

<b>SANYO</b>	No. 3534	<b>LA4571MB</b>
		<b>Low-voltage Headphone Amplifier for Stereo Audio</b>

### OVERVIEW

The LA4571MB is a low-voltage, stereo headphone amplifier incorporating both tape head preamplifiers and headphone power amplifiers in a single chip, making it ideal for portable battery-powered equipment. It features logic-level controlled output signal muting, excellent noise characteristics and easy interconnection with signal sources, such as an AM/FM tuner IC.

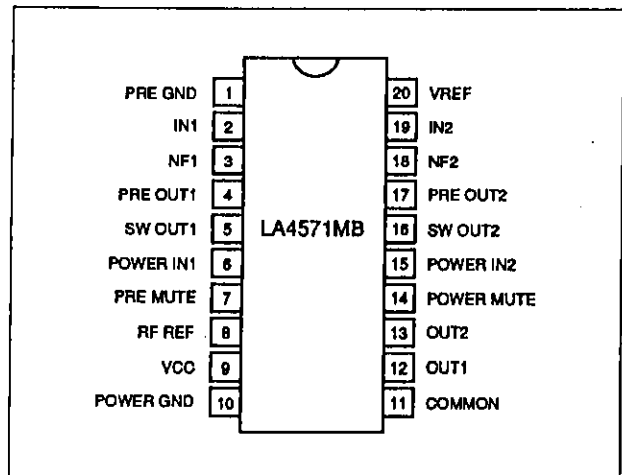
The LA4571MB requires no input or output coupling capacitors. A buffer amplifier with 10 Ω output impedance reduces the size of the virtual-earth decoupling capacitor. The preamplifier and power amplifier inputs only require the addition of an external capacitor to provide high-frequency noise filtering.

The LA4571MB operates from a 3 V supply and is available in 20-pin MFPs.

### FEATURES

- Stereo tape head preamplifiers and headphone power amplifiers on chip
- Output signal muting
- Low noise
- 8 Ω speaker driver
- 3 V supply
- 20-pin MFP

