HARDWARE FELLOWSHIP 2023

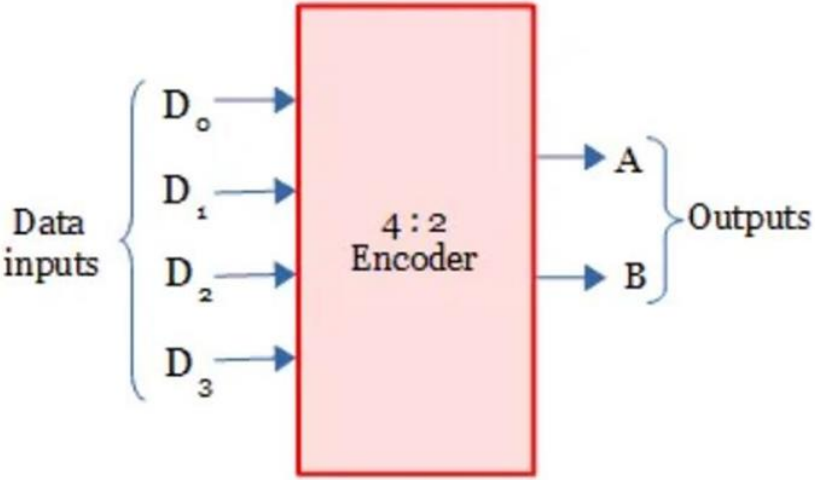
DAY 4

INSTRUCTOR: SUSHANT PANDEY

WIRELESS COMMUNICATION

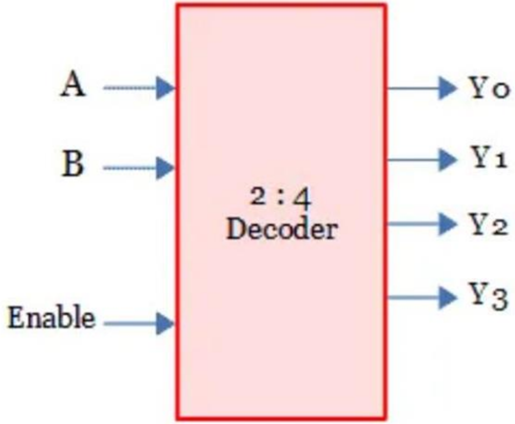
Encoder Logic

Decoder Logic



Inputs				Output	
D3	D2	D1	D0	B	A
0	0	0	0	x	x
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1

4-bit binary encoder



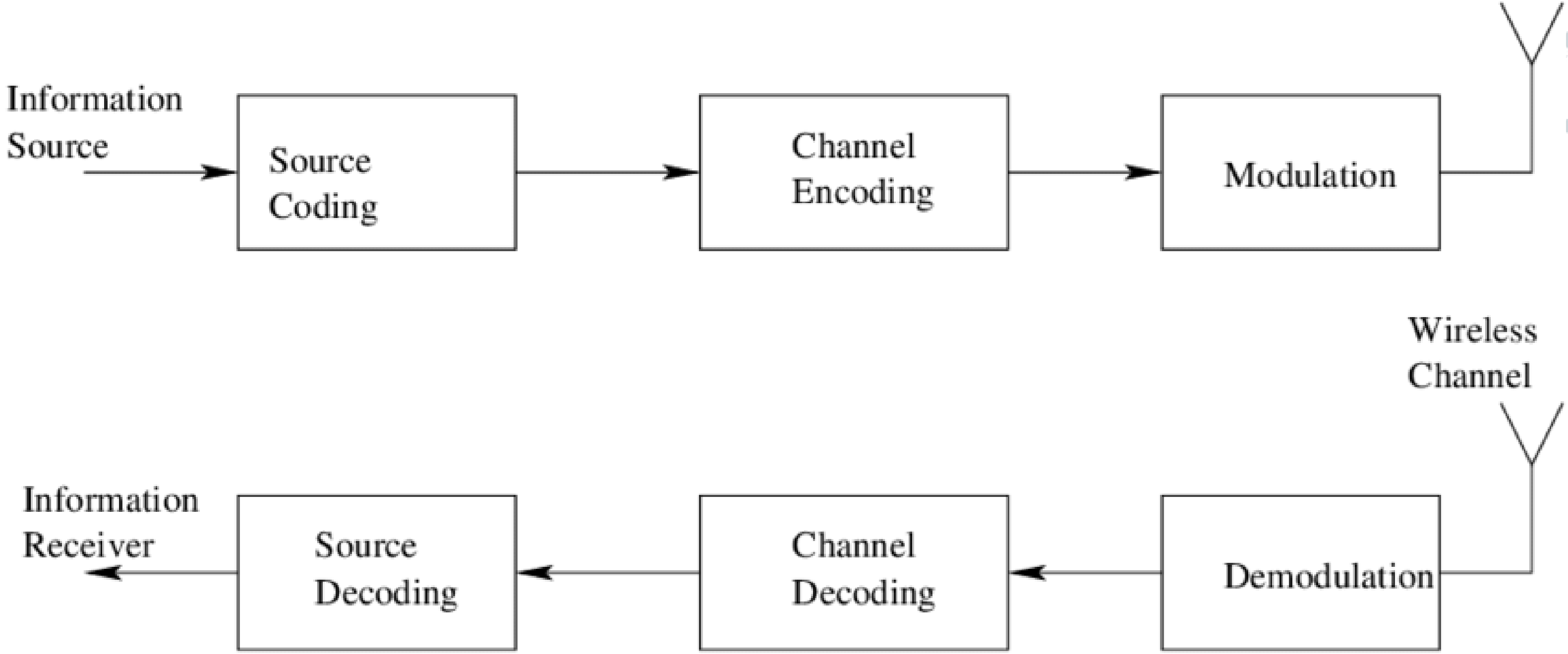
Inputs			Outputs			
EN	A	B	Y3	Y2	Y1	Y0
0	X	X	0	0	0	0
1	0	0	0	0	0	1
1	0	1	0	0	1	0
1	1	0	0	1	0	0
1	1	1	1	0	0	0

Receiver

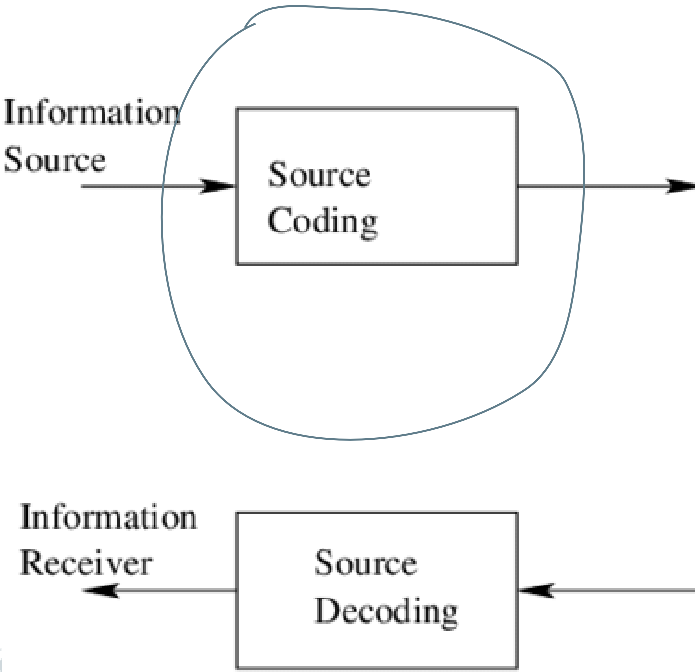
Antennas are electrical devices that transform the electrical signals to radio signals in the form of Electromagnetic (EM) Waves and vice versa. These Electromagnetic Waves propagates through space.

