National Semiconductor

December 1994

LM831 Low Voltage Audio Power Amplifier

General Description

The LM831 is a dual audio power amplifier optimized for very low voltage operation. The LM831 has two independent amplifiers, giving stereo or higher power bridge (BTL) operation from two- or three-cell power supplies.

The LM831 uses a patented compensation technique to reduce high-frequency radiation for optimum performance in AM radio applications. This compensation also results in lower distortion and less wide-band noise.

The input is direct-coupled to the LM831, eliminating the usual coupling capacitor. Voltage gain is adjustable with a single resistor.

Features

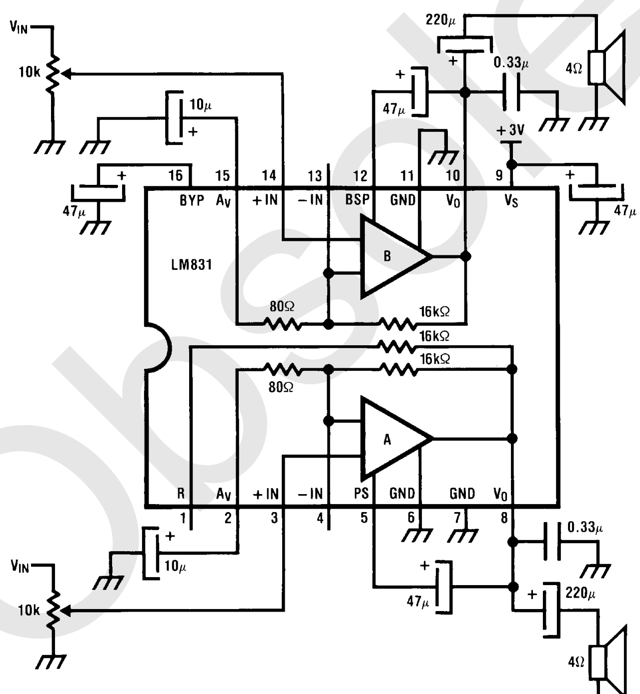
- Low voltage operation, 1.8V to 6.0V
- High power, 440 mW, 8Ω, BTL, 3V
- Low AM radiation
- Low noise
- Low THD

Applications

- Portable tape recorders
- Portable radios
- Headphone stereo
- Portable speakers

Typical Application

Dual Amplifier with Minimum Parts



TL/H/6754–1

$A_V = 46$ dB, BW = 250 Hz to 35 kHz

P_{OUT} = 220 mW/Ch, R_L = 4Ω

 RRD-B30M115/Printed in U. S. A.

Absolute Maximum Ratings

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

Supply Voltage, V_S	7.5V
Input Voltage, V_{IN}	±0.4V
Power Dissipation (Note 1), P_D	1.3W (M Package) 1.4W (N Package)
Operating Temperature (Note 1), T_{opr}	−40°C to +85°C
Storage Temperature, T_{stg}	−65°C to +150°C
Junction Temperature, T_j	+150°C
Lead Temp. (Soldering, 10 sec.), T_L	+260°C
Thermal Resistance	
θ_{JC} (DIP)	27°C/W
θ_{JA} (DIP)	75°C/W
θ_{JC} (SO Package)	20°C/W
θ_{JA} (SO Package)	95°C/W

Electrical Characteristics

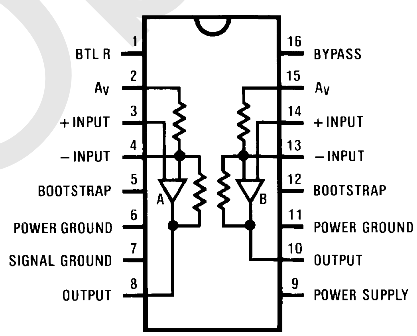
Unless otherwise specified, T_A = 25°C, V_S = 3V, f = 1 kHz, test circuit is dual or BTL amplifier with minimum parts.

Symbol	Parameter	Conditions	Typ	Tested Limit	Unit (Limit)
V_S	Operating Voltage		3 3	1.8 6	V(Min) V(Max)
I_Q	Supply Current	V_{IN} = 0, Dual Mode V_{IN} = 0, BTL Mode	5 6	10 15	mA (Max) mA (Max)
V_{OS}	Output DC Offset	V_{IN} = 0, BTL Mode	10	50	mV (Max)
R_{IN}	Input Resistance		25	15 35	k (Min) k (Max)
A_V	Voltage Gain	V_{IN} = 2.25 mV_{rms}, f = 1 kHz, Dual Mode	46	44 48	dB (Min) dB (Max)
PSRR	Supply Rejection	V_S = 3V + 200 mV_{rms} @ f = 1 kHz	46	30	dB (Min)
P_{OD}	Power Out	V_S = 3V, R_L = 4Ω, 10% THD, Dual Mode	220	150	mW (Min)
P_{ODL}	Power Out Low, V_S	V_S = 1.8V, R_L = 4Ω, 10% THD, Dual Mode	45	10	mW (Min)
P_{OB}	Power Out	V_S = 3V, R_L = 8Ω, 10% THD, BTL Mode	440	300	mW (Min)
P_{OBL}	Power Out Low, V_S	V_S = 1.8V, R_L = 8Ω, 10% THD, BTL Mode	90	20	mW (Min)
Sep	Channel Separation	Referenced to V_O = 200 mV_{rms}	52	40	dB (Min)
I_B	Input Bias Current		1	2	μA (Max)
E_{n0}	Output Noise	Wide Band (250 ~ 35 kHz)	250	500	μV (Max)
THD	Distortion	V_S = 3V, P_O = 50 mW, f = 1 kHz, Dual	0.25	1	% (Max)

