

# EE4011 RF ICs

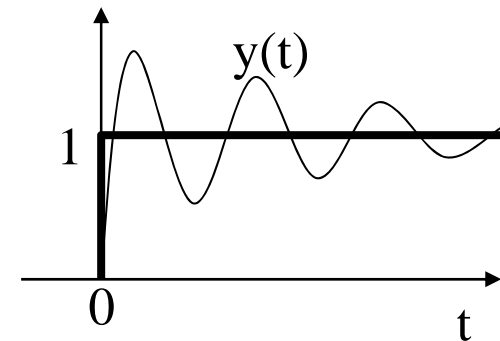
## Type I PLL: Sample Responses

# Sample Responses of a Type I PLL

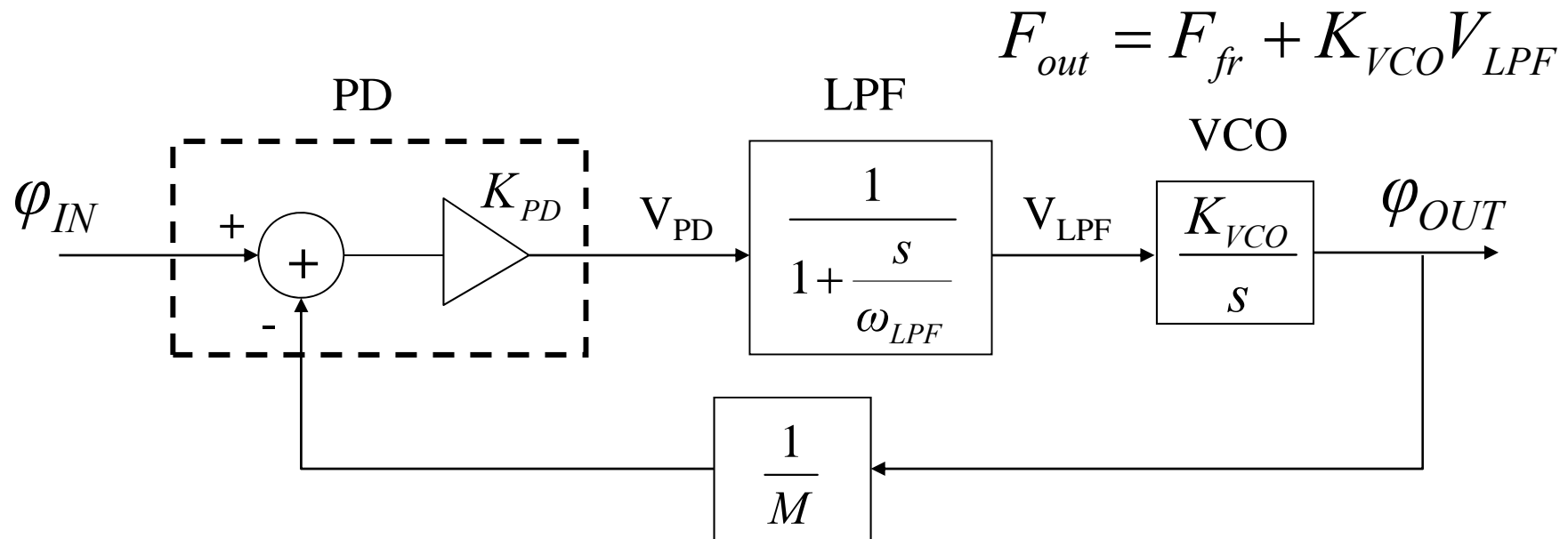
The following plots are for a type I PLL which uses a VCO with a free-running frequency of 1Hz. Initially the input frequency is also 1Hz and at  $t=2s$  something changes such as the input phase, the input frequency or the value of the feedback divider  $M$ . The inputs and outputs are shown as square waves (which can be considered to be the “sign” of the sine waves) to make it easier to see changes in phase and frequency.

The system is under-damped just to illustrate the ringing that occurs in an under-damped second order system. The response of a second-order under-damped system to a step input,  $u(t)$ , is a decaying sine wave as follows:

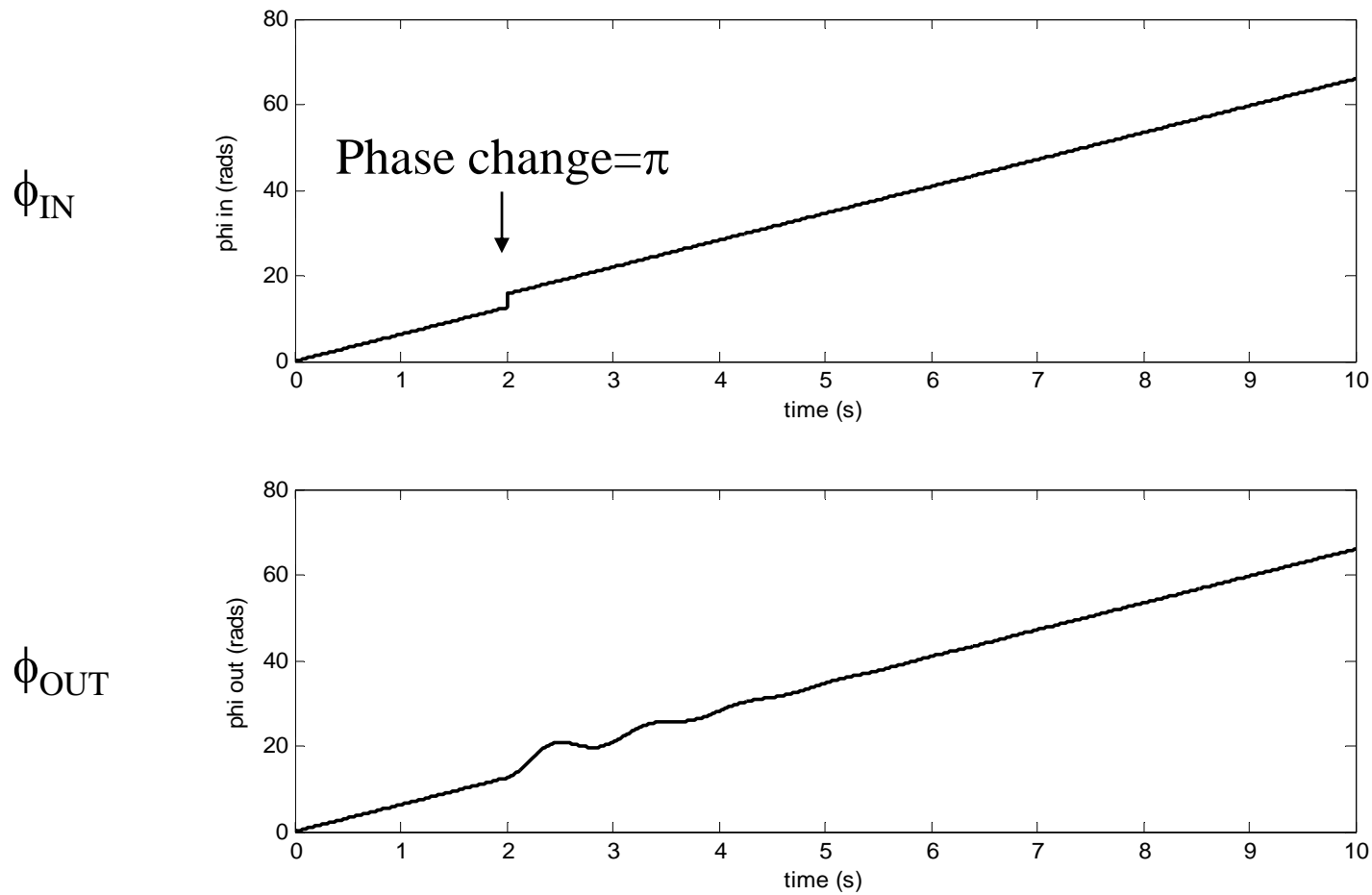
$$y(t) = \left[ 1 - \frac{1}{\sqrt{1-\zeta^2}} \exp(-\zeta \omega_n t) \times \sin(\omega_n \sqrt{1-\zeta^2} t + \psi) \right] u(t)$$
$$\psi = \sin^{-1} \sqrt{1-\zeta^2}$$



