

**P09222 Formula SAE Engine Control Unit  
Assembly & Manufacturing Plan**

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**1. Assembly Process**

- a. The Engine Control Unit PCB will be designed using Advanced Circuits PCB Artist program. This shall be a continuation of the previous year's design and shall incorporate the testing changes made during Senior Design I.
- b. Four copies of the PCB shall be ordered through the Senior Design office: one for use in software/hardware testing, one for use in burn-in testing, one for emergencies (such as board damage), and one for next year's design team to use. Board manufacturing will take from 1.5 to 2 weeks.
- c. Parts for board population will be ordered from the Senior Design office. Parts sufficient to construct up to three boards shall be ordered after taking into account existing part supplies and the updated Bill of Materials. Part orders will take four to five business days to complete.
  - i. Any parts found to have a limited availability shall be documented and a notice placed on the EDGE website for future FSAE ECU projects to investigate potential replacements. A large 'final order' of these parts will be placed so that enough are available to both construct the necessary boards and complete testing on any future replacements.
- d. Construction of the protective case will be performed by Giovanni Sorrentino. The case design will incorporate features from the previous year's design and improve upon them. Case manufacturing will take 4 to 5 weeks.
- e. Upon receiving the manufactured PCB and sufficient parts to completely construct one of the ECU boards, assembly of the first board will take place in the Rochester Institute of Technology Center for Electronics Manufacturing & Assembly located in Building 78 (CIMS) by Dereck Bojanowski, Robert Joslyn, and Andrew Rittase. This board will be used in hardware/software testing.
  - i. Simple ECU changes shall be made in the Senior Design Testing Lab if possible. More advanced or difficult changes will be made in the SMT Lab.
  - ii. Any changes made to the ECU during testing will be documented and sent to Robert Joslyn for PCB revisions. All documentation will be placed on the EDGE website.
- f. Assembly of the first board will be followed by construction of a second ECU. This will also be constructed in the RIT SMT Lab, but by Andrew Rittase and Dereck Bojanowski. This board shall be used for burn-in testing.
- g. A unique programming cable will be constructed for use in JTAG programming from the front connector. This will allow for external programming after the ECU has been sealed within its protective case. This will be completed in the Senior Design Testing Lab by Andrew Rittase and Dereck Bojanowski.
- h. Upon completion of the necessary software and hardware testing, the ECU shall be sealed inside the final version of its protective case and presented to the RIT Formula Team.

- i. The completed programming cable will also be given to the RIT Formula Team at this time.
- ii. All necessary documentation for ECU operation will be delivered to the RIT Formula Team at this time.

## **2. Fabrication Process**

- a. Fabrication of the ECU will be completed in the Rochester Institute of Technology Center for Electronics Manufacturing & Assembly located in Building 78 (CIMS). Components will be added to the ECU in the following order:
  - i. Integrated Circuits (including MOSFET devices in chip form)
    - 1. Number of pins
      - a. Reference Number on PCB
  - ii. Inductors
    - 1. Reference Number on PCB
  - iii. Crystal Oscillator
  - iv. Diodes/Regulators
    - 1. Reference Number on PCB
  - v. Resistors
    - 1. Reference Number on PCB
  - vi. Capacitors
    - 1. Reference Number on PCB
  - vii. Fuses
    - 1. Reference Number on PCB
  - viii. Connectors
    - 1. JTAG
    - 2. MOTEC Connector
- b. Fabrication of the ECU protective case will be completed in the Rochester Institute of Technology Machine Shop located in Building 9. The case will be assembled in the following order:
  - i. Base weight reduction
  - ii. Cooling fin reduction
  - iii. Lid cut from stock
  - iv. Sidewall reduction
  - v. Case Assembly Weld
  - vi. Lid Fastening & PCB Offsets installed
  - vii. PCB and thermal interface installed
  - viii. Case sealed watertight
- c. Fabrication of the external programming cable will be completed in the Senior Design Testing Lab. The cable will be fabricated in the following manner:
  - i. Cable Wiring
  - ii. Cable Connector (ECU) attached to Wiring
  - iii. Cable Connector (Power Supply) attached to Wiring
  - iv. JTAG attached to Wiring
- d. Any of these Fabrication Processes may be changed at any time and without notice under the following conditions:
  - i. Parts are not available at the moment while parts in future steps are available
  - ii. Testing shows that certain parts/conditions are not required for successful operation can be eliminated

