Lecture 16: FM Modulators and Demodulators

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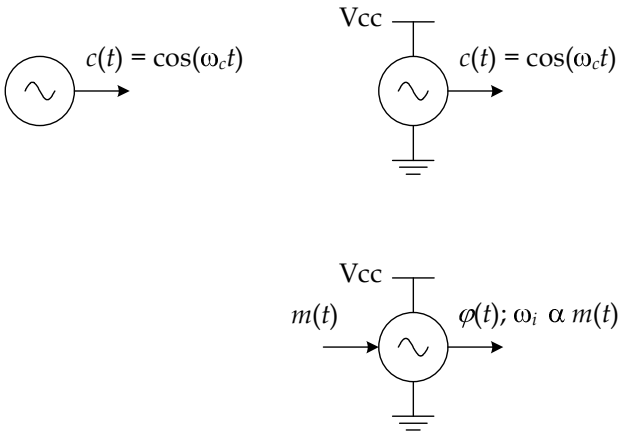
EE421: Communications I: Lecture 16. For more information read Chapter 5 in your textbook or visit http://wikipedia.org/.

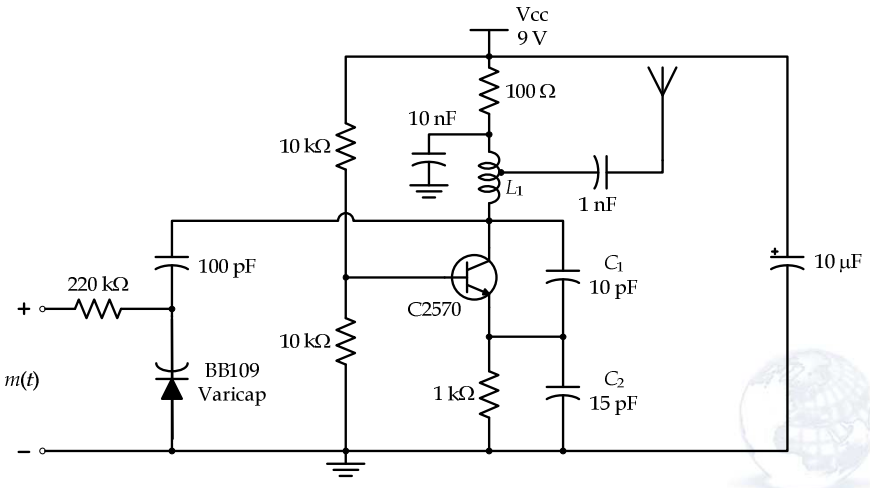
FM Modulator: VCO



Oscillator

- To build an oscillator, we require three components:
  - Amplifier
  - Positive feedback
  - LC tank
- The frequency of the oscillator is controlled by the LC tank resonant circuit.
- Many implementations available: Colpitts oscillator, Hartley oscillator, Ring oscillator, etc.

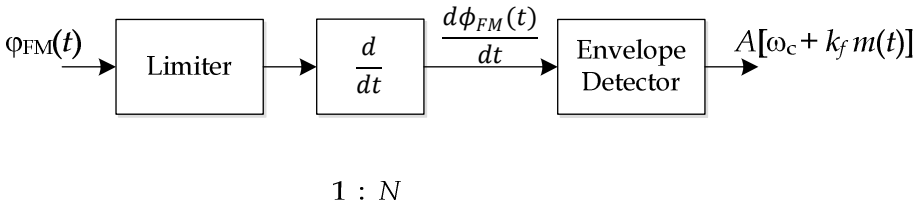
Example VCO: uses Colpitts oscillator (*NOT* in the exam)