# The Basic Type I PLL

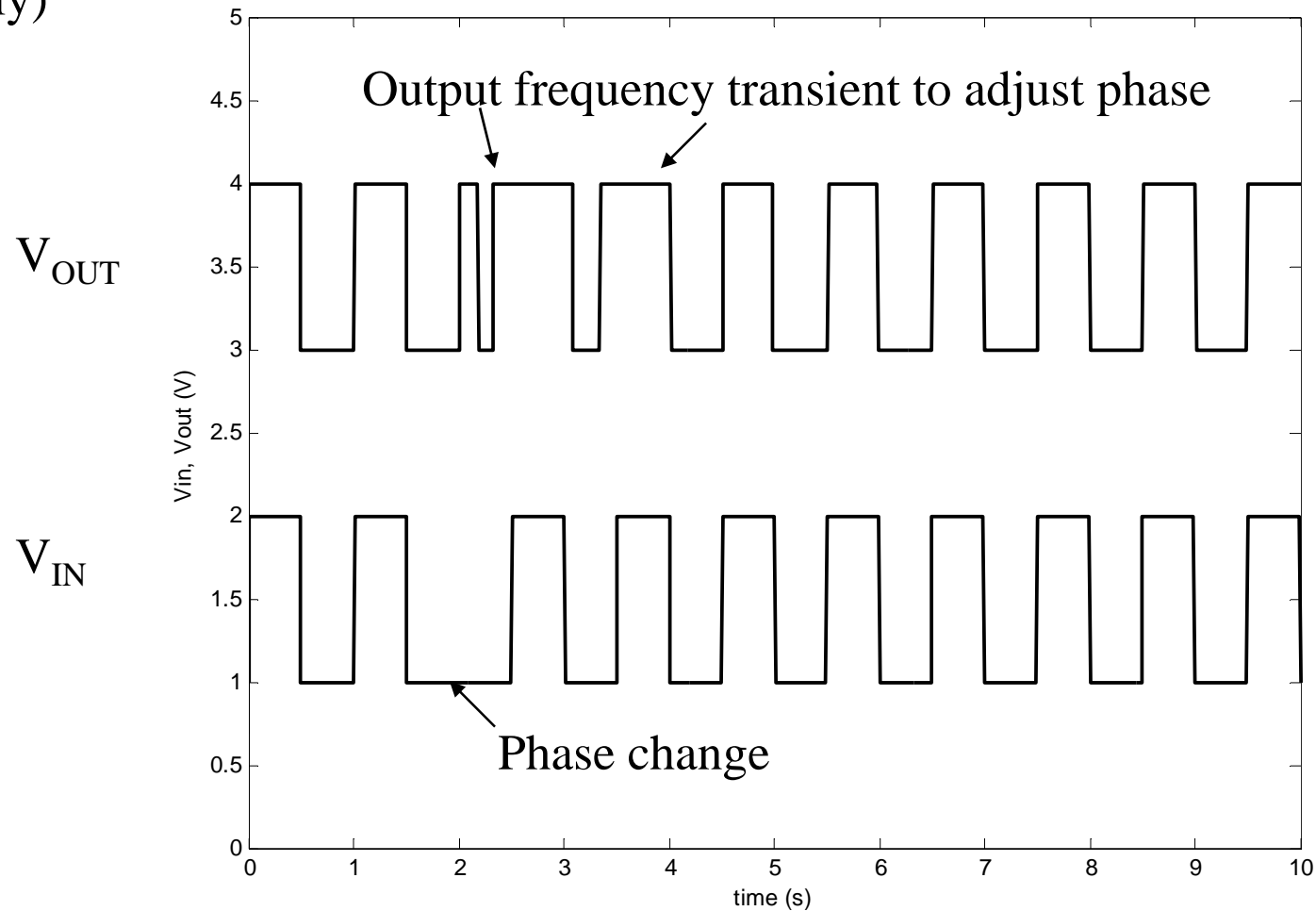


# PLL response to input phase change - 1

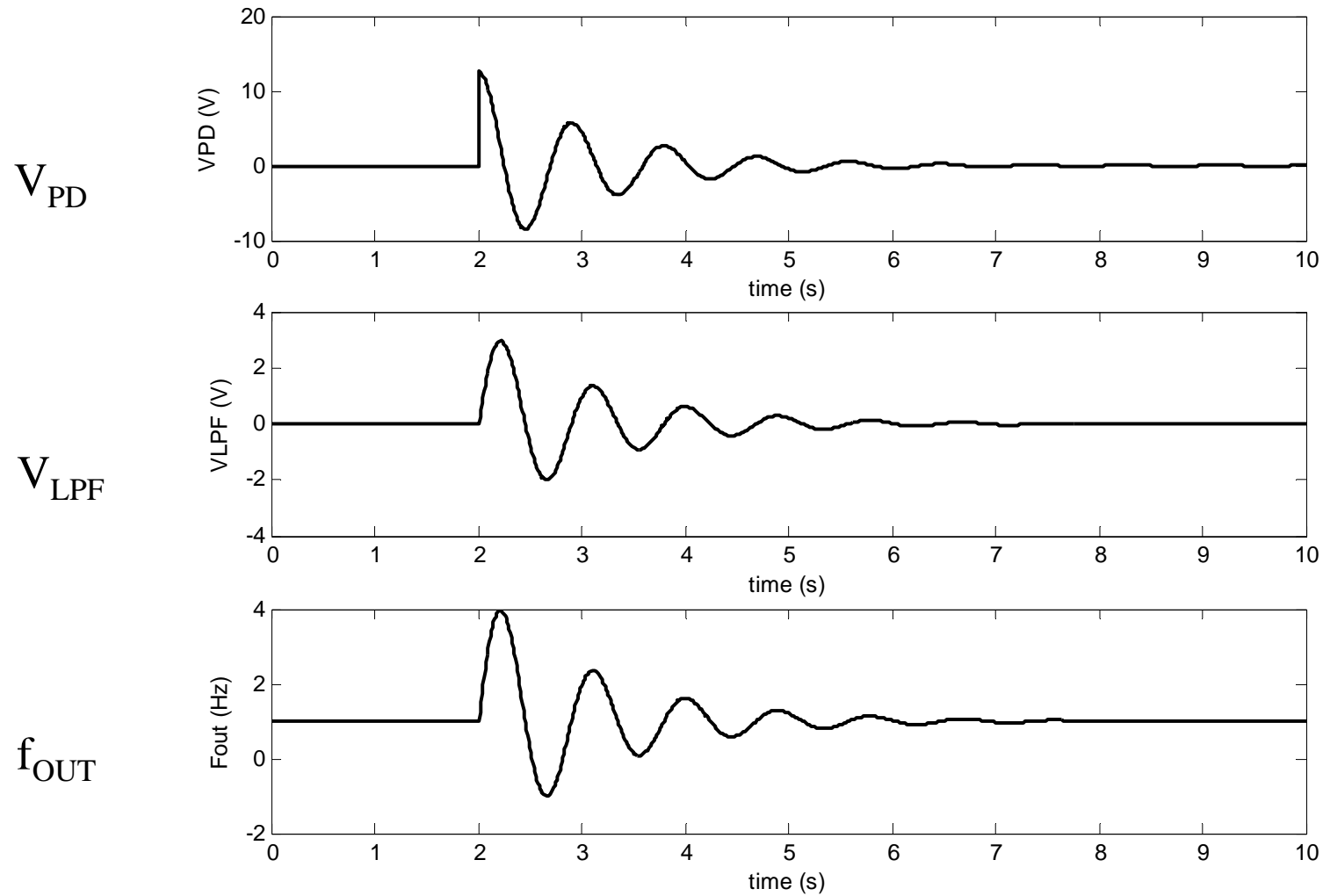


