National Semiconductor

LM1895/LM2895 Audio Power Amplifier

General Description

The LM1895 is a 6V audio power amplifier designed to deliver 1W into 4Ω. Utilizing a unique patented compensation scheme, the LM1895 is ideal for sensitive AM radio applications. This new circuit technique exhibits lower noise, lower distortion, and less AM radiation than conventional designs. The amplifier's supply range (3V–9V) is ideal for battery operation. The LM1895 is packaged in an 8-pin miniDIP for minimum PC board space. For higher supplies (V_S > 9V) the LM2895 is available in an 11-lead single-in-line package. The 11-lead package has been redesigned, resulting in a slightly degraded thermal characteristic shown in the figure Device Dissipation vs Ambient Temperature.

Features

- Guaranteed low crossover distortion
- Low AM radiation
- Low noise
- 3V, 4Ω, P_O = 250 mW
- Wide supply operation 3V–15V (LM2895)
- Low distortion
- No turn on "pop"
- Smooth waveform clipping
- 8-pin miniDIP (LM1895)
- 12V, 4Ω, P_O = 4W (LM2895)
- Tested for low crossover distortion

Applications

- Compact AM-FM radios
- Battery operated tape player amplifiers
- Line driver

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Typical Applications

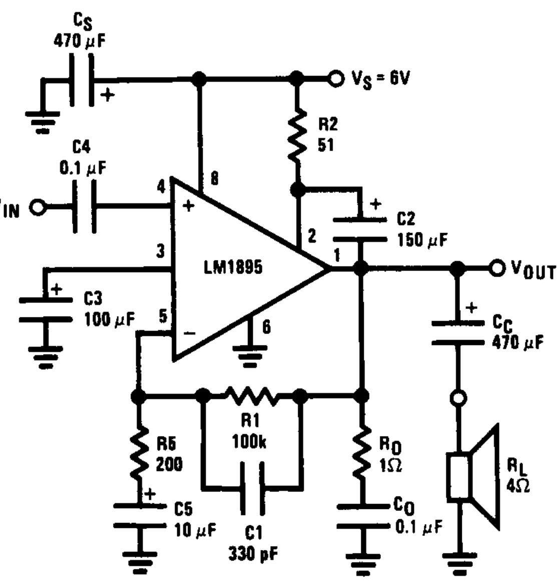

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FIGURE 1. LM1895 with A_V = 500, BW = 5 kHz, AM Radio Application (V_{IN} = 4.2 mV for Full Power Output)

Order Number LM1895N or LM2895P
See NS Package Number N08E or P11A

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	
LM1895	V_S = 12V
LM2895	V_S = 18V
Operating Temperature (Note 1)	0°C to +70°C
Storage Temperature	−65°C to +150°C
Junction Temperature	150°C
Lead Temperature (Soldering, 10 sec.)	260°C

Electrical Characteristics

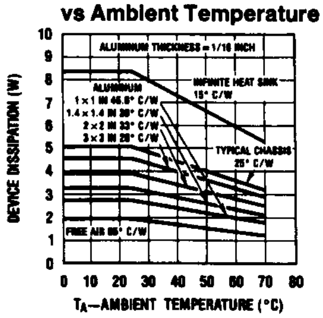
Unless otherwise specified, T_A = 25°C, A_V = 200 (46 dB). For the LM1895, V_S = 6V and R_L = 4Ω. For the LM2895, T_{TAB} = 25°C, V_S = 12V and R_L = 4Ω. Test circuit shown in *Figure 2*.