Note 1: For operation in ambient temperatures above 25°C, the device must be derated based on a 150°C maximum junction temperature and a thermal resistance of 98°C/W junction to ambient for the M package or 90°C/W junction to ambient for the N package.

Connection Diagram

Dual-In-Line Package



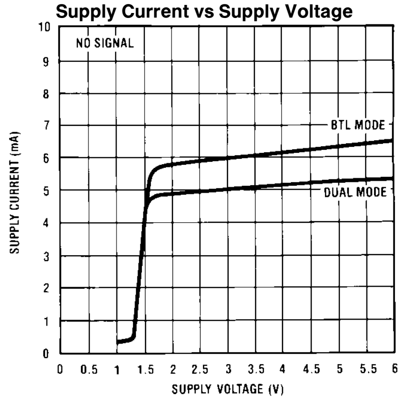
TL/H/6754–2

Top View

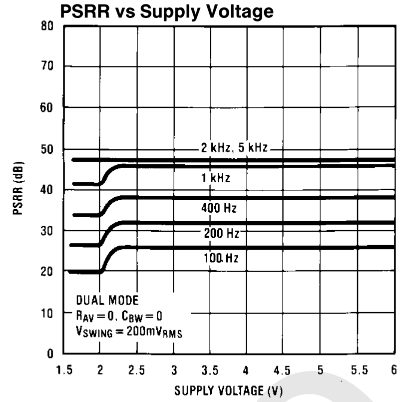
Order Number LM831M or N
See NS Package Number M16B or N16E