# PLL response to input phase change - 2

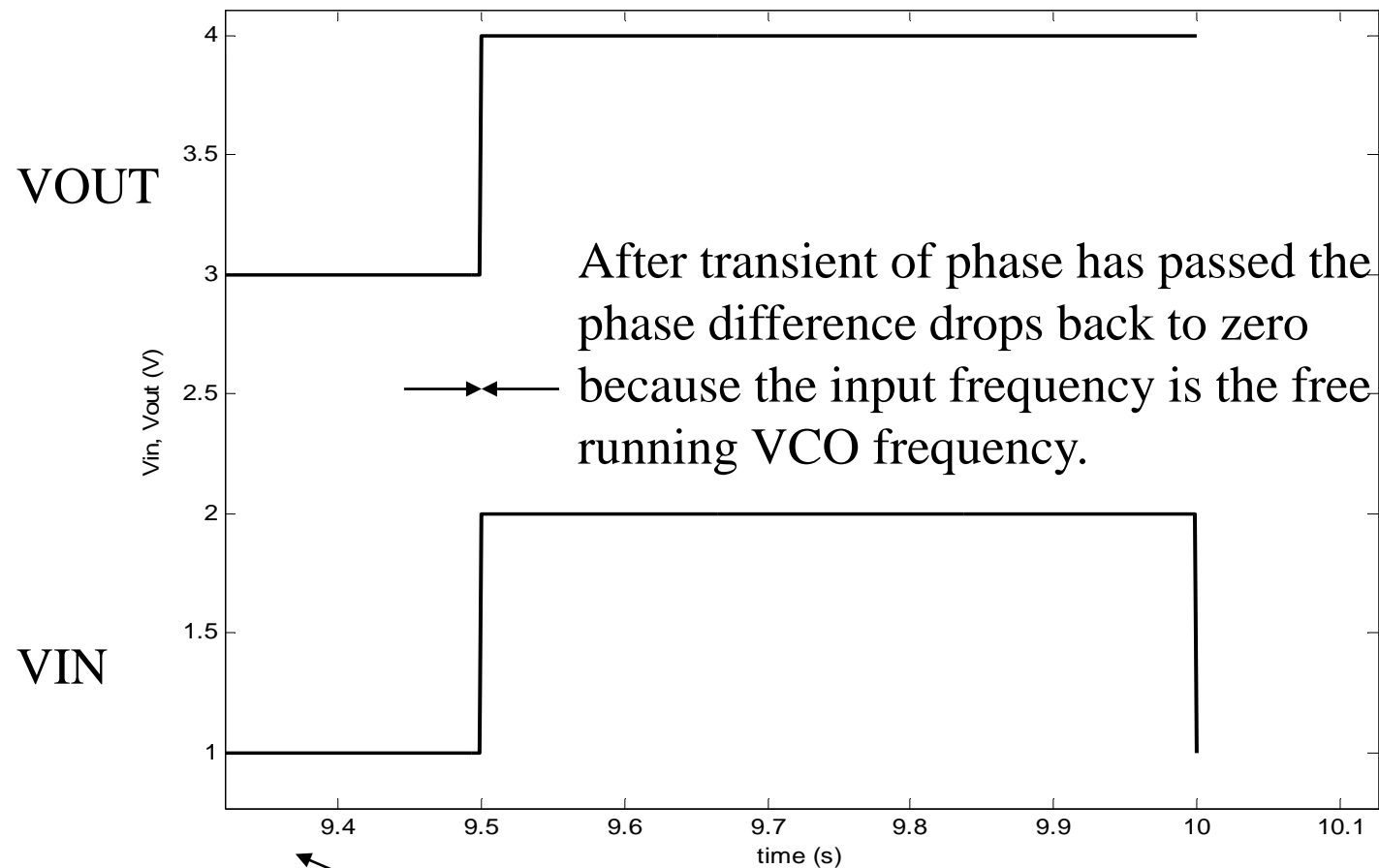
(The inputs and outputs are assumed to be square waves to see the phase change clearly)