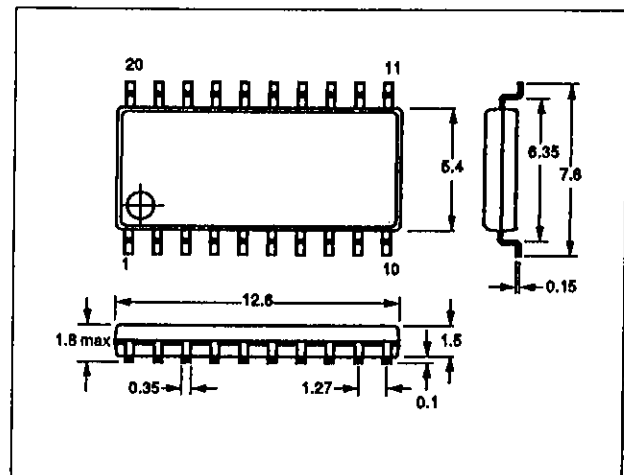
### PINOUT



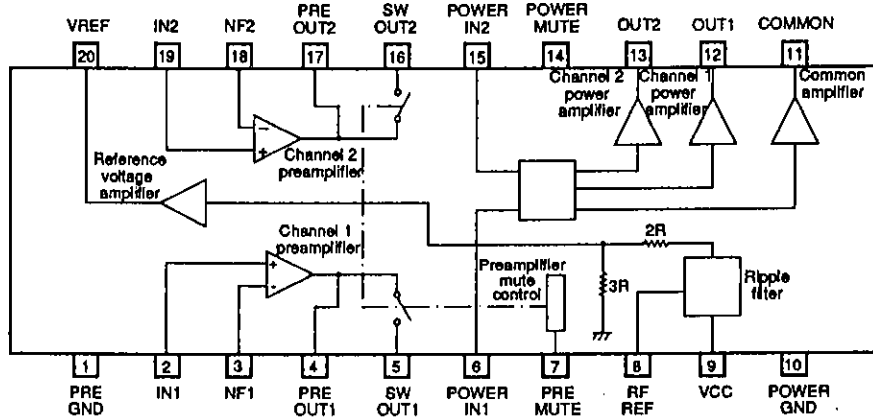
### PACKAGE DIMENSIONS

Unit: mm

3036B-MFP20



BLOCK DIAGRAM



PIN DESCRIPTION

Number	Name	Description
1	PRE GND	Preamplifier ground
2	IN1	Channel 1 preamplifier input
3	NF1	Channel 1 preamplifier negative feedback input
4	PRE OUT1	Channel 1 preamplifier output
5	SW OUT1	Channel 1 preamplifier mute-control switched output. $R_{IN} \geq 500 \text{ k}\Omega$
6	POWER IN1	Channel 1 power amplifier input. $R_{IN} \approx 30 \text{ k}\Omega$
7	PRE MUTE	Preamplifier mute control
8	RF REF	Ripple-filter capacitor connection
9	VCC	Supply voltage
10	POWER GND	Power amplifier ground
11	COMMON	Common amplifier output
12	OUT1	Channel 1 power amplifier output
13	OUT2	Channel 2 power amplifier output
14	POWER MUTE	Power amplifier mute control
15	POWER IN2	Channel 2 power amplifier input. $R_{IN} \approx 30 \text{ k}\Omega$
16	SW OUT2	Channel 2 preamplifier mute-control switched output. $R_{IN} \geq 500 \text{ k}\Omega$
17	PRE OUT2	Channel 2 preamplifier output
18	NF2	Channel 2 preamplifier negative feedback input
19	IN2	Channel 2 preamplifier input
20	VREF	Reference-voltage amplifier output. $I_{max} = \pm 500 \mu\text{A}$

## SPECIFICATIONS

### Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	$V_{CC}$ max	4.5	V
Power dissipation	$P_d$ max	400	mW
Operating temperature range	$T_{OPR}$	-20 to 75	deg. C
Storage temperature range	$T_{STG}$	-40 to 125	deg. C

### Recommended Operating Conditions

$T_a = 25$  deg. C

Parameter	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	3.0	V
Supply voltage range	$V_{CC}$ op	1.8 to 3.6	V

### Electrical Characteristics

#### Preamplifier and power amplifier

$V_{CC} = 3.0$  V,  $T_a = 25$  deg. C,  $f = 1$  kHz,  $R_L$  (pre) = 10 k $\Omega$ ,  $R_L$  (power) = 16  $\Omega$ , 0 dBm at 0.775 V unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Quiescent supply current	$I_{CCQ}$	$R_g = 2.2$ k $\Omega$ , $V_i = 0$ V	–	17	27	mA
Total voltage gain	$VG_T$	$V_o = -5$ dBm	65	68	71	dB

#### Preamplifier

$V_{CC} = 3.0$  V,  $T_a = 25$  deg. C,  $f = 1$  kHz,  $R_L$  (pre) = 10 k $\Omega$ ,  $R_L$  (power) = 16  $\Omega$ , 0 dBm at 0.775 V unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Open-loop voltage gain	$VG_o$	$V_o = -5$ dBm	70	80	–	dB
Closed-loop voltage gain	$VG_1$	$V_o = -5$ dBm	–	40	–	dB
Maximum output voltage	$V_o$ max	THD = 1%, $V_{CC} = 1.8$ V	0.1	0.2	–	V
Total harmonic distortion	THD <sub>1</sub>	$V_o = 0.2$ V, $VG = 40$ dB (NAB standard)	–	0.05	0.5	%
Input conversion noise voltage	$V_{NI}$	$R_g = 2.2$ k $\Omega$ , bandwidth = 20 Hz to 20 kHz	–	1.3	2.0	$\mu$ V
Channel crosstalk	CT <sub>1</sub>	$R_g = 2.2$ k $\Omega$ , 1 kHz tone	60	80	–	dB
Ripple rejection	$R_{r1}$	$R_g = 2.2$ k $\Omega$ , $V_{CC} = 1.8$ V, $V_r = -20$ dBm, $f_r = 100$ Hz	40	50	–	dB