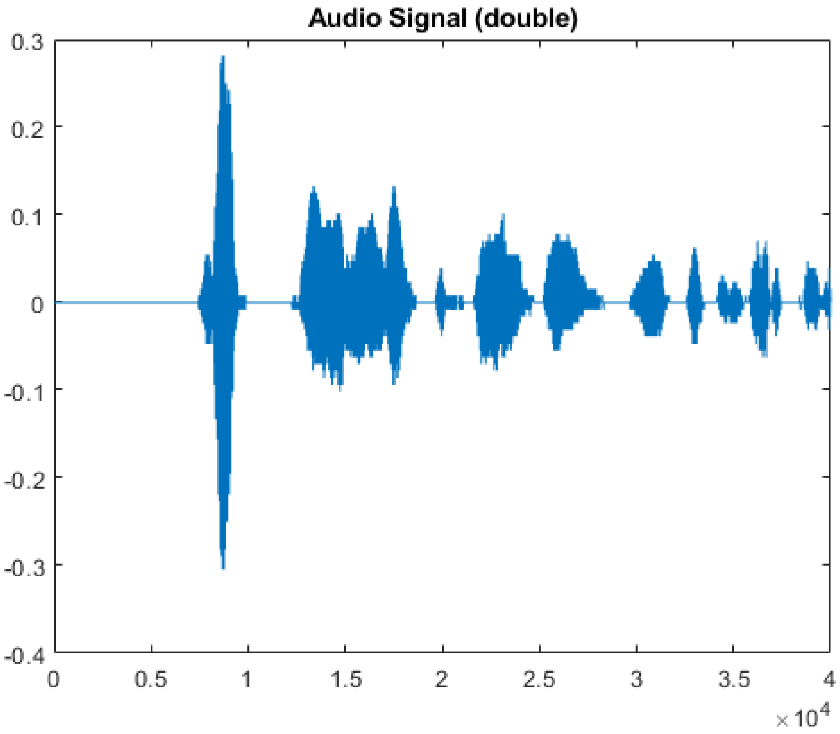
Transmitter

WIRELESS COMMUNICATION

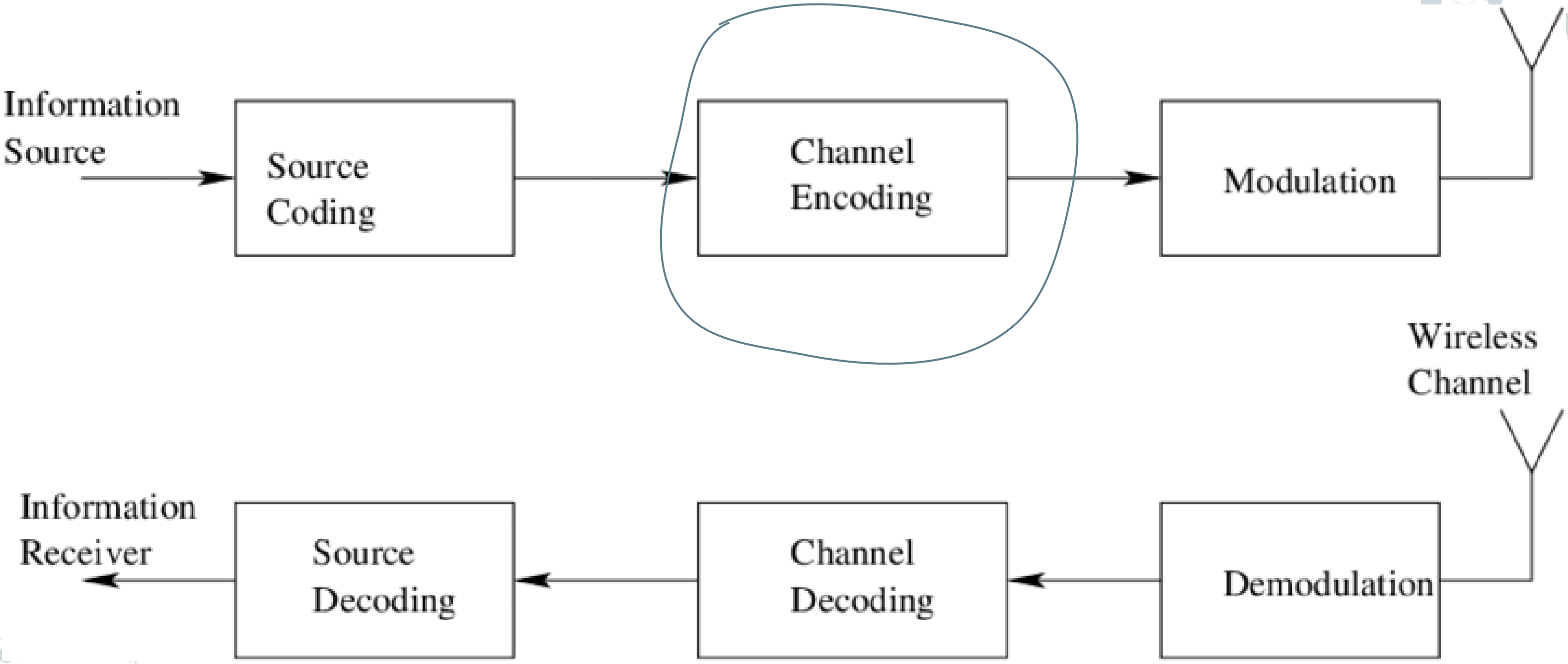


Source encoding **aims to convert information waveforms (text, audio, image, video, etc.)** in to a suitable form for applying signal processing techniques. (Remove redundant information)



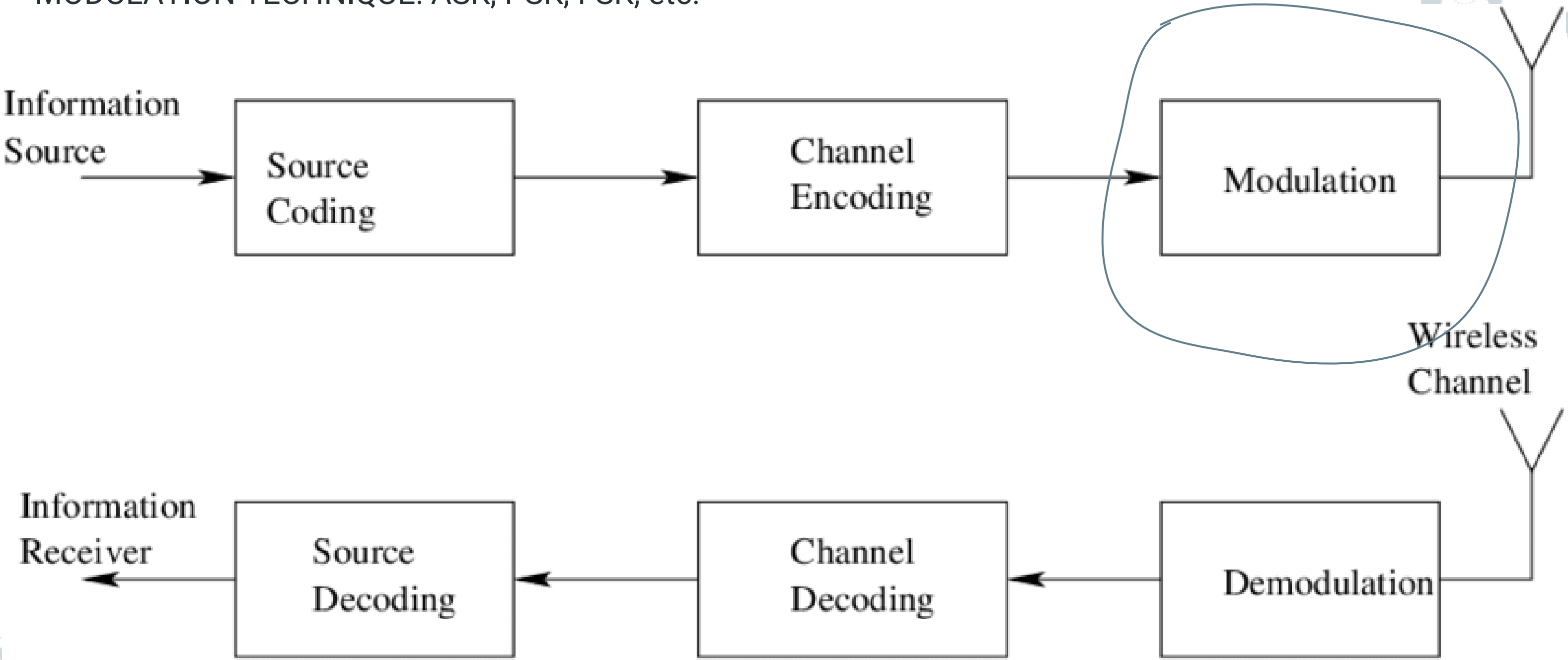


The channel encoder, **does the coding for error correction**. During the transmission of the signal, due to the noise in the channel, the signal may get altered and hence to avoid this, the channel encoder adds some redundancy.

