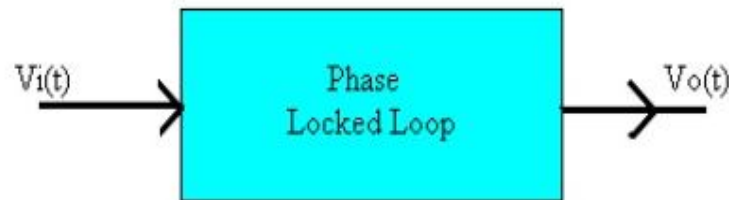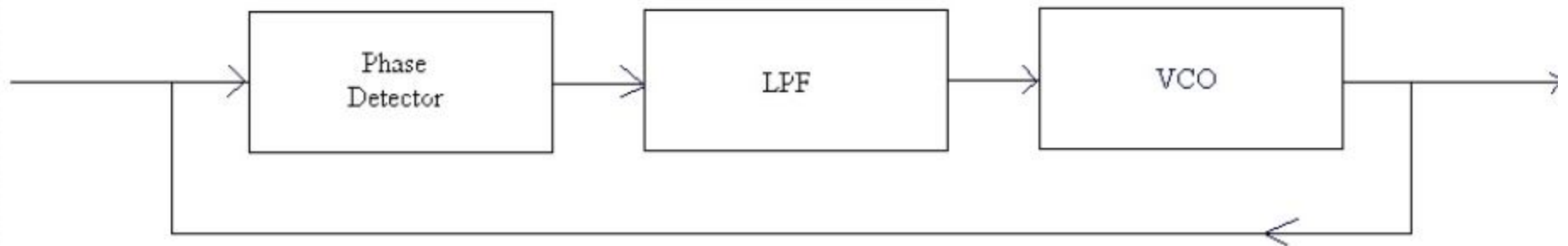# What is Phase Locked Loop (PLL)

PLL is an Electronic Module (Circuit) that locks the phase of the output to the input.

A PLL is a negative feedback system where an oscillator-generated signal is phase and frequency locked to a reference signal.
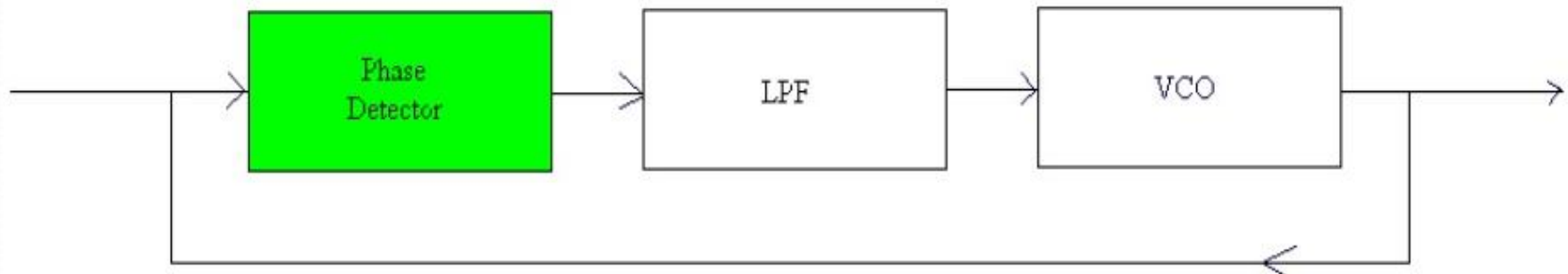
Parts of a PLL

- Phase Detector
- Filter
- Voltage Controlled Oscillator

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
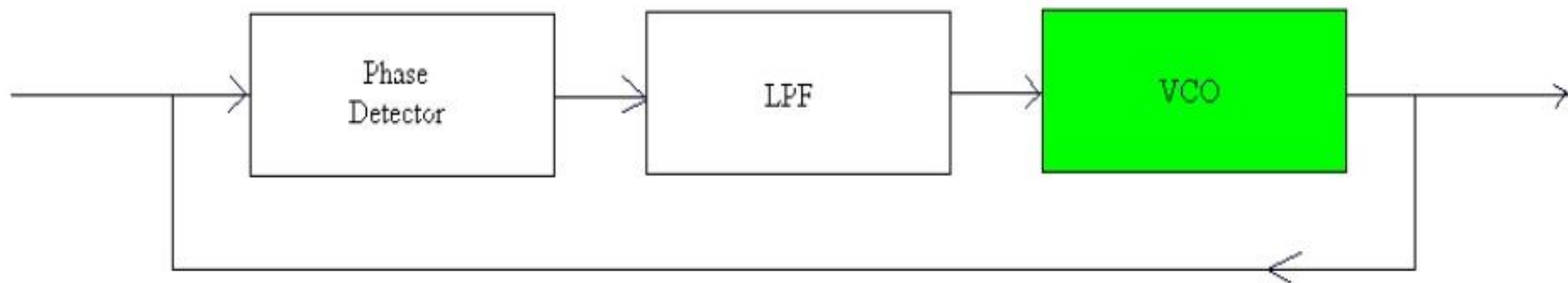
Parts of a PLL

