SKILLScomp
Skills competitions for vet development

Współfinansowane przez
Unię Europejską

Competition

Skills Professional

Electronics prototyping

March
11–13,
2024

Tasks competition

TASK
FINAL

MODULE A

Task description

The task involves mounting electronic components on a PCB using soft soldering, through-hole (THT) and surface mount (SMT) technologies.

The participant receives a double-sided PCB and electronic components for assembly.

The quality of assembly of electronic components and the number of correctly soldered components will be assessed.

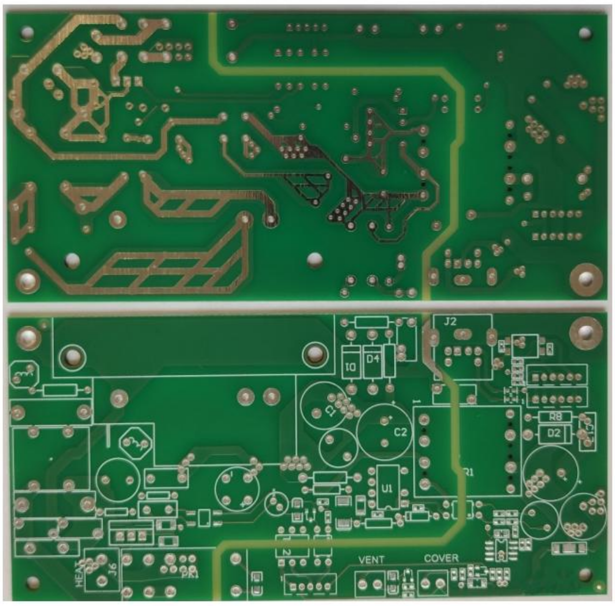


Fig. 1. Printed circuit board intended for soldering components by the participant.

Station equipment:

Soldering station

Replaceable tips for the soldering station
Tinol

Soldering solder suction device

Braid for solder extraction

Soldering iron tip cleaner

Soldering paste

Rosin

Flux

Isopropyl alcohol

Brush

Solder fume extractor

Lamp with magnifying glass

- Mounting bracket for servicing PCBs (so-called third hand)
- PCB service kit (tweezers)
- Side cutters
- Pliers for bending the legs of electronic components
- Silicone soldering mat
- Double-sided PCB
- Components for electronic assembly

The participant may be equipped with:

- Goggles
- Work gloves for cleaning up the work area after work is finished
- Protective clothing

Attention:

Participants are allowed to use their own tools for assembling electronic components.

Evaluation

For the correct completion of all elements of the task, the participant receives 30 points, which consist of the following components:

- Preparing the work station in accordance with occupational health and safety rules and ergonomic principles.
- Compliance with occupational health and safety regulations while working.
- Correct soldering of electronic components.
- Cleaning the PCB of contamination after work is completed.
- Tidying up the workstation after completing the task.

The assessment covers the correct selection of components for soldering locations on the PCB - in accordance with the reference board - and the correct execution of soldering.

Comments:

- Soldered joints should have the correct shape and be light silver in color, free from impurities, foreign inclusions and holes.
- The participant receives photos of soldered components on the master board, which are located on the computer desktop in the folder: **"Module A – soldering".**
- The participant has the opportunity to check the arrangement of soldered components on the reference board at a separate station.
- The participant receives a few more components of a given type (selected components) to solder than are placed on the reference PCB.
- The participant is to solder components that are compatible with the given types, but it is not necessary to mount components that are compatible with the reference parameters (e.g. an electrolytic capacitor is to be soldered in the place intended for soldering an electrolytic capacitor, but its parameters do not have to be compatible with the reference board).
- Not all components soldered on the master board need to be soldered by the participant (the participant should solder the components from among those available at the station).

Working time

- The participant is given a time limit of 120 minutes to complete the task.
- There will be no breaks during the task.

