Organizers: "Politehnica" University of Bucharest – Faculty of Electronics, Telecommunications and Information Technology
Center for Technological Electronics and Interconnection Techniques

1 General description of the project

The project goal is to design and generate layout and fabrication files for the electronic system of a vehicle instrument cluster, as shown in figure 1.

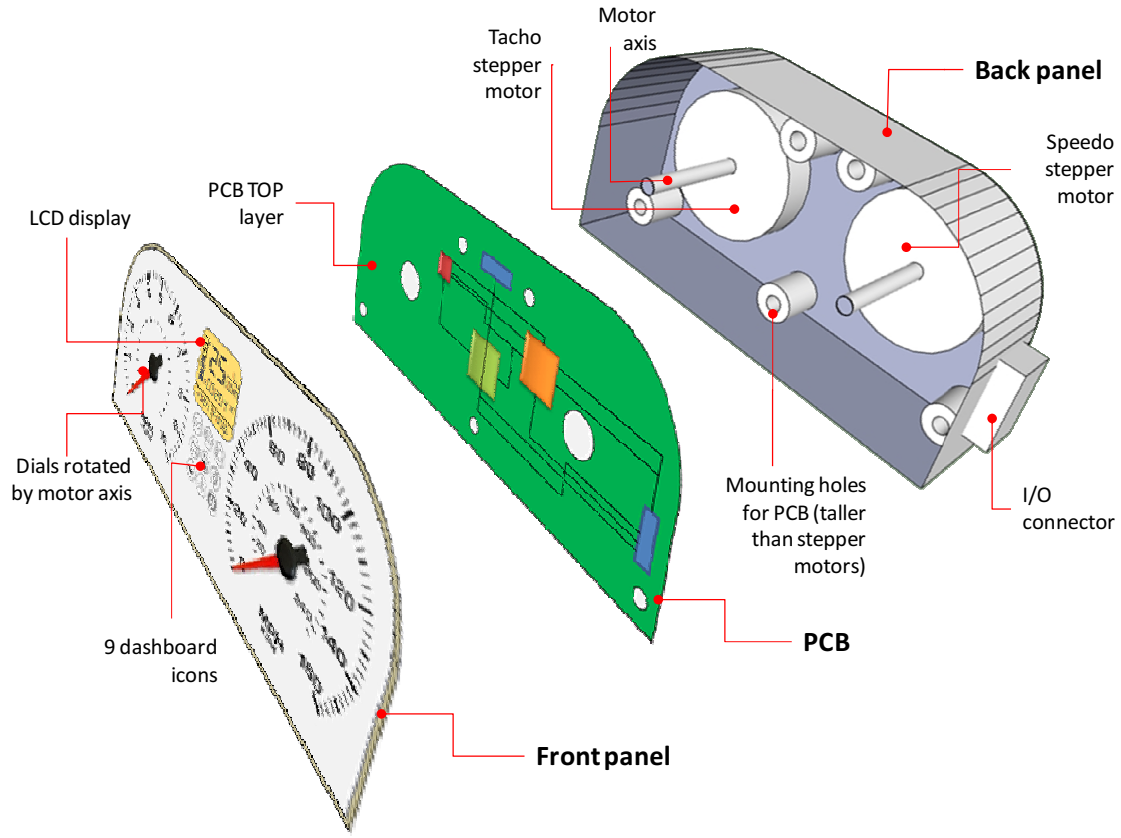

Figure 1. Vehicle instrument cluster.

The vehicle instrument cluster has three (3) parts:

1. Front panel: tachometer and speedometer dials, multi-purpose display and 9 dashboard icons;
2. **PCB** – electronic system of the instrument cluster – **this is the part that should be designed**;
3. Back panel – Aluminum housing having two stepper motors and interface connector already mounted.

The **block diagram** of the electronic system for which the PCB should be designed is shown in figure 2. The complete **schematic diagram** is presented in page 5.