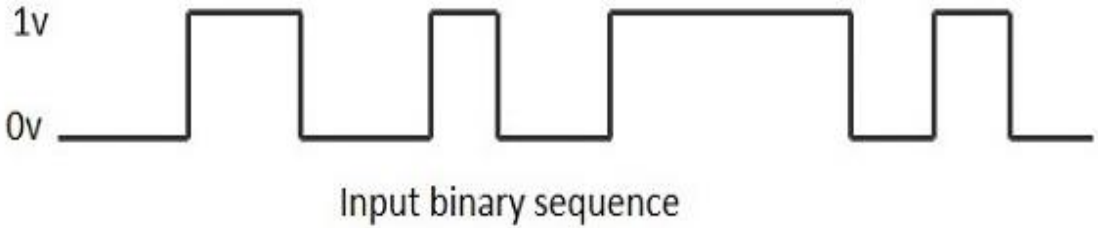


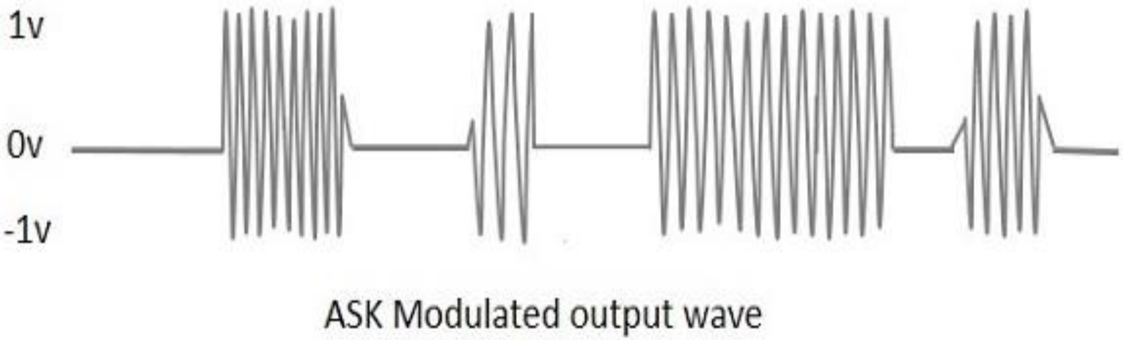
Modulation is **the process of converting data into radio waves by adding information to an electronic or optical carrier signal**.
(process of encoding information from a message source in a way that is suitable for transmission)

MODULATION TECHNIQUE: ASK, PSK, FSK, etc.

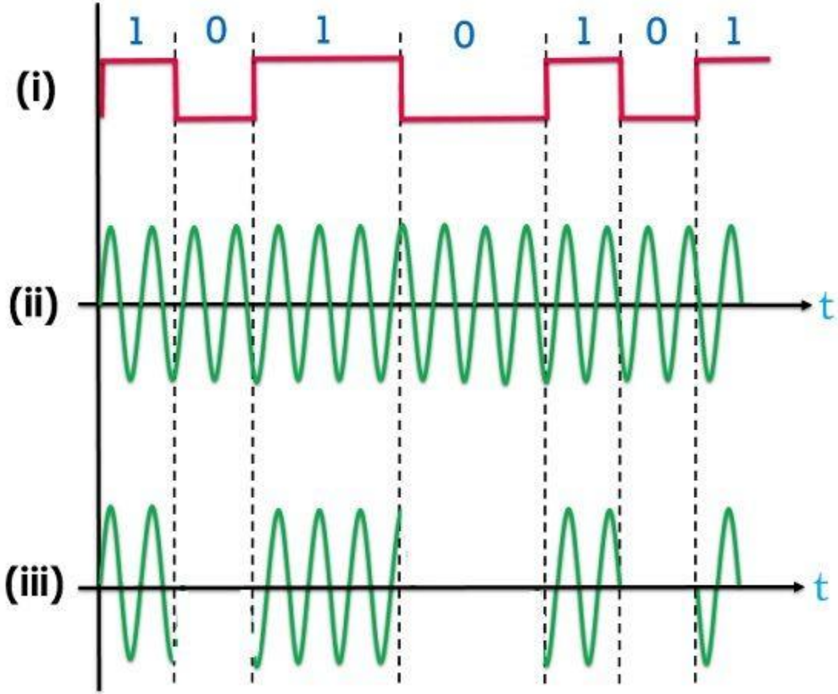


ASK (Amplitude Shift Keying (Modulation)





ASK (Amplitude Shift Keying (Modulation)

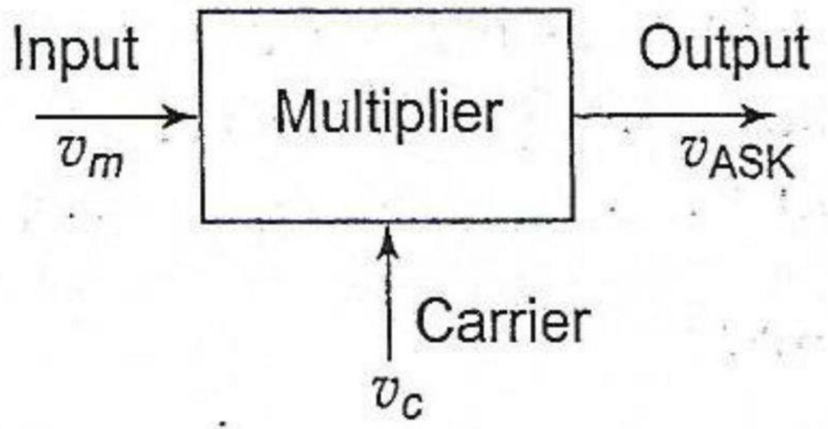


(i) = Digital bit sequence
(ii) = Carrier wave
(iii) = ASK modulated wave

Electronics Coach

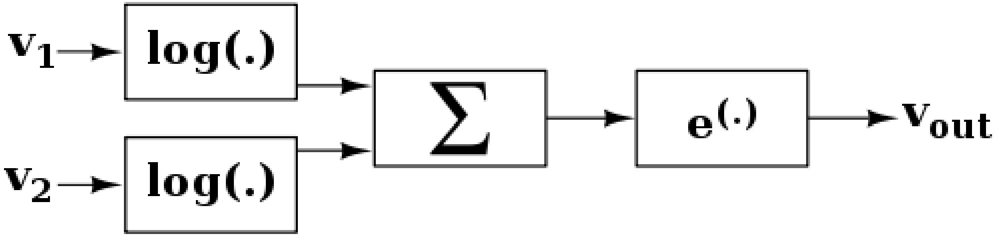
Generation of ASK

Generation of ASK signal



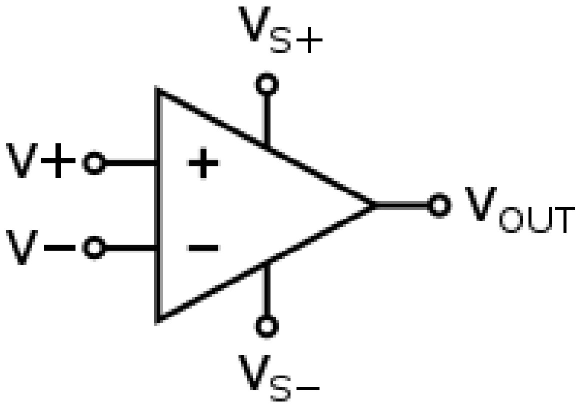
Block diagram of generation of ASK

Multiplier



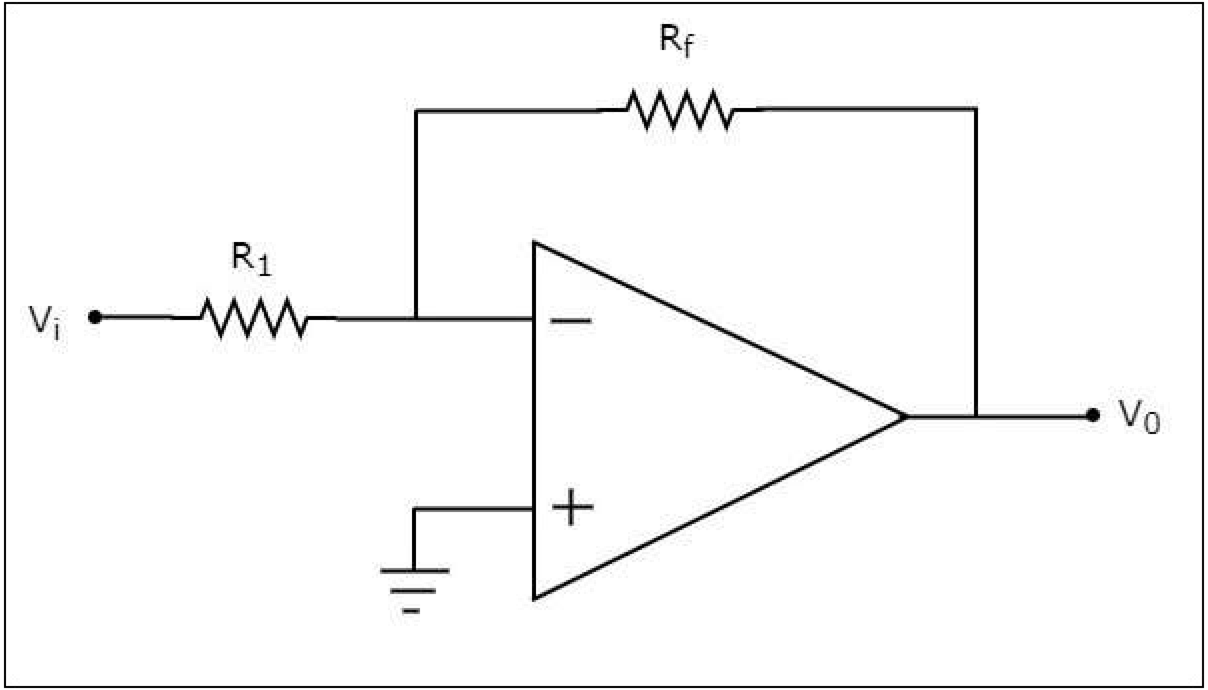
log(xy) = log(x) + log(y)