# PLL response to input phase change - 3

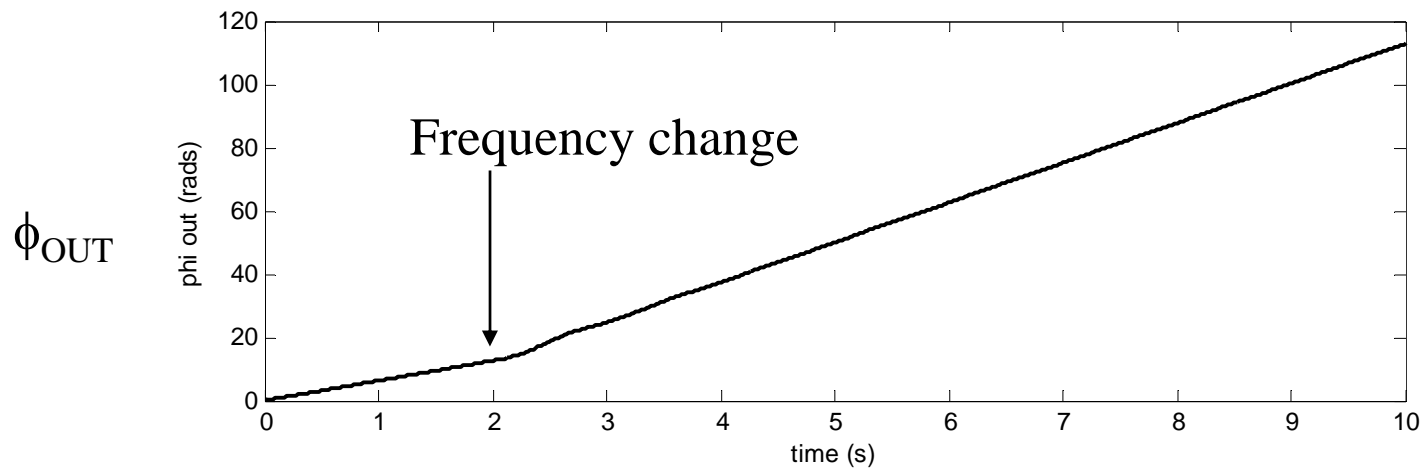
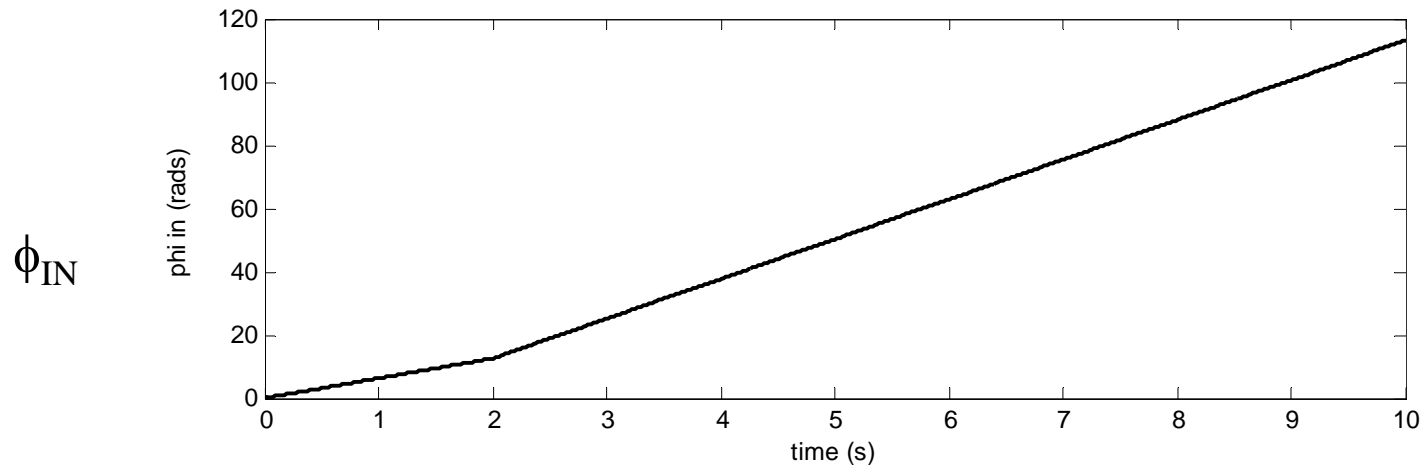


