

# Three Phase Motor Control Utilizing FPGA Implementations

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## Need

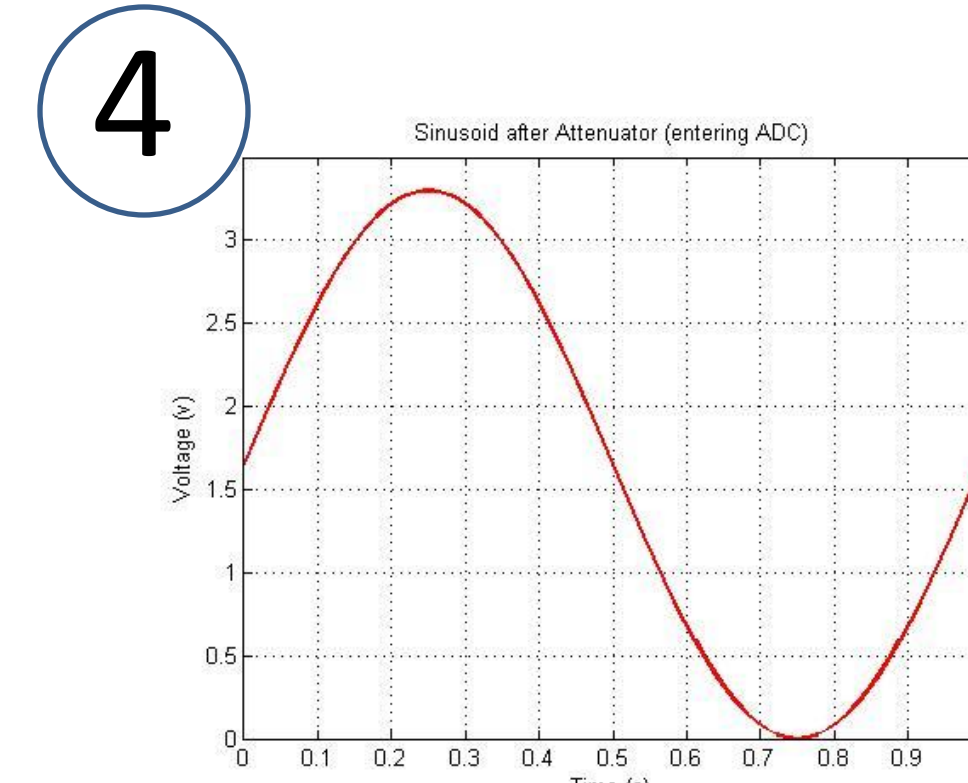
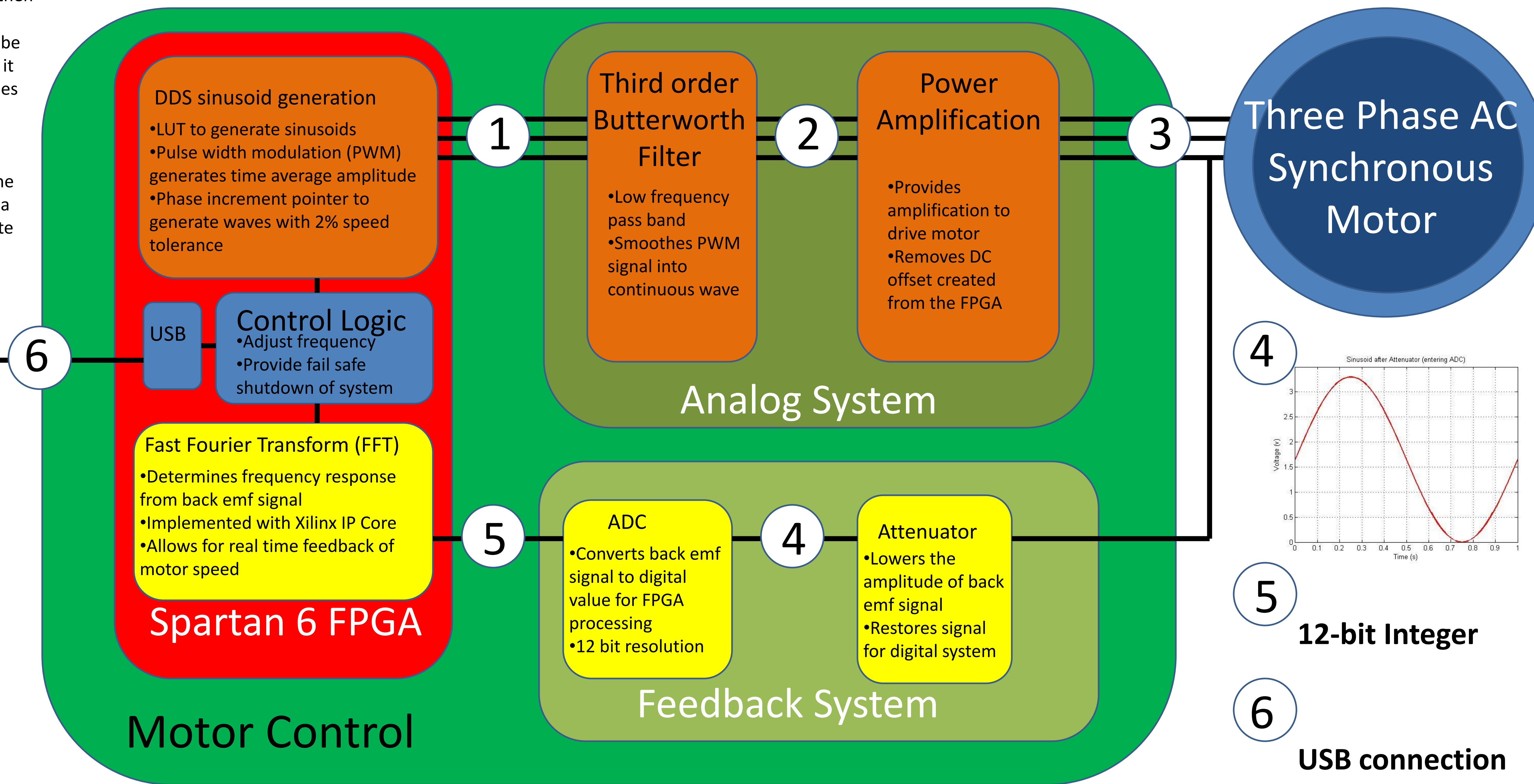
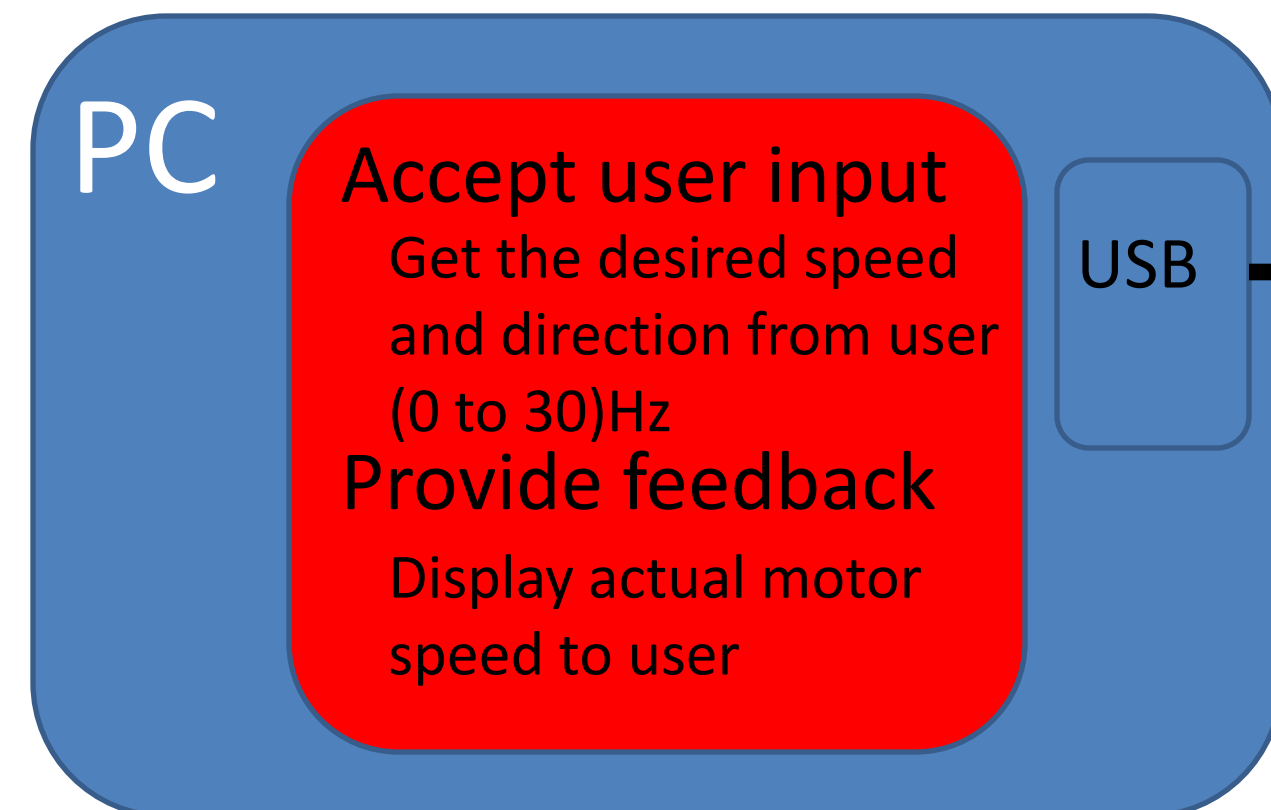
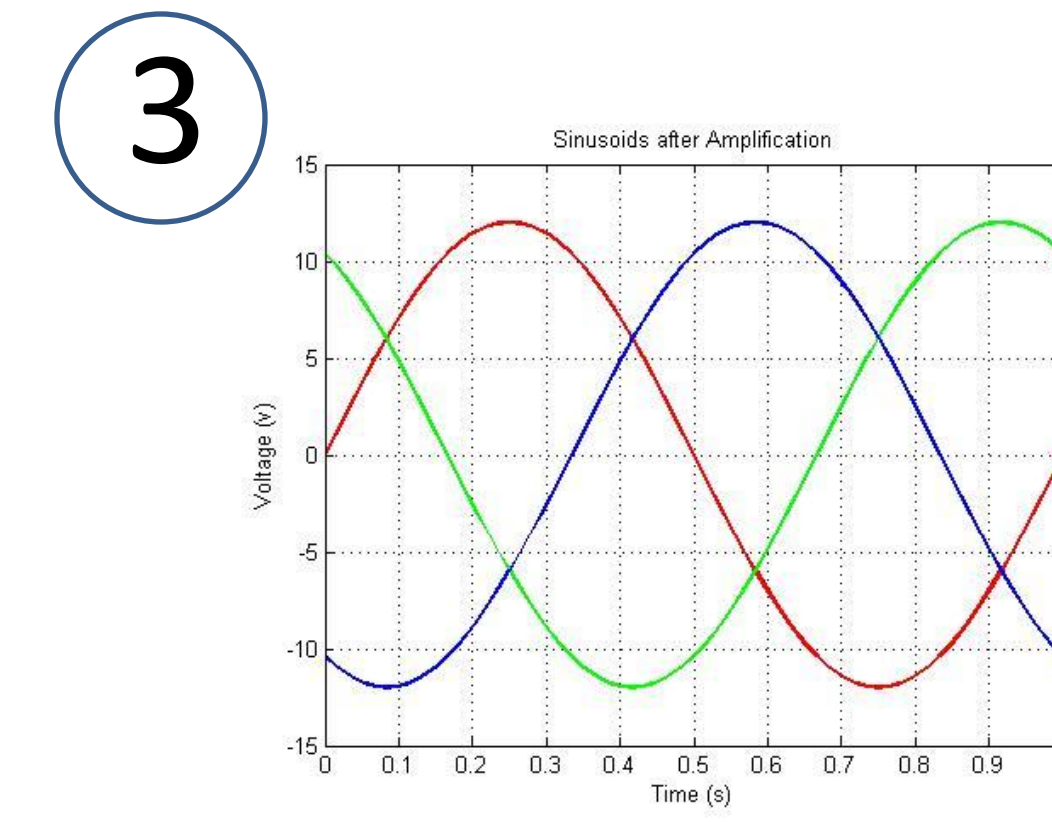
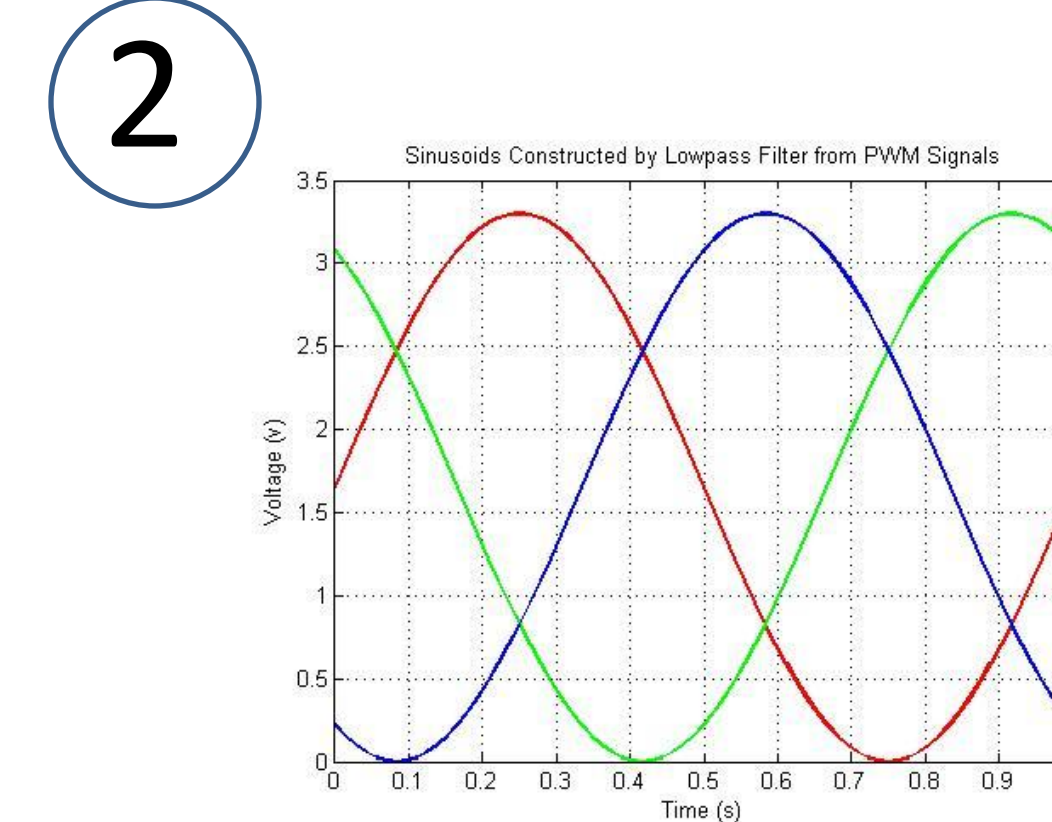
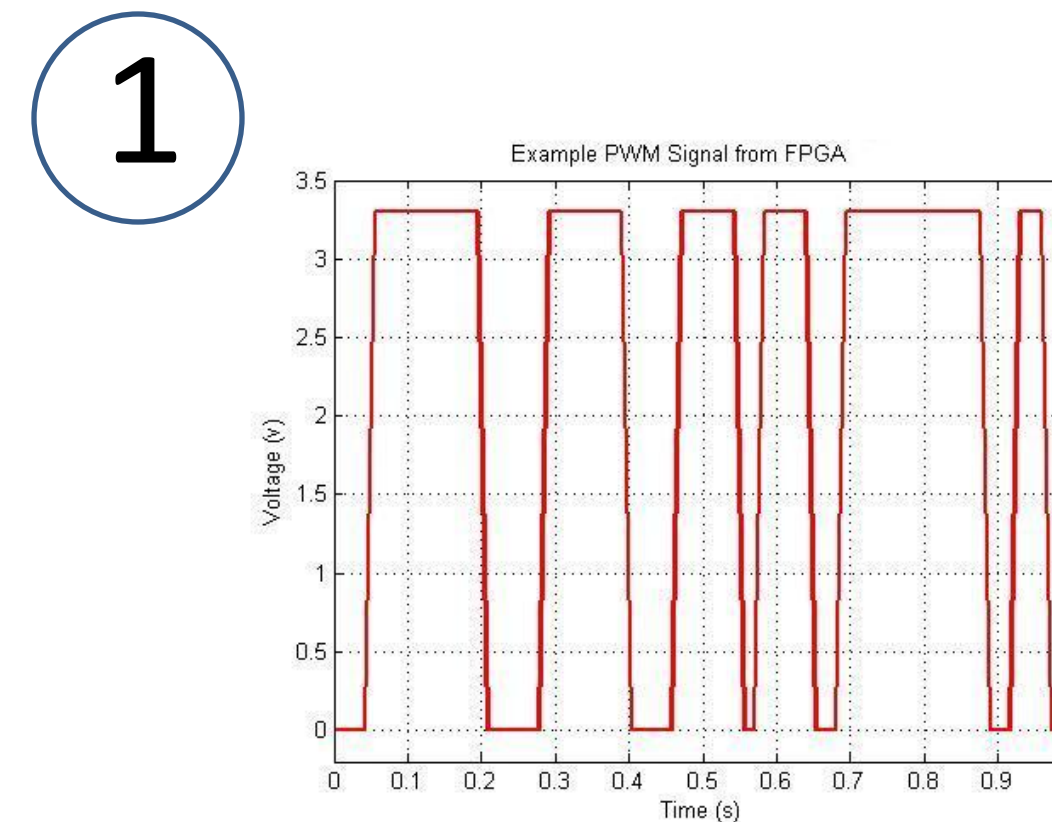
