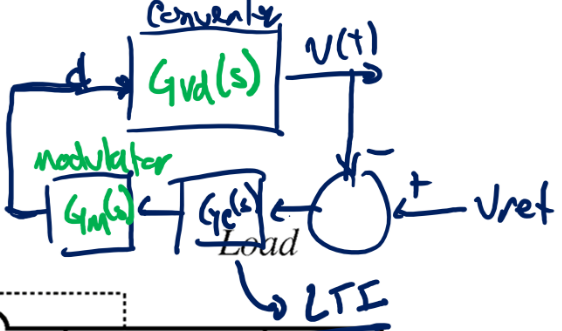
Dynamic Modeling Introduction

So far, focus on periodic steady-state

Have looked at nonideal (loss) impact on conversion ratio

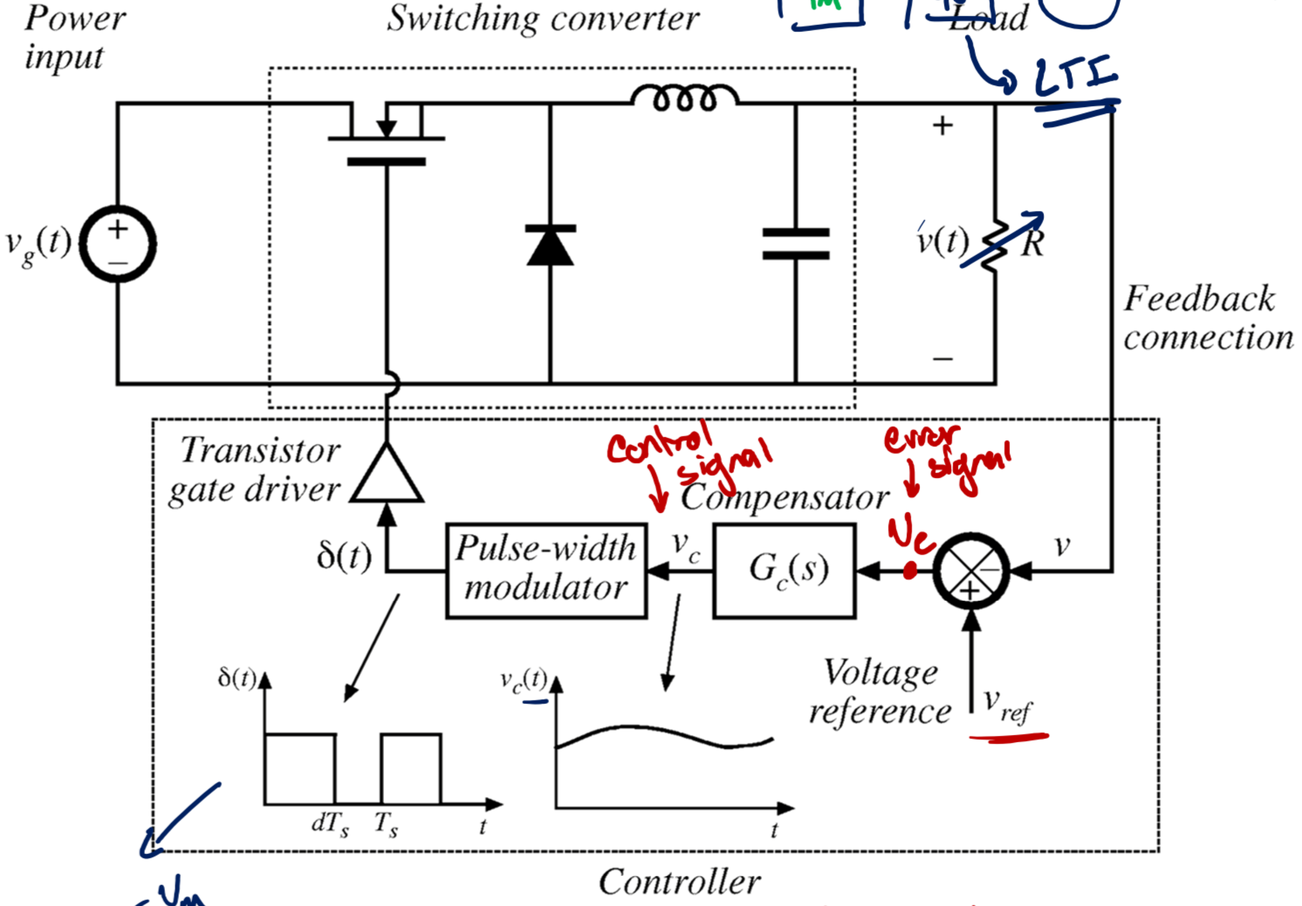


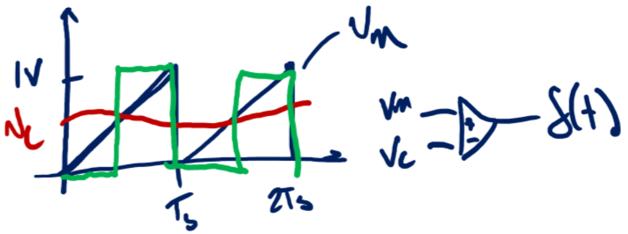
① We have some uncertainty in our model that will change the output

