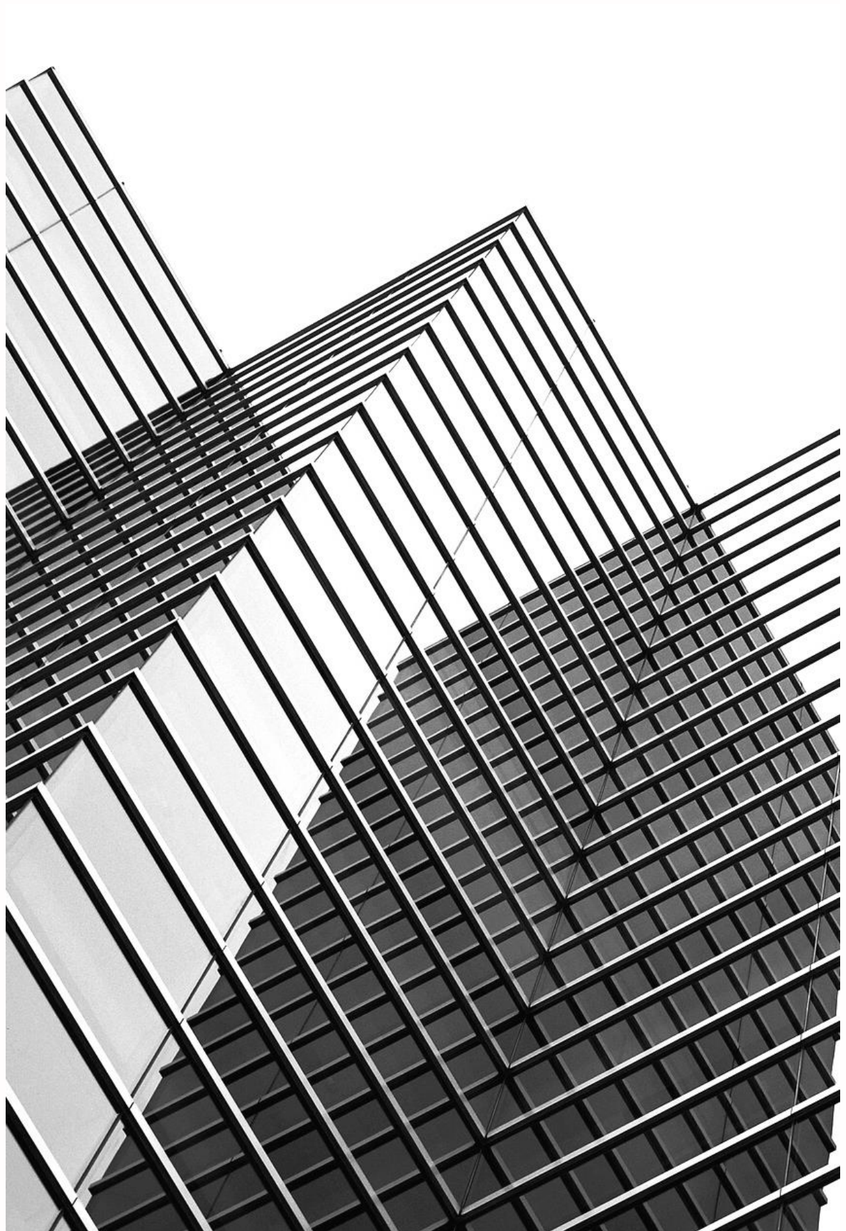
Robotic Positioner



PRESENTED BY GROUP 5:
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Agenda

- Doepker Industries Ltd
- Problem Description
- Requirements Analysis
- System Alternatives
- System Design

DOEPKER INDUSTRIES LTD

About Doepker Industries

- Provides value in the transportation industry in North America
  - Agriculture
  - Flat decks
  - Oil & gas
  - Forestry
  - Gravel
  - Heavy haul

PROBLEM DESCRIPTION

Problem Definition

- A device which can be used to rotate equipment for welding, blasting, painting, or finishing that can be mounted to their existing rotator frames.

