Amplifiers are devices used in electronics, to improve or multiply the strength of a signal. Depending on the requirements amplifiers are used to increase the voltage of the signal or the current of the signal or the power of the signal. Generally amplifiers are 3 port devices, with an input port, an output port and a power supply port. Generic operation of an amplifier is to produce a strengthened version of the input signal at the output, consuming the power from the power supply. The ratio between the output signal and the input signal of a property such as voltage, current or power is referred to as Gain. For example, ratio between output voltage and the input voltage is the Voltage gain of the amplifier $GAIN_{voltage} = V_{out} / V_{in}$, and similarly $GAIN_{power} = P_{out} / P_{in}$. For linear operation of an amplifier, as required in most cases, the gain values have to be constant in the region of operation.

Voltage Amplifier

Voltage amplifiers are devices that amplify the input voltage, if possible with minimal current at the output. Technically, an amplifier with high voltage gain is a voltage amplifier, but it may or may not have a low current gain. The power gain of an amplifier is also low due to these properties. Transistors, and op amps, given proper biasing and other conditions, act as basic voltage amplifiers. The main application of voltage amplifiers is to strengthen the signal to make it less affected by noise and attenuation. When transmitted signals lose its strength and get deformed, an amplification of the voltage at the transmitter will minimize the effect and receiver will be able to capture and interpret the signal with reasonable accuracy.

Ideal voltage amplifiers have infinite input impedance and zero output impedance. In practice, an amplifier with high input impedance relative to the output impedance is considered as a good voltage amplifier.

Power Amplifiers

Power amplifiers are devices to amplify the input power, if possible with minimal change in the output voltage with respect to the input voltage. That is, power amplifiers have a high power gain, but the output voltage may or may not change. The amplifier efficiency of power amplifiers is always lower than 100%. Therefore, high heat dissipation is observed at power amplification stages. Power amplifiers are used in devices which require a large power across the loads. In multi stage amplifiers, power amplification is made in the final stages of amplification. Audio amplifiers and RF amplifiers use power amplifiers at the final stage to deliver sufficient power the load. Servo motor controllers also use power amplifiers to drive the motors. Power amplifiers are classified into several classes depending on the fraction of the input signal used in amplification. Classes A, B, AB and C are used in analog circuits, while classes D and E are used in switching circuits.

In modern electronics, most power amplifiers are constructed with semiconductor based components while, vacuum tube (valve) based amplifiers are still used in environments, where precision, frequency response, and endurance are a primary requirement. For example, guitar amplifiers use valves for quality and military equipment use valves for its endurance against strong electromagnetic pulses.

Difference between Voltage amplifier and Power Amplifier

Voltage Amplifier	Power Amplifier
In voltage amplifier the amplitude of input A.C signal is small.	In power amplifier the amplitude of input A.C signal is large.
In voltage amplifier the collector current is low, about 1 mA.	In power amplifier the collector current is very high above greater than 100mA.
The transistor used can dissipate less heat produced during its operation.	The transistor used can dissipate more heat produced as compared to voltage amplifier during its operation.
RC coupling is used in voltage amplifier.	In power amplifier invariably transformer coupling is used.
The transistor used has thin base to handle low current.	The transistor used has thick base to handle large current.
In voltage amplifier the A.C power output is low.	In power amplifier the A.C power output is high.
The physical size of transistor used is usually small and is known as low or medium power transistor.	The physical size of transistor used is usually large and is known as power transistor.
In voltage amplifier the collector load has high resistance, typically 4kΩ to 10kΩ.	In power amplifier the collector load has low resistance, typically 5Ω to 20Ω.

VOLTAGE AMPLIFIER

- voltage amplifier increase only the voltage level of signal.
- it is small signal amplifier.
- as compared to power amplifier less heat generates as it minimizes the current at some extent.
- simple BJTs are used.

CURRENT AMPLIFIER

- whereas current amplifier increase current which results to increase the power.
- it is large signal amplifier.
- also called power amplifier.
- more heat generation so more power dissipation(due to increase in power).
- Special power BJTs are used.

Generally, large signal or power amplifiers are used in the output stages of audio amplifier systems to drive a loudspeaker load. A typical loudspeaker has an impedance of between 4Ω and 8Ω, thus a power amplifier must be able to supply the high peak currents required to drive the low impedance speaker.

Classes of Amplifiers

There are different types of classes of amplifiers mentioned in the following

- Class A amplifier
- Class B amplifier
- Class C amplifier
- Class D amplifier
- Class AB amplifier
- Class F amplifier
- Class S amplifier
- Class R amplifier

Class A Amplifier

The class A amplifiers are simple designed amplifiers and this amplifier is mostly commonly used amplifiers. Basically, the class A amplifiers are the best class amplifiers because of their low distortion levels. This amplifier is the best in the audio sound system and in most of the sound system use the class A amplifier. The class A amplifiers are formed by the output stage devices which are biased for the class A operation. By comparing the other classes amplifiers to class A amplifier has the highest linearity.

