



Contestant number:

Delivery time:

Number of points complex project:

Connection design max. 10b:

Resolution max. 10b:

Display of the max. 10b:

Documentation, max. 10b:

A complex project in the field of electronics

In this part, your task is to design and implement an electronic circuit based on the specified requirements and parameters. The goal is to test the ability to understand the task, the ability to combine theoretical and practical knowledge and the creativity of the contestants.

Do all sketches and calculations directly in the text of the assignment, you have dedicated pages for that. Results without calculation, justification and without correct physical units will not be recognized.

The use of any external assistance is prohibited at the competition. Violation of the regulation will be penalized by disqualification.

Assignment:

Design a circuit, which will measure the number of supplied pulses and display this in a human-readable form. The required circuit parameters are:

1. The input signal has the following characteristics:
 - a. CMOS logic levels (0/5 V)
 - b. maximum frequency 1000 Hz
 - c. leading edges of the pulses are counted
2. The range of the number of registered impulses is 0 to 99, expandable to 9999 impulses
3. The measured data must be displayed in a human-readable form (e.g. a number in the decimal system, a number in the hexadecimal system, a binary code, etc.)
4. Functions controlled by buttons
 - a. button 1: pulse counting active
 - b. button 2: pulse counting stopped
 - c. button 3: reset the counter
5. Supply voltage of the circuit +5 V from an external source

You can only use components from the list on the other side of the sheet in the circuit. The design of the circuit connection, the complexity and the way the frequency will be measured and the data displayed is entirely up to you.

Document the circuit in detail. Describe the measurement method in detail. Explain why you chose this connection and describe the function of the circuit. Calculate or justify the values of all components. Draw a complete circuit diagram. The diagram must contain all used components, specific values of all components, designation of terminal numbers, etc.

Make the connection on the contact field.

During work, you have the opportunity to continuously test the connection and possibly fine-tune its parameters to achieve the maximum number of points.

The grading is as follows:

1. General design proposal 10 points



2. Basic range 99 pulses 5 points, extended range 9999 pulses 10 points
3. Value display: as a number in the decimal system without the need to convert 10 points, as a number with the need to convert to the decimal system 7 points, indication in binary form 5 points
4. Project documentation 10 points

List of material available to you:

Integrated circuits:

NE555P	Universal timer, astable, monostable circuit
MCP6002-E/P	Dual, rail to rail operational amplifier, 1MHz, power supply 1.8 to 5.5V
NE5532P	Dual operational amplifier, 10MHz, supply ± 5 to $\pm 15V$
SN74HC00N	NAND 2 inputs, 4 gates
SN74HC02N	NOR 2 inputs, 4 gates
SN74HC04N	inverter, 6 gates
SN74HC08N	AND 2 inputs, 4 gates
CD74HC4002E	NOR 4 inputs, 2 gates
SN74HC20N	NAND 4 inputs, 2 gates
CD74HC21E	AND 4 inputs, 2 gates
SN74HC42N	Decoder from BCD to 1 of 10
CD74HCT73E	JK flip-flop, 2 channels
SN74HC74N	Flip-flop D, with Set-Reset function, 2 channels
CD74HCT93E	4bit binary counter
CD74HC123E	Monostable multivibrator, 2 channels
SN74HC138N	3 bit to 1 of 8 decoder/demultiplexer
SN74HC139N	Decoder/demultiplexer 2 bits on 1 of 4 lines. 2 channels
SN74LS192N	Synchronous 4-bit BCD decade counter up/down with setting
74HC193N	4-bit binary up/down counter with setting
CD4518BE	4-bit decade BCD counter
CD4543BE	BCD code decoder for 7-segment display with register

Discrete components:

BC557A	Transistor PNP bipolar. 50V/100mA/500mW
BC547A	Transistor NPN bipolar. 50V/100mA/500mW
1N4148-TAP	Positive signal diode 100V/300mA
LTL2R3KRD-EM	LED 5mm red. Operating current 2mA
LTL2R3KGD-EM	LED 5mm green. Operating current 2mA
TDSR1360	7-segment common cathode LED display. Operating current 1mA (!)

Passive components:

E12 series resistors , tolerance 1%, values 10 Ω to 10 M Ω
capacitors : 1n, 2n2, 4n7, 10n, 22n, 47n, 100n, tolerance typically $\pm 10\%$
ceramic: 220n, 470n, tolerance typically $-80\ldots+22\%$
electrolytic: 1 μF , 2.2 μF , 4.7 μF , 10 μF , 22 μF , 47 μF , tolerance typically $\pm 20\%$
electrolytic: 100 μF , 220 μF , tolerance typically $\pm 20\%$

Data sheets for semiconductor components and documentation for integrated circuits can be found on the USB stick you received.

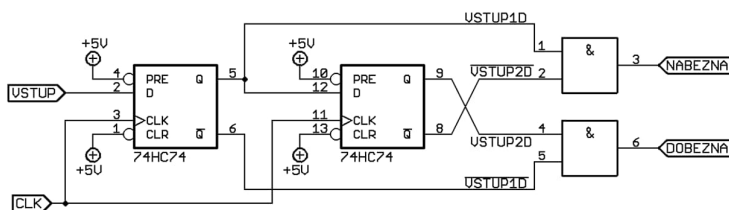
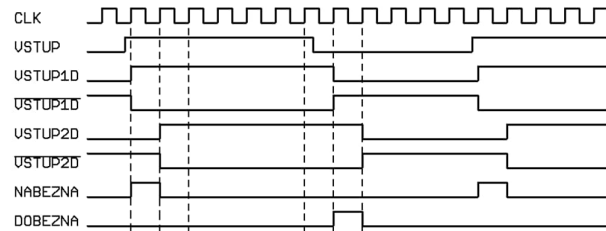


Useful circuits.

