UNIT-5
Lecture-3
PLL Basics and Design

What is it?

- PLL = Phase Lock Loop

1. A circuit which synchronizes an adjustable oscillator with another oscillator by the comparison of phase between the two signals.
2. An electronic circuit that synchronizes itself to an external reference signal.

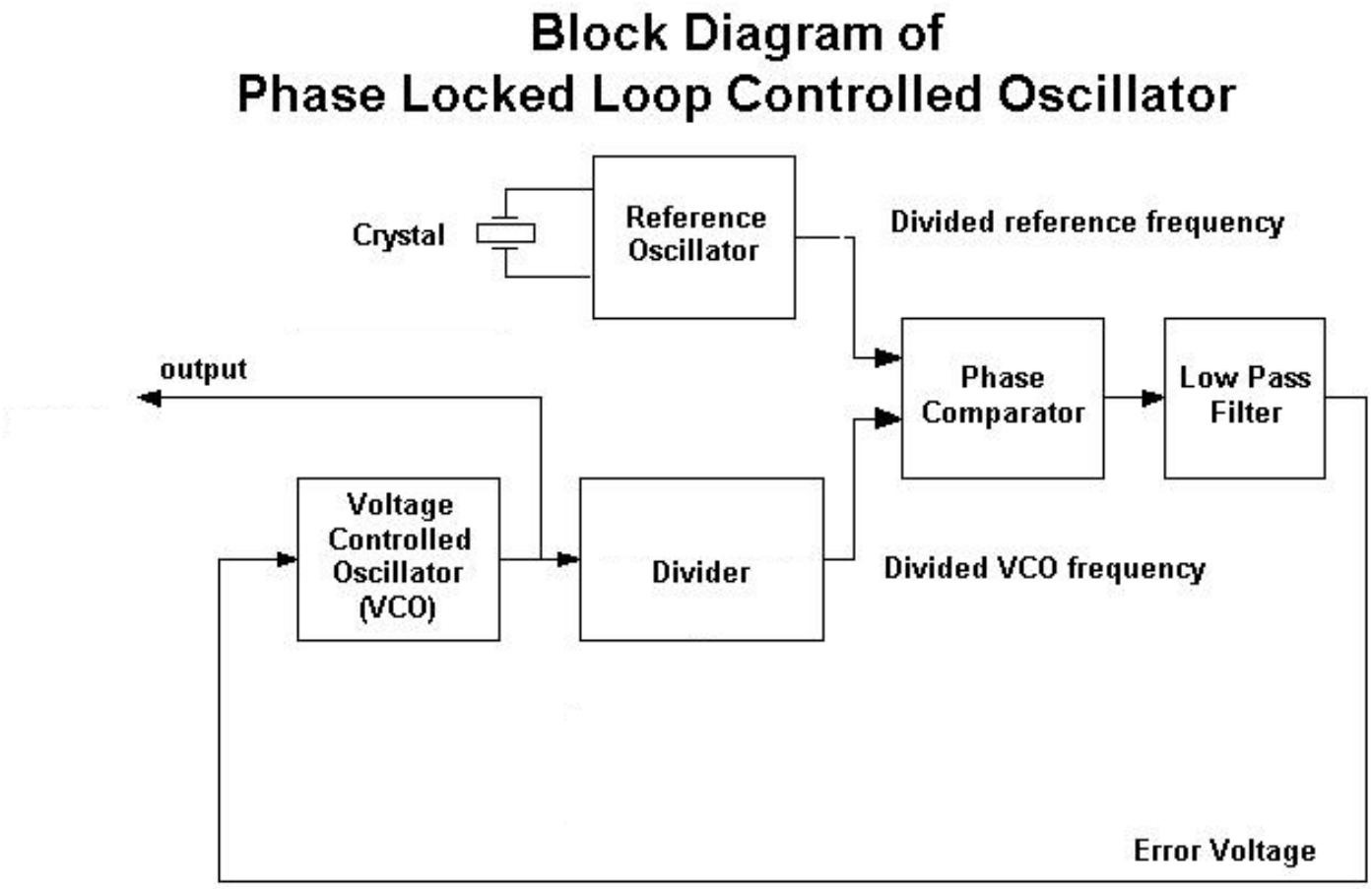
What is it for?