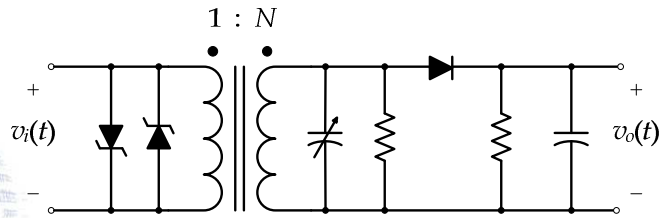


FM Demodulators

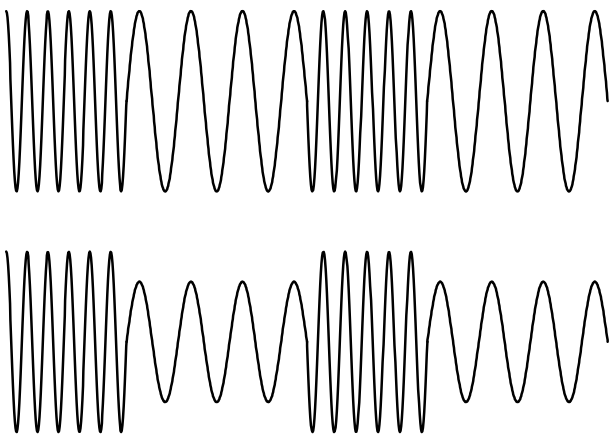
- FM Discriminator (also called Slope Detector or Ratio Detector):
  - Convert frequency variations into amplitude variations, then use an envelope detector.
- Quadrature Detector:
  - Convert frequency variations into phase variations, then use a phase-difference detector.
- Phase-Locked Loop:
  - A phase-difference feedback system.

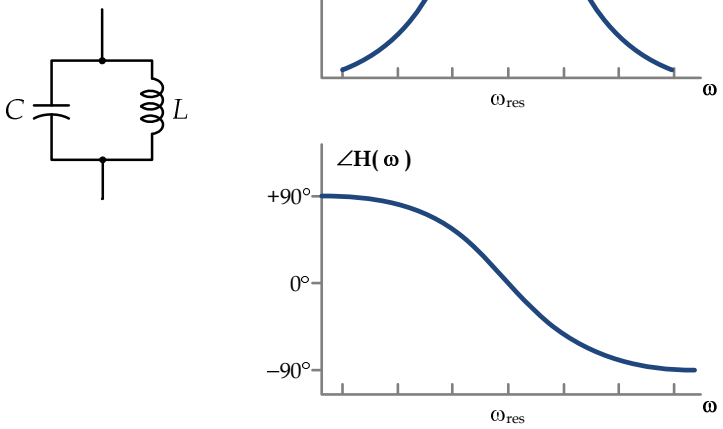
FM Discriminator



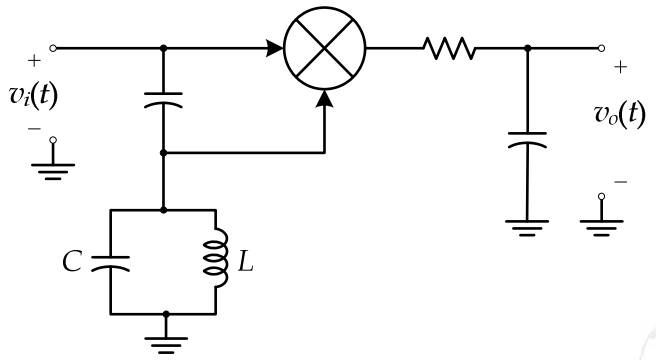


(FM) into (FM+AM)

