UNC Charlotte – Lee College of Engineering Senior Design Program

Company Information

Company Name	Atom Power Inc.	Date Submitted	*06/01/2021*
Project Title	Intelligent robotic actuators for high efficient test bed for SSCB **(ATOM_SSCB)**	Planned Starting Semester	*Fall 2021*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

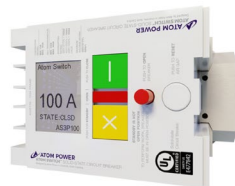| Discipline	Number	Discipline	Number
Mechanical	2	Electrical	1
Computer	2	Systems	
Other ( )			

Company and Project Overview:

Circuit breakers manage the flow of electricity and protect us from the immense hazards of surging electrical currents. Yet something so integral to the safe and reliable distribution of power hasn't meaningfully changed since Edison's lab. Circuit breakers have been mechanical for as long as they've existed. Until now. The modern world has outgrown the risks and constraints of traditional circuit breakers. To meet our evolving needs, Atom Power built the world's first and only true solid-state circuit breaker (SSCB). By using semiconductors to control the current digitally, Atom Power's breakthrough marks a quantum leap for power distribution and consumption.

An Intelligent Power Distribution Ecosystem For The Commercial Power Industry

Atom Power's product suite includes a circuit breaker (Atom Switch), distribution panel (Atom Panel), and software (Atom Insight) that can intelligently control the flow of electricity to and from buildings and things. For the commercial power industry, this user-friendly system immediately enables more control, customization, capacity, and speed than ever before, while dramatically reducing current dangers like electrical explosions.

UNC CHARLOTTE
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Industrial Solutions Laboratory

Looking ahead, Atom Power will be the foundation for innovations across distributed energy, sustainability, and efficiency that powers our increasingly digital world

ATOM SWITCH
SOLID-STATE CIRCUIT BREAKER

ATOM PANEL
SMART POWER DISTRIBUTION

Project Overview:

The Atom Switch SSCB is UL489 standard compliant and has to go through a rigorous product qualification and validation process. Most of these tests require automatic actuation of the different states of the SSCB by means of a robot that is mounted on the Atom Switch. This project involves design and development of the robot that aids in the qualification of the Atom Switch and improves efficiency of the test process.

Project Requirements:

Atom Switch operation: The Atom Switch SSCB has solid state modules (Mosfets) as the primary means

of making and breaking an electrical circuit. To provide a galvanic isolation between the line side and load side, an air gap is provided with a mechanical disconnect to open and close the air gap. This airgap is in series with the mosfets (refer Fig.1) . The air gap is opened only after the mosfets are turned off, ensuring an arc-less operation, as the contacts don't break or make a live circuit.
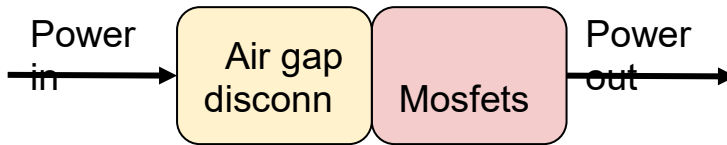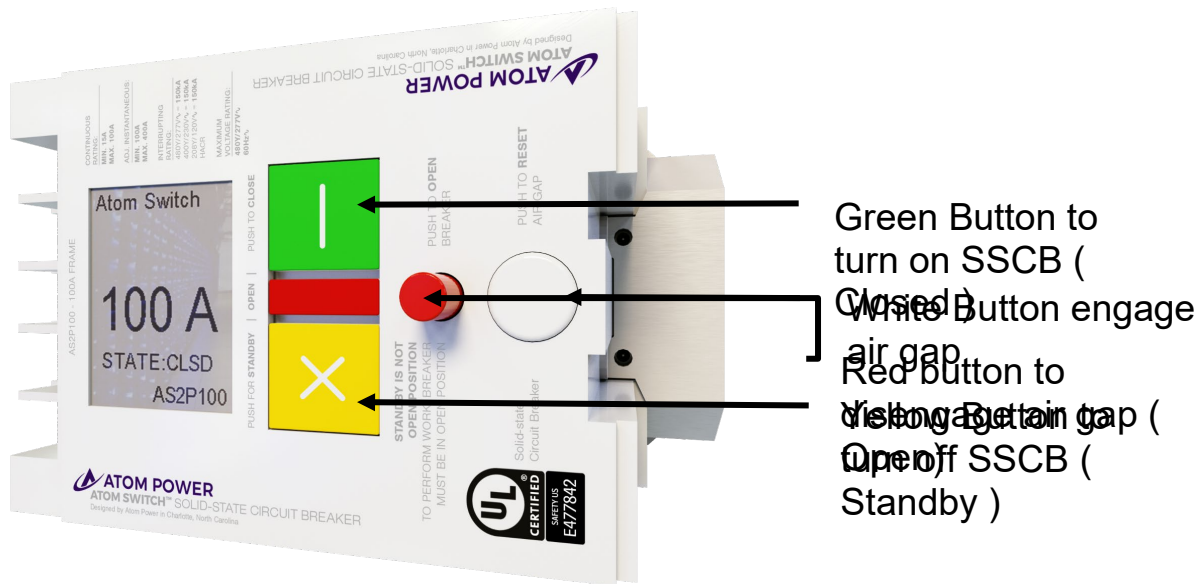
Power in → [Air gap disconn] [Mosfets] → Power out

Fig1. Atom Switch power flow

There are three states of the Atom Switch SSCB.