- loss models
- $v_g(t)$
- L/C/ r_{on}

② We will experience dynamic changes in the circuit

- R (or more complicated load model)
- $v_g(t)$

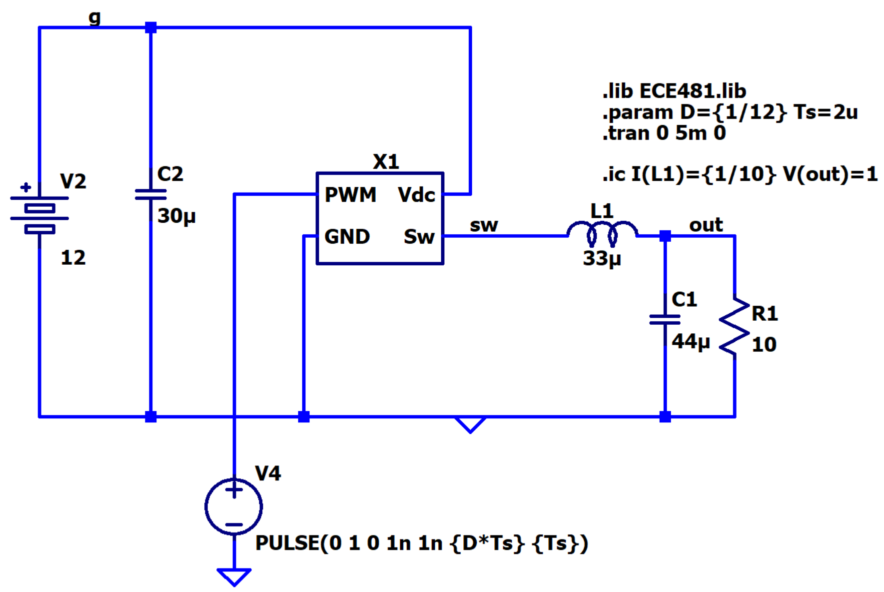