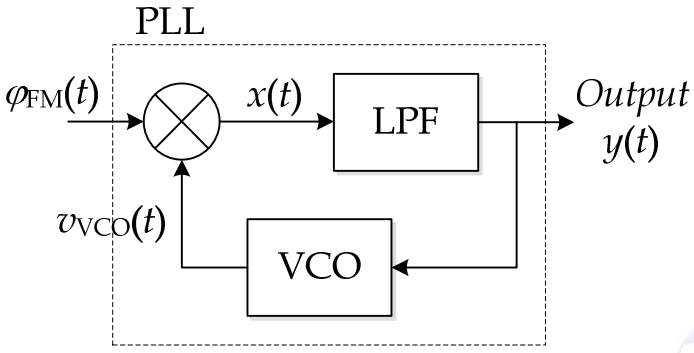




Quadrature Detector



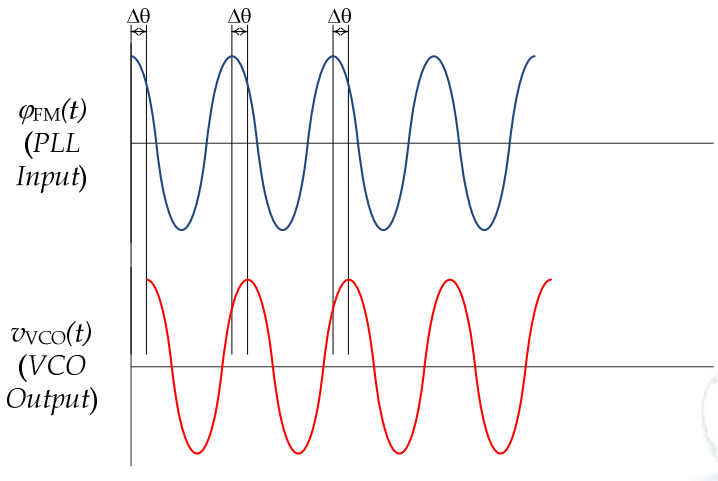
Phase-Locked Loop (PLL)



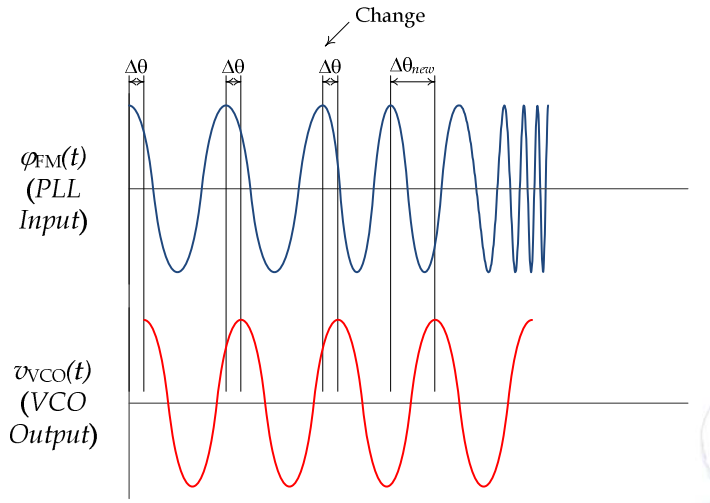
PLL Terminology

- A PLL is said to be **in-lock** if the frequency of the inner VCO $v_{VCO}(t)$ is exactly the *same* as the frequency of the received signal $v_{in}(t) = \varphi_{FM}(t)$.
- If the PLL stays in-lock, then the output voltage $v_{out}(t)$ is proportional to the baseband message signal $m(t)$.
- We want the PLL to stay in-lock.
- See the datasheet for MC4046 for details.

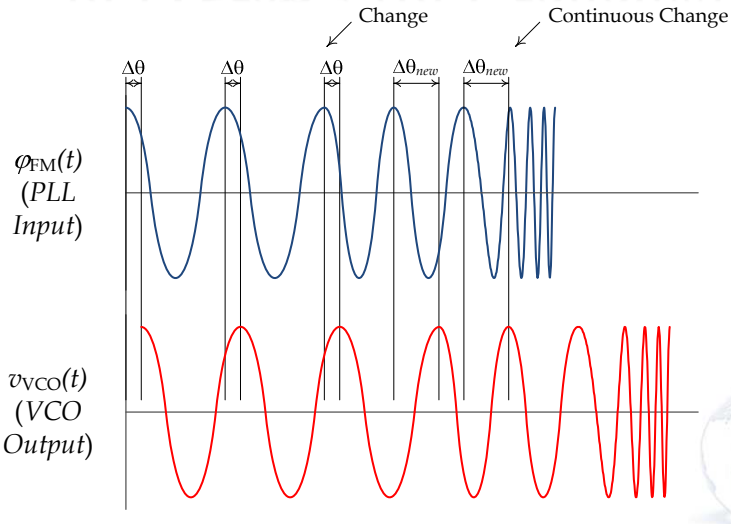
PLL: Step 1 (In Lock)



PLL: Step 2 (Input changes)



PLL: Step 3 (PLL follows)



PLL Applications

- Carrier recovery for Synchronous detectors.
- Clock recovery for digital baseband receivers.
- Stabilizing VCO frequencies in FM transmitters.
- FM Demodulator.

PM Demodulator: Synchronous