Typical Performance Characteristics

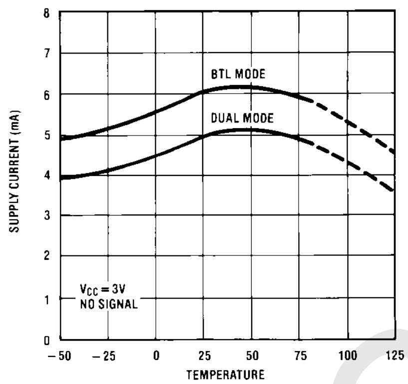
Supply Current vs Supply Voltage



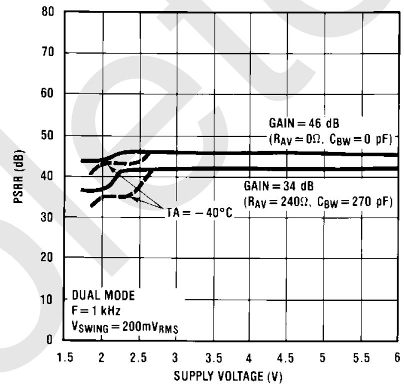
PSRR vs Supply Voltage



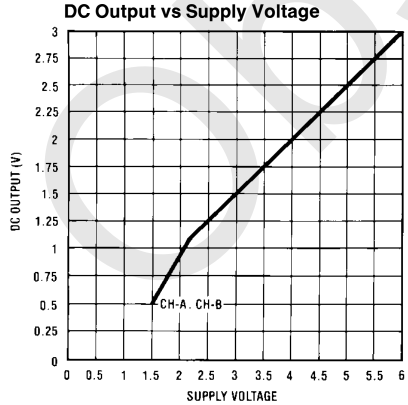
Supply Current vs Temperature



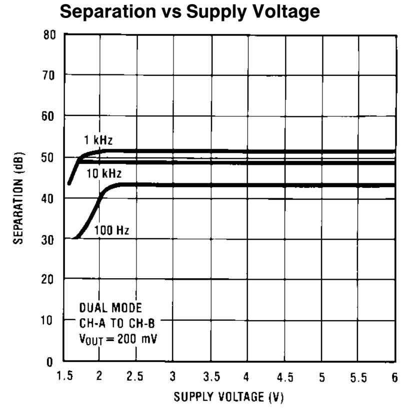
PSRR vs Supply Voltage



DC Output vs Supply Voltage



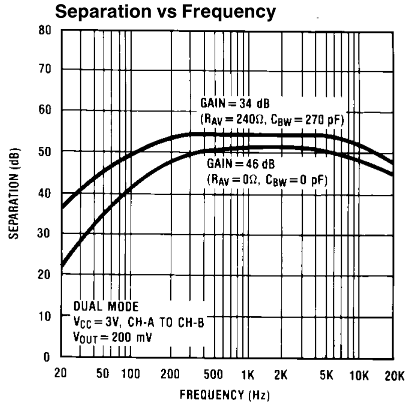
Separation vs Supply Voltage



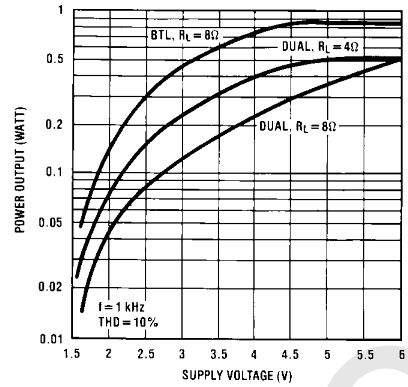
TL/H/6754–4

Typical Performance Characteristics (Continued)

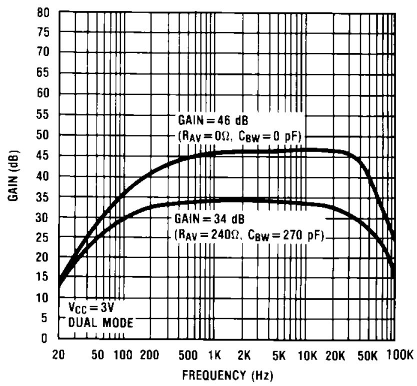
Separation vs Frequency



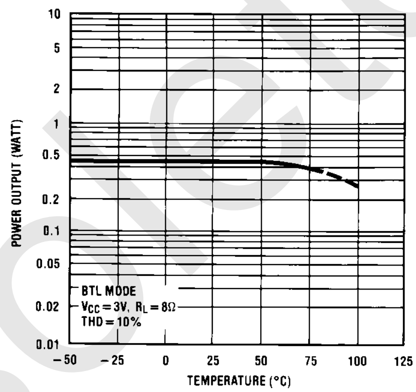
Power Output vs Supply Voltage



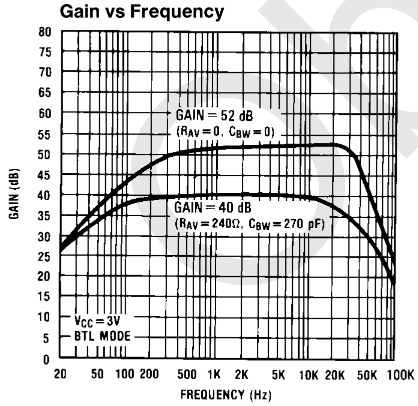
Gain vs Frequency



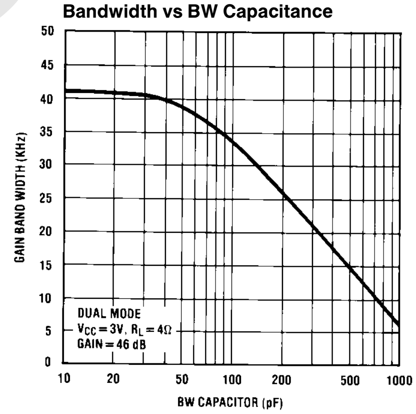
Power Output vs Temperature



Gain vs Frequency



Bandwidth vs BW Capacitance



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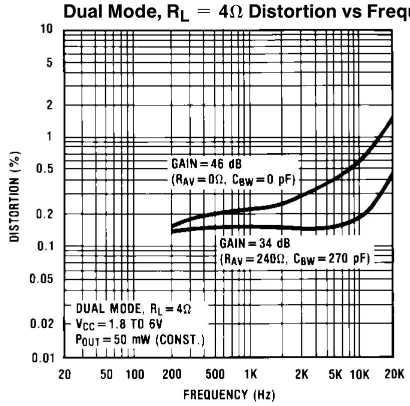
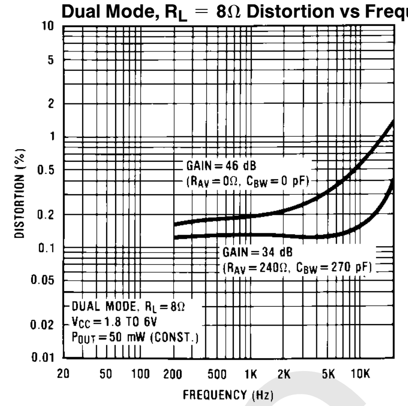
Typical Performance Characteristics (Continued)

