POWER AMPLIFIER CIRCUIT DESIGN pdf

1: Electronic Circuit

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 wave form.

The heat sink barely gets warm! Have you always wanted to build your own audio power amplifier? If your answer is yes, then you should continue reading this article on how to build your own Class D amplifier. I will explain to you how they work and then guide you step by step to make the magic happen all by yourself. Theoretical Basics What is a Class-D audio power amplifier? The answer could be just a sentence long: It is a switching amplifier. Traditional amplifiers, like the class AB, operate as linear devices. For comparison, the class B amplifier can only achieve a maximum efficiency of Below you can see the block diagram of a basic PWM Class-D amplifier, just like the one that we are building. This basically means that the input is encoded into the duty cycle of the rectangular pulses. The rectangular signal is amplified, and then a low-pass filter results in a higher-power version of the original analog signal. Pulse-Width Modulation Using a Comparator In the plot below, you can see how we transform a sinusoidal signal the input into a rectangular signal by comparing it to a triangle signal. The actual frequency of the triangle signal is much higher, on the order of hundreds of kHz, so that we can later extract our original signal. A real filter, not an ideal one, does not have a perfect "brick-wall" transition from passband to stopband, so we want the triangle signal to have a frequency at least 10 times higher than 20KHz, which is the upper human hearing limit. Two issues are the rise and fall time of the devices in the power stage and the fact that we are using an NMOS transistor for the high-side driver. Low-Pass Filter For the filtering stage, one of the best ways to do this is to use a Butterworth filter. These types of filters have a very flat response in the passband. This means that the signal that we want to achieve will not be attenuated too much. It is best to choose something between 40 and 60 kHz. These are the formulas used to calculate the values of the inductor and the capacitor: Below you can see the schematic of the amplifier that I designed. Click to enlarge I will now tell you some design choices and how the components work with each other. Input Circuitry For the input circuitry, I decided that it was best to use a high-pass filter followed by a low-pass filter. It is that simple. The values of the resistor and the capacitor set a frequency of approximately kHz. Any higher than this and we will run into trouble because the comparator and the MOSFET driver are not the fastest devices. Comparator For the comparator, you can use whichever component you wantâ€”it just needs to be fast. If you want to use other ICs, just be careful to check that the pins match or you will have to modify the PCB design. In theory, an op-amp can be used as a comparator, but in reality op-amps are designed for other types of work, so make sure you use an actual comparator. Because we need two outputs from the comparator, one for the high-side driver and one for the low-side driver, I decided to use the LMAP. These devices may offer somewhat improved performance, but they could also be more expensive. An alternative is the IR, which is used in the reference design. This integrated circuit makes sure to add that dead time that I talked about in the previous section. Because the VSS pin of the IC is tied to the negative power supply, we need to level shift the signals from the comparator. This is done using PNP transistor and 1N diodes. This requires a voltage that is higher than the positive supply; the IR provides this drive voltage with the help of our bootstrap capacitor, C Filter Finally the filter. The cut-off frequency is 40kHz, and the load resistance is 4 ohms because we have a 4-ohm speaker the values used here will also work with an 8-ohm speaker, but it is best to adjust the filter according to the speaker you choose. With this information we can calculate the values of the inductor and the capacitor: The rest of the capacitors in the design also need to have an appropiate voltage rating. I designed this amplifier for an output power of about W.

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2: Amplifier - Wikipedia

A power amplifier circuit is the one with minimum output impedance, used to drive loads like a speaker, which require high power at low impedance. Here we designed a power amplifier circuit using push pull class AB configuration to derive a power of W to drive a load of 8 Ohms (speaker).