Why is this important?

- Currently uses mechanical equipment
- Advancing mechanical machines forward with electronics.
- Provides a safer environment for the users.
- Improves efficiency.

Problem Statement

“There exists a need for a low cost system that can electrically rotate a load for welding applications to increase efficiency and safety.”

REQUIREMENTS ANALYSIS

Design Requirements

The System Shall:

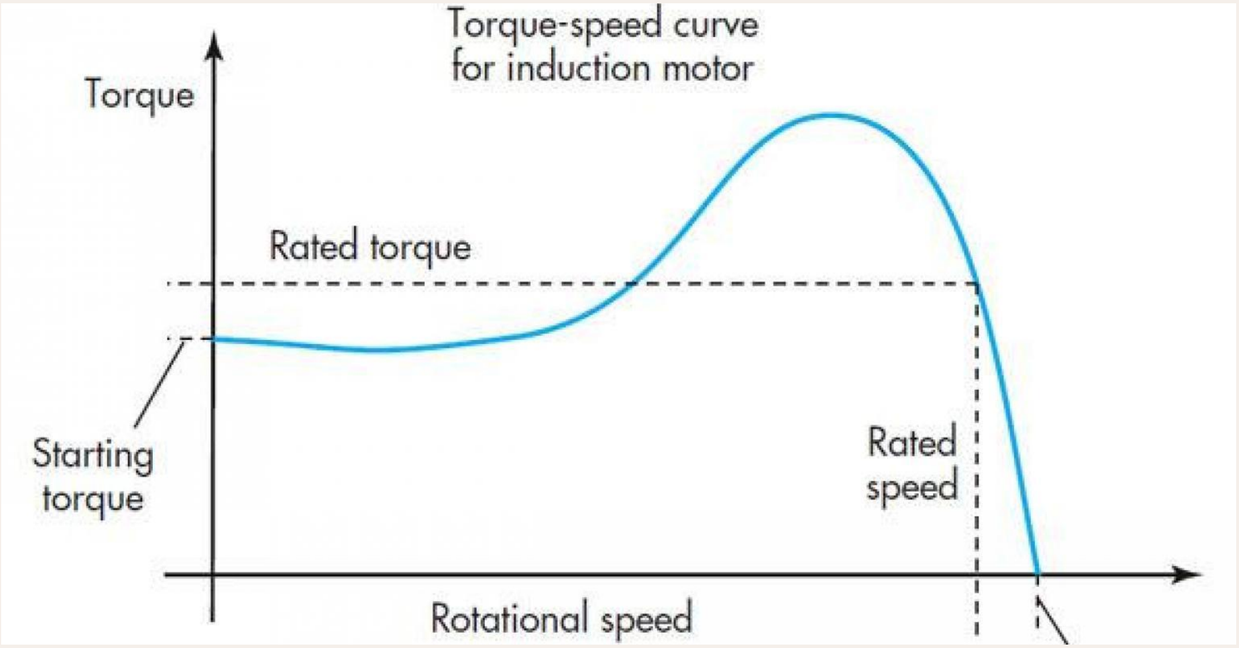
- rotate a load 360˚ around the horizontal axis
- recall and rotate to a preset angular position
- support up to max load of 500 kilograms
- have a rotation speed between 1-5 rpm
- be built using two “A” frame supports
- not exceed $10,000 Canadian Dollars to build
- use RoHS compliant components

