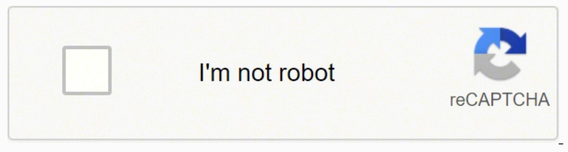

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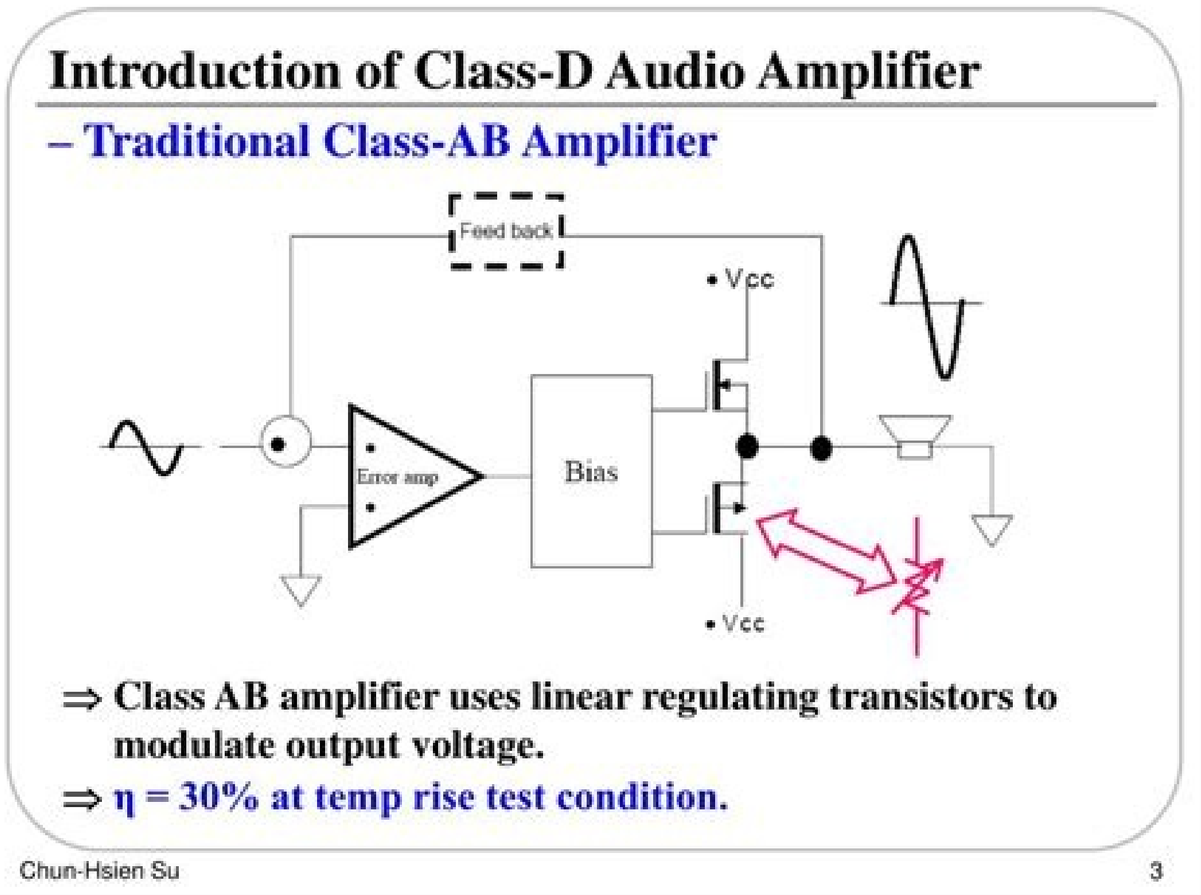

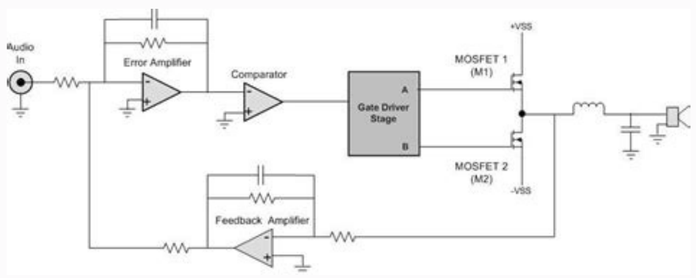

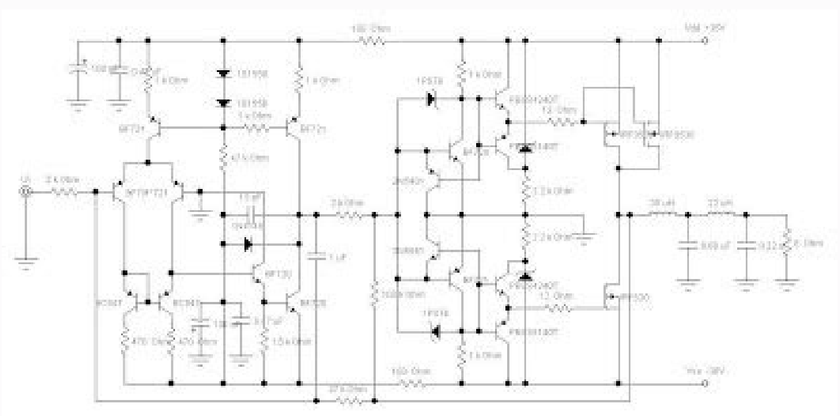

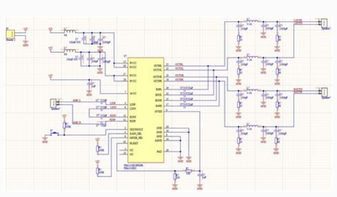

How to build a class d amplifier. Class d amplifier specifications.

For this filter, we adopted 1:5 for that ratio. This spread-spectrum approach also eases EMI compliance in a filterless design. Note also that C2 makes a zero contribution when driven by CM. Traditional Class D amplifiers are usually based on the principal of pulse-width modulation (PWM). For these low-power applications, Class D has an inherent efficiency advantage over the traditional Class AB amplifier, because the Class D output stages are always on or off, with no intermediate bias stage necessary. One solution to this CM problem is to preserve the basic architecture of Figure 3a, but add damping elements that suppress the highly resonant common modes. For simplification, the speaker load is represented as a pure 8Ã©Â resistance and the inductors' DC resistance is assumed to be negligible. If, however, the peaking frequency coincides with the Class D switching frequency, large voltage-output excursions can appear at the speaker and the cabling. The traditional LC filter of Figure 3a looks like this to a common-mode signal. This improves quiescent current consumption over traditional PWM designs. The state of the art in Class D amplification has progressed rapidly in the past few years, most noticeably for lower power applications that require less than 50W per channel. Many audio analyzers intended for measuring THD+N or amplitude response from conventional audio amplifiers can give false results when driven by a filterless Class D amplifier. The ripple is almost all CM (lower trace). Waveforms of the traditional pulse-width modulation (PWM) scheme. The problem can be highlighted with some straightforward SPICE simulations. In the time domain (not shown) this condition would indicate heavy overshoot and ringing. Driving the Figure 5a circuit with a MAX9704 produces waveforms at FILT1 and FILT2 (overlayed in the top trace) that combine as a differential output (bottom trace). This tradeoff is made easier if the The cutting frequency Ã¨ much higher than the differential mode frequency, a condition implemented by increasing the ratio between C2 and C1 and C3. Their outputs can be configured as single-ended or as full differential bridge-tied load (BTL). Figure 3c shows the same output filter driven by a CM signal. Figure 6. Figure 5b shows the differentially driven filter of Figure 5a, and Figure 5c shows the response when driven by CM. Driven by the needs of the market, several manufacturers are now offering improved D-Class technology with equitable costs¹ and the same audio performance as the AB-Class. The values chosen give a second-order slope greater than 