- To generate High Frequency Clock in Microprocessor.
- In Mobile Communication to generate Carrier Frequency.
- Can you think of any other Application? Actually there are many.

What does Industry say?

- ST Microelectronics has vacancies for “PLL Designers”.
- Texas Instruments (TI) want to recruit “PLL designers”.
- A lot more Opportunities……..
- Why it is so challenging?

Basic Block Diagram



1.Voltage Controlled Oscillator (VCO)

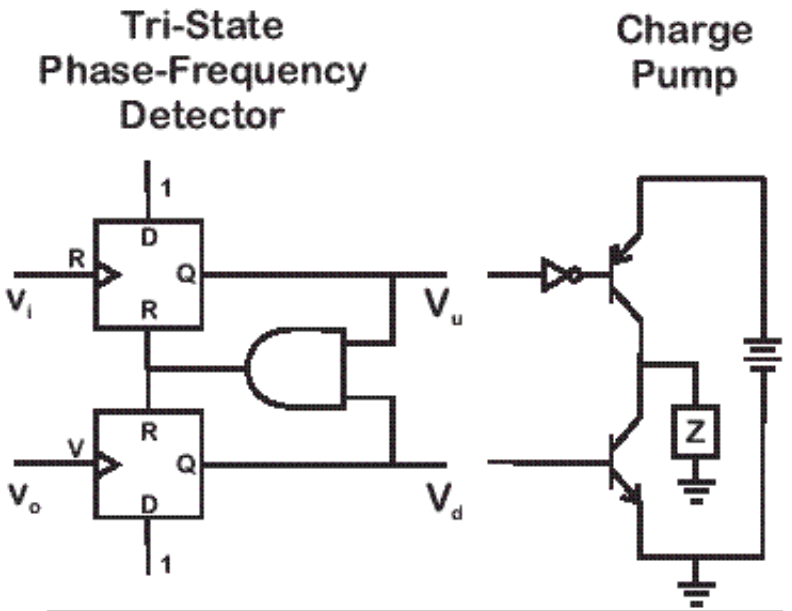
- What it does?
- Requirements:
  - High Frequency Operation
  - Good Programmability Range
  - Less sensitive to environment
- Basic Model: $F_{out} = K * V_{in}$
- Different Oscillators in literature. How to Select?
- A simple Example: Ring Oscillator
- Common Challenges:
  - Programmability Range (Giga-Hertz Order)
  - Maximum Noise limit

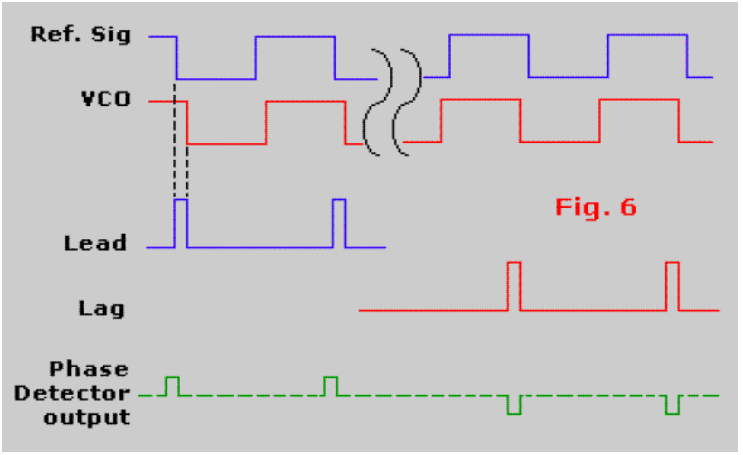
2. Divider

- What it Does?
- Requirements:
  - Should work on High Frequency(Giga Hertz Order)
  - Should be less power Consuming
- Challenges:
  - Power Consumption (Power is proprotional to frequency)
  - Switching Speed.

