

# LM4840 Boomer® Audio Power Amplifier Series

## Stereo 2W Audio Power Amplifiers

### with Digital Volume Control and Input Mux

#### General Description

The LM4840 is a monolithic integrated circuit that provides digital volume control and stereo bridged audio power amplifiers capable of producing 2W into 4Ω (Note 1) with less than 1.0% THD or 2.2W into 3Ω (Note 2) with less than 1.0% THD.

Boomer® audio integrated circuits were designed specifically to provide high quality audio while requiring a minimum amount of external components. The LM4840 incorporates a digital volume control, stereo bridged audio power amplifiers, an input mux, and a last volume level memory function to save the volume setting during shutdown. These features make it optimally suited for multimedia monitors, portable radios, desktop, and portable computer applications.

The LM4840 features an externally controlled, low-power consumption shutdown mode, and both a power amplifier and headphone mute for maximum system flexibility and performance.

**Note 1:** When properly mounted to the circuit board, the LM4840LQ and LM4840MH will deliver 2W into 4Ω. The LM4840MT will deliver 1.1W into 8Ω. See the Application Information section LM4840LQ and for LM4840MH usage information.

**Note 2:** An LM4840LQ and LM4840MH that have been properly mounted to the circuit board and forced-air cooled will deliver 2.2W into 3Ω.

#### Key Specifications

- P<sub>O</sub> at 1% THD+N
  - into 3Ω (LM4840LQ, LM4840MH) 2.2W (typ)
  - into 4Ω (LM4840LQ, LM4840MH) 2.0W (typ)
  - into 8Ω (LM4840) 1.1W (typ)
- Single-ended mode - THD+N at 85mW into 32Ω 1.0% (typ)
- Shutdown current 0.2μA (typ)

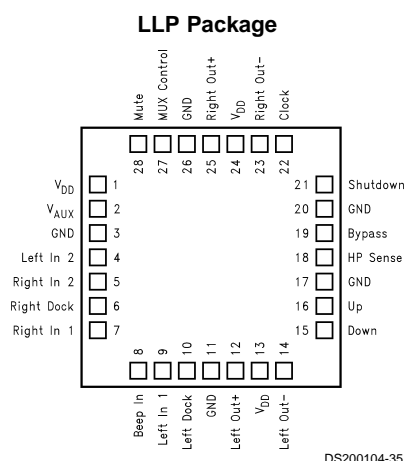
#### Features

- PC98 and PC99 Compliant
- Digital Volume Control Interface
- System Beep Detect
- Stereo switchable bridged/single-ended power amplifiers
- "Click and pop" suppression circuitry
- Thermal shutdown protection circuitry
- Input Mux
- Capless headphone drivers
- Last volume memory from shutdown

#### Applications

- Portable and Desktop Computers
- Multimedia Monitors
- Portable Radios, PDAs, and Portable TVs

