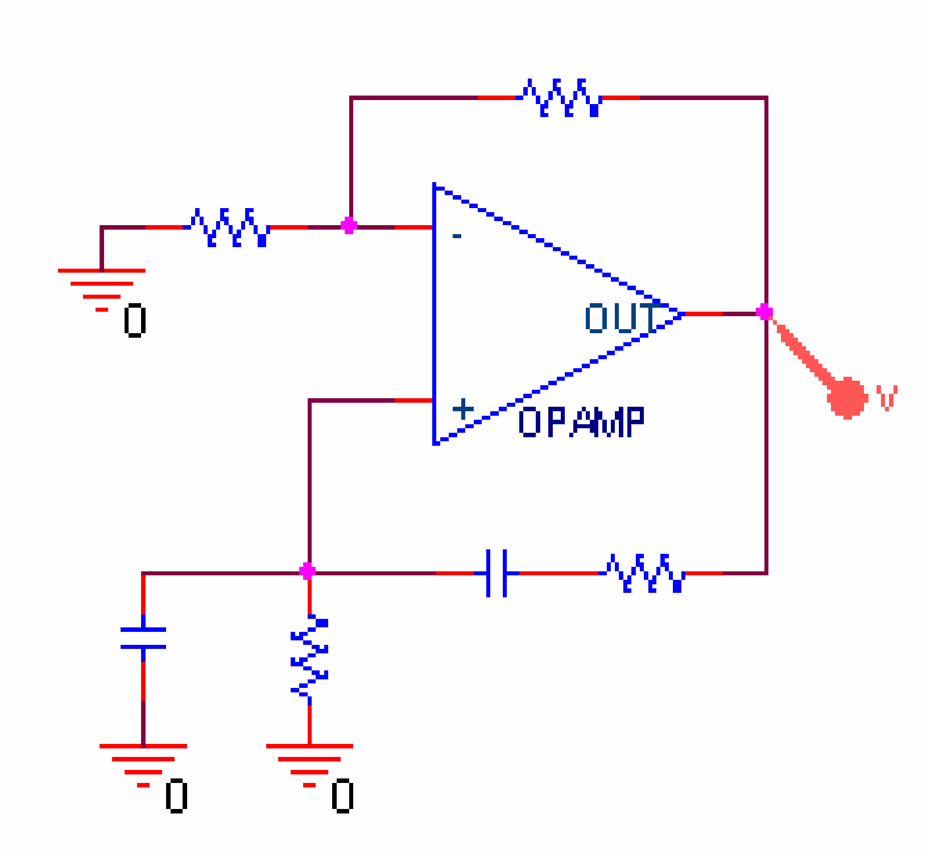
2-3 Types of Signal Generators

1- Low Frequency (LF) Signal Generators

- **LF** signal generators usually generates up to 100 kHz (maximum frequency) and 10 V (maximum amplitude).
- There are several types of sin-wave oscillator circuit that can be used for signal generation.
- The **Wein bridge** is one of the circuit that gives an output with good frequency and amplitude stability, and a low distortion wavefrom. The Wein bridge is an AC bridge in which balance is obtained only at a particular frequency depending on the values of the bridge components.

The Wien-Bridge

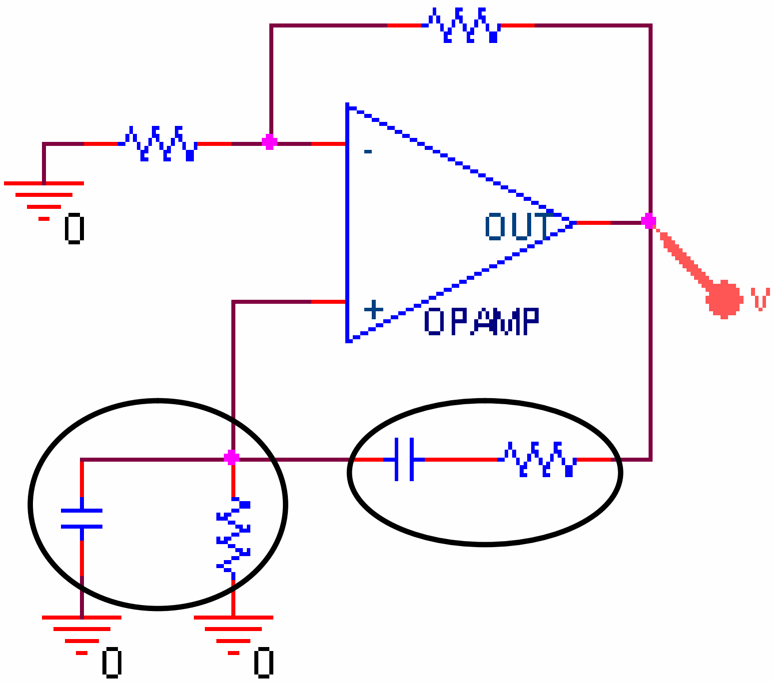
- It generates an oscillatory output signal without having any input source.