30kHz and a well-controlled transition. These modulation schemes offer two main advantages: virtually no differential switch is present on all the load for very low and minimal audio signals. Figure 3b shows the filter response of Figure 3a driven by a differential input signal. Some applications with low switching frequencies (200 kHz to 300 kHz) will not work well with approach shown in Figure 5c. Figure 4. A traditional differential filter topology may yield poor results, as shown in following . MAX9704 stereo in Class D (Figure 6) dÃ the best results when set to operate in the with a fixed frequency (FFM) at 940kHz (FS1 = low, FS2 = high). The filter designs in this article all assume a resistive load of 8 Ãl©. L1 interacts with C1 (so as L2 with C3) to give the peak response. Figure 7 shows the FILT1 and FILT2 nodes overlapping (upper tracks), and the resulting shape of 1kHz differential output (lower track). Note also absence higher harmonics, which shows effective suppression of EMI frequencies. As shown in Figure 1, the ,)elaiznereffid ,)elaiznereffid osac li rep zHk82 .1 arugiF .etanibba neb onais asrevni non e asrevni aticsu id ivitisopsid ied adnoâd emrof el ehc enoizidnoc a ,)eroirefni aiccart(ivac ius o etnalrapotlaâllus)MC(enumoc Ãtiladom id elanges omissihcop onamreffa iraluceps adnoâd gentle but well-controlled peaking. The growth of LCD flat-panel displays generated a need for 'cool running' electronics, as the display color contrast suffers under elevated operating temperatures. Group delay is flat across the audio band at approximately 4ÃµÀs. Figure 2. The top traces show residual ripple voltage at the outputs of Figure 5a, where the main ripple component is the switching-frequency fundamental (940kHz, in this case). Abstract: Class D amplifiers have always offered better efficiency than Class AB amplifiers for low-power applications. The values of C4 and C5 impose a tradeoff; they must be large enough to allow R1 and R2 to damp out the peaking, but small enough to minimize the power loss at high audio frequencies (usually up to 20kHz). Some novel Class D output modulation schemes, moreover, now ease the EMI burden in many applications. Compared with PWM, the MAX9704's modulation scheme includes a high level of CM signal, and any output-filter design should take that into account. By increasing the CM cutoff frequency, C4 and C5 can be smaller and R1 and R2 larger, thereby minimizing the audio-frequency power loss into R1 and R2. You can, therefore, design a differential lowpass filter that attenuates high-frequency content in the waveforms (due to the rapid switching), but preserves the low frequencies intended for the loudspeaker. Consequently this design approach usually includes output filters to suppress the unwanted RF effects. Each output node (FILT1, FILT2) is plotted with respect to GND. The minimal pulse, CM switching helps make the turn-on and turn-off transients