Lecture 11: AM Hardware

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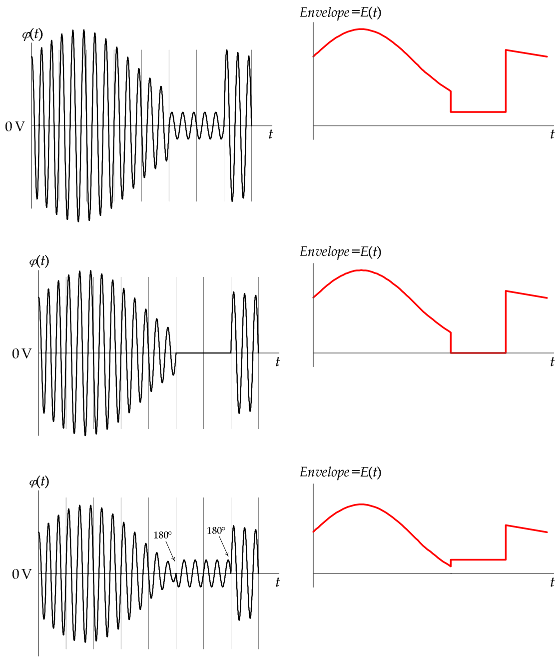
EE421: Communications I. For more information read Chapter 4 in your textbook or visit http://wikipedia.org/.

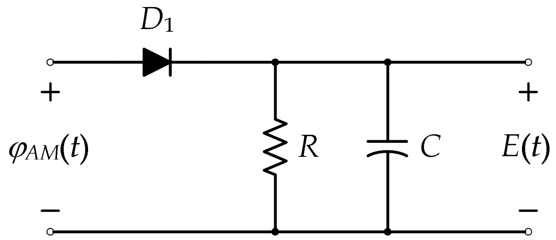


AM Demodulation

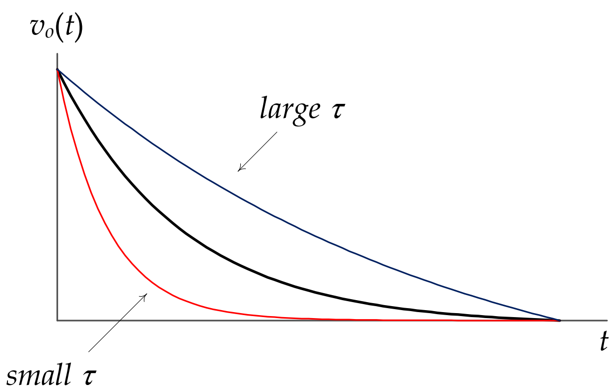
$m \leq 1$ (choice between: Synch. & Asynch.)

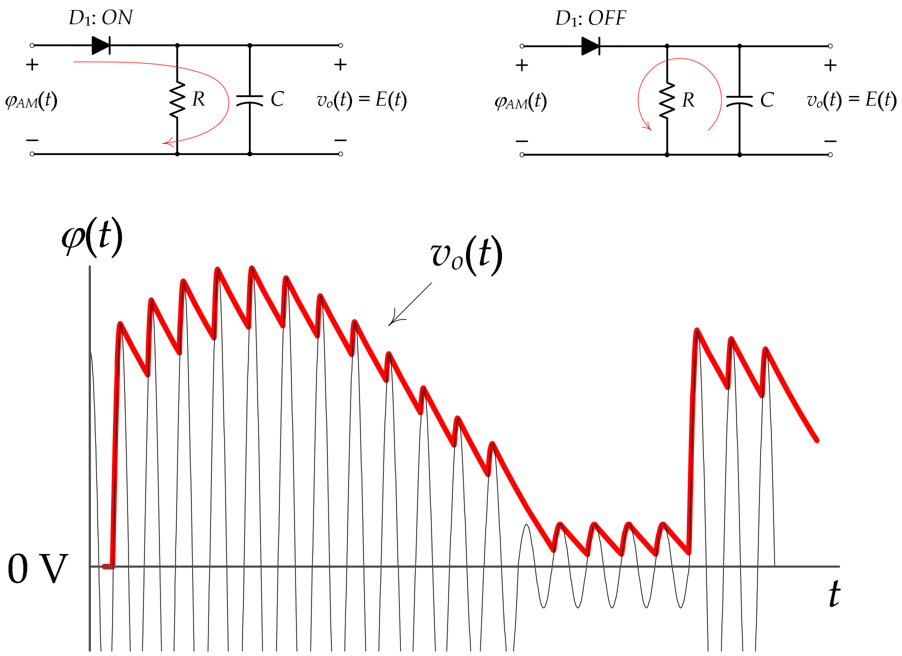
$m > 1$ (one choice: Synch.)