Active vibration control (AVC) is a technique used in industry to stabilize systems that are in a state of imbalance. In order to design a specific embodiment of AVC, the control of a three phase motor is necessary. Our industry sponsor, LORD Corporation, requires the design of a three phase motor control implemented with a modern FPGA and standard development methods.

## Solution

A Xilinx Spartan 6 FPGA is implemented to generate sinusoids at a controlled frequency. This signal is generated with three pins through direct digital synthesis (DDS) via a sine wave lookup table(LUT).(1) Analog filter design smoothes the output from the FPGA and provides a low pass bandwidth.(2) The signal is then amplified to drive the motor.(3)

One phase from the motor is attenuated to a level that can be measured by the ADC. (4) The ADC samples data and sends it to the FPGA for real time frequency analysis.(5) This provides the actual speed of the motor.

Control logic in the FPGA, implemented as a state machine, adjusts the frequency based on user input and the current motor speed. Data is transferred via a USB connection to the PC.(6) Control and speed of the motor is provided through a GUI. Failsafe operation will halt the motor if the current state exceeds speed tolerances.



- FPGA
  - DDS signal generation
  - Fourier analysis
- Analog System
  - Digital to analog smoothing
  - Amplification
- Feedback System
  - Back emf detection
  - Analog to digital conversion

## System Overview of Motor Control

Industry sponsor  
**LORD**  
AskUsHow™

Faculty advisors  
Dr. Vibhuti Davé  
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Dr. Thomas Hemminger