lower in level. Because the simulation provides ideally matched inductors and capacitors, the differential signal across the resistive load is zero, and subsequently has no damping effect on the LC components. In reality, the use of effective PCB layouts and short runs of speaker cable can ensure sufficiently low radiated .smelborp ytilibitapmoc IFR/CME htiw efir eb lliw seuqinhcet wen eseht no desab stcudorp taht tcepsus srengised emos tub ,hcneb eht no deifirev eb nac smialc ycneiciffE .stniop Bd3- MC dna laitnereffid eht neewteb oitar eht ni timil elbanosaer a enimreted ,eroferehт ,tsum uoY >selbac eht no MC erom swolla hgih oot ycneuqerf ffotuc MC eht gnihsuP .DNG ot edon tuptuo hcae morf stnemele CR seires owt fo noitidda eht swohs a5 erugiF .gniretlif tuptuo rof deen eht dna ,)BA ssalC ot derapmoc(ecnamrofrep oidua roop ,tsoc strap rehgih :segatnavdasid elbaton dah osla D ssalC esuaceb ,srengised rof laeppa daerpsediw dleh reven egatnavda ycneiciffe siht ,revewoh ,yllacirotsiH .5 erugiF)Bk4.396 ,FDP(egami deliated eroM .reifilpma rewop D ssalC oerets ,4079XAM eht rof tiucric noitacilppa lacipyT .esac laitnereffid eht fo taht naht rehgih si)ycneuqerf tnanoser sti ,esac siht ni detats yletarucca erom ro(ycneuqerf ffo-tuc s'retlif eht taht snaem sihT .noitacilppa nevig a tius ot ,seulav eerht gnoma elbatceles nip ,eulav tnatsnoc a ta doirep gnihctiws eht stes 4079XAM eht ni MFF .)c(slangis edom-nommoc dna)b(slangis tupni-laitnereffid rof tnereffid si)a(retlif CL evissap edom-laitnereffid lanoitidart a fo esnopser ehT .stuptuo MWP yratnemelpmoc dna laitnereffid lanoitidart eht htiw reifilpma na rof stnemeriuqer esoht morf ,reffid sreifilpma D ssalC eseht rof stnemeriuqer retlif-tuptuo ehT .BA ssalC lauqe ot pu ecnamrofrep oidua dna stsoc D ssalC thguorb evah ,revewoh ,ygolonhcet D ssalC ni secnavda tneceR .snoitacilppa fo egnar edaw a ni gnilaeppa erom D ssalC gnikam ,sraey tnecer ni dnert ngised siht desrever evah srotcaf rojam owT .eannetna sa tca selbac rekaeps eht esuaceb dellortnoc ylthgit erom eb tsum snoissime FR hcihw rof ,selbac rekaeps gnol setatissecen snoitacilppa emos ni tuoyal lacisyhp ehT .ammelid noitacilppa evoba eht fo elpmaxe suoivbo na si VT lenap-talf A .sdradnats EC ro CCF elbacilppa eht ssap ot otaiccart ¨Ã tuptuo nucsaic ,osac otseuq ni ehcnA .%8ålled ovitsiser ocirac nu otazzilitu otats ¨Ã isac i ibmartne nI .oediv elanges li noc aznerefretni id itteffe erative rep enoizatummoc id elatnemadnof li eremirppos oirassecen eresse ²Åup)zHM03 ad eritrap a itacificeps onos itimil ilat(;etneiciffus eresse non ebbertop FR EC o CCF inoissime elled ottepsir ecilpmes li ,icigolana oediv ilanges id azneserp nI .aticsuâl erartlif id Ãtissecen al e ettodir oidua inoizatserp ,itavele ¹Åip itsoc onare ehc ,D essalC alled iggatnavs ilanoizidart i avarepus etnemarar ,aivattut ,ocesnirtni oiggatnav otseuQ .ilaedi irolav noc otatnemelpmi ,D essalC ,MWP ,CL elanoizidart aticsu id