

EXERCISE 1

TOPIC: Introduction to Digital Electronics Laboratory

PURPOSE OF EXERCISES

Getting to Know the lab.

EXERCISE PROGRAM:

Task 1

Refer to the measurement frame and typical modules arranged at the measurement frame

Task 2

Refer to the data sheets of chips with a simple logic gates.

Task 3

Using the measurement system (frame) check operations of selected logic gates and flip-flops.

Task 4

Using the oscilloscope and signal generator test the measurement channel.

Literature:

1. John F. Wakerly; Digital Design, Principles and Practices, (4th Edition), Pearson/Prentice Hall, 2005.
2. M. Morris Mano, Michael D. Ciletti; Digital Design (4th Edition), Prentice Hall, 2006.
3. All about circuits; <http://www.allaboutcircuits.com>
4. Other Internet resources (e.g. datasheets of microchips).

For all exercises 2-7 the **reports** should be prepared. In the report, the results of measurements, tables, graphs, schematics of designed circuits and conclusions should be included.

EXERCISE 2

TOPIC: Static and dynamic parameters of gates

PURPOSE OF EXERCISES

Introduction to basic digital circuits made of TTL technology

ISSUES:

TTL gates. Gate characteristics: input, transient and output. Tristate, OC and Schmitt gates. The electrical parameters of gates.

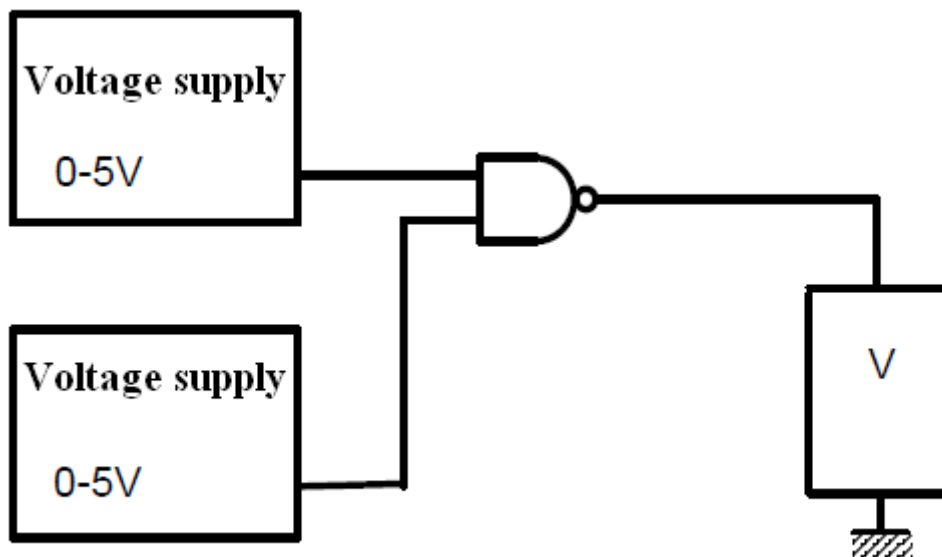
EXERCISE PROGRAM:

Task 1

Using the keys and indicator lights specify the truth table for selected 3 logic gates. Note: Please remember to give power to the frame.

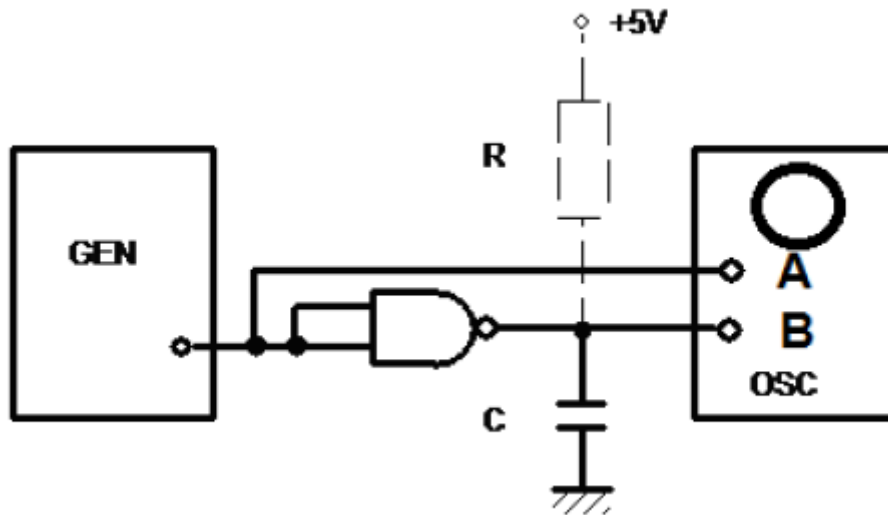
Task 2

In the arrangement shown in figure below draw the characteristic surface of the gate 7400.