Power amplifier by Skyworks Solutions in a Smartphone. A power amplifier is an amplifier designed primarily to increase the power available to a load. In practice, amplifier power gain depends on the source and load impedances , as well as the inherent voltage and current gain. A radio frequency RF amplifier design typically optimizes impedances for power transfer, while audio and instrumentation amplifier designs normally optimize input and output impedance for least loading and highest signal integrity. Efficiency considerations lead to the various classes of power amplifier based on the biasing of the output transistors or tubes: Audio power amplifiers are typically used to drive loudspeakers. They will often have two output channels and deliver equal power to each. An RF power amplifier is found in radio transmitter final stages. A Servo motor controller: Operational amplifiers op-amps [edit] Main articles: Operational amplifier and Instrumentation amplifier An operational amplifier is an amplifier circuit which typically has very high open loop gain and differential inputs. Op amps have become very widely used as standardized "gain blocks" in circuits due to their versatility; their gain, bandwidth and other characteristics can be controlled by feedback through an external circuit. Though the term today commonly applies to integrated circuits, the original operational amplifier design used valves, and later designs used discrete transistor circuits. A fully differential amplifier is similar to the operational amplifier, but also has differential outputs. Distributed amplifier These use balanced transmission lines to separate individual single stage amplifiers, the outputs of which are summed by the same transmission line. The transmission line is a balanced type with the input at one end and on one side only of the balanced transmission line and the output at the opposite end is also the opposite side of the balanced transmission line. The gain of each stage adds linearly to the output rather than multiplies one on the other as in a cascade configuration. This allows a higher bandwidth to be achieved than could otherwise be realised even with the same gain stage elements. Switched mode amplifiers[edit] These nonlinear amplifiers have much higher efficiencies than linear amps, and are used where the power saving justifies the extra complexity. Class-D amplifiers are the main example of this type of amplification. Certain requirements for step response and overshoot are necessary for an acceptable TV image. They typically can amplify across a broad spectrum of frequencies; however, they are usually not as tunable as klystrons. Klystrons are designed for large scale operations and despite having a narrower bandwidth than TWTAs, they have the advantage of coherently amplifying a reference signal so its output may be precisely controlled in amplitude, frequency and phase. The maser is a non-electronic microwave amplifier. Musical instrument amplifiers[edit] Instrument amplifiers are a range of audio power amplifiers used to increase the sound level of musical instruments, for example guitars, during performances. Classification of amplifier stages and systems[edit] Common terminal[edit] One set of classifications for amplifiers is based on which device terminal is common to both the input and the output circuit. In the case of bipolar junction transistors , the three classes are common emitter, common base, and common collector. For field-effect transistors , the corresponding configurations are common source, common gate, and common drain; for vacuum tubes , common cathode, common grid, and common plate. The common emitter or common source, common cathode, etc. The common collector arrangement applies the input voltage between base and collector, and to take the output voltage between emitter and collector. This causes negative feedback, and the output voltage tends to follow the input voltage. This arrangement is also used as the input presents a high impedance and does not load the signal source, though the voltage amplification is less than one. The common-collector circuit is, therefore, better known as an emitter follower, source follower, or cathode follower. The input impedance of a unilateral amplifier is independent of load, and output impedance is independent of signal source impedance. Bilateral amplifier input impedance depends on the load, and output impedance on the signal source impedance. All amplifiers are bilateral to some degree; however they may often be modeled as unilateral under operating conditions

