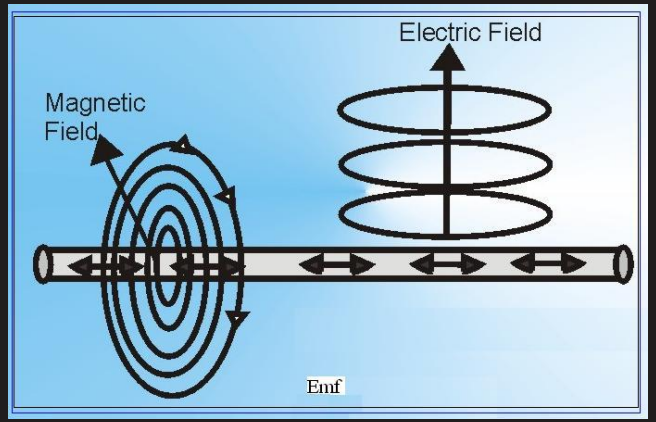
Feedback Control System Objectives

Understand:

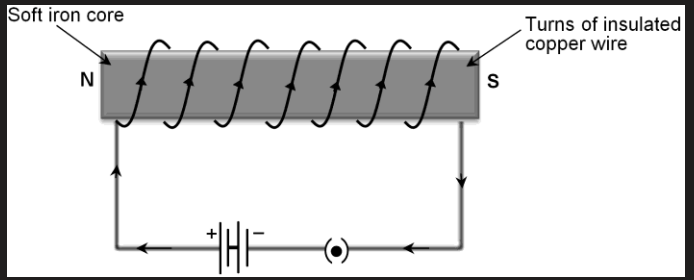
- ❑ Components of a control system with feedback
- ❑ Control algorithm in a control system with feedback

Magnetism

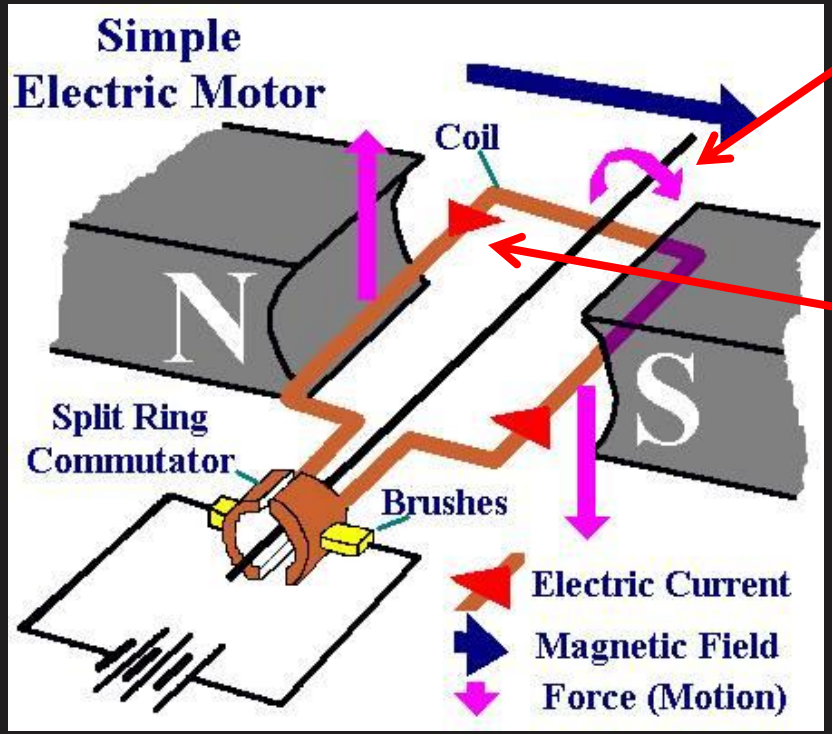


Hans Christian Orsted observed a magnetic field in 1820

Electromagnet



DC Motor



Torque is produced from opposing magnetic fields

⇒Load (opposing torque) slows motor down until load torque = torque from magnetic force

Current in a wire Produces a magnetic field

Ohm's Law:

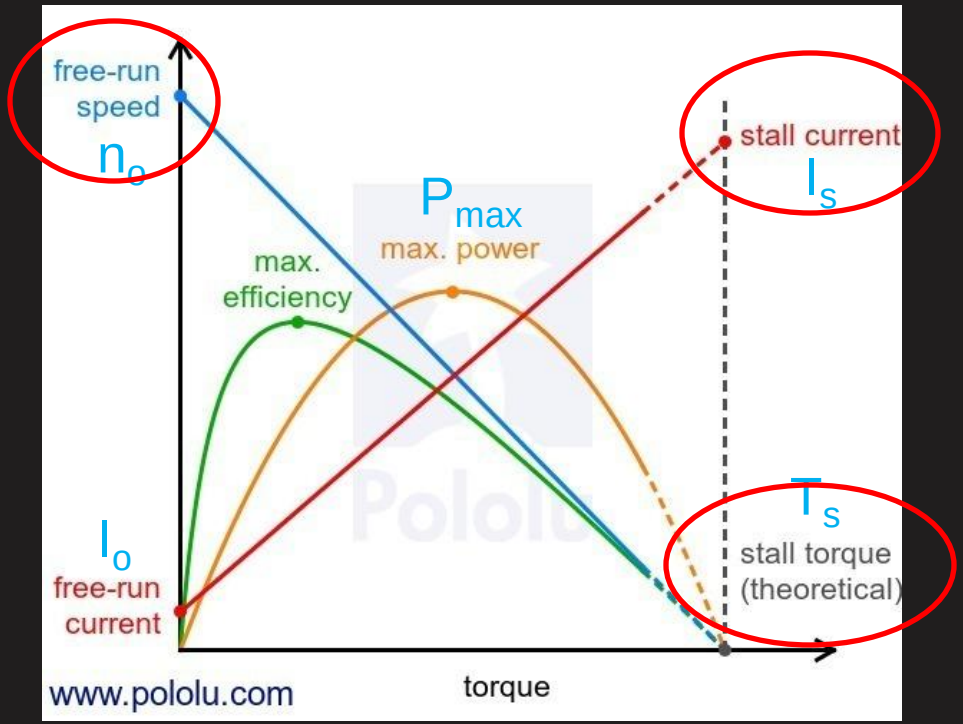
Current = Voltage / Resistance

⇒Increasing voltage increases current and magnetic field

Motor Characteristics

Motor Characteristics from Data Sheet

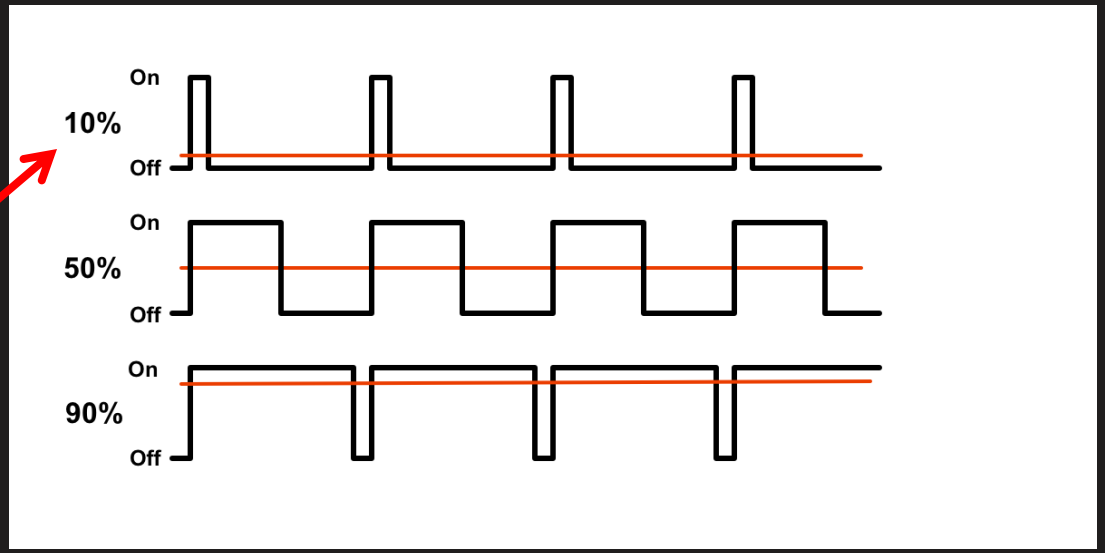
- Max Power
- Stall Torque
- Stall Current
- Free running Current
- Free running Speed