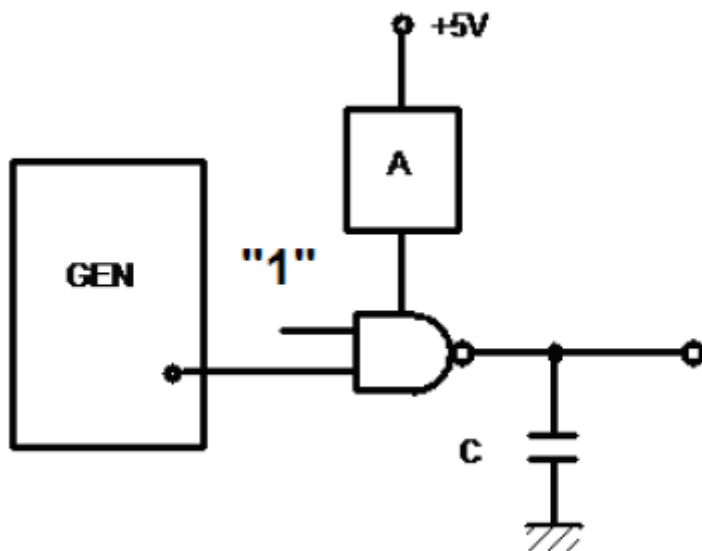
Task 3

The system shown in figure below measure rise time and fall time (t_r , t_f) of signal on gates output 7400 and 7403 for five capacitances C selected from the range of 0 to 500 pF ($f_g = 3\text{kHz}$). Plot the $t_r = f(C)$, and $t_f = f(C)$.



Task 4

In the system shown in figure below carry out measurements of the power consumption of the gate 7400 as a function of frequency f of the input signal ($0 < f < 5\text{ MHz}$) for $C = 0\text{ pF}$, 50 pF and 250 pF .



When drawing a graph $P = f(f)$ on the frequency axis adopt a logarithmic scale.

Warning: The chip must be inserted into the cradle. Remember to connect supply voltage and ground.

EXERCISE 3

TOPIC: Combinational blocks: multiplexers, demultiplexers and decoders.

PURPOSE OF EXERCISE:

Introduction to basic combinational integrated circuits

ISSUES:

Medium Scale of Integration microchips. Construction and principles of operation of: multiplexers, demultiplexers and decoders.

EXERCISE PROGRAM:

Task 1

Realize 2x1 multiplexer on logic gates.

Task 2

Realize 10x1 multiplexer using 74151 series TTL chips and other gates.

Task 3

Realize demultiplexer 1x2 on logic gates.

Task 4

Realize decoder 1x10 using 74139 chips and a TTL gates.

EXERCISE 4

TOPIC: Arithmetic and Logic Units

PURPOSE OF EXERCISE:

The aim of the exercises is to familiarize with the construction and operation of integrated circuits performing arithmetic functions

ISSUES:

Codes and coding. BCD code. Binary arithmetic. Arithmetic operations in the code KU2. Construction and operation of arithmetic and logic circuits: comparators, adders and arithmetic and logic unit (ALU). Familiarization with the data sheets of integrated circuits: comparator 7485, the adder 7483, 74181 ALU system. The basic properties of the 74181.

EXERCISE PROGRAM:

Task 1

Realize 1 bit adder on logic gates

Task 2

Refer to the data sheet of the 4-bit adder 7483. Check the operations of the chip. Use parallel adder 7483 for adding the 4-bit numbers.

Task 3

Build and examine decimal code 8421 adder on 7483 chips and logic gates.

Task 4

Refer to the datasheet and check the operation of the comparator of two 4-bit numbers (7485).

Task 5

Refer to the datasheet of the 74181 chip. Using the 74181 chip build the 8-bit adder.

EXERCISE 5

TOPIC: Sequential blocks: registers and counters.

PURPOSE OF EXERCISE:

Familiarize with with sequential integrated circuits.

ISSUES:

Principles of operation registers and counters. Asynchronous and synchronous counters. Controlling counters. Reverse counters.

EXERCISE PROGRAM:

Task 1.

Realize 1-bit counter on the D flip-flop.

Task 2

Design and build the modulo 5 counter on the D-type flip-flops

Task 3.

Examine the decimal counter (7490 chip).

Task 4.

Realize 3-bit registers using D-type flip-flops:

- a) parallel
- b) serial (shifting)

EXERCISE 6

TOPIC: Integrated timers and multivibrators.