SYSTEM ALTERNATIVES

Motor Alternatives

Induction Motors

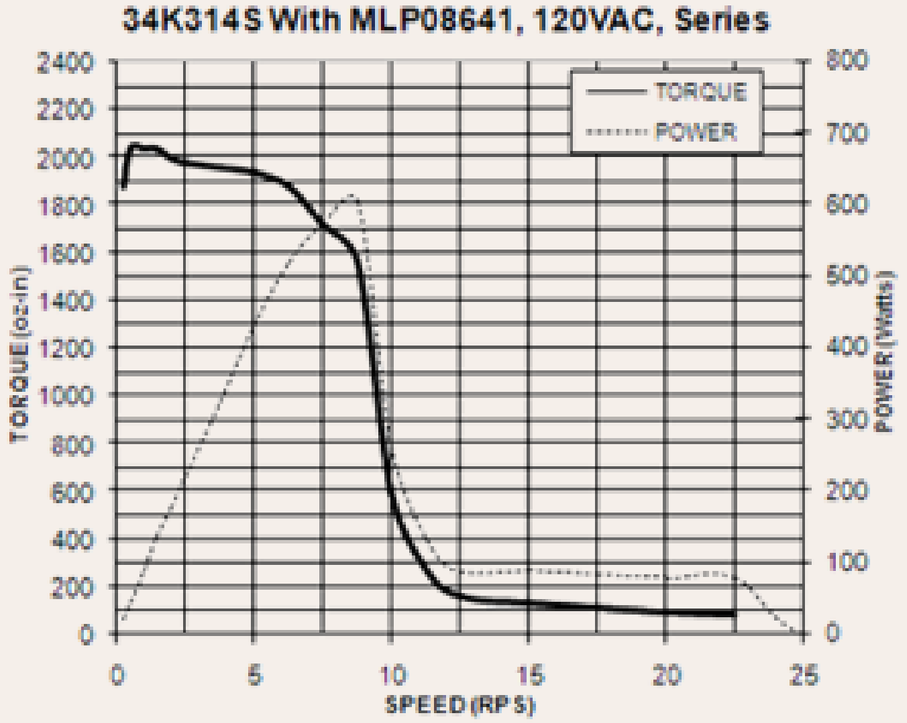
- Pros
  - Inexpensive
  - Easy to maintain
- Cons
  - Speed control is very limited and expensive via variable frequency drive
  - High in rush current when heavy loaded
  - Requires external positioning sensors



Motor Alternatives

Stepper Motors

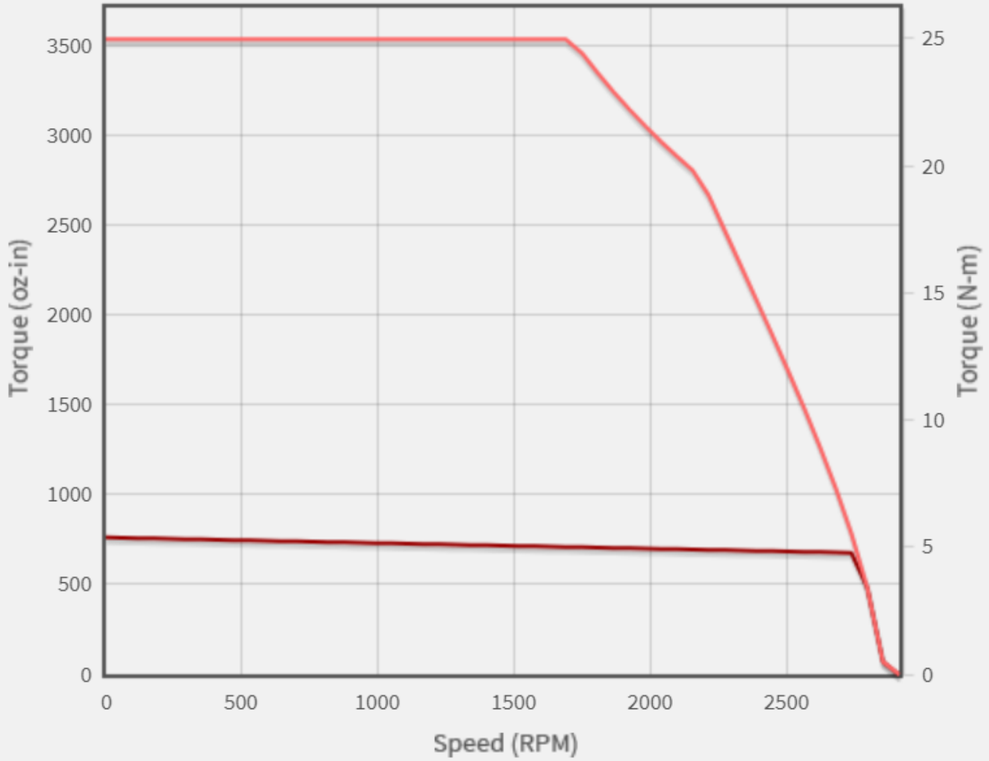
- Pros
  - High torque at lower speeds
  - Relatively simple operation
  - Possible to operate in closed loop feedback eliminating external sensor
- Cons
  - Sudden drop off in torque as speeds increase
  - Noisy
  - Requires external driver