Op amp



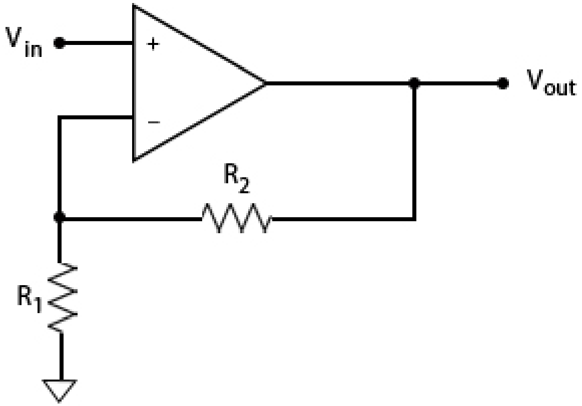
An operational amplifier (op amp) is an analog circuit block that takes a differential voltage input and produces a single-ended voltage output.

Inverting Op amp



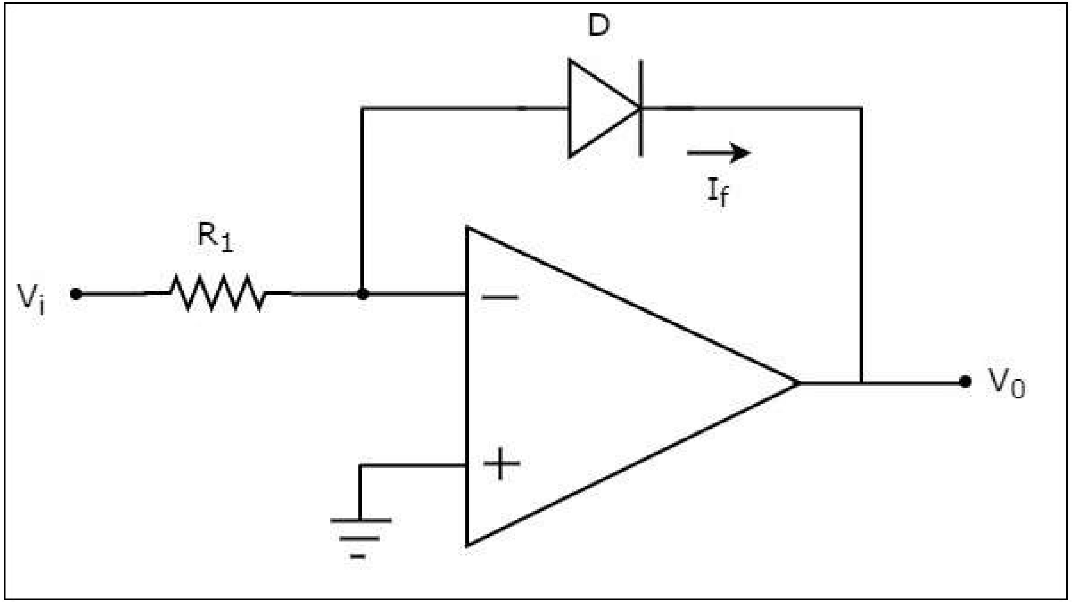
$$V_{out} = -\frac{R_f}{R_{in}} \times V_{in}$$

Non-inverting Op amp



$$\Rightarrow v_o = v_i \left(1 + \frac{R_f}{R_1}\right)$$

Log Amplifier



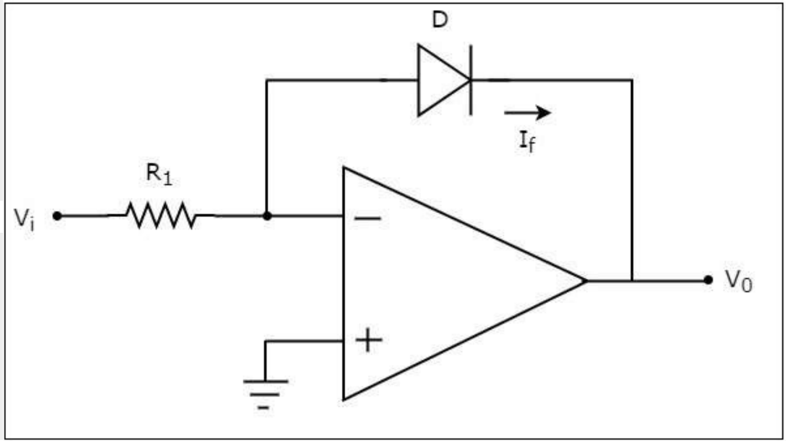
log(xy) = log(x) + log(y)

A logarithmic amplifier, or a log amplifier, is an electronic circuit that produces an output that is proportional to the logarithm of the applied input.

Log Amplifier

The **nodal equation** at the inverting input terminal's node is −

$$\frac{0 - V_i}{R_1} + I_f = 0$$



$$=> I_f = \frac{V_i}{R_1} \ldots\ldots Equation1$$

The following is the **equation for current** flowing through a diode, when it is in forward bias −

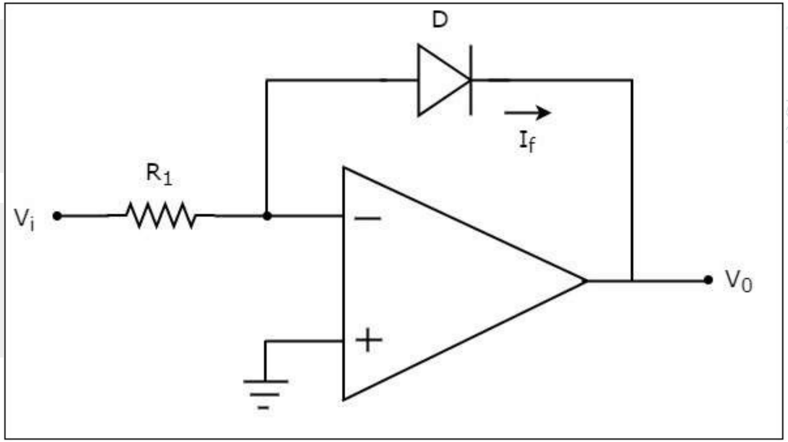
$$I_f = I_s e^{\left(\frac{V_f}{nV_T}\right)} \ldots\ldots Equation2$$