- 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

$Wout = Wo + Kvco\ Vcont$

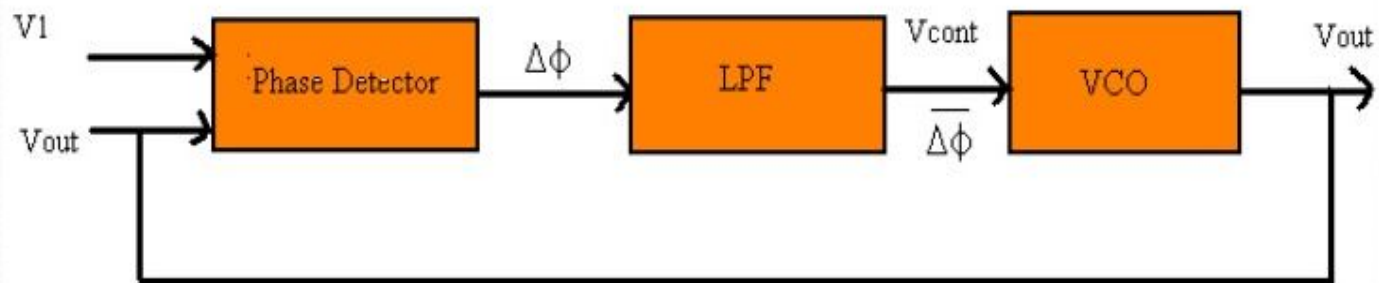# Locked Condition
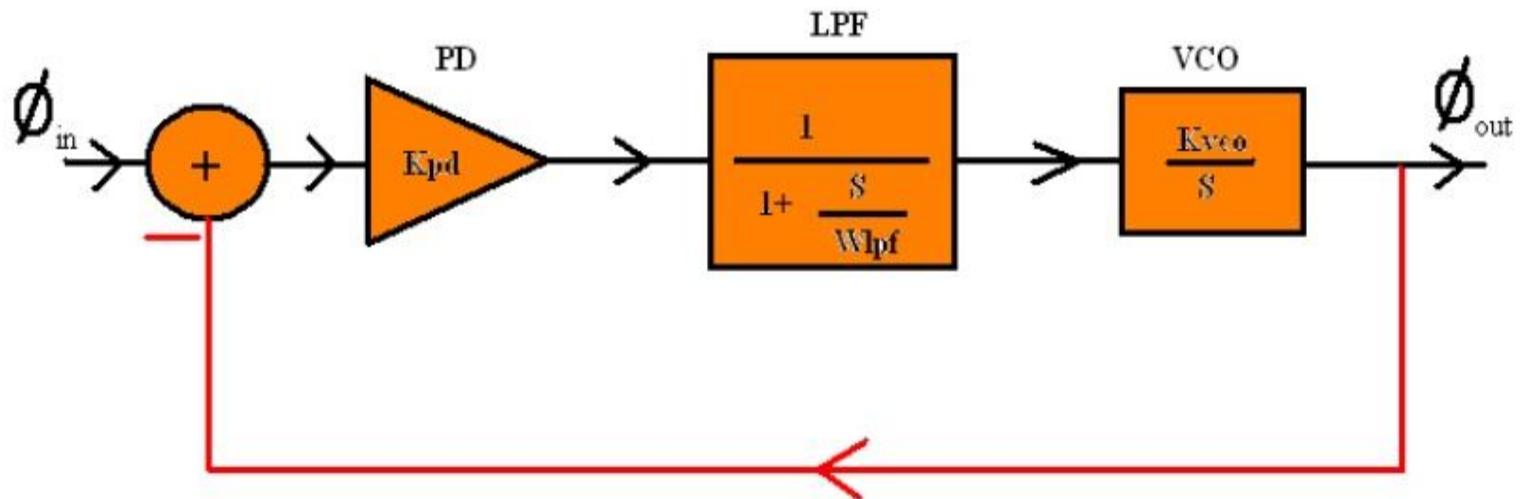
- Locked Condition

