National Semiconductor

March 2001

# LM4835 Boomer® Audio Power Amplifier Series
# Stereo 2W Audio Power Amplifiers with DC Volume Control and Selectable Gain

## General Description

The LM4835 is a monolithic integrated circuit that provides DC 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 LM4835 incorporates a DC volume control, stereo bridged audio power amplifiers and a selectable gain or bass boost, making it optimally suited for multimedia monitors, portable radios, desktop, and portable computer applications.

The LM4835 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 LM4835LQ and LM4835MTE will deliver 2W into 4Ω. The LM4835MT will deliver 1.1W into 8Ω. See the Application Information section LM4835LQ and for LM4835MTE usage information.

**Note 2:** An LM4835LQ and LM4835MTE that have been properly mounted to the circuit board and forced-air cooled will deliver 2.2W into 3Ω.

## Key Specifications

- $P_O$ at 1% THD+N
- into 3Ω (LM4835LQ, LM4835MTE) 2.2W (typ)
- into 4Ω (LM4835LQ, LM4835MTE) 2.0W (typ)
- into 8Ω (LM4835) 1.1W (typ)
- Single-ended mode - THD+N at 85mW into 32Ω 1.0% (typ)
- Shutdown current 0.7µA (typ)

## Features

- PC98 Compliant
- DC Volume Control Interface
- System Beep Detect
- Stereo switchable bridged/single-ended power amplifiers
- Selectable internal/external gain and bass boost configurable
- “Click and pop” suppression circuitry
- Thermal shutdown protection circuitry

## Applications

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

## Block Diagram

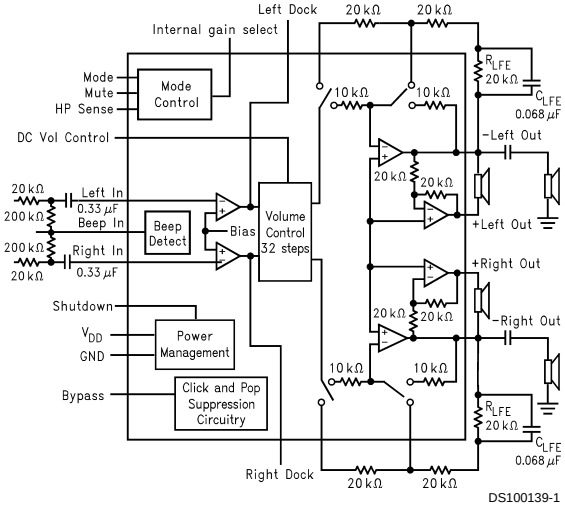
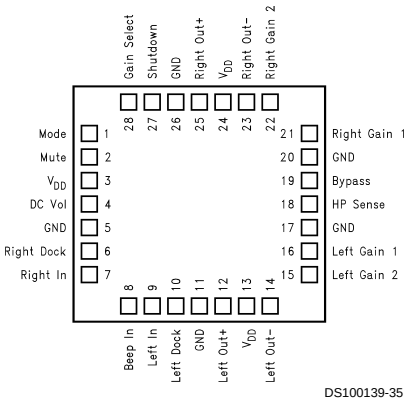



**FIGURE 1. LM4835 Block Diagram**

## Connection Diagram

**LLP Package**




**Top View**
**Order Number LM4835LQ**
**See NS Package Number LQA028AA for Exposed-DAP LLP**

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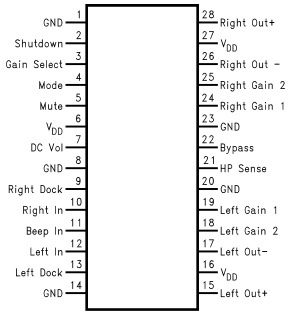
## Connection Diagram (Continued)

**TSSOP Package**




DS100139-2

**Top View**
**Order Number LM4835MT**
**See NS Package Number MTC28 for TSSOP**
**Order Number LM4835MTE**
**See NS Package Number MXA28A for Exposed-DAP TSSOP**