Parameter	Conditions	LM1895			LM2895			Units
		Min	Typ	Max	Min	Typ	Max	
Supply Current	P_O = W		8	14		12	20	mA
Operating Supply Voltage		3		10	3		15	V
Output Power LM1895N LM2895P	THD = 10%, f = 1 kHz V_S = 6V, R_L = 4Ω } T_A = 25°C V_S = 9V, R_L = 8Ω V_S = 12V, R_L = 4Ω } T_{TAB} = 25°C V_S = 12V, R_L = 8Ω	 0.9 	 1.1 1.1 		 3.6 	 4.3 2.5		 W W W W
Distortion	f = 1 kHz P_O = 50 mW P_O = 0.5W P_O = 1.0W f = 20 kHz, P_O = 100 mW, V_S = 3.6V		 0.27 0.20 	 3.0		 0.27 0.20 0.15 	 3.0	 % % % %
Crossover Distortion	f = 20 kHz, R_L = 4Ω, P_O = 100 mW, V_{CC} = 3.6V			3			3	%
Power Supply Rejection Ratio (PSRR)	C_{BY} = 100 μF, f = 1 kHz, C_{IN} = 0.1 μF Output Referred, V_{RIPPLE} = 250 mV	40	52		40	52		dB
Noise	Equivalent Input Noise R_S = 0, C_{IN} = 0.1 μF, BW = 20 −20 kHz CCIR/ARM Wideband		 1.4 1.4 2.0			 1.4 1.4 2.0		 μV μV μV
DC Output Level		2.8	3.0	3.2	5.6	6.0	6.4	V
Input Impedance		50	150	350	50	150	350	kΩ
Input Offset Voltage			5			5		mV
Input Bias Current			120			120		nA

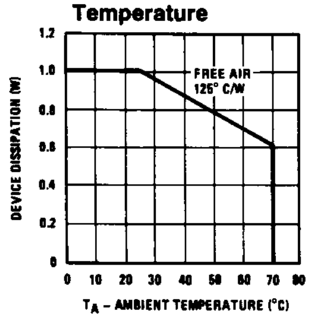
Note 1: For operation at ambient temperature greater than 25°C, the LM1895/LM2895 must be derated based on a maximum junction temperature using a thermal resistance which depends upon mounting techniques.

Typical Performance Characteristics

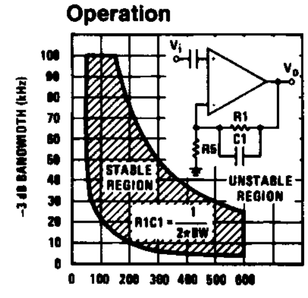
LM2895 Device Dissipation vs Ambient Temperature



LM1895 Maximum Device Dissipation vs Ambient Temperature



−3 dB Bandwidth vs Voltage Gain for Stable Operation



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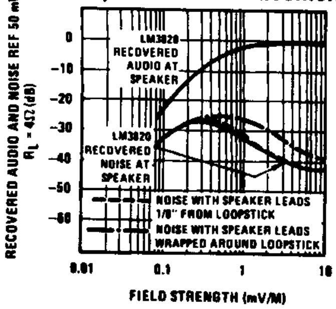
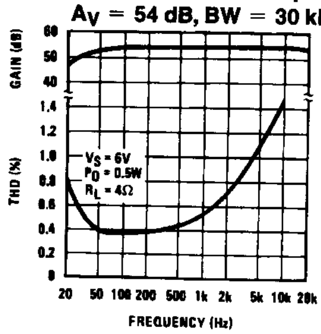
Typical Performance Characteristics (Continued)

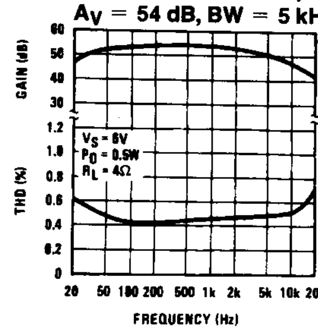
AM Recovered Audio and Noise vs Field Strength for Different Speaker Lead Placement



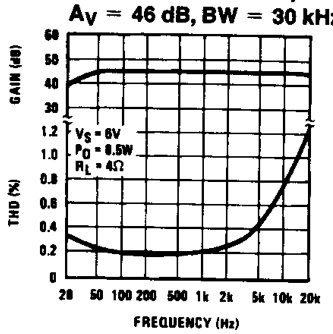
THD and Gain vs Frequency A_V = 54 dB, BW = 30 kHz



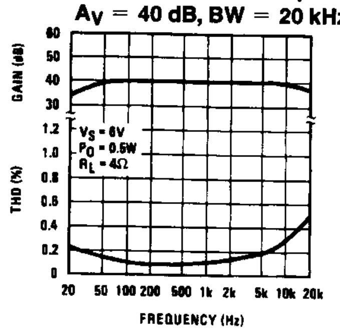
THD and Gain vs Frequency A_V = 54 dB, BW = 5 kHz