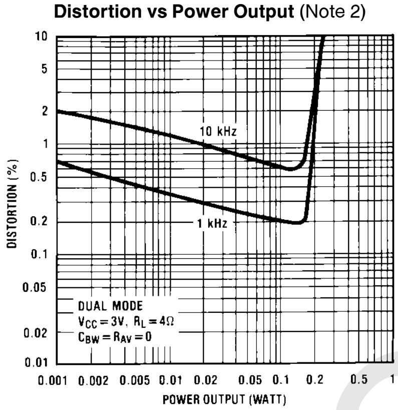
Dual Mode, R_L = 4Ω Distortion vs Frequency



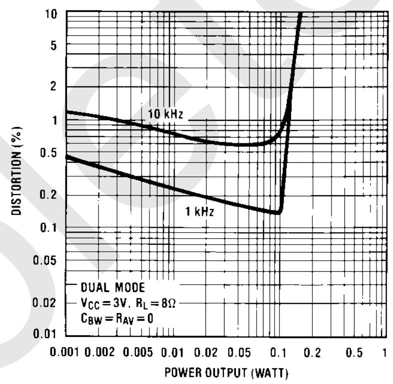
Dual Mode, R_L = 8Ω Distortion vs Frequency



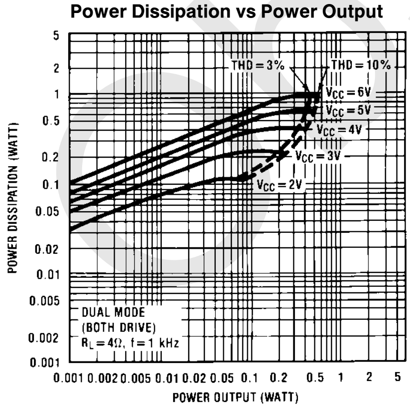
Distortion vs Power Output (Note 2)



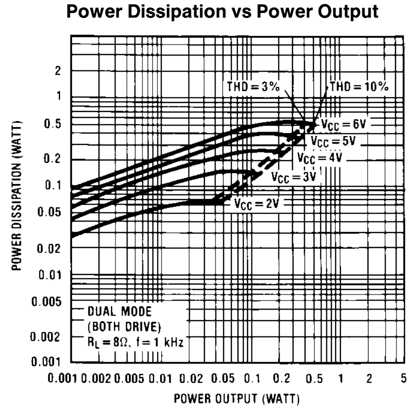
Distortion vs Power Output (Note 2)



Power Dissipation vs Power Output



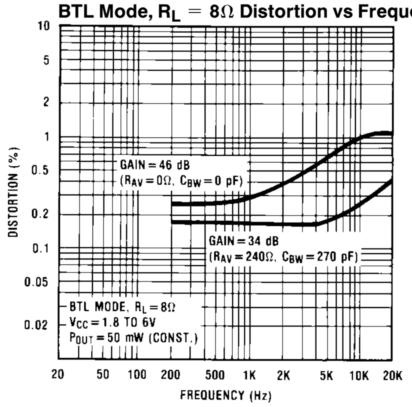
Power Dissipation vs Power Output



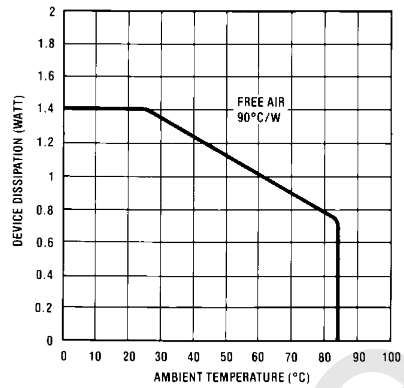
TL/H/6754–6

Typical Performance Characteristics (Continued)

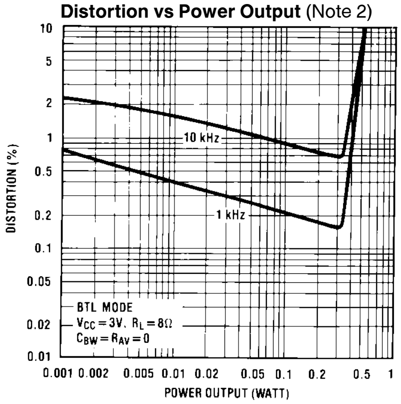
BTL Mode, $R_L = 8\Omega$ Distortion vs Frequency



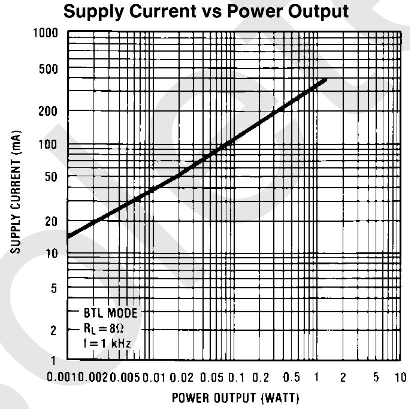
Device Dissipation vs Ambient Temperature