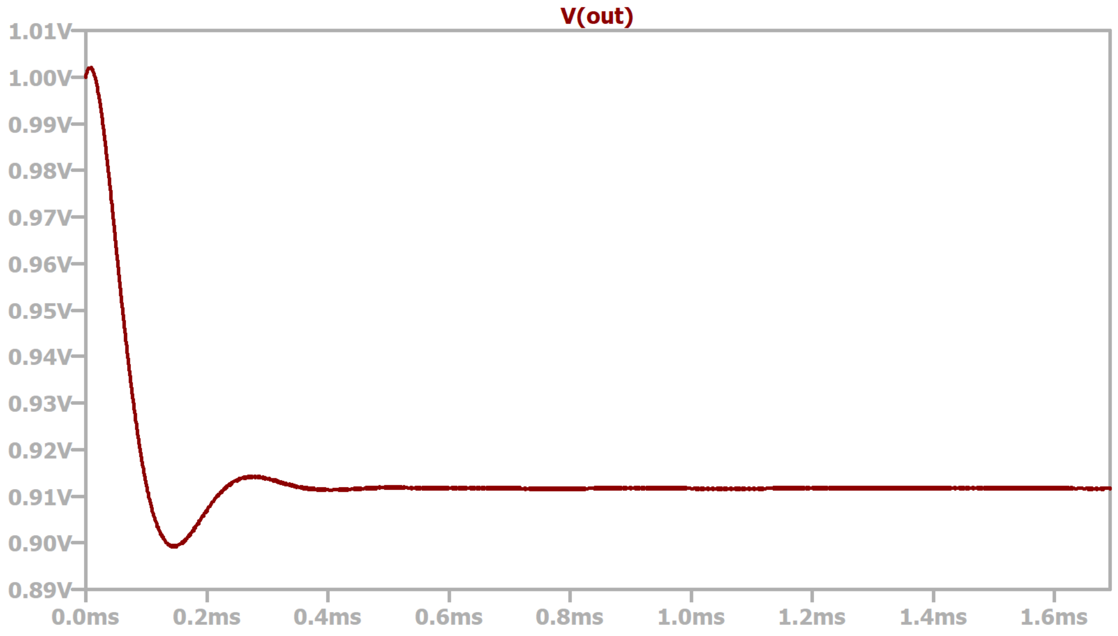


$G_c(s)$ → designed to yield

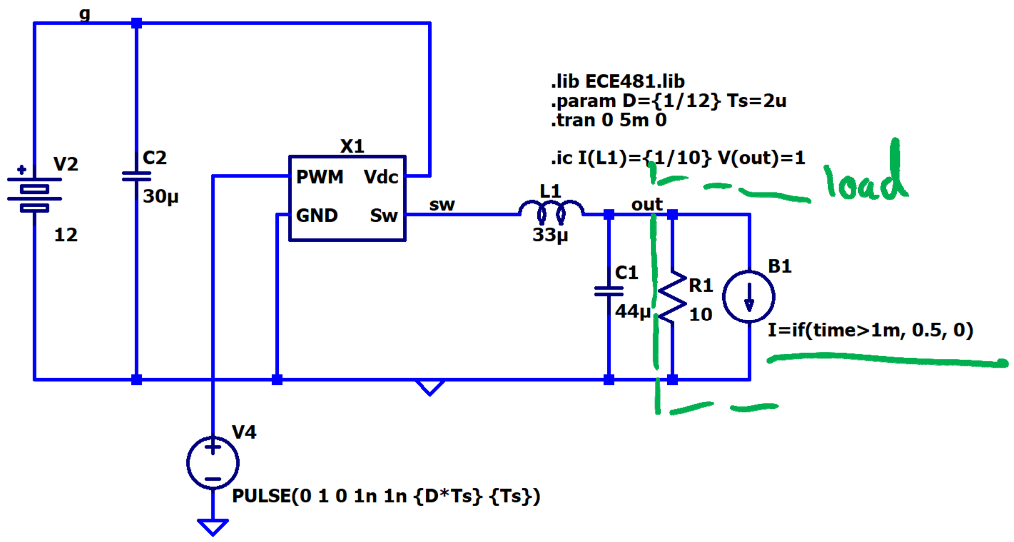
- zero steady-state error
- fast transient response
- limited overshoot & ringing