## 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.

| | |
|---|---|
| $\theta_{JC}$ (typ)—LQA028AA (Note A) | TBD˚C/W |
| $\theta_{JA}$ (typ)—LQA028AA (Note B) | TBD˚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 | |
| $T_{MIN} \le T_A \le T_{MAX}$ | −40˚C ≤TA ≤ 85˚C |
| Supply Voltage | 2.7V≤ $V_{DD}$ ≤ 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˚C.

| Symbol | Parameter | Conditions | LM4835 | | 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 | 15 | 30 | mA (max) |
| $I_{SD}$ | Shutdown Current | $V_{pin\ 2} = V_{DD}$ | 0.7 | 2.0 | µA (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˚C.

| Symbol | Parameter | Conditions | LM4835 | | Units (Limits) |
|---|---|---|---|---|---|
| | | | Typical (Note 14) | Limit (Note 15) | |
| $C_{RANGE}$ | Attenuator Range | Gain with $V_{pin\ 7}$ = 5V | 0 | ±0.5 | dB (max) |
| | | Attenuation with $V_{pin\ 7}$ = 0V | -81 | -80 | dB (min) |
| $A_M$ | Mute Attenuation | $V_{pin\ 5}$ = 5V, Bridged Mode | -88 | -80 | dB (min) |
| | | $V_{pin\ 5}$ = 5V, Single-Ended Mode | -88 | -80 | 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˚C.

| Symbol | Parameter | Conditions | LM4835 | | Units (Limits) |
|---|---|---|---|---|---|
| | | | Typical (Note 14) | Limit (Note 15) | |
| $P_O$ | Output Power | THD = 1.0%; f = 1kHz; $R_L$ = 32Ω | 85 | | mW |
| | | THD = 10%; f = 1 kHz; $R_L$ = 32Ω | 95 | | mW |
| THD+N | Total Harmonic Distortion+Noise | $V_{OUT}$ = 1$V_{RMS}$, f=1kHz, $R_L$ = 10kΩ, $A_{VD}$ = 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˚C.

| Symbol | Parameter | Conditions | LM4835 | | Units (Limits) |
|---|---|---|---|---|---|
| | | | Typical (Note 14) | Limit (Note 15) | |
| PSRR | Power Supply Rejection Ratio | $C_B$ = 1.0 µF, f =120 Hz, $V_{RIPPLE}$ = 200 mVrms | 58 | | dB |
| SNR | Signal to Noise Ratio | $P_{OUT}$ =75 mW, $R_L$ = 32Ω, A-Wtd Filter | 102 | | dB |
| $X_{talk}$ | Channel Separation | f=1kHz, $C_B$ = 1.0 µF | 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˚C.

| Symbol | Parameter | Conditions | LM4835 | | Units (Limits) |
|---|---|---|---|---|---|
| | | | Typical (Note 14) | Limit (Note 15) | |
| $V_{OS}$ | Output Offset Voltage | $V_{IN}$ = 0V | 5 | 30 | mV (max) |
| $P_O$ | Output Power | THD + N = 1.0%; f=1kHz; $R_L$ = 3Ω (Note 8) | 2.2 | | W |
| | | THD + N = 1.0%; f=1kHz; $R_L$ = 4Ω (Note 9) | 2 | | W |
| | | THD = 0.5% (max);f = 1 kHz; $R_L$ = 8Ω | 1.1 | 1.0 | W (min) |
| | | THD+N = 10%;f = 1 kHz; $R_L$ = 8Ω | 1.5 | | W |
| THD+N | Total Harmonic Distortion+Noise | $P_O$ = 1W, 20 Hz< f < 20 kHz, $R_L$ = 8Ω, $A_{VD}$ = 2 | 0.3 | | % |
| | | $P_O$ = 340 mW, $R_L$ = 32Ω | 1.0 | | % |
| PSRR | Power Supply Rejection Ratio | $C_B$ = 1.0 µF, f = 120 Hz, $V_{RIPPLE}$ = 200 mVrms; $R_L$ = 8Ω | 74 | | dB |
| SNR | Signal to Noise Ratio | $V_{DD}$ = 5V, $P_{OUT}$ = 1.1W, $R_L$ = 8Ω, A-Wtd Filter | 93 | | dB |
| $X_{talk}$ | Channel Separation | f=1kHz, $C_B$ = 1.0 µF | 70 | | dB |