TASK FINAL

MODULE B1

Design and construct a passive band-pass RC filter with a passband from 100 Hz to 900 Hz. Investigate the filter's performance by determining its transfer characteristic Uout (Uin) and frequency response K(f).

Where:

R – resistance,

C – capacity,

AT You – filter output voltage,

Uwe – filter input voltage,

K – amplification (Uwy /Uwe),

f – frequency

To complete the task you must:

1. Select the values of the missing filter parameters.

2. Build the filter system.

Note! By raising your hand, report to the judging panel that you have completed this part of the task (item 2 of module B1) in order to check the quality of your work.

3. Take measurements of the filter system and answer the questions in point c:

a) determine experimentally the transition characteristic and select the values based on it input voltage,

b) experimentally determine the frequency response of the filter and, on its basis, determine the filter cut-off frequencies and the passband width,

c) for what frequency is the filter attenuation the lowest?

A band-pass filter consists of two RC filters: a high-pass filter and a low-pass filter, connected in series. The output signal from the first filter is fed to the input of the second. As a result, frequencies that both filters simultaneously pass are passed, and frequencies that each filter attenuates are attenuated.

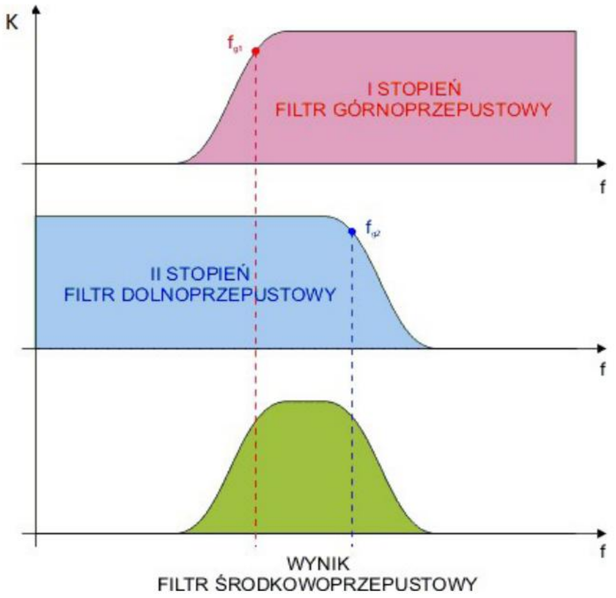
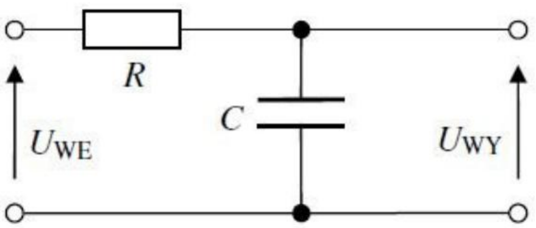


Fig. 1. Amplitude-frequency characteristic of the filter

The cut-off frequencies should be selected so that fg1 < fg2, fg1 – cut-off frequency of the high-pass filter, fg2 – cut-off frequency of the low-pass filter.

A band-pass filter passes frequencies from fg1 to fg2 and attenuates the remaining frequencies. The frequencies passed by the filter constitute the passband. The center frequency of the passband is calculated as the geometric mean of the cutoff frequencies.

Passive RC filters are made based on the diagrams shown below:



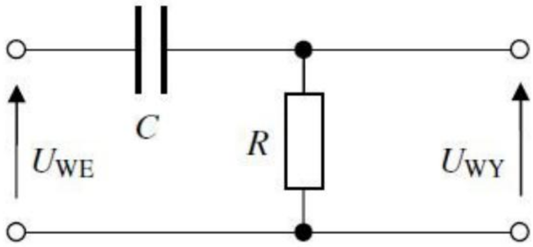


Fig. 2. Schematic diagram of a low-pass RC filter. **Fig. 3.** Schematic diagram of a high-pass RC filter.