# PLL response to input phase change - 4



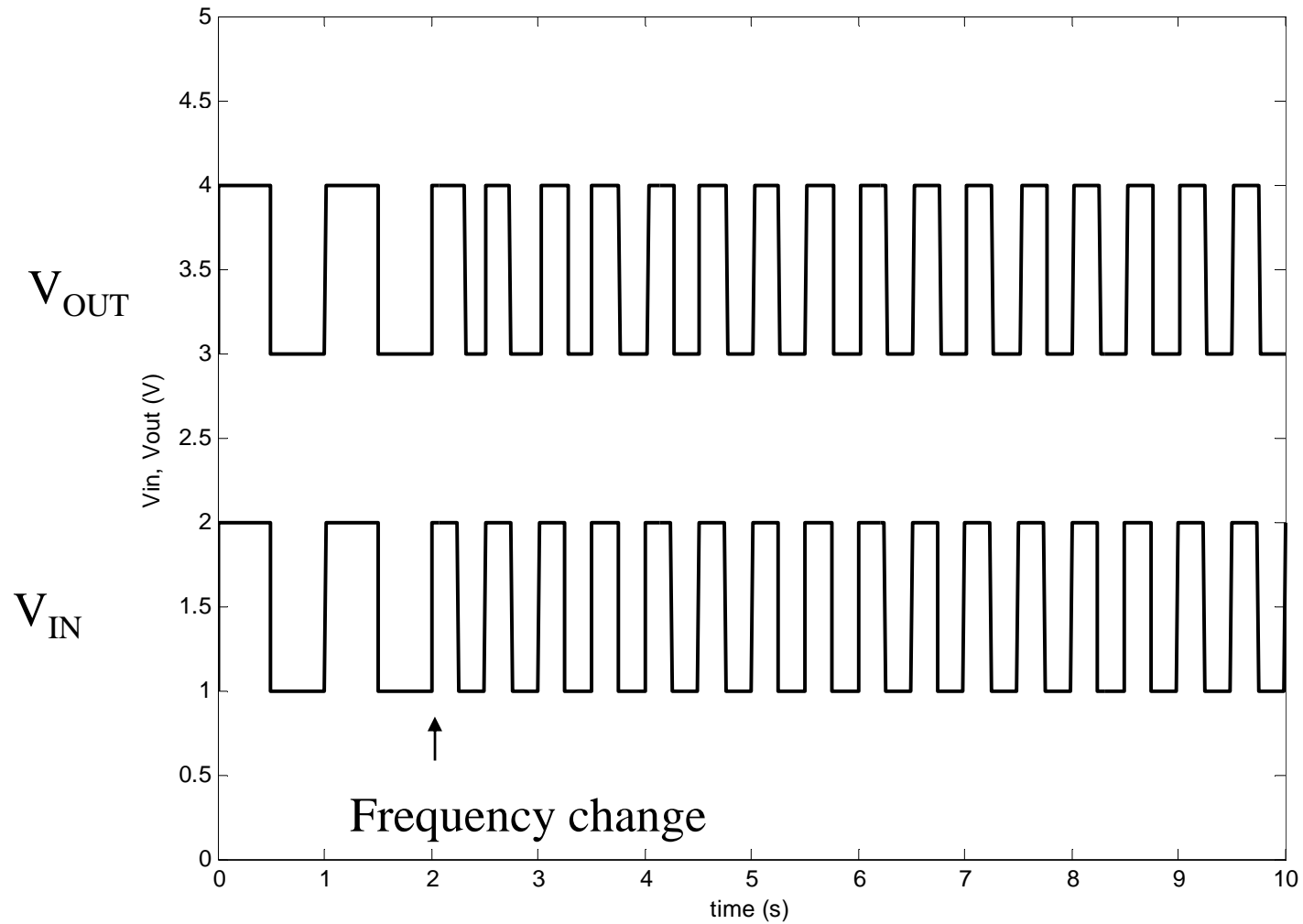
Zoom in of time around 9s

# PLL response to input frequency change - 1

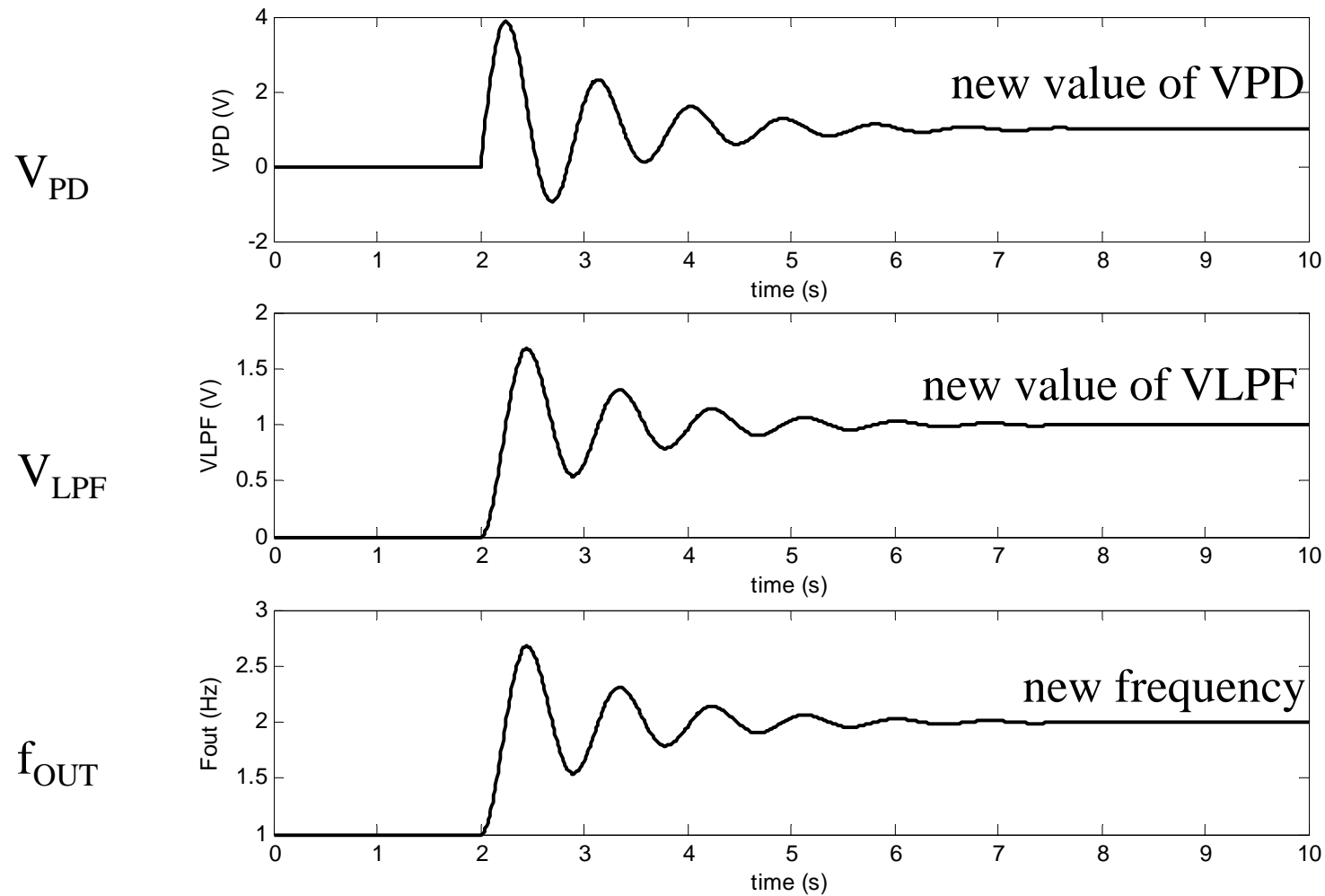