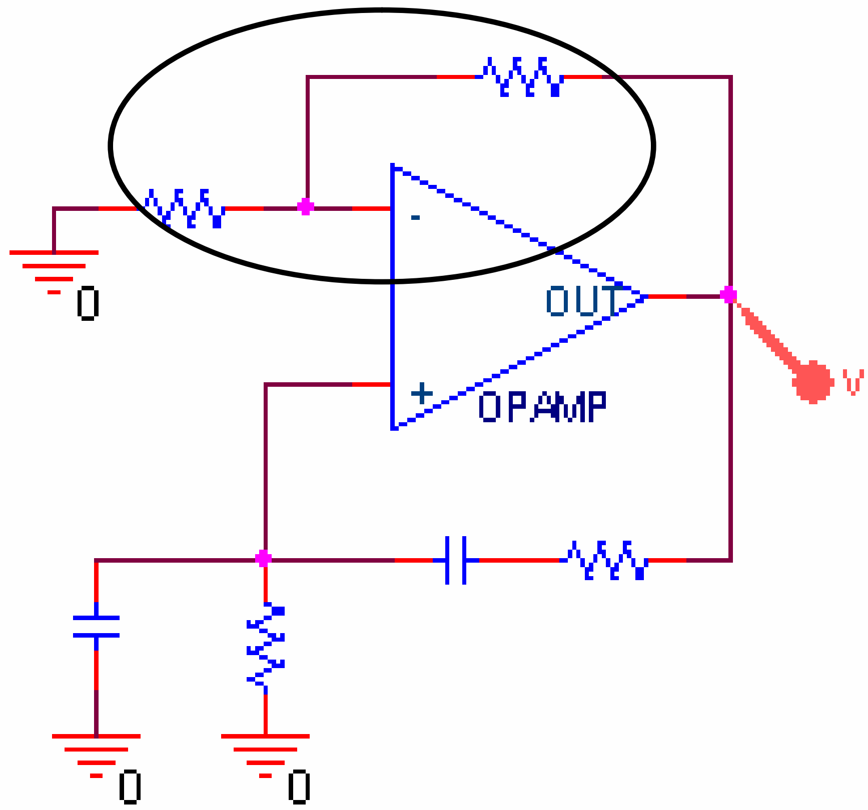
Basics About the Wien-Bridge

- Uses two RC networks connected to the positive terminal to form a frequency selective feedback network