The cut-off frequencies of the filters are determined from the following relationship:

$$f_g = \frac{1}{2\pi RC};\ ÿ = \left|\frac{f_p\ \ f_m}{f_m}\right|\ ÿ\ 100\%;$$

Where:

ÿ – measurement error,

f_g – cut-off frequency,

f_p – correct frequency (calculated based on the selected filter parameters),

fm – measured frequency (from the filter frequency response).

The width of a filter's passband is defined as the difference between the upper and lower cutoff frequencies. The quality factor of a filter, Q, is defined as the ratio of the frequency least attenuated by the filter to the width of its passband.

The parameter values of the filter elements that will be used to make it were selected from the E12 series (Table 1):

Table 1. Series E12

E12	10	12	15	18	22	27	33	39	47	56	68	82

Equipment of the stand:

Function generator

Mini electric drill

Vapor filtering absorption station

Soldering station

Universal multimeter

Analog and digital oscilloscope

Set of insulated screwdrivers

Tweezers

Crimping tool for F-type compression plugs Wire stripper

Fitter's knife

Side cutting pliers

Set of metal drill bits

Tin extractor

2m tape measure

Calculator

Safety glasses

DY installation cable 0.5 mm2

TRISET-113 PE coaxial cable type RG6, class A 75 ÿ

F straight compression plug type RG6 (4 pcs.)

Universal double-sided PCB board 20x80mm,

angled mounting socket BNC-G/PCB/KAT F /

BNC adapter

Solder (with rosin)

Braid for solder extraction.

Soldering iron tip cleaner.

Soldering paste

Rosin

Isopropyl alcohol

Lamp with magnifying glass

Mounting bracket for servicing PCBs

Silicone soldering mat

Set of resistors and capacitors from the E12 series

PC computer

Protective clothing - equipment provided by the participant

ATTENTION:

Participants may use their own equipment for assembling electronic components.

The participant should have a scientific calculator

Working time

The participant has a time limit of 300 minutes to complete the task (module B1 and B2).

During the execution of the task, breaks are planned according to the competition schedule.

Completing the task

To complete the task, you should use the following resistors:

R1 = 330ÿ,

R2 = 680ÿ.

Based on the calculations performed, select the capacitor capacitances using the values of the E12 series. Complete Table 2.

Installing the filter system

Identify the resistors that make up the RC filter at the assembly station. The circuit should be assembled on a universal PCB (Fig. 4) using soft soldering and through-hole (THT) assembly. The input and output leads should be terminated with BNC sockets.
-G/PCB. Mount the BNC-G/PCB sockets on the outermost fields of the PCB by drilling the appropriate holes. Make electrical connections using DY 0.5 mm2 wire.

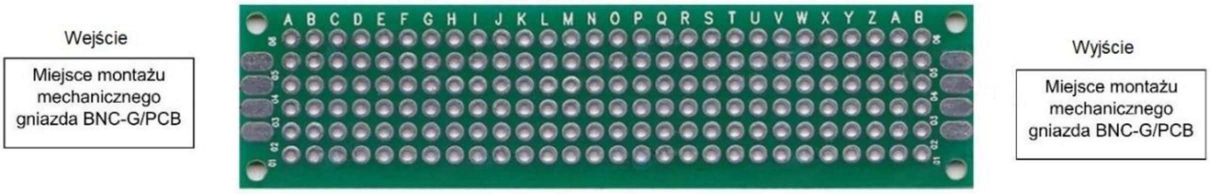


Fig. 4 Universal PCB

To perform the measurements, prepare two 50 cm long coaxial cables terminated with F-type compression plugs. Using the prepared coaxial cables and F/BNC adapters, connect the measurement system according to the block diagram shown in Figure 5.

