The background of the slide features a faint, light gray Bode plot grid. It consists of concentric circles representing constant magnitude and radial lines representing constant phase, centered around a point on the left side of the slide.

# Phase Locked Loop Design

Matt Knoll  
Engineering 315

# Introduction

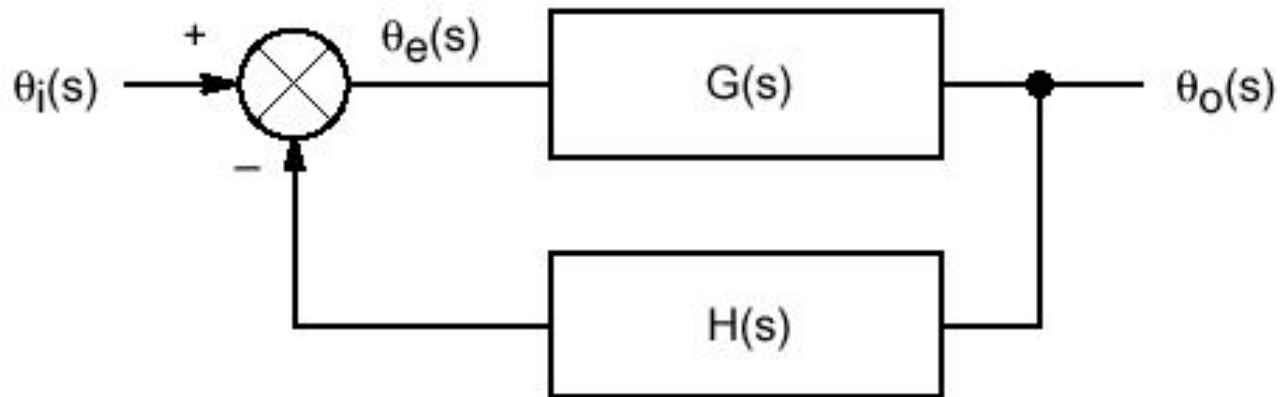
- ◆ What is a PLL?
- ◆ Control System Representation
- ◆ Parts of a PLL
- ◆ PLL in Simulink

# What is a PLL?

- ◆ Digital frequency control system
  - ◆ Generate high speed oscillations
  - ◆ Acquire and track signals
    - Radio Frequency Demodulation
    - DX-ing
    - RF communications

# Control system representation

## Feedback System



$\theta_i(s)$  Phase Input

$\theta_e(s)$  Phase Error

$\theta_o(s)$  Output Phase

$G(s)$  Product of the Individual Feed  
Forward Transfer Functions

$H(s)$  Product of the Individual Feedback  
Transfer Functions

# Modeling a PLL

Representing a Phase Locked Loop as a transfer function

System sensitivity:

$$\frac{\theta_e(s)}{\theta_i(s)} = \frac{1}{1 + G(s) \cdot H(s)}$$

**Where:**

$\theta_i(s)$  = Phase input

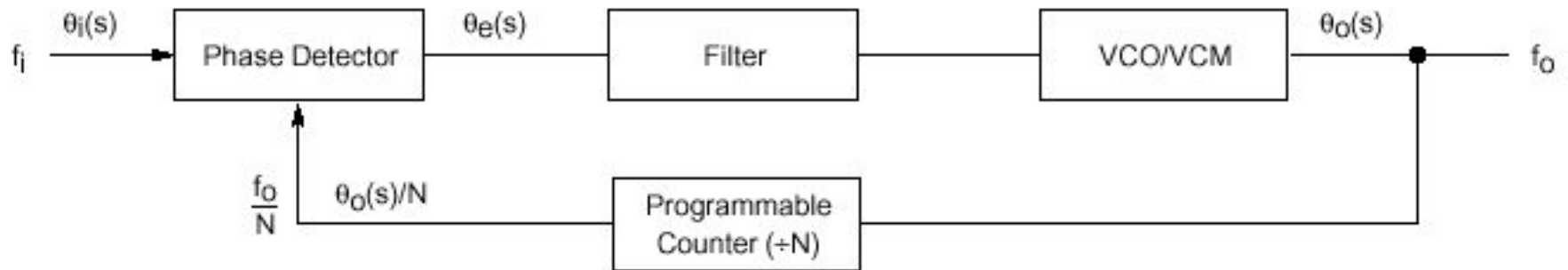
$\theta_o(s)$  = Output phase

$\theta_e(s)$  = Phase error

Closed loop transfer function:

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{G(s)}{1 + G(s) \cdot H(s)}$$