- Causes Oscillations to Occur

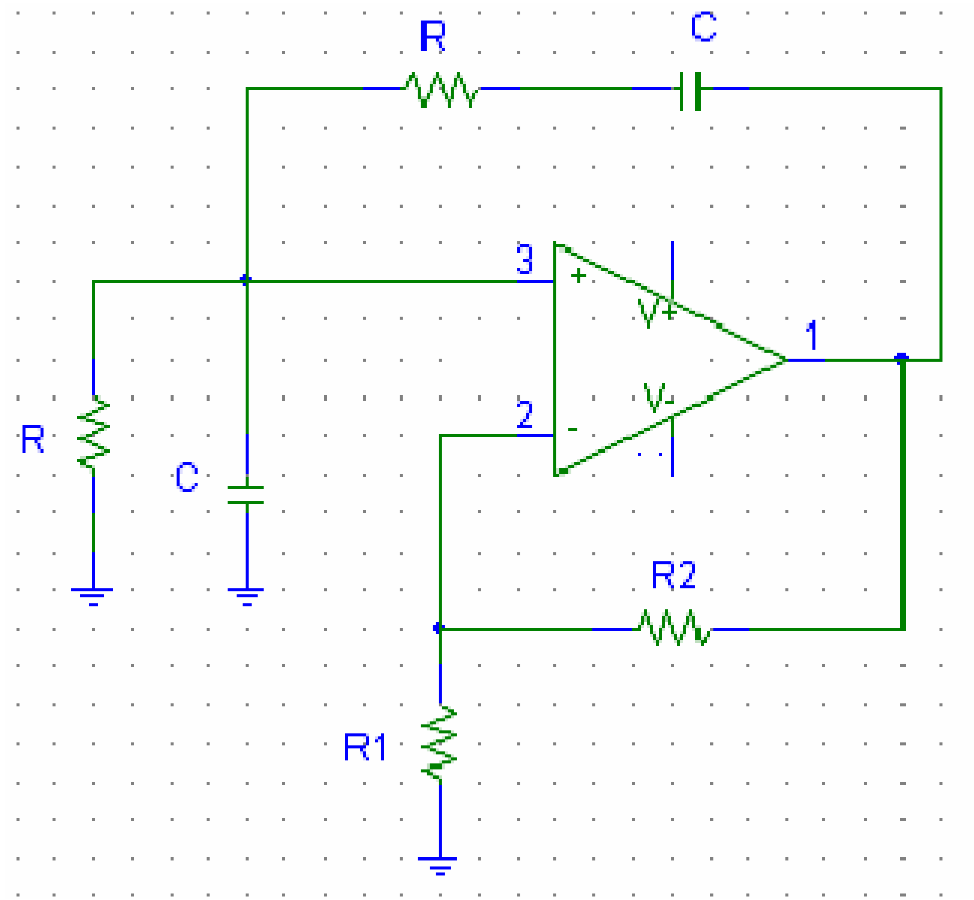


- Amplifies the signal with the two negative feedback resistors



Conditions of Oscillations

- For the two RC networks, we assume that $R_{nt1}=R_{nt2}=R$ and $C1=C2=C$ for simplicity. $Z_1= R+Z_c$ and $Z_2 = R//Z_c$.
- The two negative feed back resistors are **R1** and **R2**.



As before, **A** is the open loop gain

$$A = (1 + \frac{R_2}{R_1})$$

B is the feed back gain

$$B = \frac{Z_2}{Z_1 + Z_2}$$

where

$$Z_1 = R + \frac{1}{J\omega C}$$

$$Z_2 = \frac{R.(1/J\omega C)}{R + (1/J\omega C)}$$

In this case,

$$AB = \frac{J\omega RC\,(1 + R_2 / R_1)}{(1 - \omega^2 R^2 C^2) + 3J\,\omega RC}$$

The conditions of oscillations are

$$|AB| = 1$$

$$\angle AB = 0$$

In order to have a phase shift of zero

$$1 - \omega^2 R^2 C^2 = 0$$

This happens at $\omega = 1/RC$ i.e. $f = 1/(2\pi RC)$

when $\omega = 1/RC$, we have:

$$AB = (1 + \frac{R_2}{R_1})/3$$

The condition |AB|=1 is satisfied when

$$1 + (R_2 / R_1) = 3 \text{ (i.e. A} = 3\text{), thus}$$

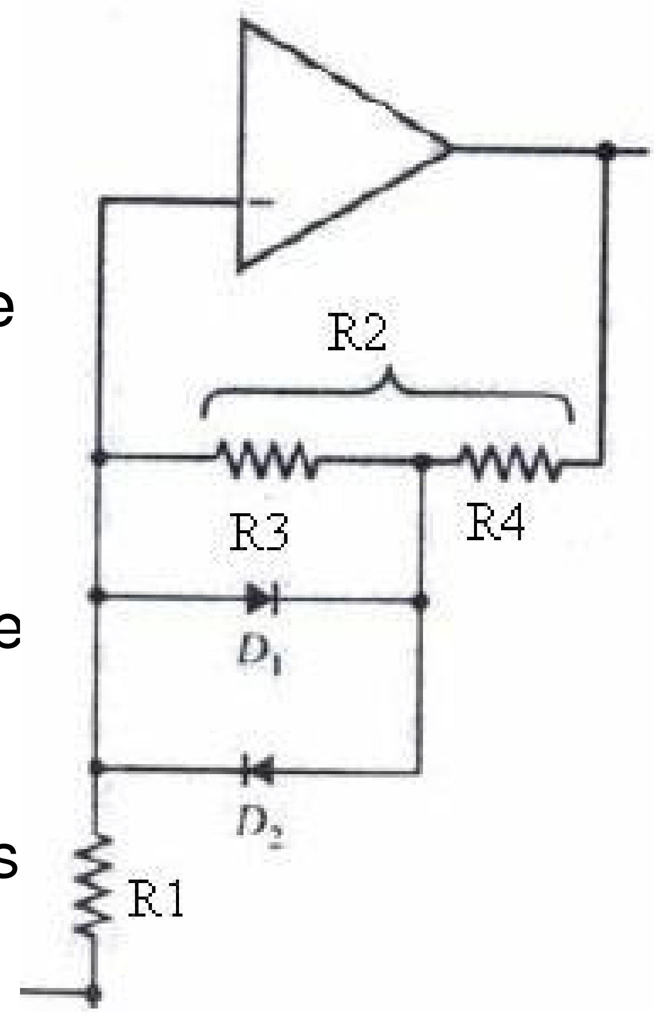
$$R_2 = 2R_1$$

Conclusion: The condition of oscillation occurs at frequency $f = 1/2\pi RC$

when $R_{nt1}=R_{nt2}$, $C_1=C_2$, and $R_2=2R_1$

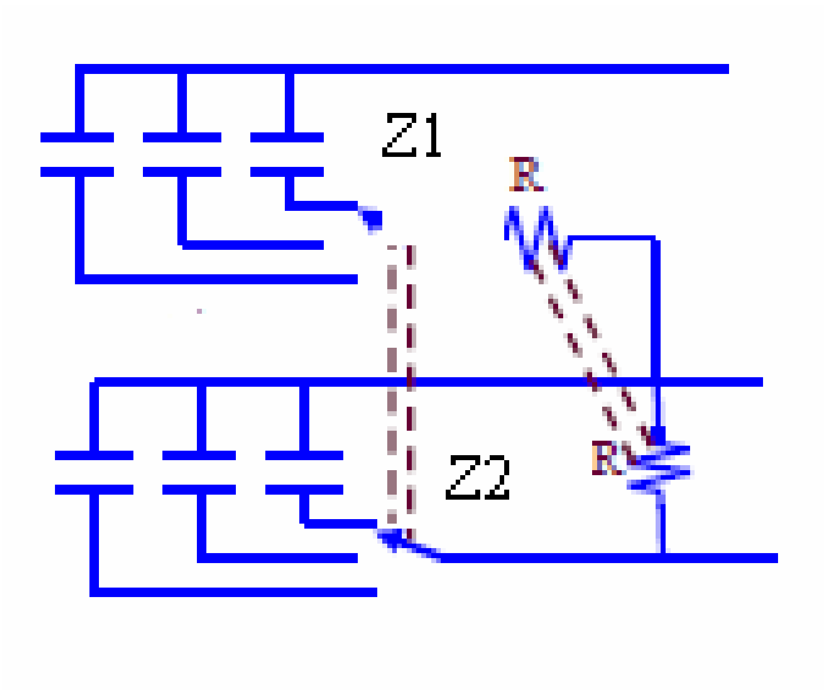
How to stabilize the output amplitude

- To avoid saturation, the diode circuit shown in figure can be used to stabilize the output amplitude by reducing the gain at high output amplitude.
- When the output amplitude is small, the voltage drop across R_3 is not large enough to forward bias the diodes, **$A=(R_1+R_2)/R_1$**.
- When the output amplitude is +ve or –ve large, diode **D_1 or D2** is on and **R_3 is short circuited.** in this case: **$A=(R_1+R_4)/R_1$**. In this case, the gain A is reduced to prevent large output oscillations. This value is adjusted according to the value of **R_4**.