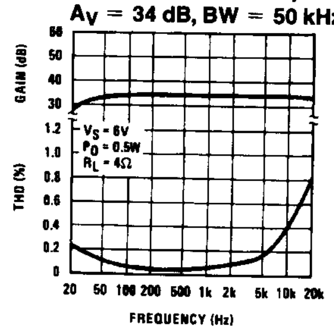
THD and Gain vs Frequency A_V = 46 dB, BW = 30 kHz



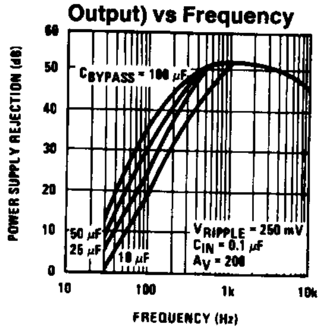
THD and Gain vs Frequency A_V = 40 dB, BW = 20 kHz



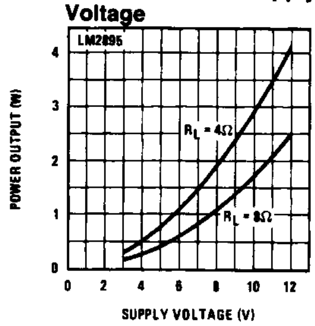
THD and Gain vs Frequency A_V = 34 dB, BW = 50 kHz



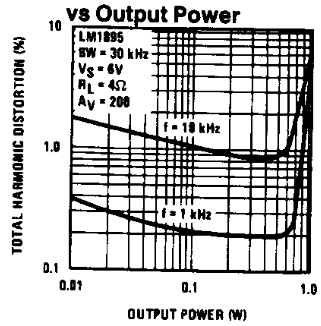
Power Supply Rejection Ratio (Referred to the Output) vs Frequency



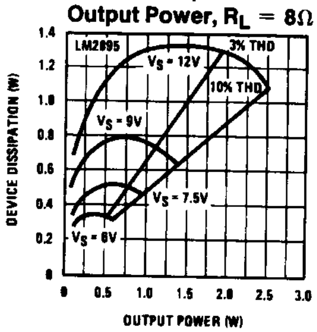
Power Output vs Supply Voltage



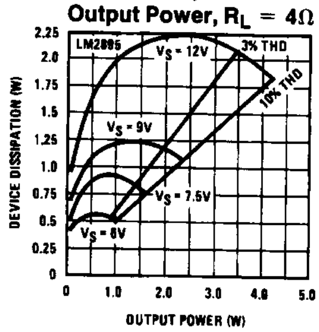
Total Harmonic Distortion vs Output Power



Power Dissipation vs Output Power, R_L = 8Ω



Power Dissipation vs Output Power, R_L = 4Ω



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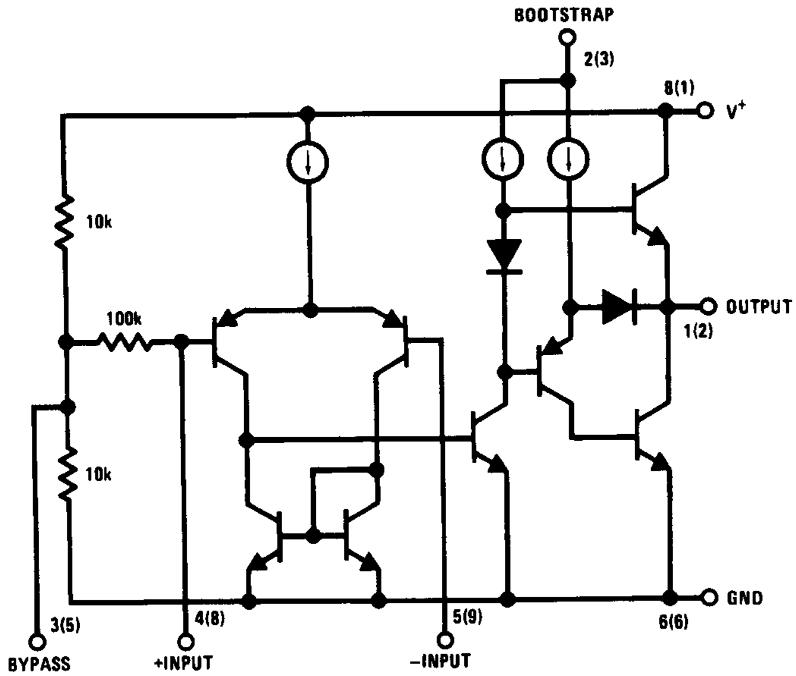
Equivalent Schematic