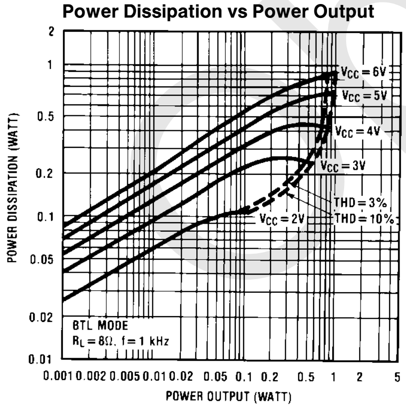
Distortion vs Power Output (Note 2)



Supply Current vs Power Output



Power Dissipation vs Power Output

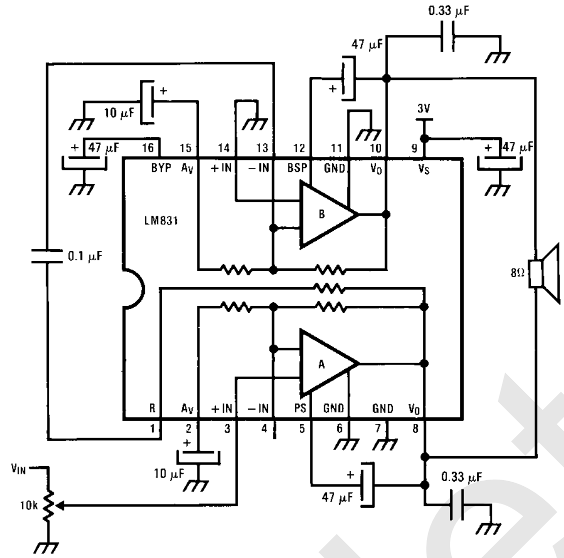


Note 2: 1 kHz curve is measured with 400 Hz–30 kHz Filter.

TL/H/6754–7

Typical Applications

BTL Amplifier with Minimum Parts

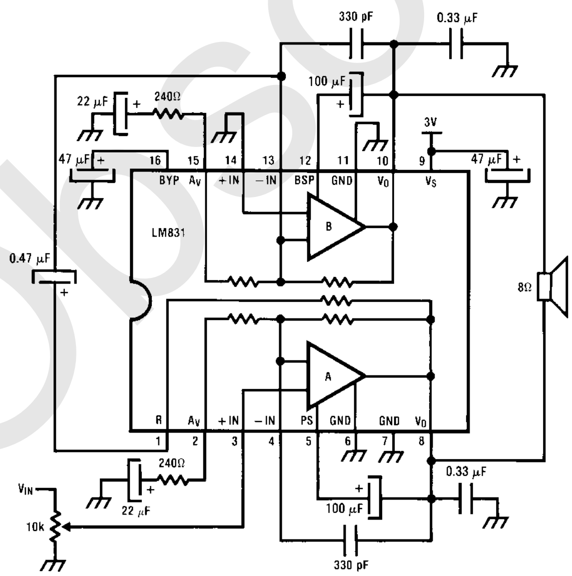


TL/H/6754–8

A_V = 52 dB, BW = 250 Hz to 25 kHz

P_{OUT} = 440 mW, R_L = 8Ω

BTL Amplifier for Hi-Fi Quality



TL/H/6754–9

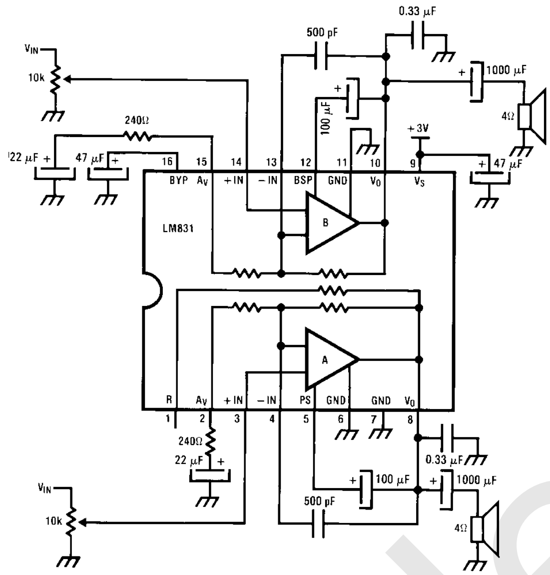
A_V = 40 dB, BW = 20 Hz to 20 kHz

P_{OUT} = 440 mW, R_L = 8Ω

(Dynamic Range Over 80 dB)

Typical Applications (Continued)