The **PCB** of instrument cluster system consists in the following blocks:

- Speed ctrl (U1) – controls: the speedometer stepper motor, backlight LEDs and dashboard lights;
- Tacho ctrl (U2) – controls: the tachometer stepper motor, corresponding backlight LEDs and LCD display;
- PCB I/O connector (J5 placed on top side) – connecting the PCB with LIN bus, power supply lines and programming signals for U1 and U2;
- Stepper motors connectors (J1, J3 – placed on the bottom side) – connecting the PCB with stepper motors mounted on the back panel;
- 12 backlight LEDs (6 LEDs for each dial) – mounted on the PCB, beneath the dials on a circular path;
- Display connectors (J2, J4 placed on top side) – connecting the PCB with dashboard lights unit and LCD unit mounted on the front panel.

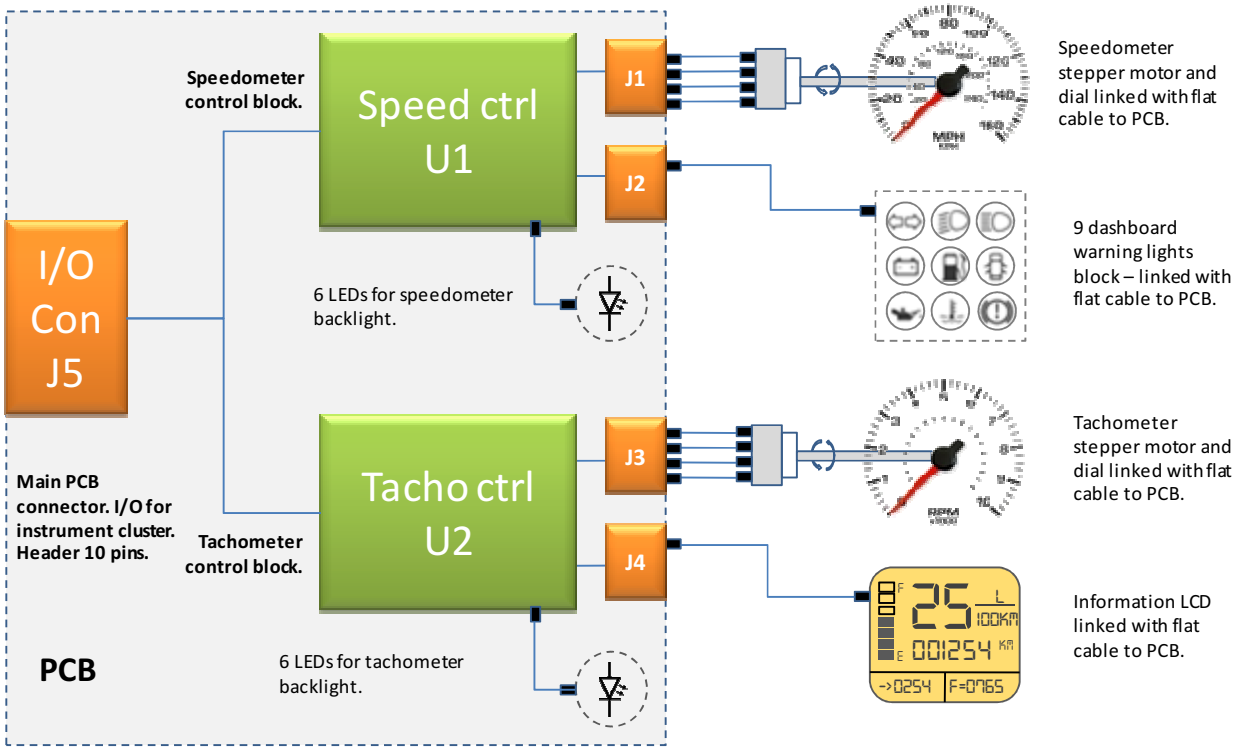

Figure 2. Block diagram of the instrument cluster system.

Short functional description:

- The instrument cluster system receives information (speed, tacho, warnings, odometer, trip, etc.) over the LIN bus (J5) and displays the information using driver circuits (U1, U2) for driving needle of dials, lights or information display.
- The functionality of each driver circuit is factory programmed using the same J5 connector, over a serial interface.

