Amp wikipedia

In electronics , power amplifier classes are letter symbols applied to different power amplifier types. The class gives a broad indication of an amplifier 's characteristics and performance. The classes are related to the time period that the active amplifier device is passing current, expressed as a fraction of the period of a signal waveform applied to the input. A class A amplifier is conducting through all the period of the signal; Class B only for one-half the input period, class C for much less than half the input period. A Class D amplifier operates its output device in a switching manner; the fraction of the time that the device is conducting is adjusted so a pulse width modulation output is obtained from the stage. Additional letter classes are defined for special purpose amplifiers, with additional active elements or particular power supply improvements; sometimes a new letter symbol is used by a manufacturer to promote its proprietary design. The 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. In the illustrations below, a bipolar junction transistor is shown as the amplifying device. The active element remains conducting [2] all of the time. Amplifying devices operating in class A conduct over the entire range of the input cycle. A class-A amplifier is distinguished by the output stage devices being biased for class A operation. Subclass A2 is sometimes used to refer to vacuum-tube class-A stages that drive the grid slightly positive on signal peaks for slightly more power than normal class A A1; where the grid is always negative [3] [4]. This, however, incurs higher signal distortion [citation needed]. Class-A power amplifier designs have largely been superseded by more efficient designs, though their simplicity makes them popular with some hobbyists. There is a market for expensive high fidelity class-A amps considered a "cult item" among audiophiles [6] mainly for their absence of crossover distortion and reduced odd-harmonic and high-order harmonic distortion. Class A power amplifiers are also used in some "boutique" guitar amplifiers due to their unique tonal quality and for reproducing vintage tones. Some hobbyists who prefer class-A amplifiers also prefer the use of thermionic valve tube designs instead of transistors, for several reasons:. Transistors are much less expensive than tubes so more elaborate designs that use more parts are still less expensive to manufacture than tube designs. A classic application for a pair of class-A devices is the long-tailed pair , which is exceptionally linear, and forms the basis of many more complex circuits, including many audio amplifiers and almost all op-amps. Class-A amplifiers may be used in output stages of op-amps [9] although the accuracy of the bias in low cost op-amps such as the may result in class A or class AB or class B performance, varying from device to device or with temperature. They are sometimes used as medium-power, low-efficiency, and high-cost audio power amplifiers. The power consumption is unrelated to the output power. At idle no input , the power consumption is essentially the same as at high output volume. The result is low efficiency and high heat dissipation. In a class-B amplifier, the active device conducts for degrees of the cycle. This would cause intolerable distortion if there were only one device, so two devices are usually used, especially at audio frequencies. At radio frequency , if the coupling to the load is via a tuned circuit , a single device operating in class B can be used because the stored energy in the tuned circuit supplies the "missing" half of the waveform. Devices operating in Class B are used in linear amplifiers, so called because the radio frequency output power is proportional to the square of the input excitation voltage. This characteristic prevents distortion of amplitude-modulated or frequency-modulated signals passing through the amplifier. When Class-B amplifiers amplify the signal with two active devices, each operates over one half of the cycle. Efficiency is much improved over class-A amplifiers. A practical circuit using class-B elements is the pushâ€"pull stage , such as the very simplified complementary pair arrangement shown at right. Complementary devices are each used for amplifying the opposite halves of the input signal, which is then recombined at the output. This is called crossover distortion. An improvement is to bias the devices so they are not completely off when they are not in use. This approach is called class AB operation. In a class-AB amplifier, the conduction angle is intermediate between class A and B; each one of the two active elements conducts more than half of the time. Class AB is widely considered a good compromise for amplifiers, since much of the time the music signal is quiet enough that the signal stays in the "class-A" region, where it is amplified with good fidelity, and by definition if passing out of this region, is large enough that the distortion products typical of class B are relatively small. The crossover distortion can be reduced further by using negative feedback. In class-AB operation, each device operates the same way as in class B over half the waveform, but also conducts a small amount on the other half. The result is that when the waveforms from the two devices are combined, the crossover is greatly minimised or eliminated altogether. The exact choice of quiescent current the standing current through both devices when there is no signal makes a large difference to the level of distortion and to the risk of thermal runaway , which may damage

the devices. Often, bias voltage applied to set this quiescent current must be adjusted with the temperature of the output transistors. For example, in the circuit shown at right, the diodes would be mounted physically close to the output transistors, and specified to have a matched temperature coefficient. Another approach often used with thermally tracking bias voltages is to include small value resistors in series with the emitters. Class AB sacrifices some efficiency over class B in favor of linearity, thus is less efficient below It is typically much more efficient than class A. A vacuum tube amplifier design will sometimes have an additional suffix number for the class, for example, class B1. A suffix 1 indicates that grid current does not flow during any part of the input waveform, where a suffix 2 indicates grid current flows for part of the input waveform. This distinction affects the design of the driver stages for the amplifier. Suffix numbers are not used for semiconductor amplifiers. Distortion is high and practical use requires a tuned circuit as load. The usual application for class-C amplifiers is in RF transmitters operating at a single fixed carrier frequency , where the distortion is controlled by a tuned load on the amplifier. The input signal is used to switch the active device, causing pulses of current to flow through a tuned circuit forming part of the load. The class-C amplifier has two modes of operation: tuned and untuned. This is called untuned operation, and the analysis of the waveforms shows the massive distortion that appears in the signal. When the proper load e. The first is that the output's bias level is clamped with the average output voltage equal to the supply voltage. This is why tuned operation is sometimes called a clamper. This restores the waveform to its proper shape, despite the amplifier having only a one-polarity supply. This is directly related to the second phenomenon: the waveform on the center frequency becomes less distorted. The residual distortion is dependent upon the bandwidth of the tuned load, with the center frequency seeing very little distortion, but greater attenuation the farther from the tuned frequency that the signal gets. The tuned circuit resonates at one frequency, the fixed carrier frequency, and so the unwanted frequencies are suppressed, and the wanted full signal sine wave is extracted by the tuned load. The signal bandwidth of the amplifier is limited by the Q-factor of the tuned circuit but this is not a serious limitation. Any residual harmonics can be removed using a further filter. In practical class-C amplifiers a tuned load is invariably used. In one common arrangement the resistor shown in the circuit above is replaced with a parallel-tuned circuit consisting of an inductor and capacitor in parallel, whose components are chosen to resonate at the frequency of the input signal. Power can be coupled to a load by transformer action with a secondary coil wound on the inductor. The average voltage at the collector is then equal to the supply voltage, and the signal voltage appearing across the tuned circuit varies from near zero to near twice the supply voltage during the RF cycle. The input circuit is biased so that the active element e. The active element conducts only while the collector voltage is passing through its minimum. By this means, power dissipation in the active device is minimised, and efficiency increased. Class-D amplifiers use some form of pulse-width modulation to control the output devices. The conduction angle of each device is no longer related directly to the input signal but instead varies in pulse width. In the class-D amplifier the active devices transistors function as electronic switches instead of linear gain devices; they are either on or off. The analog signal is converted to a stream of pulses that represents the signal by pulse-width modulation , pulse-density modulation , delta-sigma modulation or a related modulation technique before being applied to the amplifier. The time average power value of the pulses is directly proportional to the analog signal, so after amplification the signal can be converted back to an analog signal by a passive low-pass filter. The purpose of the output filter is to smooth the pulse stream to an analog signal, removing the high frequency spectral components of the pulses. The frequency of the output pulses is typically ten or more times the highest frequency in the input signal to amplify, so that the filter can adequately reduce the unwanted harmonics and accurately reproduce the input. The main advantage of a class-D amplifier is power efficiency. Because the output pulses have a fixed amplitude, the switching elements usually MOSFETs , but vacuum tubes, and at one time bipolar transistors , were used are switched either completely on or completely off, rather than operated in linear mode. A MOSFET operates with the lowest resistance when fully on and thus excluding when fully off has the lowest power dissipation when in that condition. Compared to an equivalent class-AB device, a class-D amplifier's lower losses permit the use of a smaller heat sink for the MOSFETs while also reducing the amount of input power required, allowing for a lower-capacity power supply design. Therefore, class-D amplifiers are typically smaller than an equivalent class-AB amplifier. Another advantage of the class-D amplifier is that it can operate from a digital signal source without requiring a digital-to-analog converter DAC to convert the signal to analog form first. If the signal source is in digital form, such as in a digital media player or computer sound card , the digital circuitry can convert the binary digital signal directly to a pulse-width modulation signal that is applied to the amplifier, simplifying the circuitry

