# Exercise 1.

# Building and measuring a simple electronic circuit

## Aim of the measurement

The main goal is that the students get practical experiences concerning building, measuring and testing electronic circuits.

## Keywords

Circuit design, measurement, test, operational amplifier

## References

[1] Wikipedia: Operational amplifier and its applications (inverting, non-inverting amplifier, Integrator,Schmitt trigger)
http://en.wikipedia.org/wiki/Operational_amplifier
http://en.wikipedia.org/wiki/Operational_amplifier_applications

[2] Wikipedia: Frequency response: http://en.wikipedia.org/wiki/Frequency_response

## Measurement instruments:

| | |
|---|---|
| Oscilloscope | Agilent 54622A |
| Power supply | Agilent E3630 |
| Function Generator | Agilent 33220A |
| Digital multimeter (6½ digit) | Agilent 33401A |
| Digital multimeter (3½ digit) | Metex ME-22T |
| PC | NEC TM600 |

Parts used for circuit building:

- breadboard (2 pc.),
- tools: tweezers, pliers, crocodile clips, test probe, etc.
- op-amp ICs (TL082), passive parts (resistors, capacitances, diodes),

# Laboratory exercises

## 1. Basic amplifier circuits

1.1. Student A: using the breadboard and the parts obtained from the tutor, build the basic non-inverting amplifier circuit (See fig. 1-1.). The power supply should be ±15 V.

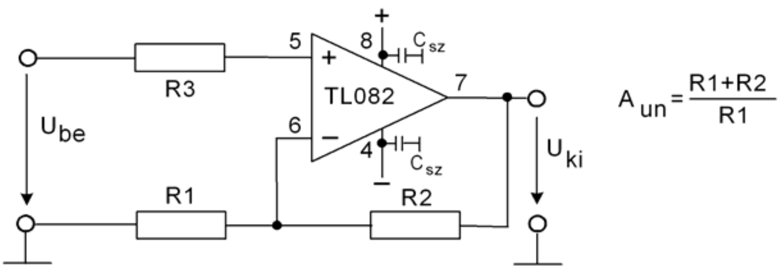


Figure 1-1. Basic non-inverting amplifier circuit

1.2. Student B: using the breadboard and the parts obtained from the tutor, build the basic inverting amplifier circuit (See fig. 1-2.). The power supply should be ±15 V. Use AC coupling on the input.

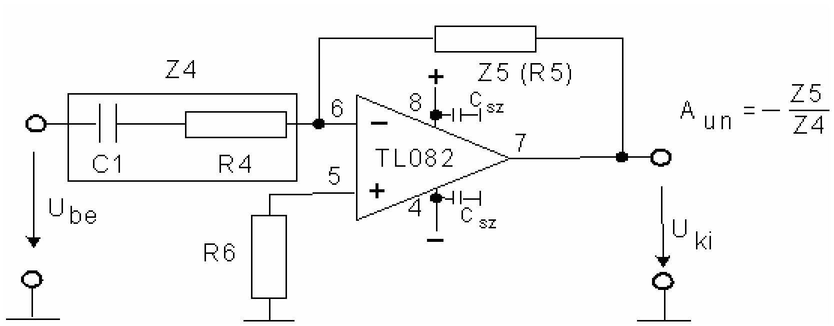


Figure 1-2. Basic inverting amplifier circuit with AC coupling on input

## 2. Measurements with the non-inverting amplifier

Double check the value of supply voltages (±15V) and the polarity of connections. Switch on the circuit ***only*** if the tutor has checked it.

2.1. Measuring the offset voltage of the amplifier (shortcut on the input). Measure the output voltage, if the input voltage is 0 (output offset)! Calculate the input offset! Evaluate the result: What is the reason for offset voltages? Is the measured value plausible (compare with datasheet values)? What is caused by the operation point bias current? How can you select the optimal value for *R3*?

2.2. Measurement of the saturation voltages: Trace the output by means of oscilloscope. Increase the input amplitude until the output distortion is notable. After that, decrease the amplitude until the distortion disappears. Measure the input and output voltages (RMS and PP values)!

2.3. Measure the voltage gain!

## 3. Measurements with the inverting amplifier

3.1. Measure the voltage gain at 1 kHz!

3.2. Examine the impulse transfer! Measure rise- and fall-time, over- and undershoot!

3.3. Compare the large- and small-signal operation!

3.4. Calculate the slew-rate of the op-amp!

## 4. Waveform generator

4.1. Build the circuit depicted in fig. 1-3! The parameter values should be determined by the tutor! (The integrator should be built by student A, the Schmitt-trigger (comparator) by student B)

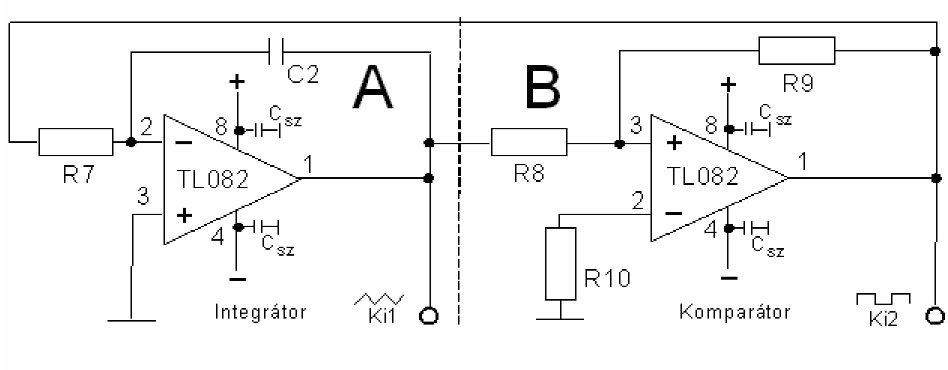


Figure 1-3. Waveform generator

4.2. Build the Waveform generator: connect the comparator output to the integrator input. Double check the power supply (±15 V)! Switch on the circuit ***only*** if the tutor has checked it.

After the successful design and building, a triangle signal can be measured on clamp “Ki1” and a square on “Ki2”. The amplitude of the latter one is determined by the saturation voltage of the op-amp. The triangle is determined by the threshold levels of the Schmitt-trigger.

4.3. Copy the typical waveforms ($U_{ki1}$, $U_{ki2}$) to the protocol!