**Note 3:** The $\theta_{JA}$ given is for an MXA28A package whose exposed-DAP is soldered to an exposed 2in $^2$ 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 2in$^2$ 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 1in $^2$ 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 3Ω loads from a 5V supply the LM4835LQ and LM4835MTE must be mounted to the circuit board and forced-air cooled.

**Note 9:** When driving 4Ω loads from a 5V supply the LM4835LQ and LM4835MTE 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 LM4835LQ and LM4835MT, $T_{JMAX}$ = 150˚C, and the typical junction-to-ambient thermal resistance, when board mounted, is 80˚C/W for the MTC28 package and TBD˚C/W for the LM4835LQ package.

**Note 12:** Human body model, 100 pF discharged through a 1.5 kΩ resistor.

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

**Note 14:** Typicals are measured at 25˚C and represent the parametric norm.

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

## Typical Application

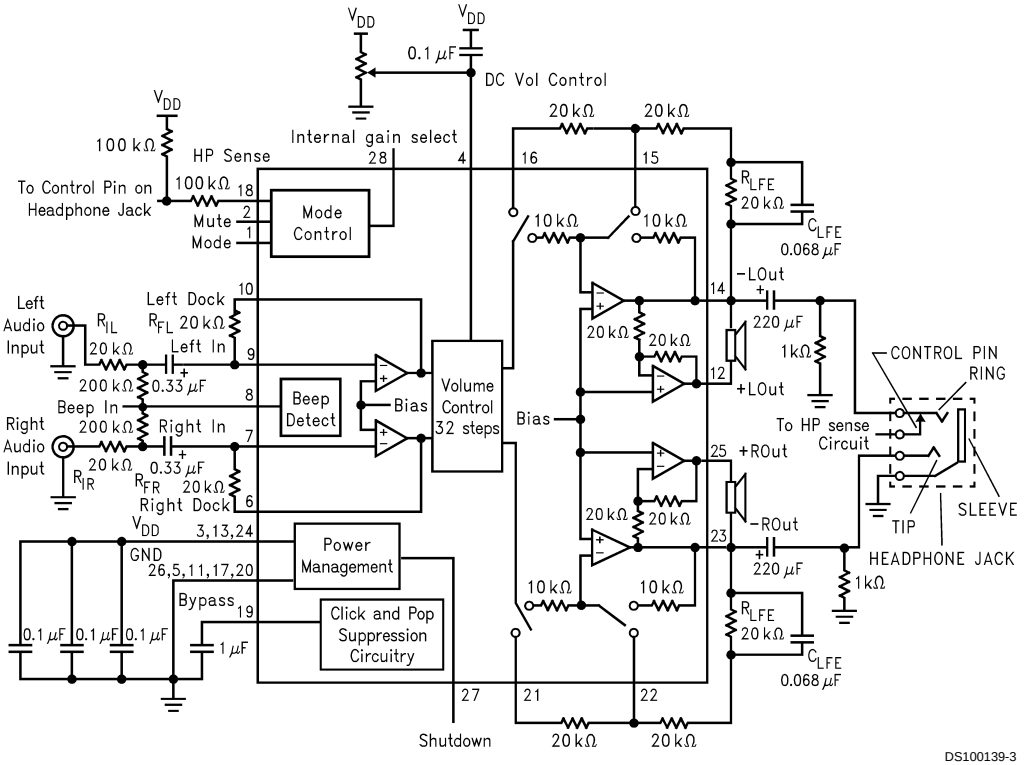



**FIGURE 2. Typical Application Circuit**

## Truth Table for Logic Inputs (Note 16)

| Mute | Mode | HP Sense | DC Vol. Control | Bridged Output | Single-Ended Output |
|---|---|---|---|---|---|
| 0 | 0 | 0 | Fixed Level | Vol. Fixed | _ |
| 0 | 0 | 1 | Fixed Level | Muted | Vol. Fixed |
| 0 | 1 | 0 | Adjustable | Vol. Changes | _ |
| 0 | 1 | 1 | Adjustable | Muted | Vol. Changes |
| 1 | X | X | _ | Muted | Muted |

**Note 16:** If system beep is detected on the Beep In pin (pin 11), the system beep will be passed through the bridged amplifier regardless of the logic of the Mute and HP sense pins.

## Application Information (Continued)

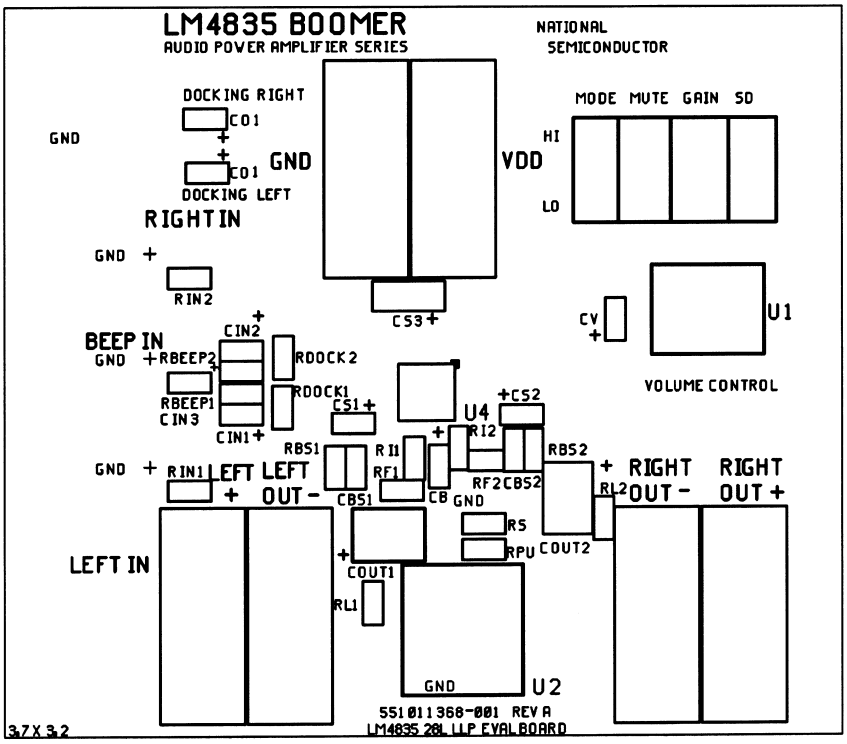



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**Figure 6. Recommended LQ PC Board Layout: Component-Side Silkscreen**

