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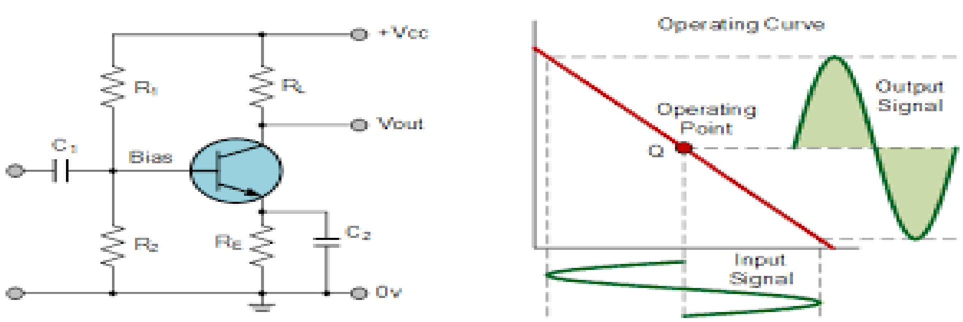
Class A Amplifier

Class A Amplifiers are the most common type of amplifier topology as they use just one output switching transistor (Bipolar, FET, IGBT, etc) within their amplifier design. This single output transistor is biased around the Q-point within the middle of its load line and so is never driven into its cut-off or saturation regions thus allowing it to conduct current over the full 360 degrees of the input cycle. Then the output transistor of a class-A topology never turns “OFF” which is one of its main disadvantages.

Class “A” amplifiers are considered the best class of amplifier design due mainly to their excellent linearity, high gain and low signal distortion levels when designed correctly. Although seldom used in high power amplifier applications due to thermal power supply considerations, class-A amplifiers are probably the best sounding of all the amplifier classes mentioned here and as such are used in high-fidelity audio amplifier designs.

Class A Amplifier.



To achieve high linearity and gain, the output stage of a class A amplifier is biased “ON” (conducting) all the time. Then for an amplifier to be classified as “Class A” the zero signal idle current in the output stage must be equal to or greater than the maximum load current (usually a loudspeaker) required to produce the largest output signal.

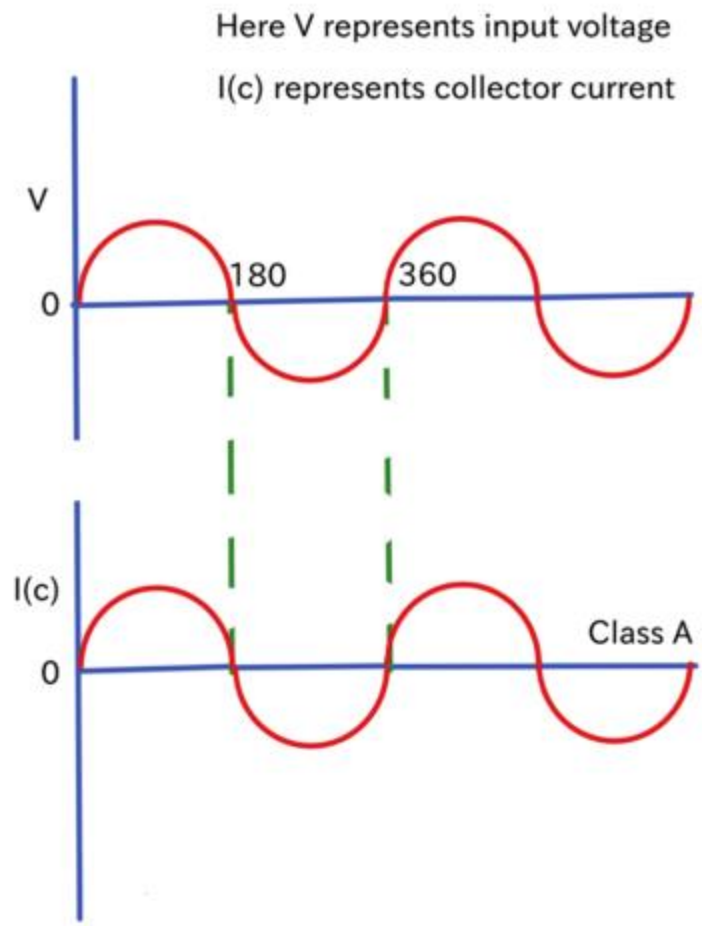
As a class A amplifier operates in the linear portion of its characteristic curves, the single output device conducts through a full 360 degrees of the output waveform. Then the class A amplifier is equivalent to a current source.

Since a class A amplifier operates in the linear region, the transistors base (or gate) DC biasing voltage should by chosen properly to ensure correct operation and low distortion. However, as the output device is “ON” at all times, it is constantly carrying current, which represents a continuous loss of power in the amplifier.

Due to this continuous loss of power class A amplifiers create tremendous amounts of heat adding to their very low efficiency at around 30%, making them impractical for high-power amplifications. Also due to the high idling current of the amplifier, the power supply must be sized accordingly and be well filtered to avoid any amplifier hum and noise. Therefore, due to the low efficiency and over heating problems of Class A amplifiers, more efficient amplifier classes have been developed.