Open state - The Mosfets are off and the air gap is open (Indicated by red led) .
Standby state - The Mosfets are off and the air gap is closed (Indicated by yellow led)
Closed state - The Mosfets are on and the air gap is closed (Indicated by green led).

There are buttons that serve as HMI (Human machine interface) on the face of the Atom Switch. These buttons help with the transition between the three states. Note that the atom switch can be turned on only after the air gap is closed. There is intelligence built into the SSCB to prevent the mosfets from getting turned on when the air gap is open. Thus it is possible to go to closed state only from standby state.

Green Button to turn on SSCB (Closed)

White Button engage air gap.

Red button to disengage air gap (open)

Yellow Button to turn off SSCB (Standby)

Check this youtube video for a visual demonstration of the operation:
https://www.youtube.com/watch?v=ubU5lXG7ydY.

Robot:

The robot of this project is required to be mounted onto the atom switch and have the ability to transition the atom switch between these three states automatically with the help of actuators, and be controlled remotely.

The Robot comprises of the following elements:

1. Four actuators in position to press each of the four buttons of atom switch.
2. Main control board acting as the brain of the robot.
3. Robot housing that clamps onto the Atom Switch

Feature set for the Robot:
1. Ability to actuate and press the buttons in the following two sequences:
    a. Sequence 1
        i. White button
        ii. Green button
        iii. Red button
    b. Sequence 2
        i. Green button
        ii. Yellow button
2. Timing of the operation is such that the sequence is repeated every 10 seconds, and the time for which the atom switch is in closed state is 300ms
3. Ability to dial in the number of operations, so that the robot stops automatically after the number of operations is completed,
4. Display on the robot to indicate the number of operations and other information
5. Buttons to start/stop robot and to navigate a menu on display to choose number, and sequence of operations. In addition, there should be an option to select each of the actuators separately. For eg) Two actuators to only actuate red and green buttons may be desired, while other actuators are disabled.
6. Interface to an external CT relay acting as a closed loop to count the number of operations
7. CanFD communication between atom switch and robot
8. Wireless robot control (wifi or bluetooth)- to turn on/off, and to change the number of operations.
9. Ability to synchronize wirelessly with other robots if more robots are added, such that the robots operate sequentially, so that no two atom switches are turned on at the exact same time.

Mechanical dimensions of the Atom Switch:
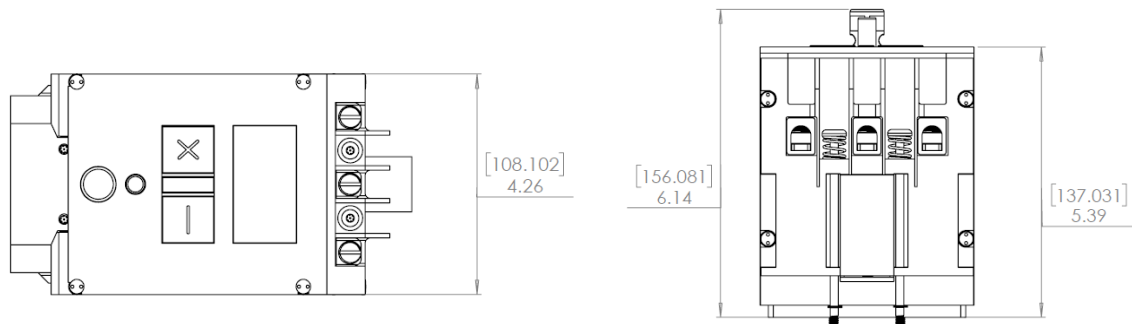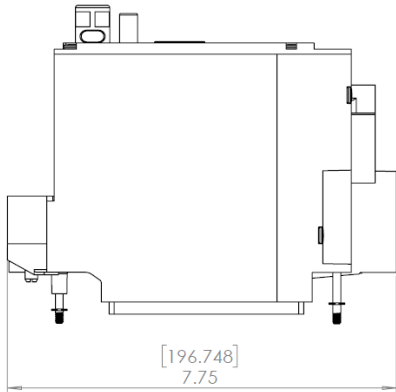
Expected Deliverables/Results:

- Three (3) working robots with full feature set as described in the previous section, with each of the robots including the following
  - Robot housing, with a mechanical clamp to atom switch
  - Actuators for button press
  - Fully assembled Control board
  - Source code of the control board processor

Disposition of Deliverables at the End of the Project:

The robots are to be delivered to Atom Power at the end of the design expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):
- Electronic design
- C programming
- PCB design
- 3D printing
- Pneumatics