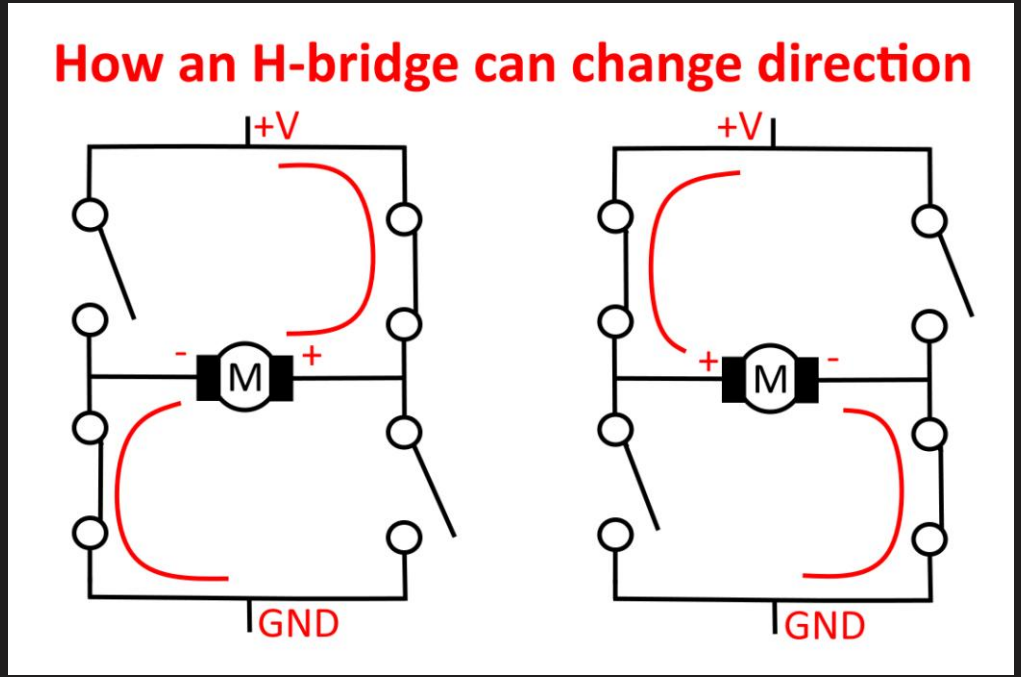
Pulse Width Modulation (PWM)

Pulse Width Modulation (PWM)

Average Value



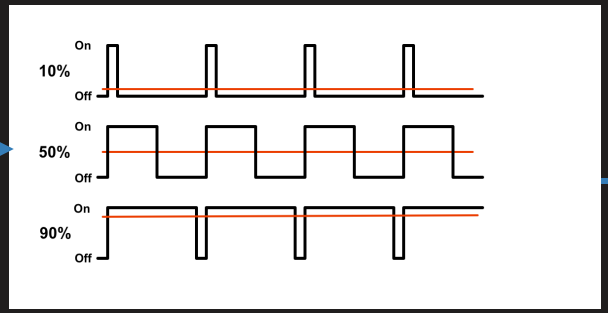
H Bridge



Motor Circuit

PWM (SRX-15KHz)

Command
(0-100%)

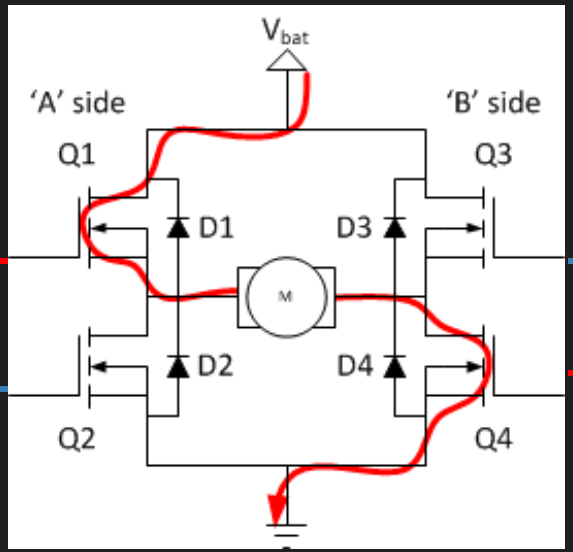


Direction

Limit Switches
(stops motion)

