



SPBBTR

SmartPlug Bluetooth button transmitter and receiver

ELECOMP Capstone Design Project 2021-2022

This project is a continuation of 2020-2021 Project SPBBTR

Taco Comfort Solutions is continuing their support of the Program for the 4th consecutive year.

<https://web.uri.edu/elecomp-capstone/project-details-by-team/taco-comfort-solutions/>
<https://web.uri.edu/elecomp-capstone/project-details-by-team-2018-2019/taco/>

Sponsoring Company:

Taco Comfort Solutions

1106 Cranston Street
Cranston, RI, 02920

<https://tacocomfort.com>

Company Overview:

Taco Comfort Solutions is a third generation, family-owned American manufacturer of high quality, high-efficiency heating, cooling, plumbing, and irrigation products. Our expertise, products, and support save our customers energy, money, and resources while improving their indoor environmental quality. We engineer and manufacture fluid control solutions for industry, agriculture, and energy exploration. Our expertise, reliability and field support boosts customer productivity and return on investment.

Headquartered in Cranston, RI, Taco is global in scope with manufacturing facilities in Rhode Island, Massachusetts, Arkansas, Ontario, Vietnam, Switzerland, Czech Republic, and Italy. Its skilled employees produce precision pumps, valves and controls, air-dirt separators, heat exchangers, tanks, domestic hot water recirculation systems, and web-based building management controls.



Since its founding, Taco has been dedicated to the success of its people and its customers, bringing products to market that save energy, enhance system longevity, and provide a superior level of safety and comfort to building occupants.

With nearly 100 years in the HVAC industry, Taco's knowledge and engineering expertise is passed along to professionals through the company's expansive factory training and online learning programs. That same depth of experience is applied every day at hundreds of job sites across the country, making Taco one of the most trusted names in controlling the flow of water.

Technical Directors:

Phil Manning

Embedded Controls Engineer

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Software Engineer

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We will be available for campus visits, and to host Cranston, RI factory visits for the team current conditions permitting. Otherwise, we can meet via Microsoft Teams meeting.

Project Motivation:

In California there is a requirement for on demand recirculation for hot water. This requires a recirculation pump that will turn on and circulate hot water in the piping system to provide hot water at the faucet. Thus, reducing the amount of water wasted down the drain while waiting for the water to become hot at the faucet. Taco's current product in this area uses an inefficient pump. The new system would use the SmartPlug module with an ECM high efficiency pump to recirculate the hot water. This project would be developing a Bluetooth button transmitter and add Bluetooth capability to the SmartPlug to control the demand for hot water.



Anticipated Best Outcome:

Develop the hardware and firmware for both the Bluetooth button and SmartPlug module and update the SmartPlug firmware to interact with the Bluetooth module to control the pump. Develop the Bluetooth module hardware to fit inside a currently produced Taco SmartPlug enclosure. Have a functional prototype ready for alpha testing in the lab and possibly field alpha testing. With the development of this device Taco would realize increases on demand Recirculation product sale in the range of \$380k to \$475k annually.

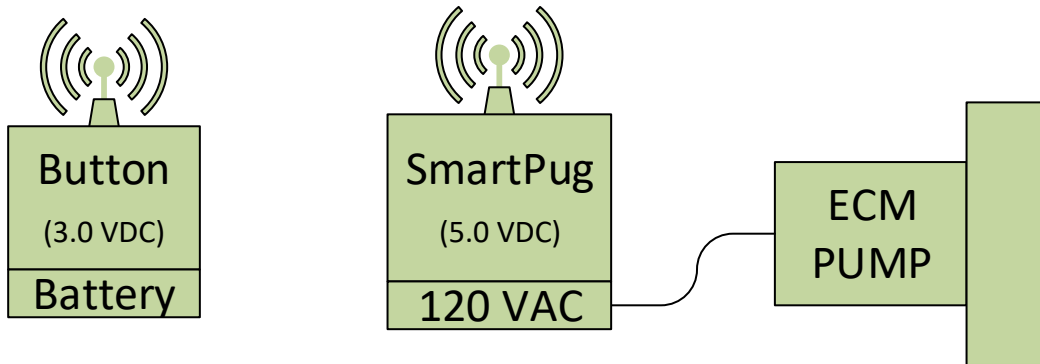
Functions include:

- Bluetooth Button:
 - Coin Cell Battery operation for 5-10 years
 - Push button
 - Bluetooth Communication
- Bluetooth SmartPlug Module:
 - Pairing with push button
 - Bluetooth Communication
 - Control SmartPlug functionality via GPIO and drivers
 - Update SmartPlug firmware to provide on demand recirculation functions

Project Details:

Develop a Bluetooth button module that will detect and send a button press over a Bluetooth connection to the SmartPlug to turn on a pump for recirculation.

Replace the existing SmartPlug microcontroller with a Bluetooth enabled module that will receive the button press message and via GPIO signal instruct the SmartPlug electronics to have the pump perform the recirculation.



Project Continuation

This project is a continuation of the same project last year and will build on the progress from last year. The team last year was able to:

- Prototype Bluetooth communication using Arduino boards
- Create a prototype Bluetooth button PCB design

These will be excellent starting points to help meet the Best Outcome.

Hardware Tasks Include

- Finalize the development of hardware for the Bluetooth remote button and for the addition of Bluetooth to the SmartPlug module.
- Research best components for cost, availability, and support.
- Finalize the development of the Schematic
- Finalize the development of PCB layout
- Build Prototypes

Firmware Tasks Include

- Finalize the development of firmware to detect and de-bounce the button press. Transmit that signal over the Bluetooth channel.
- Finalize the development of the method of pairing and un-pairing the button and the module.
- Finalize the development of firmware to receive the button press signal and transfer it to the SmartPlug.
- Finalize the development of firmware for on demand recirculation of a pump.



Composition of Team:

1-2 Computer Engineers (CPE) & 1-2 Electrical Engineers (ELE)

Skills Required:

Electrical Engineering Skills Required:

- Low power battery operation
- Micro-Controller circuit development
- Bluetooth module selection
- Schematic capture
- PCB Layout

Computer Engineering Skills Required:

- Develop the firmware to detect and de-bounce button press.
- Bluetooth pairing
- Microchip Technology and Nordic Semiconductor microcontrollers
- Timers
- Communications
- State Machines

Anticipated Best Outcome's Economic Impact on Company's Business:

Develop the hardware and firmware. Have a functional prototype ready for alpha testing in the lab and possibly field alpha testing.

Broader Implications of the Best Outcome on the Company's Industry:

As this product gets out in the field and is successful in California other states will adopt this technology increasing sale volume for Taco.