considerably. A class-D amplifier with moderate output power can be constructed using regular CMOS logic process, making it suitable for integration with other types of digital circuitry. Thus it is commonly found in System-on-Chips with integrated audio when the amplifier shares a die with the main processor or DSP. Class-D amplifiers are widely used to control motors â€"but are now also used as power amplifiers, with extra circuitry that converts analogue to a much higher frequency pulse width modulated signal. Switching power supplies have even been modified into crude class-D amplifiers though typically these only reproduce low-frequencies with acceptable accuracy. High quality class-D audio power amplifiers have now appeared on the market. These designs have been said to rival traditional AB amplifiers in terms of quality. An early use of class-D amplifiers was high-power subwoofer amplifiers in cars. Class-D amplifiers for driving subwoofers are relatively inexpensive in comparison to class-AB amplifiers. The letter D used to designate this amplifier class is simply the next letter after C and, although occasionally used as such, does not stand for digital. Class-D and class-E amplifiers are sometimes mistakenly described as "digital" because the output waveform superficially resembles a pulse-train of digital symbols, but a class-D amplifier merely converts an input waveform into a continuously pulse-width modulated analog signal. A digital waveform would be pulse-code modulated. Other amplifier classes are mainly variations of the previous classes. For example, class-G and class-H amplifiers are marked by variation of the supply rails in discrete steps or in a continuous fashion, respectively following the input signal. Wasted heat on the output devices can be reduced as excess voltage is kept to a minimum. The amplifier that is fed with these rails itself can be of any class. These kinds of amplifiers are more complex, and are mainly used for specialized applications, such as very high-power units. Also, class-E and class-F amplifiers are commonly described in literature for radio-frequency applications where efficiency of the traditional classes is important, yet several aspects deviate substantially from their ideal values. These classes use harmonic tuning of their output networks to achieve higher efficiency and can be considered a subset of class C due to their conduction-angle characteristics. The class-E amplifier is a highly efficient tuned switching power amplifier used at radio frequencies. It uses a single-pole switching element and a tuned reactive network between the switch and the load. The circuit obtains high efficiency by only operating the switching element at points of zero current on to off switching or zero voltage off to on switching which minimizes power lost in the switch, even when the switching time of the devices is long compared to the frequency of operation. The class-E amplifier is frequently cited to have been first reported in In pushâ€"pull amplifiers and in CMOS, the even harmonics of both transistors just cancel. Experiment shows that a square wave can be generated by those amplifiers. Theoretically square waves consist of odd harmonics only. In a class-D amplifier, the output filter blocks all harmonics; i. So even small currents in the harmonics suffice to generate a voltage square wave. The current is in phase with the voltage applied to the filter, but the voltage across the transistors is out of phase. Therefore, there is a minimal overlap between current through the transistors and voltage across the transistors. The sharper the edges, the lower the overlap. While in class D, transistors and the load exist as two separate modules, class F admits imperfections like the parasitics of the transistor and tries to optimise the global system to have a high impedance at the harmonics. Because the combined current through both transistors is mostly in the first harmonic, it looks like a sine. That means that in the middle of the square the maximum of current has to flow, so it may make sense to have a dip in the square or in other words to allow some overswing of the voltage square wave. A class-F load network by definition has to transmit below a cutoff frequency and reflect above. Any frequency lying below the cutoff and having its second harmonic above the cutoff can be amplified, that is an octave bandwidth. On the other hand, an inductive-capacitive series circuit with a large inductance and a tunable capacitance may be simpler to implement. By reducing the duty cycle below 0. The voltage square waveform degrades, but any overheating is compensated by the lower overall power flowing. Any load mismatch behind the filter can only act on the first harmonic current waveform, clearly only a purely resistive load makes sense, then the lower the resistance, the higher the current. Class F can be driven by sine or by a square wave, for a sine the input can be tuned by an inductor to increase gain. If class F is implemented with a single transistor, the filter is complicated to short the even harmonics. All previous designs use sharp edges to minimise the overlap. There are a variety of amplifier designs that enhance class-AB output stages with more efficient techniques to achieve greater efficiency with low distortion. These designs are common in large audio amplifiers since the heatsinks and power transformers would be prohibitively large and costly without the efficiency increases. The terms "class G" and "class H" are used interchangeably to refer to different designs, varying in definition from one manufacturer or paper to another. Class-G amplifiers which use "rail switching" to decrease power consumption and increase efficiency are more

efficient than class-AB amplifiers. These amplifiers provide several power rails at different voltages and switch between them as the signal output approaches each level. Thus, the amplifier increases efficiency by reducing the wasted power at the output transistors. Class-G amplifiers are more efficient than class AB but less efficient when compared to class D, however, they do not have the electromagnetic interference effects of class D. Class-H amplifiers create an infinitely variable analog supply rail. They are sometimes referred to as rail trackers. This is done by modulating the supply rails so that the rails are only a few volts larger than the output signal "tracking" it at any given time. The output stage operates at its maximum efficiency all the time. Refer to the schematic figure. The class H amplifier can actually be thought of as two amplifiers in series. If vout music signal is operating below 40 volts, the amplifier only has the losses associated with a W amplifier. This is because the Class H upper devices T2 and T4 are only used when the music signal is between and Watts output. The key to understanding this efficiency without churning the actual numbers is that we have a Watt capable amplifier but with the efficiency of a Watt amplifier. This is because the wave-forms of music contain long periods under Watts and contain only brief bursts of up to Watts instantaneous; in other words, the losses at Watts are for brief time periods. If this example were drawn as a class AB with just the 80 V supplies in place of the 40 V supplies, the T1 and T3 transistors would need to be in conduction throughout the 0 V to 80 V signal with the corresponding VI losses all through the vout wave period – not just the brief high energy bursts. To achieve this rail tracking control, T2 and T4 act as current amplifiers, each in series with its low voltage counterpart T1 and T3. The purpose of T2 and T3 is to allow back-biasing diode D2 when vout is at a positive peak above During the vout musical peaks from to Watts, the 40 V supplies have zero Amperes drawn from them as all current comes from the 80 V rails. This figure is too simplistic however as it will not actually control the T2 T4 transistors at all. This is because the D1 and D3 diodes which are intended to provide a path for the vout back into the upper devices are always reverse biased. They are drawn backwards. In place of these diodes, a voltage amplifier with gain which uses vout as its input would be needed in an actual design. There is another reason for this gain requirement between vout and T2 base in an actual class H design and that is to assure that the signal applied to the T2 is always "ahead" of the Vout signal so it can never "catch up" with the rail tracker. From Wikipedia, the free encyclopedia. Main article: Class-D amplifier. This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. June Learn how and when to remove this template message. Retrieved Maximum Efficiency of Class A Amplifiers. Transformer Coupled Loads. Basic Electronics Tutorials. Electronic Design March, Output characteristics DC load line". Malvino, Electronic Principles 2nd Ed. Sokal and A. SC, pp. Categories : Electronic amplifiers. Hidden categories: All articles with unsourced statements Articles with unsourced statements from December Articles with unsourced statements from April Articles needing additional references from June All articles needing additional references. Namespaces Article Talk. Views Read Edit View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version. AMP was first announced on October 7, The AMP Project was announced by Google on October 7, , following discussions with its partners in the Digital News Initiative DNI , and other news publishers and technology companies around the world, about improving the performance of the mobile web. AMP pages first appeared to web users in February , when Google began to show the AMP versions of webpages in mobile search results. AMP pages are published on-line and can be displayed in most current browsers. Any organization or individual can build products or features which will work on AMP pages, provided they comply with the AMP Project specifications. Google reports that AMP pages served in Google search typically load in less than one second and use ten times less data than the equivalent non-AMP pages. With pre-rendering, the AMP version is approximately nine times faster than the non-AMP version, though pre-rendering may consume additional mobile data. Google has announced that as of February 1, , it will require the content of canonical pages and those displayed through AMP be substantially the same. It's the difference between saying come into my walled garden vs. However, some critics believe that AMP is an impending walled garden as Google begins to host AMP-restricted versions of their websites directly on google. Some publishers have complained that as Google prioritizes AMP links—as it recently said it will do in mobile search—media companies will lose even more control because AMP pages are hosted and controlled by Google. AMP has been criticized by figures inside the tech industry [41] [42] [43] [44] [45] [46] [47] as an attempt by Google to exert its dominance on the web by dictating how websites are built and monetized, and that "AMP is Google's attempt to lock publishers into its ecosystem". These charges were rebutted by Google. Madhav Chinnappa stated that AMP must be a collaborative industry initiative in order for it to succeed