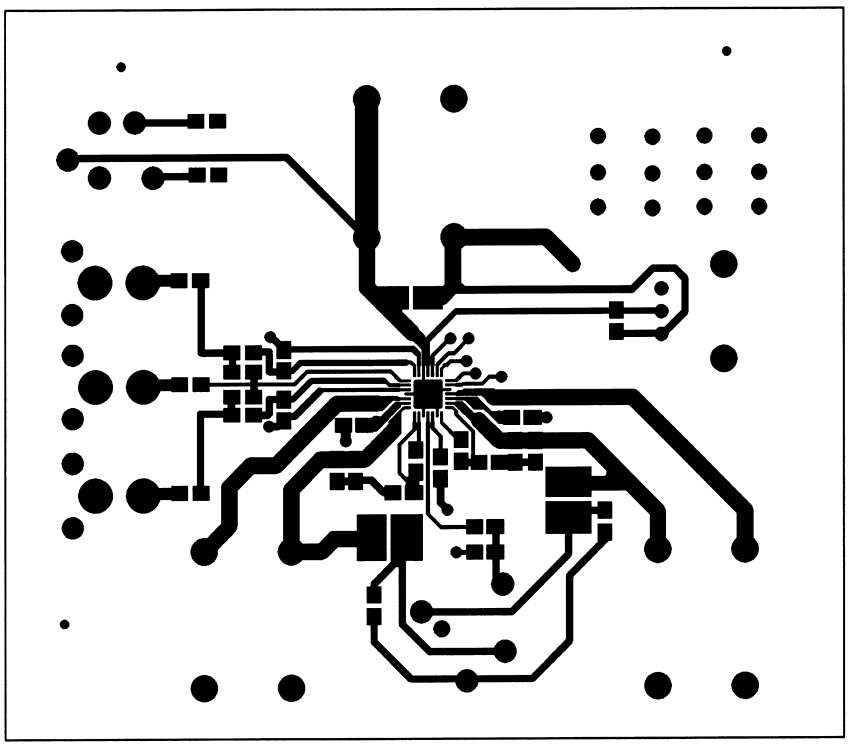

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**Figure 7. Recommended LQ PC Board Layout: Component-Side Layout**

## Application Information (Continued)

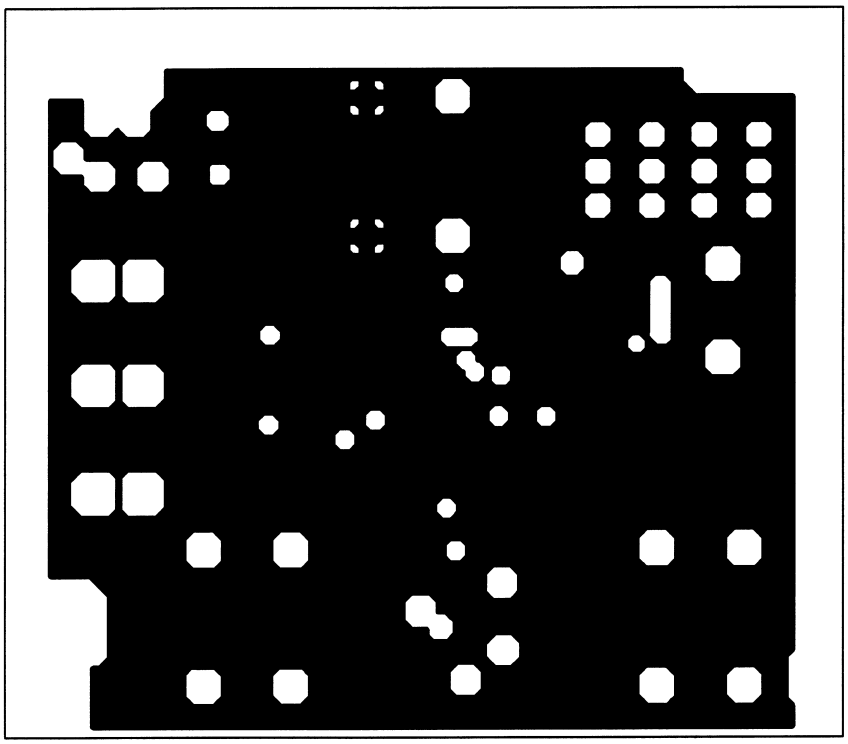

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**Figure 8. Recommended LQ PC Board Layout:
Upper Inner-Layer Layout**

