



Indian Institute of Technology Bombay

WIRELESS & RF COMMUNICATION

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Outline

- Basics of wireless communication
- Modulation schemes
- Frequency spectrum and RF
- Blocks of Tx-Rx System
- Serial communication
- Modules
- Circuits v/s RF Circuits



Types of communication

- Analog – AM, FM, PM
- Digital – ASK, FSK, PSK
- Simplex
- Half Duplex
- Full Duplex



Terms used frequently

- Bandwidth
- Carrier
- Modulation – Demodulation
- Amplifier
- link
- Antenna



Amplitude Modulation

- Amplitude of carrier is modulated

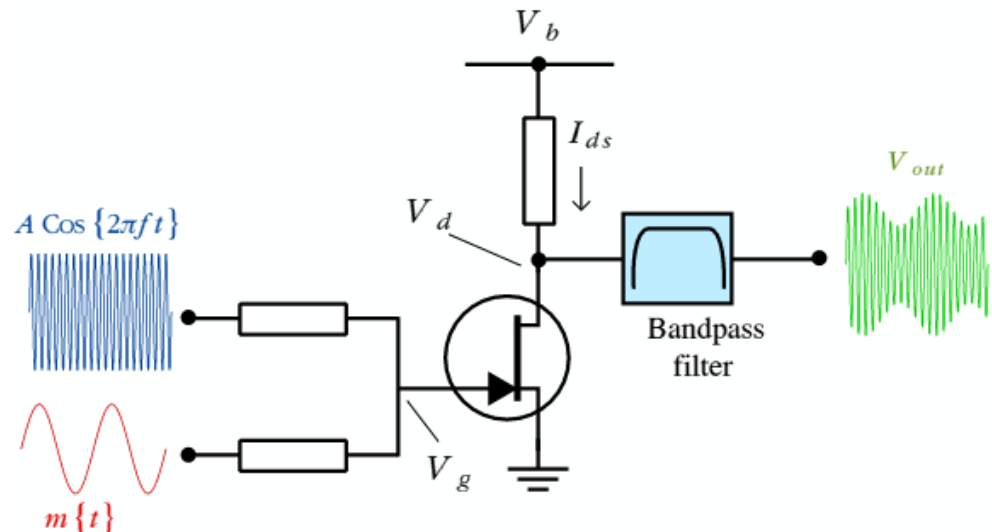
$$S(t) = A_c \{1 + K_a m(t)\} \cos(2\pi f_c t)$$

$$\text{where } m(t) = A_m \cos(2\pi f_m t)$$

- Modulation index,

$$\mu = K_a A_m$$

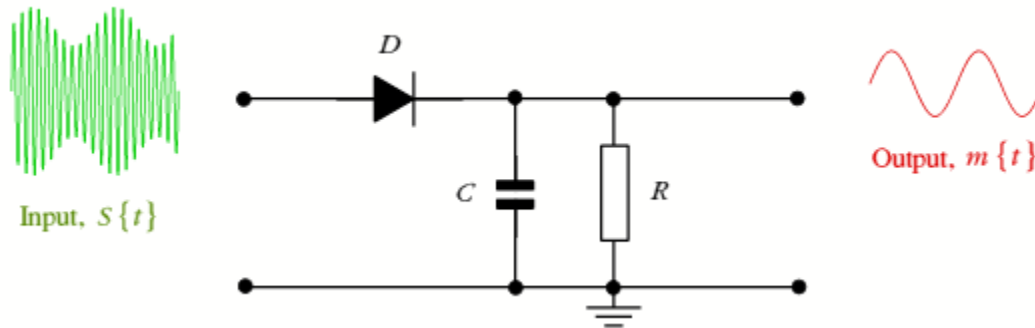
- AM modulator using square law devices





Amplitude Modulation

- AM demodulator using envelope detector



- Bandwidth = $2 fm$
- Carrier power, $P_c = \frac{A_c^2}{2R}$
- Total power $P_t = P_c \left(\frac{1 + \mu^2}{2} \right)$



