Ch0 - Control for Power Electronics Engineering

Kelvin Leung
8-5-2021

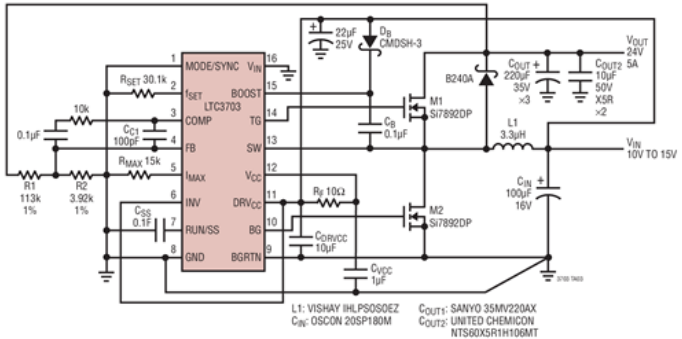
Control Theory – Definition in Wikipedia

- Control theory deals with the ***control of dynamical systems*** in engineered processes and machines. The ***objective*** is to develop a model or algorithm governing the application of system inputs ***to drive the system to a desired state***, while ***minimizing*** any ***delay, overshoot, or steady-state error*** and ensuring a level of ***control stability***; often with the aim to achieve a degree of optimality

From Physical Circuit to S-Domain

Physical World

Circuit Model



Laplace Transform (S-Domain)

$$\mathscr{L}\{f(t)\} = F(s)$$

Ch1 : 1st and 2nd order Transfer Function

1st Order Transfer Function

$$G(s) = \frac{p}{s+p}$$

2nd Order Transfer Function

$$G(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

To Understand Basic System Dynamic

- Poles : Determine stability
  - LHP stable
  - RHP unstable
- Zeros : Affect transient dynamic
  - LHP increase overshoot
  - RHP step response starts in wrong direction
- Damping factor and natural frequency
  - Overshoot
  - System response time

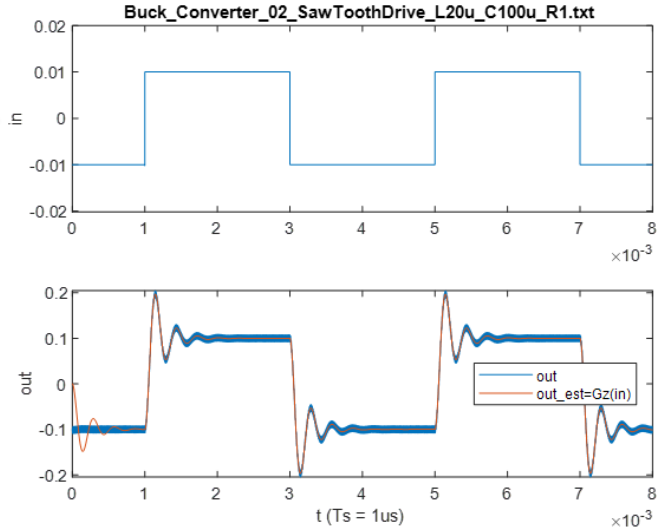
Ch2 : System Identification Method

[3] Identify System Transfer Function G(s)

Input → SMPS G(s) → Output

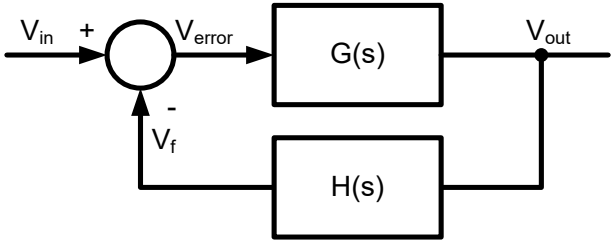
[1] Inject step response

[2] Measure output profile



Ch3 : Close Loop and Open Loop System

Close-Loop Transfer Function

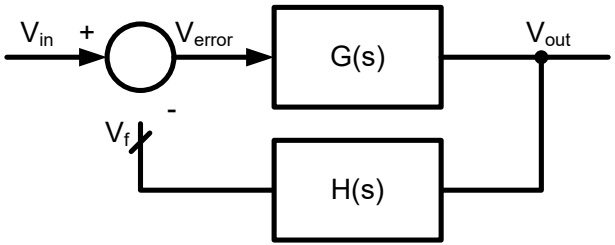


$$T(s) = \frac{V_{out}}{V_{in}} = \frac{G(s)}{1 + G(s)H(s)}$$

Goal is close-loop

But firstly back to something we familiar

Open-Loop Transfer Function



$$GH(s) = \frac{V_f}{V_{in}} = \frac{V_f}{V_{error}} = G(s)H(s)$$

Open Loop and Close Loop Relationship
Bode Method (Frequency Domain)

- DC Gain – Steady State Error
- Phase Margin – Damping Ratio
- Gain Margin – System Robustness
- Gain/Phase Crossover Freq – Natural Frequency