NPTEL ONLINE CERTIFICATION COURSES

DIGITAL CONTROL IN SMPCs AND FPGA-BASED PROTOTYPING

Dr. Santanu Kapat
Electrical Engineering Department, IIT KHARAGPUR

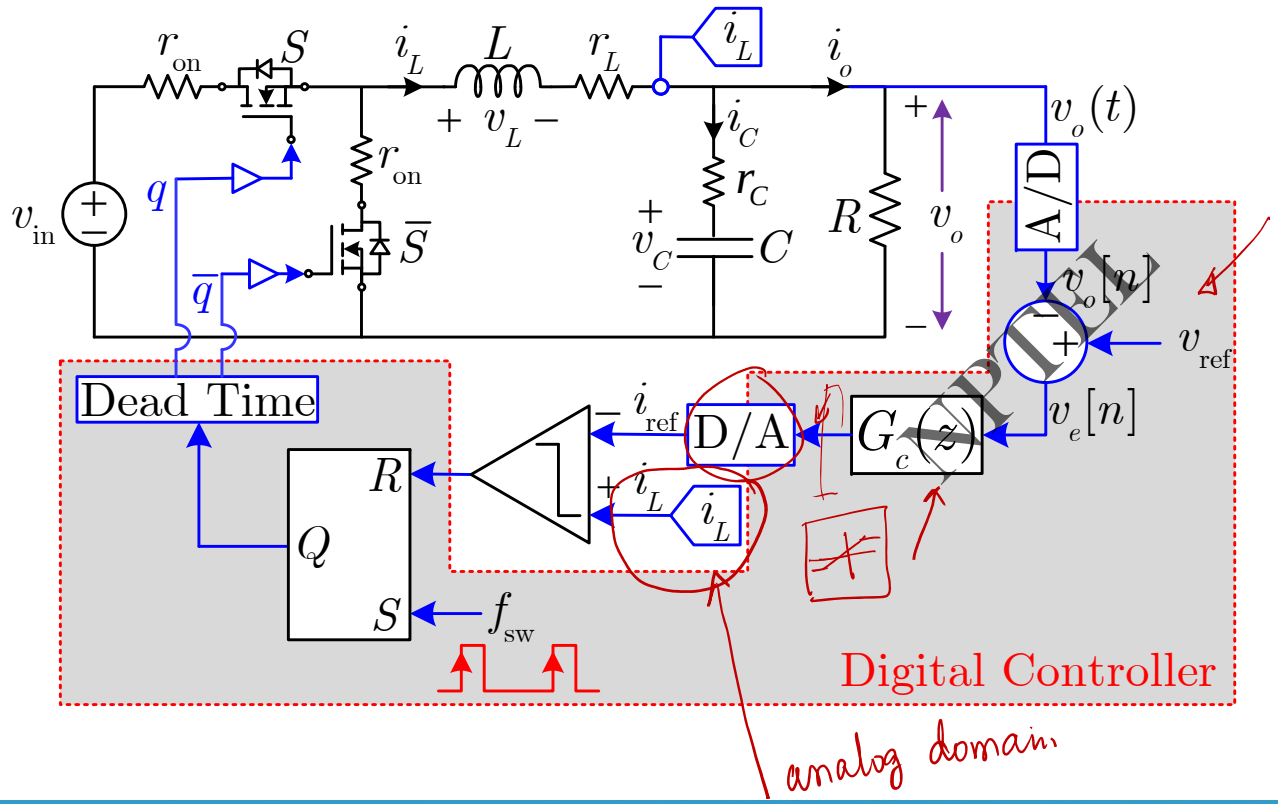
Module 02: Fixed and Variable Frequency Digital Control Architectures