Frequency Modulation

- Frequency of carrier is modulated

$$S(t) = A_c \cos\{2\pi f_c t + \beta \sin 2\pi f_m t\}$$

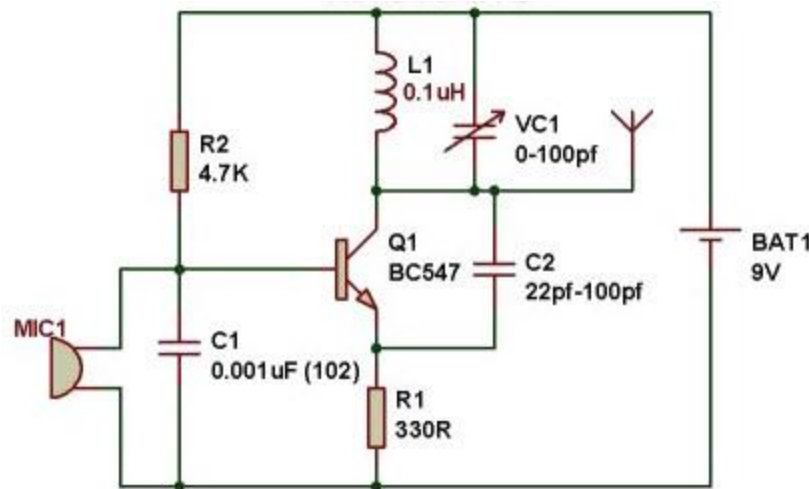
$$\text{Where } m(t) = A_m \cos(2\pi f_m t)$$

- Modulation index $\beta = \frac{K_f A_m}{f_m} = \frac{\Delta f}{f_m}$



Frequency Modulation

- Need an Oscillator

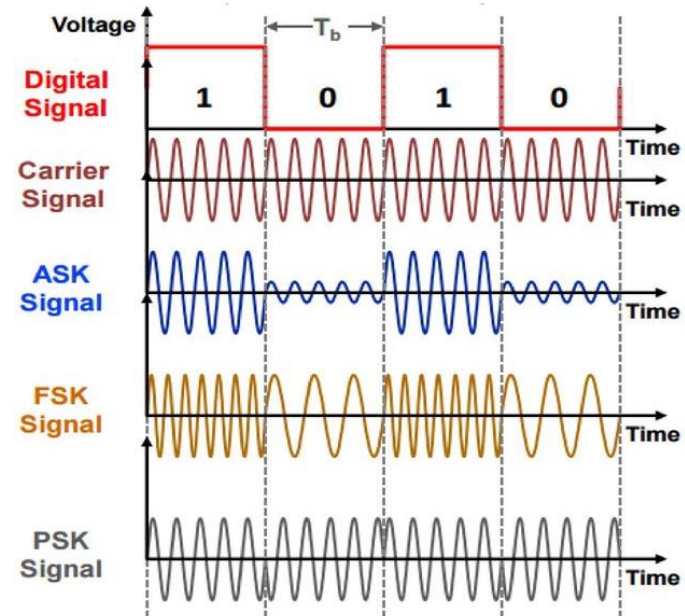


- Bandwidth = $2(\beta + 1)f_m$
- Total power, $P_t = P_c = \frac{A_c^2}{2R}$



Digital Modulation Schemes

- Amplitude Shift Keying
- Frequency Shift Keying
- Phase Shift Keying
- QAM, QPSK...