Log Amplifier

The **KVL equation** around the feedback loop of the op amp will be −

$$0 - V_f - V_0 = 0$$

$$=> V_f = -V_0$$



Substituting the value of V_f in Equation 2, we get −

$$I_f = I_s e^{\left(\frac{-V_0}{nV_T}\right)} ......Equation3$$

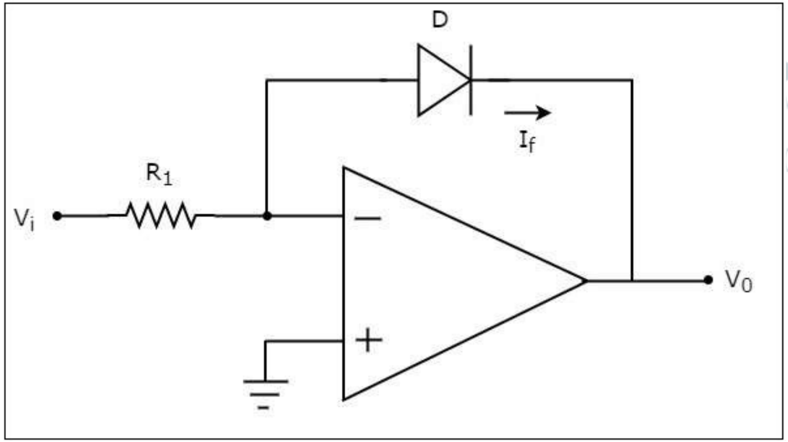
$$\frac{V_i}{R_1} = I_s e^{\left(\frac{-V_0}{nV_T}\right)}$$

$$\frac{V_i}{R_1 I_s} = e^{\left(\frac{-V_0}{nV_T}\right)}$$

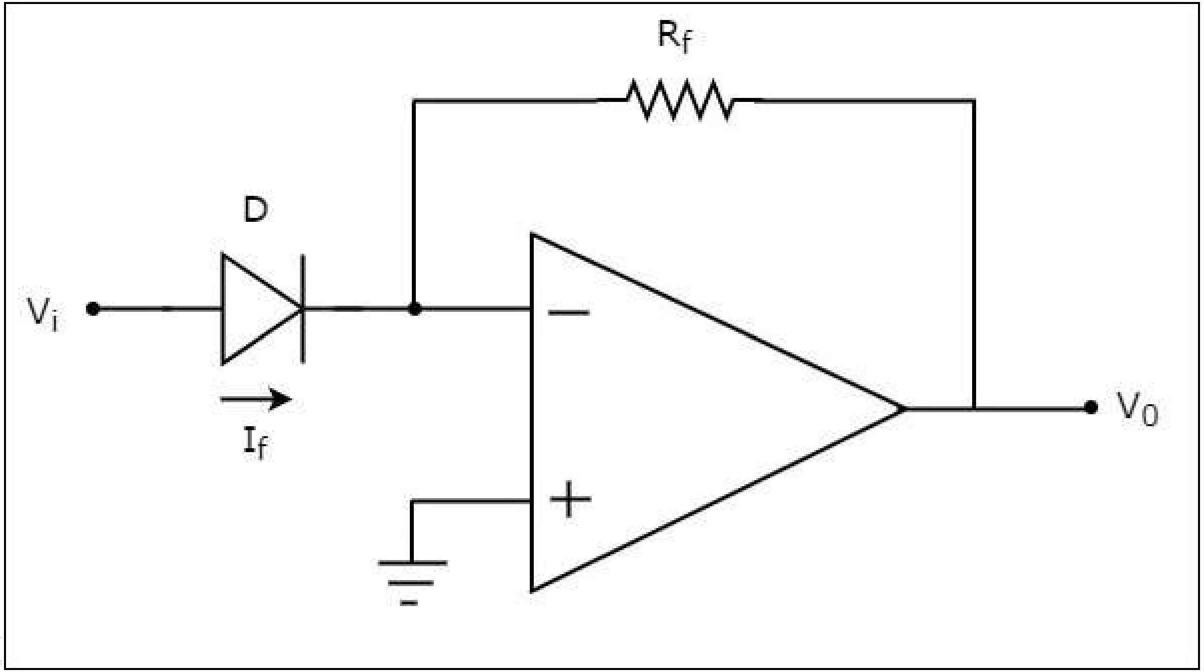
Applying **natural logarithm** on both sides, we get −

$$In\left(\frac{V_i}{R_1 I_s}\right) = \frac{-V_0}{nV_T}$$

$$V_0 = -nV_T In\left(\frac{V_i}{R_1 I_s}\right)$$



AntiLog Amplifier



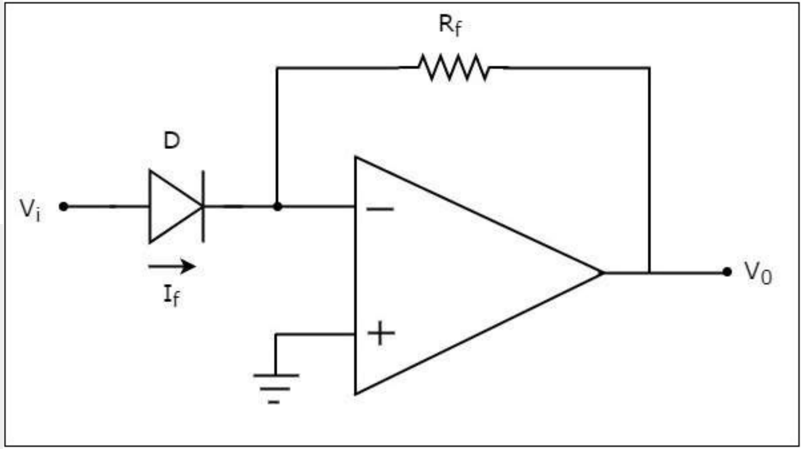
AntiLog Amplifier

The **nodal equation** at the inverting input terminal's node is –

$$-I_f + \frac{0 - V_0}{R_f} = 0$$

$$=> -\frac{V_0}{R_f} = I_f$$

$$=> V_0 = -R_f I_f ....Equation4$$

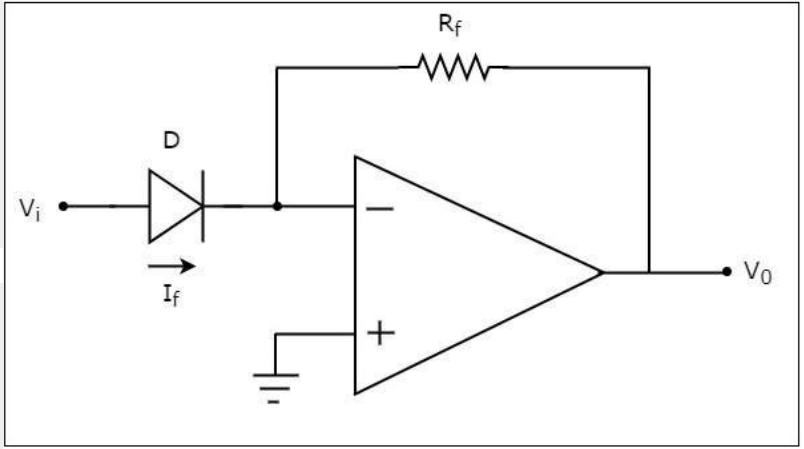


We know that the equation for the current flowing through a diode, when it is in forward bias, is as given below −

$$I_f = I_s e^{\left(\frac{V_f}{nV_T}\right)}$$

Substituting the value of I_f in Equation 4, we get

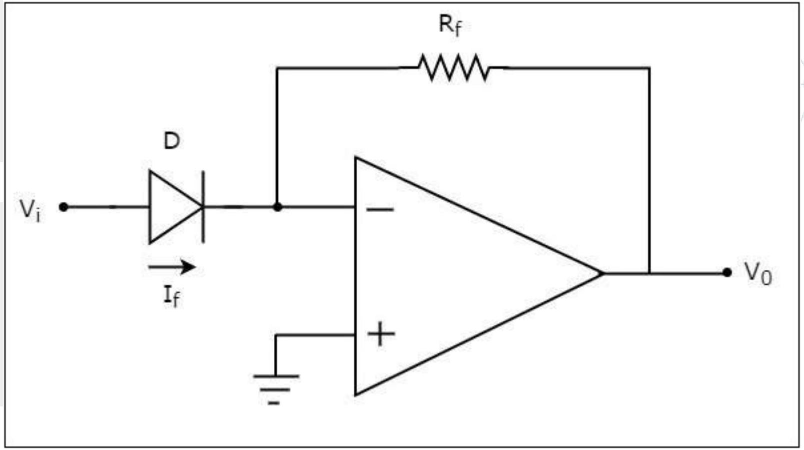
$$V_0 = -R_f \left\{ I_s e^{\left(\frac{V_f}{nV_T}\right)} \right\}$$



$$V_0 = -R_f I_s e^{\left(\frac{V_f}{nV_T}\right)} \ldots\ldots Equation 5$$

The KVL equation at the input side of the inverting terminal of the op amp will be