# PLL Control System



**Phase Locked Loop**



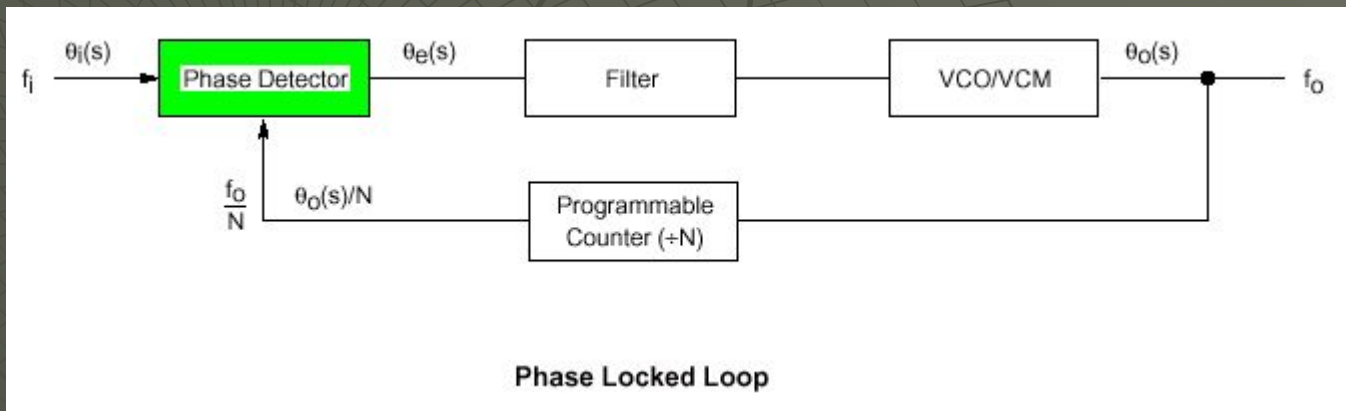
# Parts of a PLL

- ◆ Phase Detector
- ◆ Filter
- ◆ Voltage Controlled Oscillator
- ◆ Programmable Counter

# Parts of a PLL

## ◆ Phase Detector

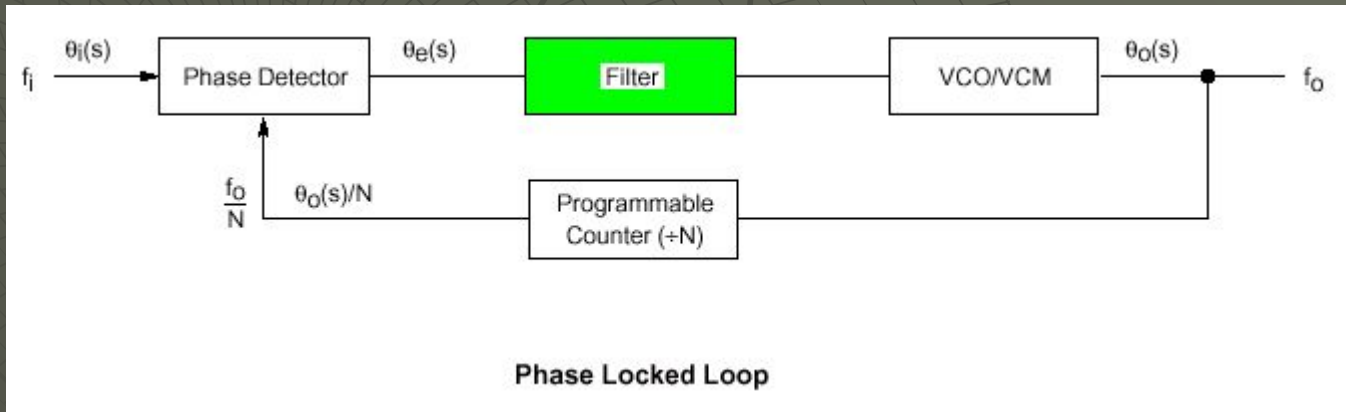
- ◆ Acts as comparator
- ◆ Produces a voltage proportional to the phase difference between input and output signal
- ◆ Voltage becomes a control signal