Design #A: Envelope Detector

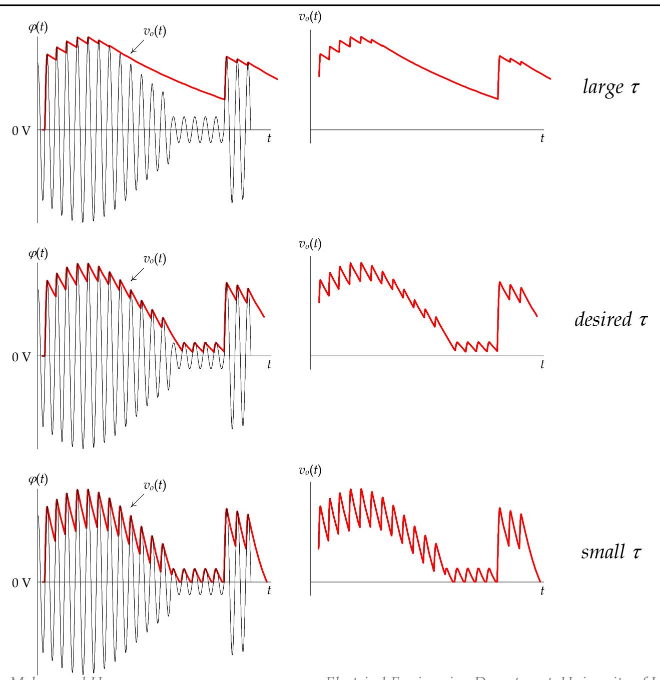


First-order RC circuit dischage



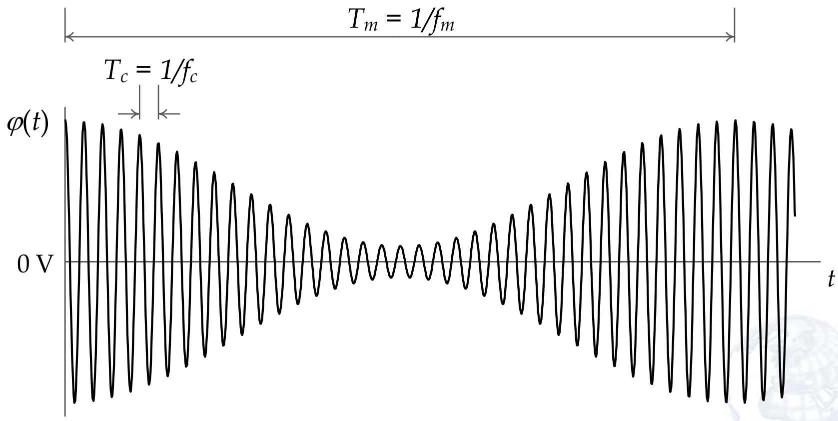


D1: ON
D1: OFF
φAM(t)
R
C
vo(t) = E(t)
φ(t)
vo(t)
0 V
t

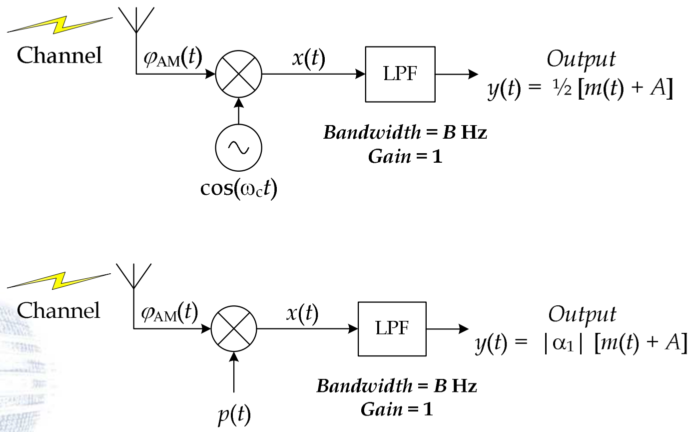