Motor Alternatives

Servo Motors

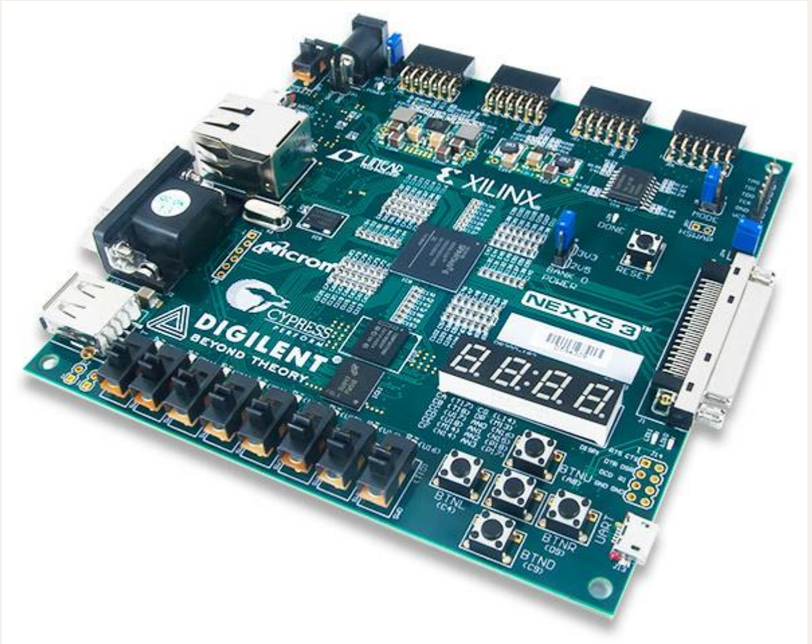
- Pros
  - Encoder allows for a closed loop feedback operation
  - Near constant torque within operational speeds
  - Integrated encoder for high precision position tracking
- Cons
  - Expensive



Control System Alternatives

FPGA

- Pros
  - Precise PWM motor control
  - Optimal performance
- Cons
  - Time intensive software development
  - Difficult memory management
  - Can be expensive



Control System Alternatives

Programmable Logic Controller (PLC)

- Pros
  - Reliability
  - Remote control
  - Possible to operate in closed loop feedback eliminating external sensor
- Cons
  - Expensive
  - Not much benefit for this application

Control System Alternatives

Microcomputer

- Pros
  - Simple learning curve
  - Powerful in terms of processing power
- Cons
  - Analog to digital conversion
  - Less accurate timing control
  - SD card will wear out

Control System Alternatives

Microcontroller

- Pros
  - Quickly prototype projects
  - Robust memory management
  - Abundant or expandable pins & ports
  - Reasonable learning curve
  - Inexpensive
- Cons
  - Reliability

Choosing A System

- Employed a weighted decision matrix based on requirements and safety considerations:

Requirement	Weight	FPGA	PLC	Microcomputer	Microcontroller
Cost	20%	2	1	3	4
Memory Management	20%	1	2	3	4
Compatibility	20%	4	2	1	3
Reliability	20%	4	3	1	2
Development	20%	1	3	2	4
TOTAL	**100%**	**2.4**	**2.2**	**2**	**3.4**

SYSTEM DESIGN

Key Components

- **MICROCONTROLLER**

  A compact integrated circuit designed to operate the motor.