Modulation	Noise Immunity	Bandwidth	Complexity
ASK	Low	Baud rate	Low
FSK	Medium	2*ASK	Medium
PSK	High	Baud rate	High



Frequency Spectrum

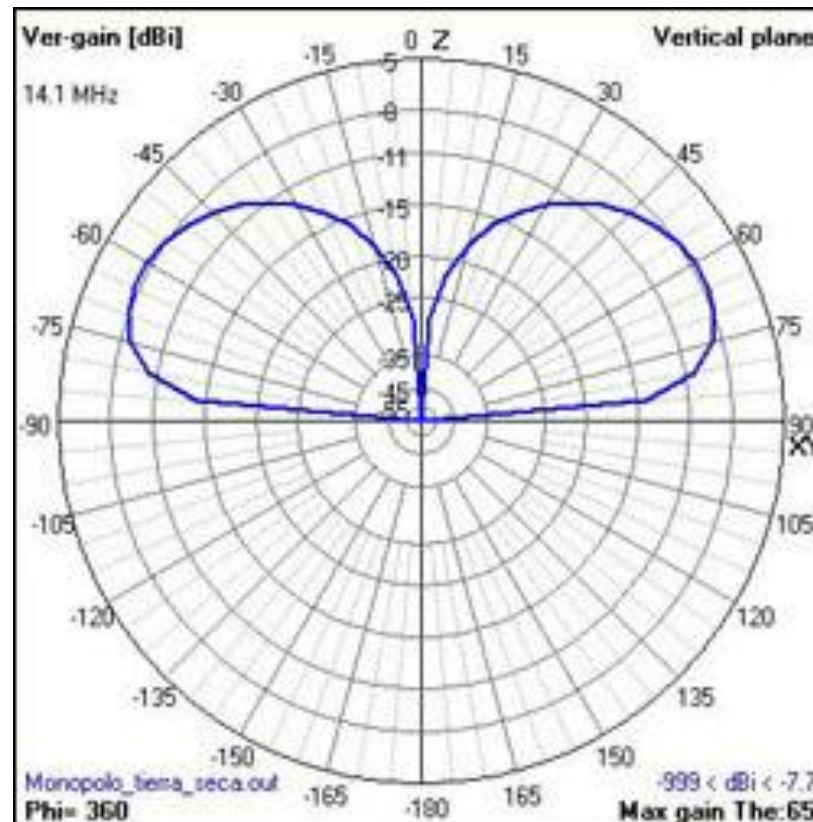
Frequency	Band	Application
30kHz – 300kHz	LF	Aeronautical and Marine Navigation
300kHz – 3MHz	MF	AM Radio Broadcast
3MHz – 30MHz	HF	Ham and Citizen Band
30MHz – 300MHz	VHF	TV and FM Broadcasting
300MHz – 3GHz	UHF	UHF TV, Cellular Phones
3GHz – 30GHz	SHF	Wifi, Satellite comm and Radar
30GHz – 300GHz	EHF	Satellite communication and Radar



Antenna



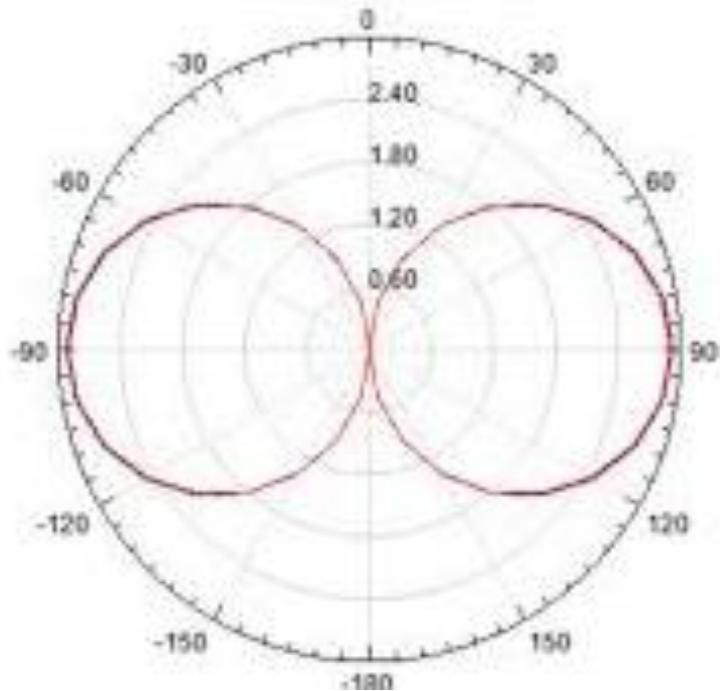
$$\text{Monopole Antenna Length} = \frac{\text{Wavelength}}{4} = \frac{\lambda}{4}$$