Dual Amplifier for Hi-Fi Quality



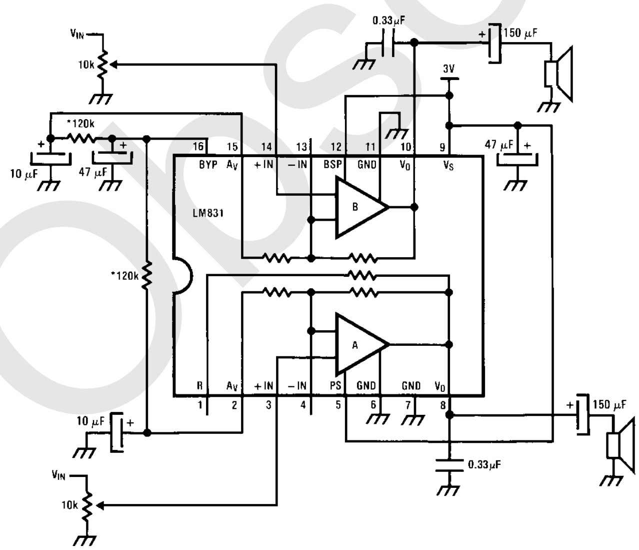
TL/H/6754–10

A_V = 34 dB, BW = 50 Hz to 20 kHz

P_{OUT} = 220 mW/Ch, R_L = 4Ω

(Dynamic Range Over 80 dB)

Low-Cost Power Amplifier (No Bootstrap)



TL/H/6754–11

P_{OUT} = 150 mW/Ch, BW = 300 Hz to 35 kHz

BTL Mode is also possible

*For 3-cell applications, the 120k resistor should be changed to 20K.

LM831 Circuit Description

Refer to the external component diagram and equivalent schematic.

The power supply is applied to Pin 9 and is filtered by resistor R_1 and capacitor C_{BY} on Pin 16. This filtered voltage at Pin 16 is used to bias all of the LM831 circuits except the power output stage. Resistor R_0 generates a biasing current that sets the output DC voltage for optimum output power for any given supply voltage.

Feedback is provided to the input transistor Q_1 emitter by R_6 and R_7.

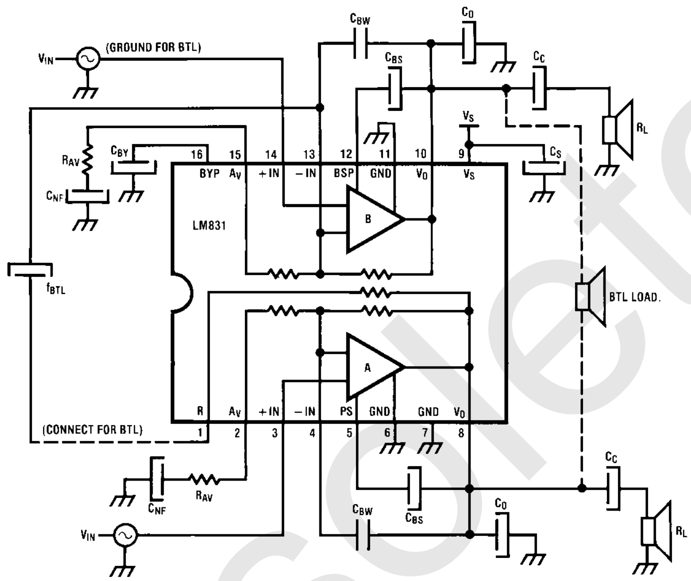
The capacitor C_{NF} on Pin 2 provides unity DC gain for maximum DC accuracy.

Q_2 provides voltage gain and the rest of the devices buffer the output load from Q_2's collector.

Bootstrapping of Pin 5 by C_{BS} allows maximum output swing and improved supply rejection.

R_5 is provided for bridge (BTL) operation.