- **SERVO MOTOR**

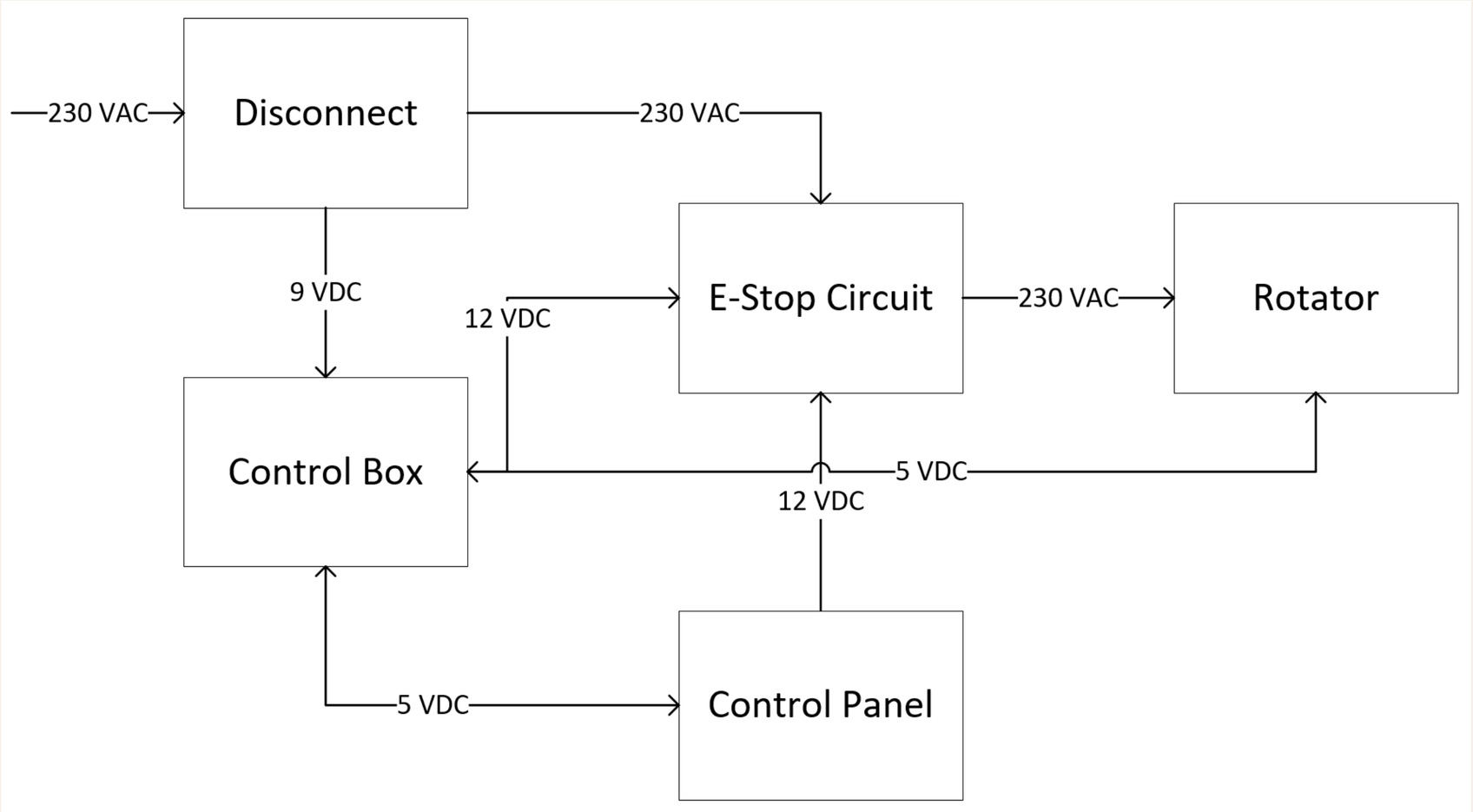
  A rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.