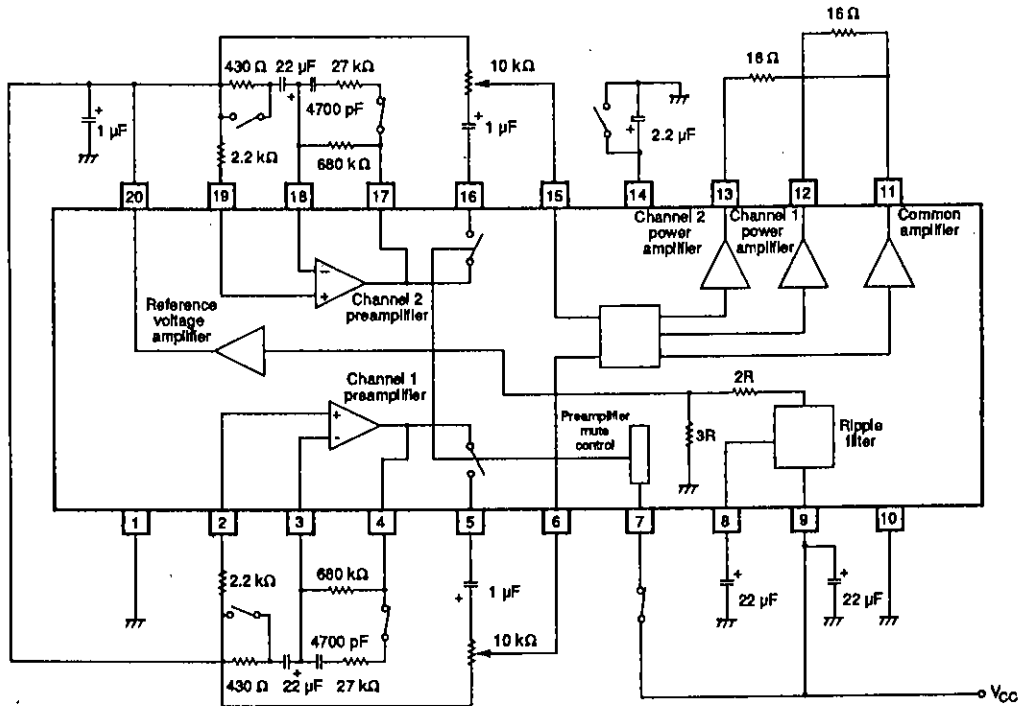
LA4571MB

Power amplifier

$V_{CC} = 3.0\text{ V}$ ,  $T_a = 25\text{ deg. C}$ ,  $f = 1\text{ kHz}$ ,  $R_L\text{ (pre)} = 10\text{ k}\Omega$ ,  $R_L\text{ (power)} = 16\text{ }\Omega$ ,  $0\text{ dBm}$  at  $0.775\text{ V}$  unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output power	$P_o$		23	32	-	mW
Closed-loop voltage gain	$V_{G2}$	$V_o = -5\text{ dBm}$	25	28	31	dB
Total harmonic distortion	$THD_2$	$P_o = 1\text{ mW}$	-	0.4	1.0	%
Channel crosstalk	$CT_T$	$V_o = -5\text{ dBm}$ , $R_v = 0\text{ }\Omega$	30	40	-	dB
Output noise voltage	$V_{NO}$	$R_o = 0\text{ }\Omega$ , bandwidth = 20 Hz to 20 kHz	-	24	40	$\mu\text{V}$
Ripple rejection	$R_{r2}$	$R_o = 0\text{ }\Omega$ , $V_r = -20\text{ dBm}$ , $f_r = 100\text{ Hz}$ , $V_{CC} = 1.8\text{ V}$	45	60	-	dB
Input resistance	$R_i$		22	30	38	$\text{k}\Omega$
Output DC offset voltage	$V_{OS}$		-90	-	90	mV