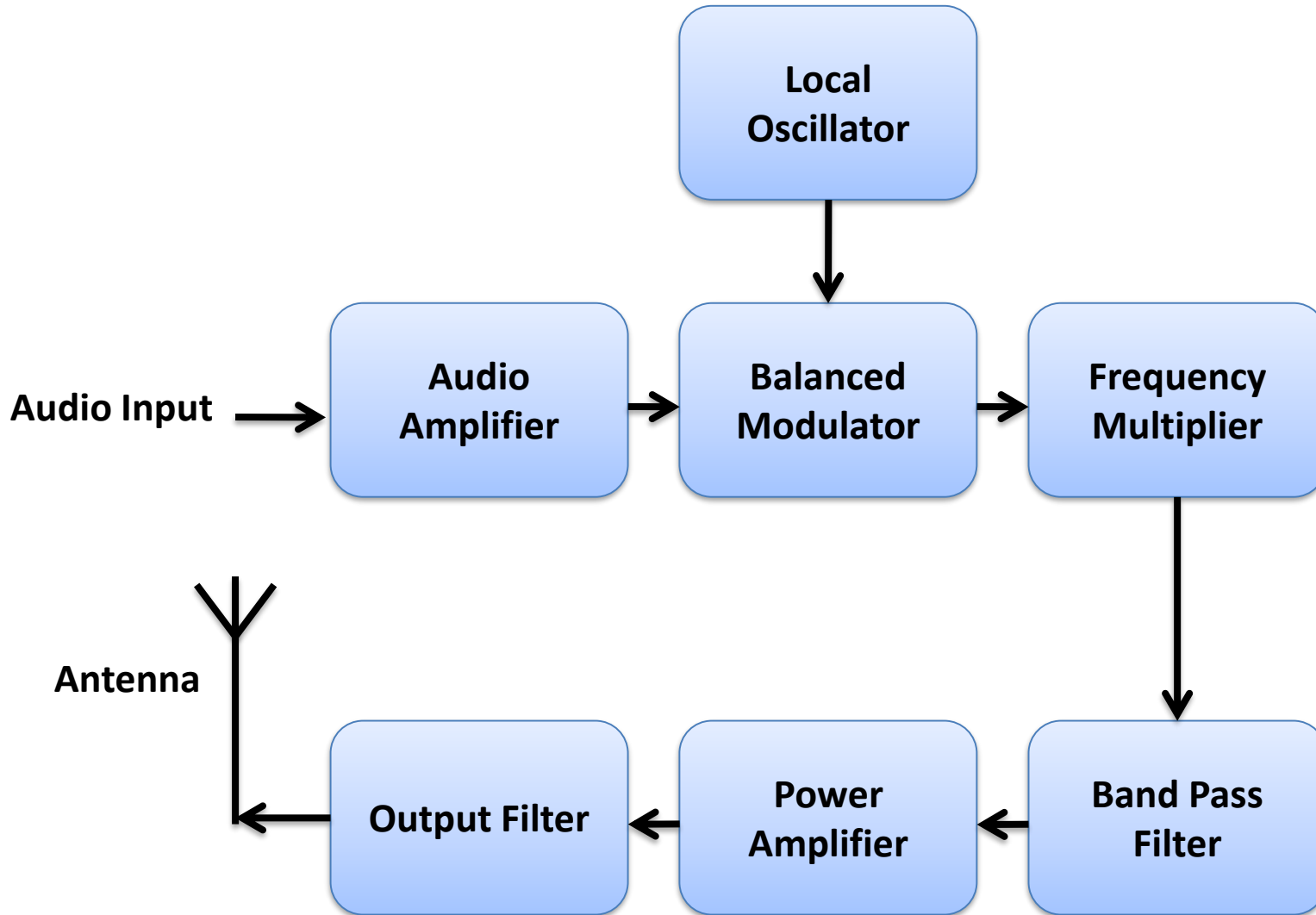
Antenna

$$\text{Dipole Antenna Length} = \frac{\text{Wavelength}}{2} = \frac{\lambda}{2}$$