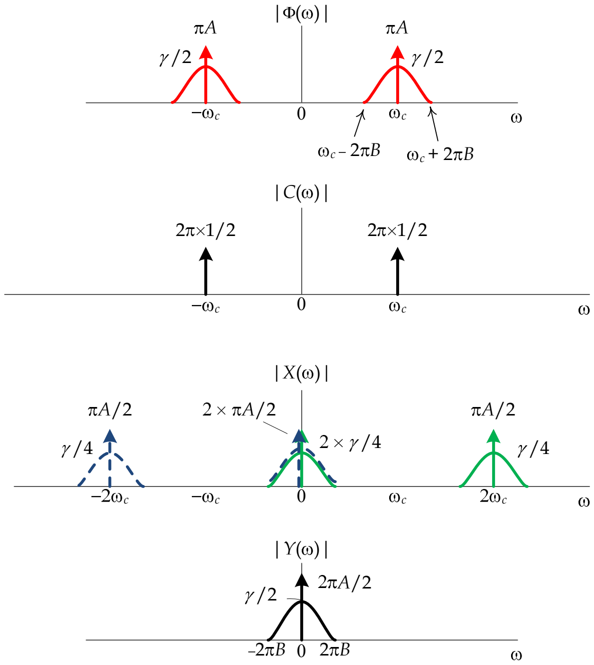
φ(t)
vo(t)
0 V
t
large τ
desired τ
small τ

Choosing Time Constant τ

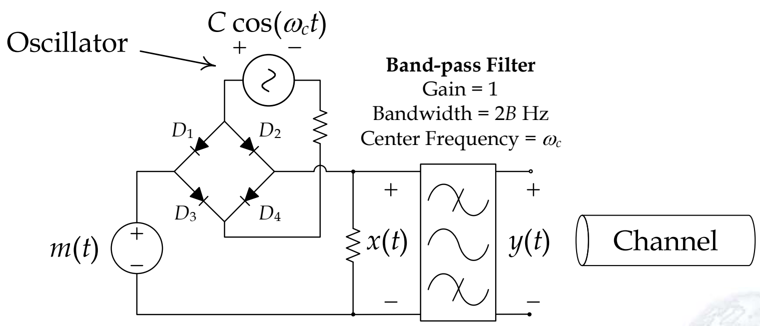


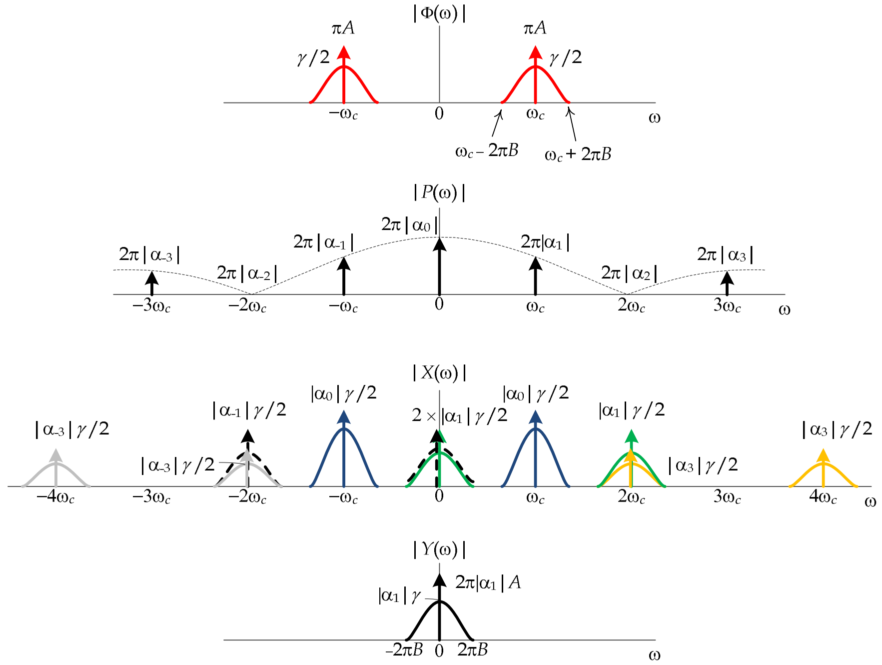
Design #B: Synchronous Detector (aka Product Detector)