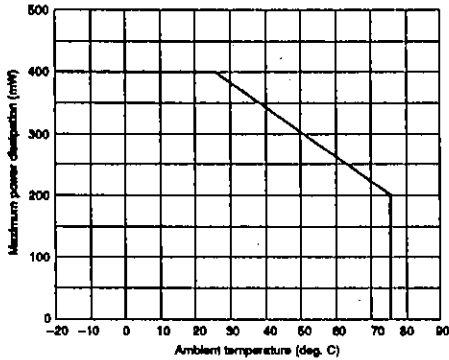
Measurement circuit



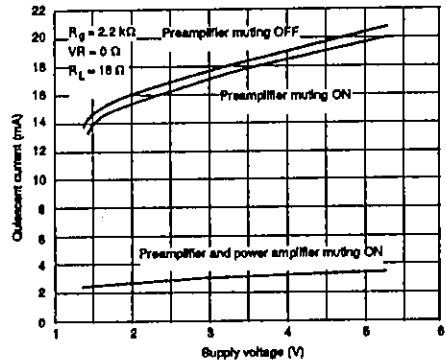
Typical Performance Characteristics

Preamplifier and power amplifier

Maximum power dissipation vs. temperature

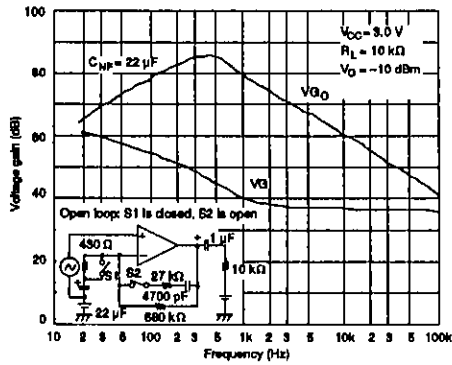


Quiescent supply current vs. supply voltage

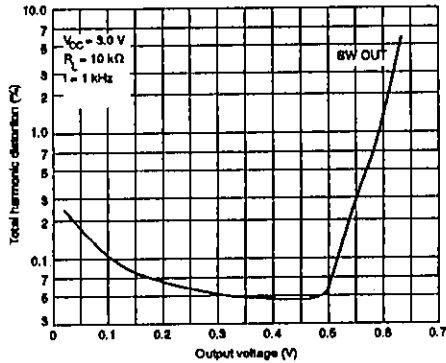


Preamplifier

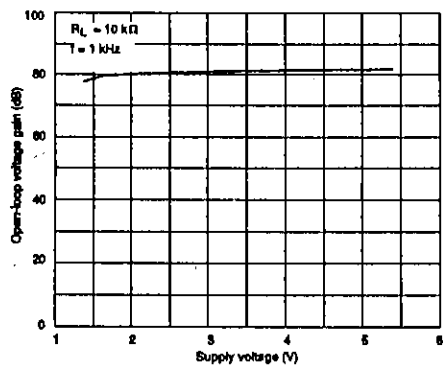
Frequency response



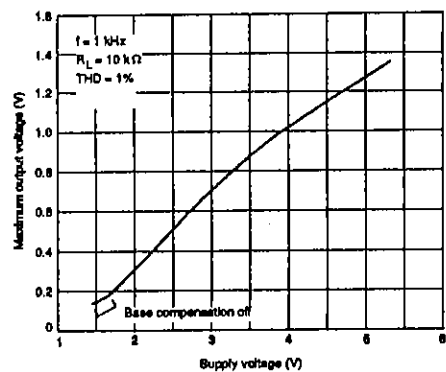
Total harmonic distortion vs. output voltage



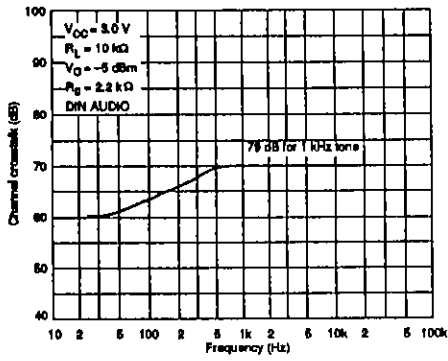
Open-loop voltage gain vs. supply voltage



