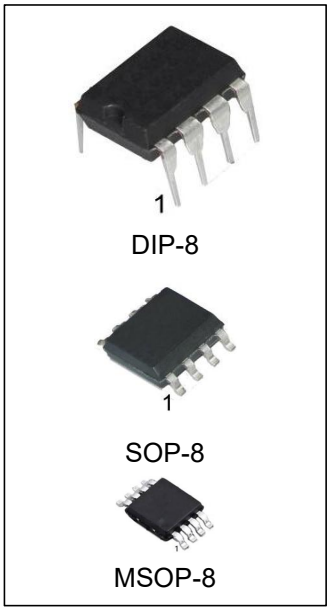
LM386 Low Voltage Audio Power Amplifier

General Description

The LM386 is a power amplifier designed for use in low volt- age consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value up to 200.

The inputs are ground referenced while the output is auto- matically biased to one half the supply voltage. The quies- cent power drain is only 24 milliwatts when operating from a 6 volt supply, making the LM386 ideal for battery operation.



Features

- Battery operation
- Minimum external parts
- Wide supply voltage range: 4V~12V or 5V~18V
- Low quiescent current drain: 4 mA
- Voltage gains from 20 to 200
- Ground referenced input
- Self-centering output quiescent voltage
- Low distortion
- Available in 8 pin DIP/SOP/MSOP package

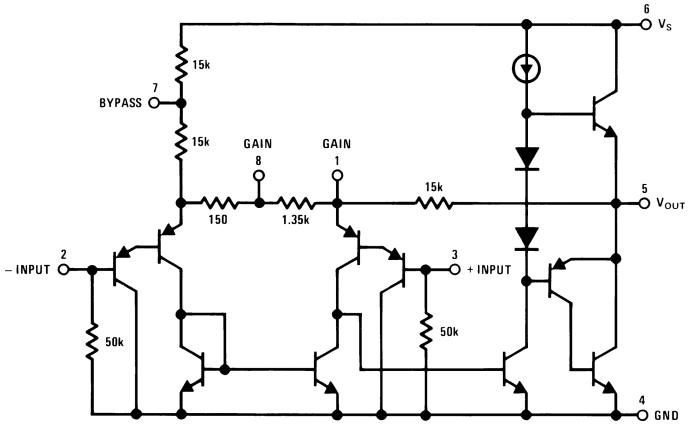
Applications

- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems
- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

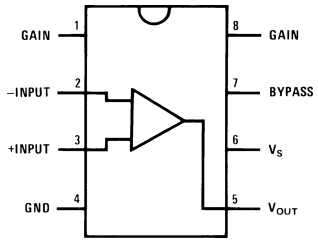
Ordering Information

DEVICE	Package Type	MARKING	Packing	Packing Qty
LM386N-1	DIP-8	LM386-1	TUBE	2000pcs/box
LM386N-3	DIP-8	LM386-3	TUBE	2000pcs/box
LM386N-4	DIP-8	LM386-4	TUBE	2000pcs/box
LM386M-1/TR	SOP-8	LM386-1	REEL	2500pcs/reel
LM386MM-1/TR	MSOP-8	Z86	REEL	3000pcs/reel

Equivalent Schematic and Connection Diagrams



DIP/SOP/MSOP



Absolute Maximum Ratings

Parameter	Limits
(LM386N-1, -3, LM386M-1)	15V
Supply Voltage (LM386N-4)	22V
Package Dissipation (Note 3)	
(LM386N)	1.25W
(LM386M)	0.73W
Input Voltage	0.4V
Storage Temperature	−65˚Cto+150˚C
Operating Temperature	0˚C to +70˚C
Junction Temperature	+150˚C
Soldering Information (Soldering 10 sec)	+260˚C
Thermal Resistance	
$_{JC}$(DIP)	37˚C/W
$_{JA}$(DIP)	107˚C/W
$_{JC}$(SOP Package)	35˚C/W
$_{JA}$(SOP Package)	172˚C/W
$_{JA}$(MSOP)	210˚C/W
$_{JA}$(MSOP)	56˚C/W