PURPOSE OF EXERCISE:

Familiarization with simple timing systems

ISSUES:

Monostable systems. Realization of simple generators. multivibrator chips 74121, 74122, 74123. NE 555 generator. Square wave generators.

EXERCISE PROGRAM:

Before attempting to appropriate tasks please check the measuring circuit containing oscilloscope and generator.

Task 1

Realize a square-wave generator on logic gates

Task 2

Realize a square-wave generator using 74121 chips.

Task 3

Realize a square-wave generator using the Schmitt gate.

Task 4

Realize a square-wave generator using NE 555 chip.

EXERCISE 7

TOPIC: The digital-to-analog and analog-to-digital converters.

PURPOSE OF EXERCISE:

Introduction to the design and operation of AD and DA converters

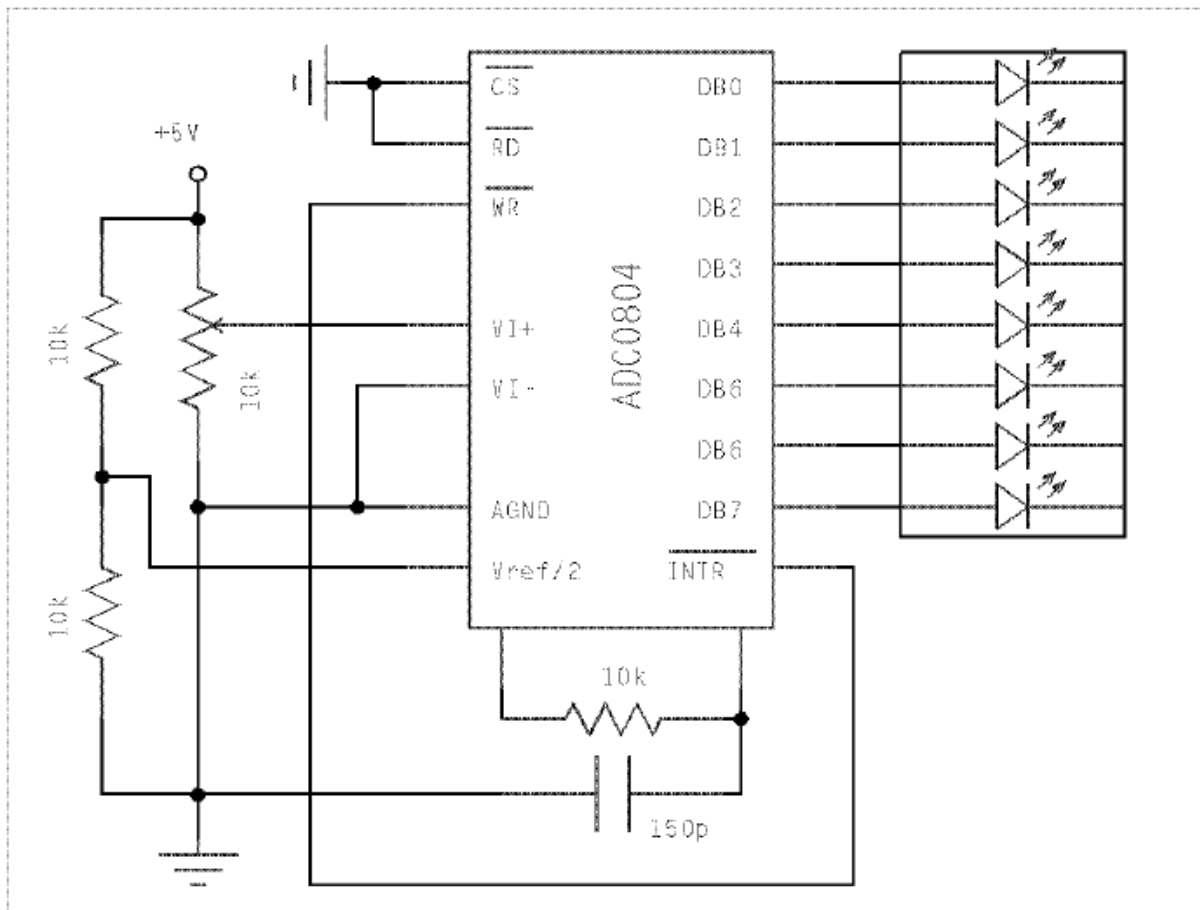
ISSUES:

The analog-to-digital processing. Basic components of AD and DA converters: Reference voltage source, voltage comparators, analog switches, operational amplifiers, sample and hold circuits.

EXERCISE PROGRAM:

Task 1.

Assemble the AD converter as shown below.