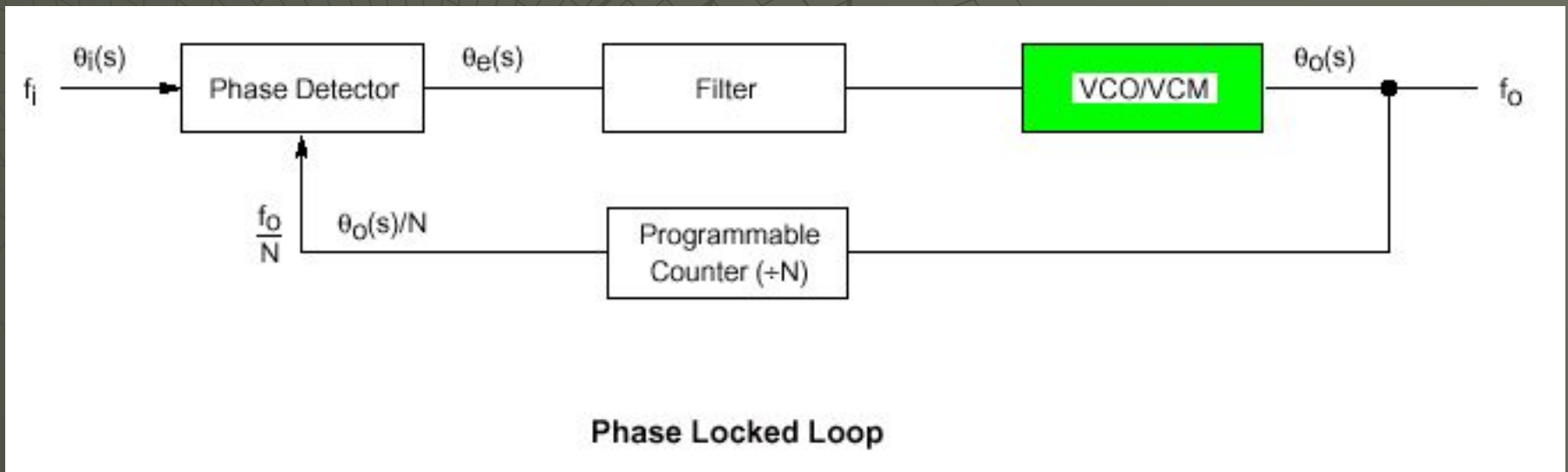
# Parts of a PLL

- ◆ Filter
  - ◆ Determines dynamic characteristics of PLL
    - ◆ Specify Capture Range (bandwidth)
    - ◆ Specify Tracking Range
  - ◆ Receives signal from Phase Detector and filters accordingly



# Parts of a PLL

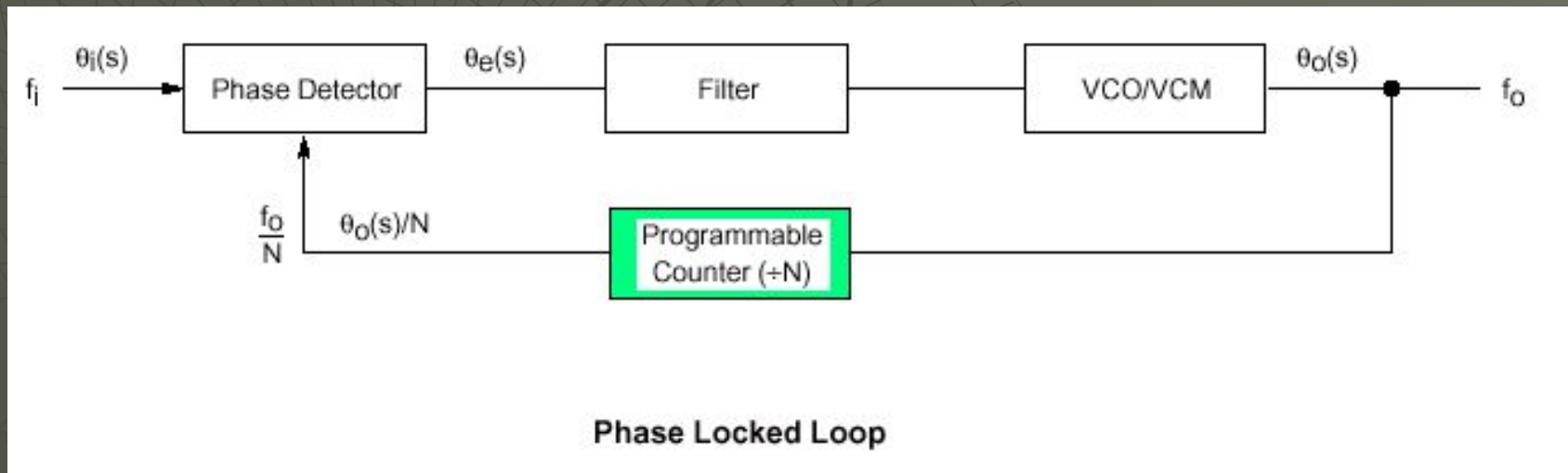
- ◆ Voltage Controlled Oscillator
  - ◆ Set tuning range
  - ◆ Set noise margin
  - ◆ Creates low noise clock oscillation



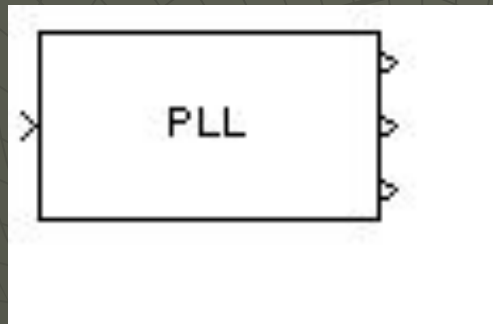
# Parts of a PLL

- ◆ Divider

- ◆ Divides the VCO output by the degree of the open loop gain
- ◆ Feedback loop allows phase comparison



# PLL in Simulink



**Block Parameters: Charge Pump PLL**

Charge Pump PLL (mask)

Implement a charge pump phase-locked loop using a digital phase detector. The three outputs are the outputs of the lowpass filter, the phase detector, and the voltage controlled oscillator (VCO). The input must be a sample-based scalar signal.

Parameters

Lowpass filter numerator:  
[3.0002 0 40002]

Lowpass filter denominator:  
[1 67.46 2270.9 40002]

VCO input sensitivity (Hz/V):  
1

VCO quiescent frequency (Hz):  
100

VCO initial phase (rad):  
0

VCO output amplitude:  
1

OK Cancel Help Apply



Questions?