3. Phase-Frequency Detector (PFD)

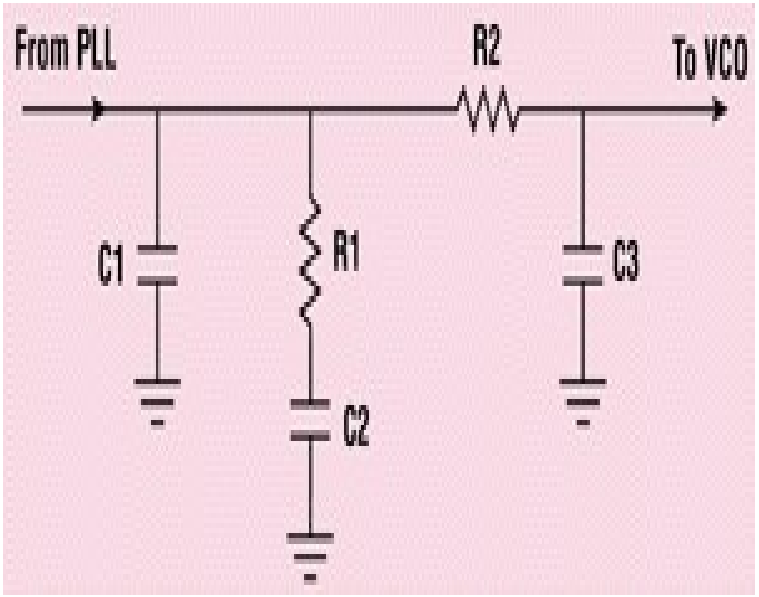
- What it does?
- Requirement:
  - High Sensitivity
  - Moderate Frequency Operation
- Challenges:
  - Linearity of PFD
  - Gain of PFD



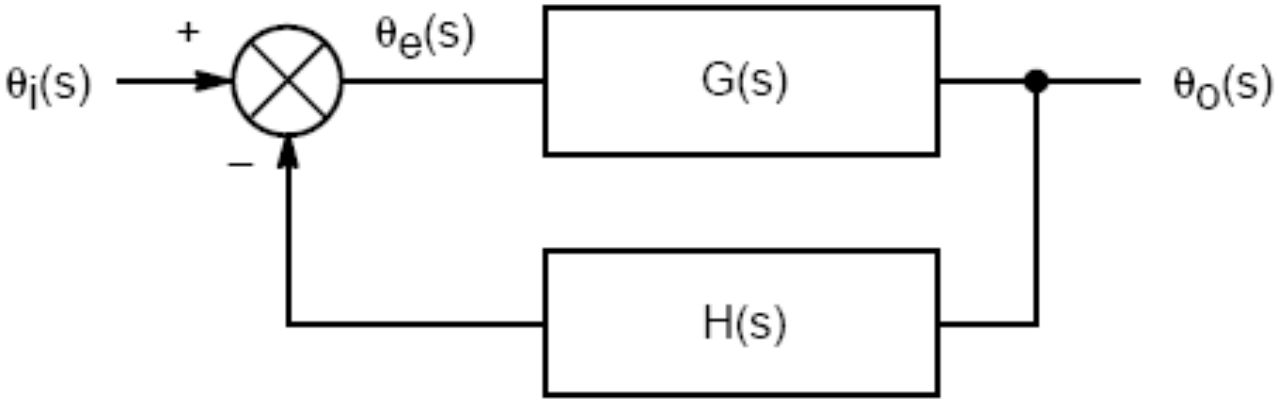


4. Loop Filter

- Functionality
- Low pass filter
- Filters out noise of PLL loop



Control Model of PLL



$\theta_i(s)$	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

Some definitions:

- Order of PLL – Highest degree of polynomial of characteristics equation (1+ G(s)H(s))
- Type of PLL – No of poles of loop Transfer function (G(s)H(s)) locate at origin

Food for Thought

- What will be the resolution in terms of frequency of PLL? How will you increase it?
- What changes you need to do to achieve above goal?
- What will be specifications of PLL?
- What is the performance metric of VCO?
  - For Microprocessor?
  - For Transmitter/Receiver IC?