in the long term:. In September , Google began transitioning AMP to a more open governance model with governing committees composed of different stakeholders in the project, ranging from publishers that use AMP including The Washington Post and Axios to other companies such as Microsoft and Twitter. As in other cases where pre-rendering is used, this is out of the user's control and may increase data usage. The average 1. Other publishers have reported better success with AMP monetization. The Washington Post has been able to generate approximately the same amount of revenue from AMP pages as from standard mobile pages, according to director of product Joey Marburger. To improve advertising performance, the AMP Project launched the AMP Ads Initiative which includes support for more advertising formats and optimizations to improve ad load speed. Some observers believe AMP allows more effective phishing attempts. One serious flaw, noted by tech writer Kyle Chayka, is that disreputable parties who misuse AMP as well as Facebook's similar Instant Articles enable junk websites to share many of the same visual cues and features found on legitimate sites. That makes separating the real from the fake even harder," said Chayka. In September , Russian hackers used an AMP vulnerability in phishing e-mails sent to investigative journalists critical of the Russian government, and hacked into their websites. From Wikipedia, the free encyclopedia. Open source HTML framework optimised for mobile web browsing. This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. January Learn how and when to remove this template message. Retrieved February 29, Retrieved November 6, Retrieved August 21, Archived from the original on March 13, Bing Webmaster Tools. The AMP Blog. Search Engine Watch. Retrieved April 3, Retrieved February 9, October 7, Business Insider. Search Engine Land. October 3, Retrieved August 31, The AMP Channel. Retrieved October 11, Bing Webmaster Blog. September 23, Retrieved April 8, Digital Marketing Blog by Adobe. February 23, Archived from the original on September 1, July 7, September 19, AMP Project. Retrieved December 7, April 19, GlobeNewswire News Room. Search Engine Journal. Retrieved June 3, Retrieved September 7, September 20, Los Cabos. Retrieved July 23, The Verge. Retrieved November 20, Retrieved February 28, Archived from the original on November 18, Apple Newsroom. Retrieved August 4, Retrieved April 16, Boing Boing. Ars Technica. The Drum. Retrieved September 18, Retrieved December 10, October 14, Wall Street Journal. September 24, Google Search Central Blog. Free and open-source software portal. Google free and open-source software FOSS. Chromium OpenRefine Tesseract. Dart Go Sawzall. Hidden categories: All articles with dead external links Articles with dead external links from September Articles with permanently dead external links Use mdy dates from July Articles with short description Short description is different from Wikidata Articles needing additional references from January All articles needing additional references All articles with unsourced statements Articles with unsourced statements from February Official website different in Wikidata and Wikipedia Webarchive template wayback links. Namespaces Article Talk. Views Read Edit View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version. Applications Chromium OpenRefine Tesseract. Marshall Amplification is a British company that designs and manufactures music amplifiers , speaker cabinets , brands personal headphones and earphones, [2] a record label [3] and, having acquired Natal Drums , drums and bongos. It was founded by drum shop owner and drummer Jim Marshall , and is now based in Bletchley , Milton Keynes , Buckinghamshire. Marshall's guitar amplifiers are among the most recognised in the world. Their signature sound, characterized by sizzling distortion and "crunch," was conceived by Marshall after guitarists, such as Pete Townshend , visited Marshall's drum shop complaining that the guitar amplifiers then on the market didn't have the right sound or enough volume. Marshall also manufactures less expensive solid-state, hybrid vacuum tube and solid state and modelling amplifiers. After a successful career as a drummer and teacher of drum technique, Jim Marshall first went into business in with a small shop in Hanwell , London, selling drums, cymbals and drum-related accessories; Marshall himself also gave drum lessons. According to Jim, Ritchie Blackmore , Big Jim Sullivan and Pete Townshend were the three main guitarists who often came into the shop and pushed Marshall to make guitar amplifiers and told him the sound and design they wanted. These were very popular with guitarists and bass players, but were very expensive. The three guitarists were among the first customers of the first 23 Marshall amplifiers made. The sixth prototype produced, in Jim's words, the "Marshall Sound", although at this time the only involvement Jim had was to sell the amps on a commission basis in his shop. As business increased, Marshall asked the three to work for him in his shop, as he had more space and capital to expand. As of Dudley's death in and Ken Bran's death in , the only original individual is Ken Underwood. They were almost copies of the Bassman circuit, with American military-surplus power valves, a relative of the 6L6. Few speakers then were able to handle more than 15 watts, [citation needed

] which meant that an amplifier approaching 50 watts had to use four speakers. For their Bassman, Fender used four Jensen speakers in the same cabinet as the amplifier, but Marshall chose to separate the amplifier from the speakers, and placed four inch Celestion speakers in a separate closed-back cabinet instead of the four inch Jensens in an open-back combo. These circuit changes gave the amp more gain so that it broke into overdrive sooner on the volume control than the Bassman, and boosted the treble frequencies. This new amplifier, tentatively called the "Mark II", was eventually named the " JTM 45 ", after Jim and his son Terry Marshall and the maximum wattage of the amplifier. Jimi Hendrix, Eric Clapton, and other blues rock-based bands from the late s such as Free used Marshall stacks both in the studio and live on stage making them among the most sought after and most popular amplifiers in the industry. Marshall entered into a year distribution deal with British company Rose-Morris during , which gave him the capital to expand his manufacturing operations, though it would prove to be costly. In retrospect, Marshall admitted the Rose-Morris deal was "the biggest mistake I ever made. Rose-Morris hadn't a clue, really. The new contract had disenfranchised several of Marshall's former distributors, among them his old friend Johnny Jones. Marshall's contract did not prevent him from building amplifiers outside the company, and so Marshall launched the Park brand name, inspired by the maiden name of Jones's wife. For instance, often the Parks had silver or black front panels instead of the Marshall's gold ones, some of the enclosures were taller or shaped differently, and controls were laid out and labelled differently. Starting in early , Park produced a number of amplifiers including a watt head. Most of these had Marshall layout and components, though some unusual amplifiers were made, such as a 75 watt keyboard amplifier with KT88 tubes. In , Park came to an end, though Marshall later revived the brand for some transistor amplifiers made in Asia. Amplifiers sold under these brand names are quite rare, and sell to collectors at high prices. To reduce costs Marshall started sourcing parts from the UK. This led to the use of Dagnall and Drake-made transformers, and a switch to the KT66 valve instead of the 6L6 tube commonly used in the United States. The changes gave Marshall amplifiers a more aggressive voice, which quickly found favour with players such as Eric Clapton , who would sit in Jim's shop practising. Clapton asked Jim Marshall to produce a combo amp with tremolo, which would fit in the boot of his car, and one of the most famous Marshall amps was born, the " Bluesbreaker " amp. The amplifiers from this era are easily identifiable by their acrylic glass a. Plexiglas front panel, which earned them the nickname "Plexi". In , Marshall released a watt version of the watt Superlead known as the Model. In , the plexiglass panel was replaced by a brushed metal front panel. Other early customers included Pete Townshend and John Entwistle of The Who , whose search for extra volume led Marshall to design the classic watt valve amplifier. Four of these amplifiers were built and delivered to Pete Townshend, and the Marshall Super Lead Model , the original Plexi , was born in Still, most modern watt heads have roots in Marshall's design, even though they often contain many more features or different tubes, such as the more American-sounding 6L6 tubes. Hence, another valve change was made, with Marshall starting to use European-made Mullard EL34 power stage valves. In Jimi Hendrix was in Jim's shop, trying the amplifiers and guitars. Jim Marshall expected Hendrix to be "another American wanting something for nothing" but to his surprise, Hendrix offered to buy the amplifiers at retail price if Jim would provide him with support for them around the world. After , to streamline production, labour-intensive handwiring was discontinued and Marshall valve amplifiers were switched to printed-circuit-board PCBs. Much of the debate about the difference in tone between the plexi- and aluminium-panel Marshall amps originates from when a number of circuit changes were made to the and amplifiers, with the addition of 'mkII' added to the 'Super Lead' name on the back panel and 'JMP' "Jim Marshall Products" added to the left of the power switch on the front panel. The combined effect of different tubes and a modified circuit gave these mids Marshalls a very bright and aggressive sound that was punchier than the EL34 sound, but not as rich, compressed, and had less poweramp distortion. This was an attempt to control the volume level of the amplifiers whilst maintaining the overdriven distortion tones that had become synonymous with the Marshall brand. To do this, Marshall designers connected the two input stages in series rather than parallel on the , but not initially on the , and modified the gain stage circuitry to preserve the tonal characteristics of the 'cranked Plexi' sound and converted the now obsolete second channel volume control to a Master Volume by wiring it between the preamp and EQ circuit. The followed suit in early and changed its preamp circuit to match the then more popular Per Rick Reinckens, who was a short-term Unicord employee electronic technician who tested the first units when they arrived from England. Tony Frank, Unicord's chief design engineer, came up with this idea for a dual-volume-control a preamp gain and a master volume. The circuitry modifications were optimised to replicate the sound of the earlier non-MV Marshall's with the Master Volume control set 'low', however players quickly realised that 'cranking' the MV of these