Lecture 14: Sampling Methods under Fixed Frequency Current Mode Control

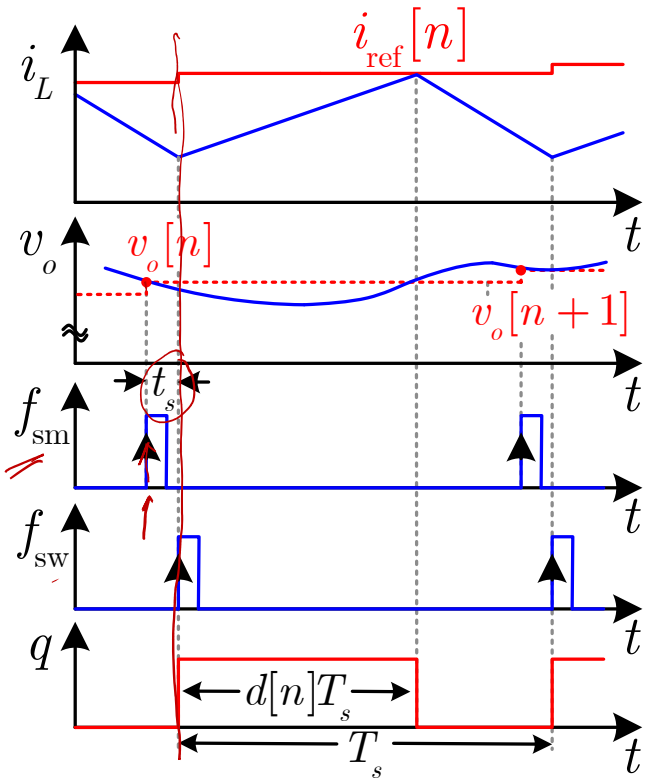
CONCEPTS COVERED

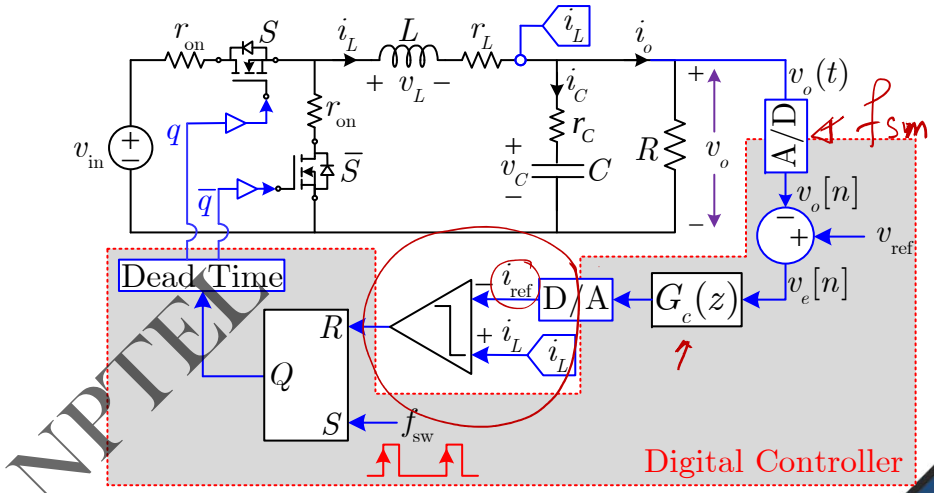
- Overview of sampling methods in digital current mode control
- Mixed-signal current mode control and control waveforms
- Fully digital current mode control and control waveforms