- iii. Per request placed by a an authoritative source or member of the P09222 Formula Team
- iv. The information contained within this testing document is shown to be inaccurate or misinformed and can be proven using pre-existing documentation or evidence

### **3. Estimated Resource Requirements**

- a. PCB
  - i. PCB boards will be designed using the PCB Artist software.
  - ii. PCB Artist is custom software from Advanced Circuits, whom the boards will be ordered from.
  - iii. All orders shall go through the Senior Design office and will include the following approvals:
    - 1. Verbal approval from Prof. Slack.
    - 2. Written approval from Prof. Nye on the purchase order.
- b. ECU Electronic Components
  - i. The parts for the ECU will be ordered from the list of pre-approved vendors off of the Senior Design Purchasing Guidelines
    - 1. All inductors are excused from this rule on the condition that they are ordered directly from the manufacturer
  - ii. No parts other than those listed on the most current version of the Bill of Materials shall be ordered and in no more than three times the requirement necessary for the construction of a single ECU after taking into account existing stock supplies.
    - 1. Due to problems during Formula SAE Engine Control Unit Gen. 2's testing, 0.5A and 1.0A fuses may ignore this requirement.
    - 2. All parts with a minimum purchase order that will exceed this requirement may ignore this requirement.
  - iii. All parts shall be ordered through the Senior Design Purchasing Office. This will include the following approvals:
    - 1. Verbal Approval from Prof. Slack (Faculty Guide)
    - 2. Written Approval from Prof. Nye on the Purchase Order (Faculty Guide)
    - 3. Written Approval from Bob Raymond on the Purchase Order (team purchasing agent)
  - iv. Part orders for parts which may be difficult to order will be placed in an order separate from any major component orders to speed up purchasing time.
  - v. Parts ordered will be RoHS compliant if possible
- c. ECU Protective Case
  - i. The protective case will be made using existing materials from the Formula SAE Engine Control Unit Gen. 1's design.
  - ii. Any additional required materials are determined to cost well below the financial limit set by the Senior Design Purchasing Office. Therefore, these materials will be purchased by Giovanni Sorrentino who will then be reimbursed by the Design Purchasing Office.
- d. Programming Cable
  - i. Wire used in cable assembly will be 20 gauge or lower
  - ii. Wire will be insulated with sufficient protection
  - iii. Connectors will the same as those used on the existing ECU

- iv. Connector outputs/inputs will be pin-equivalent to the existing ECU pin outputs/inputs
- v. The final cable will be protected with Vinyl Electrical Tape or an equal/superior material

#### **4. Facilities**

- a. All ECU assembly will take place within the Rochester Institute of Technology Center for Electronics Manufacturing & Assembly located in Building 78 (CIMS).
  - i. All assembly will be supervised by Jeff Lonneville
    - 1. Phone Number: (585) 745-4908
    - 2. Email Address: [jglaspl@rit.edu](mailto:jglaspl@rit.edu)
- b. Repairs and modifications to the ECU will be made in the Rochester Institute of Technology Senior Design Lab located on the third floor of Building 09 if possible. If more advanced equipment is required, repairs and modifications will be made in the Center for Electronics Manufacturing and Assembly.
- c. Construction of the ECU protective case will be completed in the Rochester Institute of Technology Machine Shop in Building 9.
  - i. All assembly will be supervised by Dave Hathaway
    - 1. Phone Number: (585) 475-2184
    - 2. Email Address: [dlh6477@rit.edu](mailto:dlh6477@rit.edu)
- d. The programming cable will be assembled in any of the qualified electronics labs located in Building 09. The Senior Design Lab will be the preferred location for its construction.

#### **5. Schedule**

- a. All manufacturing and assembly in this documentation will adhere to the schedule posted on the P09222 EDGE website.
- b. The Senior Design team and Faculty Guide(s) will be notified of any delays in the posted schedule so that appropriate action may be taken to rectify the problem.

#### **6. Personnel Requirements**

- a. All personnel requirements will be assigned as detailed in the documentation above.
- b. Any personnel requirements not assigned in the above documentation will be allocated through group consensus.
- c. Should the ECU become damaged during testing, the individual(s) completing the test when the unit became damaged will take the necessary steps to return it to a working condition.
  - i. Burn-in testing is excused from this requirement
- d. All major assembly modifications to the ECU or its various accessories should be documented by the person implementing the changes. The Senior Design team and Faculty Guide(s) should be notified of the change at the weekly meeting.