where feedback is small enough to neglect for most purposes, simplifying analysis see the common base article for an example. Inverting or non-inverting[edit] Another way to classify amplifiers is by the phase relationship of the input signal to the output signal. An emitter follower is a type of non-inverting amplifier, indicating that the signal at the emitter of a transistor is following that is, matching with unity gain but perhaps an offset the input signal. Voltage follower is also non inverting type of amplifier having unity gain. This description can apply to a single stage of an amplifier, or to a complete amplifier system. Function[edit] Other amplifiers may be classified by their function or output characteristics. These functional descriptions usually apply to complete amplifier systems or sub-systems and rarely to individual stages. A servo amplifier indicates an integrated feedback loop to actively control the output at some desired level. A DC servo indicates use at frequencies down to DC levels, where the rapid fluctuations of an audio or RF signal do not occur. These are often used in mechanical actuators, or devices such as DC motors that must maintain a constant speed or torque. An AC servo amp. A linear amplifier responds to different frequency components independently, and does not generate harmonic distortion or intermodulation distortion. No amplifier can provide perfect linearity even the most linear amplifier has some nonlinearities, since the amplifying devicesâ€" transistors or vacuum tubes â€"follow nonlinear power laws such as square-laws and rely on circuitry techniques to reduce those effects. A nonlinear amplifier generates significant distortion and so changes the harmonic content; there are situations where this is useful. Amplifier circuits intentionally providing a non-linear transfer function include: Following such an amplifier with a so-called tank tuned circuit can reduce unwanted harmonics distortion sufficiently to make it useful in transmitters , or some desired harmonic may be selected by setting the resonant frequency of the tuned circuit to a higher frequency rather than fundamental frequency in frequency multiplier circuits. The non-linearities are assumed arranged so the relatively small signal amplitude suffers from little distortion cross-channel interference or intermodulation yet is still modulated by the relatively large gain-control DC voltage. Operational amplifier comparator and detector circuits. A wideband amplifier has a precise amplification factor over a wide frequency range, and is often used to boost signals for relay in communications systems. A narrowband amp amplifies a specific narrow range of frequencies, to the exclusion of other frequencies. An RF amplifier amplifies signals in the radio frequency range of the electromagnetic spectrum , and is often used to increase the sensitivity of a receiver or the output power of a transmitter. This category subdivides into small signal amplification, and power amps that are optimised to driving speakers , sometimes with multiple amps grouped together as separate or bridgeable channels to accommodate different audio reproduction requirements. Frequently used terms within audio amplifiers include: Power amplifier normally drives loudspeakers , headphone amplifiers, and public address amplifiers. Stereo amplifiers imply two channels of output left and right , though the term simply means "solid" sound referring to three-dimensional â€"so quadraphonic stereo was used for amplifiers with four channels. Buffer amplifiers , which may include emitter followers , provide a high impedance input for a device perhaps another amplifier, or perhaps an energy-hungry load such as lights that would otherwise draw too much current from the source. Line drivers are a type of buffer that feeds long or interference-prone interconnect cables, possibly with differential outputs through twisted pair cables. Interstage coupling method[edit] See also: Different types of these include: Resistive-capacitive RC coupled amplifier, using a network of resistors and capacitors By design these amplifiers cannot amplify DC signals as the capacitors block the DC component of the input signal. RC-coupled amplifiers were used very often in circuits with vacuum tubes or discrete transistors. In the days of the integrated circuit a few more transistors on a chip are much cheaper and smaller than a capacitor. Inductive-capacitive LC coupled amplifier, using a network of inductors and capacitors This kind of amplifier is most often used in selective radio-frequency circuits. Transformer coupled amplifier, using a transformer to match impedances or to decouple parts of the circuits Quite often LC-coupled and transformer-coupled amplifiers cannot be distinguished as a transformer is some kind of inductor. Direct coupled amplifier , using no impedance and bias matching components This class of amplifier was very uncommon in the vacuum tube days when the anode output voltage was at greater than several hundred volts and the grid input voltage at a few volts minus. So they were only used if the gain was specified down to DC e. In the context of modern electronics developers are encouraged to use directly

coupled amplifiers whenever possible. Therefore, DC component of the input signals is automatically filtered. Frequency range[edit] Depending on the frequency range and other properties amplifiers are designed according to different principles. Frequency ranges down to DC are only used when this property is needed. Amplifiers for direct current signals are vulnerable to minor variations in the properties of components with time. Depending on the frequency range specified different design principles must be used. Up to the MHz range only "discrete" properties need be considered; e. For example, a specified length and width of a PCB trace can be used as a selective or impedance-matching entity. Above a few hundred MHz, it gets difficult to use discrete elements, especially inductors. In most cases, PCB traces of very closely defined shapes are used instead stripline techniques. Power amplifier classes[edit] Main article: Power amplifier classes Power amplifier circuits output stages are classified as A, B, AB and C for analog designsâ€”and class D and E for switching designs. The power amplifier classes are based on the proportion of each input cycle conduction angle during which an amplifying device passes current. The angle of flow is closely related to the amplifier power efficiency. Example amplifier circuit[edit] A practical amplifier circuit The practical amplifier circuit to the right could be the basis for a moderate-power audio amplifier. It features a typical though substantially simplified design as found in modern amplifiers, with a class-AB pushâ€”pull output stage, and uses some overall negative feedback. Bipolar transistors are shown, but this design would also be realizable with FETs or valves. The input signal is coupled through capacitor C1 to the base of transistor Q1. The capacitor allows the AC signal to pass, but blocks the DC bias voltage established by resistors R1 and R2 so that any preceding circuit is not affected by it. Q1 and Q2 form a differential amplifier an amplifier that multiplies the difference between two inputs by some constant , in an arrangement known as a long-tailed pair. This arrangement is used to conveniently allow the use of negative feedback, which is fed from the output to Q2 via R7 and R8. The negative feedback into the difference amplifier allows the amplifier to compare the input to the actual output. The amplified signal from Q1 is directly fed to the second stage, Q3, which is a common emitter stage that provides further amplification of the signal and the DC bias for the output stages, Q4 and Q5. R6 provides the load for Q3 a better design would probably use some form of active load here, such as a constant-current sink. So far, all of the amplifier is operating in class A. The output pair are arranged in class-AB pushâ€”pull, also called a complementary pair. They provide the majority of the current amplification while consuming low quiescent current and directly drive the load, connected via DC-blocking capacitor C2. The diodes D1 and D2 provide a small amount of constant voltage bias for the output pair, just biasing them into the conducting state so that crossover distortion is minimized.