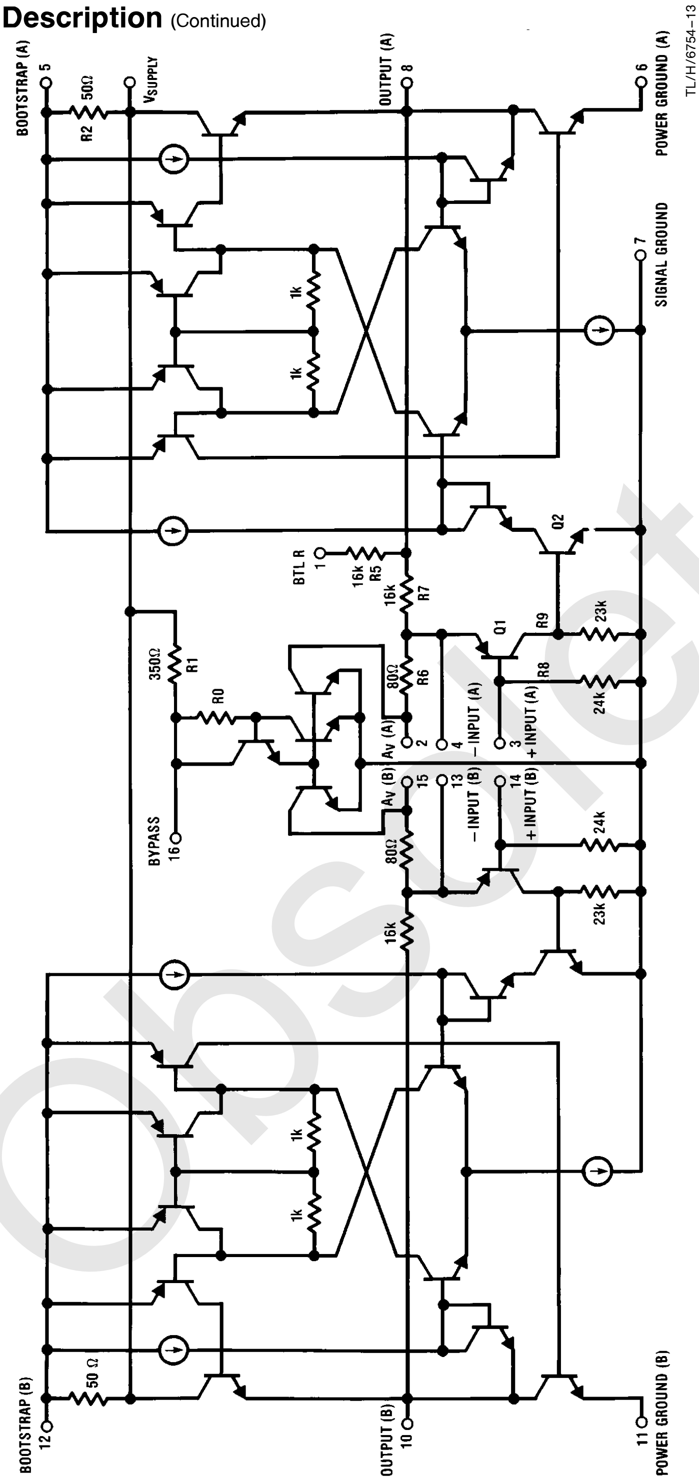
External Component Diagram



TL/H/6754–12

LM831 Circuit Description (Continued)

LM831 Equivalent Schematic

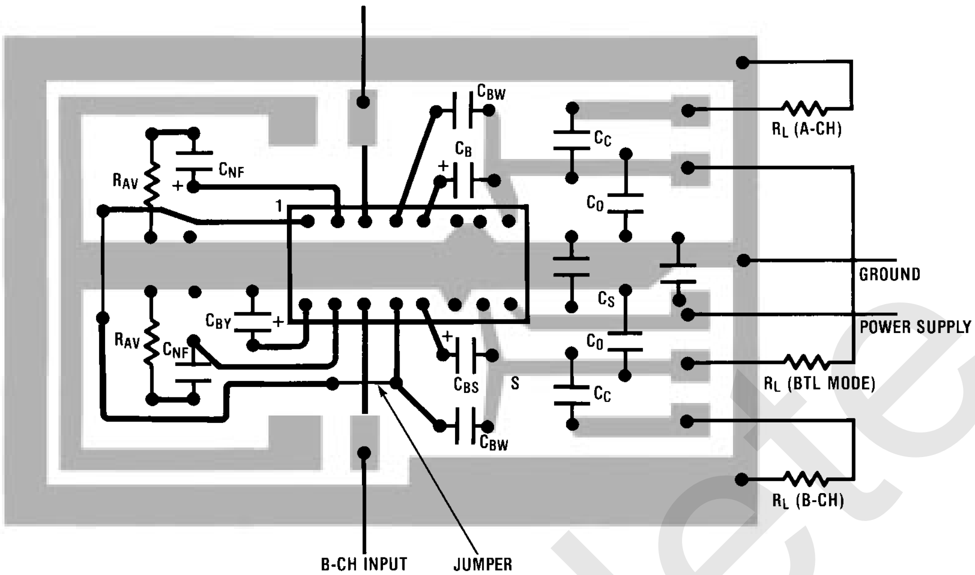


External Components (Refer to External Component Diagram)

Component	Comments	Min	Max
C_O	Required to stabilize output stage.	0.33 µF	1 µF
C_c	Output coupling capacitors for Dual Mode. Sets a low-frequency pole in the frequency response. $f_L = \frac{1}{2\pi C_c R_L}$	100 µF	10,000 µF
C_{BS}	Bootstrap capacitors. Sets a low-frequency pole in the power BW. Recommended value is $C_{BS} = \frac{1}{10 \bullet 2\pi \bullet f_L \bullet R_L}$	22 µF or (short Pins 4 & 12 to 9)	470 µF
C_S	Supply bypass. Larger values improve low-battery performance by reducing supply ripple.	47 µF	10,000 µF
C_{BY}	Filters the supply for improved low-voltage operation. Also sets turn-on delay.	47 µF	470 µF
C_{NF}	Sets a low-frequency response. Also affects turn-on delay. $f_L = \frac{1}{2\pi \bullet C_{NF} \bullet (R_{AV} + 80)}$ In BTL Mode, C_{NF} on Pin 15 can be reduced without affecting the frequency response. However, the turn-on "POP" will be worsened.	10 µF	100 µF
C_{BTL}	Used only in the Bridge Mode. Connects the output of the first amplifier to the inverting input of the other through an internal resistor. Sets a low-frequency pole in one-half the frequency response. $f_L = \frac{1}{2\pi \bullet C_{BTL} \bullet 16k}$	0.1 µF	1 µF
C_{BW}	Improves clipping waveform and sets the high-frequency bandwidth. Works with an internal 16k resistor. (This equation applies for $R_{AV} \neq 0$. For 46 dB application, see BW−C_{BW} curve.) $f_H = \frac{1}{2\pi \bullet C_{BW} \bullet 16k}$	See table below	
R_{AV}	Used to reduce the gain and improve the distortion and signal to noise. If this is desired, C_{BW} must also be used.	See table below	

