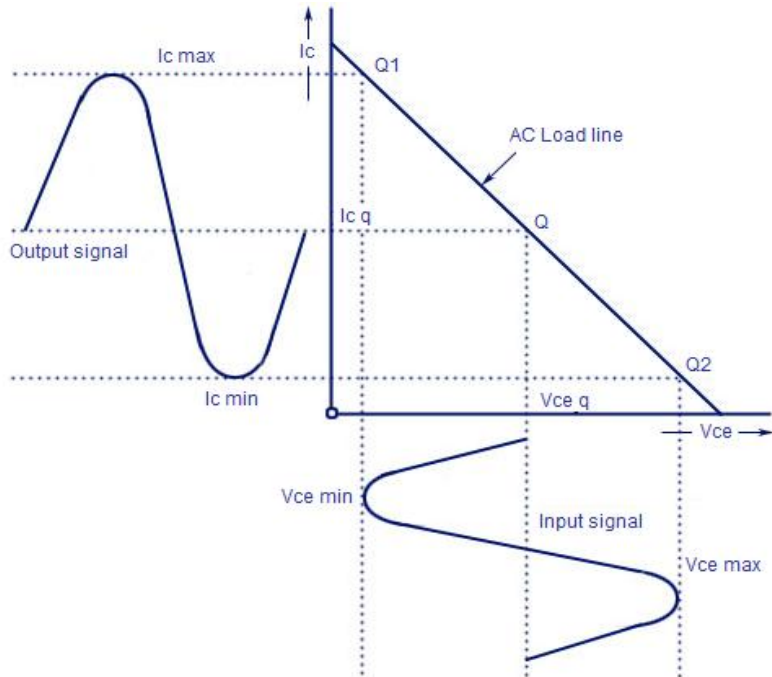


CLASS A POWER AMPLIFIER.

Class A power amplifier is a type of power amplifier where the output transistor is ON full time and the output current flows for the entire cycle of the input waveform. Class A power amplifier is the simplest of all power amplifier configurations. They have high fidelity and are totally immune to crossover distortion. Even though the class A power amplifier have a handful of good feature, they are not the prime choice because of their poor efficiency. Since the active elements (transistors) are forward biased full time, some current will flow through them even though there is no input signal and this is the main reason for the inefficiency. Output characteristics of a Class A power amplifier is shown in the figure below.

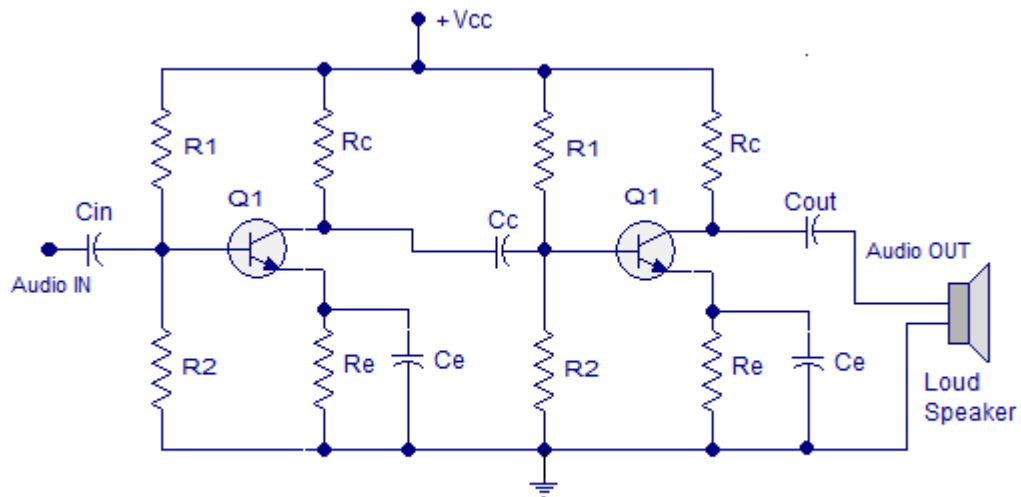


Class A power amplifier output characteristics - AC load line

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From the above figure it is clear that the Q-point is placed exactly at the center of the DC load line and the transistor conducts for every point in the input waveform. The theoretical maximum efficiency of a Class A power amplifier is 50%. In practical scenario, with capacitive coupling and inductive loads (loud speakers), the efficiency can come down as low as 25%. This means 75% of power drawn by the amplifier from the supply line is wasted. Majority of the power wasted is lost as heat on the active elements (transistor). As a result, even a moderately powered Class A power amplifier require a large power supply and a large heat sink.

Class A power amplifier circuit.