How to Change the Frequency

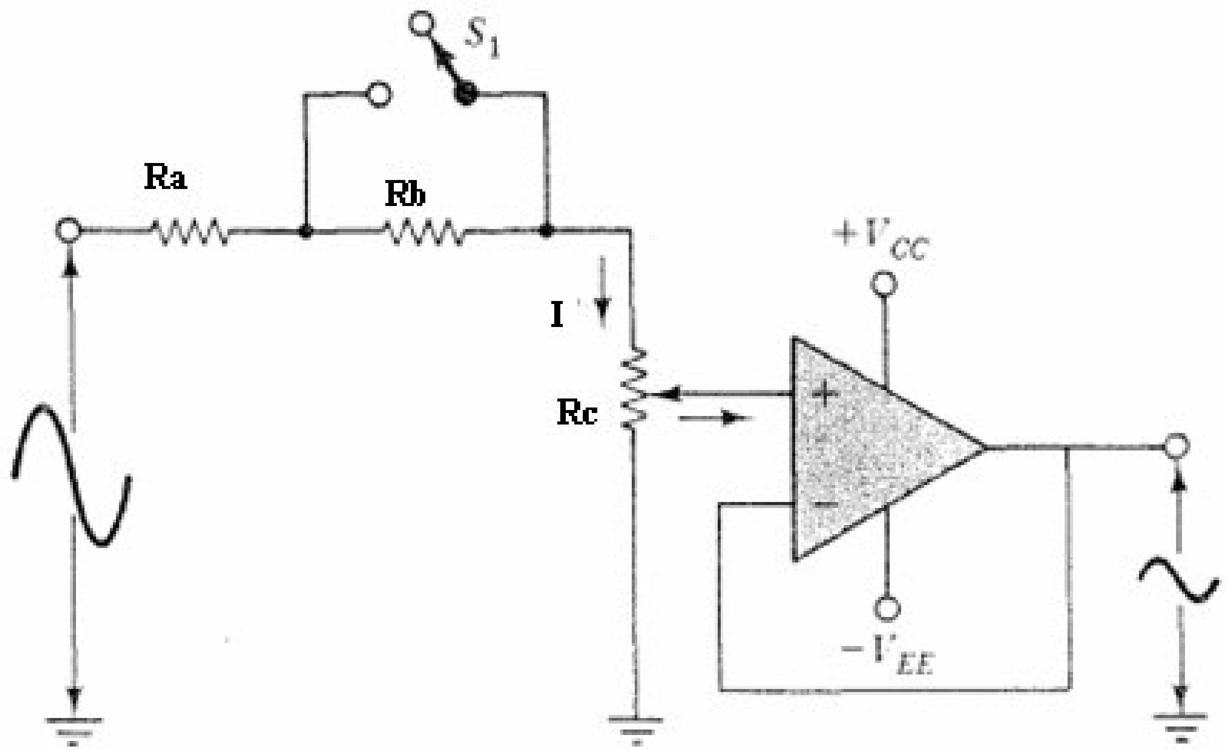
- The frequency **range** can be chosen by switching different **C** . Frequency **adjustment** is performed using continous variable resistors **R** (as shown in figure).



How to Control the Amplitude

- The amplitude can be controlled using different resistors (R_a, R_b, R_c to achieve voltage divider) and voltage follower (buffer). R_c controls the output amplitude and switch S_1 allows the output to be switched between two amplitude ranges (as shown in figure).

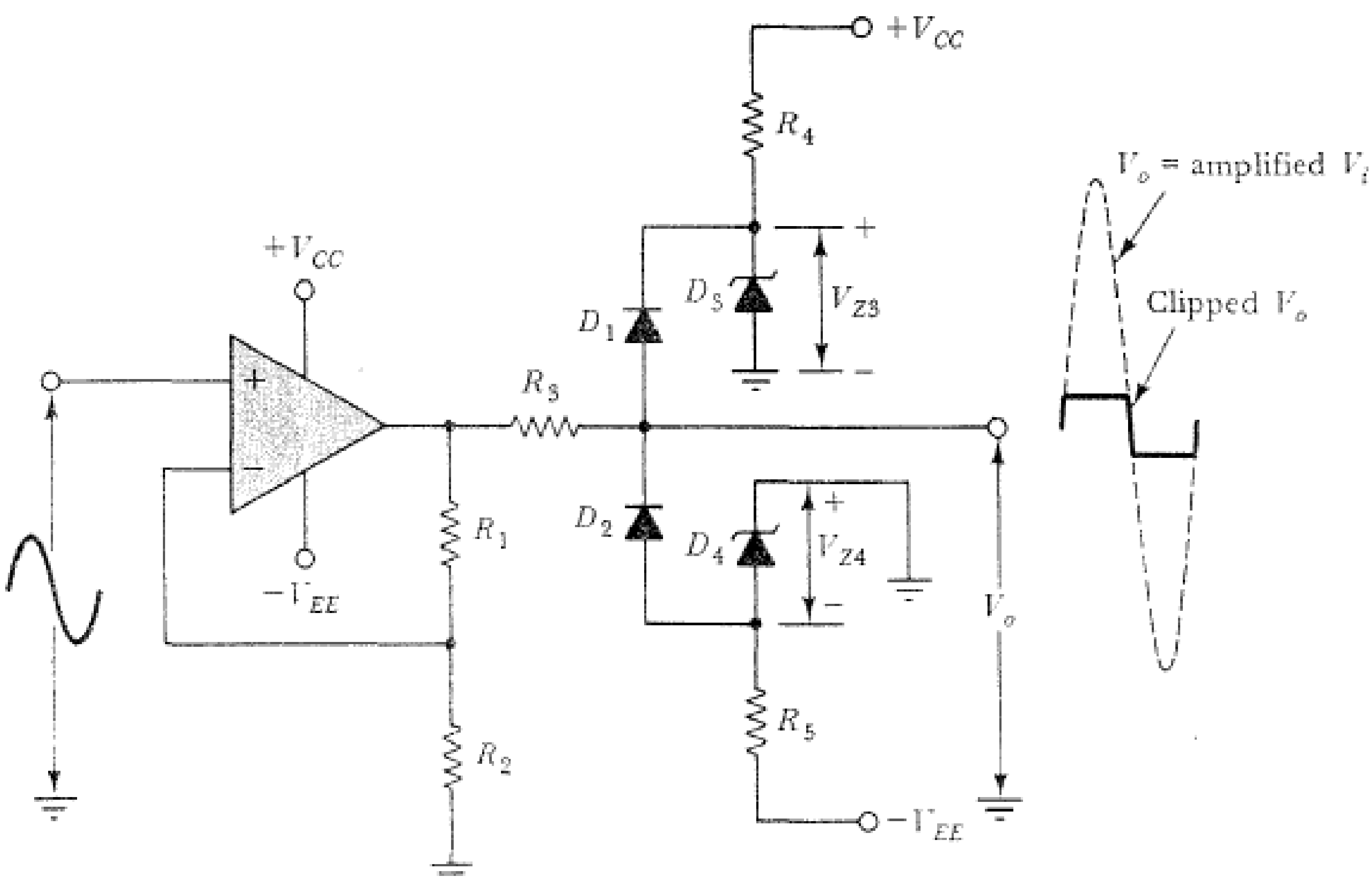
Output from oscillator



Output after controlling the amplitude

Square wave converter

- It converts the sin wave output from an oscillator into a square wave.
- It consists of a noninverting op. amp and a clipper circuit.
- The amplifier has a very high gain, so that the amplified output tends to be very large (as shown in figure).
- Diodes D1 and D2 together with zener diodes D3 and D4 and the associated resistors form the clipper circuit.
- The +ve and –ve half cycles of the amplifier output are clipped at certain voltage level.
- When the amplifier output is +ve (-ve), D_1 (D_2) becomes forward and prevents the output from exceeding $+(V_Z + V_D)$ ($-(V_Z + V_D)$).
- The square wave output amplitude is $V_0 = \pm(V_Z + V_D)$



Square Wave Converter: Amplifying and clipping a sin wave to get a square wave

General Block diagram of a LF Generator

- A LF signal generator normally consists of a sinusoidal oscillator, a sin-to-square-wave converter and an attenuator output stage (as shown in figure). A switch **S** is switched between the oscillator output and the square wave output (attenuator input).