new Marshall amps would yield even more overdrive distortion, the tone of which was more cutting and edgy, and later found favour with players such as Randy Rhoads , Zakk Wylde and Slash. The and non-master volume models also continued under the JMP line until Soon after the Rose-Morris deal had ended in late , Marshall repackaged two MV models, the and the at and 50 watts, respectively , along with the and non-master volume Super Lead in a new box with a new panel, and called it the " JCM " series named after his initials and the registration plate of his car. A landmark year for Jim Marshall was It marked 25 years in the amplifier business and 50 years in music. This was celebrated with the release of the Silver Jubilee series of amps. The Silver Jubilee series consisted of the watt head , 50 watt head along with other x model numbers denominating various combos and even a "short head". The Jubilee amps were heavily based on the JCMs of the time, featuring a very similar output section along with a new preamp. Their most publicised feature was the half-power switching, which is activated by a third rocker switch next to the standard "power" and "standby" switches. On the watt model this was reflected in the numbering â€" is switchable from 25 to 50 watts â€" and also reflected Marshall amps' 25th anniversary and Jim Marshall's 50 years in music. The amps were trimmed in silver covering, and had a bright silver-coloured faceplate, along with a commemorative plaque. The Jubilee also featured a "semi-split channel" design, in which two different input gain levels could be set, running through the same tone stack and master volume control. This allowed for a "classic Marshall" level of gain to be footswitched up to a modern, medium to high gain sound, slightly darker and higher in gain than the brasher JCM sound that typified s rock music. The gain by today's standards is medium. It can be heard on some of the Velvet Revolver material though. The Jubilee amps also featured a "pull out" knob that activated a diode clipping circuit similar to boosting the amp's input with an overdrive pedal. After the Jubilee year, production of the 25xx series amplifiers continued for one more year with no internal changes , but reverted to a standard Marshall livery of black and gold. These are sometimes referred to as the JCM Custom amplifiers. Marshall began to see more competition from American amplifier companies such as Mesa Boogie and Soldano. Marshall then updated the JCM range with additional models and new features such as "channel switching", which meant that players could switch between clean and distorted tones with the push of a foot-operated switch. This feature debuted in the 50 watt and watt series and these amps contained more pre-amp gain than ever thanks to a new innovation; diode clipping. This meant a solid-state diode added additional distortion to the signal path, akin to adding a distortion pedal. As such the split channel JCMs were the highest gain Marshalls yet built â€" "When they were first released, many players were shocked some were even put off by its bright, intense distortion â€" far more than any other amp of the day. Marshall around this time began further experiments with solid-state amplifiers, which were increasingly improving in quality due to technological innovations but were still considered beginner level equipment. Regardless, solid-state product lines with the Marshall name on them were and still are a wild if critically discounted success for the company, allowing entry level guitarists to play the same brand of amp as their heroes. In the s, Marshall updated its product line again with the JCM series. Reviewed by Guitarist magazine in the UK and given the line, "Shredders, here is an amp you won't need to have modified", this move by Marshall was again an outgrowth of musicians' desires, featuring more distortion than ever and retaining popular aspects of the late JCM models. However, despite such marketing claims they were not as hi-gain as advertised, and used solid state components for much of the distortion in some models - something which many guitarists did not like. Still, if not with shredders, the JCM line was well received by younger players associated with pop, rock, punk and grunge which was widespread by the early s. There are three different variants of the JCM These models feature two channels, a largely solid state preamp, and diode distortion. These are easily the highest distortion of the three variants. A number of these were shipped with Sovtek valves, a ruggedized variant of the 6L6 family of output valves, due to a lack of suitable quality EL34s. Most of the JCMs and s built between â€" left the factory with the s. Around this time, Marshall released a few "special edition" amps in this range, including a "Slash Signature" model, a first for the company. This was actually a re-release of the earlier Silver Jubilee amplifier, with identical internals, a standard Marshall look, and a Slash logo. This amp retained EL34s and 3, units were produced from to To commemorate this milestone, Marshall released the 30th Anniversary series of amplifiers, the EL34 powered LE with commemorative blue covering and gold faceplate; which was followed by the in blue tolex and still EL34 powered and then in the LM in standard Marshall livery but now powered like the JCMs of the time. All versions of the had three channels; clean, crunch and lead. The clean channel featured a mid shift, which gave the option of a more "Fender-like" voicing, and the crunch channel featured three modes recreating all the classic Marshall crunch tones of the past three decades. The lead channel featured a switchable gain

boost and a mid-range contour switch, which gave it the tone and gain levels, which Marshall's engineers hoped would keep it competitive in the high-gain world in the early to mids. In fact some players felt the lead channel was perhaps the weaker link in the amplifier's arsenal, and it came in for revisions in the third year of production the LM standing for "Lead Mod". This revision featured even higher gain. The Anniversary series found prominence with Joe Satriani in particular, who favoured the early EL34 powered versions and used only the clean channel live along with his signature Vox Satchurator distortion pedal which is based on his old modded Boss DS Satriani used these older Boss pedals almost exclusively for live work and on a number of studio albums including The Extremist until the early s. Despite all this complication the amps had a pure signal path that did not share preamp tubes between channels unlike later Marshall designs like the TSL and JVM. Marshall currently produces a number of amplifiers, which are a mix of modern designs and vintage reissues. Most models attempt to include the "classic" Marshall "roar". As of [update] , Marshall produced a wide range of amps with the look and sound of the Marshall valve amp. The longest running of such models is the JCM range, which is split into the two- and three-channel series, known as the Dual and Triple Super Leads. These amps are a continuation of the JCM and series, although the controversial diode clipping circuit used in the later and amps has been removed in favour of additional valve gain stages. Marshall looked towards a new flagship to nail all the compromising of the earlier models, the JVM, made in a variety of models and ranges. These amps have up to four channels, each with three-foot-switchable modes, dual master volumes, reverb controls for each channel, and a foot-switchable effects loop. These features can be programmed into the standard foot-switch to be foot-switchable as "patches", so now the user can switch from, say, a clean channel with a chorus in the effects loop and reverb, to a medium-gain rhythm sound with no effects, to a high-gain lead sound with boosted output volume, with one click of the foot-switch per sound. The JVMC, a watt four-channel 2x12" combo. Around the same time as the release of the JVM, Marshall also released an amp called the Vintage Modern, which is designed to be much simpler, with a single channel and designed to be controlled more by the player's style and guitar than by channel switching or multiple settings, reminiscent of the vintage "Plexi" and JCM range, but with modern conveniences such as foot-switchable dynamic ranges distortion levels , effects loop and reverb. The Vintage Modern series consists of the watt head and watt head with matching combos and a matching cabinet loaded with G12C watt Greenbacks. In , Marshall reissued many of its earlier amplifiers, such as the Model SLP , which is designed to be a reissue of the lates era "Plexi" amplifier, but which are in reality reissues of the post Super Lead models in that they use printed circuit boards internally to reduce manufacturing cost. The original design utilised hand-wired circuits on turret boards, which is now available for a premium in the "hand-wired" series. Other reissues are similarly PCB designed, even where the originals were hand-wired, except where explicitly noted i. Marshall's "Valvestate" amplifiers contained a hybrid of valve and solid-state technology. Currently named the "AVT series" although these are now out of production, being replaced with the "AVT tribute" for a short time , there are a number of different models, all of which are less expensive than their all-valve counterparts. It is Marshall's current line of "hybrid" amplifier, featuring a 12AX7 preamp tube employed in the preamp to "warm up" the signal as well as solid-state components, with a solid-state power amp. These are considered and marketed as intermediate-level equipment to bridge the gap between the higher valve range and lower range MG series. In January , Marshall released their latest variant of the MG line of practice amplifiers. Replacing the MG3 line, the MG4 has been designed to offer the guitarist a whole host of features whilst keeping the control of the amplifier simple. Marshall currently manufactures a professional, all-valve bass rig called the VBA There are also solid-state models called MB series [24] ranging from 15 watts to watts and extension cabinets. The amplifiers can be controlled via Bluetooth from iOS and Android devices and can also be used to stream audio from a PC. A series of low-wattage, all tube heads and combos assembled in Vietnam hearkening back to the plexi era of the company. The Origin series was introduced to address a demand for lower volume amps that many guitarists were calling for. To address this, Marshall announced the Origin5, a 5-watt amplifier that can run on either high 5-watt or low 0. With the introduction of the Powerstem technology, the Origin amps are able to provide reduced output power while retaining the same tonal characteristics of a full-powered amp. This is accomplished through the new attenuation system, Powerstem, by dynamically reducing the rail voltages throughout the amplifier. Occasionally confusion has arisen due to Marshall's method of naming each amp model, especially during its first few decades, when it was distributed under Rose-Morris. Early Amplifier models were simply named after their catalogue number, so for example the blues breaker was item one thousand, nine hundred and sixty-two in the Rose-Morris catalogue. In August , Marshall announced two smart speakers which run Amazon Alexa. The top cabinet has the top two loudspeakers angled

