INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*Curtiss - Wright*	**Date Submitted**	*10/13/2025*
Project Title	*Design of a Brushless DC (BLDC) Motor Controlled Actuator Emulator (Curtiss-Wright_Emulator)*	**Planned Starting Semester**	*Fall 2026*

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	1	Electrical	1
Computer/Software	2	Systems	0-1

Company and Project Overview:

Curtiss-Wright Corporation has the most renowned legacy in the aerospace industry. In 1929, Curtiss-Wright was formed by the merger of companies founded by Glenn Curtiss, the father of naval aviation, and the Wright brothers, renowned for history's first flight. These technological pioneers ushered in the era of aviation and their trailblazing spirit made history. Curtiss-Wright has changed dramatically over the past nine decades and continues to transform itself to be at the forefront of the markets that we serve.

Curtiss-Wright Actuation Division designs, manufactures, and supports electro-mechanical actuation products and systems for use in demanding applications in Aerospace, Defense, and Industrial Automation markets. Our market leading solutions help improve the reliability, efficiency and performance of our customers' operations and platforms, as well as reducing their environmental impact with energy efficient electro-mechanical designs and technology.

Leveraging both standard products and custom designs, our engineering teams are experts in the markets they support and focus on a deep understanding of customer requirements to develop the right solution. We make use of an extensive technology portfolio and lean manufacturing processes to offer faster time to deployment.

For the Aerospace market, we supply actuation systems for flight control, landing gear, utility and other applications on both commercial and military aircraft.
In Ground & Naval Defense markets, we support a wide array of applications ranging from door assist, ramp and hatch actuation, weapons handling systems, radar and launch platform actuation, and robotic (AUV/ROV) actuation.

This project will involve designing a brushless DC motor driven actuator emulator to verify motor control electronics and introduce failure cases. See product examples below:

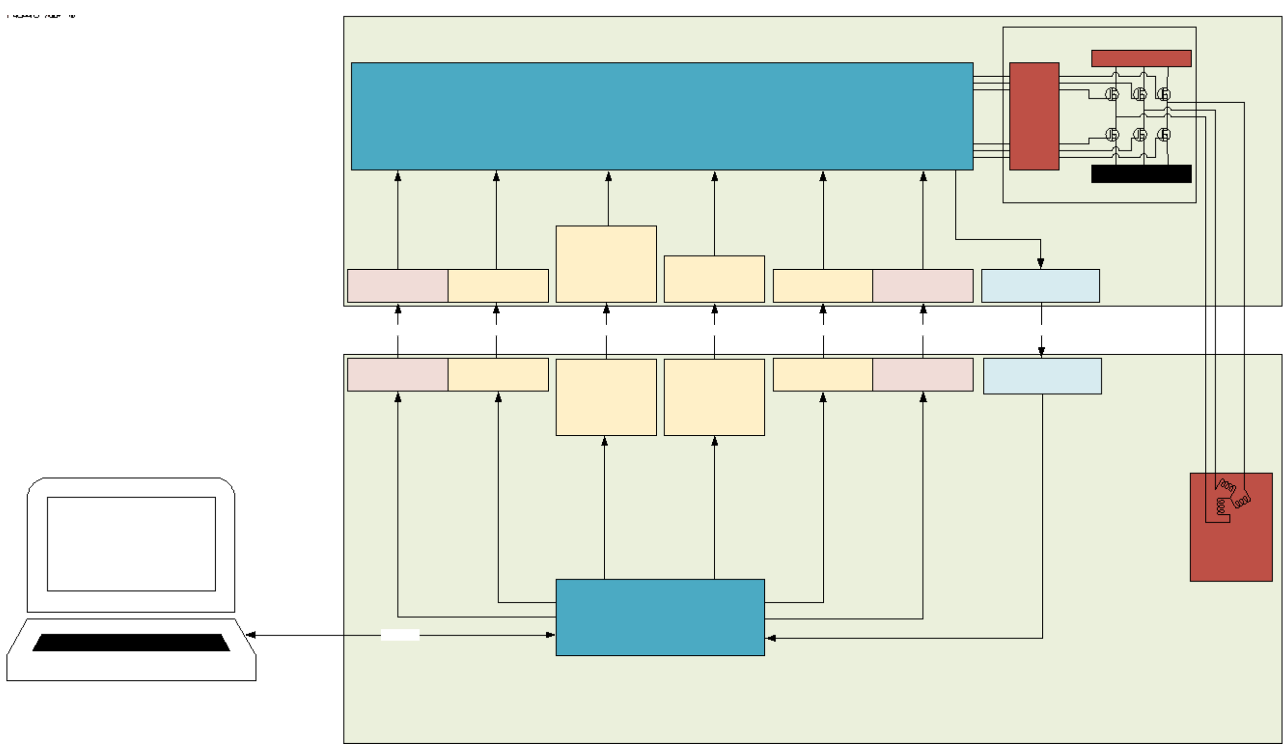

Figure 1: BLDC Actuator Emulator and GUI Test Setup Diagram

Project Requirements:

Curtiss-Wright (CW) actuators are used in aerospace applications for control of primary control surfaces (ailerons, rudder and elevator) and secondary control surfaces (tabs, flaps, spoilers and slats). Electrically motor-driven actuators require a motor controller to command and control the motor. This motor controller consists of power electronics for the input/output power stages as well as motor control circuitry; software-based or hardware-based. Software-based motor controllers utilize a DSP or other micro-processor for receiving commands and motor feedback, as well as processing the control loop and providing the necessary drive logic to the power electronics. On the other hand, some actuators are free of any programmed components – they are purely hardware-based motor controllers. This is accomplished with a motor controller IC accompanied by various digital and analog control and feedback circuits to achieve the desired actuation profile.

Regardless of whether the motor control unit is software-based or hardware-based, it is important to be able to test the motor controller's functionality, design requirements, and power stages. One method of testing would be with a representative motor, or a 'Golden' motor. Unfortunately, this introduces additional complexities with the real dynamics of the motor, as well as availability of a representative motor and load. With software-based motor controllers, it is possible to 'trick' the controller into various operating stages by emulating the position sensors, current sensors, feedback, etc. This can all be done within software such that the power stages can be tested with a simple LR load. Software can override the sensor signals to create the desired outcome.

Unfortunately, unlike a software-based motor controller, testing a hardware-based motor controller without a representative motor must be done through external emulation. External signals need to be implemented to 'trick' the analog hardware IC into providing the proper signals to the power stages to drive the motor. The controller/power stages will then drive the LR load the same way that it would drive the motor. The emulator must be able to measure the output from the power stages and adjust the motor controller inputs in a way that simulates the behavior of the motor. For example, the emulator must measure currents and voltages being delivered to the load and adjust the position sensors appropriately. The emulator should be able to account for the characteristics of the motor as well as the desired torque loading of the motor to define this relationship.

By defining this relationship between controller output power, motor dynamics, and loading, the emulator should be able to emulate varying loads according to a given load profile.

In addition to the motor dynamics that need to be simulated, a lot of actuators have additional command and control inputs. Examples of these include Near-End-Of-Travel sensors, End-Of-Travel sensors, temperature, etc. A full-featured emulator should be able to simulate all of these signals such that the motor controller would behave functionally the same whether it is connected to the motor or the emulator.

CW has assigned an identification number to this emulator, STE-51283 – Dual BLDC Actuator Emulator. It is planned this emulator will consist of electronic hardware based on a Texas Instruments Evaluation Board, [LAUNCHXL-F28379D](). Circuits will need to be designed and implemented to accompany this evaluation board, with a preference for them to reside on a custom printed wiring assembly (PWA). Software running on the evaluation board, the Emulator Engine, has also been assigned an identification number, CPIN-00241. A graphical user interface (GUI) is also planned to interface with the emulator and is identified as CPIN-00240.

Expected Deliverables/Results:

- Test setup similar to that shown in **Figure 1**.
  - STE-51283 Hardware running both Emulator Engine, CPIN-00241, and GUI, CPIN-00240
- All Altium and Code-Composer Studio source files, drawings, and software needed.
  - CW will provide access to Altium licenses if needed and it is expected that CW Altium project templates and component libraries will be used.
  - CW will advise of any templates or project baselines from which to base the emulator engine. It is expected that this baseline will be used.
- User/Operator manual along with video demonstration.
- Project report documenting the development history, lessons learned, results, and suggestions for growth/evolution.

Disposition of Deliverables at the End of the Project:

Students are graded based on their display and presentation of their team's work product. It is mandatory that they exhibit at the Expo, so if the work product was tested at the supporter's location, it must be returned to campus for the Expo. After the expo, the team and supporter should arrange the handover of the work product to the industry supporter. This handover must be concluded within 7 days of the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If

<u>none please state none):</u>

- Fundamentals of CAD/3D modelling and the physical/mechanical implementation of the electrical design
- Fundamentals of electrical theory and application/implementation
  - Analog and digital circuits
  - Brushless DC motors
  - Power electronics
  - Control systems
- Fundamentals of "bare-metal" software programming theory and application/implementation
  - Focus on Texas Instruments' dual-core Delfino processor, TMS320F28379D
  - Focus on Texas Instruments' development environment, Code Composer Studio.
- Fundamentals of GUI programming theory and application/implementation
- Electronic hardware and software development processes and flow
- Schematic capture and circuit board design using Altium
- CAD and 3D modelling