VPWMC
Voltage to PWM Converter
ELECOMP Capstone Design Project 2019-2020

Sponsoring Company:

1106 Cranston Street, Cranston. RI, 02920   www.tacocomfort.com

Taco Comfort Solutions is continuing support of the Program for the 3rd 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/

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 manufactures 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 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.

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We will be available for campus visits, and to host Cranston, RI factory visits for the team.

Project Motivation:

In North America, the typical speed control signaling method for pumps and valves is a 0-10 Volt, 2-10 Volt, or 4-20 mA control scheme. Taco International currently has a pump that is controlled with a pulse width modulation (PWM) signal. To take advantage of this pump in North America we propose developing a voltage to PWM converter.

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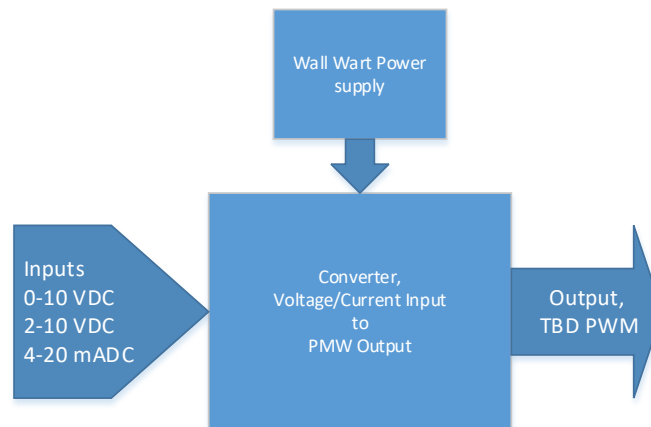
Anticipated Best Outcome:

Develop the hardware and firmware to convert a 0-10 Volt, 2-10 Volt, or 4-20 mA control scheme to a PWM signal. Develop the hardware to fit inside a currently produced Taco 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 pump sale in the range of $350,000 to $400,000 annually.

Functions include:

- Input:
    - 0-10 Volt
    - 2-10 Volt
    - 4-20 mA

- Output:
    - PWM frequency TBD
    - PWM voltage TBD
    - PWM current TBD

- Power Supply:
    - 0-10 Volt input, using a standard AC/DC power adapter (wall wart)
    - 2-10 Volt input, using the input signal to power the converter
    - 4-20 mA input, using the input signal to power the converter

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Project Details:

Develop a microprocessor-controlled converter that will take in a 0-10 volt, a 2-10 volt or a 4-20 mA signal and convert the signal to a pulse width modulated (PWM) signal to control the speed of a pump.

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                    ┌──────────────┐
                    │ Wall Wart Power│
                    │    supply     │
                    └──────┬───────┘
                           │
                           ▼
    ┌──────────┐   ┌──────────────┐
    │ Inputs    \  │  Converter,   │   ┌───────────┐
    │ 0-10 VDC   > │Voltage/Current│   │ Output,    \
    │ 2-10 VDC   / │   Input       >   │ TBD PWM     >
    │ 4-20 mADC /  │    to         │   └───────────┘
    └──────────┘   │  PMW Output   │
                   └──────────────┘
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Hardware tasks include:

- Develop hardware interface between 0-10 Volt, 2-10V and 4-20 mA and the PWM on the pump.
- Research best components for cost, availability and support.
- Research and pick a wall wart power supply to support the design
- Develop Schematic
- Develop PCB layout
- Build Prototypes

Firmware tasks include:

- Develop Firmware to convert the 0-10 V, 2-10 V, and 4-20 mA input signals to a PWM signal to vary the speed of the pump

Composition of Team:

1 Electrical Engineer (ELE) & 1 Computer Engineer
(Preference will be given to the ELE senior enrolled in the PCB Design Course, to be taught by Mike Smith on Thursday evenings.)

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Skills Required:

Electrical Engineering Skills Required:
- Power supply design convert 2-10 Volt and 4-20 mA inputs into usable source to power device
- Select wall wart power supply to power device.
- Micro-Controller circuit development
- 0-10 Volt, 2-10 Volt, and 4-20 m inputs converted to readable level by micro-Controller Analog to Digital Converter (ADC)
- Schematic capture
- PCB Layout

Computer Engineering Skills Required:
- Develop the firmware to convert the input signals (0-10 Volt, 2-10 Volt, or 4-20 mA) into a PWM output signal to drive a pump at the correct speed.
- Microchip Technology microcontrollers
- Analog to Digital Converter (ADC)
- Timers
- Pulse Width Modulation (PWM)

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. With the development of this device Taco would realize increases pump sale in the range of $350,000 to $400,000 annually.

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

As this product gets out in the field and companies see the value and cost saving of PWM control, more companies will start to develop PWM controls eliminating the need for this converter.

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