Mixed-Signal Peak CMC Architecture



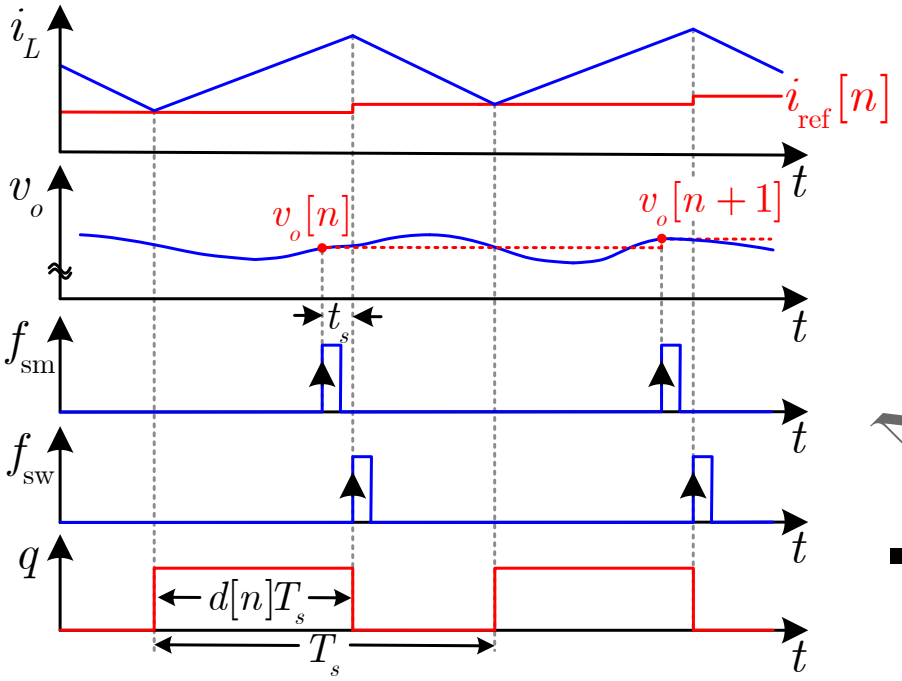
Mixed-Signal Peak CMC Architecture

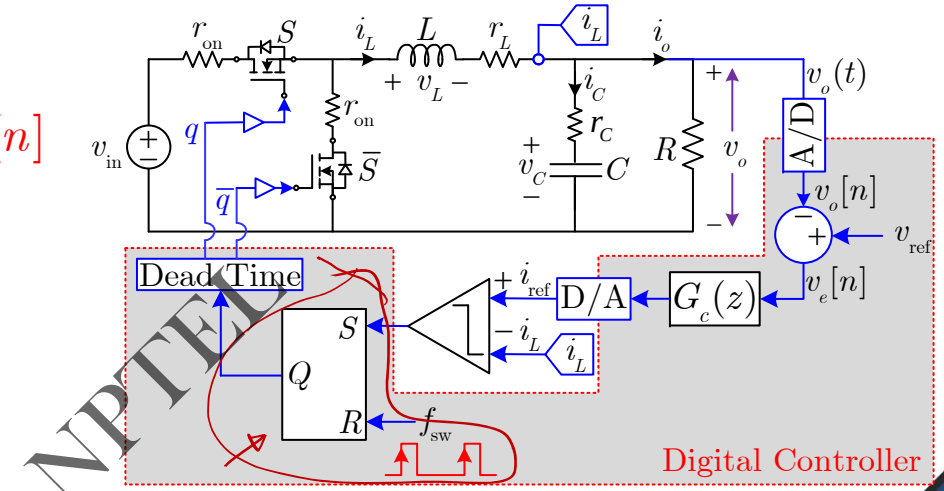




- Trailing-edge modulation with interval-2 sampling

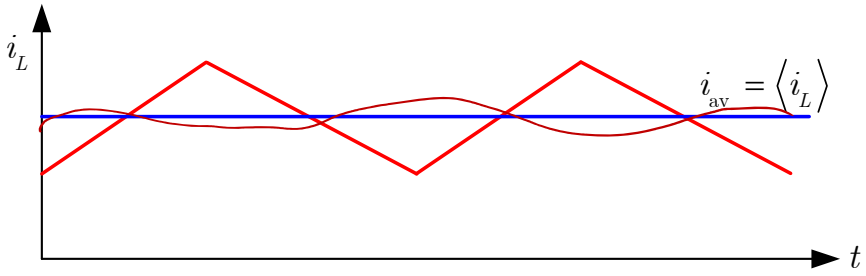
Mixed-Signal Valley CMC Architecture

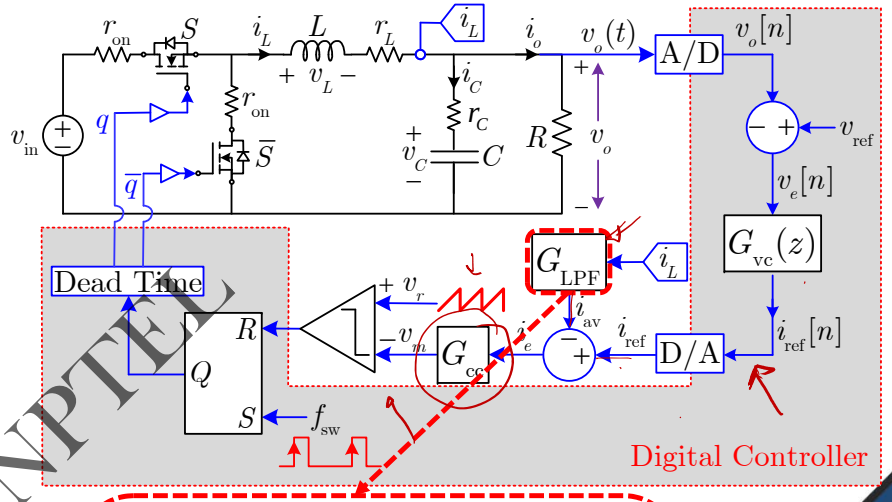




- Leading-edge modulation with interval-1 sampling

Mixed-Signal Average CMC Architecture



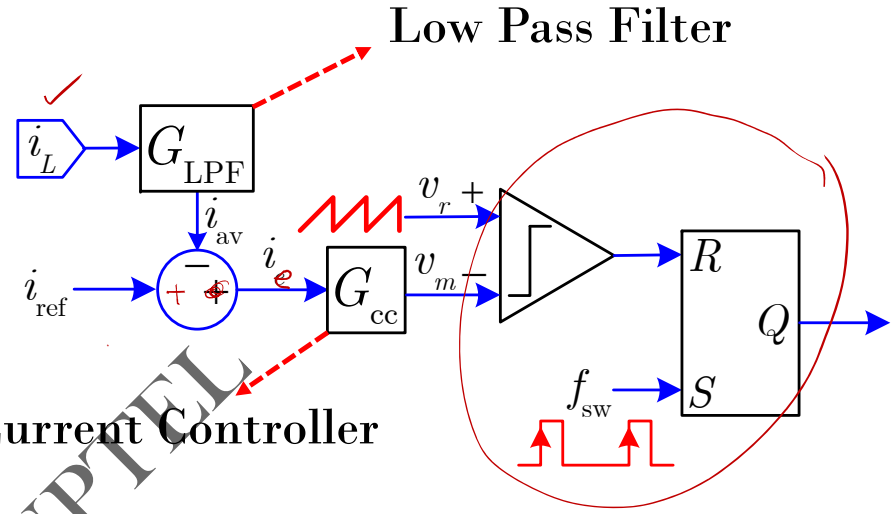