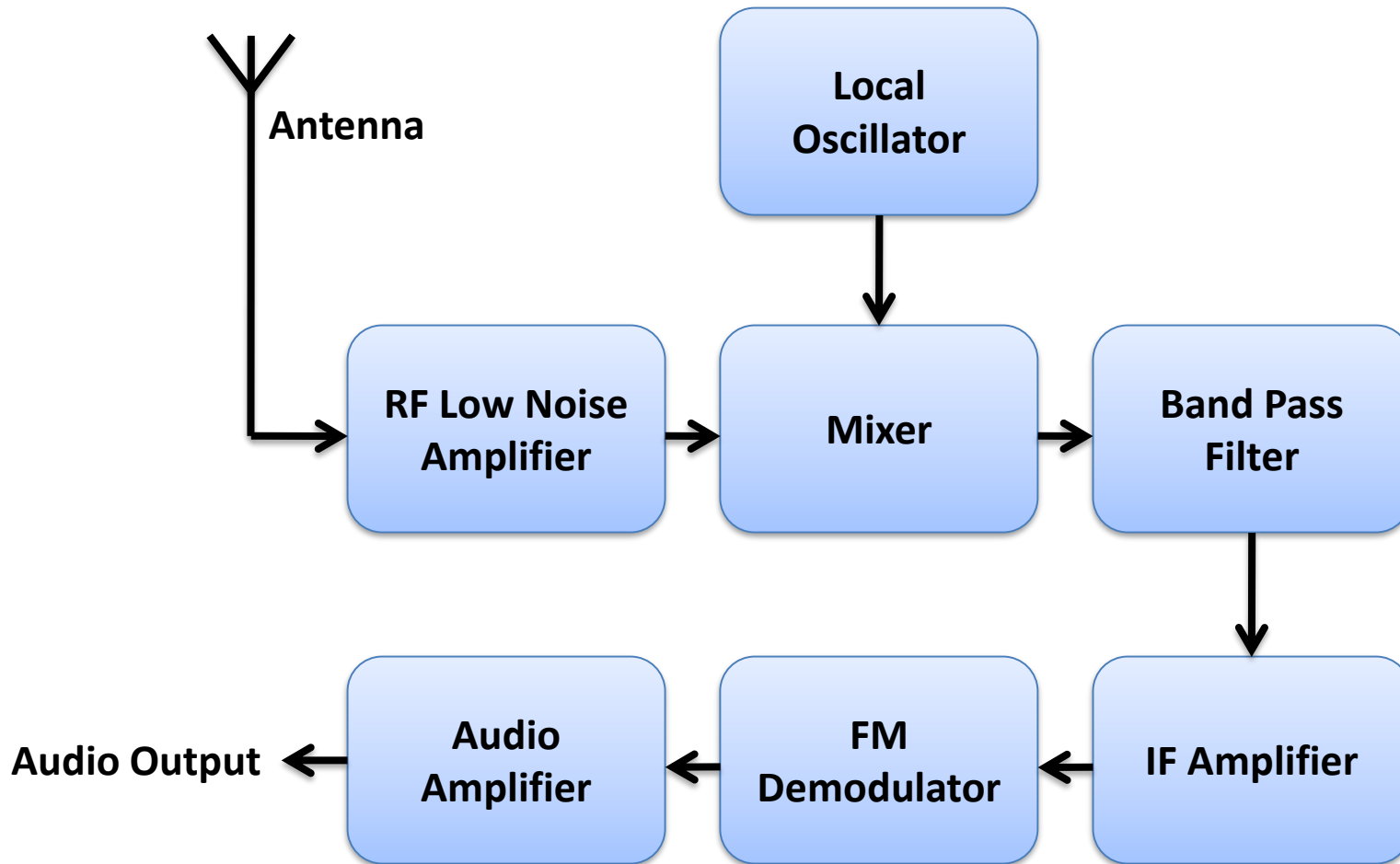


Transmitter Block Diagram





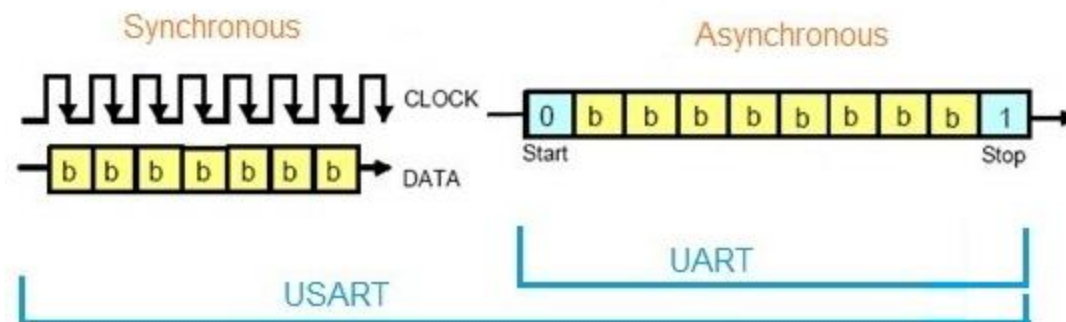
FM Receiver Block Diagram





Serial communication

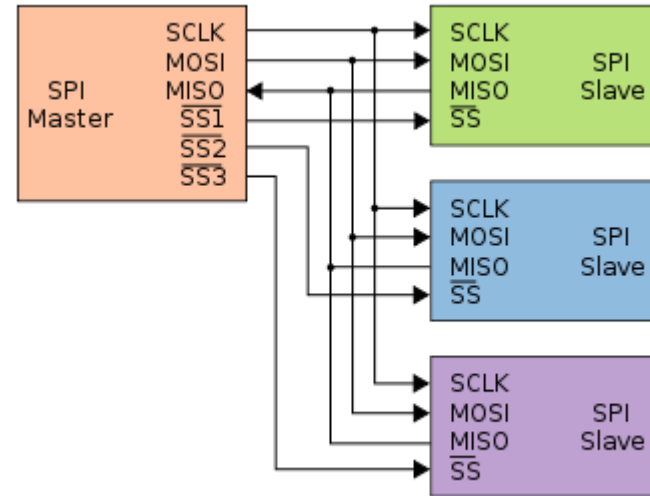
