

Electronic assembly

1. Final task assignment

In this test contestants will study the control of a servomotor or ESC (Electronic Speed Controller) of a brushless motor with the aim of completing an electronic control board.

Their skills will be assessed in two tests:

- A first test (3 hours): they will have to implement their skills of design and realization of an analog electronic function (PWM or MLI) in order to attack the motor control (ESC or integrated electronics).
- A second test (3 hours): on the one hand, they will have to use their troubleshooting skills and on the other hand, their skills in electronic board brazing.

The expected results will concern:

- The understanding of the technical documentation of electronic components;
- The relevance of the components implemented in the analog function;
- The dimensioning of the values and the choice of the components of the circuit;
- The mastering of tools of measurement and acquisition in electronics;
- The troubleshooting of the functionalities of an electronic card;
- The mastering of the techniques of electronic brazing.

TEST A: CASE STUDY AND DATA COLLECTION

During this part, the contestants will have to carry out the wiring or the soldering of circuits and to take note with the oscilloscope of the required curves.

The notation will take into account the relevance of the values of the components, the precision of the results, the harmony of the wiring...

Competitors may use either the test plates or the soldering prototyping plates.

The reference TABLE refers to the letter of the table assigned to the competitor during the draw.

A.1 Study of the control of a servomotor type FS90R

A.1.1 Make the wiring according to the following description.

Cf ANNEX A.1.1

Read the curve of the "signal" command just when the motor switches from stop to run in a clockwise direction.

Straight after, save the oscillogram on your USB key under the reference TABLE.1.1.1 and make a copy to the jury table.

A.2 Study of the control of a brushless motor of type Pichler BOOST 18 motor (Brushless)

The ESC must be supplied with 12V, 2A.

A.2.1 Make the wiring according to the description below.

Cf ANNEX A.2.1

Using a method of your choice, record the oscillograms of the three phases of the motor in accordance with the time of the control signal at the moment when the motor switches from stop to run.

Straight after, save the oscillogram on your USB key under the reference TABLE.1.2.1 and make a copy at the jury table.

A.3 Design of PWM signal generator circuits

During this test, the contestants will have to create on a the circuit testing board or on a prototyping plate to be soldered, various PWM generator circuits in order to interface the ESC module. The documentation of the components is provided in appendix.

The criteria for the creation of the interfacing circuit are:

- The circuit must be supplied with a unipolar power supply +5 V, 1A ;
- The variation of the control signal must be generated with a potentiometer;
- The output signal (PWM) has an amplitude of 0V - 5V \pm 5%;
- The frequency of the output voltage (PWM) must be in the range of 50Hz to 200Hz;
- The output voltage (PWM) must be able to control the ESC in order to start and stop the motor;
- At the input (left), the assembly must have a black wire (ground) and a red wire (power);
- At the output (right), the assembly must have a green wire (signal) and a black wire (ground);
- The time of the high state of the PWM must vary at least from 800uS to 1200uS \pm 10%.
- The ESC must be powered by 12V, 2A.

At the end of the module, contestants must provide the functional, unpowered and unconnected circuits according to the stated criteria.

The questions can be treated in any order.

Note: The BEC (Battery Eliminator Circuit) of the ESC module can be used for the 5V supply.

A.3.1 Using the NE555 component, make an assembly to control the ESC of the brushless motor at your disposal. You can propose an assembly or follow an example of assembly attached in appendix A.3.1. Your assembly will have to be created on a test plate or a soldering plate in compliance with the specifications.

Using a method of your choice, record the oscillogram of the three phases of the brushless motor in accordance with the time of the control signal at the time when the motor goes from stop to run.

Straight after, save the oscillogram on your USB key under the reference TABLE.1.3.1 and make a copy at the jury table.

A.3.2 Using the LM324 component, make an assembly to control the ESC of the brushless motor at your disposal. You can propose an assembly or follow an example

of an assembly attached in appendix A.3.2. Your assembly will have to be created on a circuit testing board or a soldering plate respecting the specifications.

Using a method of your choice, record the oscillogram of the three phases of the brushless motor in accordance with the time of the control signal at the time when the motor goes from stop to run.

Straight after, save the oscillogram on your USB key under the reference TABLE.1.3.2 and make a copy at the jury table.

A.3.3 Using 2N2222 transistors, make an assembly to control the ESC of the brushless motor at your disposal. You may propose a circuit or follow the example of a circuit attached in appendix A.3.3. Your assembly must be created on a test plate or a soldering plate in compliance with the specifications.

Using a method of your choice, take the oscillogram of the three phases of the brushless motor in accordance with the time of the control signal according to the instructions.

Immediately, save the oscillogram on your USB key under the reference TABLE.1.3.3.

The competitors must provide the soldering or circuit testing boards and the USB key respecting the constraints indicated above at the end of the test.

TEST B: TROUBLESHOOTING AND SOLDERING

At the end of the event, competitors must provide:

- An electronic power amplifier board (200W) functional under the criteria imposed;
- A functional electronic board interfacing a brushless motor. In order to test the capabilities of the finished board, it is possible to use the control board provided (shield) to create the rotation of the brushless motor;

Set point for the power amplifier: Symmetrical power supply of the card (+20V, 1A) and (-20V, 1A).