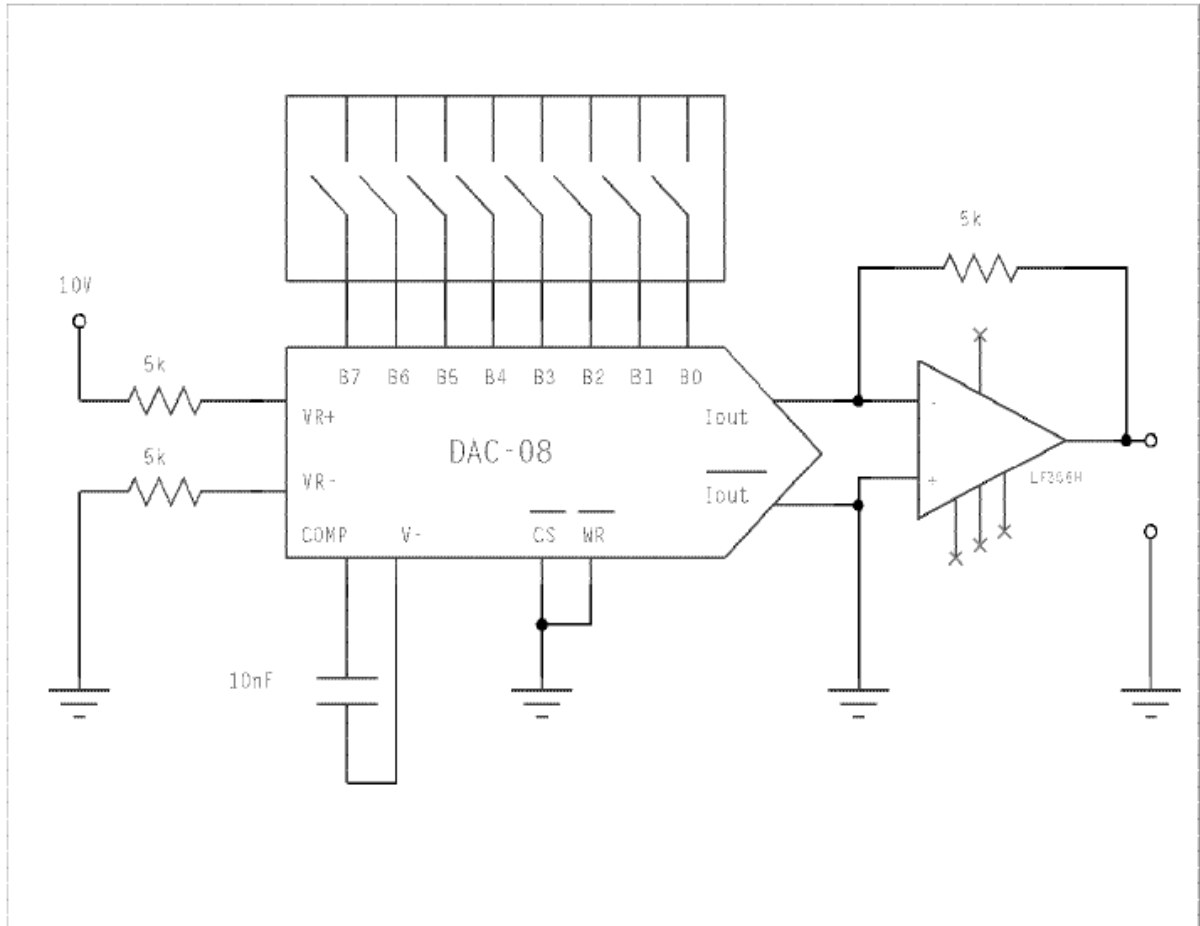
Draw the processing characteristics $N = f(U_{\text{input}})$, where N - digital result of processing, U_{input} - Input voltage retrieved from the potentiometer. The characteristics must be presented in a table and graph.

NOTE: In order to initiate the measurement when power-on, make a short connection between INTR and WR pins and the ground with an additional cable.

NOTE: After finishing the measurement do not dismantle the system!

Task 2.

Assemble the DA converter as shown below.



Draw the processing characteristics $U_{out} = f(N)$. The characteristics must be presented in the form of a table and graph.

NOTE: After finishing the measurement is not dismantle the system!

Task 3.

Remove connection with the modules 'Indicators' and 'Keys' and make direct connections with the output of A / D converter and input of D / A converter. Remove a potentiometer from the input of the A / D converter and instead connect the output of the function generator. Connect an oscilloscope to output of the D / A converter. Select the voltage range of a generator and an oscilloscope to observe the input and output voltage.

Explain the reasons for differences in the appearance of the two signals.