Two stage Class A power amplifier

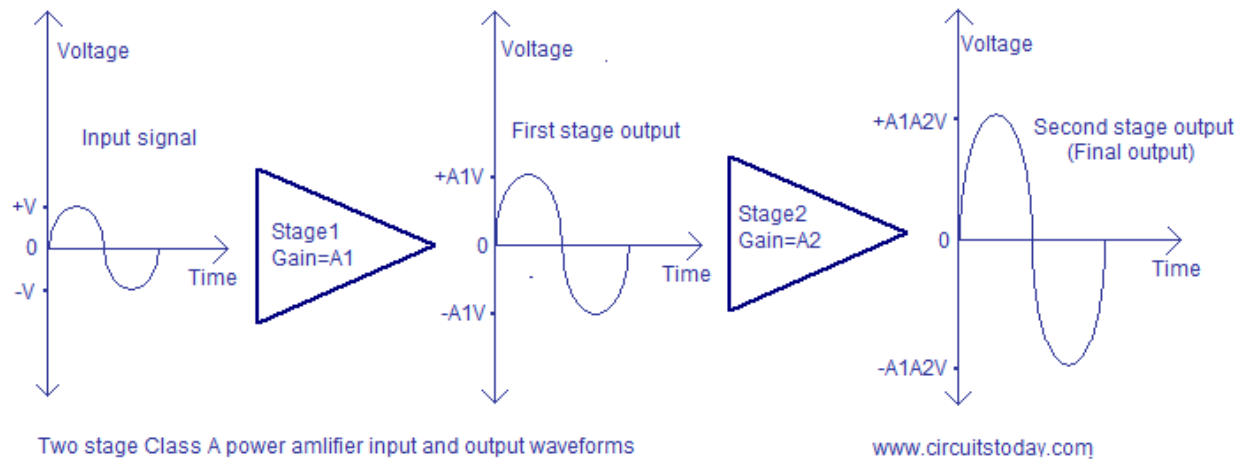
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The circuit diagram of a two stage single ended Class A power amplifier is shown above. R1 and R2 are the biasing resistors. They form a voltage divider network which supplies the base of the transistor with a voltage 0.7V higher than the “negative maximum amplitude swing” of the input signal. This is the reason behind the transistor being ON irrespective of the input signal amplitude. Capacitor C_{in} is the input decoupling capacitor which removes the DC components present in the input signal. If C_{in} is not there, and there are DC components in the input signal, these DC components will be directly coupled to the base of the transistor and will surely alter the biasing conditions.

R_c is the collector resistor and R_e is the emitter resistance. Their value is so selected that the collector current is in the desired level and the operating point is placed at the center of the load line under zero signal condition. Placing operating point as close as possible to the center of load line is very essential for the distortion free operation of the amplifier. C_c is the coupling capacitor which connects the two stages together. Its function is to block passage of DC components from first stage to the second stage.

C_e is the emitter by-pass capacitor whose function is to by-pass the AC components in the emitter current while amplifier is operating. If C_e is not there, the AC components will drop across the emitter resistor resulting in reduced gain (degenerative feedback). The most simple explanation is that, the additional voltage drop across R_e will get added to the base-emitter voltage and this means additional forward voltage is required to forward bias the transistor.

C_{out} is the output coupling capacitor which couples the output to the load (loud speaker). C_{out} blocks the DC components of the second stage from entering the load (loud speaker). The Coupling capacitor C_{out} , C_{in} and C_c all degrades the low frequency response of the amplifier. This is because these capacitors form high pass filters in conjunction with the input impedance of succeeding stages resulting in the attenuation of low frequency components. Input and output waveforms of a two stage RC couple amplifier is shown in the figure below.



Advantages of Class A power amplifier.

- Class A design is the simplest.
- High fidelity because input signal will be exactly reproduced at the output.
- Since the active device is on full time, no time is required for the turn on and this improves high frequency response.
- Since the active device conducts for the entire cycle of the input signal, there will be no cross over distortion.
- Single ended configuration can be practically realized in Class A amplifier. Single ended means only one active device (transistor) in the output stage.

Disadvantages of Class A power amplifier.

- Main disadvantage is poor efficiency.
- Steps for improving efficiency like transformer coupling etc affects the frequency response.
- Powerful Class A power amplifiers are costly and bulky due to the large power supply and heatsink.

Overall Efficiency

The overall efficiency of the amplifier circuit is given by

$$(\eta)_{\text{overall}} = \frac{\text{a.c. power delivered to the load}}{\text{total power delivered by d.c. supply}}$$

$$= \frac{(P_O)_{\text{ac}}}{(P_{\text{in}})_{\text{dc}}}$$

Collector Efficiency

The collector efficiency of the transistor is defined as

$$(\eta)_{\text{collector}} = \frac{\text{average a.c. power output}}{\text{average d.c. power input to transistor}}$$

$$= \frac{(P_O)_{\text{ac}}}{(P_{\text{tr}})_{\text{dc}}}$$

Expression for overall efficiency

$$(P_O)_{\text{ac}} = V_{\text{rms}} \times I_{\text{rms}}$$

$$= \frac{1}{2} \sqrt{[(V_{\text{ce}})_{\text{max}} - (V_{\text{ce}})_{\text{min}}]^2} \times \frac{1}{2} \sqrt{[(I_{\text{C}})_{\text{max}} - (I_{\text{C}})_{\text{min}}]^2}$$

$$= \frac{[(V_{\text{ce}})_{\text{max}} - (V_{\text{ce}})_{\text{min}}] \times [(I_{\text{C}})_{\text{max}} - (I_{\text{C}})_{\text{min}}]}{8}$$

Therefore

$$(\eta)_{\text{overall}} = \frac{[(V_{\text{ce}})_{\text{max}} - (V_{\text{ce}})_{\text{min}}] \times [(I_{\text{C}})_{\text{max}} - (I_{\text{C}})_{\text{min}}]}{8 \times V_{\text{CC}} (I_{\text{C}})_{\text{Q}}}$$