To obtain high linearity and gain in class A amplifier the output of the class A amplifier should be biased ON for all times. Hence the amplifier is said to be as a class A amplifier. The zero signal ideal current in the output stage should be equal to or more than the maximum load current is required to produce more amount of signal.

Advantages

- It eliminates Non-linear distortion
- It has low ripple voltage
- It does not require any frequency compensation
- There is no cross and switching distortions
- There is low harmonic distortion in the voltage and current amplifier

Disadvantages

- The transformers used in this amplifier are bulk and they are high cost
- Its requirement of two identical transistors

Class B Amplifier

The class B amplifiers are the positive and negative halves of the signals, that are allocated to the different parts of the circuits and the output device switched ON and OFF continuously. The basic class B amplifiers are used in two complementary transistors which are FET and bipolar. These two transistors of each half of the waveform with its output are configured in a push-pull type arrangement. Hence the each amplifier only half of the output waveform.

In the Class B amplifier, if the input signal is positive, then the positively biased transistor conduct and the negative transistor is switched OFF. If the input signal is negative, then the positive transistor switches OFF and negative biased transistor turn ON. Hence the transistor conduct half of the time whatever it may be like positive or negative half cycle of the input signal. In the Class B amplifier, if the input signal is positive, then the positively biased transistor conduct and the negative transistor is switched OFF. If the input signal is negative, then the positive transistor switches OFF and negative biased transistor turn ON. Hence the transistor conduct half of the time whatever it may be like positive or negative half cycle of the input signal

Advantages

- Some amount of distortion in the circuit gives the more output per device because of there is no presence of the even harmonics
- The use of push-pull system in the class B amplifier eliminates the even harmonic

Disadvantages

- In the class B amplifier, there is high harmonic distortion
- In this amplifier, there is no need for self bias

Applications

- The class B amplifiers are used in low-cost design
- This amplifier is more significant than the class A amplifier
- The class B amplifier suffers from the bad distortion if the signal level is low

Class AB Amplifier

The class AB is the combination of class A and class B amplifier. The class AB amplifiers are using commonly in the audio power amplifiers. From the diagram the two transistors have the small amount of voltage which is 5 to 10% of the quiescent current and the bias the transistor just above the cutoff point. Then the device may be FET or bipolar will be ON for more than the one-half of the cycle, but it is less than the one full cycle of the input signal. Hence, in the class AB amplifier design each of the push-pull transistors is conducting slightly more than the half cycle of conduction in class B, but much less than the full cycle of conduction of class A.

The conduction angle of Class AB amplifier is in between 1800 to 3600 which is depending on the bias point. The advantage of the small bias voltage is to give in series resistance and diode.

Advantages

- The class AB has a linear behavior
- The design of this amplifier is very simple
- The distortion of this amplifier is less than 0.1%
- The sound quality of this sound is very high

Disadvantages

- The power dissipation of this amplifier generates the heat and requires large amount of heat sink
- This amplifier has low power efficiency and the average efficiency is less than the 50%

Applications

The class AB amplifiers are used in hi-fi systems.

Class C Amplifier

The design of class C amplifier has a great efficiency and poor linearity. In the previous amplifiers, we have discussed the class A, B and AB are the linear amplifiers. The class C amplifier is a deeply biased hence the output current is zero for more than the one-half of the input signal and the transistor idling at the cut off point. Because of the serious audio distortion, the class C amplifiers are high-frequency sine wave oscillation.

Advantages

- The efficiency of Class C amplifier is high
- In class C amplifier the physical size is low for the given o/p power

Disadvantages

- The linearity of Class C amplifier is low
- The class C amplifiers are not used in the audio amplifiers
- The dynamic range of the class c amplifier is decreased
- The class C amplifier will produce more RF interfaces

Applications

This amplifier is used in the RF amplifiers

Class D Amplifier

The class D amplifier is non-linear switching amplifiers or PWM amplifiers. This amplifier can reach 100% efficiency in theoretically and there is no period during the cycle. The voltage and the current waveforms overlap current is drawn only with the help of transistor which is in ON state. These amplifiers are also called as the digital amplifiers

Advantages

- The class D amplifier has more efficiency that is more than 90%
- In the class D amplifiers, there is a low power dissipation

Disadvantages

The design of the class D amplifier is more complex than the class AB amplifier.

Applications

- This amplifier is used in the sound cards of the mobile devices and personal computers
- These amplifiers are used in cars of audio subwoofer amplifiers.

- Nowadays, in most of the applications, these amplifiers are using.

AMPLIFIER CLASS DESIGNATIONS & PERFORMANCE SUMMARY

AMPLIFIER CLASS	DESCRIPTION	CONDUCTION ANGLE Θ
Class A	Conduction over the full 360° of the cycle	$\theta = 2\pi$
Class B	Conduction occurs over half the cycle, i.e. for 180°	$\theta = \pi$
Class AB	Conduction occurs for slightly more than half the cycle, i.e. slightly more than 360°	$\theta < \theta < 2\pi$
Class C	Conduction occurs for less than 180° of the cycle, but this creates distortion	$\theta < \pi$
Classes D to T	These amplifier classes utilise non-linear switching techniques to improve efficiency.	N/A