- **Objective:**
  - To control average value of i_L
- **Question:**
  - How to extract average value of i_L?

$$G_{LPF}(s) = \frac{k_c}{\left(1 + \frac{s}{\omega_L}\right)}$$

$\omega_L \rightarrow$ cut-off frequency

Average CMC – Current Loop



$G_{\text{LPF}} \rightarrow$ LPF is used to extract average inductor current

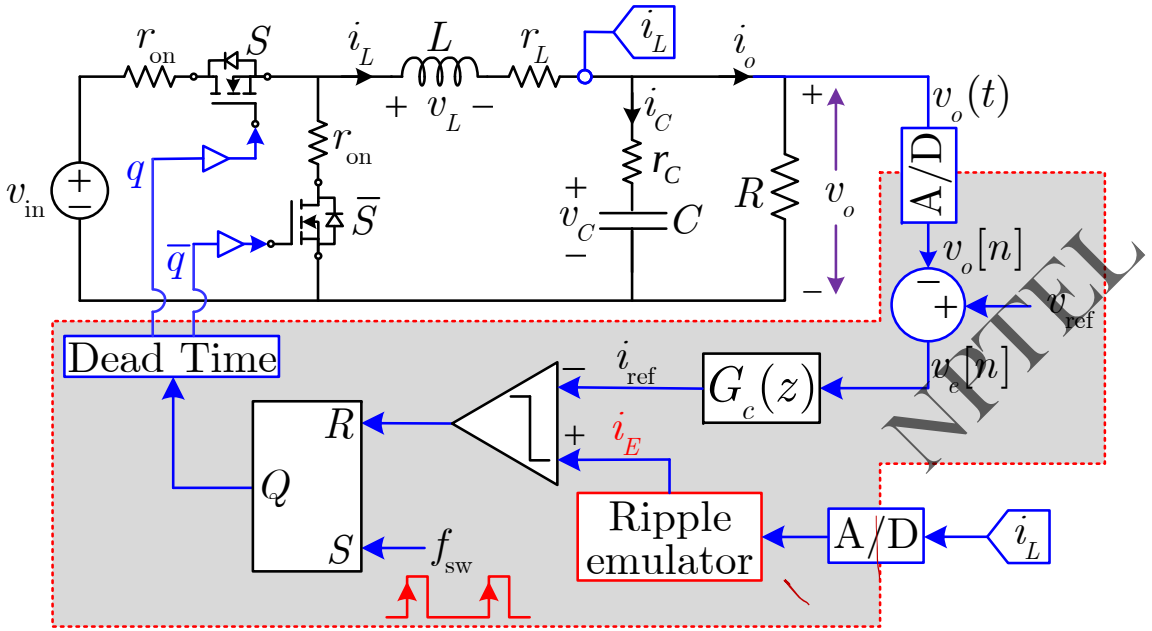
$G_{\text{cc}} \rightarrow$ Current controller (Generally PI)