2 General requirements and specifications

GEN-001	The design order is mandatory: libraries, schematic design, transfer procedure, layout design and post-processing activities.
GEN-002	All dimensions should be considered in metric system.
GEN-003	The project will be created using any CAD system accepted in the contest.

3 Schematic design specifications (80 points)

SCH-001	The components U1, U2 and U3 will be created in a new library named with the last name (surname/family name) of the contestant.
SCH-002	The schematic should be drawn in a clear manner, e.g.: all references and values should have proper size and orientation, un-necessary crossings should be avoided.

Note: the schematic should be electrically correct, clean and readable. The purpose of it is to generate a correct netlist for PCB design. Do not waste time trying to replicate artwork or explanations as in page 5.

4 Mechanical design specifications (20 points)

MEC-001	Back panel (Aluminum housing) geometry is specified in figure 3. The PCB should fit the back panel.
MEC-002	The back panel has 5 holes (5 mm diameter) for PCB fixing screws. Your PCB should accommodate all the 5 screw holes (non-plated) in order to be fixed firmly.
MEC-003	The stepper motors are already fitted on the back panel. You should provide 2 holes (20mm diameter) in the PCB (see figure 3) for motor's axis, with specified size and position.

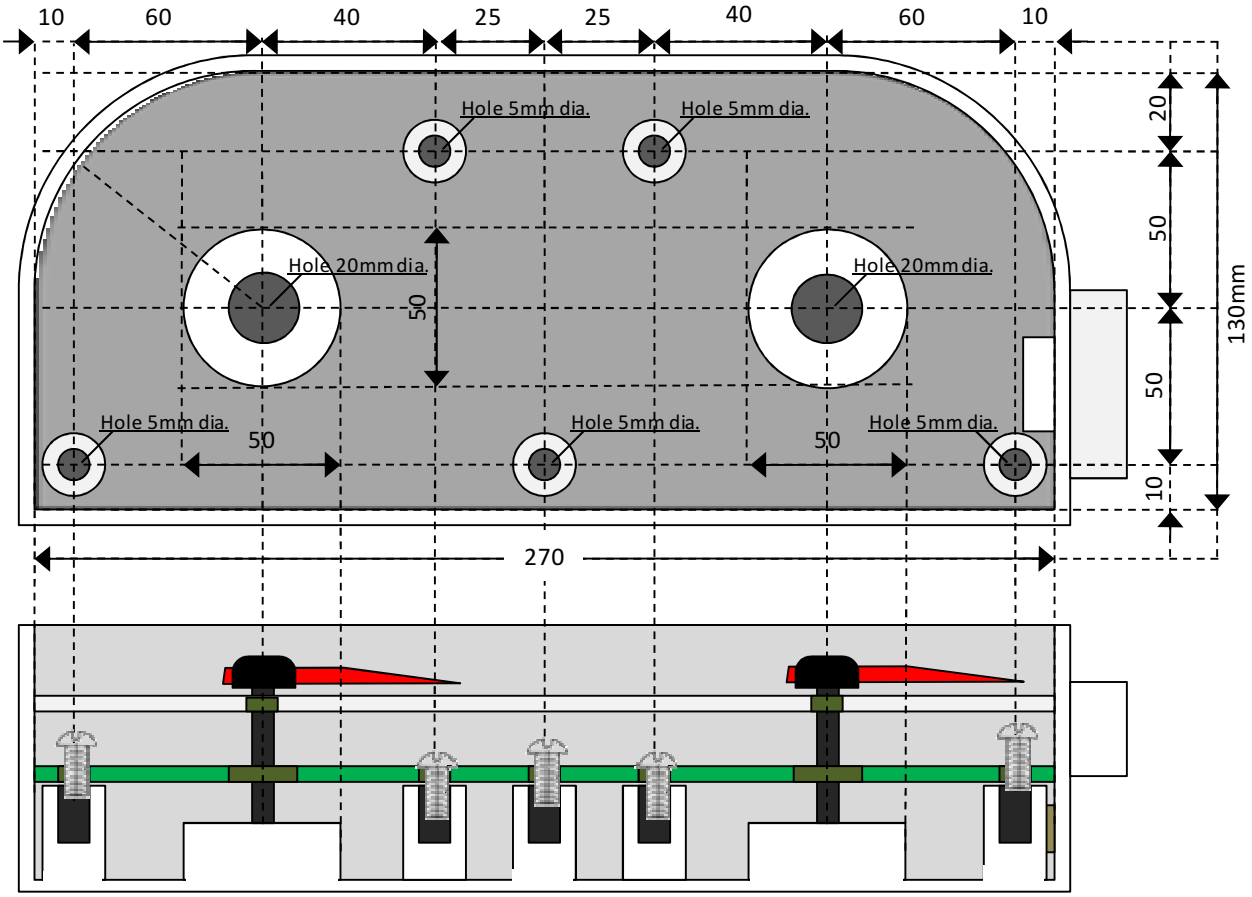

Figure 3. Mechanical drawing for back panel Aluminum housing (all dimensions are in [mm]).

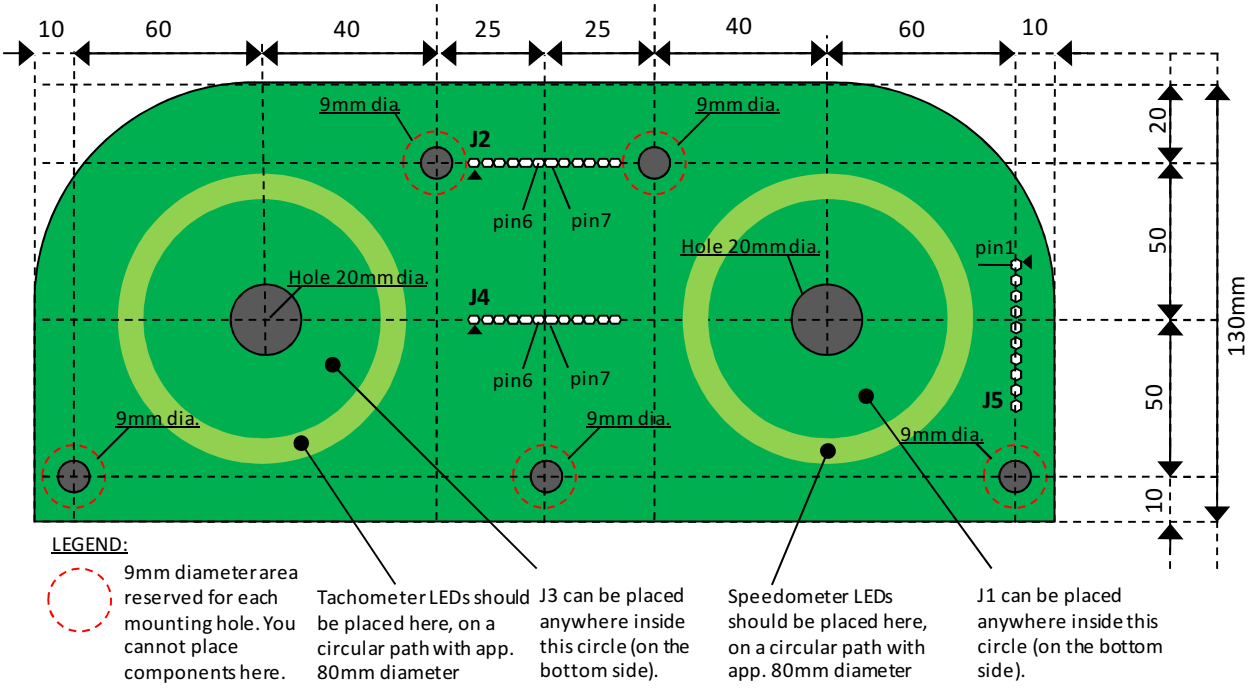

Figure 4. Placement for critical components (J2, J4, J5 – critical). J5 has to be placed at 10mm from board edge, vertical position should be up to designer's choice. All dimensions are in [mm].