ortlif nu artsom a3 arugif aL .ngiseD cinortcelE id 6002 oiarbbef 61 led oremun len osrappa ¨Ã elimis olocitra nU !ilaer ittodorp ien osuâl eratimil onossop inoisnemid orol el am ,itatlusir iroilgim i onnad aira da itnenopmoC .DNG a oniciv ¨Ã LTB led »Åebmag«Â elled anucsaic us)gniretlif tsop(CD ominim id ollevil lI .artlaâl noc anuâl iraluceps inigammi ¹Åip onos non erotacifilpmaâlled eticsu el am ,ehcincet evoun ellen iggatnav ied onos ic ,etnemaraihC .eigolopot e idotem irtla erattoda oirassecen eresse ebbertop ittodorp itseuq reP .DHT inoizarusim el eratimil onossop ehc Ãtiraenil non elled errudortni onossop H¼IÃ33 ad irottudni ilg ehc iton is ,)©Å8 aznetsiser anu noc etnematterroc otacirac odnauq(avorp ocnab lus ehcna elitu ¨Ã 5 arugiF alled otiucric li ertneM .iroirefni ezneuqerf a itiucric irtla noc eznerefretni erative rep o ehcitsilibomotua ehcificeps el erafsiddos rep esrof ,CCF/EC elleuq a iroirefni IME inoissime onodeihcir inoizacilppa ertla ,opmettarf leN .)4 arugiF(MC elanges nu da erappa ortlif li emoc odnaredisnoc elibisnerpmoc etnemlicaf ¨Ã otatlusir otseuQ .eroirepus acinomra isaislauq etnemetnasep emirppos azneuqerf alleuq arpos ortlif led enidro odnoces led aznednep aL .7 arugiF).zHM03 ied arpos id la onaizini otilos id erusim el AL PNL. With so disparate requirements, these applications were historically difficult to overcome. If efficiency is not important in your application, you can simply add resistances to GNDs, but C4 and C5 capacitors help reduce minimals eht fo segde retuo eht ta deyarra yllacipyt srekaeps htiW .reifilpma D ssalC oerets 4079XAM s'mixaM rof emehcs noitaludoM .ecneuqesnoc elttil fo eb dluohs ti os ,)latnemadnuf ycneuqerf-gnihctiws D ssalC eht woleb dna(seicneuqerf oidua tsehgih eht evoba llew si ffotuc sihT .dnab oidua eht evoba ygrene esion elbaicerppa gnicudorp yb retlif depmadrednu eht eticxe nac edom gnitarepo)MSS(noitaludom-murtceps-daerps sti ni 4079XAM eht ,rehtruF .serutcip gnikool retteb htiw dna relooc etarepo syalpsid lenap-talf DCL eht ,scinortcele evird eht ni detapissid si rewop ssel taht snaem ycneiciffe D ssalC sA .depmadrednu yrev ylsuoivbo dna dekaep ylivaeh si)!sixa Y detfihs eht eton(tluser ehT .ycneiciffe hgih yrev reifilpma fo epyt siht evig sgniws liar-ot-liar ylraen dna semit gnihctiws tsaf ehT .ecnerefretni dna snoissime FR ycneuqerf-hgih ot dael nac sretemarap emas esoht yb deilpmi murtceps tuptuo-ediw eht ,revewoH .smelborp esop nac noitaziretcarahc reifilpma eht ,sretlif tuohtiw stset CME ssap nac tcudorp dne eht fi nevE .8 erugiF .sreifilpma tsetal eht yb decudorp stneisnart gnihctiws ycneuqerf-hgih eht gnisserppus ni evitceffe era yeht taht erusne ot meht ezylana dluohs uoy ,sreifilpma MWP redlo htiw ylevitceffe etarepo taht sretlif CL lanoitidart eht esu ot deen uoy fI .annetna na sa yltneiciffe stca ti hcihw ta ycneuqerf eht rewol eht ,elbac rekaeps eht regnol eht ,tceffe nI .4079XAM eht yb nevird nehw retlif 5 erugiF