Set point for the card interfacing the brushless motor: 12V, 2A supply.

B.1 Troubleshooting and completion of the power amplifier board (Appendix B.1)

B.1.1 Troubleshooting

A faulty and incomplete electronic board is provided to competitors. Using the technical documents available for the event, the competitor must locate the errors, and if necessary, troubleshoot the errors on the board.

B.1.2 Soldering of missing through-hole components

Complete the board to make it operational.

On the final board, take the oscillogram of the input voltage (sinusoidal of 1V peak to peak, frequency 1kHz) and the output voltage in time concordance.

Straight after, save the oscillogram on your USB key under the reference TABLE.B.1.2 and make a copy to the jury table.

B.2 BRUSHING of the control board of a BRUSHLESS motor (Appendix B.2)

The supply voltage must respect (12V, 2A) ;

B.2.1 Soldering of a mixed component board

Using the technical documents provided, solder the electronic board interfacing the brushless motor.

B.2.2 Testing the board

By attaching the control board (shield) to the finished board, the assembly must cause the brushless motor to rotate;

The assembly allows the rotation speed of the brushless motor to accelerate or slow down by using of the push buttons.

At the end of the event, the competitors must provide a functional power amplifier board and a brushless motor control board.

2. Allocated time: 6 hours

The contest duration is 6 hours.

Test A: 3 hours.

Test B: 3 hours.

3. Requirements

- ✓ At the beginning of each task, the jury will collect all communication devices (cellphone, connected watch, digital tablet...) which will be returned at the end of each task.
- ✓ Any contestant caught cheating, talking to someone from the public or using communication device will suffer a penalty of 5 points for the first transgression. A second transgression will lead to an exclusion from the contest.
- ✓ Contestants must:
 - respect the safety rules and the jury's instructions.
 - keep their workstation neat and organized during the test.
 - use only the equipment, components and cards provided for the test.
 - check that the instruments provided for the test are working properly.

4. Procedure

Day - 1 (March 23rd): On the day before the competition, contestants will be welcomed by members of the jury. A briefing about the organization of the competition and the safety rules will be arranged. Contestants will draw lots to be assigned to a work station.

Day 1 (March 24th): Contestants will have 3 hours to complete Test A.

Day 2 (March 25th): Contestants will have 3 hours to complete Test B.

5. Scoring criteria

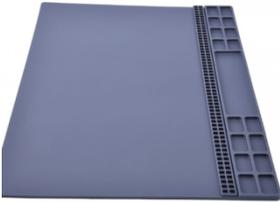
N°	Items to be evaluated	O/S	Scoring scale
TEST A: CASE STUDY AND DATA COLLECTION			50
01	A.1.1 Present and correct oscillogram of the FS90R control <i>A.1.1 Oscillogramme présent et correcte de la commande FS90R</i>	O	2,5
02	A.2.1 Present and correct oscillogram of the ESC control <i>A.2.1 Oscillogramme présent et correcte de la commande ESC</i>	O	2,5
03	A.3.1.1 Correct oscillogram <i>A.3.1.1 Oscillogramme correct</i>	O	2,5
04	A.3.1.2 The manipulation of the potentiometer generates TH = 800 $\mu\text{s} \pm 5\%$. <i>A.3.1.2 La manipulation du potentiometre génère TH = 800 $\mu\text{s} \pm 5\%$</i>	O	2,5
05	A.3.1.3 The manipulation of the potentiometer generates TH = 1200 $\mu\text{s} \pm 5\%$. <i>A.3.1.3 La manipulation du potentiometre génère TH = 1200 $\mu\text{s} \pm 5\%$</i>	O	2,5
06	A.3.1.4 Harmony of the NE555 based assembly <i>A.3.1.4 Harmonie du montage à base du NE555</i>	S	7,5
07	A.3.2.1 Correct oscillogram <i>A.3.2.1 Oscillogramme correct</i>	O	2,5
08	A.3.2.2 The manipulation of the potentiometer generates TH = 800 $\mu\text{s} \pm 5\%$. <i>A.3.2.2 La manipulation du potentiometre génère TH = 800 $\mu\text{s} \pm 5\%$</i>	O	2,5
09	A.3.2.3 Handling the potentiometer generates TH = 1200 $\mu\text{s} \pm 5\%$. <i>A.3.2.3 La manipulation du potentiometre génère TH = 1200 $\mu\text{s} \pm 5\%$</i>	O	2,5