- UART (Universal Asynchronous Rx-Tx)
- RS 232 protocol
- USART (Universal Synchronous Asynchronous Rx-Tx)



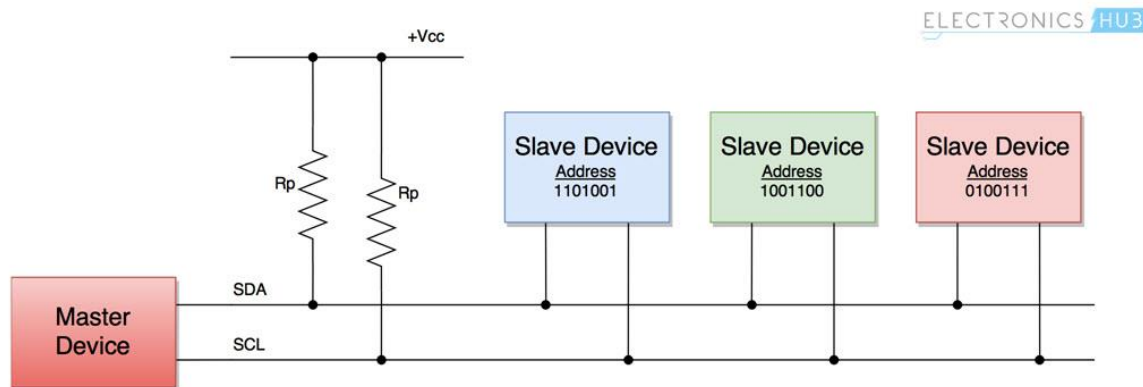


Serial communication

- Serial Peripheral Interface (SPI)