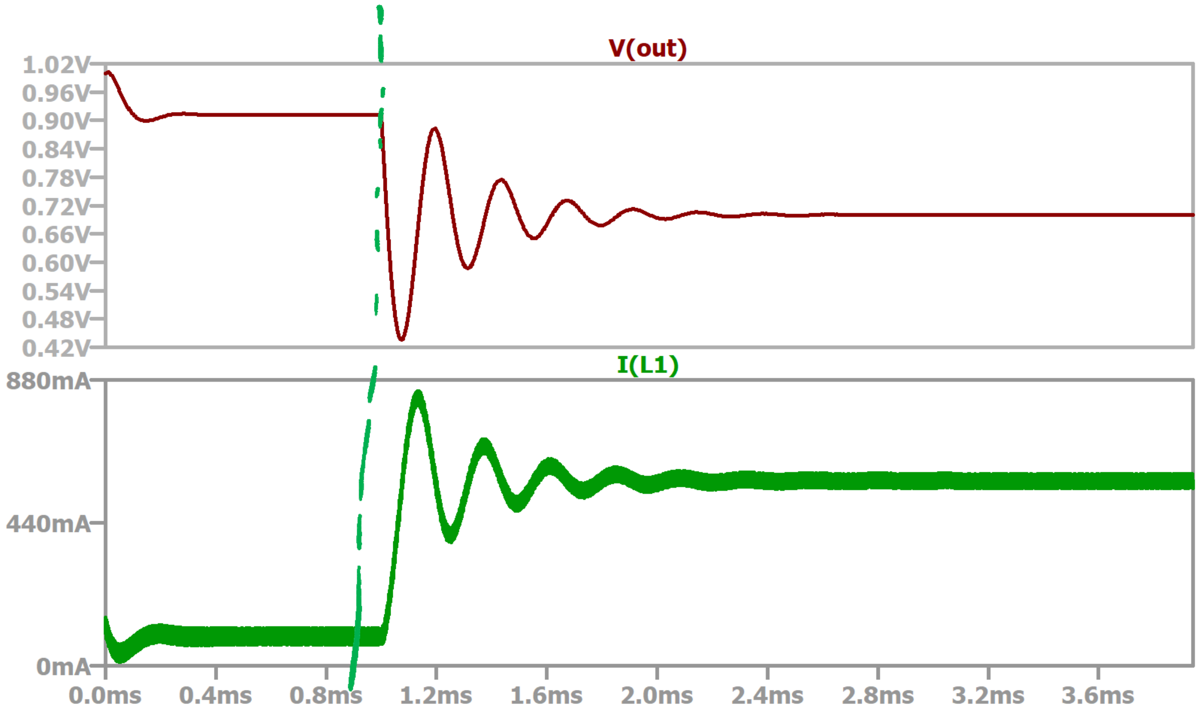
Example Simulation





Converter Step Response





Control Objectives and Inputs

Vout control

- power supply
- off-grid inverter

Iout control

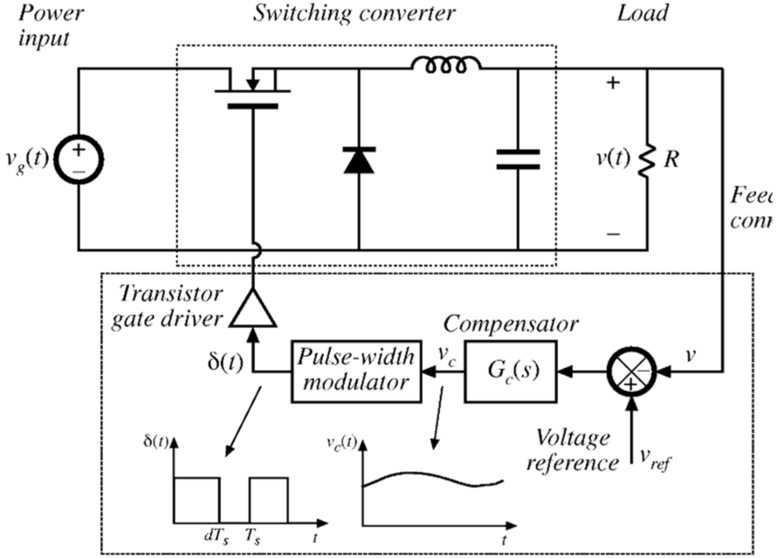
- grid-tied inverter
- battery charger

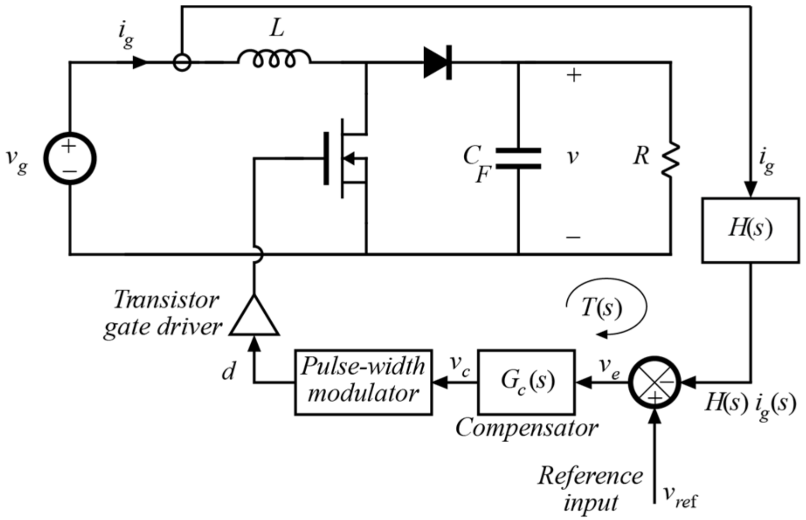
Vin Control

- PV MPP control

Iin Control

- Grid-tied rectifier

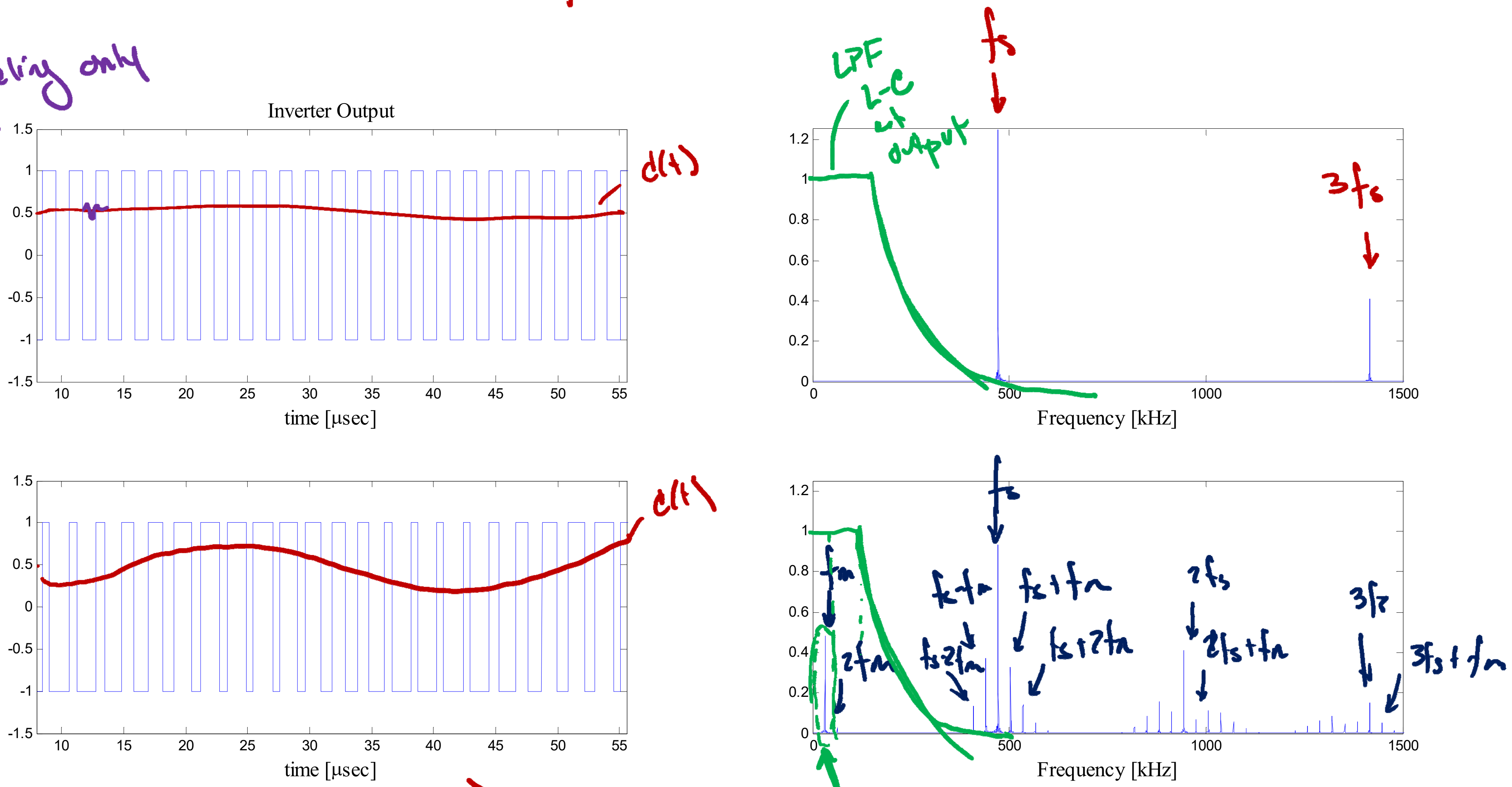




PWM Spectrum

$f_s = 450\,kHz$

We'll be modeling only for $f \ll f_s$



Model only this for an LTI model

$d(t) = D_0 + D_m \sin(\omega_m t)$

$f_m = \frac{\omega_m}{2\pi}$

Neglecting The Switching Ripple

Averaging + small-signal linearization

+ Gives LTI model $G_{vd}(s) = \frac{v(s)}{d(s)}$

- Introduces error through neglecting (real) nonlinearity & ripple

↳ accurate only for $f << f_s$

Bandwidth designed w/ these models must be $\sim f_s/10$