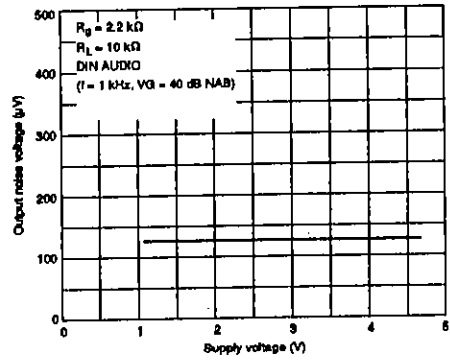
Maximum output voltage vs. supply voltage



Channel crosstalk vs. frequency

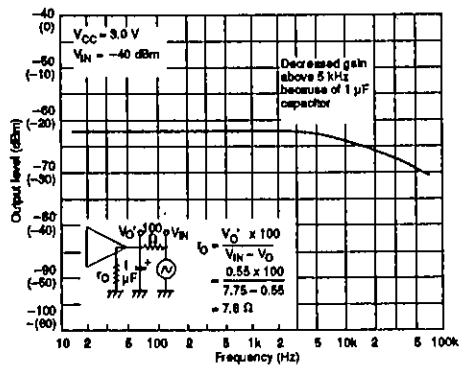


Output noise voltage vs. supply voltage

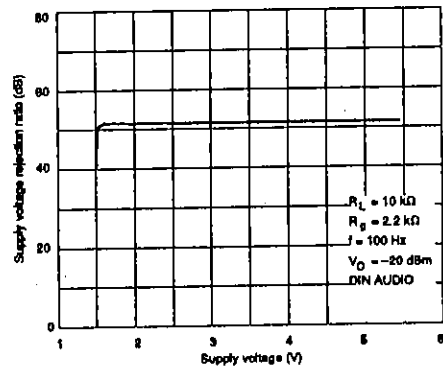


Reference-voltage amplifier

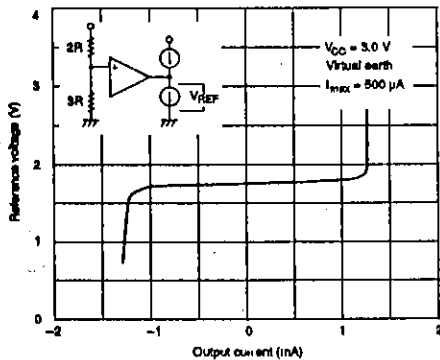
Output level vs. frequency



Supply voltage rejection ratio vs. supply voltage

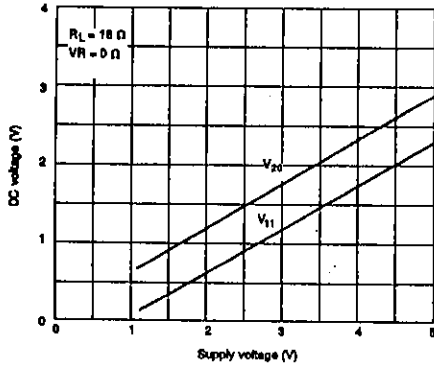


Reference voltage vs. output current

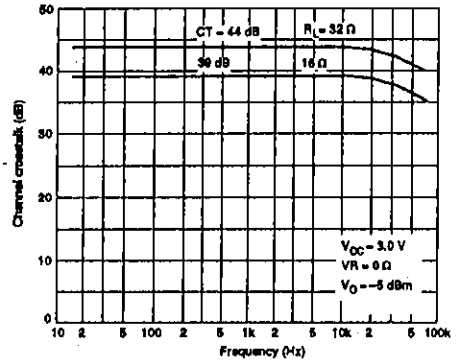