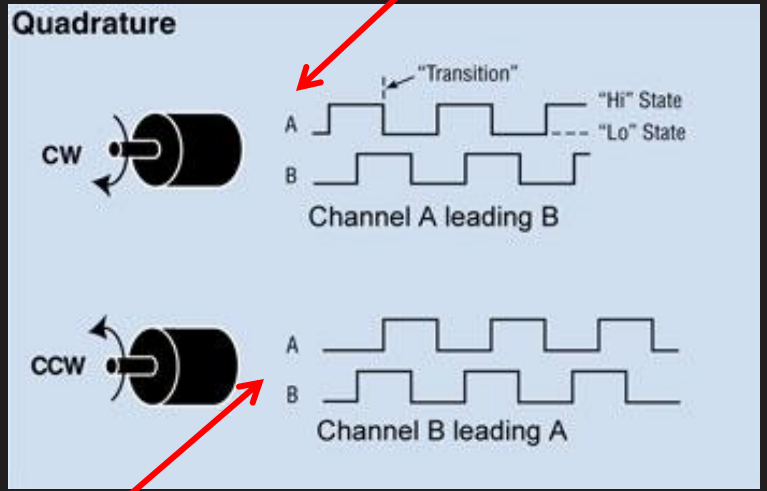
Logic

H - Bridge



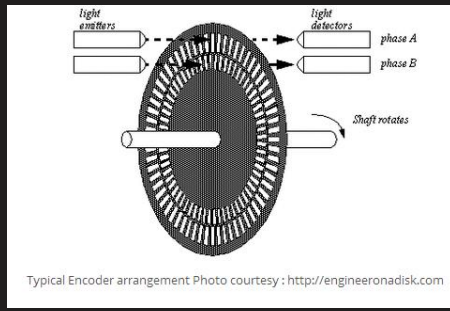
Quadrature Encoder (Enc)

A Channel Leads B Channel



B Channel Leads A Channel

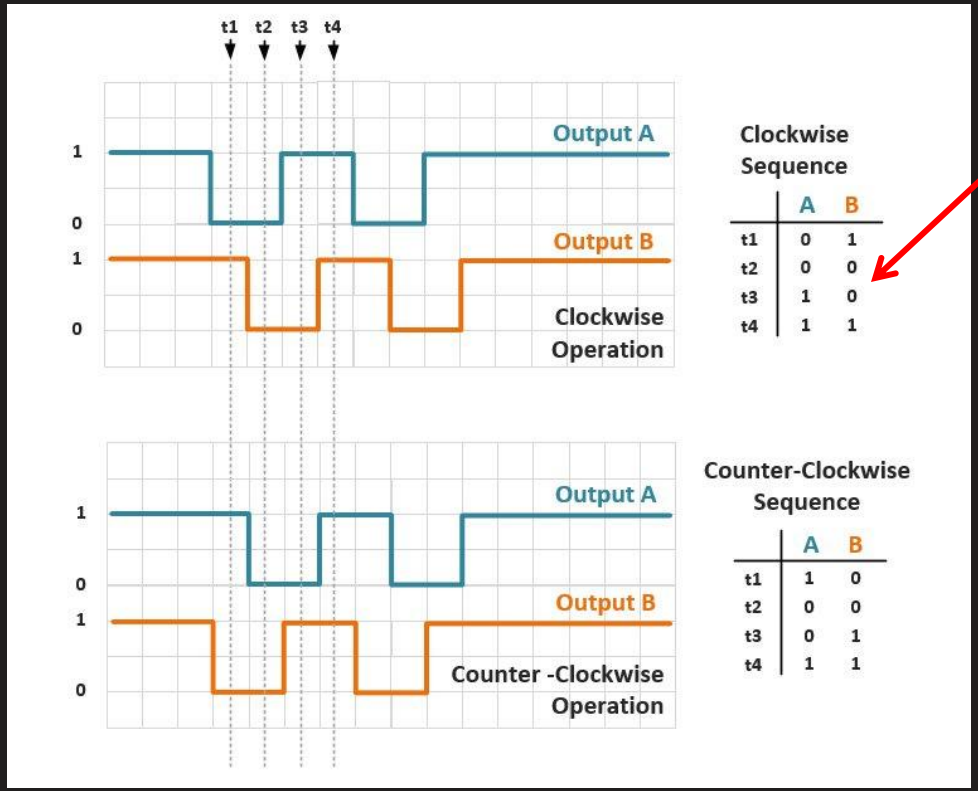
Optical Encoder



Typical Encoder arrangement Photo courtesy : http://engineeronadisk.com

Photo Courtsey : www.designworldonline.com

Quadrature Encoder (x4 Encoding)



x4 (all edges counted)

