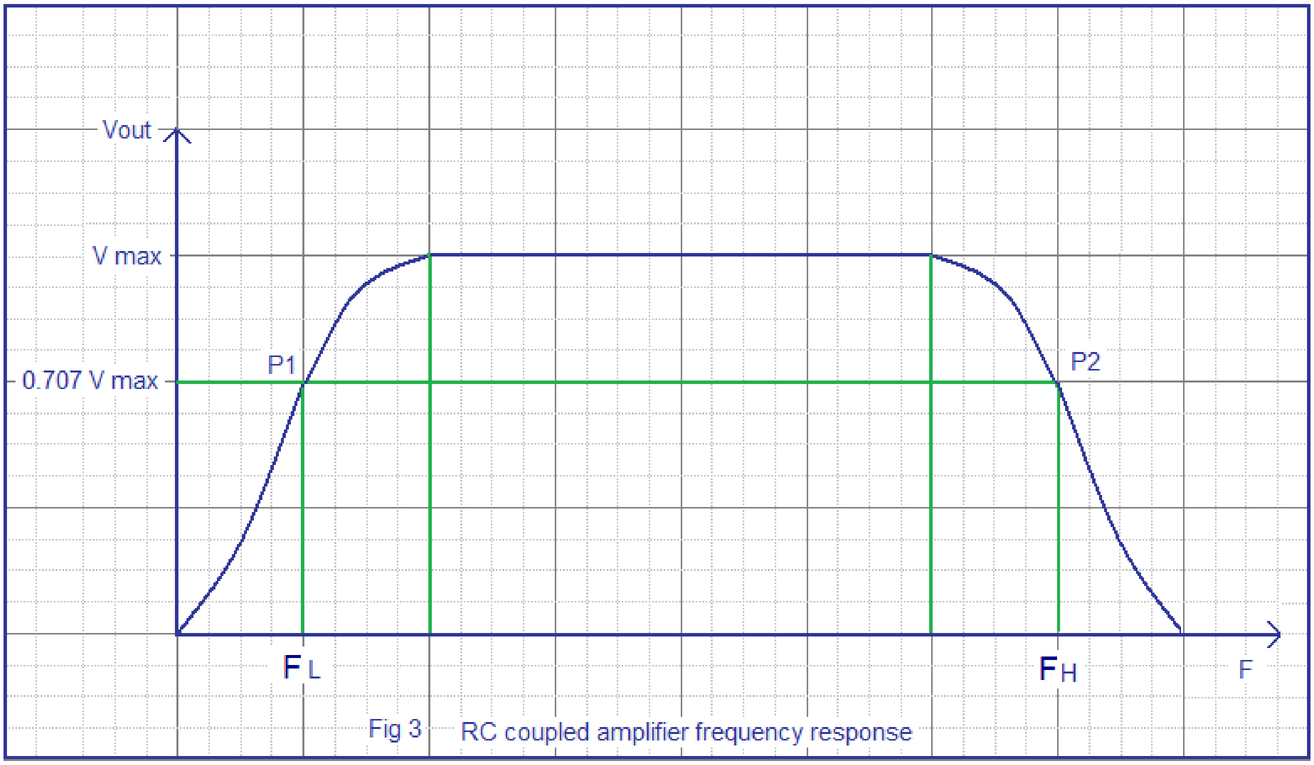
TRANSISTOR AMPLIFIER

Amplifier is a circuit that is used for amplifying a signal. The input signal to an amplifier will be a current or voltage and the output will be an amplified version of the input signal. An amplifier circuit which is purely based on a transistor or transistors is called a transistor amplifier. Transistors amplifiers are commonly used in applications like RF (radio frequency), audio, OFC (optic fibre communication) etc. Anyway the most common application we see in our day to day life is the usage of transistor as an audio amplifier. As you know there are three transistor configurations that are used commonly i.e. common base (CB), common collector (CC) and common emitter (CE). In common base configuration has a gain less than unity and common collector configuration (emitter follower) has a gain almost equal to unity). Common emitter follower has a gain that is positive and greater than unity. So, common emitter configuration is most commonly used in audio amplifier applications.

A good transistor amplifier must have the following parameters; high input impedance, high band width, high gain, high slew rate, high linearity, high efficiency, high stability etc. The above given parameters are explained in the next section.
Input impedance: Input impedance is the impedance seen by the input voltage source when it is connected to the input of the transistor amplifier. In order to prevent the transistor amplifier circuit from loading the input voltage source, the transistor amplifier circuit must have high input impedance.

Bandwidth.

The range of frequency that an amplifier can amplify properly is called the bandwidth of that particular amplifier. Usually the bandwidth is measured based on the half power points i.e. the points where the output power becomes half the peak output power in the frequency Vs output graph. In simple words, bandwidth is the difference between the lower and upper half power points. The band width of a good audio amplifier must be from 20 Hz to 20 KHz because that is the frequency range that is audible to the human ear. The frequency response of a single stage RC coupled transistor is shown in the figure below (Fig 3). Points tagged P1 and P2 are the lower and upper half power points respectively.



RC coupled amplifier frequency response

Gain.

Gain of an amplifier is the ratio of output power to the input power. It represents how much an amplifier can amplify a given signal. Gain can be simply expressed in numbers or in decibel (dB). Gain in number is expressed by the equation G = P*out* / *Pin*. In decibel the gain is expressed by the equation Gain in dB = 10 log (P*out* / P*in*). Here Pout is the power output and Pin is the power input. Gain can be also expressed in terms of output voltage / input voltage or output current / input current. Voltage gain in decibel can be expressed using the equation, Av in dB = 20 log (V*out* / V*in*) and current gain in dB can be expressed using the equation Ai = 20 log (I*out* / I*in*).

Derivation of gain.

G = 10 log (P*out* / P*in*)………(1)

Let P*out* = V*out* / R*out* and P*in* = V*in* / R*in*. Where V*out* is the output voltage V*in* is the input voltage, Pout is the output power, P*in* is the input power, R*in* is the input voltage and R*out* is the output resistance. Substituting this in equation 1 we have

$G = 10\log (V_{out}^2/R_{out}) / (V_{in}^2/R_{in})$…………(2)

Let R*out* = R*in*, then the equation 2 becomes

$G = 10\log (V_{out}^2 / V_{in}^2)$

i.e.

$$G = 20 \log (Vout / Vin)$$

Efficiency.

Efficiency of an amplifier represents how efficiently the amplifier utilizes the power supply. In simple words it is a measure of how much power from the power supply is usefully converted to the output. Efficiency is usually expressed in percentage and the equation is $\zeta = (P_{out}/ P_s) \times 100$. Where ζ is the efficiency, P_{out} is the power output and P_s is the power drawn from the power supply.

Class A transistor amplifiers have up to 25% efficiency, Class AB has up to 55% can class C has up to 90% efficiency. Class A provides excellent signal reproduction but the efficiency is very low while Class C has high efficiency but the signal reproduction is bad. Class AB stands in between them and so it is used commonly in audio amplifier applications.

Stability.

Stability is the capacity of an amplifier to resist oscillations. These oscillations may be high amplitude ones masking the useful signal or very low amplitude, high frequency oscillations in the spectrum. Usually stability problems occur during high frequency operations, close to 20KHz in case of audio amplifiers. Adding a Zobel network at the output, providing negative feedback etc improves the stability.

Slew rate.

Slew rate of an amplifier is the maximum rate of change of output per unit time. It represents how quickly the output of an amplifier can change in response to the input. In simple words, it represents the speed of an amplifier. Slew rate is usually represented in V/μS and the equation is $SR = dV_o/dt$.

Linearity.

An amplifier is said to be linear if there is a linear relationship between the input power and the output power. It represents the flatness of the gain. 100% linearity is not possible practically as the amplifiers using active devices like BJTs , JFETs or MOSFETs tend to lose gain at high frequencies due to internal parasitic capacitance. In addition to this the input DC decoupling capacitors (seen in almost all practical audio amplifier circuits) sets a lower cutoff frequency.

Noise.

Noise refers to unwanted and random disturbances in a signal. In simple words, it can be said to be unwanted fluctuation or frequencies present in a signal. It may be due to design flaws, component failures, external interference, due to the interaction of two or more signals present in a system, or by virtue of certain components used in the circuit.

Output voltage swing.

Output voltage swing is the maximum range up to which the output of an amplifier could swing. It is measured between the positive peak and negative peak and in single supply amplifiers it is measured from positive peak to the ground. It usually depends on the factors like supply voltage, biasing, and component rating.

Source : http://todayscircuits.blogspot.com/2011/12/transistor-amplifier.html#.VUBxr9Kqqkp