- **ENCODER**

  A motor mounted encoder provides closed loop feedback signals to communicate the speed and position of the motor shaft.

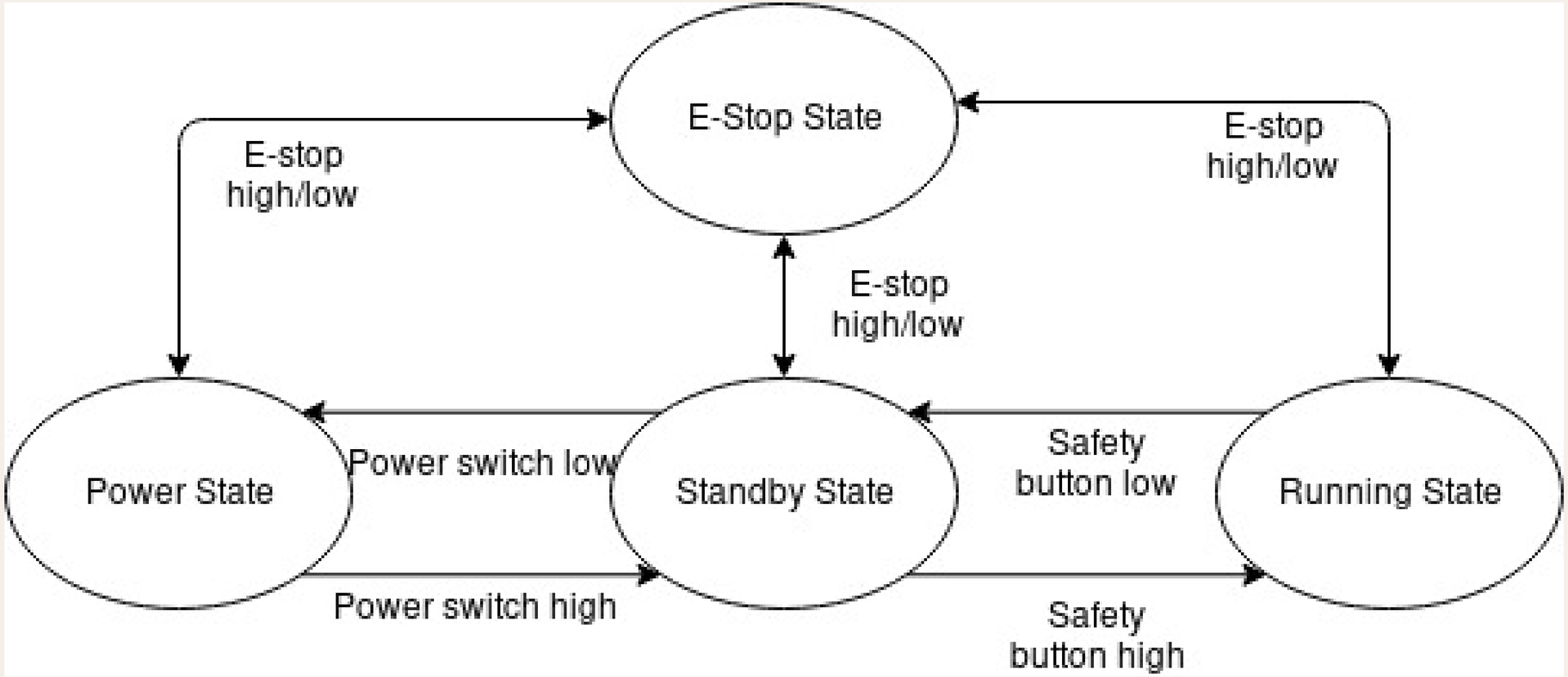
- **GEARBOX**

  A mechanical drive to step down the speed of rotation from the motor shaft to the output drive, proportionally increasing the torque.



System-Level Block Design

Hardware Design



System-Level Block Design

Software Design

Q&A