Electrical Characteristics (Notes 1, 2)T_A = 25˚C

Parameter	Conditions	Min	Typ	Max	Units
Operating Supply Voltage (V_S) LM386N-1, -3, LM386M-1, LM386MM-1, LM386N-4		 4 5		 12 18	 V
Quiescent Current (I_Q)	V_S = 6V, V_{IN} = 0		4	8	mA
Output Power (P_{OUT}) LM386N-1, LM386M-1,LM386MM-1 LM386N-3 LM386N-4	 V_S = 6V, R_L = 8Ω, THD = 10% V_S = 9V, R_L = 8Ω, THD = 10% V_S =16V, R_L =32Ω,THD= 10%	 250 500 700	 325 700 1000		 mW mW mW
Voltage Gain (A_V)	V_S = 6V, f = 1 kHz 10 μF from Pin 1 to 8		26 46		dB dB
Bandwidth (BW)	V_S = 6V, Pins 1 and 8 Open		300		kHz
Total Harmonic Distortion (THD)	V_S = 6V, R_L = 8Ω, P_{OUT} = 125 mW f = 1 kHz, Pins 1 and 8 Open		0.2		%
Power Supply Rejection Ratio (PSRR)	V_S = 6V, f = 1 kHz, C_{BYPASS} = 10 μF Pins 1 and 8 Open, Referred to Output		50		dB
Input Resistance (R_{IN}) Input Bias Current (I_{BIAS})	 V_S = 6V, Pins 2 and 3 Open		50 250		kΩ nA

Note 1: All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is func- tional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guar- antee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 3: For operation in ambient temperatures above 25˚C, the device must be derated based on a 150˚C maximum junction temperature and 1) a thermal resis- tance of 107˚C/W junction to ambient for the dual-in-line package and 2) a thermal resistance of 170˚C/W for the small outline package.

Application Hints

GAIN CONTROL

To make the LM386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open the 1.35 kΩ resistor sets the gain at 20 (26 dB). If a capacitor is put from pin 1 to 8, bypassing the 1.35 kΩ resistor, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. Gain control can also be done by capacitively cou- pling a resistor (or FET) from pin 1 to ground.

Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and fre- quency response for individual applications. For example, we can compensate poor speaker bass response by fre- quency shaping the feedback path. This is done with a series RC from pin 1 to 5 (paralleling the internal 15 kΩ resistor). For 6 dB effective bass boost: R ≈ 15 kΩ, the lowest value for good stable operation is R = 10 kΩ if pin 8 is open. If pins 1 and 8 are bypassed then R as low as 2 kΩ can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9.

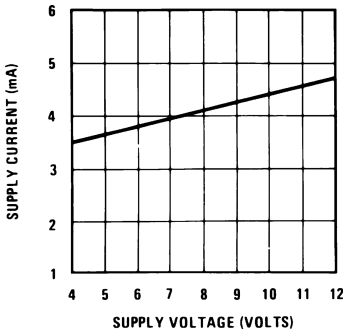
INPUT BIASING

The schematic shows that both inputs are biased to ground with a 50 kΩ resistor. The base current of the input transis- tors is about 250 nA, so the inputs are at about 12.5 mV when left open. If the dc source resistance driving the LM386 is higher than 250 kΩ it will contribute very little additional offset (about 2.5 mV at the input, 50 mV at the output). If the dc source resistance is less than 10 kΩ, then shorting the unused input to ground will keep the offset low (about 2.5 mV at the input, 50 mV at the output). For dc source resistances between these values we can eliminate excess offset by put- ting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset prob- lems are eliminated if the input is capacitively coupled.

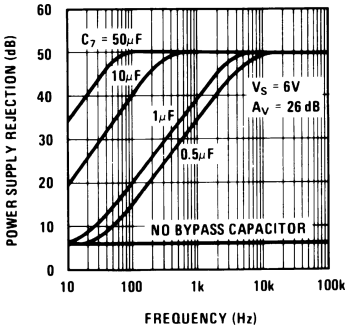
When using the LM386 with higher gains (bypassing the 1.35 kΩ resistor between pins 1 and 8) it is necessary to by- pass the unused input, preventing degradation of gain and possible instabilities. This is done with a 0.1 µF capacitor or a short to ground depending on the dc source resistance on the driven input.