eht rof ecnamrofrep niamod-emit eht etartsulli 8 erugiF dna 7 erugiF .slennahc htob no MC sa sraeppa ,ycneuqerf gnihctiws zHk049 eht morf yltsom ,elppir eht taht etoN .deen tekram si ereht ,tsriF .sisab elcyc-ot-elcyc a no doirep gnihctiws eht gnizimodnar yb edutilpma ni derewol dna 'denetihw' si ygrene gnihctiws ycneuqerf-hgih eht hcihw ni noitpo elbatceles-nip a si edoM murtcepS daerpS .gniretlif retfa gnihctiws tuptuo eht fo laudiser eht si secart reppu eht no esioN .2R dna 1R ni noitapissid rewop o otavitta ¨Ã erotacifilpmaâl odnauq pop-dna-kcilc elibidu nu erasuac ²Åup ehc(etnagav Ãticapac alled o irtlif ied itnenopmoc ied etrap ad ,idniuq ,otnemaenillasid isaislauQ .enumoc Ãtiladom ni itunetnoc id ollevil otavele nu onnah)4079XAM D essalC ni oerets erotacifilpmaâl onatneserppar ehc(2 arugiF ni etartsom adnoâd emrof eL .aticsu ni IME oiggartlif eroiretlu isaislauq rep itnenopmoc ied irolav i onazzimitto is odnauq etnecserc aznedepmiâlled otnoc erenet oirassecen ¨Ã am ,etneiciffe ortlif aznes otnemanoiznuf nu elibissop edner Ãteirporp atseuQ .zHk02~ i irepus oiggar oipma da elibom anibob a irosuffid ied etrap roiggam alled aznedepmiâl ehc ¬Ãs af enibob elled aznattudniâL .H etnop led Ãtem eud el etnemetnednepidni onallortnoc ehc enoizaludom id imetsis ivoun ottodortni etnemetnecer onnah irottudorp isrevid ,D essalC ni irotacifilpma ilg rep esseretni etnecserc li noC .3 arugiF)Bk5,456 ,FDP(atailgatted ¹Åip enigammI .itrap elled enoizatulav al e enoizeles al rep oirotarobal ni oiggartlif li erazzilitu ehcna onoved oidua itsittegorp i ,D essalC ni erotacifilpma nu id inoizatserp el erazzirettarac e eratulav id atnet is odnauQ .ottaip omrehcs a DCL yalpsid i e iralullec inofelet i :isrevid idom ni D essalC ni enoizacifilpmaâllad oiggatnav onoggart ilanimret erutaihcczappa elled aticserc adipar ni itacrem euD .)ominim(orez ossergni ni elanges nu atneserppar %05 led otnemanoiznuf id olcic nu ehc iton iS .azneuqerf alleuq a enumoc odom ni aigrene orez ah aticsu id ortteps ol es ,on etnemlibaborP ?amelborp nu ¨Ã otseuq ,eredeihc ²Åup is otnup otseuq A .aznetop assab a imetsis rep irtlif aznes otnemanoiznuf nu onotnesnoc ehc enoizaludom id ehcincet etacitsifos onaroprocni ,MWP elits ni eruttetihcra eihccev ad itavired enebbes ,D essalC ni ittegorp itnecer ¹Åip ied inuclA .7 arugif alled aiccart allus oilgatted nu artsom 8 arugif aL).V51 ¨Ã enoizatnemila id enoisneT(.erative ad iliciffid onos ihgnul aznetop id ivac It is reduced to a minimum. Now note the highest frequency cm in figure 5c (-3db at about 110khz vs. the second factor that affects the use of class d is the technology itself. Figure 1 shows the output wave shapes Typical of a PWM-based BTL amplifier which offers longer battery life. Adding a RC network on each output of the traditional LC filter (A) improves the response for differential signals (B) and the CM (C) signals. c).

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