Electronic Speed Controller (ESC)

Talon SRX ESC

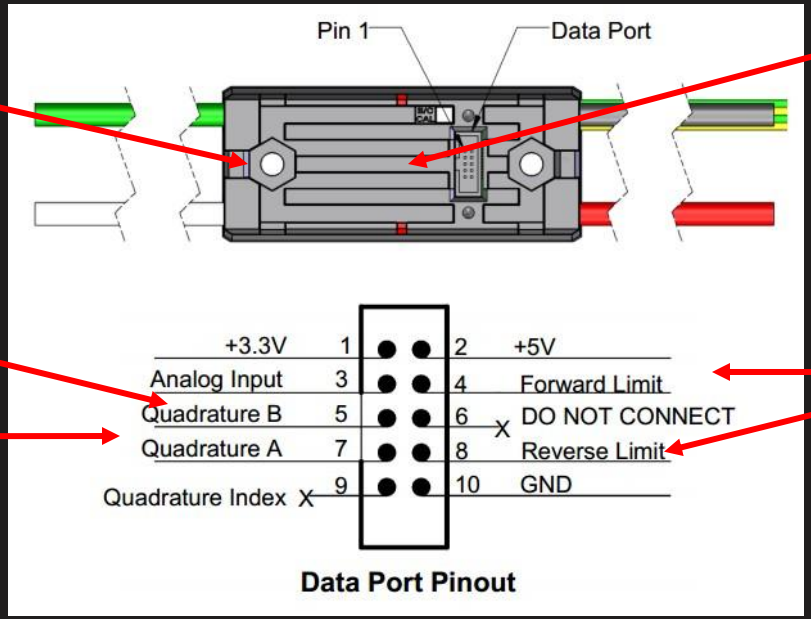
PWM Commands Over CAN Bus

PWM and H-Bridge Circuits

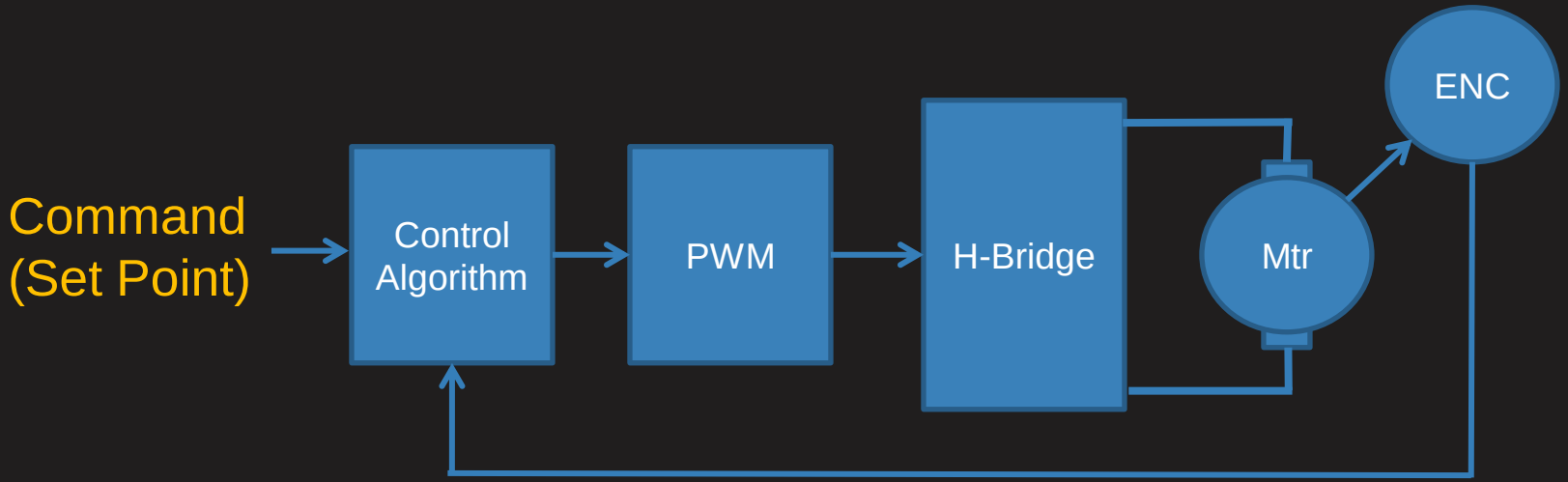
Analog Feedback

Encoder Feedback

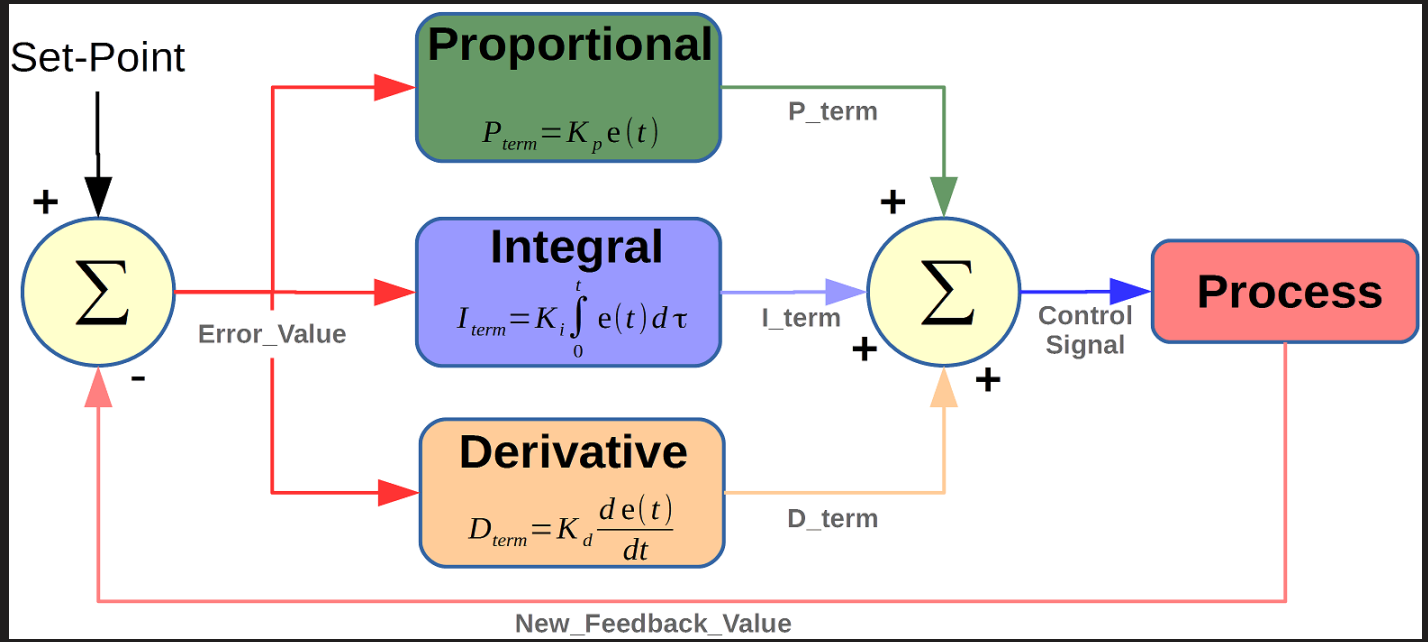
Limit Switches



Feedback Control

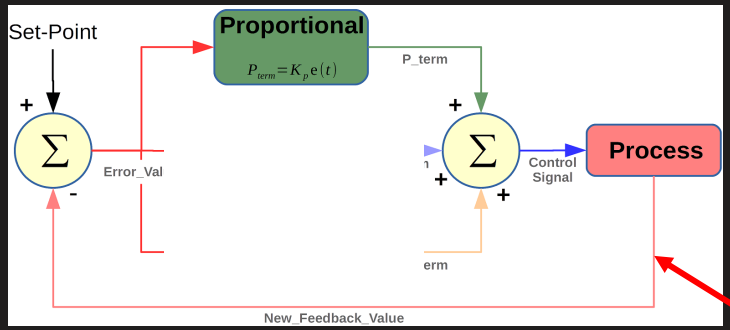