Power amplifier

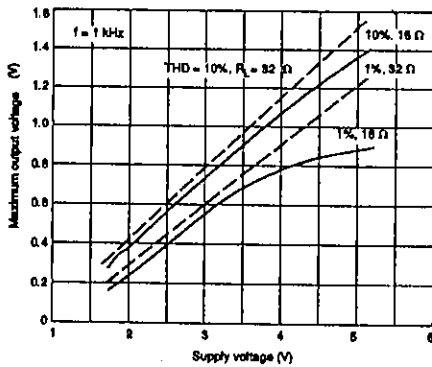
DC voltage vs. supply voltage



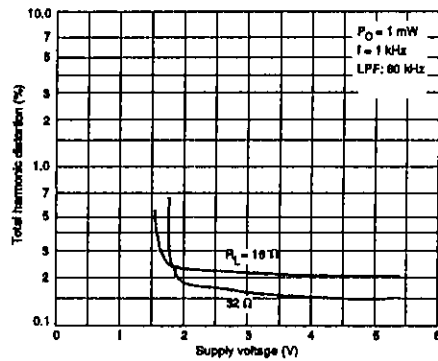
Channel crosstalk vs. frequency



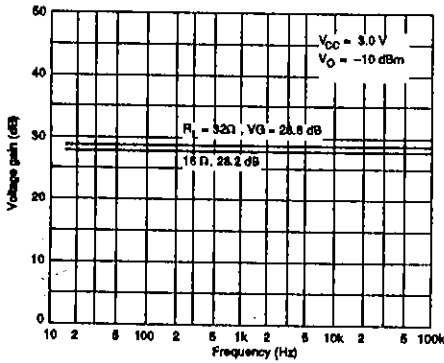
Maximum output voltage vs. supply voltage



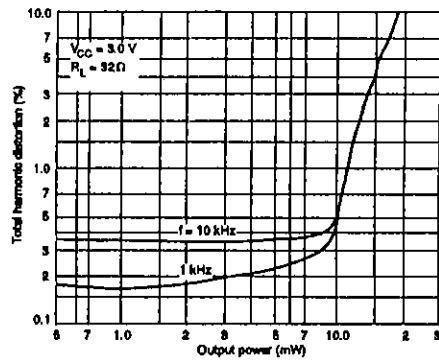
Total harmonic distortion vs. supply voltage



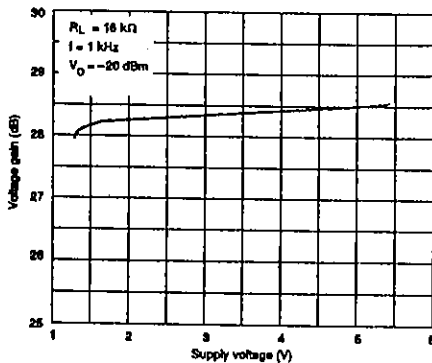
Frequency response



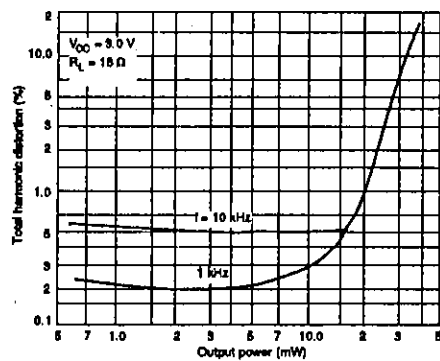
Total harmonic distortion vs. output power (1)