Notes:

- 12 backlight LEDs should be placed on the PCB beneath the speedo and tacho dials (6 LEDs for each), on the circular path presented above;
- J2 and J4 connectors should be placed exactly as specified in the placement diagram in order to fit the corresponding connectors for dashboard lights and LCD display (already mounted on the front panel);

5 Layout design specifications (140 points)

PCB-001	Components footprints and layout guidelines are specified in the attached datasheets. Accepted tolerance is ±0.1 mm, except for pitch values where no tolerance is allowed.
PCB-002	The layout design should take into consideration a double-sided PCB with 35µm copper thickness on each layer. Minimum copper width is 0.2 mm and minimum clearance is 0.2 mm.
PCB-003	Vias will have 0.6 mm drill and 1.27 mm pad diameter.
PCB-004	Placement should follow the instructions given in figure 4. Components should be placed on top side, except for J1 and J3 – placed on the bottom side.
PCB-005	Backlight for dials will be provided by LEDs (D1…D6, D10…D15) placed in a proper manner beneath dials, as presented in figure 4.
PCB-006	All components footprints are specified in table 1. Use provided datasheets for more information.
PCB-007	Component U3 should be provided with both footprints (SOIC−14 and TSSOP−14) on the same layout. In this way, the PCB can be equipped with SOIC−14 or TSSOP−14, depending on the stock situation of the manufacturer.
PCB-008	Layout recommendations for U1, U2 are mandatory. (see page 44 from U1_U2_MM908E625.pdf).
PCB-009	The copper width for ground and power lines, for each driver circuit (U1 and U2), should be sized for a maximum current of 1.5 A (ΔT = 10°C).
PCB-010	The copper width for stepper driver and high-side outputs (pins HB1, HB2 HB3, HB4 and HS) should be sized for a maximum current of 1.0 A (ΔT = 10°C).

6 Test specifications (10 points)

TST-001	Test pads (according to IPC) should be placed on a 2.54 mm spacing grid.
TST-002	Global fiducial markers, having circular shape, according to IPC, must be introduced in a proper number.
TST-003	Local fiducial markers will be placed for components U1 and U2.

7 Fabrication specifications (20 points)

Note: generation of fabrication files is accepted only with, at least, partial routing.

FAB-001	The necessary PCB fabrication files (in extended Gerber format) should be provided.
FAB-002	Distinct files for non-plated and plated holes should be provided.
FAB-003	Distinct files for board outline cut-out and inside cut-outs (e.g.: for motor axis holes) should be provided.
FAB-004	Pick-and-place file for all SMT components must be generated. Make sure that all insertion points are centered on components bodies.
FAB-005	A list of testpoint co-ordinates should be created, as a text file.
FAB-006	The assembled PCB will be produced in 2 versions: one full version and one reduced version (without the electronic components associated with tachometer and LCD display). You should provide a second set of assembly files for the reduced version, whilst keeping the same PCB.

Item	Quantity	Reference	Value	Package
1	7	C1,C4,C5,C6, C9,C12,C13	100nF	C0402
2	2	C2,C10	330uF	D (7343)
3	2	C3,C11	100pF	C0402
4	12	D1..D6, D10..D15	LED	LED 1206
5	3	D7,D16	MRA4007T3	SMA (403D)
6	2	J1,J3	CON6	Header 0.100" 6 way
7	2	J2,J4	CON12	Header 0.100" 12 way
8	1	J5	CON10	Header 0.156" 10 way
9	2	L1,L2	MMZ2012	L0805
10	12	R1,R2,R3,R4,R5,R6,R8,R9,R10,R11,R12,R13	1k2	R0402
11	16	TP1.. TP16	test point	test pad
12	2	U1,U2	MM908E625	54-PIN SOICW-EP
13	1	U3	74HC125	SOIC−14 and TSSOP−14
14	2	V1,V2	VAR	V1608

Table 1. Bill of materials (BOM) for the instrument cluster system.