Group C1
9/19/06

Concept Memo

Precision SATLab

The Precision SATLab team will be designing a circuit board assembly system, Solder Baat, for a target market of circuit board manufacturing and assembly companies. Specific criteria have been established to tailor to our customers needs. The product will be constructed based on these specifications, which will be provided by the customer. For this specific product, the key system requirements have been defined as the ability to place a single circuit element into a predetermined position on a printed circuit board. From here, the two leads of the circuit element must be soldered to the circuit board, which will be tested for functionality.

In order to accomplish the requirements identified by the customer, the Solder Baat will utilize a pick and place mechanism to remove the fuse from its cartridge and place into the circuit board. This pick and place mechanism will have two directions of motion, horizontal and vertical. The horizontal motion will be controlled by a lead screw connected to a stepper motor and stabilized by two guide rails. The vertical motion will be controlled by a scissor action lift, which will be actuated by another lead screw powered by a motor. The scissor motion will be achieved by pinning one of the lower struts to the frame, while the other is moved along a rail by the lead screw. There will be a gripper mechanism situated on the horizontal track which will utilize a continuous duty linear solenoid. This gripper mechanism will secure the fuse to the sliding track, translate over to the soldering station where the gripper will be used to insert the fuse into the printed circuit board. The gripper platform will be designed in order to secure the printed circuit board while soldering the fuse into place. The circuit board will be brought up to a stationary soldering iron where soldering wire will be fed through a tube to meet the heated soldering iron tip and fuse leads. This process will be completed for both fuse leads, with precaution taken to ensure that there is no overlap between soldering beads. Upon completion of soldering to the circuit board, an optical sensor will be used test the functionality of the completed circuit assembly. In order to maintain the complete automation of the process, a single start button will be used to control the entire solder, assembly, and test of the circuit board. For safety reasons, an emergency power shut off switch will be included in the system. An LCD display will track the progress of the system, monitor conditions, and provide the user with friendlier interface. This process will make use of several imbedded intelligent features. The horizontal position will be controlled through the use of an infrared range finder using a pre-calibrated position. The temperature of the soldering iron will be continuously monitored by a thermocouple, the output of which will be used to determine if the iron is ready for the soldering operation. A photo resistor will be used during the test portion of the process to determine if the recognition light stays lit for 15 seconds. This sensor will relay its result to the LCD display to provide the user with the results of the assembly process.

The most pertinent technical challenges to this process are accuracy and precision. These are important issues due to the fact that there is very little room for error because of the small clearance between the leads and circuit board holes. For the horizontal motion, the issue of accuracy will arise with the tolerances between the guide rails and the platform. The platform is driven by the lead screw, which also has its specific tolerances. This source of error is also found in the vertical motion with the scissor action. In this case, the tolerance will be rooted in

the rail system in which the scissor's bearings are guided. The stack up between tolerances in bearings, bushings, rails, and lead screws will contribute to the majority of the accuracy related technical challenges. These challenges will be assessed via trade studies on bearing and slider connections, the mechanics of a scissor action lift, and the horizontal position control. Another key technical challenge will be the automation of the soldering process. Issues with this process are melting rate and temperature of the solder along with the solder feed rate. The amount of solder to be used will also be important to this process. This challenge will be addressed via the soldering trade study. One last technical challenge will be the design and functionality of a gripper mechanism. Issues with this mechanism include the friction between the gripper and the fuse, the force needed to remove the fuse from its holder, and the accuracy in positioning the fuse. This challenge will be addressed via the trade study on the gripper mechanism.

Proposed Schedule

Sept. 28 – Completed Trade Studies Results
Oct. 5 - Finalize the Concept Design
Oct. 12 – Submit Individual Trade Study Documentation
Oct. 12 – Completed CAD design
Oct. 12 - Purchase Materials
Oct. 31 - Manufacture Parts Completed
Oct. 31 - Complete coding
Nov. 7 - Complete Prototype Development
Nov 16 – Website Completed