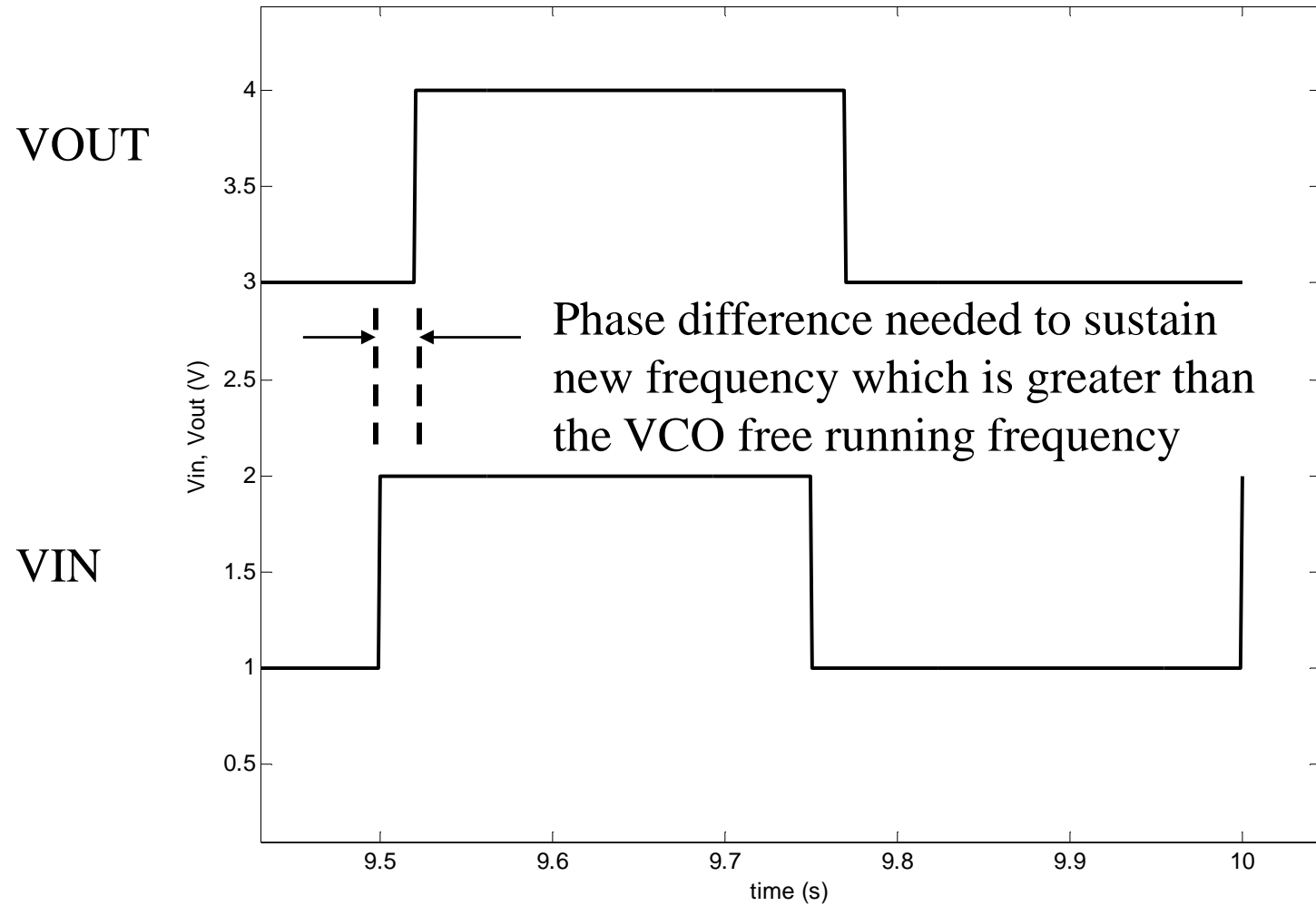
# PLL response to input frequency change - 2



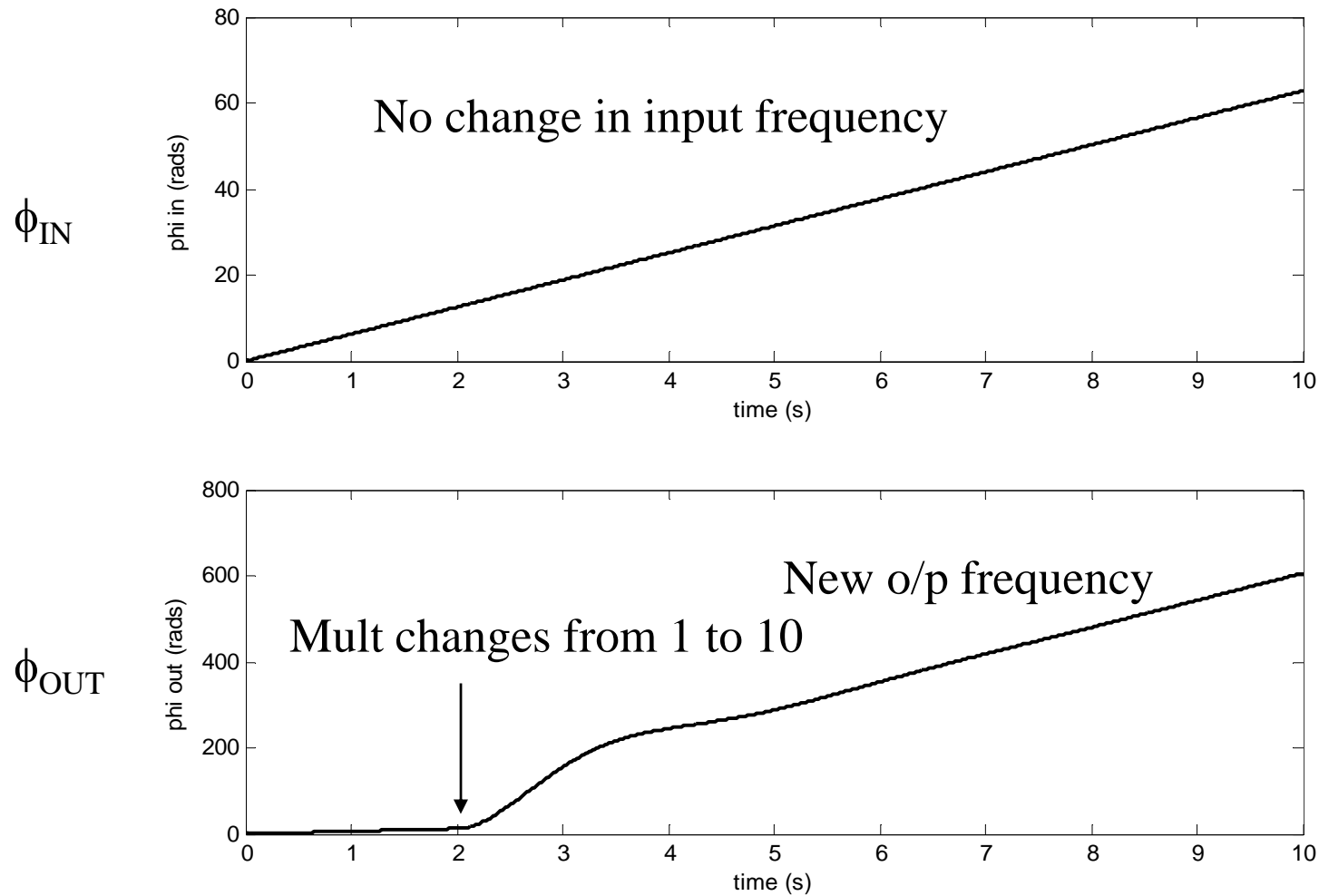
# PLL response to input frequency change - 3