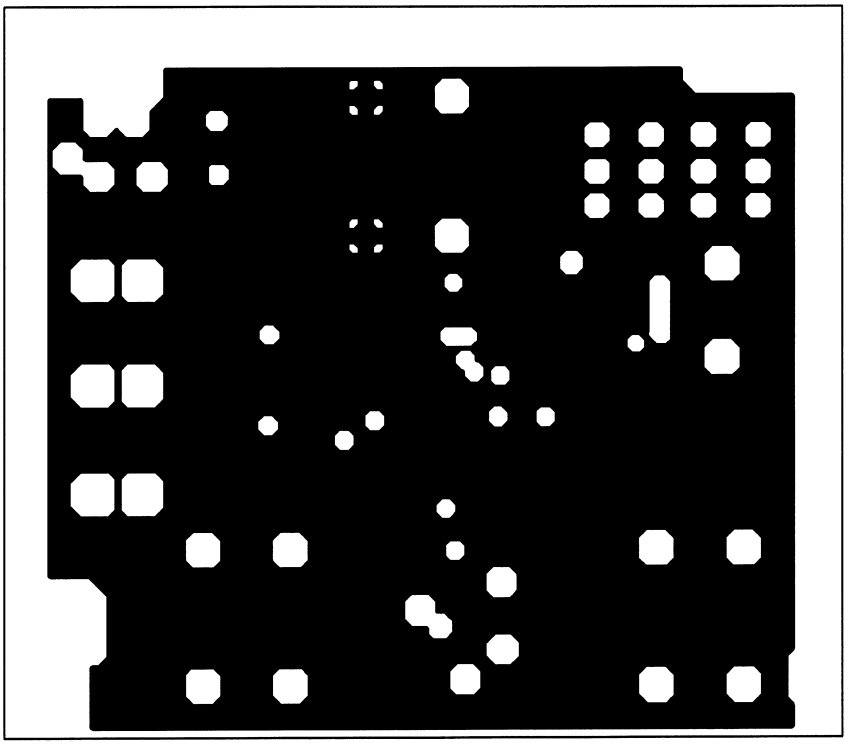

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**Figure 9. Recommended LQ PC Board Layout:
Lower Inner-Layer Layout**

## Application Information (Continued)

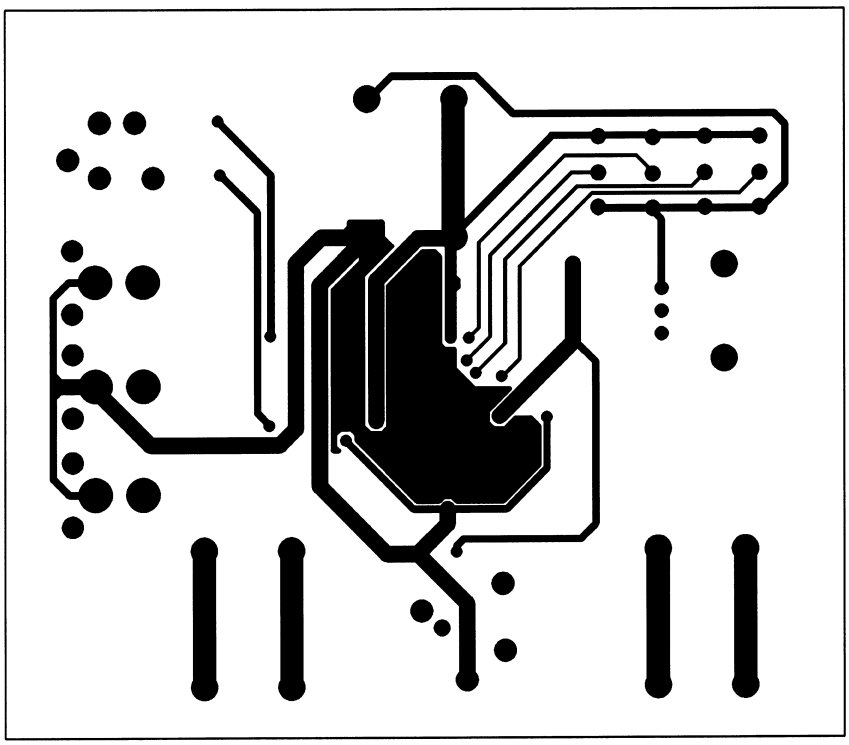

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**Figure 10. Recommended LQ PC Board Layout:
Bottom-Side Layout**