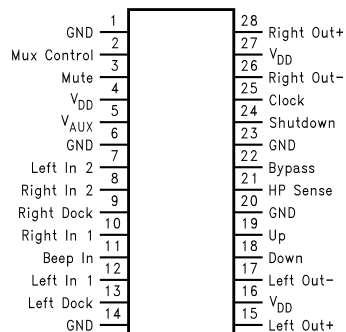
#### Connection Diagram



**Top View**  
**Order Number LM4840LQ**  
**See NS Package Number LQA028A for Exposed-DAP LLP**

# Connection Diagram (Continued)

## TSSOP Package



DS200104-2

## Top View

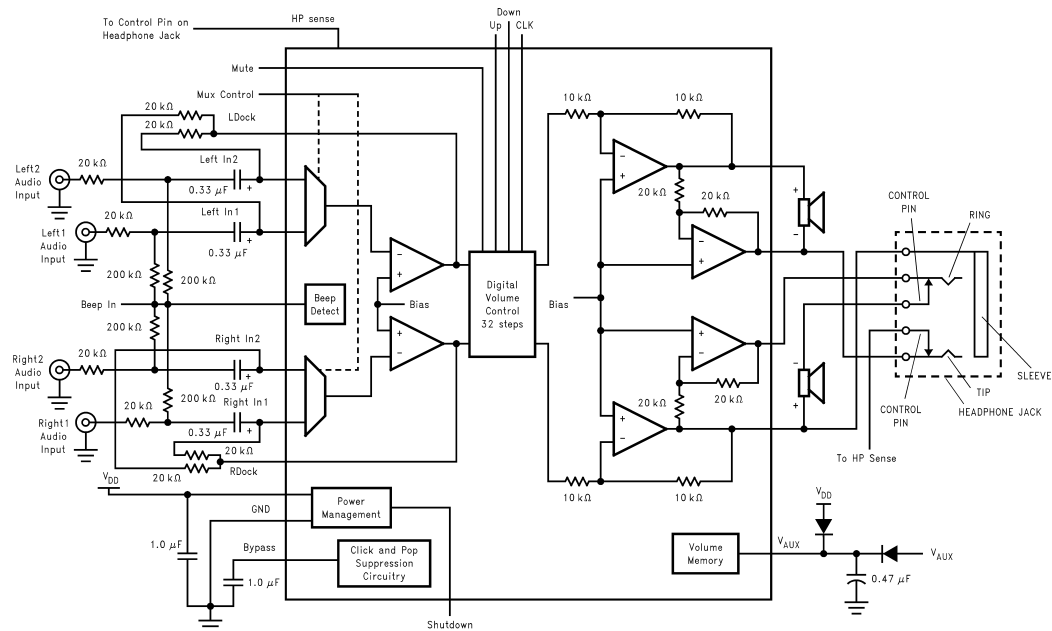
Order Number LM4840MT

See NS Package Number MTC28 for TSSOP

Order Number LM4840MH

See NS Package Number MXA28A for Exposed-DAP TSSOP

## Block Diagram



DS200104-1

FIGURE 1. LM4840 Block Diagram

## Absolute Maximum Ratings (Note 10)

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

Supply Voltage	6.0V
Storage Temperature	-65°C to +150°C
Input Voltage	-0.3V to $V_{DD} + 0.3V$
Power Dissipation	Internally limited
ESD Susceptibility (Note 12)	2000V
ESD Susceptibility (Note 13)	200V
Junction Temperature	150°C
Soldering Information	
Small Outline Package	
Vapor Phase (60 sec.)	215°C
Infrared (15 sec.)	220°C

See AN-450 "Surface Mounting and their Effects on Product Reliability" for other methods of soldering surface mount devices.

See AN-1187 "Leadless Leadframe Package" for detailed information on usage of LLP devices.

$\theta_{JC}$ (typ)—LQA028A (Note A)	3°C/W
$\theta_{JA}$ (typ)—LQA028A (Note B)	42°C/W
$\theta_{JC}$ (typ)—MTC28	20°C/W
$\theta_{JA}$ (typ)—MTC28	80°C/W
$\theta_{JC}$ (typ)—MXA28A	2°C/W
$\theta_{JA}$ (typ)—MXA28A (Note 4)	41°C/W
$\theta_{JA}$ (typ)—MXA28A (Note 3)	54°C/W
$\theta_{JA}$ (typ)—MXA28A (Note 5)	59°C/W
$\theta_{JA}$ (typ)—MXA28A (Note 6)	93°C/W

## Operating Ratings

Temperature Range	$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$
Supply Voltage	$2.7V \leq V_{DD} \leq 5.5V$

## Electrical Characteristics for Entire IC

(Notes 7, 10)

The following specifications apply for  $V_{DD} = 5V$  unless otherwise noted. Limits apply for  $T_A = 25^{\circ}\text{C}$ .

Symbol	Parameter	Conditions	LM4840		Units (Limits)
			Typical (Note 14)	Limit (Note 15)	
$V_{DD}$	Supply Voltage			2.7	V (min)
				5.5	V (max)
$I_{DD}$	Quiescent Power Supply Current	$V_{IN} = 0V, I_O = 0A$	12	30	mA (max)
$I_{SD}$	Shutdown Current	$V_{SHUTDOWN} = V_{DD}$	0.7	2.0	$\mu A$ (max)
$V_{IH}$	Headphone Sense High Input Voltage			4	V (min)
$V_{IL}$	Headphone Sense Low Input Voltage			0.8	V (max)

## Electrical Characteristics for Volume Attenuators

(Notes 7, 10)

The following specifications apply for  $V_{DD} = 5V$ . Limits apply for  $T_A = 25^{\circ}\text{C}$ .

Symbol	Parameter	Conditions	LM4840		Units (Limits)
			Typical (Note 14)	Limit (Note 15)	
$C_{RANGE}$	Attenuator Range	Gain with Digital Volume Max	0	$\pm 0.5$	dB (max)
		Attenuation with Digital Volume Min	-81	-75	dB (min)
$A_M$	Mute Attenuation	$V_{pin\ 3} = 5V$ , Bridged Mode	-88	-78	dB (min)
		$V_{pin\ 3} = 5V$ , Single-Ended Mode	-88	-78	dB (min)

## Electrical Characteristics for Single-Ended Mode Operation

(Notes 7, 10)

The following specifications apply for  $V_{DD} = 5V$ . Limits apply for  $T_A = 25^{\circ}\text{C}$ .