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Pin 7 no connection on LM1895

Pins 4, 7, 10, 11 no connection on LM2895

( ) indicates pin number for LM2895

Typical Applications (Continued)

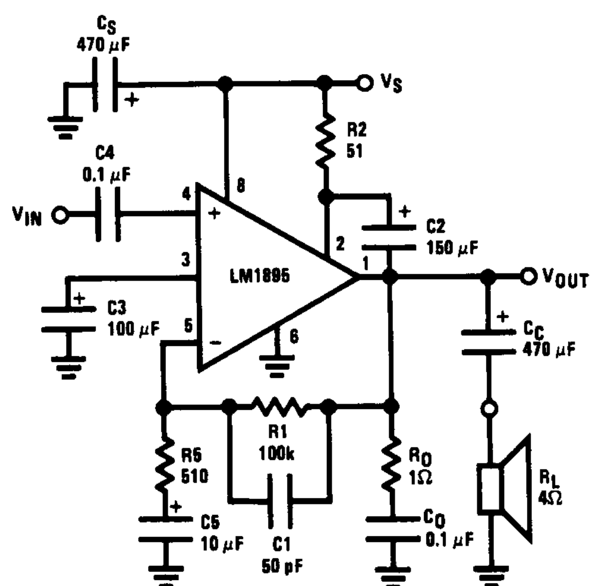

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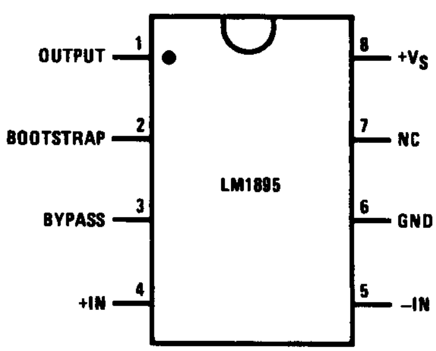
FIGURE 2. Amplifier with $A_V = 200$, BW = 30 kHz

External Components *(Figure 2)*

Components	Comments
1. R1, R5	Sets voltage gain, $A_V = 1 + R1/R5$
2. R2	Bootstrap resistor sets drive current for output stage and allows pin 2 to go above V_S
3. R_O	Works with C_O to stabilize output stage
4. C4	Input coupling capacitor. Pin 4 is at a DC potential of $V_S/2$. Low frequency pole set by: $f_L = \frac{1}{2\pi R_{IN}C4}$
5. C5	Feedback capacitor. Ensure unity gain at DC. Also a low frequency pole at: $f_L = \frac{1}{2\pi R5C5}$
6. C2	Bootstrap capacitor, used to increase drive to output stage. A low frequency pole is set by: $f_L = \frac{1}{2\pi R2C2}$
7. C1	Compensation capacitor. This stabilizes the amplifier and adjusts the bandwidth. See curve of bandwidth vs allowable gain
8. C3	Improves power supply rejection. (See Typical Performance Curves). Increasing C3 increases turn-on delay
9. C_C	Output coupling capacitor. Isolates pin 1 from the load. Low frequency pole set by: $f_L = \frac{1}{2\pi C_CR_L}$
10. C_O	Works with R_O to stabilize output stage
11. C_S	Provides power supply filtering