slightly upwards, giving the Marshall stack a distinctive appearance. When a single cabinet is used, the complete unit is called a half stack. In the early-to-mids, Pete Townshend and John Entwistle of The Who were responsible for the creation and widespread use of stacked Marshall cabinets. Townshend later remarked that Entwistle started using Marshall Stacks to hear himself over Keith Moon 's drums and Townshend himself also had to use them just to be heard over Entwistle. In fact, the very first watt Marshall amps were created specifically for Entwistle and Townshend when they were looking to replace some equipment that had been stolen from them. They approached Jim Marshall asking, if it would be possible for him to make their new rigs more powerful than those they had lost, to which they were told that the cabinets would have to double in size. They agreed and six rigs of this prototype were manufactured, of which two each were given to Townshend and Entwistle and one each to Ronnie Lane and Steve Marriott of The Small Faces. These new "double" cabinets each containing 8 speakers proved too heavy and awkward to be transported practically, so The Who returned to Marshall asking if they could be cut in half and stacked, and although the double cabinets were left intact, the existing single cabinet models each containing 4 speakers were modified for stacking, which has become the norm for years to follow. This, in turn, also had a strong influence on the band's contemporaries at the time, with Cream , The Jimi Hendrix Experience and Led Zeppelin following suit. However, due to the cost of transport, The Who could not afford to take their full rigs with them for their earliest overseas tours, thus Cream and Hendrix were the first to be seen to use this setup on a wide scale, particularly in America. Ironically, although The Who pioneered and directly contributed to the development of the "classic" Marshall sound and setup with their equipment being built and tweaked to their personal specifications, they would only use Marshalls for a couple of years before moving on to using Hiwatt equipment. Cream, and particularly Hendrix, would be widely credited with the invention of Marshall Stacks. The search for volume was taken on its next logical step with the advent of "daisy chaining" two or more amplifiers together. As most amplifier channels have two inputs, the guitar signal being present on both sockets, the cunning musician hooked the spare input of one channel to an input on another amp. By , Hendrix was daisy-chaining four stacks, incorporating both Marshall and Sound City amplifiers, as recommended to him by Townshend. Artists such as Slayer and Yngwie Malmsteen also use walls of Marshalls; both Kerry King and Jeff Hanneman of Slayer would often be seen playing in front of a total of 24 cabinets. Malmsteen toured with 30 heads and 28 cabinets, and in said he would use 60 full stacks on his next tour. Marshall is an important sponsor of sport in the local area. Marshall were one of the earliest shirt sponsors for Milton Keynes Dons , [32] they also sponsored Milton Keynes Athletic Club as well as Milton Keynes Lions basketball club, [33] before the latter relocated to London. In early , Marshall Amplification announced it has started a record label , Marshall Records. From Wikipedia, the free encyclopedia. This article contains content that is written like an advertisement. Please help improve it by removing promotional content and inappropriate external links , and by adding encyclopedic content written from a neutral point of view. June Learn how and when to remove this template message. 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Retrieved 28 October Zound Industries Urbanears Marshall adidas. Oath Inc. Retrieved 30 August Archived from the original on 16 July Archived from the original on 25 March Retrieved 17 February Marshall Records Official Website. Marshall Amplification. Categories : Marshall amplifiers Audio amplifier manufacturers Guitar amplifier manufacturers Musical instrument manufacturing companies of the United Kingdom Companies based in Milton Keynes British brands British companies established in Electronics companies established in Mobile phone manufacturers JAM Industries Audio equipment manufacturers of the United Kingdom. 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output source transistor Q The transistor Q22 prevents this stage from delivering excessive current to Q20 and thus limits the output sink current. Transistor Q16 outlined in green provides the quiescent current for the output transistors, and Q17 provides output current limiting. The biasing circuit of this stage is set by a feedback loop that forces the collector currents of Q10 and Q9 to nearly match. Input bias current for the base of Q1 resp. At the same time, the magnitude of the quiescent current is relatively insensitive to the characteristics of the components Q1–Q4, such as h fe , that would otherwise cause temperature dependence or part-to-part variations. Through some [vague] mechanism, the collector current in Q19 tracks that standing current. In the circuit involving Q16 variously named rubber diode or V BE multiplier , the 4. Then the V CB must be about 0. This small standing current in the output transistors establishes the output stage in class AB operation and reduces the crossover distortion of this stage. A small differential input voltage signal gives rise, through multiple stages of current amplification, to a much larger voltage signal on output. The input stage with Q1 and Q3 is similar to an emitter-coupled pair long-tailed pair , with Q2 and Q4 adding some degenerating impedance. The input impedance is relatively high because of the small current through Q1-Q4. The common mode input impedance is even higher, as the input stage works at an essentially constant current. This differential base current causes a change in the differential collector current in each leg by i in h fe . This portion of the op amp cleverly changes a differential signal at the op amp inputs to a single-ended signal at the base of Q15, and in a way that avoids wastefully discarding the signal in either leg. To see how, notice that a small negative change in voltage at the inverting input Q2 base drives it out of conduction, and this incremental decrease in current passes directly from Q4 collector to its emitter, resulting in a decrease in base drive for Q On the other hand, a small positive change in voltage at the non-inverting input Q1 base drives this transistor into conduction, reflected in an increase in current at the collector of Q3. Thus, the increase in Q3 emitter current is mirrored in an increase in Q6 collector current; the increased collector currents shunts more from the collector node and results in a decrease in base drive current for Q Output transistors Q14 and Q20 are each configured as an emitter follower, so no voltage gain occurs there; instead, this stage provides current gain, equal to the h fe of Q14 resp. The output impedance is not zero, as it would be in an ideal op amp, but with negative feedback it approaches zero at low frequencies. The net open-loop small-signal voltage gain of the op amp involves the product of the current gain h fe of some 4 transistors. The ideal op amp has infinite common-mode rejection ratio , or zero common-mode gain. The 30 pF capacitor stabilizes the amplifier via Miller compensation and functions in a manner similar to an op-amp integrator circuit. This internal compensation is provided to achieve unconditional stability of the amplifier in negative feedback configurations where the feedback network is non-reactive and the closed loop gain is unity or higher. The potentiometer is adjusted such that the output is null midrange when the inputs are shorted together. Variations in the quiescent current with temperature, or between parts with the same type number, are common, so crossover distortion and quiescent current may be subject to significant variation. The output range of the amplifier is about one volt less than the supply voltage, owing in part to V BE of the output transistors Q14 and Q Later versions of this amplifier schematic may show a somewhat different method of output current limiting. While the was historically used in audio and other sensitive equipment, such use is now rare because of the improved noise performance of more modern op amps. Apart from generating noticeable hiss, s and other older op amps may have poor common-mode rejection ratios and so will often introduce cable-borne mains hum and other common-mode interference, such as switch 'clicks', into sensitive equipment. The description of the output stage is qualitatively similar for many other designs that may have quite different input stages , except:. The use of op amps as circuit blocks is much easier and clearer than specifying all their individual circuit elements transistors, resistors, etc. In the first approximation op amps can be used as if they were ideal differential gain blocks; at a later stage limits can be placed on the acceptable range of parameters for each op amp. Circuit design follows the same lines for all electronic circuits. A specification is drawn up governing what the circuit is required to do, with allowable limits. A basic circuit is designed, often with the help of circuit modeling on a computer. Specific commercially available op amps and other components are then chosen that meet the design criteria within the specified tolerances at acceptable cost. If not all criteria can be met, the specification may need to be modified. A prototype is then built and tested; changes to meet or improve the specification, alter functionality, or reduce the cost, may be made. That is, the op amp is being used as a voltage comparator. Note that a device designed primarily as a comparator may be better if, for instance, speed is important or a wide range of input voltages may be found, since such devices can quickly recover from full on or full off "saturated" states. A voltage level detector can be obtained if a reference voltage V ref is applied to one of the op