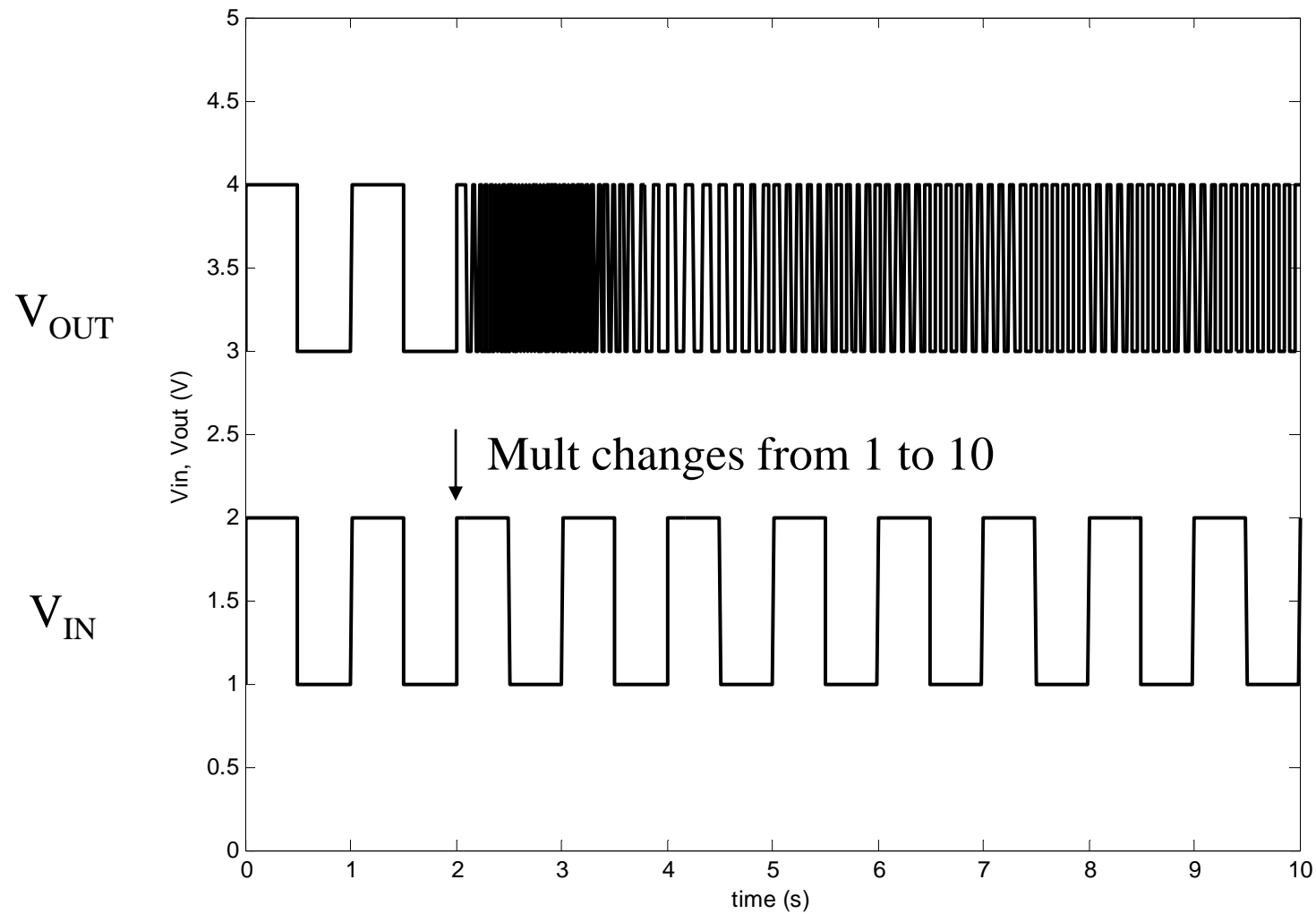
# PLL response to input frequency change - 4