$$V_i - V_f = 0$$

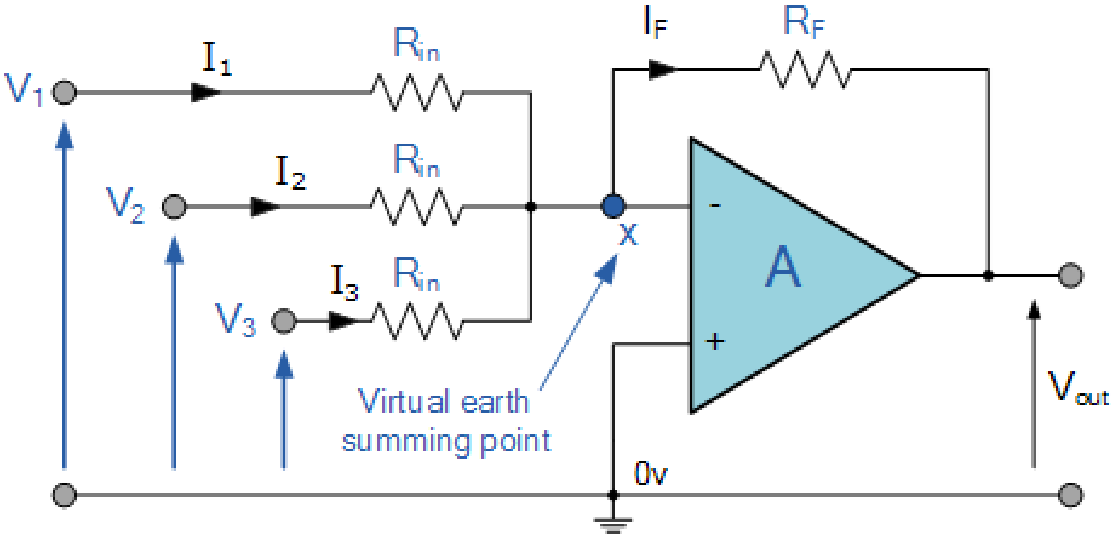


$$V_f = V_i$$

Substituting, the value of Vf in the Equation 5, we get −

$$V_0 = -R_f I_s e^{\left(\frac{V_i}{nV_T}\right)}$$

OPamp as Summer

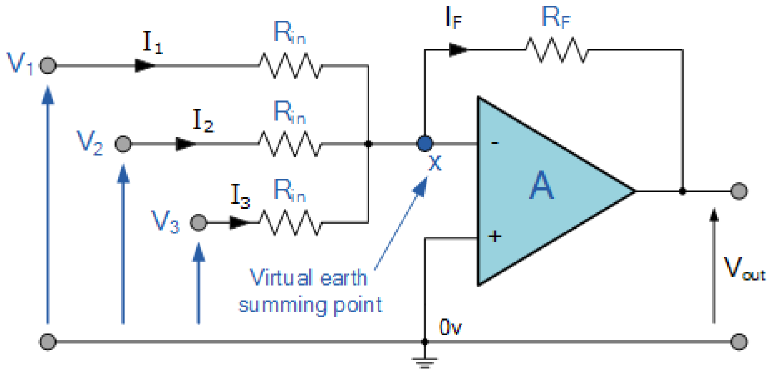


OPamp as Summer

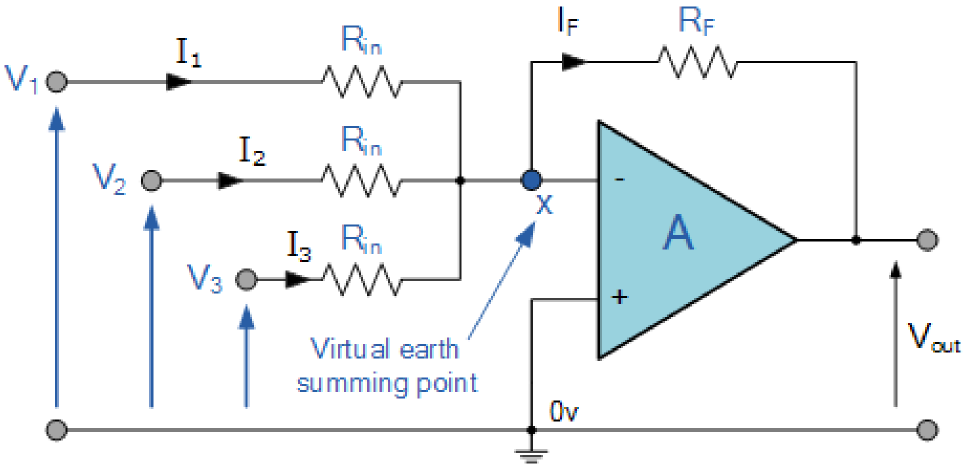
$$I_F = I_1 + I_2 + I_3 = -\left[\frac{V1}{Rin} + \frac{V2}{Rin} + \frac{V3}{Rin}\right]$$

$$\text{Inverting Equation: } Vout = -\frac{Rf}{Rin} \times Vin$$

$$\text{then, } -Vout = \left[\frac{R_F}{Rin}V1 + \frac{R_F}{Rin}V2 + \frac{R_F}{Rin}V3\right]$$