Typical Performance Characteristics

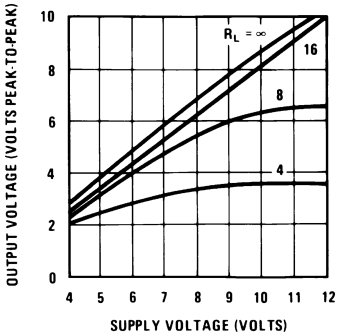
Quiescent Supply Current vs Supply Voltage



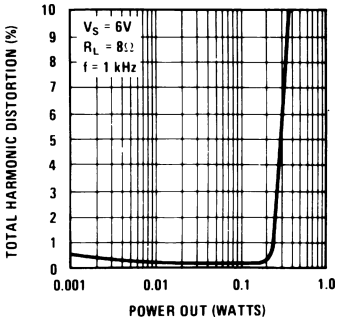
Power Supply Rejection Ratio(Referred to the Output) vs Frequency



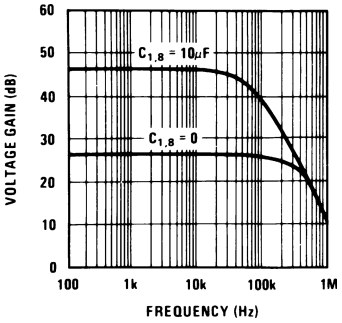
Peak-to-Peak Output Voltage Swing vs Supply Voltage



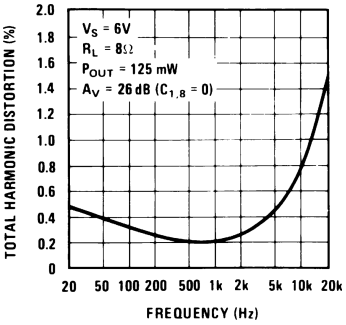
Voltage Gain vs Frequency



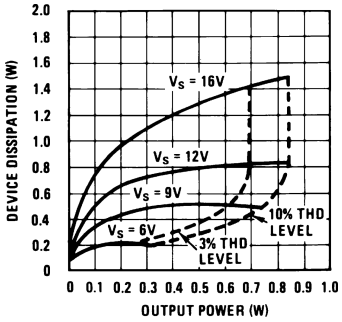
Distortion vs Frequency



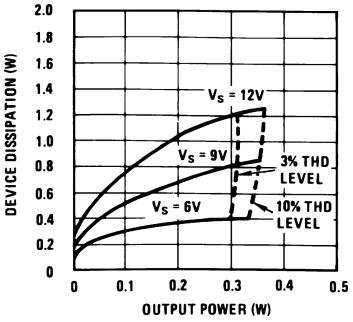
istortion vs Output Power



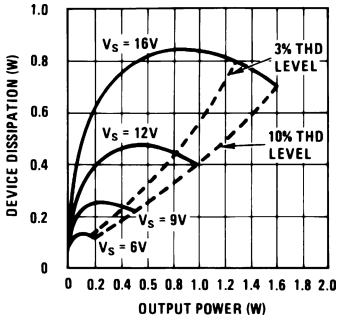
Device Dissipation vs Output Power-4Ω Load