Connection Diagrams

Dual-In-Line Package



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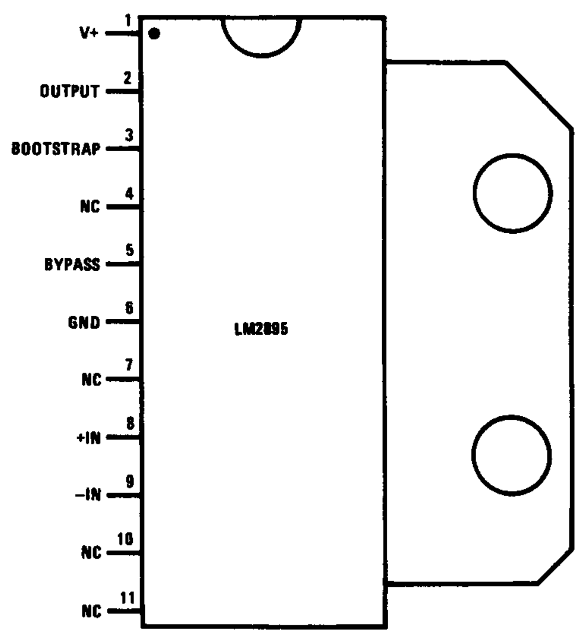
Top View

Single-In-Line Package



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Top View

Application Hints

AM Radios

The LM1895/LM2895 have been designed to fill a wide range of audio power applications. A common problem with IC audio power amplifiers has been poor signal-to-noise performance when used in AM radio applications. In a typical radio application, the loopstick antenna is in close proximity to the audio amplifier. Current flowing in the speaker and power supply leads can cause electromagnetic coupling to the loopstick, resulting in system oscillation. In addition, most audio power amplifiers are not optimized for lowest noise because of compensation requirements. If noise from the audio amplifier radiates into the AM section, the sensitivity and signal-to-noise ratio will be degraded.

The LM1895 exhibits extremely low wideband noise due in part to an external capacitor C1 which is used to tailor the bandwidth. The circuit shown in *Figure 2* is capable of a signal-to-noise ratio in excess of 60 dB referred to 50 mW. Capacitor C1 not only limits the closed loop bandwidth, it also provides overall loop compensation. Neglecting C5 in *Figure 2*, the gain is:

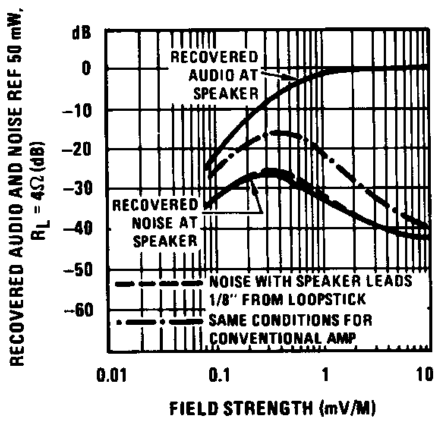

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FIGURE 3. Improved AM Sensitivity Over Conventional Design

$$A_V(S) = \frac{S + A_V\omega_0}{S + \omega_0}$$

where $A_V = \frac{R1 + R5}{R5}$, $\omega_0 = \frac{1}{R1C1}$

A curve of -3 dB BW (ω_0) vs A_V is shown in the Typical Performance Curves.

Figure 3 shows a plot of recovered audio as a function of field strength in μV/M. The receiver section in this example is an LM3820. The power amplifier is located about two inches from the loopstick antenna. Speaker leads run parallel to the loopstick and are 1/8 inch from it. Referenced to a 20 dB S/N ratio, the improvement in noise performance over conventional designs is about 10 dB. This corresponds to an increase in usable sensitivity of about 8.5 dB.

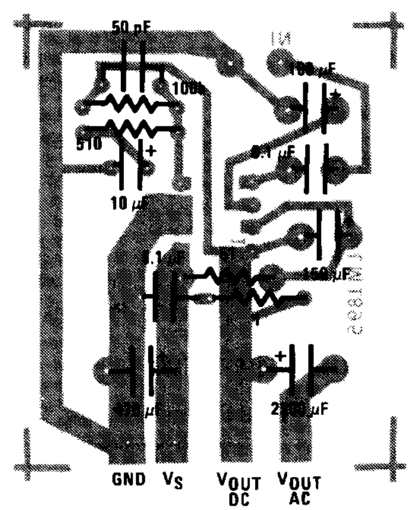

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FIGURE 4. Printed Circuit Board Layout for LM1895