$$d/dt(\varphi in - \varphi out) = 0$$

This implies that

$$win = wout$$

Dynamics of Simple PLL

- PLL is a feedback system
    - PD is a gain amplifier
    - LPF be first order filter
    - VCO is a unit step module
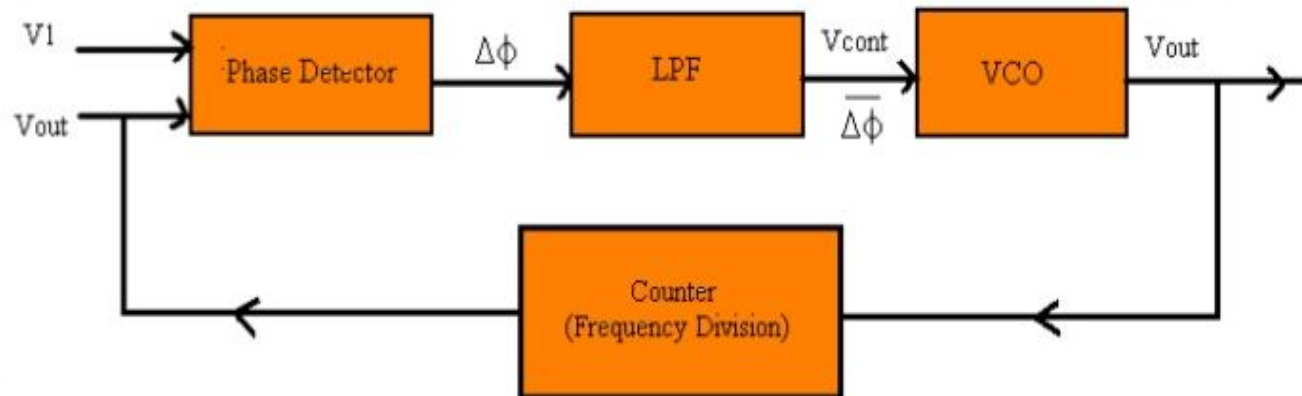- The transfer function of the feedback system is given as:

Application of PLL
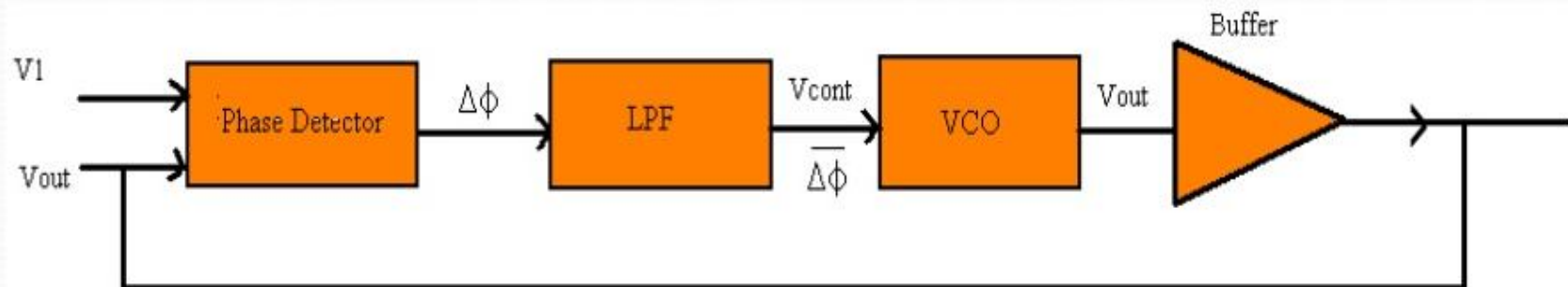
- Frequency Multiplications

  The feedback loop has frequency division.

  Frequency division is implemented using a counter.

- Jitter Reduction
- Clock Skew Reduction

  Buffers are used to distribute the clock

  Embed the buffer within the loop

Other applications include:

- Demodulation of both FM and AM signals
- Recovery of small signals that otherwise would be lost in noise (lock-in amplifier)
- Recovery of clock timing information from a data stream such as from a disk drive
- Clock multipliers in microprocessors that allow internal processor elements to run faster than external connections, while maintaining precise timing relationships
- DTMF decoders, modems, and other tone decoders, for remote control and telecommunications