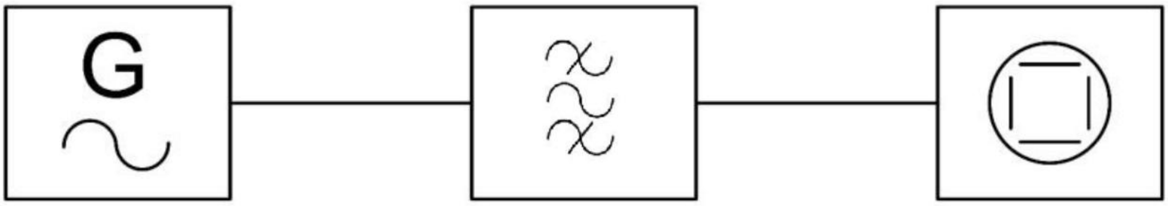


Fig. 5. Block diagram of the measurement system

Table 2. Values of selected parameters and elements of the RC filter (module B1)

No.	Parameter	Designation	Value	Unit of measurement
1	Lower cut-off frequency calculated based on RC parameters used to build the filter (correct value)	fg1		
2	Upper cut-off frequency calculated based on the RC parameters used to build the filter (correct value)	fg2		
3	The lower frequency determined from the frequency response	fgg1		
4	The upper frequency determined from the frequency response	fgg2		
5	Calculated error of the lower frequency measurement	ÿd		
6	Calculated upper frequency measurement error	ÿg		
7	Calculated center frequency	f0		
8	Resistance of resistor R1	R1		
9	Resistance of resistor R2	R2		
10	Calculated capacitance of capacitor C1	C1		
11	The selected capacitance of capacitor C1 from the series E12	Cd1		
12	Calculated capacitance of capacitor C2	C2		
13	The selected capacitance of capacitor C2 from the series E12	Cd2		
14	Selected input voltage value	Uwed		
15	Calculated bandwidth	B		
16	Calculated filter quality factor	Q		

Answer to the question from point 3c of module B1 of the final task:

Transfer characteristic of the RC bandpass filter made in the B1 module

Frequency response of the RC bandpass filter implemented in the B1 module

Frequency response (logarithmic scale) of the RC bandpass filter implemented in the B1 module

TASK FINAL

MODULE B2

Redesign the previously constructed RC bandpass filter so that its Q factor is maximized while maintaining a constant center frequency. Verify the correctness of the task using its frequency response.

To complete the task you must:

1. Select new filter parameters (R and C).

2. Desolder any unnecessary components from the previously made circuit. After desoldering the components, ments clean the PCB.

Note! By raising your hand, report to the judging panel that you have completed this part of the task (item 2 of module B2) in order to check the quality of your work.

3. Build the filter system.

4. Perform measurements of the filter system and answer the questions formulated in the sub-points tach d, e, f:

a) determine experimentally the transfer characteristic and, on its basis, select the input voltage value within the linear part of this characteristic,

b) experimentally determine the frequency response of the newly created filter,

c) prove the improvement of the filter quality factor by comparing the quality factors of the filters made from modules B1 and B2 of the final task.

d) Is the center frequency consistent with that determined in module B1? The answer justifies sit down,

e) How can the selectivity of the filter performed in the task from module B2 be increased by using elements from the E12 series prepared for the task?

Table 3 Values of selected parameters and elements of the RC filter (module B2)

No.	Parameter	Designation	Value	Unit of measurement
1	Lower cut-off frequency calculated based on RC parameters used to build the filter (correct value)	fg1		
2	Upper cut-off frequency calculated based on the RC parameters used to build the filter (correct value)	fg2		
3	The lower frequency determined from the frequency response	fgg1		
4	The upper frequency determined from the frequency response	fgg2		
5	Calculated error of the lower frequency measurement	ÿd		
6	Calculated upper frequency measurement error	ÿg		
7	Calculated center frequency	f0		
8	Selected resistance of resistor R1	R1		
9	Selected resistance of resistor R2	R2		
10	Calculated capacitance of capacitor C1	C1		
11	The selected capacitance of capacitor C1 from the series E12	C2		
12	Calculated capacitance of capacitor C2	Cd1		
13	The selected capacitance of capacitor C2 from the series E12	Cd2		
14	Selected input voltage value	Uwe		
15	Calculated bandwidth	B		
16	Calculated filter quality factor	Q		

