



## VI. What is Single-Ended, Class A, B, AB, ultralinear, etc?

**1.** Class A means that the power tube conducts the same amount of current all the time, whether idling or producing full power. Class A is very inefficient with electricity but usually gives very low distortion. \* There are single-ended class-A, or SE, amplifiers. They use one or more tubes in parallel, which are all in phase with each other. This is commonly used in smaller guitar amps and in exotic high-end amplifiers. Many audiophiles prefer the SE amplifier, even though it has relatively high levels of even-order distortion. Most 300B high-end amplifiers are SE. Negative feedback, which can be used to decrease the distortion of an amplifier, is felt by some people to sound inferior. Most SE amps have no feedback.

Unfortunately, the high saturation currents in SE-amp output transformers tend to limit the bass-frequency response of such amps. Unless you use a subwoofer with a separate driver amplifier, the SE amp will tend to give inferior performance. We also feel that keeping distortion down is important (though not as important as engineers tend to think). SE amps made with low-mu triodes can have very low distortion, IF they are properly designed. Beware of some SE amps that are designed entirely "by ear", especially those made by small companies run by audio-guru egomaniacs. The amps made by such firms might NOT do everything well, and might not be the sound you would prefer.

\* Push-pull class-A amplifiers also exist--they use two, four or more tubes (always in pairs) which are driven in opposite phase to each other. This cancels out the even-order distortion and gives very clean sound. Push-pull Class A operation usually involves low plate voltages and high plate currents, compared to Class AB operation below. The high currents might tend to wear out the tube cathodes faster than in an AB amplifier.

\* There are two kinds of class-A operation, which can apply to single-ended or push-pull. --Class A1 means that the grid voltage is always more negative than the cathode voltage. This gives the greatest possible linearity and is used with triodes such as the 300B, and sometimes with audio beam tetrodes and pentodes. (Such amps are rare in the modern trend-driven and ego-ridden world of high end audio today--most gurus lean either toward Class AB beam-tube amplifiers, or toward SE triodes.)

--Class A2 means that the grid is driven MORE POSITIVE than the cathode for part or all of the waveform. This means the grid will draw current from the cathode and heat up. A2 is not often used with beam tetrodes, pentodes or triodes like the SV300B, especially in audio. Usually a class-A2 amplifier will use tubes with special rugged grids, such as the 811A or SV572 triodes. Class A2 also requires a special driver circuit, that can supply power to the grid.

**2.** Class AB applies only to push-pull amplifiers. It means that when one tube's grid is driven until its plate current cuts off (stops) completely, the other tube takes over and handles the power output. This gives greater efficiency than Class A. It also results in increased distortion, unless the amplifier is carefully designed and uses some negative feedback. Most guitar amps are push-pull Class AB. The biggest high-end amplifier manufacturers love to build big Class AB amplifiers using 6550s or KT88 type beam tubes--primarily because their wealthy customers often have very inefficient speakers, such as electrostatic panels or Magneplans. (There are class-AB1 and class-AB2 amplifiers; the differences are the same as were explained above--the tube's grids are not (AB1) or are (AB2) driven positive. AB2 is rare in today's high end market, primarily because the egomaniacs who often design such amps do not how to design a reliable and good-sounding AB2 amplifier....)

**3.** Class B applies only to push-pull amplifiers in audio; it SOMETIMES applies to RF power amplifiers with one tube. It is like Class AB, except that the tubes idle at or near zero current. This gives even greater efficiency than Class A or AB. It also results in increased distortion, unless the amplifier is carefully designed and uses some negative feedback. If careful design is not undertaken, the result may be crossover distortion, which appears at the midpoint of the output waveform and has very bad-sounding effects in audio. Most solid-state audio amplifiers use class B, because the transistors

undergo less heat stress when idling. Class B amplifiers can sound very good, if well-designed. The classic Altec 1570 is an example.

**4.** Ultralinear operation is usually considered to be invented by David Hafler and Herbert Keroes in 1951. It uses only beam tetrodes or pentodes, and special taps on the output transformer. The taps connect to the screen grids of the tubes, causing the screens to be driven with part of the output signal. This lowers distortion considerably. It is usually seen only in hi-fi amplifiers that use power tubes such as the 6L6GC, 6550/KT88, EL84 or EL34. All classic Dynaco amplifiers used ultralinear connection. It is VERY hard on the screen grid of the tube, especially the EL34 type. So good-quality EL34s are critical in such amplifier circuits.

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