Typical A_V	R_{AV}	C_{BW}	
		Min	Max
46 dB	Short	Open	4700 pF
40 dB	82	100 pF	4700 pF
34 dB	240	270 pF	4700 pF
28 dB	560	500 pF	4700 pF

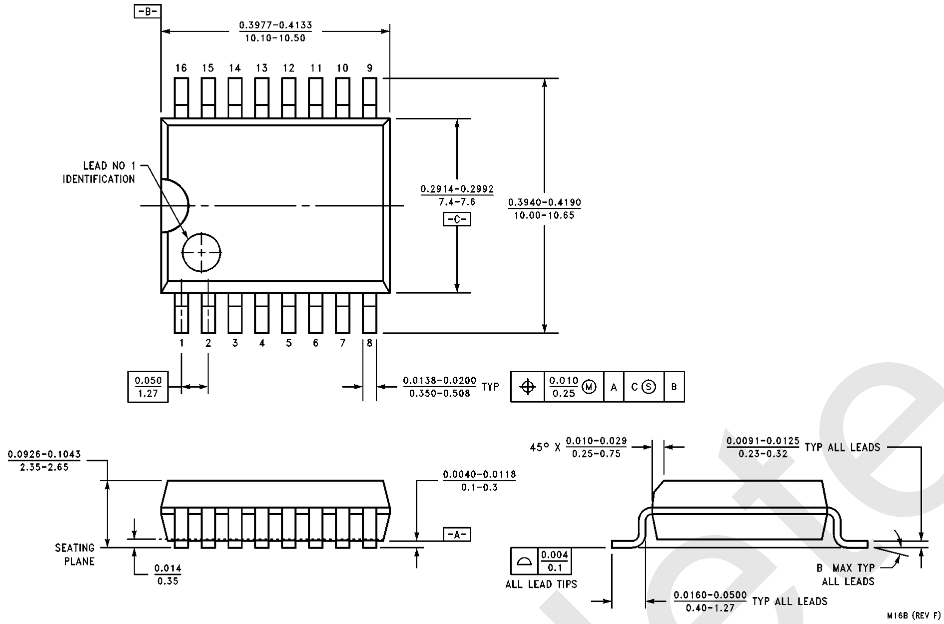
Printed Circuit Layout for LM831N (Foil Side View) Refer to External Component Diagram



TL/H/6754–14

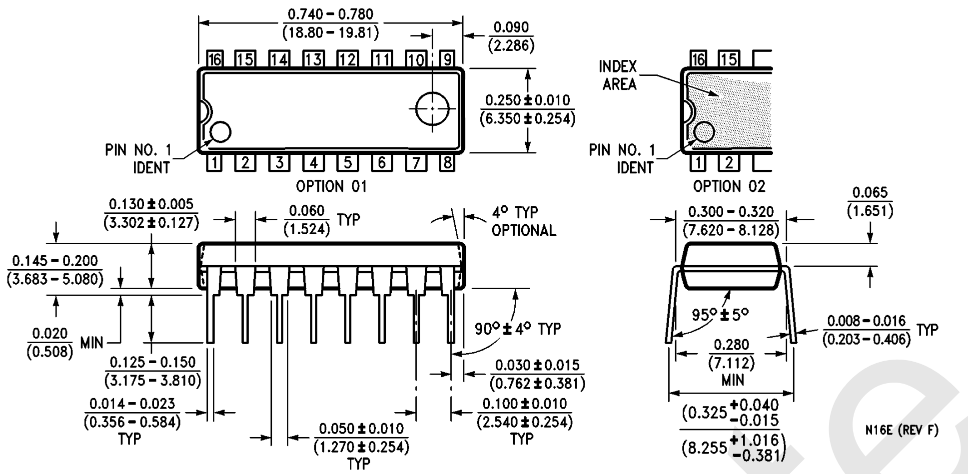
Note: Power ground pattern should be as wide as possible. Supply bypass capacitor should be as close to the IC as possible. Output compensation capacitors should also be close to the IC.

Physical Dimensions inches (millimeters)



Molded SO Package (M)
Order Number LM831M
NS Package Number M16B

Physical Dimensions inches (millimeters) (Continued)



Molded Dual-In-Line Package (N)
Order Number LM831N
NS Package Number N16E

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