Remember:
series-bridge diode modulator





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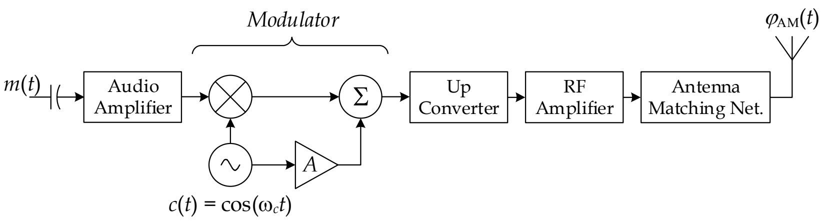
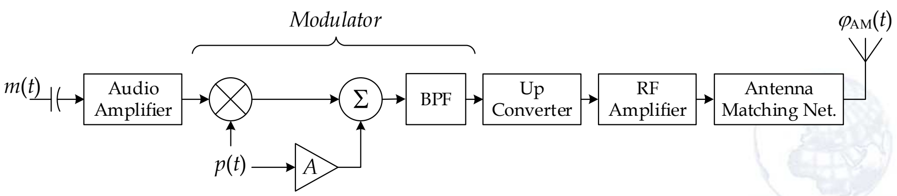
AM Transmitters: Design #A





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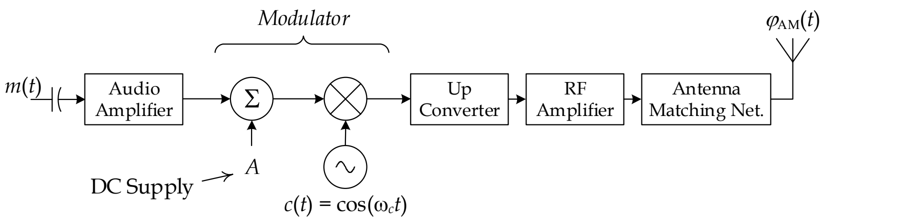
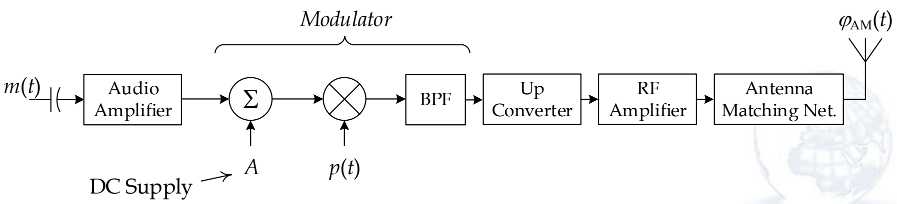
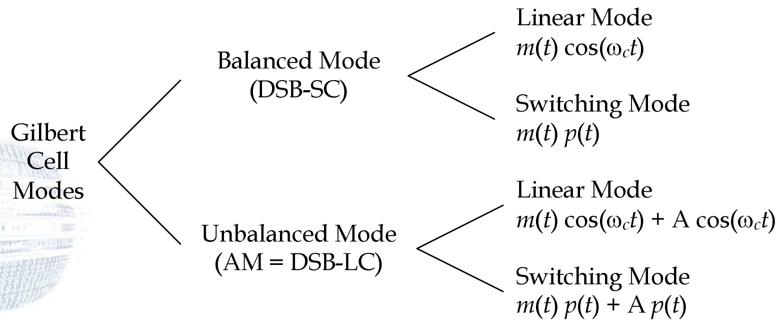
AM Transmitters: Design #B