Device Dissipation vs Output Power-8Ω Load

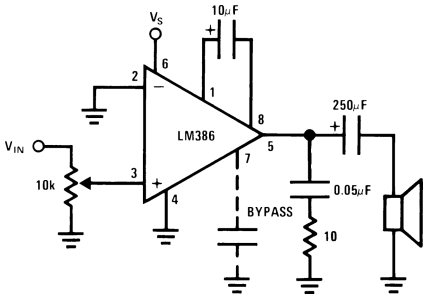


Device Dissipation vs Output Power-16Ω Load

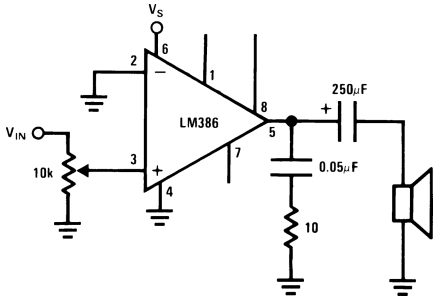


Typical Applications

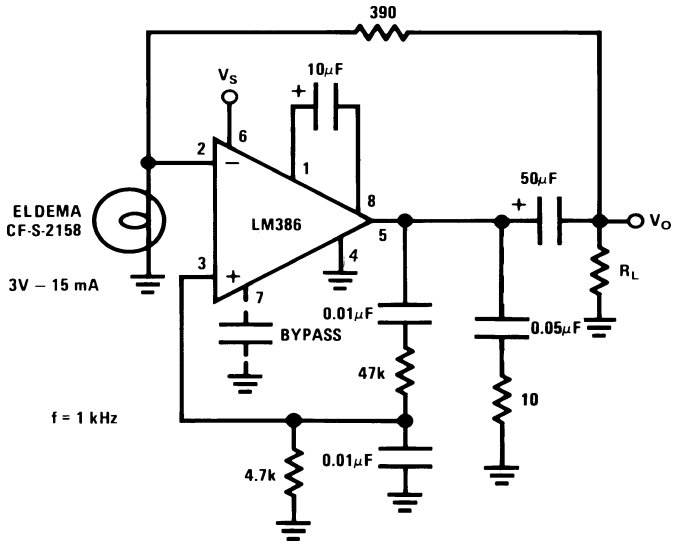
Amplifier with Gain=20 Minimum Parts



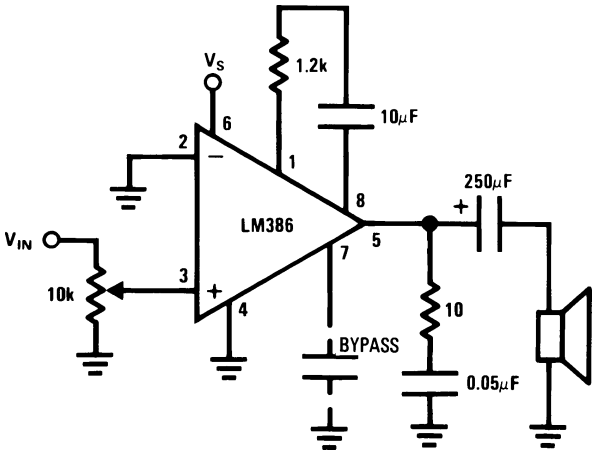
Amplifier with Gain = 200



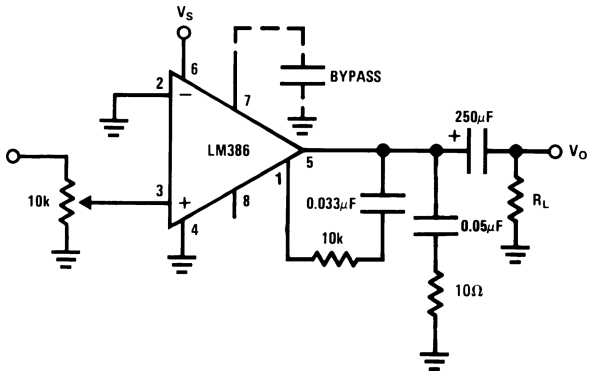
Amplifier with Gain = 50



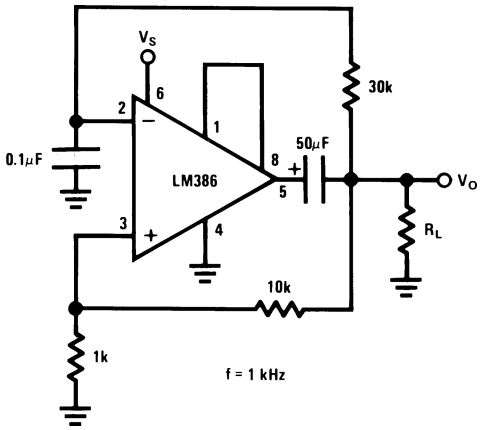
Low Distortion Power Wienbridge Oscillato



Amplifier with Bass Boost

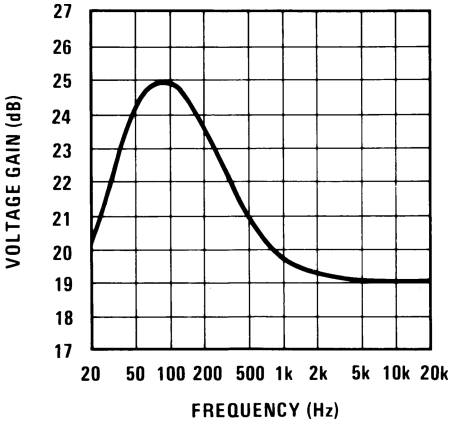


Square Wave Oscillator

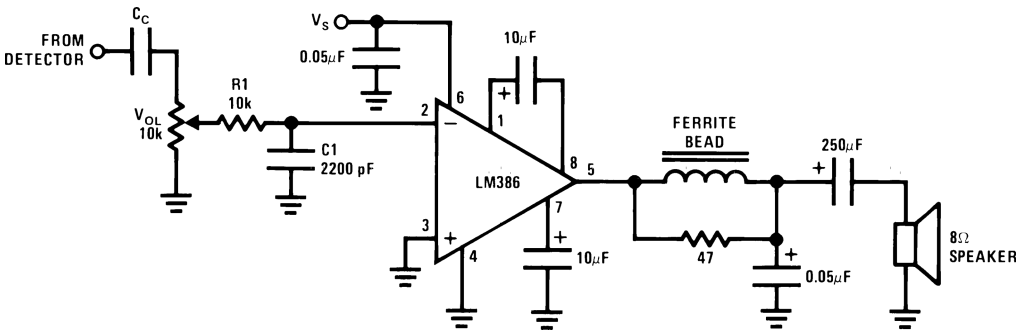


Typical Applications (Continued)