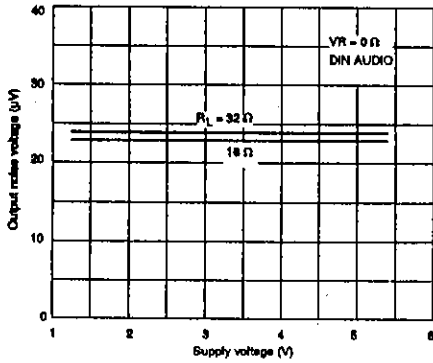
Voltage gain vs. supply voltage



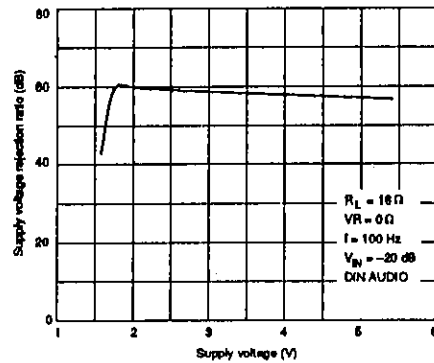
Total harmonic distortion vs. output power (2)



Output noise voltage vs. supply current



Supply voltage rejection ratio vs. supply voltage



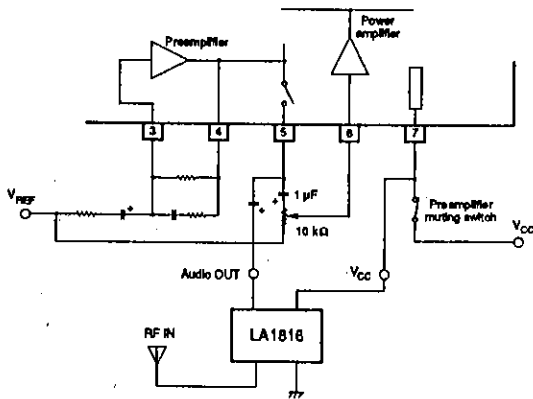
**FUNCTIONAL DESCRIPTION (channel 1 only)**

**Tape Head Preamp**

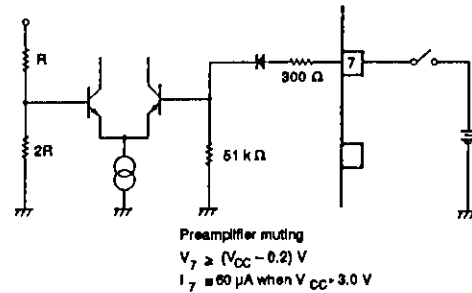
Tape head signal sources are connected to the non-inverting input of the op-amp, negative feedback preamplifier.

When PRE MUTE is open, the preamplifier output is connected to SW OUT1, and when PRE MUTE is HIGH ( $V_{CC} \pm 0.2$  V at 60  $\mu$ A input current), SW OUT1 is open. This can be used to switch, or mute, the preamplifier output.

The following figure shows a circuit with preamplifier muting which amplifies an audio signal from an RF tuner.



The internal circuit of the PRE MUTE pin is shown in the following figure.

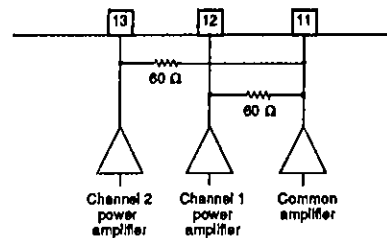


The output pins, PRE OUT1 and SW OUT1, can both drive a 10 k $\Omega$  load resistance.

The preamplifier input pin, IN1, the negative feedback input pin, NF1, and the output pin, PRE OUT1, are biased at 1.8 V.

**Power Amplifier**

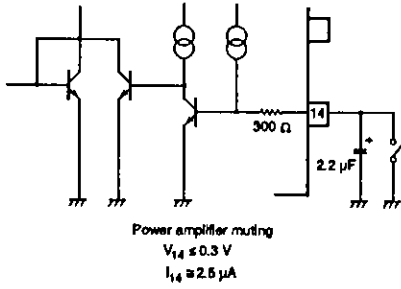
The power amplifier stage comprises an amplifier for each channel and a common amplifier. The power amplifier outputs are connected internally by 60  $\Omega$  resistors to prevent oscillation, as shown in the following figure.



When POWER MUTE is LOW (less than 0.3 V at 2.5  $\mu$ A input current), the power amplifier output signal is muted. The power amplifier mute release time is set by an external capacitor.



The internal circuit of the POWER MUTE pin is shown in the following figure.