Answers to questions from points 4d, 4e of module B2 of the final task:

Transfer characteristic of the RC bandpass filter made in module C

Frequency response of the RC bandpass filter made in module C

Frequency response (logarithmic scale) of the RC bandpass filter implemented in the B1 module

Evaluation

For the correct completion of all elements of the task, the participant receives **40 points,** which consist of the following elements:

Preparing the work station in accordance with the principles of occupational health and safety and ergonomics

Compliance with occupational health and safety regulations while working

Correctly calculated values of RC filter parameters (module B1)

Correct soldering of electronic components and making electrical connections (module B1)

Manufacturing coaxial cables terminated with F plugs

Construction of the measurement system and development of the RC filter characteristics (module B1)

Correctly completed table 2

The correct answer to the question in point 3c

Preparation (cleaning and desoldering of components) of the PCB for the production of the module B2

Correctly calculated values of RC filter parameters (module B2)

Correct soldering of electronic components and making electrical connections (module B2)

Construction of the measurement system and development of the RC filter characteristics (module B2)

Correctly completed table 3 Correct

answer to the question in points 4d, 4e Tidying up the workstation after

completing the task.

TASK FINAL

MODULE C

The task is to build and program an electronic device whose main element is an ATmega328 microcontroller placed on a prototype board compatible with Arduino Uno Rev3.

The competition participant must perform the following activities, which are subject to evaluation:

1) Build a robot arm from the provided components.

2) Program the constructed robot arm so that it can be controlled using the supplied Joystick.

3) Program the robot arm so that when entered via UART (Universal Asynchronous Receiver-Transmitter), it automates the execution of activities.

When performing the task, it is allowed to use all technical documentation and information available on the Internet, as well as your own materials.

Note 1) The competition stand contains a set of components from which a robot arm must be constructed. The assembled arm, serving as an example, is available for viewing by all competitors at any time. Technical documentation and several illustrative photographs are located in the MIKROKONTROLER folder on the computer's desktop.

Re. 2) The second stage of the task will involve launching the constructed robot and programming it so that it can be controlled using the provided joystick. Successful completion of this task is considered the transfer of three elements from a predetermined location to another predetermined location (behind line X). The participant indicates their readiness for evaluation by raising their hand to the judge. Time and precision in completing the task are measured.

Ad. 3) The ATmega 328 microcontroller should be programmed so that the robot can move three elements marked 1, 2, and 3, which are placed in any position on the numbered lines (respectively marked 1, 2, and 3), to line 4, stacking the elements one on top of the other. It is assumed that the order of the elements being moved during task verification is entered randomly from the computer keyboard (using the serial port monitor), e.g., "1 3 2," and the robot arranges the elements in that order.

If one number is missing in the record, e.g. "2 3", the robot will be the third one to move the element that is not listed (in this case with the number "1").

If you enter only one number (e.g., "2"), the element whose number you entered will be transferred first (in this case, "2"), followed by the remaining elements in order of increasing element numbers (in this example: "1" and then "3").

ATTENTION:

It is forbidden to establish contacts using computer networks and telecommunications devices, e.g. chats, forums, e-mail, smartwatches, etc. under penalty of disqualification from the competition.

Station equipment:

A computer with Arduino IDE software installed and internet access.

Complete robot kit in self-assembly version.

Wiring for programming the robot.

The board and elements needed to complete the task.

Set of screwdrivers.

Set of open-end wrenches.

Working time

To complete the task, the participant has a time limit of **120 minutes – the first part and 60 minutes – the second part.**

During the entire task, breaks will be planned according to the competition schedule.

Evaluation

For the task, the participant can receive a maximum of **30 points,** which consist of the following elements:

Preparing the work station in accordance with the principles of occupational health and safety and ergonomics.

Compliance with occupational health and safety regulations while working.

Correct assembly of the device.

Programming the device to perform a given task.

Tidying up the workstation after completing the task.