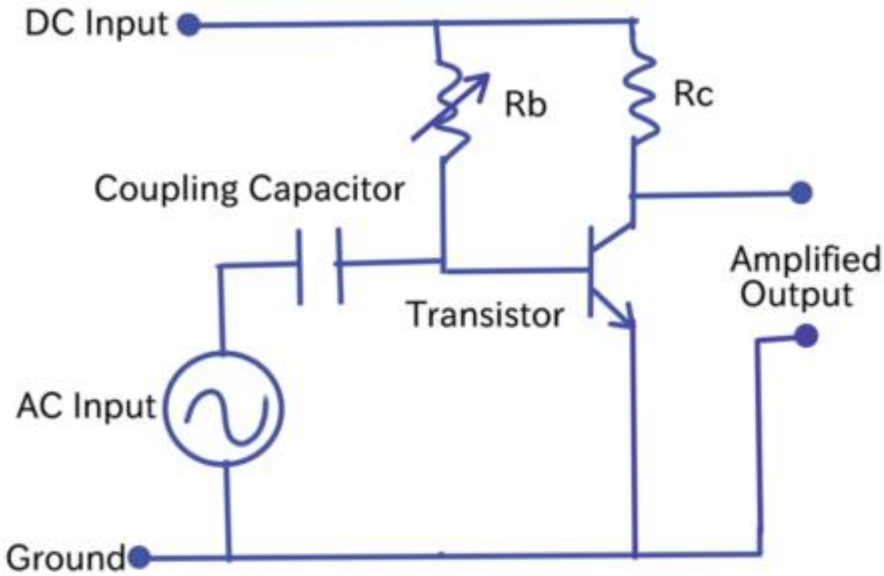
Working of a Class A Amplifier

The power efficiency and distortion in the signal is determined by the class of an amplifier circuit. The figure below shows the waveforms in case of a class A amplifier. The first wave shown below is the input which actually drives the base of the transistor while the second wave is that of collector

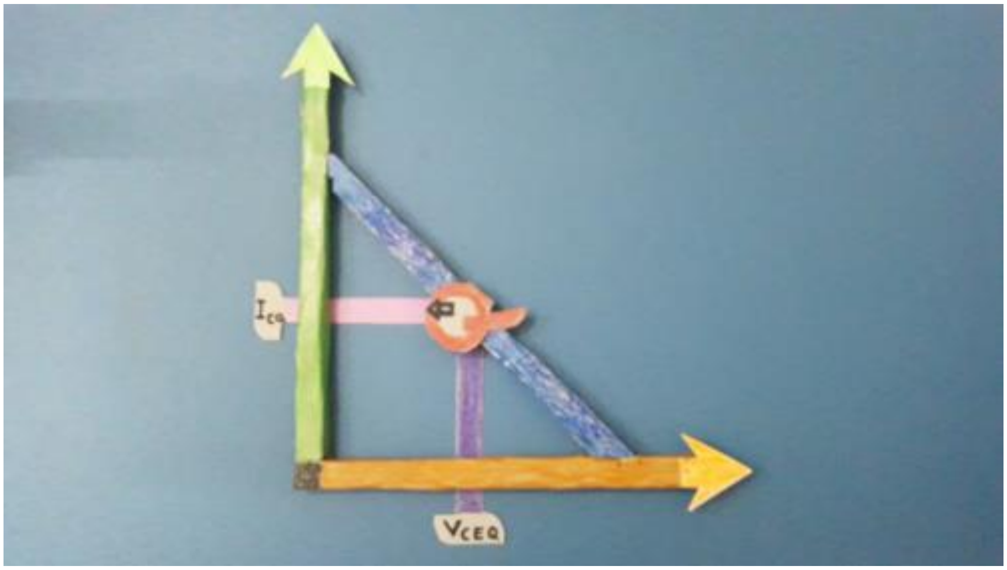


current I(c) which flo ws as a result of input.

The Y-axis or the horizontal axis line represents the conduction angle in the above figure. It is clearly evident from the above figure that collector current I(c) flows for 360 degree of the input signal. Thus the amplifier is always in ON state as a result of which efficiency of a class A amplifier is very poor, about 25 to 30 percent. However, the gain of such an amplifier is high because of this reason. Class A Amplifier serves as a linear amplifier as the output is a copy (amplified copy to be more precise) of input signal. However, it should be noted that the transistor working should never be pushed towards saturation or cut-off due to input signal. If this happens for some reason you would get output waveform with flat peaks.



The circuit shown in the above figure is that of a Common-Emitter class A amplifier. Aha! so you can relate it with the general amplifier whose working you already understood in the beginning of this article. Yes, it's very much the same with some minor changes which I will describe now. First of all the biasing resistors R1 and R2 are replaced by a single variable resistor R(b). R3 is renamed as R(c). R4 and bypass capacitor are fired from their job and are unemployed here. The working principle is same as the general amplifier, already explained well earlier. The Q point that slides in the load line otherwise is brought to it's centre by adjusting the R(b).



The above model shows the load line with Q point at it’s centre. V(CEQ) is pretty much the same as V(CE) in terms of it’s behaviour, with the only difference being that it’s more of a specific kind of value than rather being a range of values. The same is true for I(CQ) and I(C) as well.

Characteristics of Class A Amplifier

It’s a low distortion type amplifier having very low efficiency but high gain. When there’s a cut-off in the transistor, the Collector-Emitter region behaves as open while in case of saturation the same Collector-Emitter region behaves as short.

Calculations in a Class A Amplifier

The biasing base current is given by the formula
I(B) = (DC Input Voltage – V(BE))/R(b)

I(C) = I(B) × DC current gain

V(CE) = DC Input Voltage – (I(C) × R(c))

Voltage gain = V(out)/V(in)

Applications of Class A Amplifier in Real World

1. Voltage amplifier.
2. Current amplifier.
3. Power amplifier.