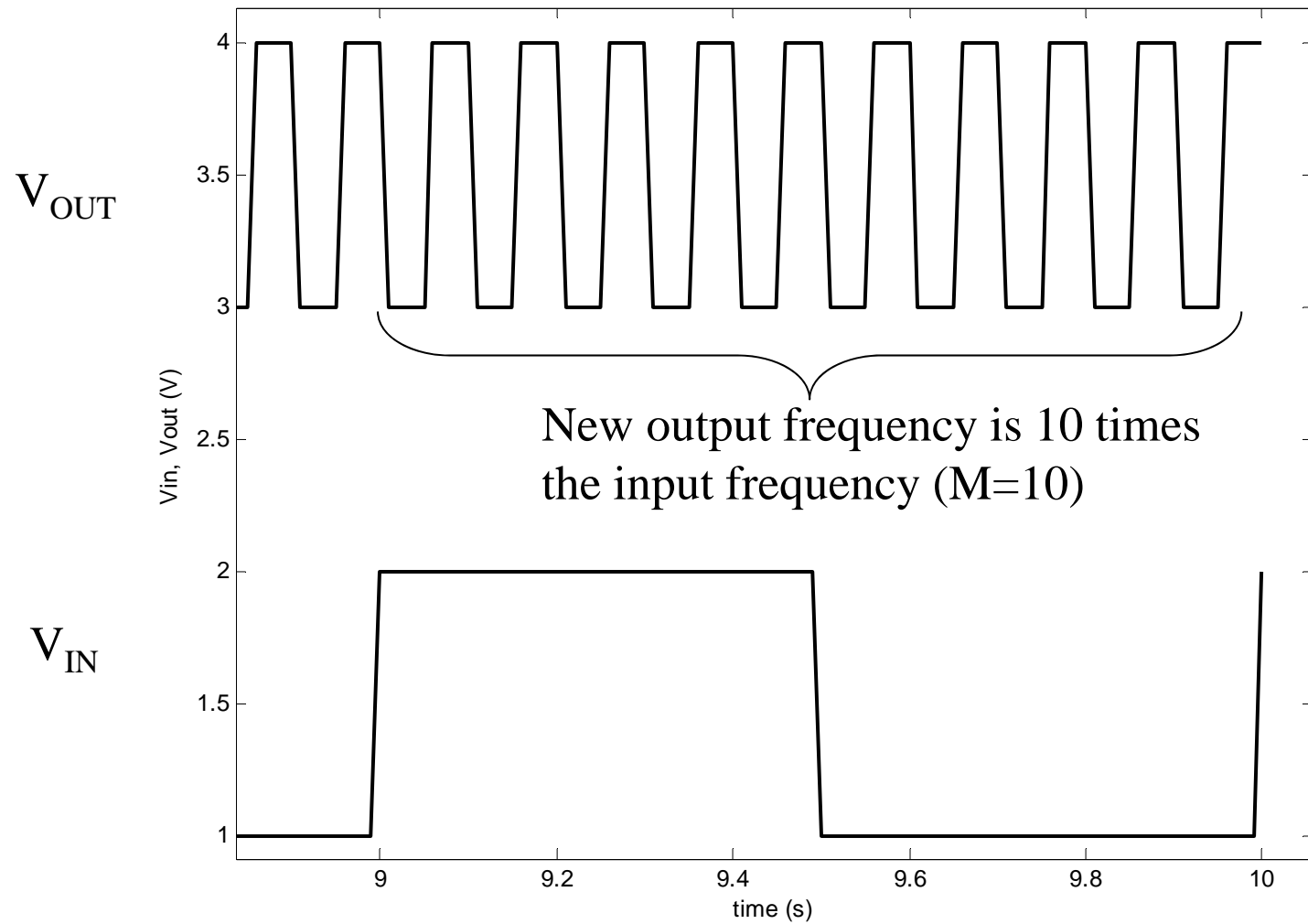
# PLL response to change of M from 1 to 10 - (a)



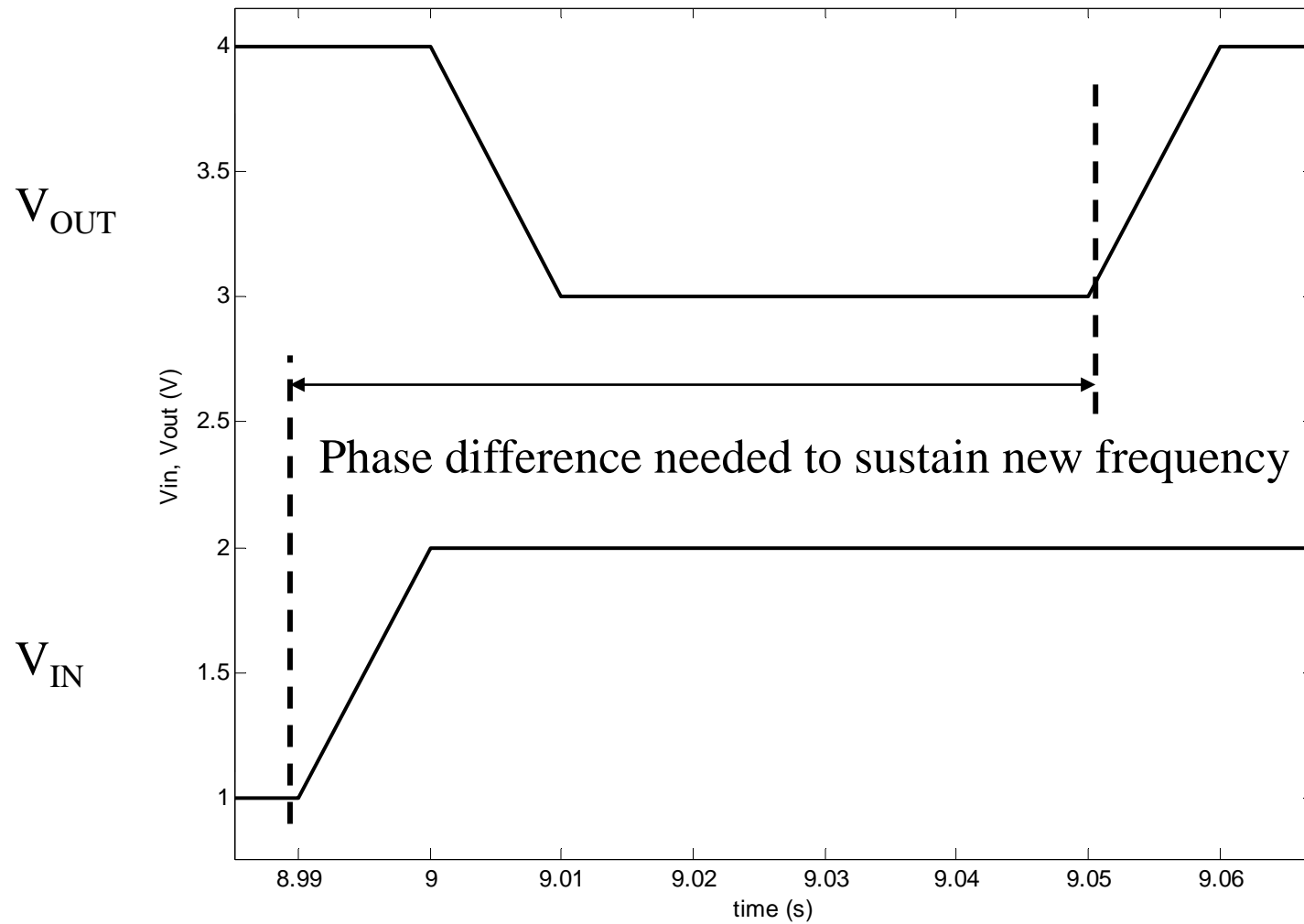
## PLL response to change of M from 1 to 10 – (b)



## PLL response to change of M from 1 to 10 – (c)



## PLL response to change of M from 1 to 10 – (d)



# PLL response to change of M from 1 to 10 – (e)