$$G_{\text{LPF}} = \frac{k_c}{\left(1 + \frac{s}{\omega_L}\right)}$$

$$w_L \ll 2\pi f_{\text{sw}}$$

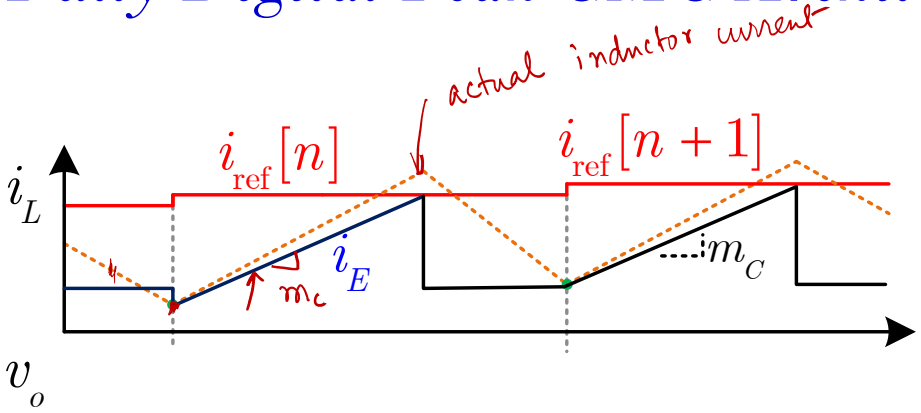
$$w_L \approx \frac{2\pi f_{\text{sw}}}{10} \quad \textit{(Thumb rule)}$$

