Understanding BLDC Motor & Motion Control

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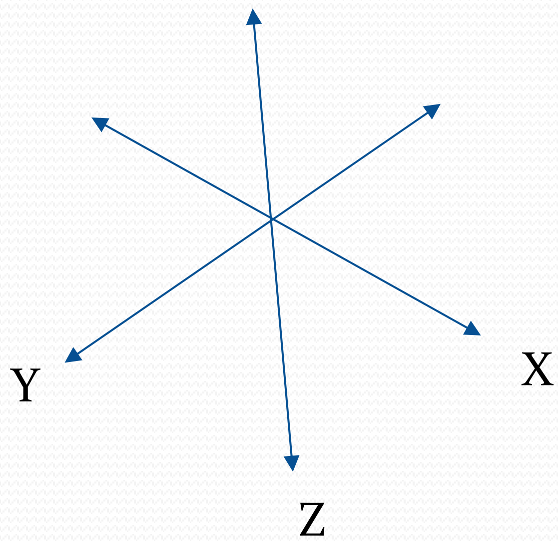
What is Motion Control ?

Controlling Moving and Non-Moving Objects in Space

3-Dimensional Space



- Distance
  - From/To
- Time (RMS)
  - Acceleration
  - Run Time
  - Deceleration
  - Wait Time
- Direction
  - CW/ CCW / Both
- Obstacles
  - Moving / Stationary

What is System Engineering ?

First . . . What is a System ?

WIKIPEDIA

A *system* is a set of interacting or interdependent component parts to form an intricate whole.

Every *system* is delineated by its :

spatial (placement) and temporal (time) boundaries,
surrounded and influenced by its environment,
described by its structure and purpose
expressed by its ‘form, fit and function’

Second . . . What is an Engineer ?

INTERNET

Dreamer, Innovator, Researcher, **Problem Solver**, Inventor, Creator

Information to Know When Designing for Applications

Application Type
Motor Type
Torque Requirement
Gearing
Drive Style
Sensored/Sensorless
  Halls, Encoder, Optics, other
Nominal Voltage
Operating Voltage Range
Short Term Voltage Spikes
Current / Power
Temperature Range
Speed Requirement
Accel/Decel/RMS Profile
Regulation
Fault Signal Requirements
Command Styles
  Analog/PWM/Programmable/other
Direction Control
MTBF
FMEA
FTA
Weight
L x W x H or L x Dia
Cost
Time to Market

Fault Signal Requirements
Operating Environment
Customer Spec Submitted
DO-160 Test Requirements
DO-178 Requirements
DO-254 Requirements
MIL-STD Testing Requirements
Other Certifications

Description	Discrete	ASIC/PLD/uP	BLDC Controller
Component Count	Very High	High	Low
MTBF (hrs)	80k-100k	100k-200k	> 200k
Adjustability	Design Change	Programming	External Component
Footprint	Large	Moderate	Small
Temperature Range	-55C to 125C	-40C to 125C	-55C to 125C
Current Control	By Design	By Design	YES
Fault Detection	By Design	Programmable	Built-In
Sensor/Sensorless	YES/NO	YES/wExt Ckts	YES/YES
Speed Control	NO	YES	YES
Cost	High	Medium	Low
Time to Market	Long (~2yrs)	Medium (~1yr)	Short (<1yr)

Typical reasons for Discrete Designs

- Simple component usage:

  i.e. no Specialized devices
- Simple problem(s) being solved
- Simple solutions with lower cost components
- Simpler design components supporting years design life & Manufacturing support

Reasons for Complex designs

- Minimize component count
  - Use of uP or ASIC devices
  - Increased MTBF
  - Simpler design reducing manufacturing errors
- Allows for additional features where/when required
- Typically single sourced devices (not good)
- May or may not include software
- Reduce Torque Ripple by use of current monitoring

Trapezoidal Commutation

1. Speed Control Generation & EMI
2. Unbalanced Amplifier Stages creating Torque Ripple
3. Phase to Phase Distortion creating Torque Ripple
4. Gain characteristics from one system to another
5. Current differences affect the amplifier outputs

Sinusoidal Commutation

1. Speed Control Generation & EMI
2. Gain characteristics from one system to another
3. Current differences which can affect the Amplifier Gain

Motor Control Comparison

	Discrete Drive		Integrated Drive	
	Pro	Con	Pro	Con
Pure Open Loop	X	-	X	-
Speed Control	X	-	X	-
Reduced EMI	X	-	X	X
Component Count	-	Hi	LOW	-
Design Complex	-	X	X	-
Class A ?	-	X	X	-
Fixed current optimization	-	X	X	-
Software configurable current optimization	-	NA	X	-

Technology differences

Discrete Design

- Use RC time constants
- Simple comparators
- Simple OR/AND logic
- High component count
- Use of smaller parts
- Other ???

Complex Design

- Application specific driver
- Low component count
- Microcontroller for timing and logical
- Easier to maintain
- Other ???