- I2C





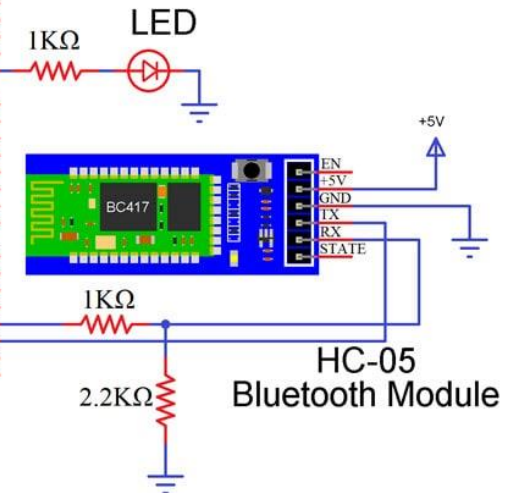
SH_BT_Board V1.3

POWER: 3.6-6V

STATE
RXD
TXD
GND
VCC
EN



ELECTRONICS HUB

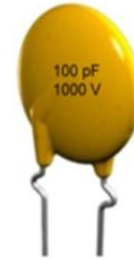


Source: www.electronicshub.org



RF Circuits

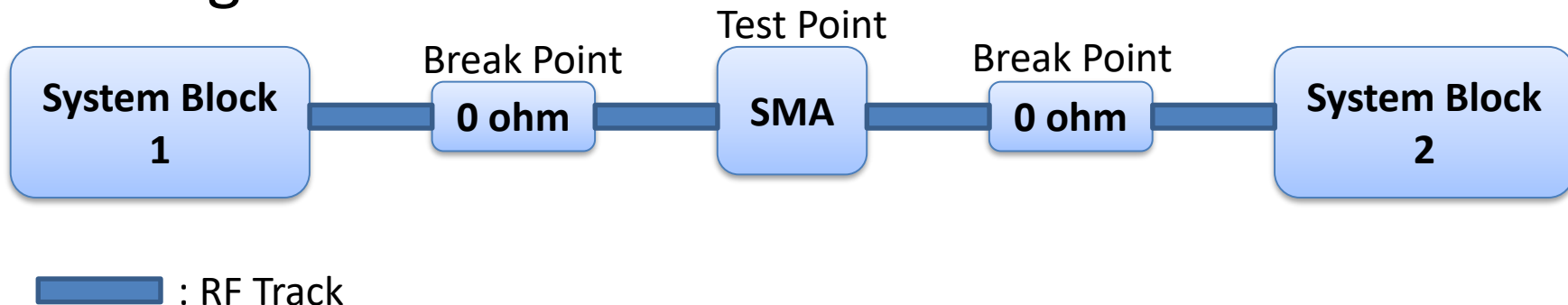
- Grounding
- Controlled Impedances
- Parasitic components thus use smd for Higher Frequency
- Testing RF circuits



Thru-Hole Ceramic Capacitor



SMD Ceramic Capacitor



- Electrostatic Discharge



Source: www.coep.org.in/csar



RF Circuits



Swayam Satellite communication Board

Source: www.coep.org.in/csatsat



Questions

1. Is power of AM dependent upon modulation index?
2. You want to talk to your friend around campus, what frequency, modulation and power(in Watts) will you prefer?
3. Draw receiver block diagram.
4. Will simply adding amplifier in the link help you establish the voice link?
5. Multiple sensors or peripherals, you will choose which scheme
 - a. SPI
 - b. USART
 - c. I2C



Questions

6. Calculate length of dipole antenna for 150MHz?
7. Walky Talky is which kind of communication?
 - a. Simplex
 - b. Half Duplex
 - c. Full Duplex