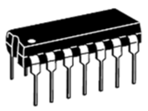


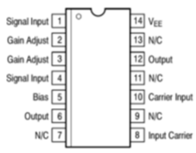
AM Transmitters: Design #C

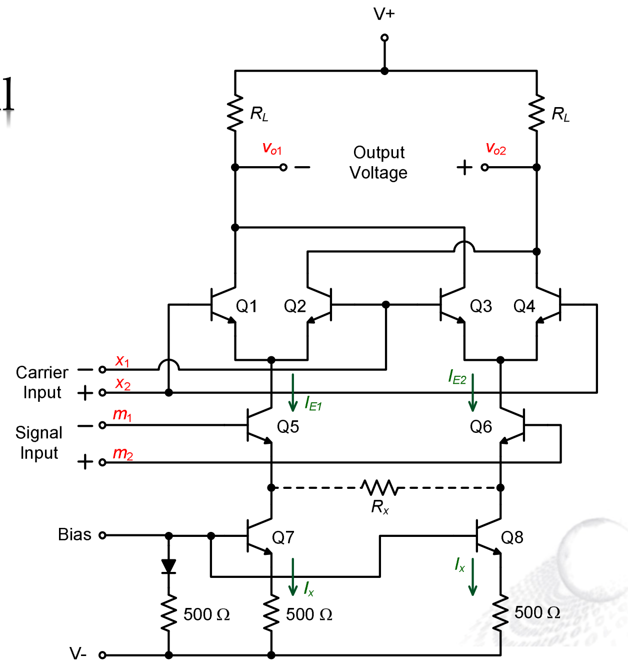
- Use the Gilbert Cell (MC1496) in the unbalanced mode, in which the gain of the top two differential amplifiers is unbalanced, which adds a residual carrier in the output signal.



Gilbert Cell (MC1496) Schematic







AM Signal-to-Noise Ratio

- An AM (DSB-LC) signal is sent though a channel with no attenuation. The channel is affected by AWGN noise. At the receiver side:
- Show the block diagram of the receiver. Use a product detector with capacitor in series.
- Determine $SNR_{channel}$.
- Determine SNR_{in}.
- Determine SNR_{out}.
- Determine NF for the demodulator.

Solution

$$SNR_{out} = \eta \frac{S_{in}}{N_0 B}$$

$$S_{in} = \frac{1}{2}\overline{m^2(t)} + \frac{A^2}{2}$$

$$NF = -10\log(2\eta)$$

Modulation Technique	Modulated Signal Bandwidth	SNR_{out}	Noise Figure NF, dB	Typical Applications
DSB-SC	$2B$	$\frac{S_{in}}{N_0 B}$	-3	Analog instrumentation; multiplexing as part of FM stereo
SSB-SC	B	$\frac{S_{in}}{N_0 B}$	0	Point-to-point voice
VSB-SC	$B \sim 2B$	$\frac{S_{in}}{N_0 B}$	$-3 \sim 0$	Facsimile (Fax machines)
QAM	$2B$ for two signals	$\frac{S_{in,effective}}{N_0 B}$	0	Transmit color information in TV broadcasting; digital data
AM	$2B$	$\eta \frac{S_{in}}{N_0 B}$	$-10\log(2\eta)$	Broadcast AM radio; point-to-point voice
SSB+C	B	$\eta \frac{S_{in}}{N_0 B}$	$-10\log(\eta)$	Multiplexing in old telephony systems; point-to-point voice
VSB+C	$B \sim 2B$	$\eta \frac{S_{in}}{N_0 B}$	$-10\log(2\eta) \sim -10\log(\eta)$	Analog Television broadcasting
FM	$2\Delta f + 2B$	$\left(\frac{3\beta^2}{k_m^2}\right)\frac{S_{in}}{N_0 B}$	$10\log\left(\frac{k_m^2}{6(\beta+1)\beta^2}\right)$	Broadcast FM radio; analog microwave links
PM	$2\Delta f + 2B$	$\left(\frac{(\Delta\theta)^2}{k_m^2}\right)\frac{S_{in}}{N_0 B}$	$10\log\left(\frac{k_m^2 B}{2(\Delta\theta)^2(\Delta f + B)}\right)$	Telemetry; digital data