For inspiration, we remind you of several connections that may come in handy when developing a circuit diagram according to the assignment.

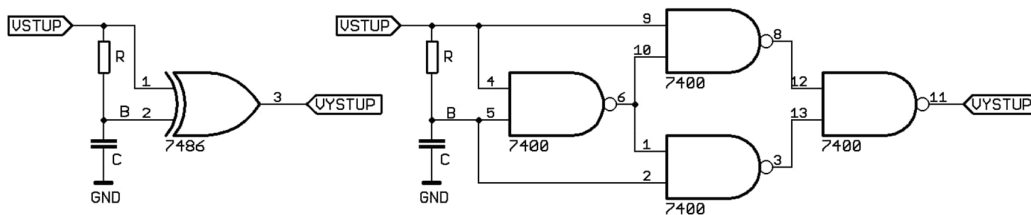
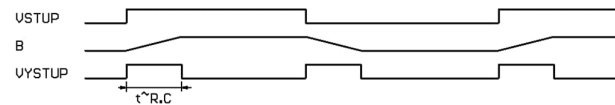
Leading and trailing edge detector

The circuit generates a pulse with the length of one period of the input clock signal on the rising or falling edge of the input pulse.



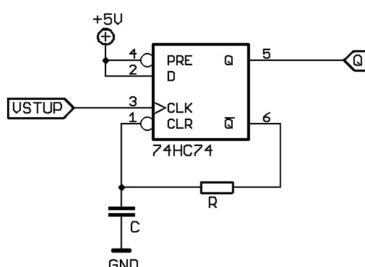
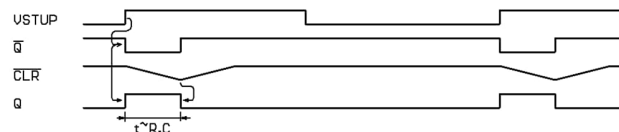
Edge detector

A circuit based on an XOR gate generates a pulse on both the rising and falling edges of the input signal. Also shown is the implementation of the logic function XOR (left) using NAND gates (right). Reasonable pulse lengths are more than a microsecond and significantly less than the duration of the input signal.



Short pulse generator

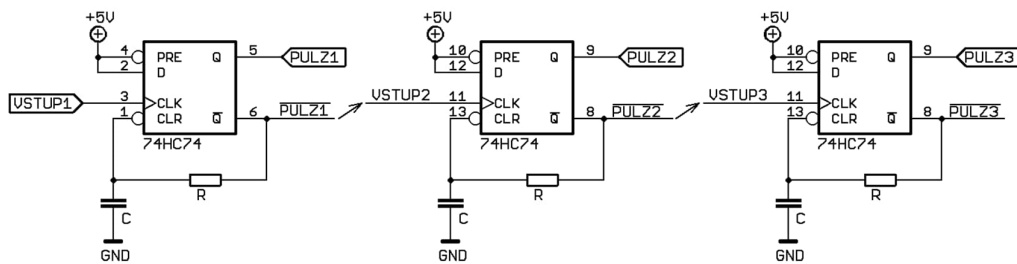
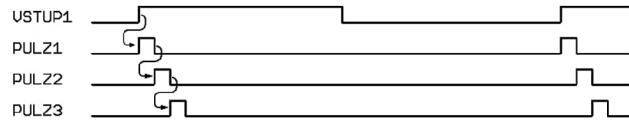
The circuit generates a short 0-1-0 pulse on the rising edge of the input signal. The pulse length is approximately $t \sim RC$. Reasonable pulse lengths are more than a microsecond and significantly less than the duration of the input signal.





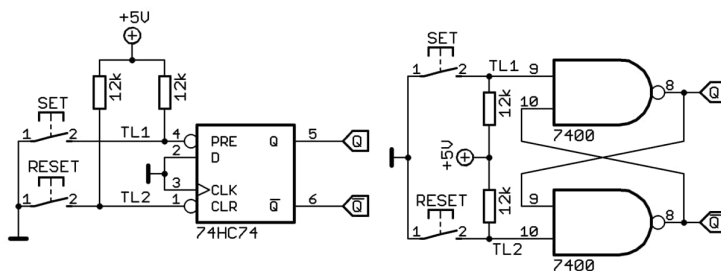
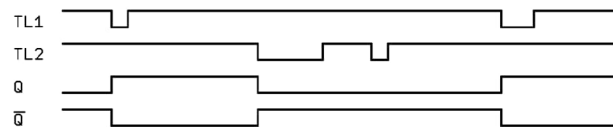
Generator of a series of short pulses

The circuit is based on the connection from the previous point, it uses several chained generators of short pulses. The rising edge of the VSTUP1 signal generates a short pulse PULZ1. This starts the next generator and generates a delayed short pulse PULZ2. In this way, it is possible to generate an arbitrarily long series of pulses, which can be useful for timing, or sequential triggering of events in a more complex circuit. Reasonable pulse lengths are more than a microsecond and significantly less than the duration of the input signal.



RS (set-reset) flip-flop

The RS circuit is a bistable flip-flop circuit that allows memorizing the state, for example, after the arrival of a pulse. It is very often used together with buttons. One button (e.g. Set) is set, the other button (e.g. Reset) is deleted. The picture shows the implementation using the 7474 integrated circuit or the 7400 gates. Both circuits have the same function.





Results

Contestant number:

1. Describe the measurement method in detail. Explain why you have chosen this involvement.
2. Describe the function of the circuit.
3. Calculate or justify the values of the components used.

Detailed list of parts and material used:



Complete circuit diagram, including all component values and IC pin descriptions: