Audio Amplifier

- The goal of an audio amplifier is to exactly reproduce a small, audio signal at a considerably higher signal strength.
Audio Amplifier Project

Objectives

☐ Develop your design skills in electronics.

☐ Develop your research/learning skills to acquire new knowledge as needed.

☐ Increase your awareness of the wide variety of integrated circuits (ICs) that are available for system design.

☐ Build a practical audio amplifier.
Audio Amplifier Project

Specifications

- Power Output: 11 W
- Total Harmonic Distortion: <0.1%
- Frequency Response: 20 Hz – 20 kHz ± 0.5 dB
- Load: 8 Ω speakers
- Stereo
- Tone and Balance controls - optional
- Power: ±13.8 VDC from the lab supplies.

NO SINGLE CHIP SOLUTIONS.
Audio Amplifier Project

Specifications - continued

- Efficiency. No spec given, but a highly inefficient amp will not get as high of a grade as another amp that also meets all the other specs.

- The single most important spec for any electronic product/project is that it does not produce a dangerous situation for the user.
Hearing – Primer

- The smallest step-change in amplitude that can be detected is about 0.3 dB for a pure tone. (0.5-1.0 dB for real music)
- The smallest detectable change in frequency is about 0.2% in the band of 500 Hz - 2 kHz.
- The least detectable harmonic distortion is probably between 0.3 - 1%.
Architectures

- The majority of commercial amplifiers use a 3-stage architecture.

- A 2-stage amplifier may seem easier to build, but it is in fact more challenging to design and usually results in more distortion and no reduction in parts count.

- Class D amplifiers are available in some commercial products.
3-Stage Audio Amplifier

Ref: Audio Power Amplifier Design Handbook by Douglas Self
3-Stage Audio Amplifier

NFB, Stability, and “Compensation”

Negative Feedback (NFB) is a common technique in analog circuit design. It consists of taking a portion of the output and “feeding it back” to the input. It is called “negative” because the fed back signal is subtracted from the input signal.

The primary goal of NFB is to design circuits with specific characteristics (gain, etc.) that are insensitive to individual device parameters (beta, etc).

See Ch. 10 in “Microelectronic Circuits” by Sedra/Smith.
3-Stage Audio Amplifier

NFB, Stability, and “Compensation”

In Audio Amplifiers, NFB has the advantages of:

- reducing harmonic distortion
- reducing output impedance
- enhancing supply-rail rejection
- improving frequency response
- improving gain stability

HOWEVER, excessive NFB can lead to instability!

The mathematics of stability are covered in Control Theory.
Compensation is the technique of modifying the open-loop gain and phase characteristics so that the amplifier is stable under closed-loop conditions, i.e., when global NFB is implemented.

In the 3-stage architecture, Compensation occurs by placing a capacitor from the base-to-collector of the transistor in the VAS (voltage amplification stage.)

The typical value for this capacitor is 100 pF.
Class D Audio Amplifier

Spring, 2014

Ref: Electronics & Technology Cosmos International, February 2014
Class-D Audio Amplifier

Ref: Electronics & Technology Cosmos International, February 2014
References

- Electronics & Technology Cosmos International, February 2014
- See web site for additional references.