Symbol	Parameter	Conditions	LM4840		Units (Limits)
			Typical (Note 14)	Limit (Note 15)	
$P_O$	Output Power	THD = 1.0%; $f = 1\text{kHz}$ ; $R_L = 32\Omega$	85		mW
		THD = 10%; $f = 1\text{kHz}$ ; $R_L = 32\Omega$	95		mW
THD+N	Total Harmonic Distortion+Noise	$V_{OUT} = 1V_{RMS}$ , $f=1\text{kHz}$ , $R_L = 10k\Omega$ , $A_{VD} = 1$	0.065		%

## Electrical Characteristics for Single-Ended Mode Operation (Continued)

(Notes 7, 10)

The following specifications apply for  $V_{DD} = 5V$ . Limits apply for  $T_A = 25^\circ C$ .

Symbol	Parameter	Conditions	LM4840		Units (Limits)
			Typical (Note 14)	Limit (Note 15)	
PSRR	Power Supply Rejection Ratio	$C_B = 1.0 \mu F$ , $f = 120 \text{ Hz}$ , $V_{RIPPLE} = 200 \text{ mVrms}$	58		dB
SNR	Signal to Noise Ratio	$P_{OUT} = 75 \text{ mW}$ , $R_L = 32\Omega$ , A-Wtd Filter	102		dB
$X_{talk}$	Channel Separation	$f = 1 \text{ kHz}$ , $C_B = 1.0 \mu F$	65		dB

## Electrical Characteristics for Bridged Mode Operation

(Notes 7, 10)

The following specifications apply for  $V_{DD} = 5V$ , unless otherwise noted. Limits apply for  $T_A = 25^\circ C$ .

Symbol	Parameter	Conditions	LM4840		Units (Limits)
			Typical (Note 14)	Limit (Note 15)	
$V_{OS}$	Output Offset Voltage	$V_{IN} = 0V$	5	50	mV (max)
$P_O$	Output Power	THD + N = 1.0%; $f = 1 \text{ kHz}$ ; $R_L = 3\Omega$ (Note 8)	2.2		W
		THD + N = 1.0%; $f = 1 \text{ kHz}$ ; $R_L = 4\Omega$ (Note 9)	2		W
		THD = 1.5% (max); $f = 1 \text{ kHz}$ ; $R_L = 8\Omega$	1.1	1.0	W (min)
		THD+N = 10%; $f = 1 \text{ kHz}$ ; $R_L = 8\Omega$	1.5		W
THD+N	Total Harmonic Distortion+Noise	$P_O = 1W$ , $20 \text{ Hz} < f < 20 \text{ kHz}$ , $R_L = 8\Omega$ , $A_{VD} = 2$	0.3		%
		$P_O = 340 \text{ mW}$ , $R_L = 32\Omega$	1.0		%
PSRR	Power Supply Rejection Ratio	$C_B = 1.0 \mu F$ , $f = 120 \text{ Hz}$ , $V_{RIPPLE} = 200 \text{ mVrms}$ ; $R_L = 8\Omega$	74		dB
SNR	Signal to Noise Ratio	$V_{DD} = 5V$ , $P_{OUT} = 1.1W$ , $R_L = 8\Omega$ , A-Wtd Filter	93		dB
$X_{talk}$	Channel Separation	$f = 1 \text{ kHz}$ , $C_B = 1.0 \mu F$	70		dB

**Note 3:** The  $\theta_{JA}$  given is for an MXA28A package whose exposed-DAP is soldered to an exposed  $2 \text{ in}^2$  piece of 1 ounce printed circuit board copper.

**Note 4:** The  $\theta_{JA}$  given is for an MXA28A package whose exposed-DAP is soldered to a  $2 \text{ in}^2$  piece of 1 ounce printed circuit board copper on a bottom side layer through 21 8mil vias.

**Note 5:** The  $\theta_{JA}$  given is for an MXA28A package whose exposed-DAP is soldered to an exposed  $1 \text{ in}^2$  piece of 1 ounce printed circuit board copper.

**Note 6:** The  $\theta_{JA}$  given is for an MXA28A package whose exposed-DAP is not soldered to any copper.

**Note 7:** All voltages are measured with respect to the ground pins, unless otherwise specified. All specifications are tested using the typical application as shown in Figure 1.

**Note 8:** When driving  $3\Omega$  loads from a 5V supply the LM4840LQ and LM4840MH must be mounted to the circuit board and forced-air cooled.

**Note 9:** When driving  $4\Omega$  loads from a 5V supply the LM4840LQ and LM4840MH must be mounted to the circuit board.