Frequency Response with Bass Boost



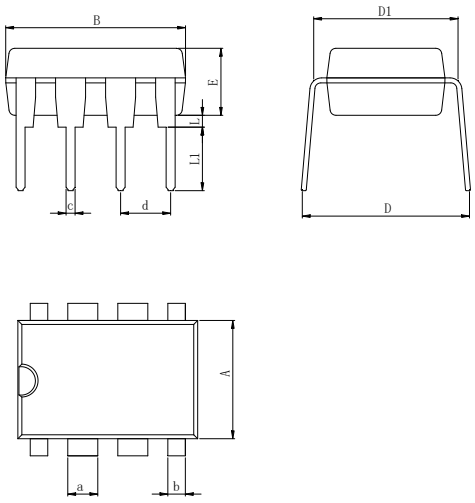
AM Radio Power Amplifier



Note 4: Twist Supply lead and supply ground very tightly.
Note 5: Twist speaker lead and ground very tightly.
Note 6: Ferrite bead in Ferroxcube K5-001-001/3B with 3 turns of wire.
Note 7: R1C1 band limits input signals.
Note 8: All components must be spaced very closely to IC.

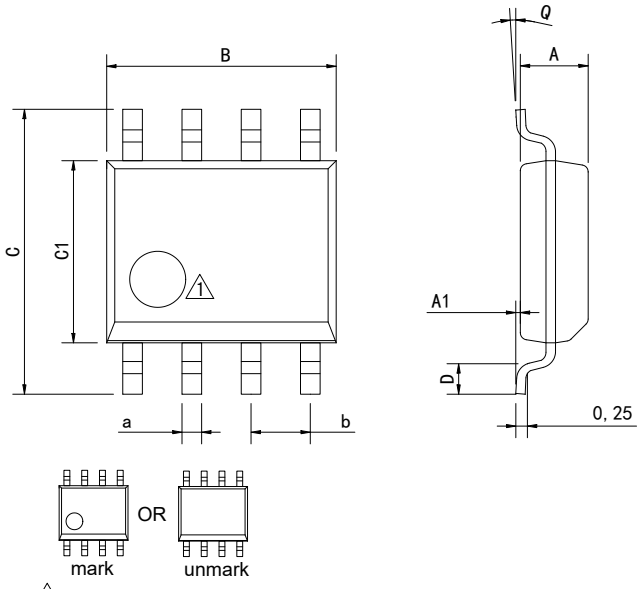
Physical Dimensions

DIP-8



Dimensions In Millimeters(DIP-8)											
Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	9.00	8.10	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	9.50	10.9	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

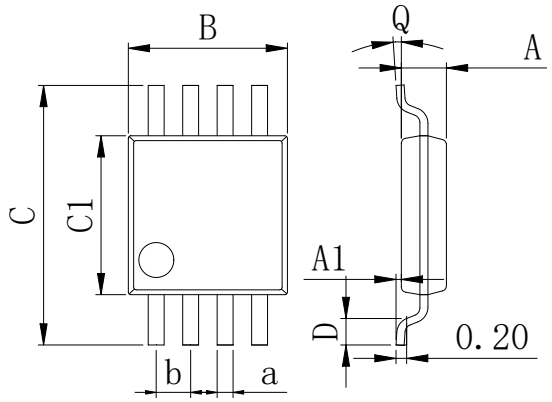
SOP-8



1 Package top mark may be in lower left corner or unmark

Dimensions In Millimeters(SOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

MSOP-8



Dimensions In Millimeters(MSOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.80	0.05	2.90	4.75	2.90	0.35	0°	0.25	0.65 BSC
Max:	0.90	0.20	3.10	5.05	3.10	0.75	8°	0.35	

Revision History

REVISION NUMBER	DATE	REVISION	PAGE
V1.0	2015-8	New	1-11
V1.1	2019-9	Update encapsulation type、Updated DIP-8 dimension.	1、8
V1.2	2024-11	Update Lead Temperature	2
V1.3	2025-12	Update important statements、Update sop-8 Dimension drawing	8、11

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