amp's inputs. This means that the op amp is set up as a comparator to detect a positive voltage. If E i is a sine wave, triangular wave, or wave of any other shape that is symmetrical around zero, the zero-crossing detector's output will be square. Zero-crossing detection may also be useful in triggering TRIACs at the best time to reduce mains interference and current spikes. Another typical configuration of op-amps is with positive feedback, which takes a fraction of the output signal back to the non-inverting input. An important application of it is the comparator with hysteresis, the Schmitt trigger. Some circuits may use positive feedback and negative feedback around the same amplifier, for example triangle-wave oscillators and active filters. Because of the wide slew range and lack of positive feedback, the response of all the open-loop level detectors described above will be relatively slow. External overall positive feedback may be applied, but unlike internal positive feedback that may be applied within the latter stages of a purpose-designed comparator this markedly affects the accuracy of the zero-crossing detection point. In a non-inverting amplifier, the output voltage changes in the same direction as the input voltage. The non-inverting input of the operational amplifier needs a path for DC to ground; if the signal source does not supply a DC path, or if that source requires a given load impedance, then the circuit will require another resistor from the non-inverting input to ground. When the operational amplifier's input bias currents are significant, then the DC source resistances driving the inputs should be balanced. That ideal value assumes the bias currents are well matched, which may not be true for all op amps. In an inverting amplifier, the output voltage changes in an opposite direction to the input voltage. Again, the op-amp input does not apply an appreciable load, so. A resistor is often inserted between the non-inverting input and ground so both inputs "see" similar resistances , reducing the input offset voltage due to different voltage drops due to bias current , and may reduce distortion in some op amps. A DC-blocking capacitor may be inserted in series with the input resistor when a frequency response down to DC is not needed and any DC voltage on the input is unwanted. That is, the capacitive component of the input impedance inserts a DC zero and a low-frequency pole that gives the circuit a bandpass or high-pass characteristic. The potentials at the operational amplifier inputs remain virtually constant near ground in the inverting configuration. The constant operating potential typically results in distortion levels that are lower than those attainable with the non-inverting topology. Most single, dual and quad op amps available have a standardized pin-out which permits one type to be substituted for another without wiring changes. A specific op amp may be chosen for its open loop gain, bandwidth, noise performance, input impedance, power consumption, or a compromise between any of these factors. An op amp, defined as a general-purpose, DC-coupled, high gain, inverting feedback amplifier , is first found in U. Patent 2,, "Summing Amplifier" filed by Karl D. Swartzel Jr. It had a single inverting input rather than differential inverting and non-inverting inputs, as are common in today's op amps. In , the operational amplifier was first formally defined and named in a paper [17] by John R. Ragazzini of Columbia University. In this same paper a footnote mentioned an op-amp design by a student that would turn out to be quite significant. This op amp, designed by Loebe Julie , was superior in a variety of ways. It had two major innovations. Its input stage used a long-tailed triode pair with loads matched to reduce drift in the output and, far more importantly, it was the first op-amp design to have two inputs one inverting, the other non-inverting. The differential input made a whole range of new functionality possible, but it would not be used for a long time due to the rise of the chopper-stabilized amplifier. In , Edwin A. Goldberg designed a chopper -stabilized op amp. This signal is then amplified, rectified, filtered and fed into the op amp's non-inverting input. This vastly improved the gain of the op amp while significantly reducing the output drift and DC offset. Unfortunately, any design that used a chopper couldn't use their non-inverting input for any other purpose. Nevertheless, the much improved characteristics of the chopper-stabilized op amp made it the dominant way to use op amps. Techniques that used the non-inverting input regularly would not be very popular until the s when op-amp ICs started to show up in the field. In , vacuum tube op amps became commercially available with the release of the model K2-W from George A. Philbrick Researches, Incorporated. Two nine-pin 12AX7 vacuum tubes were mounted in an octal package and had a model K2-P chopper add-on available that would effectively "use up" the non-inverting input. This op amp was based on a descendant of Loebe Julie's design and, along with its successors, would start the widespread use of op amps in industry. With the birth of the transistor in , and the silicon transistor in , the concept of ICs became a reality. The introduction of the planar process in made transistors and ICs stable enough to be commercially useful. By , solid-state, discrete op amps were being produced. These op amps were effectively small circuit boards with packages such as edge connectors. They usually had hand-selected resistors in order to improve things such as voltage offset and drift. There have been many different directions taken in op-amp design. Varactor bridge op amps started to be produced in the early s. By , several companies were

producing modular potted packages that could be plugged into printed circuit boards. Monolithic ICs consist of a single chip as opposed to a chip and discrete parts a discrete IC or multiple chips bonded and connected on a circuit board a hybrid IC. Almost all modern op amps are monolithic ICs; however, this first IC did not meet with much success. This simple difference has made the the canonical op amp and many modern amps base their pinout on the s. The same part is manufactured by several companies. In the s high speed, low-input current designs started to be made by using FETs. A single sided supply op amp is one where the input and output voltages can be as low as the negative power supply voltage instead of needing to be at least two volts above it. The result is that it can operate in many applications with the negative supply pin on the op amp being connected to the signal ground, thus eliminating the need for a separate negative power supply. The LM released in was one such op amp that came in a quad package four separate op amps in one package and became an industry standard. In addition to packaging multiple op amps in a single package, the s also saw the birth of op amps in hybrid packages. These op amps were generally improved versions of existing monolithic op amps. As the properties of monolithic op amps improved, the more complex hybrid ICs were quickly relegated to systems that are required to have extremely long service lives or other specialty systems. Recent trends. Recently supply voltages in analog circuits have decreased as they have in digital logic and low-voltage op amps have been introduced reflecting this. To maximize the signal range modern op amps commonly have rail-to-rail output the output signal can range from the lowest supply voltage to the highest and sometimes rail-to-rail inputs. From Wikipedia, the free encyclopedia. High-gain voltage amplifier with a differential input. Main article: Operational amplifier applications. An op amp connected in the non-inverting amplifier configuration. An op amp connected in the inverting amplifier configuration. Electronics portal. Philbrick Instrumentation amplifier Negative feedback amplifier Op-amp swapping Operational amplifier applications Operational transconductance amplifier Sallen–Key topology. Modern precision op amps can have internal circuits that automatically cancel this offset using choppers or other circuits that measure the offset voltage periodically and subtract it from the input voltage. See Output stage. Maxim Application Note Archived from the original on Retrieved November 10, Archived from the original on 1 January Retrieved 8 November Microelectronics: Digital and Analog Circuits and Systems. Archived PDF from the original on The Art of Electronics. Handbook of Operational Amplifier Circuit Design. Analog Devices. Retrieved Electronic Design News. November 18, Stanford University. Archived from the original PDF on Archived from the original on 9 October Retrieved 28 April If the other input bias current is the same and sees the same source resistance, then the two input offset voltages will cancel out. Balancing the DC source resistances may not be necessary if the input bias current and source resistance product is small. Tutorial MT Op Amp Applications Handbook. May Proceedings of the IRE. Archived from the original on 7 September Categories : Electronic amplifiers Linear integrated circuits Integrated circuits. Hidden categories: All articles with dead external links Articles with dead external links from July Articles with permanently dead external links Articles with dead external links from June CS1 maint: archived copy as title Articles with short description Short description is different from Wikidata All Wikipedia articles needing clarification Wikipedia articles needing clarification from January All articles with unsourced statements Articles with unsourced statements from February Articles with unsourced statements from January Commons category link is on Wikidata Articles with dead external links from August Wikipedia articles with GND identifiers Wikipedia articles with NDL identifiers. Namespaces Article Talk. Views Read Edit View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version. Wikimedia Commons Wikibooks. Discrete circuit Integrated circuit. Often these pins are left out of the diagram for clarity, and the power configuration is described or assumed from the circuit. Circuit diagram symbol for an op amp. Pins are labeled as listed above. Wikimedia Commons has media related to Operational amplifiers. Wikiversity has learning resources about Operational amplifier. The Wikibook Electronics has a page on the topic of: Op-Amps. An amplifier , electronic amplifier or informally amp is an electronic device that can increase the power of a signal a time-varying voltage or current. It is a two-port electronic circuit that uses electric power from a power supply to increase the amplitude of a signal applied to its input terminals, producing a proportionally greater amplitude signal at its output. The amount of amplification provided by an amplifier is measured by its gain : the ratio of output voltage, current, or power to input. An amplifier is a circuit that has a power gain greater than one. An amplifier can either be a separate piece of equipment or an electrical circuit contained within another device. Amplification is fundamental to modern electronics, and amplifiers are widely used in almost all electronic equipment. Amplifiers can be categorized in different ways. One is by the frequency of the electronic signal being amplified. Amplifiers can also be categorized by

their physical placement in the signal chain ; a preamplifier may precede other signal processing stages, for example. Today most amplifiers use transistors. The first practical prominent device that could amplify was the triode vacuum tube , invented in by Lee De Forest , which led to the first amplifiers around Vacuum tubes were used in almost all amplifiers until the sâ€"s when transistors replaced them. Today, most amplifiers use transistors, but vacuum tubes continue to be used in some applications. The development of audio communication technology in form of the telephone , first patented in , created the need to increase the amplitude of electrical signals to extend the transmission of signals over increasingly long distances. In telegraphy , this problem had been solved with intermediate devices at stations that replenished the dissipated energy by operating a signal recorder and transmitter back-to-back, forming a relay , so that a local energy source at each intermediate station powered the next leg of transmission. For duplex transmission, I. Varley for telegraphic transmission. Duplex transmission was essential for telephony and the problem was not satisfactorily solved until , when H. Shreeve of the American Telephone and Telegraph Company improved existing attempts at constructing a telephone repeater consisting of back-to-back carbon-granule transmitter and electrodynamic receiver pairs. After the turn of the century it was found that negative resistance mercury lamps could amplify, and were also tried in repeaters, with little success. The development of thermionic valves starting around , provided an entirely electronic method of amplifying signals. The first practical version of such devices was the Audion triode , invented in by Lee De Forest , [7] [8] [9] which led to the first amplifiers around The amplifying vacuum tube revolutionized electrical technology, creating the new field of electronics , the technology of active electrical devices. For 50 years virtually all consumer electronic devices used vacuum tubes. Early tube amplifiers often had positive feedback regeneration , which could increase gain but also make the amplifier unstable and prone to oscillation. Much of the mathematical theory of amplifiers was developed at Bell Telephone Laboratories during the s to s. The vacuum tube was virtually the only amplifying device, other than specialized power devices such as the magnetic amplifier and amplidyne , for 40 years. Power control circuitry used magnetic amplifiers until the latter half of the twentieth century when power semiconductor devices became more economical, with higher operating speeds. The old Shreeve electroacoustic carbon repeaters were used in adjustable amplifiers in telephone subscriber sets for the hearing impaired until the transistor provided smaller and higher quality amplifiers in the s. The first working transistor was a point-contact transistor invented by John Bardeen and Walter Brattain in at Bell Labs , where William Shockley later invented the bipolar junction transistor BJT in Atalla and Dawon Kahng at Bell Labs in The replacement of bulky electron tubes with transistors during the s and s created a revolution in electronics, making possible a large class of portable electronic devices, such as the transistor radio developed in Today, use of vacuum tubes is limited for some high power applications, such as radio transmitters. Beginning in the s, more and more transistors were connected on a single chip thereby creating higher scales of integration such as small-scale, medium-scale and large-scale integration in integrated circuits. Many amplifiers commercially available today are based on integrated circuits. For special purposes, other active elements have been used. For example, in the early days of the satellite communication , parametric amplifiers were used. The core circuit was a diode whose capacitance was changed by an RF signal created locally. Under certain conditions, this RF signal provided energy that was modulated by the extremely weak satellite signal received at the earth station. Advances in digital electronics since the late 20th century provided new alternatives to the traditional linear-gain amplifiers by using digital switching to vary the pulse-shape of fixed amplitude signals, resulting in devices such as the Class-D amplifier. In principle, an amplifier is an electrical two-port network that produces a signal at the output port that is a replica of the signal applied to the input port, but increased in magnitude. The input port can be idealized as either being a voltage input, which takes no current, with the output proportional to the voltage across the port; or a current input, with no voltage across it, in which the output is proportional to the current through the port. The output port can be idealized as being either a dependent voltage source , with zero source resistance and its output voltage dependent on the input; or a dependent current source , with infinite source resistance and the output current dependent on the input. Combinations of these choices lead to four types of ideal amplifiers. Each type of amplifier in its ideal form has an ideal input and output resistance that is the same as that of the corresponding dependent source: [19]. In real amplifiers the ideal impedances are not possible to achieve, but these ideal elements can be used to construct equivalent circuits of real amplifiers by adding impedances resistance, capacitance and inductance to the input and output. For any particular circuit, a small-signal analysis is often used to find the actual impedance. Amplifiers designed to attach to a transmission line at input and output, especially RF amplifiers , do not fit into this

classification approach. Rather than dealing with voltage or current individually, they ideally couple with an input or output impedance matched to the transmission line impedance, that is, match ratios of voltage to current. Many real RF amplifiers come close to this ideal. Although, for a given appropriate source and load impedance, RF amplifiers can be characterized as amplifying voltage or current, they fundamentally are amplifying power. Amplifiers are described according to the properties of their inputs, their outputs, and how they relate. The gain may be specified as the ratio of output voltage to input voltage voltage gain , output power to input power power gain , or some combination of current, voltage, and power. In many cases the property of the output that varies is dependent on the same property of the input, making the gain unitless though often expressed in decibels dB. Most amplifiers are designed to be linear. That is, they provide constant gain for any normal input level and output signal. If an amplifier's gain is not linear, the output signal can become distorted. There are, however, cases where variable gain is useful. Certain signal processing applications use exponential gain amplifiers. Amplifiers are usually designed to function well in a specific application, for example: radio and television transmitters and receivers , high-fidelity "hi-fi" stereo equipment, microcomputers and other digital equipment, and guitar and other instrument amplifiers. Every amplifier includes at least one active device , such as a vacuum tube or transistor. Negative feedback is a technique used in most modern amplifiers to improve bandwidth and distortion and control gain. In a negative feedback amplifier part of the output is fed back and added to the input in opposite phase, subtracting from the input. The main effect is to reduce the overall gain of the system. However, any unwanted signals introduced by the amplifier, such as distortion are also fed back. Since they are not part of the original input, they are added to the input in opposite phase, subtracting them from the input. In this way, negative feedback also reduces nonlinearity, distortion and other errors introduced by the amplifier. Large amounts of negative feedback can reduce errors to the point that the response of the amplifier itself becomes almost irrelevant as long as it has a large gain, and the output performance of the system the "closed loop performance " is defined entirely by the components in the feedback loop. This technique is particularly used with operational amplifiers op-amps. With negative feedback , distortion can typically be reduced to 0. Noise, even crossover distortion, can be practically eliminated. Negative feedback also compensates for changing temperatures, and degrading or nonlinear components in the gain stage, but any change or nonlinearity in the components in the feedback loop will affect the output. Indeed, the ability of the feedback loop to define the output is used to make active filter circuits. Another advantage of negative feedback is that it extends the bandwidth of the amplifier. The concept of feedback is used in operational amplifiers to precisely define gain, bandwidth, and other parameters entirely based on the components in the feedback loop. Negative feedback can be applied at each stage of an amplifier to stabilize the operating point of active devices against minor changes in power-supply voltage or device characteristics. Some feedback, positive or negative, is unavoidable and often undesirableâ€"introduced, for example, by parasitic elements , such as inherent capacitance between input and output of devices such as transistors, and capacitive coupling of external wiring. Excessive frequency-dependent positive feedback can produce parasitic oscillation and turn an amplifier into an oscillator. All amplifiers include some form of active device: this is the device that does the actual amplification. The active device can be a vacuum tube , discrete solid state component, such as a single transistor , or part of an integrated circuit , as in an op-amp. Transistor amplifiers or solid state amplifiers are the most common type of amplifier in use today. A transistor is used as the active element. The gain of the amplifier is determined by the properties of the transistor itself as well as the circuit it is contained within. Applications are numerous, some common examples are audio amplifiers in a home stereo or public address system , RF high power generation for semiconductor equipment, to RF and microwave applications such as radio transmitters. Transistor-based amplification can be realized using various configurations: for example a bipolar junction transistor can realize common base common collector or common emitter amplification; a MOSFET can realize common gate , common source or common drain amplification. Each configuration has different characteristics. Vacuum-tube amplifiers also known as tube amplifiers or valve amplifiers use a vacuum tube as the active device. While semiconductor amplifiers have largely displaced valve amplifiers for low-power applications, valve amplifiers can be much more cost effective in high power applications such as radar, countermeasures equipment, and communications equipment. Many microwave amplifiers are specially designed valve amplifiers, such as the klystron , gyrotron , traveling wave tube , and crossed-field amplifier , and these microwave valves provide much greater single-device power output at microwave frequencies than solid-state devices. Magnetic amplifiers are devices somewhat similar to a transformer where one winding is used to control the saturation of a magnetic core and hence alter the impedance

of the other winding. They have largely fallen out of use due to development in semiconductor amplifiers but are still useful in HVDC control, and in nuclear power control circuitry due to not being affected by radioactivity. Negative resistances can be used as amplifiers, such as the tunnel diode amplifier. 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. In general the power amplifier is the last 'amplifier' or actual circuit in a signal chain the output stage and is the amplifier stage that requires attention to power efficiency. Efficiency considerations lead to the various classes of power amplifier based on the biasing of the output transistors or tubes: see power amplifier classes below. 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 : amplifies a control voltage to adjust the speed of a motor, or the position of a motorized system. 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. 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. 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. Negative Resistance Amplifier is a type of Regenerative Amplifier [27] that can use the feedback between the transistor's source and gate to transform a capacitive impedance on the transistor's source to a negative resistance on its gate. Compared to other types of amplifiers, this "negative resistance amplifier" will only require a tiny amount of power to achieve very high gain, maintaining a good noise figure at the same time. Certain requirements for step response and overshoot are necessary for an acceptable TV image. Traveling wave tube amplifiers TWTAs are used for high power amplification at low microwave frequencies. They typically can amplify across a broad spectrum of frequencies; however, they are usually not as tunable as klystrons. Klystrons are specialized linear-beam vacuum-devices, designed to provide high power, widely tunable amplification of millimetre and sub-millimetre waves. 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. Depending on the amplifier specifications and size requirements microwave amplifiers can be realised as monolithically integrated, integrated as modules or based on discrete parts or any combination of those. Instrument amplifiers are a range of audio power amplifiers used to increase the sound level of musical instruments, for example guitars, during performances. 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. An amplifier whose output exhibits no feedback to its input side is described as 'unilateral'. The input impedance of a unilateral amplifier is independent of load, and output impedance is independent of signal source impedance. An amplifier that uses feedback to connect part of the output back to the input is a bilateral amplifier. 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. Another way to classify amplifiers is by the phase relationship of the input signal to the output signal. An 'inverting' amplifier produces an output degrees out of phase with the input signal that is, a polarity inversion or mirror image of the input as seen on an oscilloscope. A 'non-inverting' amplifier maintains the phase of the input signal waveforms. 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. 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. Amplifiers are sometimes classified by the coupling method of the signal at the input, output, or between stages. Different types of these include:. 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. Special methods, such as chopper stabilized amplifiers are used to prevent objectionable drift in the amplifier's properties for DC. 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. 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. The practical amplifier circuit shown above 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. That is, the diodes push the output stage firmly into class-AB mode assuming that the base-emitter drop of the output transistors is reduced by heat dissipation. This design is simple, but a good basis for a practical design because it automatically stabilises its operating point, since feedback internally operates from DC up through the audio range and beyond. Further circuit elements would probably be found in a real design that would roll-off the frequency response above the needed range to prevent the possibility of unwanted oscillation. A common solution to help stabilise the output devices is to include some emitter resistors, typically one ohm or so. Calculating the values of the circuit's resistors and capacitors is done based on the components employed and the intended use of the amp. Any real amplifier is an imperfect realization of an ideal amplifier. An important limitation of a real amplifier is that the output it generates is ultimately limited by the power available from the power supply. An amplifier saturates and clips the output if the input signal becomes too large for the amplifier to reproduce or exceeds operational limits for the device. The power supply may influence the output, so must be considered in the design. The power output from an amplifier cannot exceed its input power. The amplifier circuit has an "open loop" performance. This is described by various parameters gain, slew rate , output impedance , distortion , bandwidth , signal-to-noise ratio , etc. Many modern amplifiers use negative feedback techniques to hold the gain at the

desired value and reduce distortion. Negative loop feedback has the intended effect of lowering the output impedance and thereby increasing electrical damping of loudspeaker motion at and near the resonance frequency of the speaker. When assessing rated amplifier power output, it is useful to consider the applied load, the signal type e. In high-powered audio applications that require long cables to the load e. This avoids long runs of heavy speaker cables. To prevent instability or overheating requires care to ensure solid state amplifiers are adequately loaded. Most have a rated minimum load impedance. All amplifiers generate heat through electrical losses. The amplifier must dissipate this heat via convection or forced air cooling. Heat can damage or reduce electronic component service life. Designers and installers must also consider heating effects on adjacent equipment. Different power supply types result in many different methods of bias. Bias is a technique by which active devices are set to operate in a particular region, or by which the DC component of the output signal is set to the midpoint between the maximum voltages available from the power supply. Most amplifiers use several devices at each stage; they are typically matched in specifications except for polarity. Matched inverted polarity devices are called complementary pairs. Class-A amplifiers generally use only one device, unless the power supply is set to provide both positive and negative voltages, in which case a dual device symmetrical design may be used. Class-C amplifiers, by definition, use a single polarity supply. Amplifiers often have multiple stages in cascade to increase gain. Each stage of these designs may be a different type of amp to suit the needs of that stage. For instance, the first stage might be a class-A stage, feeding a class-AB pushâ€"pull second stage, which then drives a class-G final output stage, taking advantage of the strengths of each type, while minimizing their weaknesses. From Wikipedia, the free encyclopedia. This article is about electronic amplifiers. For other uses, see Amplifier disambiguation. Main article: Amplifier figures of merit. Main articles: Operational amplifier and Instrumentation amplifier. Main article: Distributed amplifier. See also: multistage amplifiers. Main article: Power amplifier classes. Electronics portal. Charge transfer amplifier CMOS amplifiers Current sense amplifier Distributed amplifier Doherty amplifier Double-tuned amplifier Faithful amplification Low-noise amplifier Negative feedback amplifier Optical amplifier Power added efficiency Programmable gain amplifier Tuned amplifier. Electronics, 2nd Ed. CRC Press. Foundations of Analog and Digital Electronic Circuits. Morgan Kaufmann. Introduction to Circuit Analysis and Design. Springer Science and Business Media. In Glen Ballou ed. Howard W. MIT Press. Retrieved January 7, The link is to a reprint of the paper in the Scientific American Supplement, No. Historical Dictionary of American Radio. Greenwood Publishing Group. Newnes Dictionary of Electronics, 4th Ed. John Wiley and Sons. Radio's Conquest of Space. Murray Hill Books. Telegraph and Telephone Age. Retrieved May 12, The Encyclopedia Americana Co. Online Etymology Dictionary. Retrieved July 10, July Bell Labs Technical Journal. See Fritz Zwicky. Archived from the original on Retrieved Vsats: Very Small Aperture Terminals. Electronic Devices and Circuit Theory, 7th Edition. Prentice Hall College Division. Symons IEEE Spectrum. Texas Instruments. June APL Technical Digest. Magnetic Resonance in Medicine. Central European Journal of Engineering. Bibcode : CEJE Electronic components. Potentiometer digital Variable capacitor Varicap. 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This is because when the society demutualised, all policy holders received shares in the new company. In , the company demerged its UK operations, creating the Henderson Group. The company provides financial planning and advice , banking , life insurance , managed funds , superannuation , property , listed assets and infrastructure. It is Australia's largest retail and corporate superannuation provider, and is the largest life risk business in Australia. David Jones was a foundation director in Many of the older AMP buildings are now heritage-listed and feature the "Amicus" statue group. The central figure in the statue group is the goddess of Peace and Plenty, holding a palm branch signifying peace and a cornucopia symbolising plenty. The male figure of Labour sits to her left and also holds the cornucopia, while the figures of the wife and the child sit on the goddess's right under her palm branch. The Australasian holdings included the former National Mutual business established in which was demutualised in Axa had gained majority ownership

of National Mutual in and renamed the company as Axa Asia Pacific. The first day of the merged group operating together was 31 March , with the companies to be gradually integrated and the Axa brand being phased out of the Australian and New Zealand market by On 8 May , directors Vanessa Wallace and Holly Kramer announced they would not be seeking re-election, in response to an imminent protest vote organised by the shareholders in the aftermath of the Banking Royal Commission. Patty Akopiantz also announced she would be resigning at the end of the year. In November , AMP admits to a second overcharging scandal. From Wikipedia, the free encyclopedia. Sydney , New South Wales , Australia. Net income. This section needs expansion with: significant events before it's years old, but nothing interesting happened until the last 20 years?. You can help by adding to it. September Banks portal. Archived from the original on 23 October SBS News

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