10	A.3.2.4 Harmony of the LM324 based board <i>A.3.2.4 Harmonie de la carte à base de LM324</i>	S	7,5
11	A.3.3.1 Correct oscillogram <i>A.3.3.1 Oscillogramme correct</i>	O	2,5
12	A.3.3.2 The manipulation of the potentiometer generates TH = 800 $\mu\text{s} \pm 5\%$. <i>A.3.3.2 La manipulation du potentiometre génère TH = 800 $\mu\text{s} \pm 5\%$</i>	O	2,5
13	A.3.3.3 The manipulation of the potentiometer generates TH = 1200 $\mu\text{s} \pm 5\%$. <i>A.3.3.3 La manipulation du potentiometre génère TH = 1200 $\mu\text{s} \pm 5\%$</i>	O	2,5
14	A.3.3.4 Harmony of the board with transistors <i>A.3.3.4 Harmonie de la carte avec transistors</i>	S	7,5
TEST B: TROUBLESHOOTING AND SOLDERING			50
15	B.1.1.1 Correction of the LED LD1 <i>B.1.1.1 Correction de la LED LD1</i>	O	2,5
16	B.1.1.2 Resistance R2 correction <i>B.1.1.2 Correction de la resistance R2</i>	O	2,5
17	B.1.1.3 Correction of the resistance R8 <i>B.1.1.3 Correction de la resistance R8</i>	O	2,5
18	B.1.1.4 Correction of the resistance R9 <i>B.1.1.4 Correction de la resistance R9</i>	O	2,5
19	B.1.2.1 Resistors well oriented <i>B.1.2.1 Résistances bien orientées</i>	O	2,5
20	B.1.2.2 Well oriented capacitors <i>B.1.2.2 Condensateurs bien orientés</i>	O	2,5
21	B.1.2.3 Soldering quality <i>B.1.2.3 Qualité des soudures</i>	S	5
22	B.1.2.4 The gain is correct <i>B.1.2.4 Le gain est correcte</i>	O	2,5
23	B.1.2.5 Harmony of the board <i>B.1.2.5 Harmonie de la carte</i>	S	2,5
24	B.2.1 Throughput resistors well oriented <i>B.2.1 Resistances traversantes bien orientés</i>	S	2,5
25	B.2.2 Well oriented SMD resistors <i>B.2.2 Resistances CMS bien orientés</i>	O	2,5
26	B.2.3 IR 2401 + MOSFETs well oriented <i>B.2.3 IR 2401 + MOSFETs bien orientés</i>	O	2,5
27	B.2.4 Leds are all well oriented <i>B.2.4 Les leds sont toutes bien orientées</i>	O	2,5
28	B.2.5 Correct implementation of other components (other than resistors, leds) <i>B.2.5 Implentation correcte des autres composants (autres que resistances, leds)</i>	S	2,5
29	B.2.6 Quality of soldering <i>B.2.6 Qualité des soudures</i>	O	5
30	B.2.7 Harmony of the board <i>B.2.7 Harmonie de la carte</i>	O	5

31	B.2.8 Functioning with the shield B.2.8 Fonctionnement avec le shield	0	2,5
TOTAL POINTS			100

6. List of equipment

LIST OF THE PROVIDED EQUIPMENT				
N°	Equipment	Photo	Qty per contestant	Specifications
01.	Power supply		1	ISO-TECH IPS 3303
02.	4-channel oscilloscope		1	DSO-X 2014A Agile Technologies
03.	Oscilloscope probe		3	
04.	Function generator		1	Keysight 33500B
05.	Prototyping test stage		1	
06.	Test plate to be welded		1	
07.	Pair of red and black banana test leads		1	
08.	Pichler BOOST 18 motor mounted on bracket		1	
09.	Digital Multimeter		1	Agilent 34405A
10.	Hobbywing Skywalker 50A 5A UBEC		1	
11.	FS90R		1	

12.	Desk lamp		1	
13.	Soldering iron		2	
14.	Soldering iron holder		1	
15.	Iron filings		1	Used for cleaning soldering
16.	Fan		1	
17.	Frame for soldering, rework, desoldering		1	
18.	LED Magnifier		1	
19.	Welding mat		1	
20.	Set of pliers		1	
21.	Component bender		1	
22.	Tweezer		1	

23.	Set of wires		1	
24.	Brazing (Fine for CMS)		1	
25.	Brazing for through-hole components		1	
26.	Desoldering braid		1	
27.	Resistor component set		2	
28.	Set of capacitor components		2	
29.	Flux syringe		1	
30.	Desoldering pipette		1	
31.	Banana cables + oscillo probes + BNC cable		1	
32.	Various components (transistors 2N2222, LM324, NE555...			

7. Appendix

THE FOLLOWING SUPPORTING DOCUMENTS ARE PROVIDED SEPARATELY:

- Technical documentation of the components
- Schematic of the different boards
- Various documents for different functions of the electronics

Appendix 1 Servomotor FS90R

Appendix 2 Pichler BOOST 18

Appendix 3 ESC Hobbywing Skywalker 50A 5A UBEC

Appendix 4 NE555

Appendix 5 LM324

Annex 6 Transistor 2N2222

Annex A.1.1 wiring diagram FS905

Annex A.2.1 wiring diagram Pichler BOOST 18

Appendix A.3.1 Wiring diagram with NE555

Appendix A.3.1 wiring diagram with LM324

Appendix A.3.1 wiring diagram with 2N2222 transistors

Appendix B.1 Wiring diagram for power amplifier

Appendix B.2 Wiring diagram for Brushless motor interface board