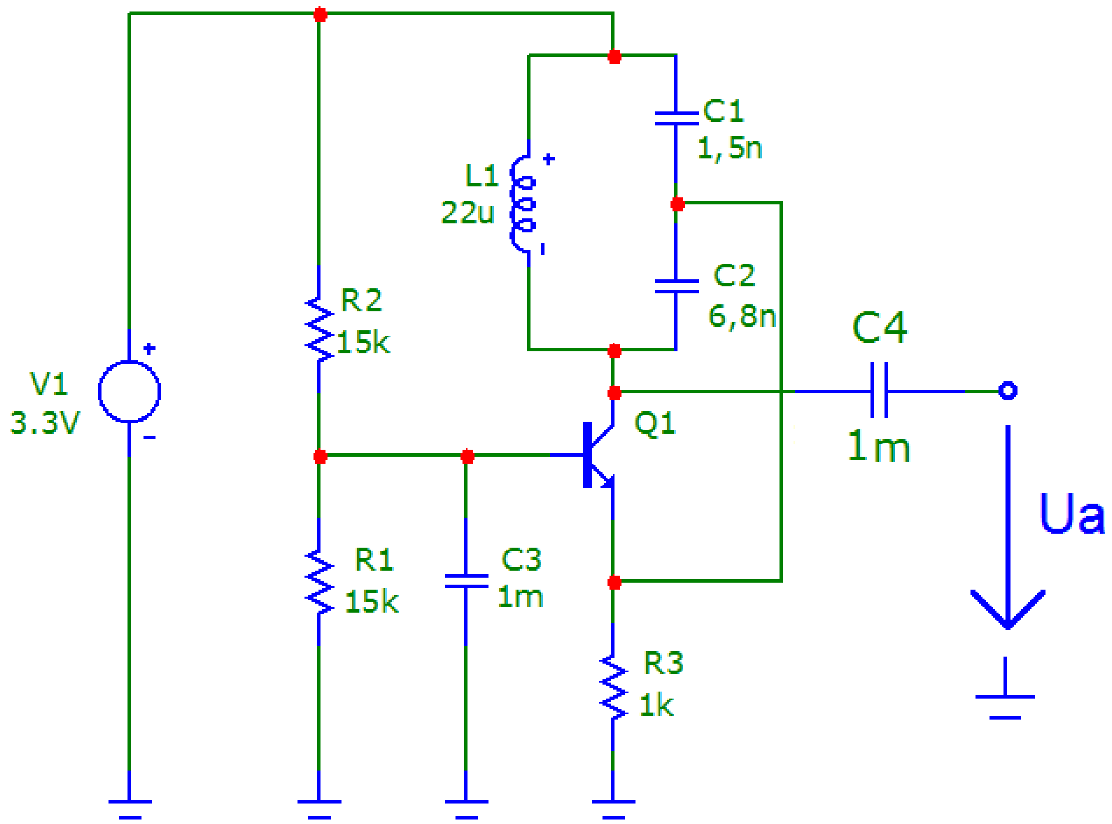

Fig. 24: Basic circuit

Calculations:

C1 should 5- 10-times be as large as C2

=> C1 = 6,8n

=> C2 = 1,5n

R3 = 1V/ 1mA = 1kΩ

LC-Oscillator

$$U_{R2} = Uo * \frac{R1}{R1 + R2}$$

$$U_{R2} = 3{,}3V * \frac{15k}{15k + 15k} = 1{,}65V$$

Measurements:

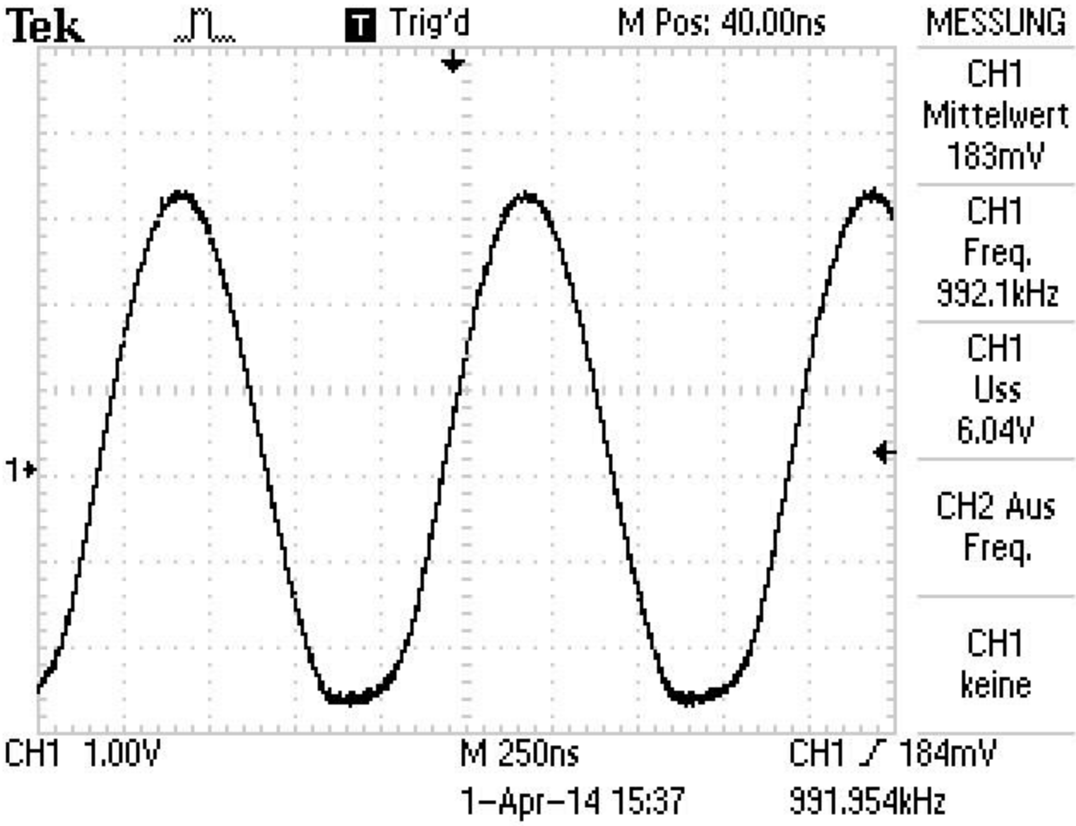

Fig. 25: Voltage course of the output voltage Ua

LC-Oscillator

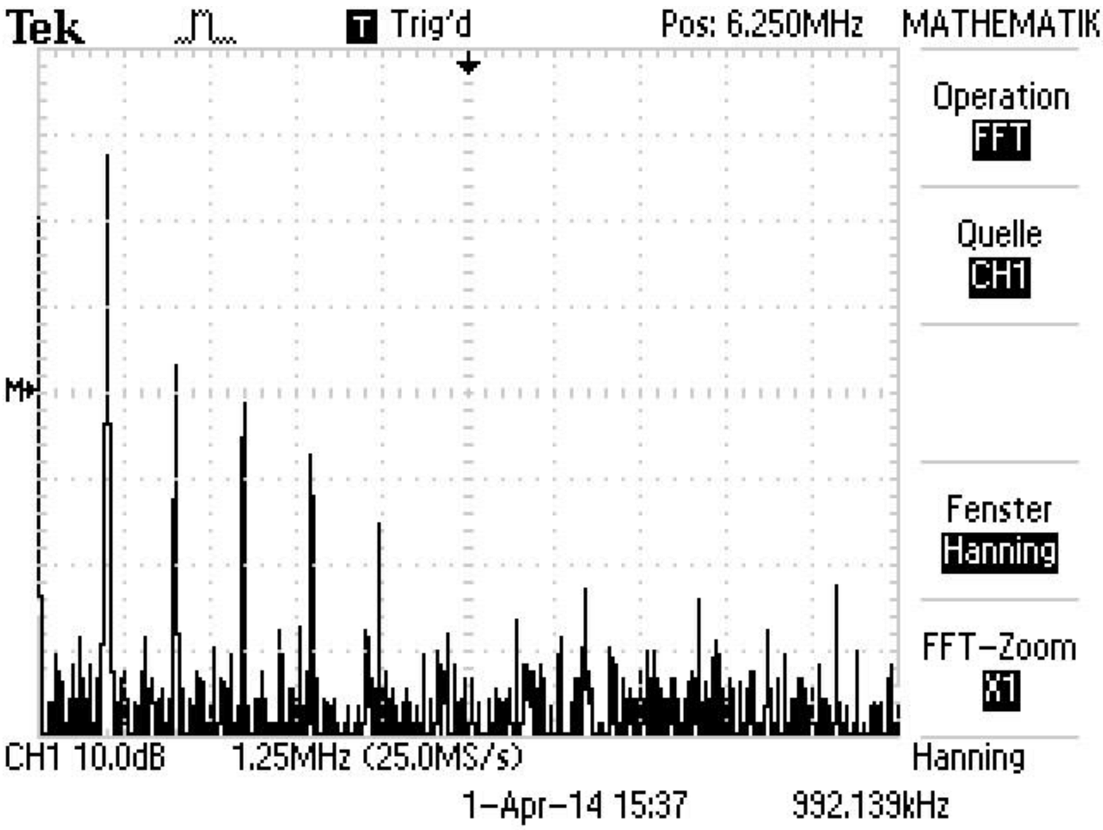

Fig. 26: FFT of the output voltage Ua

Calculation of the distortion factor:

U1/dBV	U1/V	U2/dBV	U2/V	U3/dBV	U3/V	U4/dBV	U4/V
28	25,12	3	1,41	-1	0,89	-7	0,45

$$K = \sqrt{\frac{1{,}41^2+0{,}89^2+0{,}45^2}{25{,}12^2+1{,}41^2+0{,}89^2+0{,}45^2}} = 0{,}069 \quad => 6{,}9\%$$

Comment:

It can be seen that in this circuit, the operating point is well adjusted, because the distortion is very low and the sine look at the most beautiful of all. After the 4th harmonic the FFT is uninteresting. There were no problems in the construction and in the measurement.