The power amplifier input pin, POWER IN1, is biased at 1.8 V, and the output pins at 1.2 V.

**DESIGN NOTES**

The preamplifier inputs should be connected to  $V_{REF}$  through a 2.2 kΩ resistor if there is no tape head input signal source.

The mute release time capacitor of the power amplifier should be between 1.0 and 4.7 μF. For  $V_{CC} = 3.0$  V and  $C = 2.2$  μF, the mute release time is 0.7 s.

The ripple rejection ratio setting capacitor should be between 2.2 and 33 μF. For 2.2 μF, the ripple rejection ratio is 35 dB, and for 22 μF, it is 55 dB.

When the output amplifier turns OFF, the protection circuit shown in the following figure detects the falling

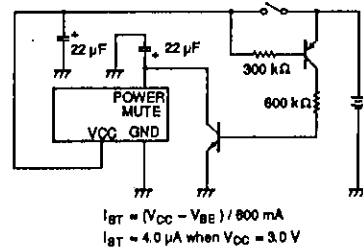
**Reference Voltage**

The input to the voltage reference amplifier is a voltage divided level from the supply voltage ripple filter. The reference voltage is given by  $0.6 \times V_{CC}$ .

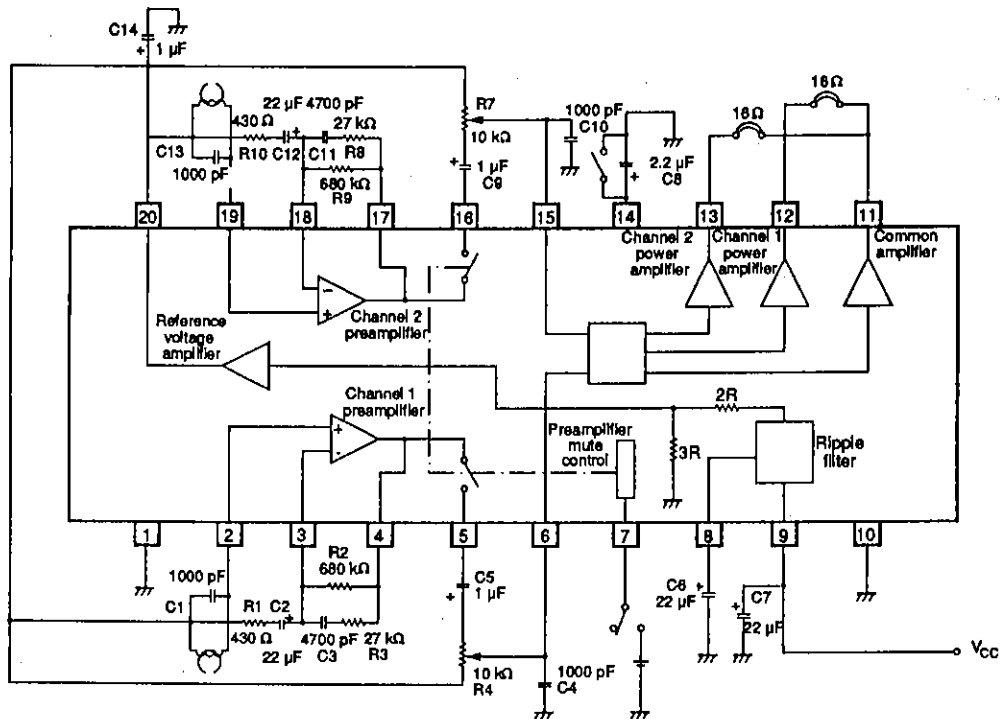
The supply voltage ripple filter requires the connection of an external filter capacitor to RF REF. A large capacitance results in a high ripple rejection ratio.

Noise filtering is achieved by the addition of a single capacitor to VREF. Since the reference voltage amplifier has a buffered output, this capacitor can be as low as 1 μF.

supply voltage and then mutes the power amplifier to protect the device.



## TYPICAL APPLICATION



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