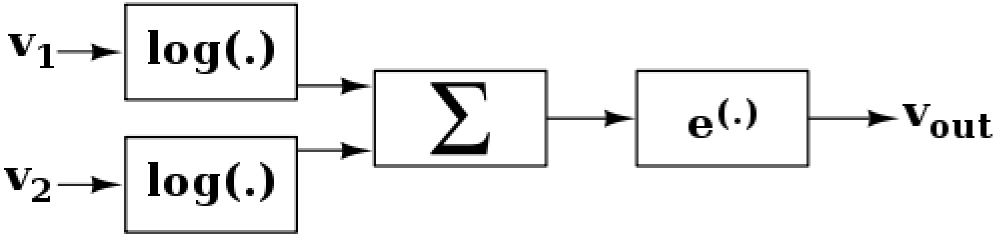


OPamp as Summer

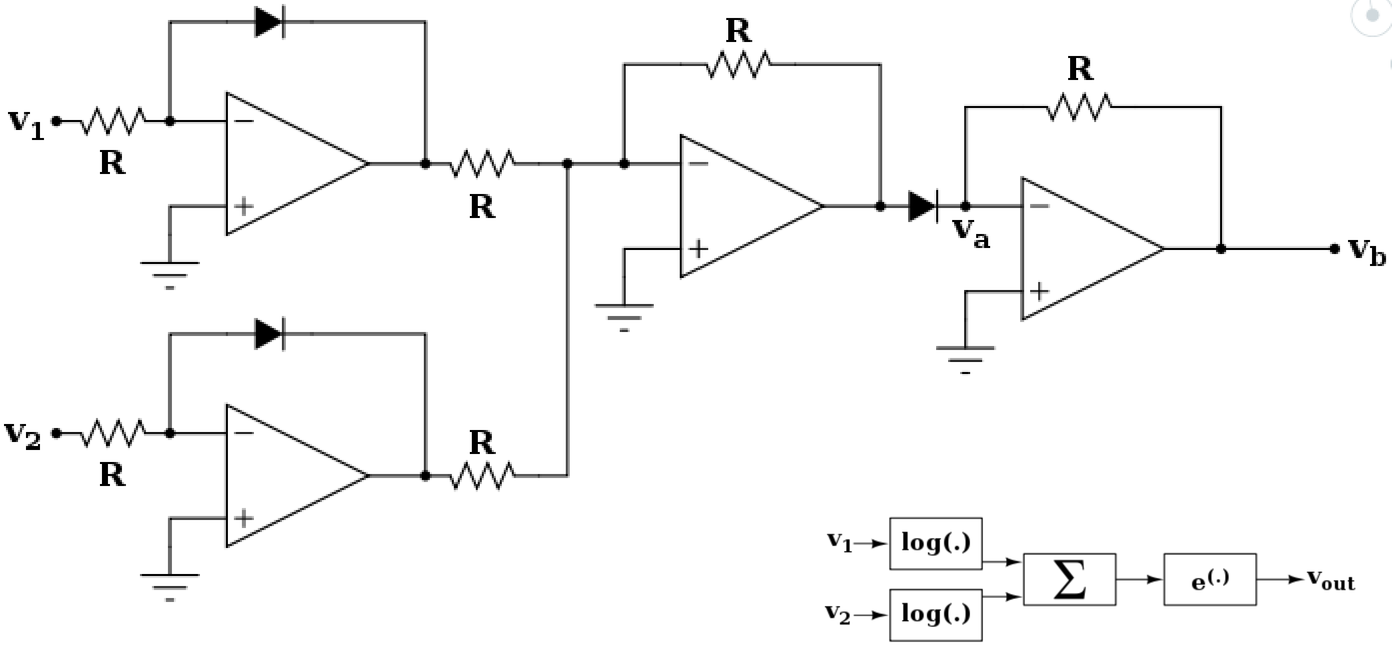


$$-Vout = \frac{R_F}{R_{IN}}\left(V1 + V2 + V3 \ldots .etc\right)$$

Multiplier

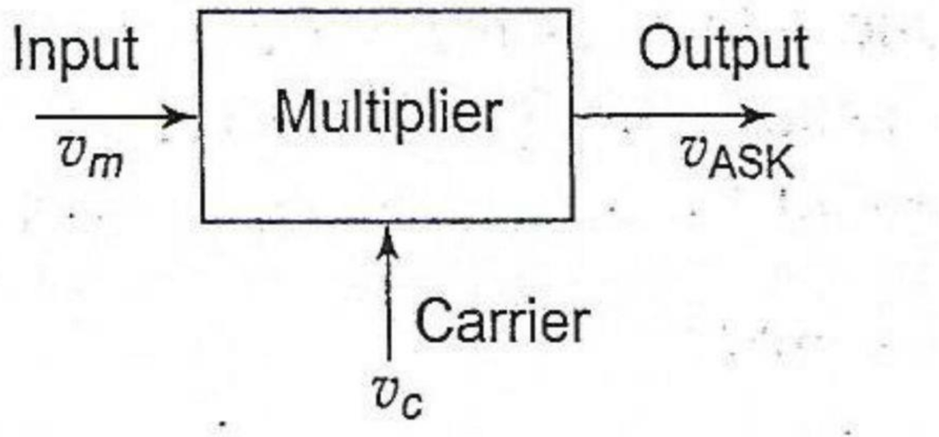


Multiplier Using Opamp



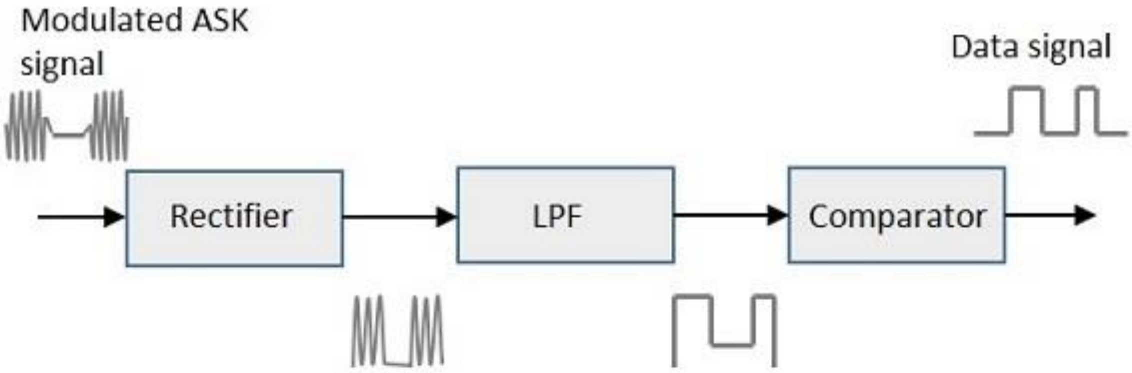
Generation of ASK

Generation of ASK signal



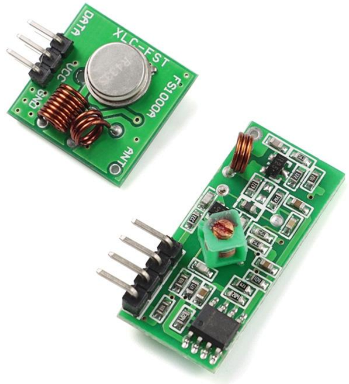
Block diagram of generation of ASK

Non-Coherent Detection of ASK



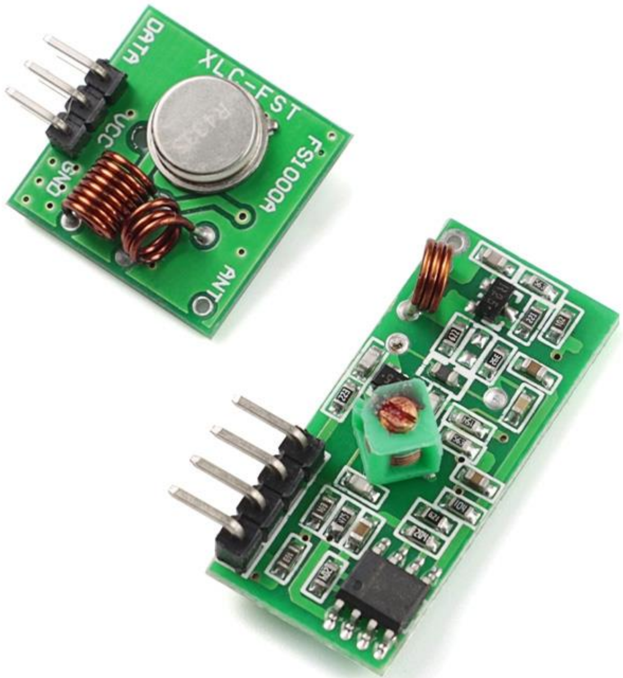
Asynchronous ASK detector

RF 433 Mhz Module

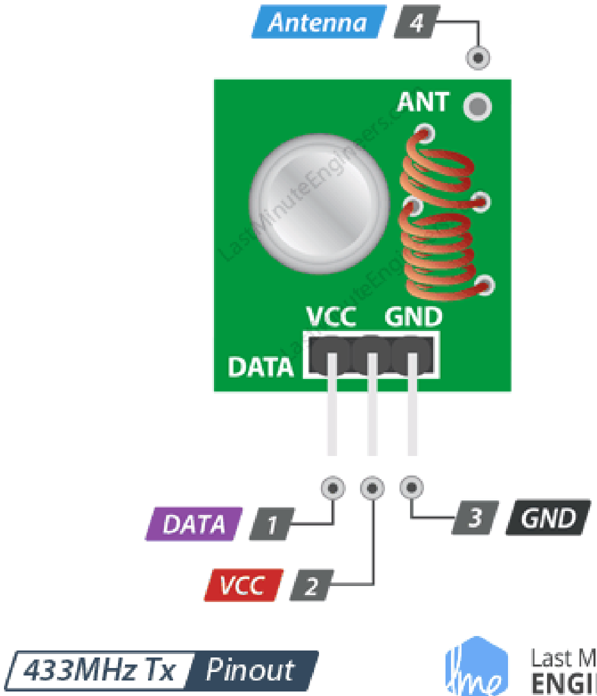


- Wireless (RF) Simplex Transmitter and Receiver
- Receiver Operating Voltage: 3V to 12V
- Receiver Operating current: 5.5mA
- Operating frequency: 433 MHz
- Transmission Distance: 3 meters (without antenna) to 100 meters (maximum)
- Modulating Technique: ASK (Amplitude shift keying)
- Data Transmission speed: 10Kbps
- Circuit type: Saw resonator