**Note 10:** *Absolute Maximum Ratings* indicate limits beyond which damage to the device may occur. *Operating Ratings* indicate conditions for which the device is functional, but do not guarantee specific performance limits. *Electrical Characteristics* state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Marshall Chiu feels there are better ways to obtain 'More Wattage in the Cottage.' Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

**Note 11:** The maximum power dissipation must be derated at elevated temperatures and is dictated by  $T_{JMAX}$ ,  $\theta_{JA}$ , and the ambient temperature  $T_A$ . The maximum allowable power dissipation is  $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ . For the LM4840LQ and LM4840MT,  $T_{JMAX} = 150^\circ C$ , and the typical junction-to-ambient thermal resistance, when board mounted, is  $80^\circ C/W$  for the MTC28 package and  $TBD^\circ C/W$  for the LM4840LQ package.

**Note 12:** Human body model, 100 pF discharged through a 1.5 k $\Omega$  resistor.

**Note 13:** Machine Model, 220 pF–240 pF discharged through all pins.

**Note 14:** Typicals are specified at  $25^\circ C$  and represent the parametric norm.

**Note 15:** Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.

## Application Information (Continued)

### Table 1: Logic Level Truth Table

SD	BEEP DETECT	MUTE	HP SENSE	MODE	R-	R+	L-	L+	
L	L	L	L	BTL SPK	ON	ON	ON	ON	
L	L	L	H	HP	ON	ON (buffer)	ON	OFF	
L	L	H	L	BTLSPK	ON	ON	ON	ON	*Amps are muted
L	L	H	H	HP	ON	ON (buffer)	ON	OFF	*Amps are muted
*Next four conditions, beep is detected; beep signal added to audio signal and bypasses volume control (unity)									
L	H	L	L	BTL SPK	ON	ON	ON	ON	
L	H	L	H	HP	ON	ON (buffer)	ON	ON	
L	H	H	L	BTL SPK	ON	ON	ON	ON	*Dual Mode
L	H	H	H	HP	ON	ON (buffer)	ON	ON	*Dual Mode
*Next eight conditions turns off all amps									
H	L	L	L	BTL SPK	OFF	OFF	OFF	OFF	
H	L	L	H	HP	OFF	OFF	OFF	OFF	
H	L	H	L	BTL SPK	OFF	OFF	OFF	OFF	
H	L	H	H	HP	OFF	OFF	OFF	OFF	
H	H	L	L	BTL SPK	OFF	OFF	OFF	OFF	
H	H	L	H	HP	OFF	OFF	OFF	OFF	
H	H	H	L	BTL SPK	OFF	OFF	OFF	OFF	
H	H	H	H	HP	OFF	OFF	OFF	OFF	

\*Beepdetect signal overrides any mute. For example, if amp is muted and bpdetect is HIGH, then amp is no longer muted.

\*\*Dual mode: When HP jack is inserted, load A (speaker corresponding to outputs A- and A+) is physically disconnected. Load B remains connected; however, amp B+ is off and differentially there is no voltage across it. If a beep is detected (i.e. beepdetect = HIGH), then summed signal (audio + beep signals) is heard in the headphones and on speaker B.

## Application Information (Continued)

Table 2: LM4840 Volume Control Steps

Volume Step	$R_{in}$ (k $\Omega$ )	$R_f$ (k $\Omega$ )	BTL (dB)	SE (dB)
1	350.00	350.00	6.00	0.00
2	370.00	330.00	5.00	-1.00
3	390.00	310.00	4.00	-2.00
4	410.00	290.00	3.00	-3.00
5	429.00	271.00	2.00	-4.00
6	448.00	252.00	1.00	-5.00
7	466.00	233.50	0.00	-6.00
8	500.50	199.50	-2.00	-8.00
9	532.00	168.00	-4.00	-10.00
10	559.00	140.50	-6.00	-12.00
11	583.50	116.50	-8.00	-14.00
<b>12</b>	<b>604.00</b>	<b>96.00</b>	<b>-10.00</b>	<b>-16.00</b>
13	621.50	78.50	-12.00	-18.00
14	636.50	63.50	-14.00	-20.00
15	648.50	51.50	-16.00	-22.00
16	658.50	41.50	-18.00	-24.00
17	666.50	33.50	-20.00	-26.00
18	673.00	27.00	-21.90	-27.90
19	678.50	21.50	-24.00	-30.00
20	683.00	17.00	-26.10	-32.10
21	686.50	13.50	-28.10	-34.10
22	689.00	11.00	-29.90	-35.90
23	692.00	8.00	-32.70	-38.70
24	694.50	5.50	-36.00	-42.00
25	696.00	4.00	-38.80	-44.80
26	697.00	3.00	-41.30	-47.30
27	698.00	2.00	-44.90	-50.90
28	699.00	1.00	-50.90	-56.90
29	699.50	0.50	-56.90	-62.90
30	699.80	0.25	-62.90	-68.90
31	700.00	0.10	-70.90	-76.90
32	700.00	0.10	-70.90	-76.90