Fully Digital Peak CMC Architecture

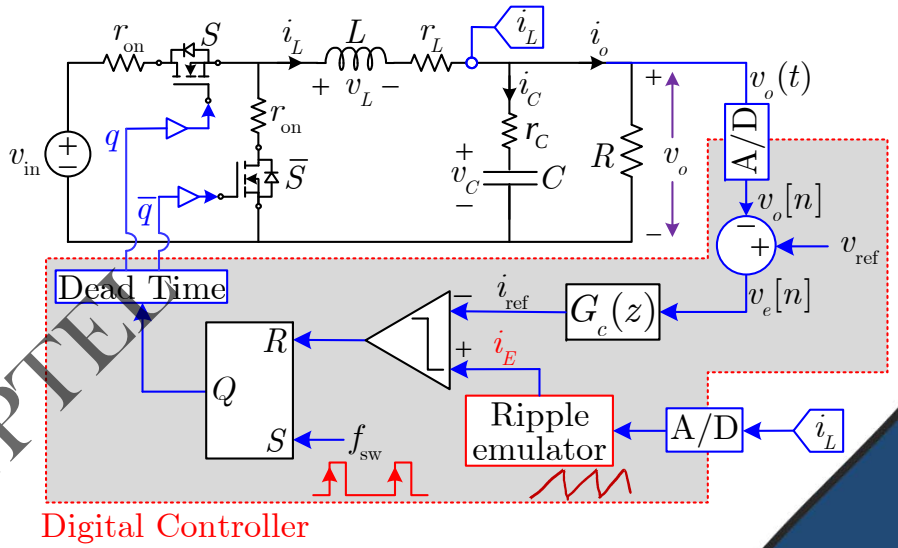


Digital Controller

Fully Digital Peak CMC Architecture



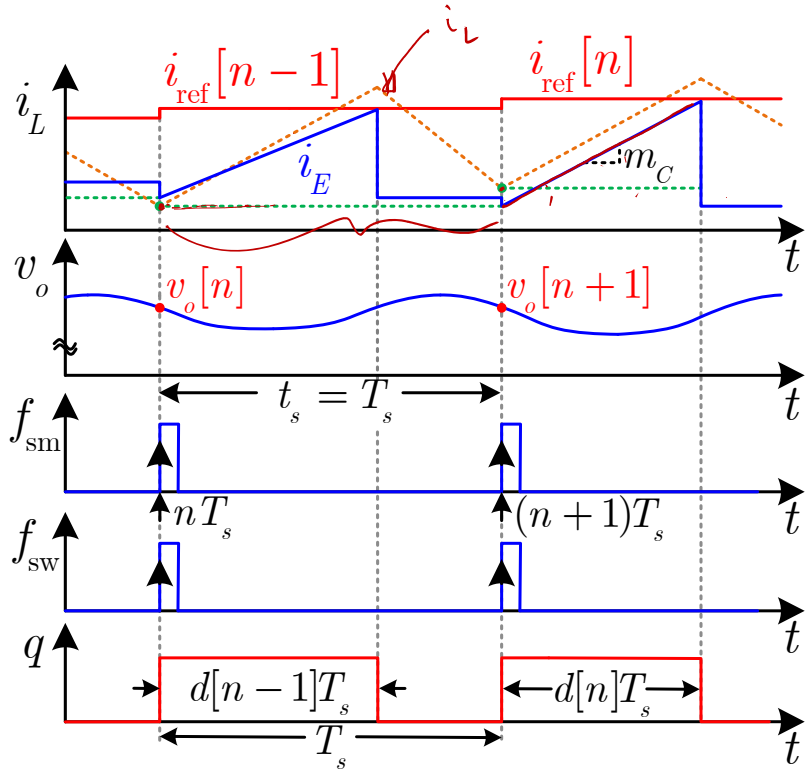
Uniform Sampling



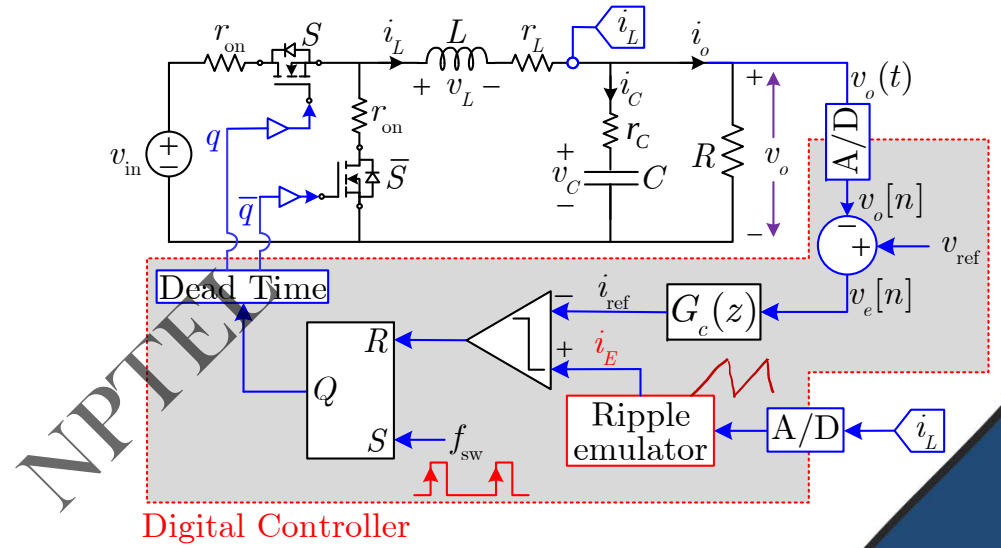
Digital Controller

- Infeasible sampling – why?

Fully Digital Peak CMC Architecture (contd…)



Uniform Sampling with one cycle delay



- **Feasible sampling**

CONCLUSION

- Overview of sampling methods in digital current mode control
- Mixed-signal current mode control and control waveforms
- Fully digital current mode control and control waveforms

THANK YOU !