RF 433 Mhz Module

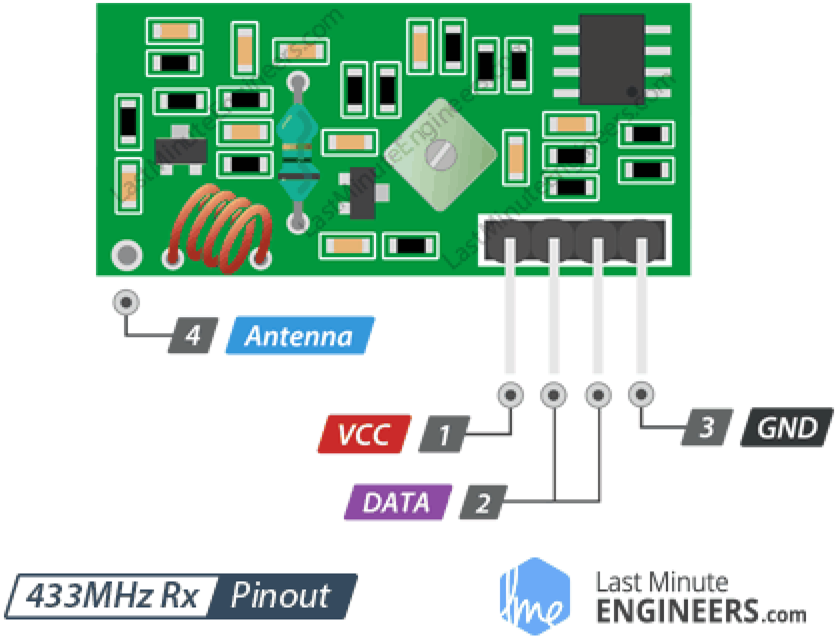


RF 433 Mhz Transmitter Pin Layout



Last Minute ENGINEERS.com

RF 433 Mhz Receiver Pin Layout



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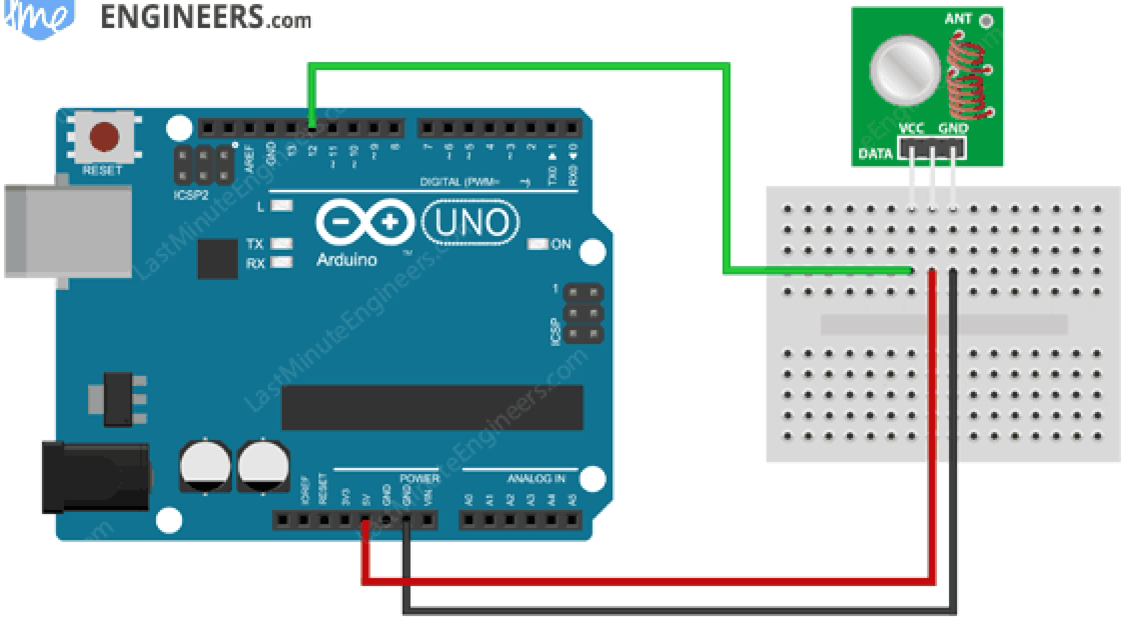

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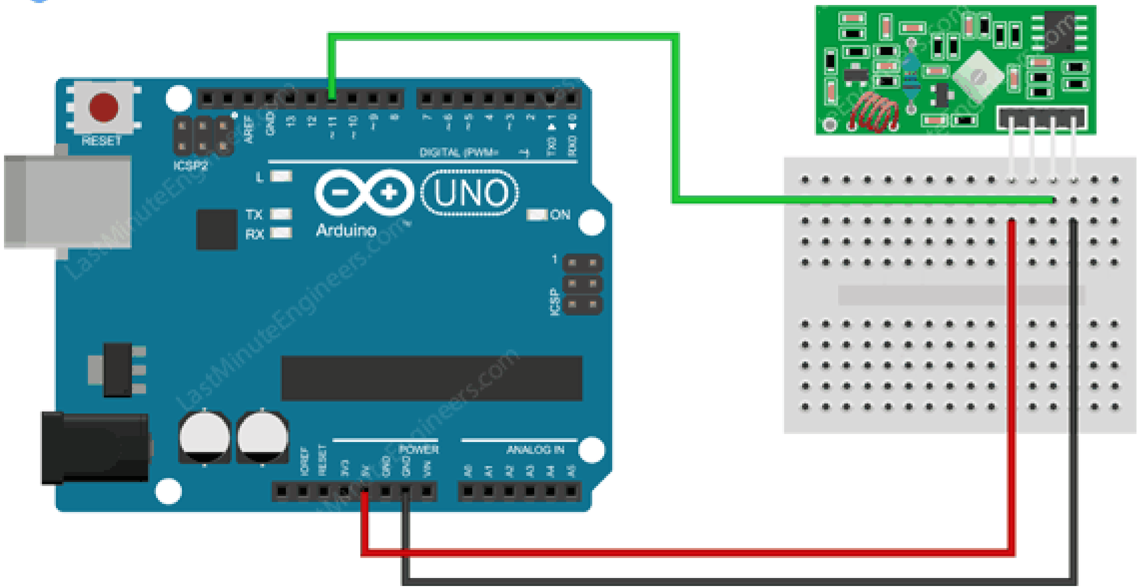
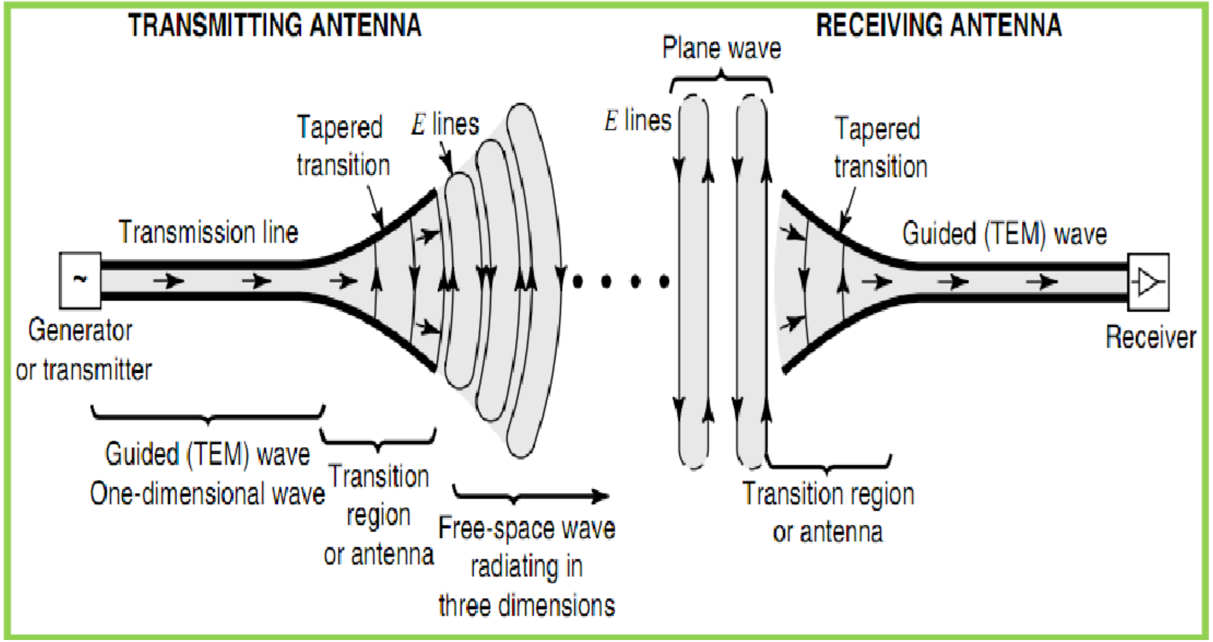


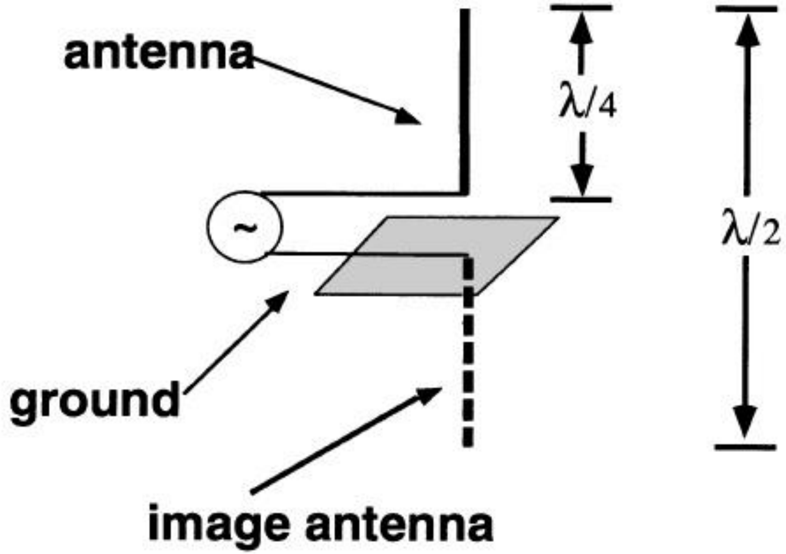
Marconi Antenna

-17.3 cm piece of solid wire



TRANSMITTING ANTENNA
RECEIVING ANTENNA
Plane wave
Tapered transition
E lines
E lines
Tapered transition
Transmission line
Guided (TEM) wave
Generator or transmitter
Receiver
Guided (TEM) wave
One-dimensional wave
Transition region or antenna
Free-space wave radiating in three dimensions
Transition region or antenna

Marconi Antenna



THANK YOU