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3: power amplifier circuit design | All About Circuits

Amplifier is the generic term used to describe a circuit which produces and increased version of its input signal. However, not all amplifier circuits are the same as they are classified according to their circuit configurations and modes of operation.

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 wave form. 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. 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 heatsink. Class A power amplifier circuit. 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. This is the reason behind the transistor being ON irrespective of the input signal amplitude. Capacitor Cin is the input decoupling capacitor which removes the DC components present in the input signal. If Cin 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. Rc is the collector resistor and Re 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. Cc 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. Ce is the emitter by-pass capacitor whose function is to by-pass the AC components in the emitter current while amplifier is operating. If Ce 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 Re will get added to the base-emitter voltage and this means additional forward voltage is required to forward bias the transistor. Cout is the output coupling capacitor which couples the output to the load loud speaker. Cout blocks the DC components of the second stage from entering the load loud speaker. The Coupling capacitor Cout, Cin and Cc 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. 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. Transformer coupled Class A power amplifier. The coupling transformer provides good impedance matching between the output and load and it is the main reason behind the improved efficiency. Impedance matching means making the output impedance of the amplifier equal to the input impedance of the load and this is an important criteria for the transfer of maximum power. Circuit diagram of typical single stage Class A amplifier is shown in the circuit diagram below. Main advantage is the improvement of efficiency. Provides good DC isolation as there is no physical connection between amplifier output and load. Audio signals pass from one side to other by virtue of induction. Disadvantages of transformer coupled amplifier. Transformers are bulky and so it increases the cost and size of the amplifier. Transformer winding

does not provide any resistance to DC current. If any DC components if present in the amplifier output, it will flow through the primary winding and saturate the core. This will result in reduced transformer action. Transformer coupling reduces the low frequency response of the amplifier. Transformer coupling induces hum in the output. Transformer coupling can be employed only for small loads.

4: The Simplest Audio Amplifier Circuit Diagram

For low power amplifier, I think a different design would be better. If you are using a transformer (I recommend toroidal because of their size), and not a SMPS, you will need a bridge rectifier and some beefy filtering caps (I personally used 2x10 uF per branch - positive/negative).

5: A Complete Guide to Design and Build a Hi-Fi LM Amplifier - Circuit Basics

2 M. Tse: Power Amplifier Design 3 Scattering Parameters When a wave arrives at a circuit, its energy is being "scattered" and partitioned into.

6: Audio Power amplifier (30W) - Amplifier Circuit Design

In this tutorial, I'll go step by step through the amplifier design process as I build a 40 Watt stereo amplifier using the LM I'll explain what each part of the circuit does, and show you how to calculate the right component values with examples from the amplifier I'm building.

7: How to Build a Class-D Power Amp

This is the circuit design of 21W class AB audio amplifier uses power transistors as the main part. It is a simple design, and simple to set up. Set the 10k trimmer to about half way and the ohm trimmer to 0 resistance.

8: Amplifier Circuits

This video will provide a foundation for understanding how power amplifier circuits work. If you are new to High-Frequency Power Amplifier Circuit Design, this is the place to start.

9: Class A Power Amplifier Circuit - Theory | Design | Circuit Diagram

The following circuit uses LM audio amplifier capable of delivering up to 30W RMS power into 8 ohm speakers with a total harmonic distortion (THD) 1%.. Note: The LM integrated circuit should be installed on the heatsink to dissipate heat properly.

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