PID Control Algorithm



PID control law developed in the 1920's and is the industry standard today

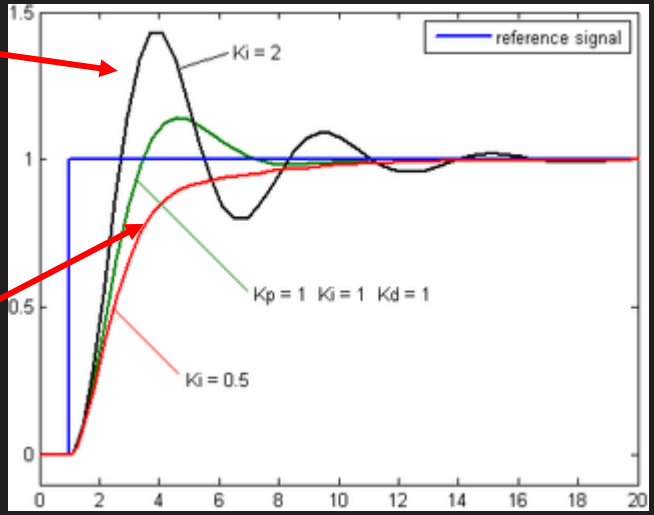
PID Control: Proportional Gain



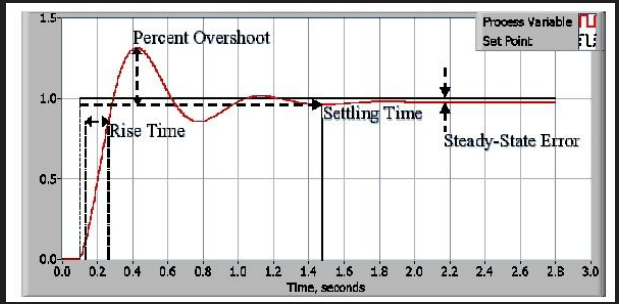
High Gain

Delay

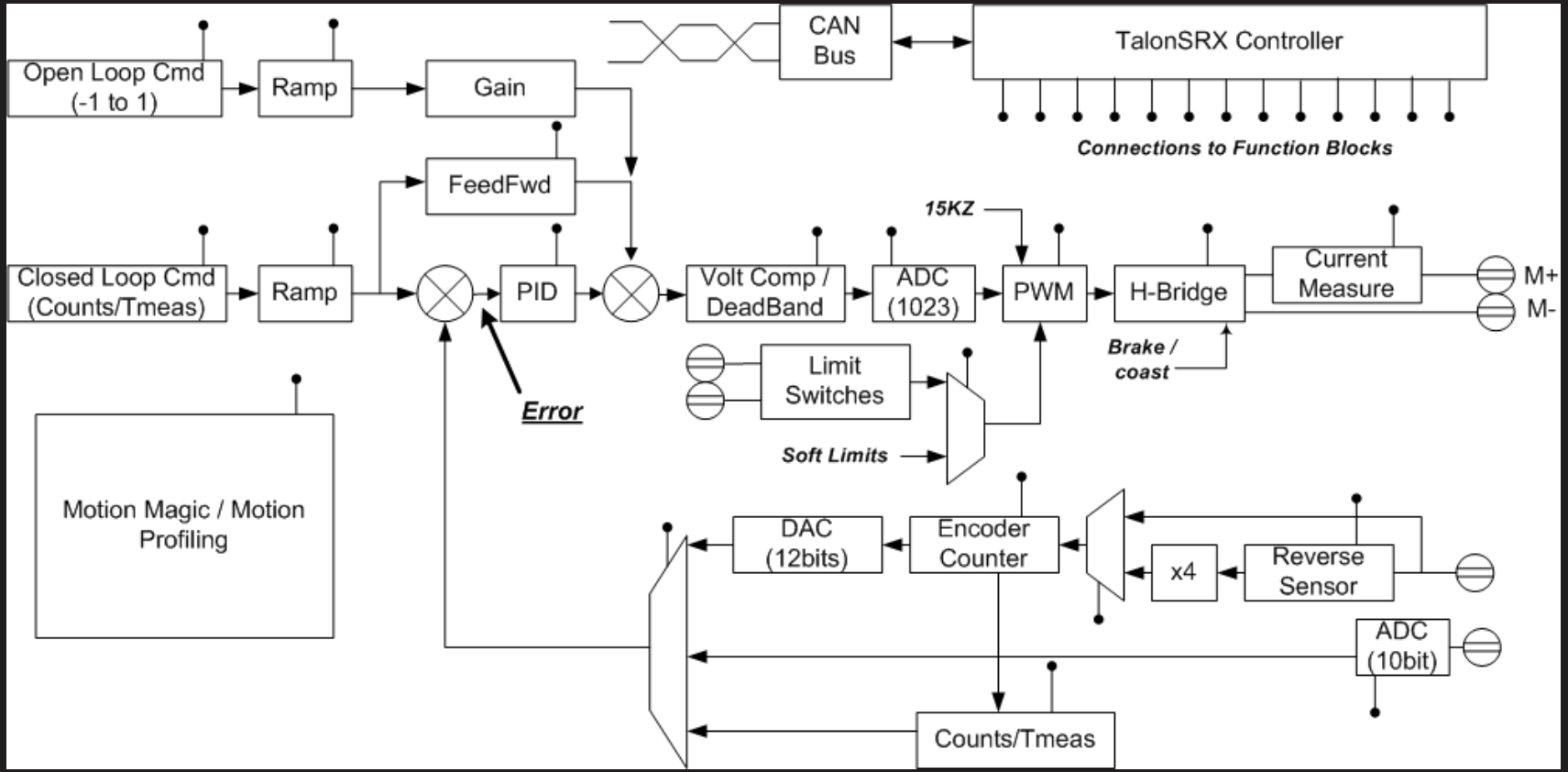
Low Gain



Signal component names



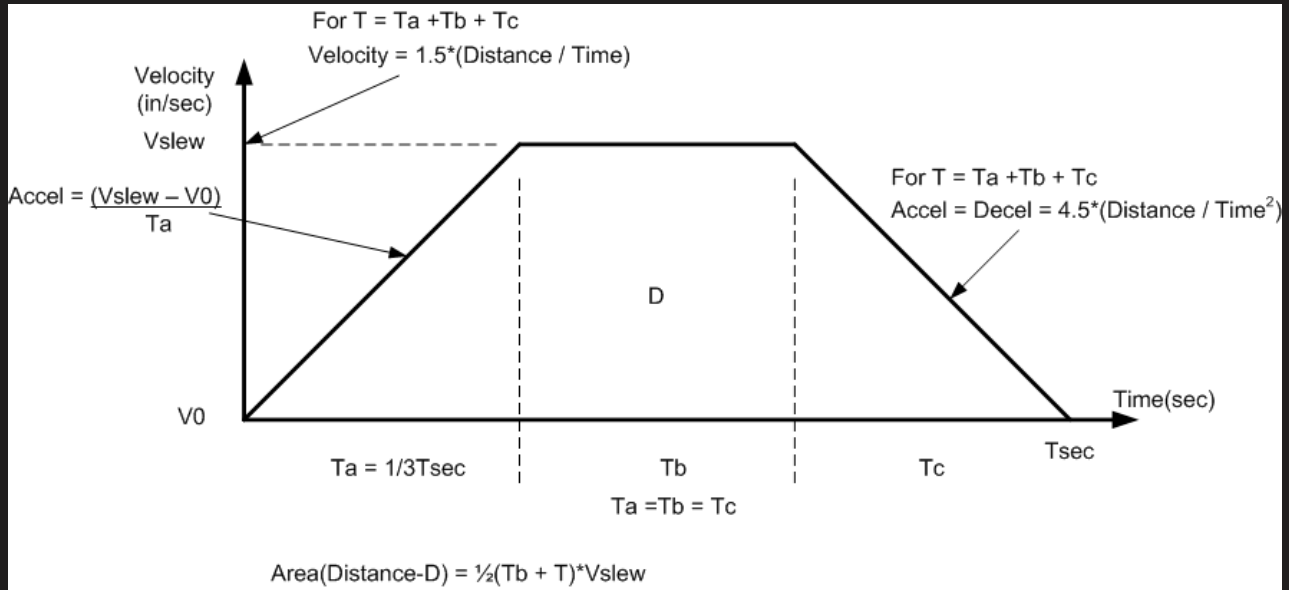
Talon SRX Block Diagram



Motion Terms

- Distance: Movement
- Velocity: Change in Distance / Time Measure
- Acceleration: Change in Velocity / Time Measure
- Jerk: Change in Acceleration / Time Measure

Trapezoidal Motion Profile



Area(Distance-D) = ½(Tb + T)*Vslew

Thus, knowing Distance and time we can calculate:

Velocity = 1.5*(Distance / Time)

Accel = Decel = 4.5*(Distance / Time^2)

Magic Motion needs to know:

Velocity(RPM) = (1.5*(Distance(in) / Time(sec))*60(sec/min)) / Wheel Circum(in/rev)

Acceleration(RPM/sec) = ((1.5*(Distance(in) / Time(sec))*60(sec/min)) / Wheel Circum(in/rev)) / Ta(sec)

Distance(Encoder Counts) = Distance(in) / (in/count)